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TWO STUDIES CONCERNING THE LEVELS OF THE GREAT LAKES

MELISSA E. BINGEMAN, FRAS [1]

1. A STUDY OF THE RELATIONSHIP BETWEEN LAKE LEVELS AND PRECIPITATION.

In the spring of 1948 (when this study was begun), after five years of higher-than-normal levels, Lake Ontario was still more than a foot higher than its monthly mean. Its surface was 247.51 feet above sea-level at mean tide in New York, as against an April mean level of 246.32 feet. For the fourteenth year Lake Ontario was still irregularly rising. By 1952, the 18th year of this irregular rise, it had reached a semi-monthly mean, from June 1 to June 15, of 249.4 feet. This was the highest stage on record. Contrast it with the lowest monthly mean stage recorded, 242.67 feet, in November 1934. A range of almost seven feet is represented.

In view of this prolonged trend it was only natural to want to form an intelligent idea of the causes and prospects; and the logical beginning of such an endeavor was a comparison between the level of the lake and the related precipitation. This called for analysis of precipitation over the basins of all the Great Lakes, because Lake Ontario, the last lake in the chain, carries the water coming down from all the others, into the outlet at the St. Lawrence River.

The appropriate government departments have all the basic data and supplied these used in this paper. Yet no graph had been made by them comparing the levels of the lakes with precipitation over their basins (Moore, 5–10–48); nor had one been made of either monthly or annual precipitation means over the lake basins (Bernard, 5–25–48).

The mean annual precipitation for the entire Great Lakes basin from 1883 to 1952, the period of Federal Government records, was 31.38 inches, while the means for the individual lake basins were: Superior, 27.95 inches; Michigan, 31.66 inches; Huron, 31.14 inches; Erie 33.87 inches, and Lake Ontario 35.0 inches. These figures were taken from a report by the Corps of Engineers, Department of the Army (Hiatt, 8–15–52).

It is not known how long it takes for waters to pass from Lake Superior to the outlet in the St. Lawrence (Moore, 5–10–48); thus precise correlation between rainfall and lake levels is not possible. Also, there are other cryptic factors, such as evaporation, run-off, and under-ground flow to be discussed farther on. Various author-

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ities, however, have expressed themselves on the general relationship between precipitation and lake levels. Horton has said that when a cycle of years with higher rainfall occurs, lake levels will rise, and the converse (Horton, p. 25). Thomson indicates that precipitation has some "limited direct influence" on the levels of the lakes, but that raw precipitation data cannot be applied directly to the lake levels (Thomson, 5–28–48). Townsend tells us that precipitation irregularities in the various lake basins are the principal cause of variations in the lake levels, but that the relation between precipitation and lake levels is complex, and has not been fully determined (Townsend, p. 3). With this opinion Moore agrees, saying that the levels of the Great Lakes depend primarily upon precipitation over their drainage basins, but that the correlation between precipitation and lake levels is complicated, depending on many factors. He says, however, that several consecutive years of high precipitation results in high levels, while a series of low precipitation years would result in low levels (Moore, 5–10–48). Speaking for the Hydrographic Survey, Canada, Price maintains that the relationship between precipitation on the basins of the Great Lakes and the level of the water in any of these lakes, is "a very debatable question, which is presently under review" (Price, 8–13–52). Chittenden, fifty years earlier, had pointed out that a period of dry years had culminated, in 1895, in the lowest mean levels that Lakes Huron, Michigan and Erie had experienced since commerce on the Lakes had become a matter of moment (Chittenden, p. 357). Freeman, in 1926, stated that the United States Engineers had found a remarkably close relationship between precipitation and lake levels from 1883 to 1898, and that this was recorded in their 1904 Report (Freeman, p. 250).

A contrary opinion could not be found anywhere in the records. In the light of this testimony pointing toward some form of relationship, it seemed desirable to make a graph correlating precipitation over the various lake basins, with lake levels. Therefore, in the summer of 1952, the writer essayed to do this and Chart I is the result. The data used includes figures on mean annual precipitation compiled by the U. S. Lake Survey; this is plotted upon their hydrographic chart, which shows the monthly mean elevation of the level of each lake.

The reliability of all this data can be realized when one considers its source, and the methods used in their collection. While there are several slightly different sets of precipitation data, such as precipitation over the land area of the basins, over the water area, or over the basins as a whole, and while data were available from the U. S. Lake Survey and the Canadian Hydrographic Service, it was the precipitation over the land surface of the basins of the several lakes that was used in Chart I. These data were also given out by the U. S. Weather Bureau.

Plotted by M. E. Biggeman

CHART I

Hydrograph of Monthly Mean Levels of the Great Lakes—United States Lake Survey—Corps of Engineers—United States Army
Correlated with the Annual Mean Precipitation over the Basins of the Great Lakes Based on Data of the United States Weather Bureau

Regular measuring, or gauging, of lake levels was instituted by the Federal Government in 1860, and therefore covers 92 years, while government gauging of precipitation was not begun until 1883, and hence covers only 70 years. Such gauging had, however, been carried on either regularly or sporadically prior to that, by various communities. Among them is Rochester, which has consistent precipitation records from 1830 on, according to the Rochester Weather Bureau, and which has occasional lake level records from around 1830 up to the time the government records were instituted, according to Herbert A. Zollweg. In Chart No. I, however, lake levels are given for only the 70 years for which there are parallel precipitation data, that is, from 1883 to 1952 inclusive.

CONTROLLING FACTORS

In studying these data, several factors should not be overlooked. Many of these can be audited, but there are also others that cannot be accurately measured, and estimates may fall wide of the mark.

The level of any one of the lakes at a given time is the running balance after all returns are in and all bills paid. Precipitation over the drainage basin can be likened to gross receipts; absorption by the soil and by vegetation would be the operating costs; precipitation over the water surface, the excess of inflow over outflow, run-off from the land surface, and the underground contribution, together, would represent net receipts; evaporation over the water surface, and excess of outflow over inflow, together, become living expenses, and the balance becomes the level of the lake. The importance of any of these factors depends not only upon the amount involved, but upon its variableness. It may be the sum of certain of the variables that determines the degree of fluctuation, while variables that cancel each other out could work for a more stable level.

Among the prime factors that can be measured to a certain extent are: precipitation, especially over the land areas; and inflow from the lake higher up and outflow into the next lake below and regulation of these. Factors that cannot be measured, although some can be estimated, are: run-off; evaporation; and the secret, subterranean movement of underground water into the lakes.

REGULATION

One of the major considerations results from the fact that Lake Superior's level has been controlled since 1916 by gates and locks in the St. Mary's River at Sault Ste. Marie. Because of this, it cannot be expected that its level will accurately reflect the relation between precipitation and a "natural" level. In fact, the "unnatural" level is achieved for the very purpose of offsetting possible effects of variations in precipitation. Since it is interesting to compare data for this controlled lake with those for the others, it will be well to consider the degree of control envisaged as possible.

All down the years authorities seem to have agreed that lake levels can be controlled at their outlets. Horton writes that the only complete and adequate remedy for extreme oscillations is regulation. This, he claims, is the only means that will provide definite, stable lake levels for all future time (Horton, p. 25); and again: "Actual height of lakes is controlled by their outlets" (Horton, p. 7). The previous year Freeman had pointed out that lakes could be controlled by means of regulatory works—saying that Lake Ontario could be held at any desired practicable elevation (Freeman, p. VIII). Regulation, he indicates, is a question of range between high and low levels, not one of absolute elevation above mean sea level (Freeman, p. 230). In his opening Summary he advocates works by means of which discharge can be regulated and the lake elevation put at any point desired (Freeman, p. XIV). He also emphasizes the fact that channels may be deepened for navigation either by raising the levels of the lakes or by dredging the channels. This, while costing more, might be necessary if higher levels would cause too much damage (Freeman, pp. 230, 231, 245, 246). Chittenden had said as long ago as 1898 that "there are those who consider the oscillations in lake levels as an evil which should not be allowed to continue." He advocated a control of the levels by which their annual and periodic fluctuations would be materially reduced (Chittenden, p. 538).

With this apparent unanimity as to whether it can be done, there does not seem to be equal unanimity as to how it should be done; but that is another story. Therein, however, may lie the reason why, up to the present, Lake Superior alone has been regulated. The objective is said to be a range of 1.5 feet, from 602.10 to 603.6 feet. Actually, it has apparently ranged from 599.98 in April 1926 to 603.60 in August 1952, a range of 3.62 feet, whereas prior to its regulation Lake Superior had ranged from 600.49 in April 1911 to 604.05 in August 1876, a range of 3.56 feet. In the eighteen years from 1934 to 1952, in which Lake Ontario ranged almost seven feet, Lake Superior ranged only 2.24 feet.

The artificial control of Lake Superior tends to obscure the natural relationship between precipitation and levels on the lower lakes as well; for it would be logical to reduce the outflow of this lake in times of deficient precipitation, and to increase it when there was an excess. Thus the lower lakes would get less water when they "need" it most, and more when they need it least. This seems to be what has occurred, according to a recent letter from J. M. Mercer of the Chicago Sanitary District; he writes: "We feel that we should call your attention to one thing that was not apparent when this [Freeman's] report was written. We now have records of an added 26 years of manipulation of the discharge at Sault Ste. Marie—careful comparisons of the records since then will show that the effect of such manipulation has been to accentuate the fluctuations in the four lower lakes—the high years are higher and the low years much lower than can be accounted for by any variation in precipitation" (Mercer, 4–1–53).

In this connection one needs also to remember that Lake Superior is the only one of the Great Lakes entirely dependent upon precipitation over its own drainage basin for its entire supply. This may simplify its control, since it does not have the variable factor of inflow from lakes higher up with which the other lakes are confronted.

Lakes Michigan and Huron have also been permanently lowered by about eight inches, says Horton, through the straightening and deepening of various sections of the channels between Lake Huron and Lake Erie. As this was done piecemeal over a number of years, the effects were not immediately recognized. Moreover, changes in outlet conditions are said to react slowly on lake levels, which, in the case of Michigan-Huron required five years for full readjustment (Horton, p. 13). Other estimates of the time-spread of readjustments to outlet conditions or to any permanent change in supply, are from five to twelve years (Freeman, p. 218). It is acknowledged that the larger the body of water affected, the longer the time required for such readjustment. Freeman cites the computations of C. E. Grunsky, who found, in a given case involving Lakes Michigan-Huron, that in the first year after such a change in supply, 38% of the adjustment was made; by the end of the second year it had reached 62%; then successively 76% after three years, 85% after four years, and 91% after five years (Freeman, p. 218). Moore feels that it takes about 12 years for a change of supply on Lake Superior to have effected its full readjustment on Lake Ontario (Moore, 5–10–48). Such a change, of course, involves the entire Great Lakes basin, and would apply to diversions into Lake Superior, the controlling works at the Lake Superior outlet, and the Chicago drainage canal. It is reasonable to gather that less time would be required for Lake Ontario to adjust to a supply or discharge change of its own, an example of which will be referred to later on. It is obvious that sporadic control measures must have left their mark on levels data.

RUN-OFF

Probably the factor most directly associated with precipitation is run-off. The less the precipitation, the lower will be the percentage that normally runs off. This is natural, as the soil and vegetation take up to their growth and evaporation needs and there is often little or none left to augment the lake reservoir. No one has thus far been able to treat the precipitation and run-off problem satisfactorily, said Rafter, participating in a discussion of the Reservoir System of the Great Lakes, at a meeting of the American Society of Civil Engineers (Rafter, p. 437). Run-off depends on too many unknown, and changing, circumstances. Some ice-conditions, for example, retard, while others facilitate run-off. In some instances when rain is slow and protracted almost all is absorbed by the soil and vegetation; while at other times, with the same kind of rain, if cloud-cover is continuous, if temperatures of water surface and the contiguous atmosphere are almost equal, if there is no wind, and vegetation is not in leaf, almost all will run off. "When rain falls on ground and foliage the surface of which is already saturated, a large portion flows off into the streams" (Freeman, p. 58). Run-off from individual streams can be measured by means of gauges, as is done in the case of the Genesee River: this forms a basis for estimates of run-off for comparatively small areas. To estimate run-off for the Great Lakes with any degree of accuracy, however, would require continuous gauging of all tributary streams. Such a task would be so extensive and expensive as to be impracticable, considering the 290,000 square miles of basin, largely in the wilds.

Notwithstanding all this, estimates of run-off are numerous. They are made, however, by Civil Engineers and Hydrologists acquainted with the physical characteristics of the areas for which they make their estimates, and are often based on sample gaugings. Estimates of 37½% run-off in the Rochester area in 1920, and of a usual one of 45% to 50% in the area, have been given by Harding (May '53). The run-off from the Lake Superior basin, writes Horton, is at least 50% of the rainfall over the land area (Horton, p. 23). Rafter also made calculations, but he purposely omitted from his tabulations, the months from June to October as that is the growing and replenishing period, during which the run-off, he claims, is comparatively small (Rafter, p. 438). Freeman cites run-off in an area with conditions comparable with the Great Lakes area, as about 55% (Freeman, p. 529). He also estimates the proportion of run-off to rainfall on the land area of each of the lakes as follows: Superior, 48%; Michigan-Huron, 32%; St. Clair and Erie, 30.1%; Ontario, 30.7%. About run-off, he explains that there are many circumstances which confuse the issue: that the run-off from the land depends as much on the concentration of rainfall, and upon the time of year when it falls, as it does upon the total depth of rainfall during the year (Freeman, pp. 45, 46).

EVAPORATION

The evaluation of evaporation is also complex. Much of the precipitation that does not run off and that is not appropriated by local vegetation eventually evaporates. There is also the important consideration of direct evaporation from the surfaces of the lakes; authorities seem to agree that this is of major importance in its influences on lake levels—not only because from one to four feet of water may be lifted off the surface of a lake in one year, but also because of variableness.

Long continued difference in total annual rainfall and in evaporation are said to be the greatest single cause of change in lake elevations (Freeman, p. 199), and extremes of low level are said to result from a combination of low rainfall and high evaporation (Freeman, p. VI). At the same time it is acknowledged that no direct measurements of evaporation from the surface of any one of the Great Lakes appears to have ever been made (Freeman, p. XVII). This judgment is shared by others. "Studies of evaporation in Canada", says Thomson, "are almost non-existent as regards the practical application to bodies of water in the open air" (Thomson, 5–28–48) while Patterson has stated that apparently no attempt had been made to determine the evaporation from actual conditions on the open lake (Patterson, p. 41). Hayford strikes the same note when he claims that maximum effectiveness (in collecting precise data) would probably be attained by first investigating evaporation as it takes place on the full scale of nature, at the surface of the Great Lakes (Hayford, p. 665). Kimble in his extensive experiments on evaporation in the British Isles, found that even in a cool, damp climate, such as that in the southeast regions, the mean annual evaporation from open tanks was from 22 to 24 inches (Kimble, pp. 75, 76, 77). The Great Lakes are in a location much more conducive to evaporation than are the British Isles; hence the evaporation from the Lakes may be assumed to be considerably greater.

That a tremendous amount of water is involved appears clear from Freeman's claims that during August, September and October of every year, evaporation takes out more water from the Great Lakes than the sum-total that drains in meanwhile from tributary land areas: that for the entire year, the rainfall on the water surface of the Great Lakes exceeds the probable evaporation by only about four inches; that the amount of water evaporated from the lakes is equal to about 76% of the average discharge from the St. Lawrence River; but that, unfortunately, no satisfactory data have ever been obtained as to its precise amount (Freeman, p. 24).

The reasons why there is such lack of precise data and why observations have apparently not been made on the open lakes, become evident when one looks at the factors that enter into gaining precise information on evaporation. The component influences that determine the amount of evaporation are conceded to include: temperatures and temperature gradients of the water at the surface of the lake and of the air in contact therewith; temperature of the air aloft; wind velocity; vapor-pressure on water; air density; relative and absolute humidity; barometric pressure; and shearing-stress of the air-mass or drag. There is a difference of opinion, however, as to the relative importance of the various factors, just as after an election there is a difference of opinion as to which issues made the voters vote as they did. Freeman speaks of humidity and vapor-pressure differences as primarily controlling evaporation (Freeman, p. 475); yet we are also told that evaporation is primarily a matter of heat (Freeman, p. 104), and he cites an authority as saying that nearly all ordinary evaporation in nature is dominated by the action of wind (Freeman, p. 440). Other authorities claim temperature differences between adjoining air and water surface, pressures and winds largely control evaporation, but that the end result of their interaction cannot be measured.

Into this already complicated situation is injected the theory that in certain circumstances evaporation may be much greater in winter than has been assumed. Freeman cites observations of open water at 37°F "steaming" into extremely cold air, 12°F; at the rate at which evaporation was apparently proceeding it could, if continued for one month, amount to seven inches (Freeman, p. 425). No wonder he speculates whether evaporation may not vary to an extent hitherto unsuspected.

In order to obtain information on probable depth of evaporation from the Great Lakes, it was therefore necessary to resort to experimentation. Some of the natural conditions could be simulated, although never all of them in any one experiment. The earliest such project is said to have been the experiment begun in Rochester in 1888 by Emil Kuichling, C. E. hydraulic engineer (Freeman, p. 428). It was continued until about 1944. Other experiments by other engineers in other localities, followed. From these experiments and the data they provided, various authorities worked out formulas for estimating evaporation. Their estimates varied. Of the ten or more located by the writer, those for Lake Superior ranged from 12.4 inches annually (Horton, p. 193), to 29.41 inches (Freeman, p. 142). Those for Lakes Michigan-Huron from 17.88 inches to 33 inches; and those for Lake Erie from 24.53 inches (Horton p. 193), to almost four feet (Moore, 5–10–48). For Lake Ontario the estimates ran from 23.82 inches (Freeman, p. 484), to 34.46 inches (Freeman, p. 142). Most of the higher figures seem possible from Kimble's observations.

UNDERGROUND FLOW

The underground factor is even more of a puzzle than are either run-off or evaporation, but apparently less volume is involved. Nor has any opinion been found by the writer as to its variability. Some authorities seem to ignore it entirely. Hayford omits it from his list of five factors which, he claims, alone determine the content of any one of the lakes, that is: precipitation, inflow, outflow, run-off and evaporation (Hayford, p. 105). Thomson writes that levels of ground waters affect the lakes only indirectly, as the water percolates into tributaries which flow into the lake; that it does not percolate directly into the lakes, which are floored with impervious rock (Thomson, 5–28–48).

Contrary opinions are expressed by Johnson and by Fairchild. Johnson points out that on the Michigan Peninsula and around the south shores of Lakes Michigan and Huron, the ground is so extremely sandy that the underground flow must be very large (Johnson, p. 432). Fairchild claims that gravel and sand deposited by glacial streams, transmit underground waters into Lake Ontario. He presents arguments, fortified by the evidence of artesian wells, that worthwhile contribution is made to Lake Ontario by underground waters, and tells of the buried canyon of a prehistoric river which predated the Genesee. He is convinced that gravel, sand and silt which fill this ancient waterway serve as a conduit which carries deep seepage through the valley of the former river into Lake Ontario (Fairchild, p. 180).

PRECIPITATION

Run-off, evaporation and underground waters present many riddles, but precipitation is more tangible. In Rochester, precipitation has been recorded since 1830, whereas Federal Government records were initiated fifty-three years later, in 1883, and thus cover only 70 years as against 122 years of local records. Various other cities were also measuring their precipitation before the Federal Government did so: Chicago, in 1840 (Mercer, 4–8–53) which may be taken to approximate precipitation over the Lake Michigan basin; Detroit in 1872 (Laidly, 4–15–53), yielding the approximate precipitation over the Lake Huron basin; Rochester, whose precipitation approximates that for the Ontario basin.

The mean annual precipitation in the Rochester area, according to the U. S. Weather Bureau station in Rochester, is 33.86 inches. This differs only slightly from that over the Lake Ontario basin, which is the mean of measurements taken at various points around the lake, Rochester among them. There are also slight differences in the records of the U. S. Lake Survey, the U. S. Weather Bureau and the Canadian Hydrographic Survey. Several of these also distinguish between precipitation over the land area of the basins and over the water areas. These slight differences are logical, as precipitation varies so widely at times in even small areas. The following comparisons illustrate this:

	(Inches annually)
1. Lake Ontario basin—U. S. Lake Survey	34.33
2. Lake Ontario, land surface—U. S. Lake Survey	35.00
3. Lake Ontario, water surface—U. S. Lake Survey	32.46
4. Lake Ontario basin—U. S. Weather Bureau	35.00
5. Lake Ontario basin—Canadian Hydrographic Survey	33.56
6. Rochester, 122-year mean—Rochester Weather Bureau	33.86

Precipitation records of the United States for the land surface and water surface, and Canadian Hydrographic Office records for the entire basins of Lakes Superior, Michigan, Huron and Erie, are given as follows:

	Superior	*Michigan*	*Huron*	*Erie*
Land surface	27.95	31.66	31.14	33.86
Water surface	29.58	30.27	30.88	32.46
Entire basin	28.82	31.11	31.11	34.37

During the 122 years of the Rochester records, precipitation in Rochester has ranged from 17.04 inches in 1834 to 49.89 inches in 1873. Under 30 inches was recorded in 35 of these years, and over 38 inches in 16 years. There were six years with less than 25 inches, and ten years with over 40 inches.

The proportion of land surface to water surface on each lake basin also has a bearing on the fluctuations. Its evaluation raises questions to which this writer could find no answers. This much is known, however: while all precipitation that falls on the water surface is instantly and automatically added to the level at the place where it falls, only varying proportions of that which falls on the land surface is ultimately added to the lake level. Moreover, it is added gradually, over a period that ranges from a few hours to days to weeks, depending upon the topography and upon the distance from the lake. Therefore the proportion of land and water of each lake basin has a direct bearing on the effect of precipitation on the level of the lake. Lake Superior, which drains the most extensive basin, has at the same time the greatest proportion of water surface. Percentages of water surface of the individual basins are:

Lake Superior	41.18% water surface
Lake Michigan	34.0 % water surface
Lake Huron	31.9 % water surface
Lake St. Clair	8.1 % water surface
Lake Erie	28.9 % water surface
Lake Ontario	21.9 % water surface

LEVELS-PRECIPITATION COMPARISONS

If run-off and evaporation vary as widely as precipitation, which appears to be quite possible, these two factors may account for some of the notable discrepancies between precipitation and lake levels, such as the high level of Lake Ontario in 1908. That year the lake was over 248 feet from April to July; yet not only had its basin received less than normal precipitation in both 1907 and 1908, but so, also, had Lakes Superior, Michigan and Huron. Then, too, Lake Erie had over its average precipitation in 1907 but was under by about the same amount in 1908. It is of course possible that Ontario's high level that year was the result of the constriction of its outlet in 1903 (about which more will be said in Study No. 2). It will be remembered that it takes a long time for a lake to re-adjust its level to a change in outlet conditions. The deficient precipitation and the fact that the other lakes did not reach higher than normal levels give weight to this explanation of Lake Ontario's high level of 1908.

The most striking discrepancy between precipitation and levels found in the records, however, is the 248.98 foot level of Lake Ontario in 1838, in the seventh consecutive year of sub-normal precipitation in this area. In this same year, 1838, all the Great Lakes are credited with maximum levels according to U. S. Lake Survey navigation charts (Freeman, p. 215). Actually, Lake Superior was not observed (Laidly, 5–15–53), and the level quoted in the records is possibly a deduction—government official lake level records began in 1860. Gauge records of 1838 that have been recognized as authentic are those made at Milwaukee (Michigan), Cleveland (Erie) and Charlotte (Ontario at Rochester).

These figures of 1838 are extremely important in a scientific study of levels and precipitation. [They have social significance, too, since they are the highest levels ever recorded from natural causes alone; and the Federal Government is assumed to have jurisdiction to maintain lake levels in the United States within the range of heights which have occurred from natural causes. In the case of international lakes there is required the concurrence of the other government involved, in this case, Canada (Freeman, p. 245; Keating, 5–11–53).]

Freeman surmises that these early records have been accepted as authentic for the useful purpose of "serving notice upon all parties concerned, that the lakes might again return to these high levels, from natural causes" (Freeman, p. 245). None of the lakes, however, has again attained its 1838 elevation from *natural causes* alone. Lake Ontario has come closest, with a level of 248.97 in 1870; it is the only lake that has since exceeded this high. Lakes Michigan and Huron had been slightly lowered in the meantime by various modifications in the channel between Lake Huron and Lake Erie, and at the outlet of Lake Huron.

Comparing the 1838 reported levels with the highest subsequent levels from "natural" causes, and with the 1952 levels, we find:

Maximum Monthly Means	Superior	Michigan-Huron	Erie	Ontario
1838 levels	605.32*	584.69	574.86	248.98
Highest subsequent levels	604.05 Aug. 1876	583.68 June 1886	574.51 June 1876	248.97 May 1870
1952 levels	603.60	582.70	574.70	249.3

* estimate

Rochester precipitation records show that the seven years which culminated in the high lake level of 1838 had an average annual precipitation, in Rochester, of 27.39 inches, against the 122-year mean of 33.86. Specifically, there was recorded at Rochester, precipitation of

31.45 inches in 1832
30.30 inches in 1833
17.04 inches in 1834*
28.60 inches in 1835
27.95 inches in 1836
30.61 inches in 1837
25.46 inches in 1838

* An all-time low record

This record goes counter to the pronouncements of all the authorities quoted previously—that high levels will follow several consecutive years of high precipitation, and low levels will follow a series of low-precipitation years. Therefore the discrepancy between precipitation and the high levels of 1838 tempts one to suspect that some error must have crept into the records, or that some important factor was either overlooked or unrecognized—or unknown. Freeman had mentioned the possibility that ice-conditions might have caused the 1838 high stages. He questioned whether nature had "temporary" regulation works in service in the form of an ice-jam in the St. Mary's as well as the St. Clair River, but he did not follow through with any supporting facts (Freeman, p. 248). Moreover, it is known that while ice-choked channels will cause the lake above the obstruction to rise, it will at the same time withhold water and lower the lake next below in the chain—unless that one is also jammed. Ice-choked channels in the St. Mary's, Detroit, St. Clair, Niagara and St. Lawrence Rivers would have been required simultaneously to raise all the lakes to unprecedented levels. Such a phenomenon should have been noticed, to say the least.

The highest levels from natural causes, recorded since the Federal Government took over the gauging, were in all cases lower than the levels said to have been reached in 1838, nor were they all reached in that year, but, variously—1870, 1876 and 1886. The comparison between precipitation and lake levels around these dates as shown in the records, is both revealing and mystifying. Examination of Chart I shows there was no excessive precipitation in 1886, although there was slightly over the average amount the previous year, 1885. Precipitation prior to the 1876 high levels, can be assumed, from the precipitation records at Chicago, Detroit and Rochester, to account for the high elevations of that year. For example, Chicago, against a mean of 31.66 inches, had an average of 37.37 for 1875 and 1876; Detroit, against a mean of 31.14 averaged 38.30 for those two years; Lake Ontario, against a mean of 33.86 at Rochester had a two-year average of 38.46. No figures are available for Lake Erie, but coming between Detroit and Rochester it was probably visited by similar weather conditions. It would seem that the year 1876 shows the most consistent high lake levels coupled with excess precipitation of any year before artificial changes of channels and outlets interfered with natural reactions of levels to weather conditions. The high level of Lake Ontario in 1870 was not duplicated on the other lakes. It may have been the result of three successive years of abnormal precipitation, 1868, 1869 and 1870, with a three-year average of 40.04 inches. (Although all the upper lakes affect Ontario, this last lake in the chain cannot affect the others, because Niagara Falls is not a weir.)

Since the 1838 and 1870 high stages were reached, Lake Ontario has had added to its level over 18 inches it did not have in 1838. Of this increase in depth, about seven inches was, in effect, donated by nature, in the form of subsidence of the earth's crust in this area. About this, Moore states that water-gauge records at Rochester beginning in 1846 show that the land there has in a 100 years subsided 0.58 feet with respect to the rock ledge forming Galops Rapids (Moore, 5–25–48), see Figure 1. There are man-made modifications too and they include: (1) diversions from the Hudson Bay drainage basin into Lake Superior in 1941 and 1943, with their contributions of a total of three inches to Lake Ontario; (2) the building of Gut Dam in 1903 which constricts the outlet of Lake Ontario at Galops Island and contributes 8 inches (Townsend, p. 3); and (3) the control of Lake Superior in 1916, which, according to Mercer, raises the levels of all the lakes when levels are high, and lowers them when levels are low, by an unknown amount (Mercer, 4–1–53).

About the constriction of the outlet of Lake Ontario, Townsend reports that the outflowing from Lake Ontario is controlled by a rock ledge in the St. Lawrence River at Galops Island. He explains that the rapids on each side of the island have a fall of some sixteen feet in about one and one-half miles, and act as a free overfall weir. Thus any change in these rapids would, he claims, affect the level of Lake Ontario. In 1903 the channel between Adams and Galops Island, known as The Gut, was closed by a dam. (It was removed in the Fall of 1952.) The building of Gut Dam resulted in raising the level of Lake Ontario approximately six inches at mean stage and approximately eight inches at high stage. There is the probability that persisting high levels may back the water up even more than this.

"Constructing works in lake outlets is the simplest, most effective and most economical method of raising the lake levels" (Chittenden, pp. 358, 359). Freeman claimed that Gut Dam was built to raise the level of Lake Ontario for navigation, and called attention to the fact that Lake Ontario's level had been raised permanently by six inches although the head of the river is 69 miles upstream from the dam. There is a fall of 1.7 feet in the river, between the lake and the dam (Freeman, pp. 208, 235, 249). Gut Dam apparently must have been an asset in low-water years, such as 1932 to 1938 or thereabouts, for it must have prevented the level from dropping six inches lower than it did.

From the foregoing it appears evident that had the natural causes that raised Lake Ontario to 248.98 feet in 1838, recurred in 1952, the lake might have been considerably higher than it actually was; for although precipitation was only 27.14 inches in 1952, it had been well over normal in both 1950 and 1951. Temperatures in 1952, however, were two degrees higher than the Rochester average, 49.6°F as against 47.5°F. This may have increased evaporation, and thus may have kept the lake from rising even higher than it did. We have seen that only Lake Ontario has risen above its 1838 level, having reached a two-week stage of 249.4 from

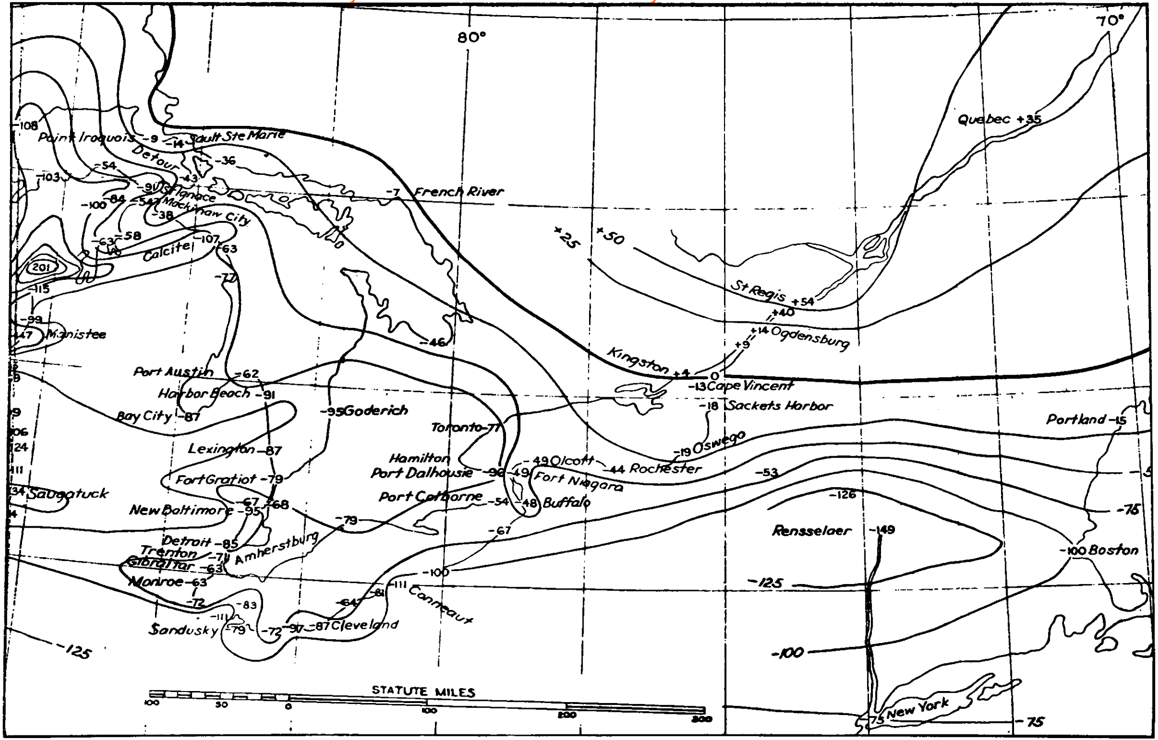


FIGURE 1: Crustal Movement with respect to sea level for the regions around Lake Ontario. Figures are given in hundredths of feet for the period 1845-1945. (Adapted from Moore, Bulletin of the Geological Society of America, July 1948.)

June 1 to 15, 1952, according to a U. S. Lake Survey Release dated July 5, 1952. This was .42 feet above the maximum high level ever recorded from natural causes alone.

The facts and opinions as presented here, have led the writer to reach the following conclusions:

CONCLUSIONS

1. Inasmuch as the effects of many of the factors that influence lake levels, are still obscure, it might be useful to make and maintain a running chart showing all pertinent known facts. Such a chart could be expected to disclose, in time, hitherto unrecognized relationships between weather and lake levels and between control and levels.

2. It might be useful to assemble and re-examine all available data on conditions preceding and during the 1838 high lake levels in an effort to discover the factors which raised the lakes to unprecedented high stages from natural causes alone, in the face of a prolonged period of deficient precipitation.

2. A STUDY OF THE RELATIONSHIP BETWEEN LAKE LEVELS, WINDS AND SHORE DAMAGE ON LAKE ONTARIO.

Turning now to the second study one finds it is generally realized that shore damage increases as lake levels rise. No record was found by the writer, however, of any analysis made by any person or agency of this rather important angle of the problem.

In Study No. 1 only the "true" levels of the lakes were involved, and these are based on the current content of each lake. In Study No. 2, transient levels also are involved. These transient levels are caused by movement of water within the lake. They do not determine the actual height of the lake at any instant. Since automatic, self-registering gauges were installed at the turn of the century, true levels could be determined with great accuracy. Transient levels, by moving the water within the lake, add to the height in one area at the sacrifice of some other area.

Such temporary changes in lake elevation are caused by tides, winds, barometric waves and seiches. Tides are said to change elevations by only a few inches, seldom over three inches (Freeman, p. 200), a fluctuation so small as to be masked by other factors. Barometric "lows" passing over the lake raise its level in passing just as a suction cup passed over a pan of water would raise the water exposed to the suction. Winds, on the other hand, have an almost unlimited range of temporary effect on the level of the lake, from the barely perceptible "light air" which merely ripples the surface, to intense storm-winds that occasionally last for days at a stretch, and which have been known to continue for over a week. Sucn winds are interspersed with gusts of even greater fury. Continuing winds have been known to raise the level on the lee side at the expense of the windward side of a lake. Strong winds and barometric waves, singly or in conjunction, may set up a rhythmical swing of the content of an entire lake, or of some major section of it. This swing, back and forth, of an entire lake or some section thereof, is termed a seiche. The lake rocks until inertia gradually cancels the motion. While all the lakes are visited by occasional seiches, only on Lake Erie are they habitually important. Accountable for this, it is believed, are several factors peculiar to this lake: It is shallow, lacking the great depth which serves as a stabilizer; it parallels the direction of one of the principal storm-tracks; and it tapers at both extremities. Therefore the water, not being able to spread out as it is piled toward either the east or west end of the lake, piles up, and is of necessity turned back, thus generating a seiche. This may continue for many hours, both rising and subsiding until it dies out. There are well-authenticated cases of Lake Erie being ten or twelve feet higher at one extremity than at the other.

Of all these transient influences, only winds are of great importance on all the lakes. This study is concerned with the effect upon the shores of Lake Ontario of a combination of winds and high lake levels. It was found that no storm studies had been made on Lake Ontario by the U. S. Lake Survey (Laidly, 9–26–52); nor any tabulations correlating winds with lake levels (Laidly, 1–13–53). Indeed, no records of storm-damage related to lake-level could be found, and no reference to such observations were discovered anywhere, except as news stories of damage appeared in the press. A check of such stories with the level of the lake at the time of the reported damage, was found to be significant.

Since no record could be found of relationship between storm-damage and lake levels, the following examples are from the writers' own observation. This has covered the thirty years since acquiring title, in 1923, to a 600 foot strip of wooded shore about twenty miles east of Rochester. The shore bordering this property consists of a shallow cove on one of the tips of a wide peninsula reaching northward. The shoreline, beginning at the east end of the concavity, faces west, then gradually north, and around to east; almost halfway around the compass. The land at the east end, which in 1923 was about 20 to 25 feet above water-level, slopes downward from the high bank, toward the south. Later, when this high bank was cut back by erosion, it became gradually lower, but it remains an excellent point of vantage from which to observe a wide expanse of lake with a horizon from east to west. From here one can observe storms, and storm-effects upon the shores. One can see the angle at which waves sweep the shore under varying conditions, as well as their force and effect.

A

B

C

FIGURE 2: From an average of 70 feet of beach in 1927 (a), the water eventually rose until it undermined the large maple tree in June, 1943 (b). In October, 1943, a moderate wind was able to uproot it (c), after at least 100 years of security.

A

C

B

D

FIGURE 3: In 1927 Lake Ontario was at an average level; the rocky point then served as storm protection for the walled bank (a). In 1929 high water washed out the old vertical wall and a new, sloping, wall was built in 1931 (b). For a dozen years the water remained at moderate or low levels and a growth of trees started on the beach around the point. They were inundated in 1943 and nearly all washed away by 1945 (c). By 1952 the water had continued to rise until it was able to wash out the new wall and undermine trees up on the bank (d).

As no two segments of the shore are identical, the effects on them by storms cannot be identical. Just as the angle at which a cutting tool is held, as well as the force of the blow, determines the effect of the blow, so the effect on the shore changes with the angle of the waves. Moreover, a slight change in wind direction may cause great changes in the effect. That is because wind factors include not only speed and direction, but also duration and "fetch", which is the distance winds have travelled over unobstructed water. Force increases with duration and fetch, and the latter may change radically with even a slight backing or veering of the wind. For example, a north wind would have a shorter fetch than would an east or a north-east wind in relation to the south shore of Lake Ontario between Pultneyville and Lewiston. A west wind brings me stone from my neighbor's beach, but undermines his bank and boathouse. An east wind returns the stone to him, but undermines the trees along my shore and cuts back my bank. Here are a few specific instances of damage that can be definitely described:

A Red Maple, estimated to be over one hundred years old, was an outpost that protected the shore in front of my cabin. It stood well back from the water for many years (See Figure 2). During the high lake levels of 1929 storms narrowed my beach by carrying away stone, which was dropped into deeper water, and therefore not returned. The tree was not damaged. Then, in 1943, the lake was up again; and between the last Sunday in September and the first Sunday in October the tree fell, torn out by the roots. Winds that week, September 27 to October 2, had ranged between 9 and 24 mph. Only three winds of 45 mph or over had been recorded that year to date; but there had been 117 winds from 19 to 44 mph clocked at the nearest United States Weather Bureau station—the one at Rochester. It was therefore these winds which had raised the waves that undermined the tree, so that a wind of 24 mph or less could bowl it over. It had withstood stronger winds for many years; obviously the lake had not been at a high enough level to permit even the strongest winds to uncover its roots in 100 years.

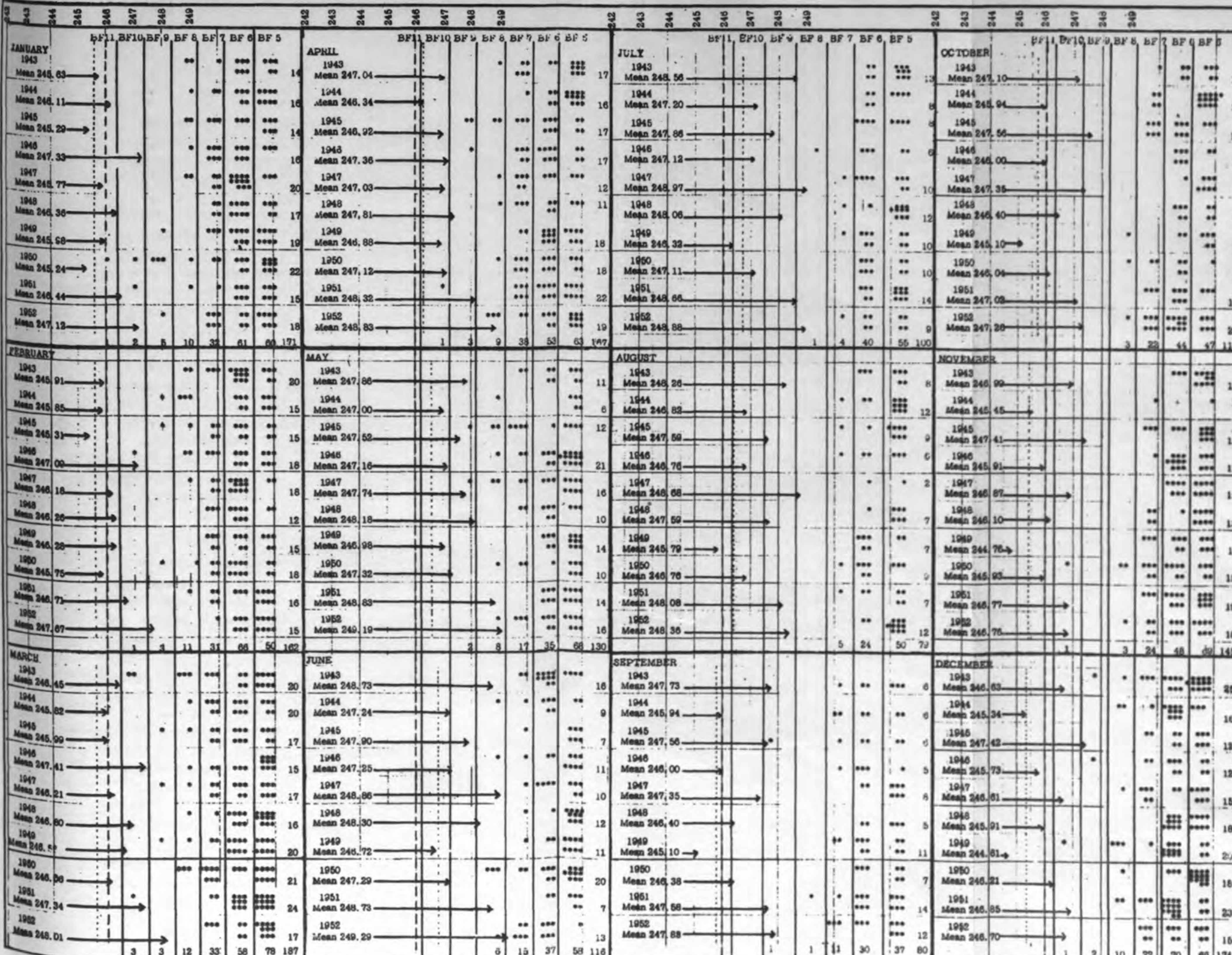
The high bank at the eastern limit of the property was protected by a great rock, outstanding among a welter of rocks that extended out into the lake as a point. This rocky point, together with the great rock, protected the high bank, breaking up the storm-waves before they reached it. Immune from damage, therefore, were the summer-house, the tree-house and the young oak that crowned the high bank. The 1929 high waters had, during the spring storms, demolished an earlier wall. A new wall had been built farther back, as the face of the bank had been washed away by the 1929 storms. The new wall was based in concrete to a depth of five feet below beach level, and was reinforced with iron piping. At various times during the past decade, the lake reached the bank, inundating the rock and obliterating the rocky point, which were no protection when submerged. Gradually the wall was outflanked, the earth behind it excavated. Early in the summer of 1952 the oak, with no more anchorage in the soil, fell and ruptured the wall, as shown in Figure 3. There had been only three winds of over 40 mph to date that year, but there had been 93 winds from 19 to 39 mph, and the lake had risen to its all-time high level of 249.4 feet during the first half of June.

In the meantime, the only effect these storms during high lake stages had on a residential cove a few thousand feet to the south-east, was a narrowing or widening of a gently sloping sandy beach, as the waters rose or fell. The beach enabled the waves to gradually lose their force without doing damage; whereas on my shore, where the lake-floor dropped at a steeper angle, they broke upon rocks, banks and trees.

These differences in the treatment of shores can be explained by the differences in shore factors. The peninsula formation which makes my property especially vulnerable, is an actual protection to the residential cove to the south-east. Shores around Lake Ontario differ in innumerable respects—profile, direction, topography, character, substance, condition, protection offered by adjoining, neighboring or more distant shores. In many instances even a few inches of additional height to the base-level of the lake may cause the waves to constantly reach some critical point, thus permitting incessant onslaught to demolish banks, denude tree-roots, or carry away shore works.

The question arises: how much is destruction of shores increased by reason of high lake levels? Obviously a three-foot wave that might be innocuous with the lake at a 245 foot level could be destructive in certain areas with the lake at a 247 foot level. Or, if a wind of a given force raises the cutting edge of a wave five feet, from 245 to 250 feet above sea-level, then a lesser wind which will raise it four feet will raise it from 246 to 250 feet, and a wind which will raise it three feet will raise it from 247 to 250 feet. Manifestly, therefore, the higher the level of the lake, the less windforce is required to work damage upon the shores. The significance of this principle lies in the fact that the number of winds increases as their velocity decreases. There are more winds of 60 mph than of 70 mph, more of 50 than of 60, and so on progressively, in this area—which is in the zone of the great westerlies.

The principle as stated is recognized; this is evident from letters received by the writer from both the U. S. Weather Bureau, and the U. S. Lake Survey. The former writes "We are glad to be able to confirm your statement, that, for a given date, the higher the level the less the velocity required to work damage upon the shores" (Hiatt, 12–1–52); and the latter replies: "The postulate set forth about damage from storms on Lake Ontario—'The higher the level of the lake, the less the velocity re-



Plotted by M. E. Bingeman

CHART II

Chronological Distribution of a Decade of Winds Related to the Corresponding Levels of Lake Ontario quired to work damage upon the shores'—has not been noted previously in this form, but appears to be a valid statement" (Laidly, 11–18–52). Yet, despite the obviousness of the principle, no analyses of wind conditions occurring during high water periods have been made.

How progressive damage is accomplished as the lake level rises, can be seen when one realizes that high levels are really a triple threat: (1) They subject hitherto untouched shore areas to the savagery of high wind-storms. (2) They enable lesser winds to cause waves to reach vulnerable areas not hitherto accessible to them nor protected against them. (3) Because of the greater number of lesser winds that can effect damage, the number of destructive storms is multiplied.

Destruction by erosion is final. Areas inundated, but not subjected to wave force can, in some cases, be reclaimed when the water subsides—*if it has not been long at its high level.* An inundated roadway on my property is an example of this. Loads of gravel raised the roadway, but aside from the labor and the cost of gravel, there was no loss. On the other hand, in a grove that had been inundated much of the time during the past decade, half a dozen of the trees, all of them tall forest trees, died. The land, however, is still there. In contrast, this is not the status that exists after erosion has taken place. Trees, earth, buildings, walls and docks washed away are gone for good.

COMPARISON OF LEVELS AND WINDS

To what extent can shore damage be attributed to high lake levels? Since the higher the level of the lake the less wind-force is required to work damage, it is apparent that wind-speed in conjunction with lake-level determines the amount of damage on any given segment of shore. It therefore seemed desirable to list the high winds, and to assay their damage potential by checking them against the level of the lake on the day of the wind. Here one runs into a problem, for, while speed and direction are recorded in the climatological data of the United States Weather Bureau, duration and fetch are not. The Lake Survey Office points out that for a given direction and duration, the effect of the wind increases as the velocity increases (Laidly, 9–6–52). Harding (May, '53) told me that they do not increase at quite the same rate, and Zollweg (April, '53) stated that two hours of a given wind will do more than twice the damage of one hour of the same wind.

If winds of high speed are checked against the monthly mean level of the lake at the time of each wind, this should provide an indicator for studying the damage for which high lake levels are responsible. The accompanying Chart II makes such a plot. In this study it is assumed that winds of the same speed are comparable in duration. Direction and fetch are not segregated because it is intended to plot an integrated general damage potential. Isolated damage at any one location would be quite dependent on the directional factor.

Only one wind, the fastest mile in each day as recorded in the climatological data of the Weather Bureau is used in this study. To simplify the task as well as the results, the Beaufort scale of wind measurement is utilized. It denotes winds by speed ranges; from "0" for calm, to "12" for hurricane force. In this chart are plotted only winds beginning at 19 to 24 m.p.h. (speed 5) because they become a definite factor in damage when the lake reaches certain levels. Speed 11, winds from 64 to 75 m.p.h., is the highest speed recorded by the Rochester Weather Bureau in the decade covered by this study.

Although these speeds were recorded on land-based anemometers, and winds on the lake are known to increase in force as they move over an unobstructed water surface (Freeman, pp. 462, 463), the land-based records are used, as it may be assumed that the increased speed of all winds over water are comparable.

The range covered by this study, and the mean, or median speed of each speed-range from 5 to 11, with the months in which these winds occurred during the decade studied, are cited here for reference:

Speed	Range	Median
5	19–24	21.5 mph
6	25–31	28 mph
7	32–38	36 mph
8	39–46	42.5 mph
9	47–54	50.5 mph
10	55–63	59 mph
11	64–75	69.5 mph

WIND FREQUENCIES

Month	Total	Speeds 8–11 only
March	187	18
December	174	13
February	162	15
January	161	18
April	161	13
November	145	4
May	130	10
June	116	6
October	116	3
July	100	1
September	80	2
August	79	2

Each wind, in this chart, is registered by a star in the appropriate column, to indicate speed, month, and year. Divided into twelve sections, one for each month, the chart thus gives a ten-year monthly report on winds of high speed experienced in the Lake Ontario area from January 1, 1943 to December 31, 1952. On the left, on each section, there is shown, by means of a vertical dashed line, the 246.00 foot annual mean level of the lake since records were instituted in 1860; and by means of vertical dotted lines there are shown the 92-year mean levels of the lake for each month. The mean for December and for January is 245.36, the mean for June is 246.82—and for the other months the mean levels fall between these two figures. On the chart, arrows point to the monthly mean of each individual month in each year. One can thus see, at a glance, whether the lake at any given time was over or under the annual mean, and under or over the monthly mean. By this token one can see the extent of any storm hazard incurred by reason of high lake levels at any time during the past decade, and the increasing hazard as the lake rises seasonally. Arrows extending *to* the right and stars meeting them *from* the right indicate high waters and winds (e.g. See April, May, and June, 1952). Inasmuch as the seasonal highs are usually experienced from March to July, the storm hazard is usually at its greatest at that time.

Study shows that although the high winds usually get the major attention when storm damage is considered, the lesser winds are more destructive because there are more of them. It is understood that a hazard does not become a reality unless the lake at the time is at a level which permits the waves to work damage upon the shores. A check with Chart No. II will show, for example, that the one No. 11 wind came when the lake was an inch or so below its monthly mean, and about .75 feet under the annual mean. Of the ten No. 10 winds, three came when the lake was under its mean level; of the nineteen No. 9 winds, seven came when the lake was under the annual mean. The ten-year record is as follows:

Totals	Number with Lake above mean
1 No. 11 wind	0
10 No. 10 winds	7
19 No. 9 winds	12
74 No. 8 winds	59
254 No. 7 winds	220
566 No. 6 winds	437
693 No. 5 winds	666

The import of the above data becomes easier to appreciate when diagrammed. In Chart III the area of a column represents the number of winds, of the Beaufort speed indicated, modified by an allowance to cover

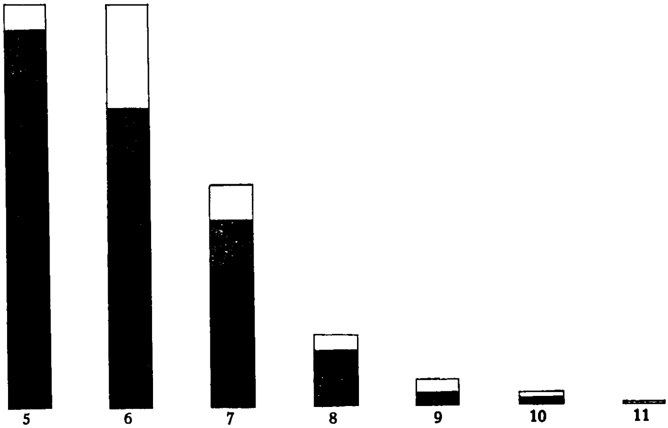


CHART III

Showing the Damage Potentials of a Decade of Winds of Various Speeds over Lake Ontario.

the increasing damage potential of speed. (Damage actually increases at a rate slightly greater than the increase in speed, but here it is assumed that the rates are the same.) The blackened part of the column represents occurrence with the Lake above the annual mean level; the blank parts show water below this elevation.

The greatly increased hazards of high levels are vividly illustrated by referring to Chart II and making a comparison between January 1950 and January 1952. In 1950, January brought the most violent winds experienced in any month of the decade, the only No. 11 wind, a No. 10, and three No. 9's, i.e., five out of the 30 strongest winds recorded in the decade. January 1952 had only one of these, a No. 9. Additional records show that high winds were registered on 23 days in January 1950, and on 18 days in 1952. The duration of winds in 1950 was lengthy—strong winds endured for eight days in a stretch, from the 13th to the 20th on six days in succession and again on five days in succession. In January 1952 there were two four-day winds. The total of 23 strong winds in January 1950 as against 18 in 1952 does not show how much worse the winds were in 1950; their speed and endurance also added to their damage-potential. Yet there was nothing in the Rochester daily papers about shore damage in January 1950, but a great deal in 1952. The reason is evident. In 1950 the lake level stood at 245.24, .12 below the January mean of 245.36; in

1952 the level was 247.67,—2.31 feet above the January mean, and 1.31 feet above the annual mean. Winds cannot be controlled; levels can.

There is no need to investigate the desirability of controlling the level and range of Lake Ontario for it has been established by competent authorities, see Study 1. What level and what range are desirable, however, will have to be carefully considered. Obviously, the "ideal" level would be neither the lowest nor the highest that has occasionally occurred in the past ninety-three years of Government record, but some intermediate stages to which shore works have been adapted. The range will have to be one that is achievable and compatible with the shores.

The assumption that the Government has jurisdiction to maintain levels at the highest stages they have reached from natural causes seems to reflect a further assumption, that a temporary level at any stage is the precedent for a permanent level at that stage, a theory which is open to question. It is untenable in many cases; for example, in the case of an inundated field, which may recover from a brief submergence, but becomes useless if the inundation is permanent: certain trees that can survive if the land is under water for a limited time, die, if the land remains under water too long; a person who is under water, whether by accident or intentionally, suffers ill effects only if he is under water too long; damage caused by a rampaging river or by an exceptionally high tide, depends upon the duration of the flood or the succession of abnormal tides. Whether minutes, days, months, or years elapse, the length of the period of submergence seems to determine the amount of damage. Government efforts to prevent the recurrence of damaging floods in the United States, illustrates a long established principle. The objective has always been to apply scientific controls, if possible, to prevent natural forces from creating havoc. The disparity between the 2.24 foot range of controlled Lake Superior and 6.72 foot range of uncontrolled Lake Ontario, during the past eighteen years, highlights the need to control Lake Ontario.

The question is—control at what levels? The elevations adopted by the U. S. Army Engineers, from many years of observation at standard average stages for the several lakes, point to a logical solution of the problems of level and range. As reported by Freeman (page 213), they have arrived at the following figures:

	Low	Mean	High	Range
For Lake Superior	600.7	602.3	604.1	3.4 feet
For Lake Michigan and Lake Huron	579.6	581.1	582.6	3.0 feet
For Lake Erie	570.8	572.3	573.8	3.0 feet
For Lake Ontario	244.5	246.0	247.5	3.0 feet

CONCLUSIONS

The facts and opinions presented here have led the writer to reach the following conclusions:

1. Inasmuch as it is evident that high lake levels, in effect, multiply the number of damaging winds there is a need to establish a controlled range for Lake Ontario at a level that will preserve its shores.

2. In order to minimize damage to the shores of Lake Ontario, the elevation adopted as normal by the U. S. Army Engineers for Lake Ontario (quoted above) should be established as soon as practicable.

3. It is submitted that it might be useful to establish a series of observation stations around the shores of Lake Ontario, in cooperation with Canada; and that at such observation stations reliable data be collected on wind and storm effects at the various lake levels. It is further submitted that both in Canada and in the United States volunteer observers might be enlisted through the Science Departments of the public schools, such volunteer observers to function under the supervision of the appropriate government officials.

For data used in these studies I am indebted, primarily, to the United States Lake Survey, but also to the United States Weather Bureau, to the Canadian Hydrographic Survey, to the Meteorological Division of the Canadian Department of Transport. For technical counsel and assistance I am indebted to Mr. Herbert A. Zollweg, Assistant City Engineer, to the staff of the Rochester Weather Bureau, to Mr. E. R. King, head of the Statistical Department, Eastman Kodak Company, to Dr. Edward T. Boardman, of the Rochester Museum of Arts and Sciences, Professor William F. Jenks, University of Rochester, to Mr. Howard Harding, Consulting Hydrologist, and to Mr. O. L. Angevine, Executive Secretary of the Rochester Engineering Society.

The references in the text indicate the many authors, speakers and government officials who have contributed information.

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HIATT, WILLIAM E.	8–15–1952 12– 1–1952
KEATING (HON.) KENNETH B.	5–11–1953
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MERCER, J. M.	4– 1–1953 4– 8–1953
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PLANTAE DUROBRIVENSIS I

SORBUS DOMESTICA, L. forma PYRIFERA (Hayne) Rehd.

BERNARD HARKNESS[1]

Under the general title of Plantae Durobrivensis it is planned to present a short sequence of notes on the woody plants of Rochester which were introduced into the city's horticulture but not permanently, at least, into the collections of the public parks. Under a companion title, Hortus Durobrivensis, publication has begun in PHYTOLOGIA of the complete catalog of the woody plants of the Rochester parks, necessarily with a briefer text and lacking the illustrative plates with which Mr. Erik Hans Krause starts this series.

In the fall of 1951 fruiting branches of the above Sorbus were brought to the Highland Park Herbarium for identification. With its distinctive little pear-shaped fruits present, it was not possible to fall into the error of referring the tree to the Mountain-Ash or Rowan-tree group which it so much resembles by leaf alone. Knowledge of the presence of this rare tree in Rochester is due solely to the persistent doubt in the mind of the owner, Mrs. David Fergusson, that an earlier identification could be right. With her gracious permission I can locate the tree as being at the rear of the residence at 13 Argyle Street. No. 13, as indicated by its adherence to the original lot numbering rather than a later house numbering in which it is out of sequence, is the senior house on Argyle Street. The area was once the Bates farm of which this section became known as the Wm. S. Little tract. This general area was devoted at one time to the growing of nursery stock and it is from this use of the land that the Sorbus is believed to remain, especially since Mrs. Fergusson informs me that there was no indication of an interest in ornamental plantings on the part of the first occupant of the property.

Examination of the specimens in two herbaria, the Bailey Hortorium and the Arnold Arboretum, indicate that it was never widely planted in the United States. Dr. L. H. Bailey took a specimen of the pear-fruited form from a tree in Geneva, New York in October, 1917. The other U. S. specimens are Missouri Botanic Garden (1904), Berkeley, California (1915), Arnold Arboretum (1921) and St. Helena, Calif. (1923). Dr. Donald Wyman of the Arnold Arboretum informs me that a living plant raised from seed from Denmark in 1918 is in the Sorbus plantings there.

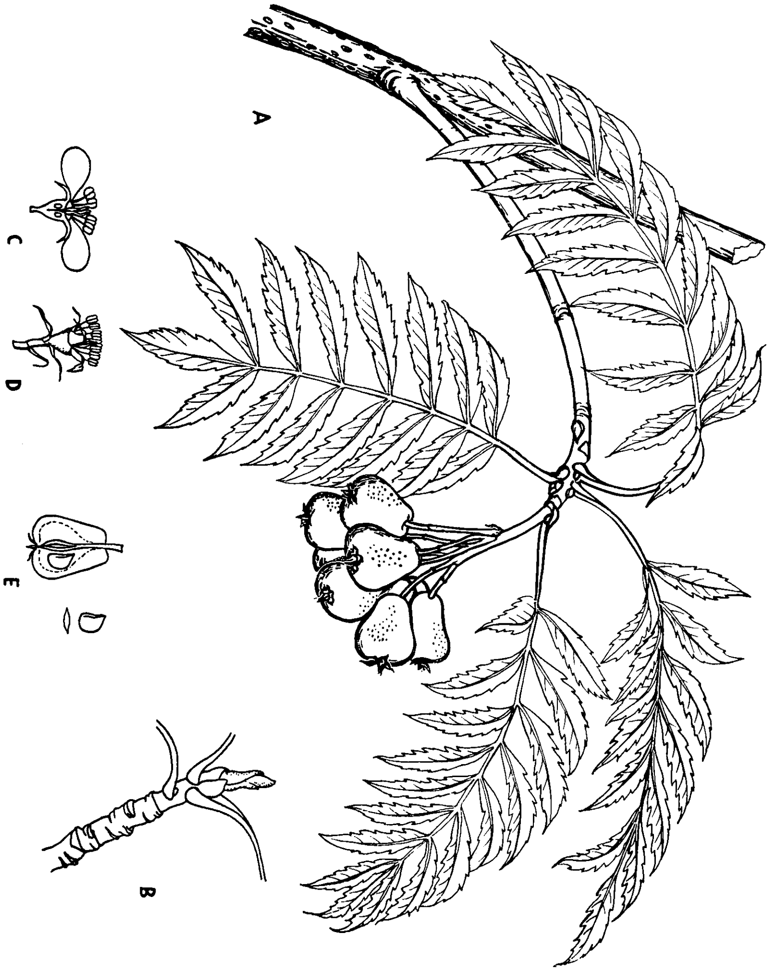
The records are more abundant from European collections. Dr. F. G. Meyer records a forty-foot tree at Kew Gardens in May, 1950. There are specimens from several continental botanical gardens in the Arnold Arboretum herbarium. There, also, is a good record of its natural range which

[1] Highland Park Herbarium, Rochester, New York.

Rehder (Manual of Cultivated Trees and Shrubs) gives as S. Europe, N. Africa, and W. Asia. Professor C. S. Sargent collected it in the mountains above Yalta, Crimea, on July 10, 1903 in his journey around the world. There are specimens from Bosnia, Hungary, Turkish Armenia, Bithynia of Galatia, Bulgaria, and Serbia. Augustine Henry collected the pear-fruited form on September 3, 1927 and noted it as wild, a tree 25 feet high, in the forest of St. Crepin at 4000 feet elevation, south of Brianson, Hautes Alpes.

In *Gardening Illustrated,* January 1950, there is a photograph of an old tree in the Botanic Garden at Oxford University. Only recently has this tree been released from suppression by an overtopping beech. In 1844 a *Sorbus domestica* was described in the Garden as 44 years old and 25 feet high. Presumably the tree is the same one as its circa 150 years would not be old in comparison with some French specimens thought to range from 300 to 800 years in age with heights to 60 feet and trunks to 4½ feet in diameter.

For its place in horticultural history the best source in Loudon's *Arboretum et Fruticetum Brittanicum,* (1844). J. C. Loudon was recently characterized (*Some Nineteenth Century Gardeners* by Geoffrey Taylor) as "beyond question a great English gardener; and therefore, no less than if he had been a statesman, a soldier, or a poet, one of England's Great Men." From Loudon we learn that he considered *Sorbus domestica* the True Service (tree), though the name Sorb Tree is noted as well as Whitty Pear Tree for the pear-fruited form. In France it was known as Cormier or Sorbier, in Germany as Speyerlingsbaum or Sperberbaum and in Italy as Sorbo. There is a cultural hint that grafted stock bears fruit much earlier than the 30 years that seedlings sometimes require. The question whether *Sorbus domestica* ever grew wild in Britain is discussed with Loudon's decision being for the negative. He comments on the scarcity of the plant in English plantings of his time attributing it to a tenderness of the young plants. Since its natural range is wide-spread into warmer areas from a center of abundance in middle France and the Alps of Italy, there may be geographical races carrying different hardiness factors. Though the apple and pear-fruited forms are all that are known now, as well as a century ago in Loudon's time, he notes that the Greeks and Romans made more use of the tree. Pliny mentions, in addition to the forms known now, a form with egg-shaped fruit and a kind that had a medicinal use as an astringent, especially to stop the flow of blood. In its native France wood of the Service-tree came into various particular uses because of its hardness; one such use being for screws to wine presses. Loudon describes the wood, having a dry weight of 72 lb. and 2 oz. per cubic foot, as the hardest and heaviest of European trees. The French, however, cared little for the fruit; Loudon quotes a local saying, "Ils ne mangent que des cormes" to designate persons in the utmost state of destitution. A Brittany cider or perry was made of the fruits of the Service-tree but had an unpleasant odor.



SORBUS DOMESTICA f. PYRIFERA

E. H. Krause, del.

A—Leaves pinnate to 9 in. long, leaflets 13 to 21 sharply toothed but entire near base, glabrous above and downy beneath.

B—Winter buds viscid, sparsely downy.

C—Flowers white, about ½ in. across, in May on short branches from the leaf-axils in a cluster 2½ to 4 in. across.

D—Calyx and flower stalks downy.

E—Fruits pear-shaped an inch or more long, brownish with red tints in the sun.

Fruiting has been abundant on the Rochester tree for many years. Mrs. Fergusson tells of a member of Rochester's Italian community who came for several years each fall to gather the fruit from the ground. Recent efforts to germinate seed have failed, and propagation of the tree seems to depend on grafting on Mountain-Ash understock.

It is interesting to have in Rochester this tree surviving from an era when knowledge of the Sorb, the Medlar, the Sloe was part and parcel of our horticulture and when an intellectual curiosity about all plants seems to have been more prevalent than it is today.

NOTES ON ASTRONOMICAL PHOTOGRAPHY

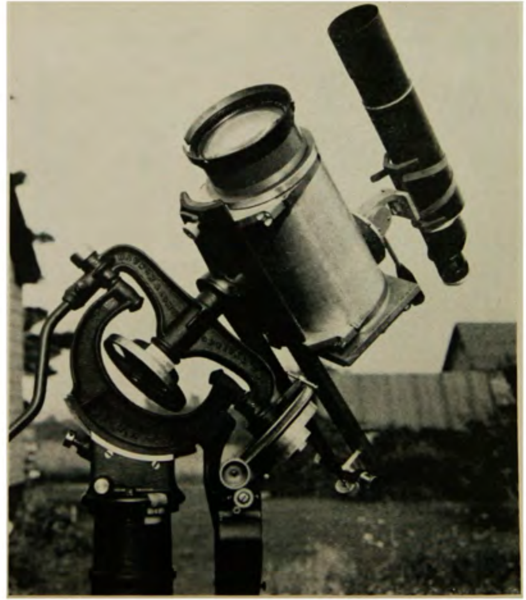
BY PAUL W. DAVIS, FRAS

Contribution of the Astronomy Section

Generally we are so impressed by the dramatic and highly significant photographic accomplishments of the large telescopes that we often fail to realize the potentialities of smaller ones—equipment in the hands of the enthusiastic layman or in those schools offering just an introductory course in astronomy.

Actually, a simple box camera, with the lens removed, can serve to hold a film or plate at the primary or secondary focus of a telescope, Figure 1a. The result is an entirely workable combination. As an alternative, an astronomical camera can readily be constructed using a good lens designed for aerial photography. Such a camera, Figure 1b, can be used to photograph various regions of the sky. Figures 2 to 6 are from photographs made with such equipment. They demonstrate that much instructive and interesting photography can be done without too elaborate apparatus.

A



B

FIGURE 1. Two arrangements for making astronomical pictures. In one case a simple camera box is "hooked-up" to a refracting telescope, while in the other, a home-made camera is supported for driving on a telescope mount.

FIGURE 2. *Approaching Ocultation of Mars by the Moon.* Photographed using a 35X eyepiece on a 5-inch, Alvin Clark Refractor of 75 inches focal length with Brownie Box as a film carrier. Exposure 1/20th of a second; Verichrome Film. The insert emphasizes the planet since the objects were allowed to trail out of the field during a time exposure.

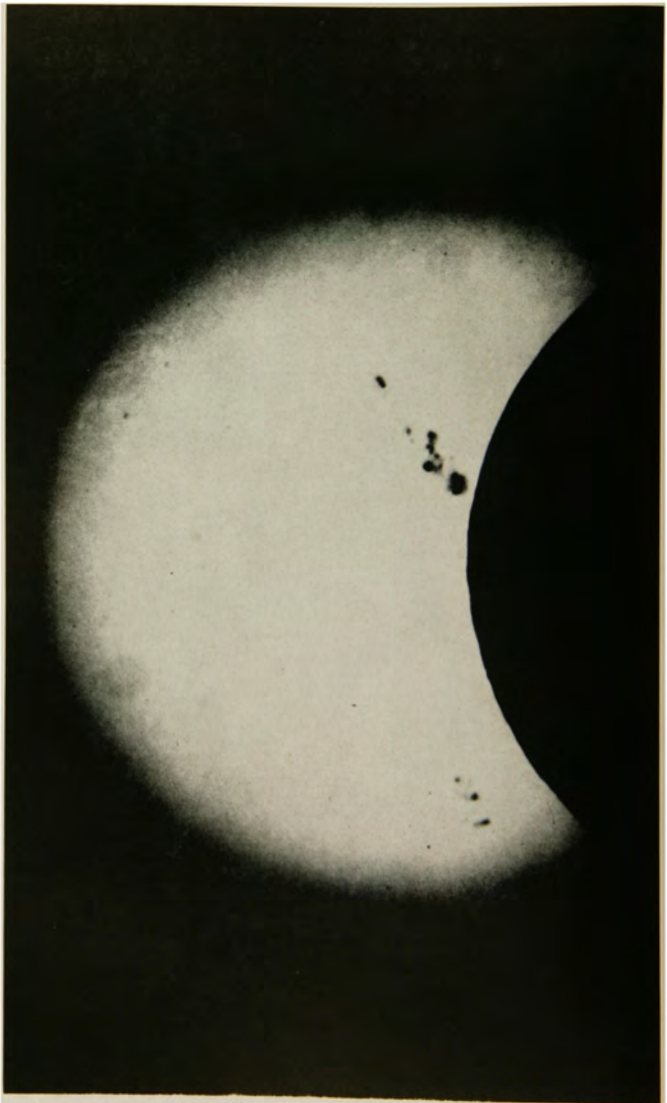


FIGURE 3. *Eclipse of Sun.* Photographed using a 35X eyepiece on a 5-inch, Alvin Clark Refractor of 75 inches focal length. A special adapter held a photographic plate inside a box camera. Exposure 1/100 second; Lantern slide plate with Wratten F (red) Filter. Notice that the lunar mountains appear as an uneven line along the silhouetted limb of the moon.

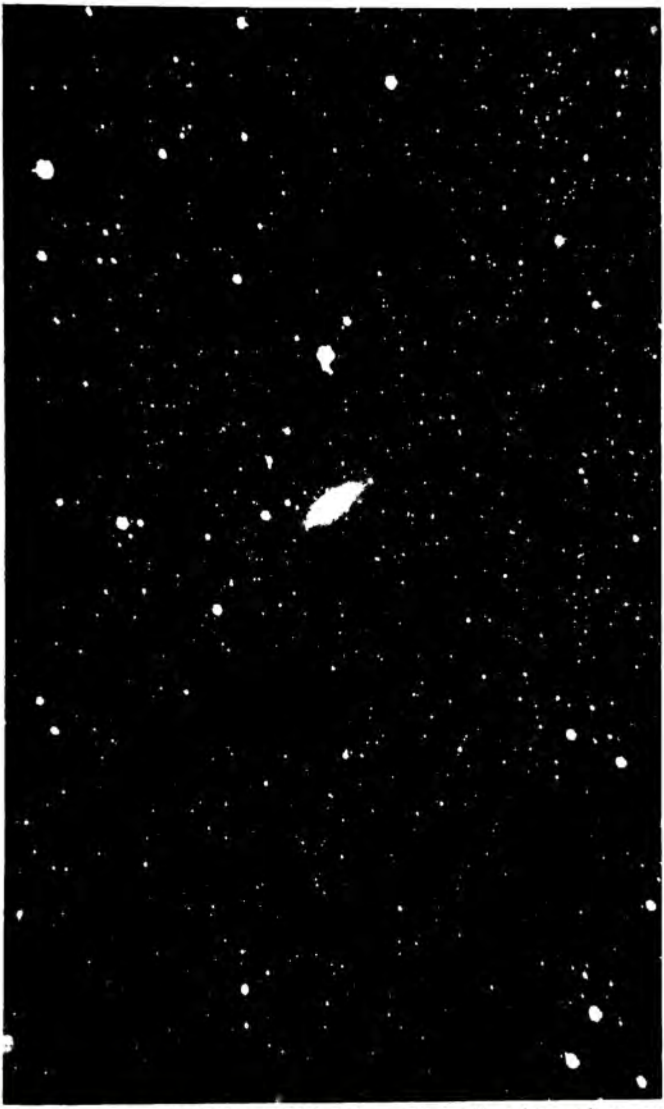
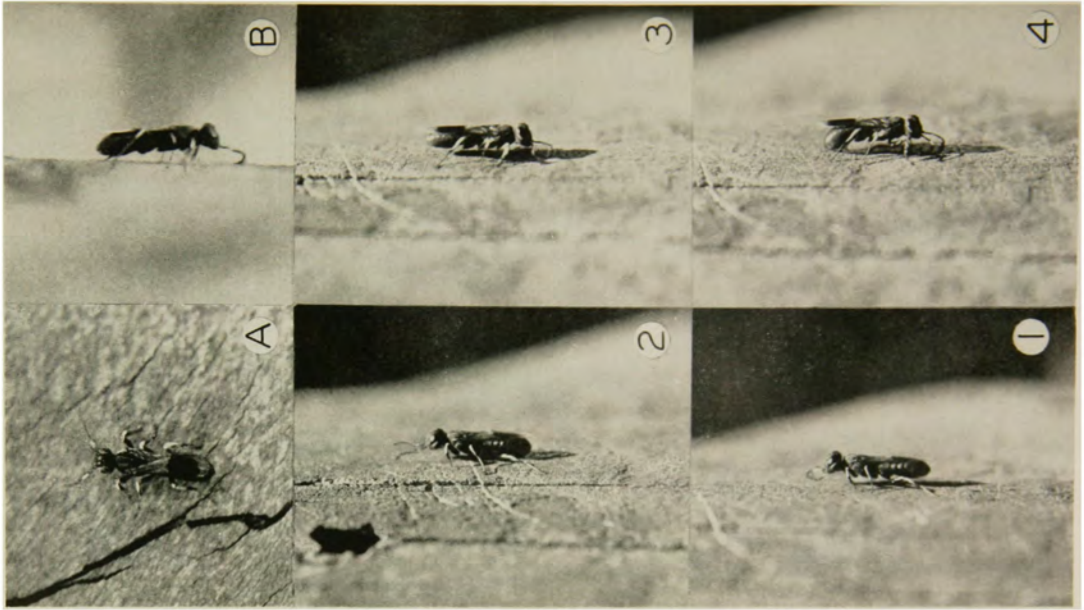


FIGURE 4. *Andromeda Nebula or M31.* Photographed with a homemade camera incorporating a Kodak Aero Ektar f/2.5 Lens; Exposure 15 minutes; 4 x 5-inch Kodak Spectographic 103AE Plate. In a long exposure such as this, the camera must be constantly guided even though the apparatus is equatorially mounted, and machine-driven.

FIGURE 5. *Northern Lights.* Photographed with a homemade camera incorporating a Kodak Aero Ektar f/2.5 Lens; 4 x 5-inch Kodak Spectographic 103AE Plate; 15-seconds exposure. Camera was pointed at Zenith and hand-followed on an equatorial mount.

FIGURE 6. *Circumpolar Stars.* Photographed with a 127-mm. Kodak Ektar f/4.5 Lens and a Commercial Graphic Camera. Exposure of 4 hours; Kodak Tri-X Film at f/4.7. During exposure a short burst of Northern Lights occurred near center of the field. Close to Polaris is a 14th magnitude star not visible in the author's 5-inch telescope; it has been recorded by the ability of the photographic plate to store up exposure to very faint light. Also, as a result of this effect, approximately 2000 trails are photographed, yet only 42 of these stars are visible to the naked eye.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EGG GIGANTISM, OVIPOSITION, AND GENITAL ANATOMY: THEIR BEARING ON THE BIOLOGY AND PHYLOGENETIC POSITION OF *ORUSSUS* (HYMENOPTERA: SIRICOIDEA)

Kenneth W. Cooper *

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INTRODUCTION

The woodwasps of the family Orussidae have long puzzled biologists interested in the Hymenoptera. On the one hand, when judged anatomically, the adult woodwasp appears in many respects to be a quite typical member of the relatively primitive suborder Symphyta, or predominantly

* The Edmund Niles Huyck Preserve, and the University of Rochester, Rochester, New York.

Plate I

Behavior of *Orussus sayii* Westwood on the weathered, bark-free surface of elm. Pictures taken in the field by sunlight. See pp. 44 to 48 for description in the text.

Figure A. Dorsal view of female sweeping antennae laterally. Note the stance, tubercles between the eyes on the front of the head, and the color band on the folded wings.

Figure B. Female with ovipositor inserted in the wood. Note stance: head down, antennae applied to surface of wood. Ordinarily the tip of the abdomen is kept in contact with the surface of the wood during the sinking of the oviposition shaft (as in Figure 4).

Figures 1–4. A female in her final selection of an oviposition site. Note that the oblique, white crack in the wood at the upper left of Figure 1 marks the relative position of the woodwasp in each of the four photographs. Figures 1 and 2, longitudinal sweep of antennae over the surface of the wood. Figure 3, lateral sweep of antennae (as in Figure A). Figure 4, oviposition. The tip of the abdomen is pressed against the wood and the ovipositor is inserted and being worked deeply into the wood. Note the characteristic way in which the antennae are held against the wood.

phytophagous Hymenoptera, of which the sawflies and horntails are familiar examples. On the other hand Burke's (1917) account of the occurrence of larvae and pupae of *Orussus* in the mines of buprestid beetles in old logs, plus his observation of an orussid larva attacking a larval buprestid, has been taken as final evidence that woodwasps are truly parasitoid forms.[1] Chalcid-like in superficial appearance and field behavior, the woodwasps have been adjudged by not a few entomologists to be parasitic Apocrita, the suborder to which the ichneumon flies, wasps, bees, and many others belong.

Bischoff (1923, 1926, 1927) has discussed this supposed contradiction of adult anatomy and larval habit at some length, but the question is not likely to be settled in the minds of those who give great weight to "biological characters" until the natural history of one or more woodwasps is quite fully known. Unfortunately orussids are both individually rare, and few in kind—perhaps no more than 40 species existing in the world today. For these reasons a deliberate study of the life histories of most woodwasps seems infeasible. As in the past, then, new information may be expected to come chiefly from fortuitous opportunities for studying one or another aspect of orussid biology.

In the summer of 1951 it was my good fortune to find 3 stands of dead trees, at the Edmund Niles Huyck Preserve, Rensselaerville, New York, that were frequented by the woodwasp *Orussus sayii* Westwood (1830). During 1951 and 1952, I enjoyed the privileges of the summer fellowship at the E. N. Huyck Preserve, and was thus able to make an initial inquiry into some aspects of oviposition habits and mechanics, as well as an examination of the internal anatomy of the reproductive systems of both male and female *O. sayii*. It is the purpose of this article to describe these observations on the rare woodwasp, and to discuss their implications. Even though large gaps remain to be filled, and many of the more significant conclusions are speculative, the facts to be recorded are of more than passing interest. Some appear to me adequate to justify a measure of doubt that *Orussus* is a parasitoid or parasite. To these observations are added my records of capture of *Orussus* from 1939 to 1951.

THE EASTERN *ORUSSUS*

The Orussidae are represented in North America by perhaps 8 species: *Orussus sayii* Westwood[2], *Orussus maurus* Harris, *Orussus occidentalis*

[1] Contrary to Bischoff's (1923) and Clausen's (1940) belief, Burke actually found no evidence that orussid larvae are internal parasites, although they might indeed be. Since Burke felt assured that they at least externally attack larger buprestid larvae, "parasitoid" seems the proper adjective.

[2] There is still considerable question about the matter of proper synonymy. In part with Harrington (1893), and in part with Pratt (1938), I believe that *O. sayii* Westwood includes: *O. terminalis* Newmann, *O. haemorrhoidalis* Harris, and also *O. affinis* Harris. Guiglia (1945) gives the same synonymy, but renders the specific name "*sayi*". It may also be the case, as Harrington supposes, that *O. maurus* Harris is no more than a melanic female form of *O. sayii*.

Cresson, *Orussus thoracicus* Ashmead, and an undescribed eastern form of *Orussus; Kulcania* sp., *Ophrynopus,* sp., and *Ophrynella nigricans* (Cameron) (cf. Ross, 1951). Although the 4 genera are easily recognized with the aid of Benson's (1938) key, it is by no means a simple matter to assign names with confidence to the North American species of *Orussus* by use of the papers by Harrington (1893), Bradley (1901), and Rohwer (1912). In the Eastern United States I have repeatedly collected examples of 2 distinct species, and apparently 2 species only. One is a small, slender, black form (length: ♀ 3–6.5 millimeters; ♂ 3–5 millimeters) for which no name seems available. The other is *Orussus sayii* Westwood, easily recognized by its large size (length: ♀ 9–18 millimeters; ♂ 7–13 millimeters). The female (Plate 1) customarily has the last 3 (or 4) abdominal segments dark blood red to bright orange-red, whereas the body of the male is wholly black. Aside from this difference in coloration, and the obvious sexual dimorphism of the abdominal terminalia, male and female *O. sayii* are similar in appearance.

Both sexes of *Orussus sayii,* when running on tree trunks, bear a superficial resemblance to large ants of the genus *Camponotus.* This resemblance is brought about in part by their deceptively ant-like manner when running about on the surface of trees, and in part by the antennae, the ant-like proportions of the head and thorax, and especially by the coloration of the wings (Plate 1, Figure A).

In *Orussus sayii,* the base of each forewing is more or less smoky white, while there is a wide subapical dark band across the distal half of the wing. When the wings are folded, and *O. sayii* is seen from above, the ant-like appearance is complete. The cylindrical abdomen, covered by the wings folded along the length of the dorsum, now appears similar to the gaster of an ant, for the white basal area of the wings disrupts the continuity of the thorax and abdomen, while the purplish-black cross-band suggests a convex, ellipsoidal gaster.

It is interesting that *Orussus sayii* and the small, unnamed eastern form of *Orussus* differ markedly in details of wing pattern, although in life each is strikingly ant-like in appearance. In the forewing of *O. sayii,* vein R_1 continues a short distance beyond the stigma as an ill-defined, colorless vein, and the area immediately below R_1, equal to about half the width of the radial cell, is also colorless. The dark brown of the transverse color band has its proximal border marked by the origin of vein 2r at the stigma, approximately the mid-point of cell $1R_1+1R_s$, and veins 1 m–cu, cu_1, and cu_{1b} (v. Ross 1936, 1937). The distal border of the dark band forms a nearly straight line, transverse to the length of the wing, about one-eighth of the wing's length from the wing-tip. Except for the elongate clear spot below and including R_1, the area between these limits is dark brown when viewed by transmitted light, shining purplish-black by reflected light. The entire distal half of the hind wing is also suffused with color, while the anterior half is hyaline. The proximal limit of the colored area of the hind wing coincides with the parting of veins R_1 and R_s, and with veins M, Cu_1, and cu–a.

In the small species of eastern *Orussus,* the proximal limit of the color band of the forewing corresponds with the base of vein R_s, cuts through the proximal third of the first medial cell, and obliquely across the anterior proximal fifth of cubital cell–1b to become confluent with vein cu–a. The distal limit of the dark band is about the same as in the forewing of *O. sayii,* but the clear band below vein R_1 is more or less *perpendicular* to the anterior margin of the wing, and generally extends across both tiers of radial cells to the medial vein, enclosing vein 2 r–m within the clear or smoky-white space. When the clear space is very pronounced, the radial sector is interrupted, and vein 2 r–m may be barely perceptible, or even absent. There appears to be little or no suggestion of color in the hind wing.

COLLECTING RECORDS AND HOST TREES

The listings which follow do not record all of the *Orussus* encountered from 1939 through 1952, but merely most of those that were preserved as labelled specimens. At least as many more woodwasps were observed as there are recorded here. In the records which follow, the small form discussed above is listed as *Orussus sp.*

Orussus sayii Westwood

New York. *Rochester*—1939: June 25, ♀ under loose bark of dead red maple sapling at margin of swamp in rather close second-growth woods. *Rensselaerville*—1951: June 24, ♀ on sunned, bark-free patch of red maple trunk in heavy stand of trees; June 26, ♀ on dead sugar maple sapling; July 1, 3 ♀♀ and 3 ♂♂ on bare trunk of dead elm at woods' margin; same, ♀ under bark of dead elm; July 6, ♀ from bole of bark-free dead elm in open swamp; July 7, ♂ from small dead elm in swamp, also ♀ from dead linden sapling at swamp's margin; July 8, ♀ searching under loose bark of dead apple tree at margin of orchard. —1952: June 25, ♀ and ♂ on partially barked, half-dead elm; June 26, 4 ♀♀ and 5 ♂♂ on bark-free dead elms at woods' margin; June 28, ♀ on bark-free dead elm; July 1, 4 ♀♀ on bark-free areas of drowned-out elms in beavor meadows; July 2, ♀ ovipositing on bark-free area of dead elm trunk.

New Jersey. *Princeton*—1947: June 12, ♀ and ♂ on dead sugar maple stump, bark-free but nearly covered with poison ivy; June 18, ♀ on bark-free area of bole of dead sugar maple. —1948: June 15, ♀ on sugar maple stump. —1952: May 27, 4 ♀♀ and 2 ♂♂ on dead elm; May 28, 3 ♀♀ and 2 ♂♂ on dead elm trunk, completely free of bark; June 2, 5 ♀♀ and 5 ♂♂ on dead elm in open field; June 8, ♀ on bark-free patch of dead wood on trunk of live elm at open woods' edge.

Orussus sp.

New York. *Rensselaerville*—1952: June 25, ♀ on bark-free dead elm; July 28, 1 ♀ and 2 ♂ ♂ on dead sugar maple sapling (no bark) in close stand at woods' margin

NEW JERSEY. *Princeton*—1947: June 3, ♀ on sugar maple stump. —1948: June 24, ♀ on sugar maple sapling. —1952: May 28, 2 ♀ ♀ and ♂ on completely bark-free dead elm at shrubbed margin of pasture; June 2, 2 ♀ ♀ and ♂ on bark-free area of dead sugar maple; June 8, ♀ on dead elm. It should be remarked that every individual tree that yielded *O. sp.* also gave *O. sayii,* although the reverse is not true.

Thus I have taken *Orussus sayii* from bark-free areas of dead wood on live, dead, or dying: red maple, sugar maple, American elm, linden and cultivated apple. Harrington (1886, 1887a b, 1893) records *O. sayii* from dead "maple", sugar maple, poplar, willow (on the basis of Harris' writings)[8], cedar telegraph poles, dead pine and larch, while Pratt (1938) collected his specimens from sugar maple. Harrington, Pratt and I have captured all of our adult specimens in a time stretch extending from late May through early July, and Pratt (1938) believes adult *O. sayii* is active until at least mid-July. Bradley's (1928) record of *O. sayii* (Peru, N. Y., September 19, 1916) is notable but in error.† I have never seen the woodwasp later than July, despite the fact that my field work has been in an area where *Orussus* seems uncommonly frequent, and even though I have made a prolonged and determined search for the adults in late July, in August, and in early September of both 1951 and 1952.

SEX RATIO AND TIME OF EMERGENCE

In my experience, each season, male *Orussus sayii* are encountered on trees about half as often as female. Of the 58 *O. sayii* recorded above, 38 are females, 20 are males (i.e., $34 \pm 6\%$ ♂ ♂). The bias in favor of the female does not simply reflect a decided peculiarity of any one year of collection, nor a particular period of the year. Thus my listed captures before 1951 give 4 ♀ ♀ + 1 ♂; then in 1951: 10 ♀ ♀ + 4 ♂ ♂, and in 1952: 24 ♀ ♀ + 15 ♂ ♂. In the interval from May 24 to June 8 there were caught 13 ♀ ♀ + 9 ♂ ♂, from June 8 to June 24: 4 ♀ ♀ + 1 ♂, and from June 24 to July 9: 21 ♀ ♀ + 10 ♂ ♂. These figures do suggest, however, that males may be proportionately more frequent on tree trunks in the early part of the season.

Adding to my own records those of Harrington's (1886, 1887a b) *captures,* the total sex ratio is 58 ♀ ♀ : 35 ♂ ♂ ($38 \pm 5\%$ ♂ ♂), and the proportion of males is highest early in the season. Thus the captures ranged 17 ♀ ♀ + 18 ♂ ♂ for May 24 to June 8, 19 ♀ ♀ + 7 ♂ ♂ for June 8 to June 24; and 21 ♀ ♀ + 10 ♂ ♂ for June 24 to July 9. On the average, then, it

[8] Rohwer (1912) gives no credence to Glover's (1877) report that the larva of *Orussus* bores in the wood of willow.

† The specimen, now in the Cornell University collection, was actually collected in June; the date on the label is: 10 VI 1916.

is quite likely that male *Orussus sayii* emerge earlier than females, as Pratt (1938) believes. However, the skewness in the sex ratio may prove to be more apparent than real. It is not improbable that the life of the male differs from that of the female in both average longevity (male shorter lived) and ecology, as well in the mean time of initial emergence.

Pratt (1938) has given the presumed earlier emergence of male *Orussus sayii* a special interpretation. He believes that this permits males to mate with the larger females as they emerge, and that the emerging female, still somewhat teneral, is unable to fend off the advances of the vigorous, wholly matured male. This interpretation seems unlikely to me. Generally speaking, larger non-social Hymenoptera pass their callow phases while remaining within their pupal enclosure, emerging in full prime. Harrington (1887a b), who claims to have observed emerging *O. sayii,* makes no claim for a callow period. Newly emerged females[4] of *O. sayii* that I have dissected were neither more weak at capture, nor less agile, than older females. Very likely female coyness is overcome by some pattern of courtship, sexual display or combat (see p. 45), rather than by simple force, although no one seems yet to have recorded the mating of *Orussus* or its preludes.

HABITS

All trees on which I have taken *Orussus sayii* have had at least one characteristic in common: a bark-free area of firm, dry dead wood, often no more than a few square inches in extent. The exposed dead wood may extend over the entire surface of the tree, or be no more than a small patch on an otherwise living, if not healthy, tree. The trees may be fully grown, or mere saplings but 2 inches in diameter; they may be entire, broken and shattered, or no more than stumps; they may be enclosed by adjoining thick growth of trees, saplings or shrubs, or stand alone in an open field. Generally, whatever their surroundings, their exposed dead wood receives full sun for at least an hour or so of the early summer day.

The surface of the dead wood is weathered, dry, extremely hard, often cracked and deeply fissured by splitting, and sometimes lightly filmed with patches of dry algal bloom. Often, but not always, it is perforated by the exit holes of *Tremex,* and of *Dicerca* and other beetles. As would be expected, these trees may support a thriving mixed colony of larger Hymenoptera, the open burrows being explored and reworked by numbers of megachilid bees, crabronids, pemphredonids, eumenids of the genus *Symmorphus,* and even the pompilid *Dipogon.* Sometimes *Orussus sayii* will pause and appear to inspect an open burrow, but I have never observed the woodwasp within such burrows, as Harrington (1887a b) has. Harrington believes *O. sayii* may shelter or conceal itself within burrows. In my experience, I have found *O. sayii* spending nights only under loose bark of trees

[4] Judged by the state of the ovaries and fat-body, as well as the texture and state of the integument and wings.

known to be coursed by *Orussus* during clear days. *O. sp.*, on the other hand, enters small burrows without hesitance.

Orussus sayii may alight noiselessly at a patch of sun-warmed, firm dead wood, or arrive with an awesome buzz. Up or downward, *Orussus* then quickly courses the trunk or limb with a characteristic, often deceptively ant-like, gait. Wings folded over the back, the woodwasp moves in rapid spurts of 6 inches or so. It tends to follow the grain of the wood, rather than a path dictated by gravity, even onto larger, buttressing roots. Sometimes a lengthwise crack becomes of consuming interest; when sufficiently deep, the woodwasp may continue its path up or down the tree within the crack. Patches of loose bark may awaken interest, and male or female woodwasps then undertake prolonged subcortical explorations, often emerging at a distant point. When moving laterally, across the grain of the wood, *Orussus* may simply take an oblique path or, crabwise, rapidly and agilely sidle to a new point. Ordinarily, female *Orussus* is alert to the presence of other woodwasps and insects, and skillfully avoids them by such crabwise motions or a sudden leap. When markedly disturbed, *Orussus* leaps into flight like a chalcid or cynipid. As Harrington and Pratt both emphasize, once flown, *Orussus* will often return within a matter of moments to the very spot from which it fled.

The hurried journeys of a male or female *Orussus sayii* up and down the bark-free length of a tree, whether the distance is but inches or 20 or more feet, or involves detours under bark or within fissures in the wood, may be repeated several times with little or no deviation from the original path. Although *Orussus* is often found rapidly coursing a tree in this manner, the activity rarely seems to bring about any result of obvious importance in the life of the individual. I have seen occasional meetings with other insects, and other *Orussus,* by female and male woodwasps jerkily running the length of the sunny side of a bark-free dead tree. In all cases but one, the meeting was brief, and simple crabwise or leaping avoiding-reactions occurred.

The single exception involved a female that had traveled down the length of a dead tree to within a few feet of the ground. There she came face to face with a male whose arrival was made without my notice. The male quickly half-circled the female, always facing her, only to have her depart with a clattery buzz and to find himself now facing 2 newly arrived males. The 3 males then promptly advanced and took to butting one another, head on, in angry little darts, finally coming to push, shove and thrust at one another from points of stance in near contact. They seemed to exhibit the purest pugnacity during the mélee, and 3 times females landed with a buzz to within inches of the apparently oblivious and heavily engaged males, which the females seemed to watch with excitement. Whether the original female was among the spectators, I cannot say, but at one point 2 females—one to each side— served as audience to the combat.

At the time I believed that I would shortly witness much of the courtship of *Orussus,* no less than the settling of supremacy among males, and resisted every urge to capture the lot. The judgment was a bad one, for without warning, and for no obvious reason, they all took off simultaneously at lightning speed. Such behavior was not again seen. Whether in fact this was one uninterrupted act of a complex sexual program of courtship with mating following at another site, or, less likely, in flight, I cannot say.

OVIPOSITION

A female *Orussus sayii* that is selecting an egg-laying site is easily recognized. Her movements are characteristic, complex, and stereotyped, and her mien is no longer that of an alert insect. Approached by another insect, a male *Orussus,* or indeed by an observer, she shows little or no concern, and continues her close scrutiny of the wood as though wholly withdrawn from the larger world about her (Plate 1, Figure A). I have witnessed the choice of an oviposition site 8 times in all, and the description which follows is a composite account. There was little notable difference, if any, in the behavior of the eight females. The first oviposition observed was on June 2, and the last on July 2, and all took place on clear sunny days between 10AM and 3 PM. The borings were made at sites approximately 6 inches, 1 foot, 2 feet, 3 feet, 4 feet (2 cases) and 4 feet 8 inches (2 cases) above ground level at the base of the trees involved.

Females choosing oviposition sites seem to show little regard for whether the point of choice for oviposition receives sun or not, and they appear to oviposit without regard to the distribution of sunshine at the time of egg laying. The female first narrows down a suitable area of dead, firm wood. To do this may take an hour or more, and she slowly moves up and down the grain of the wood in more or less laterally overlapping, successive traverses. As she inspects the wood, she often, but not always, moves with a zigzag motion, her body sweeping perhaps 15° to 20° to the left, then 15° to 20° to the right of the line of movement, seeming to pivot approximately about the tip of the abdomen, which remains on the line of her path along the wood. Thus a female 15 millimeters in length appears to examine a belt of wood approximately 1 centimeter wide in each linear transverse, for she sweeps her antennae before her, over the wood as she moves along her path, just as Burke (1917) has noted for a western species of *Orussus.* Seen from above her dorsum, the antennae appear to be swept forward until the angle included between them is about 90°. They are then swept backwards so that the included angle is increased to about 270°, then returned and swept back again countless times. Seen from the side, the antennae appear to be curled backward and then flashed forward and outward during the stroke (Plate 1, Figures 1, 2). The two antennae may move simultaneously, or one at a time (Plate 1, Figure A). From time to time the female may abruptly stop, bring her antennae together in front of her, and tap the wood alternately with the peculiarly modified tips of the two antennae (see Figure 92, Ross 1937).

Perhaps the most striking feature in a traverse is the abrupt, speedy and adroit 180° reversal along the path of travel that occurs whenever *Orussus* changes direction. This is accomplished, clockwise or counter-clockwise, as though the insect has a pivot beneath her that lies exactly along the main path of travel, and about which she is free to swing the length of her body.

As the area of interest is narrowed, the up and down traverses shorten, and are repeated over and over again. Within 7 minutes in one case, as many as 48 reversals occurred along short paths that covered an aggregate area of less than 4 square inches. Infrequently the female may suddenly walk directly up the trunk, beyond the narrowed area of interest, and then slowly zigzag its way back to the area to renew the short traverses at a slightly different spot. Once the area is finally narrowed, the female may fly elsewhere, rest a few moments, and then return quite exactly to the small strip of special interest. Or she may suddenly, crabwise, move over a few inches, and start anew in the painstaking study of another small area. Usually, however, the search goes ahead without interruption until a site is chosen and the ovipositor inserted.

Just before inserting the ovipositor, the female may drum alternately with her antennae, move forward until her abdomen is over this point, and then thump the spot with her abdomen while holding the tips of her antennae outstretched before her and applied to the surface of the wood. Thereupon she abruptly reverses in such fashion that her antennae now tap the very site just hammered with her abdomen, or close by. Finally, if not already facing head downward, she reverses again. With head facing downward, she places the apex of her abdomen firmly against the surface of the wood that has been so thoroughly tapped and thumped by antennae and abdomen. Holding the abdomen firmly against the wood, as Harrington (1887a) has noted, the protective scale is depressed at the base of the aperture from which the ovipositor is thrust. Then, with the antennal tips (Plate 1, Figures 4, B) and the apex of the abdomen held firmly against the wood (Plate 1, Figure 4), the wasp thrusts the ovipositor from the distal third of the abdomen (Plate 1, Figure B) and seems to pound it easily into the wood by rapid (3–4 per sec.) intermittent, vibratory movements of the abdominal sternites of the mid-region of the belly.

At this time a female *Orussus* may be touched with a finger, and gives no greater response than cessation of the sternal pumping movements for a brief time. The ovipositor enters the wood at an angle of approximately 50°–75°, and its tip is directed caudally as the woodwasp drives it deeply into the wood (Plate 1, Figure B). According to Bischoff (1923), European *Orussus* exserts and drives its ovipositor perpendicularly to its body axis.

The ovipositor may be inserted to the requisite depth within 4 to 20 minutes, to judge from the cessation of the pumping movements of the abdominal mid-region. At this point, which is perhaps the moment at which the egg passes down the ovipositor, the antennae are folded back along the body of the woodwasp. Shortly thereafter the antennae are returned to their former position, tips against the wood, and the apex of the abdomen is now quickly bobbed up and down, the pulsing movements of the abdominal mid-region are renewed, and the ovipositor is withdrawn in the matter of a minute or less.

The whole process of oviposition is a time-consuming one. The search and selection of the point for oviposition took, in the cases I observed, from 20 minutes to just over an hour, and thereafter oviposition took from 5 to 20 minutes. Unless the wood is quickly repierced, once the ovipositor is withdrawn the female departs and seems not to return—at least within the next hour or so. This does not seem to be owing to the using up of a unique site for oviposition which renders the tree worthless for additional egg laying, for in one case 2 females each oviposited twice in succession (at the 4-feet 8-inch level) within inches of one another. On the next day a female was found ovipositing on the same tree (at 3 feet). Very likely a small number of mature eggs is available each day.

THE OVIPOSITOR'S TARGET

Since it is generally taken as established that *Orussus'* larva is a parasite or parasitoid feeding within, or upon, immature buprestid beetles, it might be expected that female *Orussus* oviposit directly into the wood-boring larva just as Bischoff (1923) asserts it does. At the time of my field studies I did not doubt the correctness of this view, yet I was nevertheless eager to determine the path of the ovipositor through the wood, the diameter of the hole bored, and the ultimate target of egg laying. Is the egg of *Orussus* laid to the side of the beetle larva in its open mine, on the beetle larva itself, or is the immature beetle pierced by the ovipositor and the egg laid within it?

So far as I have been able to discover, the only oviposition shaft thus far examined is that mentioned by Burke (1917) in his study of *Orussus occidentalis* Cresson. However, this particular boring seemed to be a wasted effort on *Orussus'* part, for Burke states that the hole made by the ovipositor entered a larval mine where it was lost within the boring dust left by the buprestid larva. On completing this boring, Burke states that the female woodwasp withdrew its ovipositor and began re-examining the wood, presumably to oviposit anew. Unfortunately Burke captured the female forthwith, and so it cannot be known whether the woodwasp would have sunk her ovipositor once again into the frass of this mine.

At Rensselaerville, 2 female *Orussus sayii* oviposited in the bare surface of a dead elm at sites from which large blocks of wood enclosing the borings could be removed. No more impressive demonstration can be given of the hardness of the wood into which *Orussus* drives its slender ovipositor (diameter = 0.08 millimeter, or 3/1000 of an inch) than the time and labor that must be expended to remove such blocks containing the oviposition shafts with mallet and 1-inch chisel. Both of the blocks removed contained 2 ovipositor entrance holes, each 80 microns in diameter. Both had a large buprestid larval mine an inch or slightly more below the surface, and in both the buprestid mine was clearly the ovipositor's larger target.

The first block was twice perforated by the female *Orussus* in a total time of less than 5 minutes, and the two borings were set 5 millimeters apart. The block contained a long-abandoned, frass-packed, blind offshoot of a buprestid mine (probably that of *Dicerca*) just 1 inch below its surface. This mine was 5 millimeters in depth, and 9.5 millimeters wide. One of the ovipositor borings had penetrated the wood only 10 millimeters, and ended in firm wood. Extrapolation of its line of bore showed that the ovipositor would have passed wholly through wood a millimeter or so to one side of the lateral wall of the buprestid mine. Presumably the woodwasp somehow sensed this error, moved over 5 millimeters, and then drilled through 22 millimeters of firm wood to the very center of the hard-packed cast of sawdust that filled the burrow. Here the oviposition shaft ended, and no egg was found.

In the second block, the 2 entrance holes of the ovipositor were set only 1 millimeter apart. Their shafts ran remarkably true to the center of an 11-millimeter wide larval beetle mine, probably that of *Dicerca,* entering the roof of the mine approximately 3/4 millimeter apart. This buprestid mine had its floor 30 millimeters, and its roof 26 millimeters, below the surface of the wood. As in the first block, the ovipositor's borings are set at an angle of about 15° off the perpendicular to the wood's surface, and are thus directed slightly upwards with respect to the tree, and lie in a plane passing roughly through the central axis of the tree trunk. Both ovipositor borings entered just half way into the buprestid mine, that is, they were each 28 millimeters long. Their total depth could be precisely told, as in the first case, for the mine was an old abandoned one, tightly choked with hard-pressed wooden frass and borings from the work of the beetle larva that had long ago passed this point. The frass came free from the walls of the mine, as a cast does from a mold, and when broken apart it clearly showed the full extent of each of the ovipositor borings into it. No recognizable eggs were found at the ends of these borings, just as in the first case.

Now, the apparent absence of eggs was puzzling. It seemed quite likely that the egg, if laid, had been ruptured by the strains and shearing forces to which they must have been subject as the surrounding wood and frass was chiseled, shaved, and broken apart. Had the eggs been torn, then their contents surely would have been absorbed by the dry frass and sawdust, leaving at best perhaps no more than dried and shriveled remnants of their chorions stuck to the sawdust. Consequently the fragments of packed frass, from immediately about the oviposition shafts, were soaked apart in water. When the frass was wholly macerated and comminuted, 2 twisted, water resistant, delicate threads of non-woody texture were found, as well as a surprising array of unrecognizable debris. I believe that these filaments represent the dried chorions of 2 greatly elongated eggs (more than 8 millimeters in length), but this is not proven.

Nevertheless, from the facts we now know, it does seem possible that *Orussus does not* normally oviposit into larval beetles, or even close to larvae that are working open, fresh mines in the wood. Rather it seems admissable that the normal oviposition site may be the core of frass that chokes the old larval mine once worked by a beetle, but that has been abandoned. Arguments favoring this conclusion may be presented as follows.

In the case of the first block of wood, *Orussus* discontinued sinking its ovipositor after driving it 10 millimeters along a path which would have missed the buprestid mine, had it been continued. The female then relocated 5 millimeters to one side of the first boring, and sank its second shaft 22 millimeters into the very center of the core of dry frass filling the buprestid mine. Had the female shifted to the opposite side, or to 10 or more millimeters to the side to which she did shift, or had she drilled at random over most of the 4 square inches of wood surface of this block, the ovipositor would have penetrated firm wood only, even had it been sunk to the maximum depth *O. sayii* can penetrate (*ca.* 32–40 millimeters). From this observation one conclusion may be drawn, namely that the mine of a buprestid beetle is at least a part of the target at which the ovipositor is normally aimed. An added refinement to this conclusion can be made by examination of the second case.

In this instance also two oviposition shafts were sunk, and both terminated within 1 millimeter of each other in the same core of frass that plugged an old and abandoned buprestid mine. If such a plug of frass is not the proper target, the first shaft must surely have provided the ovipositing female with information regarding its error. Apparently, however, no error had been made, for the second shaft was immediately sunk into the very same core of frass, and only 3/4 millimeter distant. From this it would seem reasonable to conclude that *Orussus sayii* normally oviposits into the sawdust plugs of old buprestid mines. Interestingly enough, Burke's (1917) sole observation also supports this contention, for the approximately 19-millimeter long oviposition shaft that he examined similarly ended in the sawdust of a buprestid mine.

It may be remarked in this connection that the preliminaries to oviposition by *Orussus,* which have been described above, strongly suggest that the site at which the shaft is sunk is chosen by some manner of analysis of vibrations reflected in the wood. In the survey for an oviposition site, the curiously swollen and modified antennal tips, the grotesque forelegs (see Figure 108, Ross 1937) and the abdomen, which ends like the convex face of a ball-peen hammer, all seem involved. The tapping, hammering, and abrupt reversal of stance followed by renewed hammering and tapping, as well as the way in which the female *Orussus* applies her swollen antennal tips to the surface of the wood, make credible the notion that patterns of reflected and unreflected waves are somehow important in this choice of site. And it seems possible, too, that the antennae, and perhaps the forelegs also, serve as stethoscopes, so to speak, that provide the female with information as to the path and the aim of its ovipositor as its tip penetrates the wood. If so, we can readily understand how the female that had sunk her ovipositor but 10 millimeters could now know that she would ultimately miss the buprestid mine that lay about 1 centimeter still deeper in the wood. If *Orussus* actually sounds out her oviposition targets in some such way, then the likelihood that she normally oviposits in old, uninhabited sections of burrows must be given still added emphasis. For the sections of burrows that *Orussus* appears to seek are apparently silent ones, not producing internal noises. This is no more than to say that they are uninhabited regions of burrows.

THE EGG IN OVIPOSITION

It is a surprising fact that the mature egg of *Orussus sayii* may actually be longer than the total body length of the female laying it. Thus, among her unlaid eggs, one female *O. sayii* only 13.7 millimeters long contained an egg that was fully 16.9 millimeters long. Now it is quite possible that the other large eggs that she contained were not fully mature, even though they lay partially within the oviducts and had lost the follicular envelope that characterizes the growing oocyte. Nevertheless these eggs were also proportionately remarkably elongate, having a mean length of 10.7 ± 0.2 millimeters. The information regarding the large oocytes dissected from 5 female *O. sayii* is summarized in Table I. It is important to note that these females are neither notably large nor small. They have a mean body length of 12.9 millimeters and their 69 measured, follicle-free eggs have a mean length of 9.6 ± 0.5 millimeters.

TABLE 1

Lengths in millimeters of body and mature (or nearly so) oocytes of *Orussus sayii* Westwood. The mean body length of the five females is 12.9 millimeters, and the mean egg length (N = 69) and its standard error is 9.6±0.5 millimeters. Very likely the largest egg in each female (last column) most closely approximates the length at oviposition. (L) and (R) indicate whether the largest egg was from the left or right ovary and oviduct. In the case of female A, ten eggs were removed but no record was kept as to their ovarian sources.

Female	Body length	Number of large oocytes in ovary on the: Left	Right	Mean size and standard deviation of large oocytes in ovary on: Left	Right	Largest Egg
A	11.9	(10)		(9.4±1.8)		11.9 (?)
B	12.0	10	10	9.4±0.8	9.5±0.7	10.7 (L)
C	13.0	7	8	8.7±0.4	8.5±0.9	10.0 (R)
D	13.7	6	12	11.6±2.7	10.8±1.0	16.9 (L)
E	13.8	6	6	8.9±1.8		10.0 (L)

The egg of *Orussus sayii* (Plate II, Figure 5) has a small nubbin at its anterior end, a clearly marked and swollen egg body, and a long, slender, nearly isodiametric filament. In general, the egg body is no more than approximately a seventh or eighth of the total length of the egg. In the case of one very carefully measured egg, the nubbin is 0.2 millimeter long, the swollen egg body is 1.8 millimeters long by 0.4 millimeter wide, and the filament is 10.1 millimeters long by 0.19 millimeter at the base, decreasing to 0.1 millimeter wide at the tip. The nucleus of the egg, to judge from the location of the germinal vesicle in younger oocytes, lies in the egg body toward the nubbin-bearing end. It is very likely that the micropyle is also located at this end.

In most cases the egg appears greyish white, and by transmitted light the cytoplasm seems to be uniformly granular. Female B, however, had the cytoplasm of the egg body bright lemon yellow in mature, nearly mature, and young oocytes alike. Whether this is a common variation within the species, I cannot say.

Since the total length of the egg may exceed the length of the woodwasp containing it, and indeed as the internal reproductive organs of the mature female are only 35% of the length of the woodwasp, it is not surprising that these eggs have a very special arrangement in the ovary (Plate II, Figure 1). The papillate end lies cephalad against the germaria, and the filament of each mature (or nearly mature) egg runs posteriorly in the woodwasp, folding back on itself at its proximal fourth, then folding back again at its midpoint, so that the apical half of the filament projects down the lateral oviduct (or "uterus") and must lead the way through the ovipositor during laying.

The ovipositor itself is 2.5 to 2.7 times as long as the female woodwasp (i.e., from 30 millimeters–37 millimeters long in females A to E), and is threadlike. Although just before its tip the ovipositor is approximately 0.08 millimeter wide, along most of its length it is approximately only 65 to 70 microns in diameter. The internal bore, which I can only roughly estimate, is about 40 microns. Since the egg is approximately 0.4 millimeter (400 microns) at its widest, and since the oviposition shaft in the wood is no more than 80 to 85 microns in diameter, it follows that the egg must be markedly deformed during its laying. This fact helps make its unusual structure understandable.

The volume of a single egg of *Orussus* is approximately 0.43 millimeter^3, of which 0.20 millimeter^3 is contained in the terminal filament. If the egg is squeezed into a cylinder of diameter equal to the bore of the ovipositor in its passage, then the volume of the egg lying within the bore of the ovipositor would be approximately 0.04 millimeter^3, or a sixth of the volume of the non-filamentous part of the egg. At this point the total surface of the egg would be 4.0 millimeters^2 (the surface area of the cylinder of egg in the ovipositor) *plus* approximately 6.3 millimeters^2 (the area of the portion not yet entrant into the ovipositor), or very roughly a total surface of 10.3 millimeters^2 as compared with the original surface area of about 7.4 millimeters.^{2} There is, then, an increase in surface of about 40%, and probably no greater over-all surface increase is needed during oviposition. Movement of the egg through the ovipositor must bring about a reduction in the girth of the egg body as it enters the ovipositor, and a corresponding flaring out of the distal tip of the egg issuing from the apex of the ovipositor. If the potential energy of the elastic coat (the chorion) of the egg is at a minimum in the mature ovarian egg, then, so long as the expansion of the egg's surface during oviposition at no point reaches either a bursting point or a new stable state (*v.i.*), the egg issuing from the ovipositor will tend to regain its original shape as laying is completed, and insofar as the surrounding space into which it is laid permits.

Two adaptive features of the peculiar shape of the egg of *Orussus* now become clear. First, the great length of the egg provides an initially large surface, so that the total surface need be stretched only 40% during passage through the small bore of the long wood-boring ovipositor. This is a relatively small increase in surface. For example, a spherical egg of the same volume would have to undergo a surface increase of fully 140% to pass the ovipositor. Second, the initial passage of the egg into the ovipositor requires considerable work, and very likely there must be a sufficiently large and available egg surface for the moving valves of the ovipositor to grip the egg and help force it into the long narrow tube of the ovipositor. The filament provides just such a large initial surface and, to judge from its orientation in the oviduct, it is the first portion of the egg to be moved into the ovipositor.

THE ELASTIC PROPERTIES OF THE EGG

If the egg body of an egg of *Orussus sayii* is quickly pressed out, the filament expands into a short varicosity that does not disappear when the pressure is released. Thereafter the egg body remains more or less collapsed, for the distended surface of the varicosity of the filament has attained a new stable state. Eggs of the large ichneumon wasp, *Megarhyssa macrurus* (Linnaeus), show a similar behavior. A first estimate of the properties of the chorion was worked out on the egg of *Megarhyssa*, for *Orussus* was no longer available when it became clear that the elastic properties are of more than passing interest.

The mean total length of the egg of *Megarhyssa macrurus* is 20.2 ± 0.15 millimeters (n = 11), the egg body lacks a nubbin and is 2.8 millimeters long by 0.55 millimeter wide, and the filament is 17.4 millimeters long by 0.1 millimeter wide. Diagram I gives a model of the relationship of potential energy to the diameter of the egg filament (ignoring hysteresis in the system), and it may be remarked that the properties are strikingly similar to those of rubber. Although the diagram makes a resumé of conclusions drawn from experiments with eggs of *Megarhyssa* only, it is nevertheless probably widely applicable in a general way to the extraordinary eggs of many Hymenoptera that possess long, slender ovipositors of very narrow internal bore.

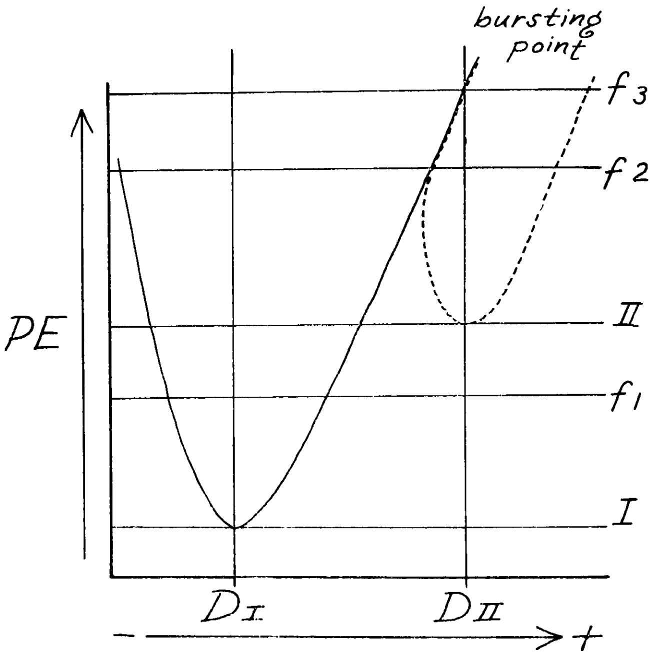

DIAGRAM 1

Model for a description of the elastic behavior of the filament of the egg of *Megarhyssa.*

Ordinate: potential energy of system. Abscissa: diameter of egg filament. Arrows indicate directions of increase.

At PE level I, the diameter D_I of the filament is normal, and stable—*i.e.*, the filament neither expands nor contracts spontaneously; work must be done to alter the diameter. A force f_1 will expand or contract the filament, depending on how it is applied; when released, there is a spontaneous return to D_I with a release of energy. If a force f_2 is applied, the filament may again be contracted or expanded. On release, the filament gives off energy and returns to D_I if it had been contracted. If expanded, the return may be along the dotted path to D_{II}; in this case the energy release is less, for the diameter at D_{II} is stable and at a higher energy level than at D_I. When the filament at D_{II} is again expanded by applying force f_3, it will again return to D_{II} on release of force. If the filament at D_{II} is *contracted*, work must be done (*i.e.*, PE raised to the level f_2) to surmount the energy peak separating the stable states D_I and D_{II}. Once surmounted, and in the presence of a restraint to expansion, contraction of the filament is spontaneous, and releases energy, until D_I is obtained. Regardless whether the start is at D_I or D_{II}, the filament will be burst if expanded much beyond f_3.

Work must be done to squeeze cytoplasm from the egg body into the filament, increasing both volume and area of the inflating filament. Work must likewise be done to decrease the diameter of the terminal filament if, conversely, cytoplasm is to be squeezed from it. Thus the moderately expanded or contracted states of the terminal filament are higher potential energy states than the normal one in which the filament has a diameter of 0.1 millimeter. If the disturbing force is removed, the filament gives off energy and returns to its original stable state of 0.1 millimeter diameter. This is shown in Diagram I, where the first trough (I) represents the normal stable state of the filament of the ovarian egg at diameter D_I, and f_1 the energy level of a moderate deforming force.

If more than moderate pressure (f_3) is used in forcing the contents of the egg body into the terminal filament, but not sufficient to reach the bursting point, then, when the force is released, the filament reduces its potential energy to the level II and remains at this new diameter. In the case of the egg of *Megarhyssa,* this new stable state (II) of the filament is at a diameter of 0.4 millimeter ($=D_{II}$). To return the filament to its original diameter (state I, D_I), work must be done to surmount the energy peak separating states I and II. Lastly, if a force is exerted which raises the potential energy level to exactly f_2, then it is a matter of chance whether the filament will return to its original stable state I, or to the new stable state II.

The significance of these facts is not as abstruse as might be imagined. If eggs are to return to their original states following oviposition, then either the forces of oviposition must not reach values of f_2 or more, or there must be an ancillary squeezing mechanism that will return the expanded filament over the energy hump separating states I and II. Furthermore the possibility exists that the compressed filament, as it issues from the ovipositor, may actually help draw the egg through the bore as it inflates in its return to its stable state. If so, the latter part of oviposition may not involve a continued expenditure of energy by the wasp, and yet the egg may appear to flow through the ovipositor as described by Smith and Compere (1928) for *Metaphycus.*

Preserving the same essential relations between one or more stable states, bursting points, and energy peaks, many of the obscure facts of oviposition and egg shape-changes in parasitic Hymenoptera appear to be explicable. It is clear that in some Hymenoptera [*e.g., Anysis saissetiae, Aphycus loundsburyi, Blastothrix sericae, Euaphycus luteolus,* etc.; *v.* Parker (1924), Smith and Compere (1928)] the laid egg has a wholly different shape from that of the ovarian egg, and that a new stable state has been reached. In others the laid egg is similar in shape to the ovarian egg [*v.* Clausen (1940) for information regarding the eggs of many entomophagous Hymenoptera.]

What the case may be for *Orussus* remains to be discovered. I had been unable to locate uninjured, freshly laid eggs, and captive *Orussus* did not attempt oviposition into large sections from dead trunks upon which they had been taken. Nor could the decapitate *Orussus* be stimulated to pass eggs when the thoracic ganglia and ventral cord were stimulated, although they readily enough exserted their ovipositors to the full extent under such stimulation. The ovipositor, which at rest lies wholly concealed within the body, is run out by the pumping movements of the abdominal sternites. These sternites possess internal pincer-like apodemes that engage the ovipositor within its sheath and thrust it from the abdomen. The sheath itself is passive, and does not extrude the ovipositor by contraction, as Bischoff (1923) maintains. The lateral valves of the ovipositor, which are toothed near their tips, also work back and forth upon one another and the median valve as the length of the ovipositor is driven from the body. During a normal oviposition, no sawdust is formed as the shaft is sunk into the wood, so the mode of penetration is very likely that of a tripartite wedge, dependent in part upon the rachet-action of the blades, and in part upon the thrust from the body of the insect. The process, in short, calls to mind the remarkable acupuncture procedures of the Orient, and it seems very likely that the oviposition shaft, only 80 microns in diameter, is formed by pressing the tissues of the wood aside. If so, the task is very likely not so difficult a one or so remarkable as it might at first seem. The ovipositor should not be viewed as dealing with a hard mass of wood, but rather with the walls of the component cells of the wood, and these only in small aggregates, or indeed as individual cells. It may also be that one or more cellulases are secreted as adjuvants to ovipositor penetration.

REPRODUCTIVE ANATOMY OF THE FEMALE

When a female *Orussus sayii* is dissected under saline, and the dorsal exoskeleton removed from the prothorax to the tip of the abdomen, 4 great structures run along the length of the opened body. Three of these, the gut and the 2 enormous, silvery lateral tracheal trunks, are familiar and equally prominent elements in the dissection of most symphytous Hymenoptera. But the fourth, the integumentary sheath of the ovipositor, is exceptional and a peculiarity of *Orussus*.

The golden yellow sheath of the ovipositor arises posteriorly in the abdomen at the basal plate, and ventral to the gut. It extends forward, twisting sinistrally over the gut, into the most anterior dorsal portion of the thorax where, seen from the left side, it is thrown into a true, counter-clockwise spiral. The ovipositor itself lies within the sheath, running cephalad from its base. At the blind end of the sinistral spiral of the sheath the ovipositor reverses its direction, and exits from the spiral in a clockwise course about the loop, taking a sinistral twist about the gut as it runs posteriorly to its point of exit from the abdomen. Rowher's and Cushman's illustration [1917, Plate 12, Figure 4; also reproduced by

Bischoff 1927] of the retracted ovipositor, removed from its sheath, shows nicely the reversal of direction in the spiral loop.

The ovaries of the 2 sides (Plate II, Figure 1) lie close to the midline, between the lateral tracheal trunks, and extend forward to unite, horseshoewise, at approximately the level of the apex of the first abdominal segment, dorsal to both the gut and the sheath of the ovipositor. The ovaries are held in this position by a half dozen or so tracheoles that run to each of them from the corresponding lateral tracheal trunk, and by a median, apical suspensory ligament (s*l*). The suspensory ligament runs below the deep notch of the scutellar apodeme, forward to apparently the dorsal internal rim of the pronotum.

Each ovary is enclosed in a delicate tunic (t). The number of ovarioles (o) per ovary was 4 in each of 3 females, but 1 female had only 3 ovarioles per ovary. The germaria (o) are small, and converge on one another anteriorly. The developing oocyte has the germinal vesicle located cephalad, close to the conduit by which the material from the cluster of 15 nurse cells passes into the oocyte. The elongate oocyte is surrounded by a cuboidal follicular epithelium. When approximately 1 millimeter long, the oocyte first sends out from its caudad end the initial rudiment of the egg filament. At this stage the cytoplasm of the oocyte is fine and homogeneous in texture, contrasting with the granular yolk that develops later as the filament lengthens.

The greatest number of nearly mature, or mature, eggs (e) found in any ovary of *Orussus sayii* [5] was 12 (female D, table 1), and none contained less than 6. These eggs no longer possess nurse cells or a follicular epithelium, and their filaments (f) are proximally folded on the egg body v. p. 51), while the ditsal half of the filament extends straight down the oviduct (od).

The ovarioles of an ovary converge at their caudal ends to form the thin-walled lateral oviduct (od). The lateral oviduct of each side terminates in an expanded bulb (oa), the internal epithelium of which is high columnar and regionally thrown into villus-like processes. The bore of the passage through this glandular site is narrowed to little more than the diameter of an egg filament, and usually the end of the filament of the largest egg projects through the passage of the bulb into the genital chamber (v).

At the level of the juncture of the oviducal bulbs of each side, which lies ventral to the gut, the duct from each large lateral accessory gland (agl) enters, as does the median ductus seminalis (ds) from the trilobed spermatheca (sp) that lies between the oviducts. The spermatozoa form a tangled mass within the cavity of the median bulb of the spermatheca.

[5] *Orussus sp.* may contain 16 or more nearly mature eggs per ovary. The eggs of these small females have quite a different ratio of egg body to filament, although the general shape is the same as that of *O. sayii.* On the average the egg filament is only 3 times, or less, the length of the egg body in *O. sp.*, whereas it is 6 to 7 times the length of the egg body in *O. sayii.*

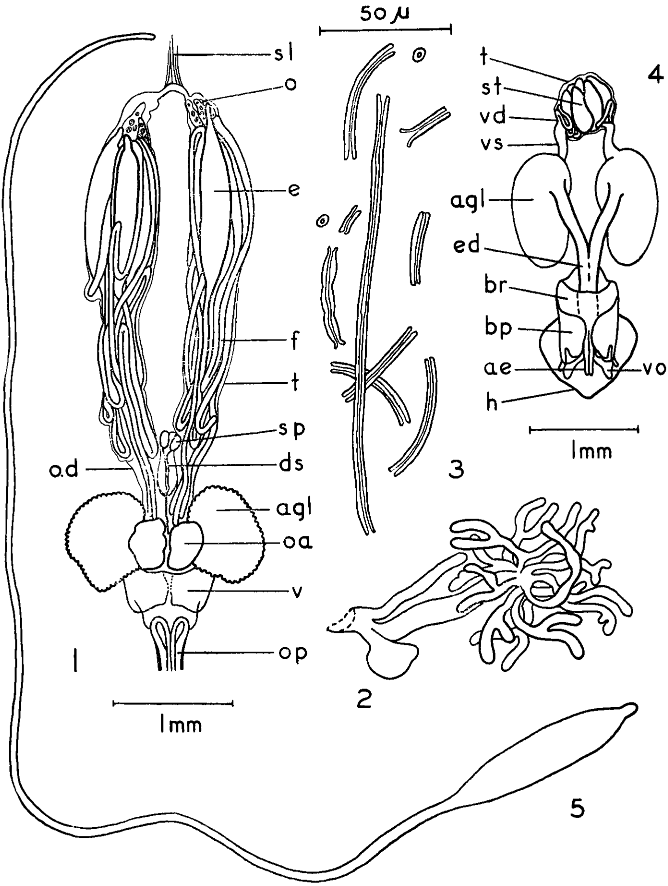

PLATE II

Figures 1–5. Reproductive anatomy of *Orussus sayii* Westwood

Figure 1. Internal reproductive organs of female. The ovaries and oviducts are in ventral view, the remainder in dorsal aspect, (see p. 56). Legend: agl-lateral accessory gland, ds—ductus seminalis, e—egg body, f—egg filament, o—germarial end of ovariole, oa—oviducal bulb or ampulla, od—oviduct, op—base of ovipositor, sl—suspensory ligament of ovary, sp—spermatheca, t—tunic, v—genital chamber, or "vagina".

Figure 2. Ventral accessory glands of female; see description, p. 59. These are drawn to the same scale as Figure 1.

Figure 3. Tubular bodies, in cross-section and lengthwise view, from lateral accessory gland of female. See pp. 59, 63.

Figure 4. Reproductive organs of male in dorsal view (see p. 59). Legend: ae—aedeagus, agl—lateral accessory gland, bp—basiparamere, br—basal ring, ed—ejaculatory duct, h—hypandrium, st—sperm tube, t—tunic, vd—vas deferens, vo—volsella, vs—vesicula seminalis.

Figure 5—Mature (or nearly so) egg, to same scale as fig. 1; see p. 51.

The common passage that receives all the entrant ducts forms the genital chamber or "vagina" (v), which is confluent with the basal entrance to the ovipositor as well as with the gonopore.

The large lateral accessory glands have a corrugated appearance. They are thin-walled sacs that are tightly packed with curious structures that appear to be tubular (Plate II, Figure 3). These rod-like elements take flow-patterns in the vicinity of the duct of an accessory gland, and there is little doubt that they are passed via the genital chamber, presumably during oviposition.

The genital chamber (v) lies ventral to the gut. It is walled by a very high columnar epithelium, and lined internally by a cuticular membrane. Anteriorly it lies against the base of the ovipositor (op) and the caudal end of the sheath of the ovipositor. Here, there is a complex median gland (Plate II, Figure 2), apparently wholly connected with the ovipositor. This accessory gland extends posteriorly below the gut and consists of a ventral pouch, a dorsal, unbranched, tubular portion, and a branched element.

Although Figure 1 in Plate II shows the connections between the different portions of the female genital anatomy, the manner of their display is artificial for the organs are actually bent upon themselves in the body. The most anterior portions of the genital anatomy are the median suspensory ligament (sl) arising from the horseshoe shaped connection between the ovaries, and the genital chamber (v). In the figure the suspensory ligament is shown at one end, the genital chamber at the other. This is owing to the fact that the genital chamber, the lateral accessory glands, the spermatheca, and oviducal bulbs or ampullae are represented in *dorsal* aspect, but the ovaries and oviducts are seen in their *ventral* view. In other words, they have been folded back fully 180° to the rear along the midline, in order to display the lateral accessory glands, oviducal bulbs, etc., over which the ovaries lie in the abdomen.

When an egg descends into the ovipositor, the tip of the filament almost certainly leads the way. When the body of the egg is drawn fully free from the ovariole and oviduct in which it rested, it lies medially along the length of the genital chamber. As the nubbin developed from the region of the oocyte that was penetrated by the yolk conduit joining the nurse cells with the oocyte, and close to which the germinal vesical was located, it seems very likely that the yolk conduit is finally transformed into the micropylar passage. If so, fertilization very probably occurs when the egg filament lies wholly within the ovipositor and the egg body lies in the genital chamber. With the egg so arranged, the apex of the nubbin is appressed against the entrance of the seminal duct to the genital chamber.

REPRODUCTIVE ANATOMY OF THE MALE

The internal reproductive organs of the male *Orussus sayii* (and *O. sp.*) are very simple in arrangement and organization (Plate II, Figure

4), and do not depart in any notable manner from those of various unrelated Hymenoptera that have been described by Bordas (1895). The testes are enclosed in a common tunic, and lie medially above the gut at the level of the fifth tergite. Each testis is made up of four sperm tubes (st) that are confluent basally. A tightly coiled vas deferens (vd) with a very narrow lumen is appressed laterally to each testis, ultimately extending posteriorly as a thick, sperm-choked vesicula seminalis (vs) that joins the lateral accessory gland (agl).

Each bean-shaped accessory gland curves ventrally on its side of the gut. From its dorsal portion, not far from the entrance of the vesicula seminalis, the lateral ejaculatory duct (ed) emerges and continues posteriorly to join that of the other side, below the gut and within the phallus.

The colorless tunic (t) of the testis is continuous with that of the vesicula seminalis and lateral accessory gland. Within the lobes of the testis are densely packed clusters of spermatids and, more rarely, secondary spermatocytes. The major waves of spermatogenesis have almost certainly passed by the time of emergence of the average male. Bundles of mature spermatozoa pack the large lumen of the vesicula seminalis, and sometimes lie in a coherent mass along the dorsal wall of the lateral accessory gland, extending to the mouth of the ejaculatory duct. The individual spermatozoan is 70 microns long, of which the head comprises 10 microns.

If the muscular tunic and high columnar epithelium of the accessory gland is opened, the whole cavity of the gland (below the mass of spermatozoa, if present) is found to be filled with a thick, gelatinous secretion. The ejaculatory ducts have a high stratified or pseudostratified epithelium that limits the lumen to a narrow slit-like passage. Normally the ejaculatory ducts are empty.

DISCUSSION

The Phylogenetic Position of the Orussidae, and the Uncertainty Regarding its Larval Feeding Habits

At the time that Rohwer (1912) monographed the North American *Orussus* and commented on the family as a whole, no definite information was available concerning the over-all life history of any member of the family. Of course, the adults were known to frequent dead trees and to oviposit in hard, dead wood, but no one knew for certain whether the larva is lignivorous, parasitic, parasitoid, or of still another food habit. Some, as Wachtl (1877), had reared *Orussus* from dead wood along with buprestid beetles of the genus *Dicerca*. Harrington (1887a b) had also found an adult *Orussus* cutting an exit burrow in the trunk of a dead tree, and still another in the larval burrow of *Dicerca*. Yet Harrington remained open-minded regarding the woodwasp's larval habits, and merely indicated that such facts do not allow a decision in the matter. Even Rohwer (1912), recording Hopkins' discovery of the pupa of *Orussus* in an old mine of a long-horned beetle (Cerambycidae) in dead wood of spruce, remained wondering: "Did this insect crawl into the Cerambycid mine to pupate? If so, where did it spend its larval period? Or, was the Orussid parasitic on the Cerambycid?" [6]

Taxonomists of this period were well agreed that the orussids belong within the suborder Symphyta (=Chalastogastra) for, as in the sawflies and their allies, the abdomen is broadly joined to the thorax (*i.e.,* not petiolate), they possess cenchri, a second anal cell in the forewing, a strong development of the basal field in the hind wing, and, although considerably reduced, the general wing venation is of the xiphydriid type, and so on. For the most part, taxonomists were also agreed that the orussids are best grouped with the Siricidae (horntails) and Xiphydriidae (camel flies) within the Symphyta. Rohwer (1912), too, held orussids to be symphytous forms, most closely allied to the Siricidae. Nevertheless he placed stronger emphasis on some of their singular attributes—such as the strongly ventral location of the antennae, the marked reduction of wing venation, the apparently 3-jointed fore-tarsus of the female, etc.—and set them apart in a new superfamily, the Oryssoidea.

When Burke (1917) announced that field observations "definitely prove that *Oryssus* is parasitic on several species of the genus *Buprestis* and probably also on other Buprestidae", Rohwer and Cushman (1917) promptly elevated these woodwasps to subordinal status, designating them as Idiogastra. They maintained that the parasitic habit of the larva indicates that the peculiar characters of the orussids are of subordinal value. "Briefly expressed", they say, "the suborder Idiogastra stands intermediate between the suborder Chalastogastra [=Symphyta]—where the adult would place it—and the suborder Clistogastra [=Apocrita]—with which the larva would ally it." [7] (Square bracketed inserts are not in the original.)

However, the suborder Idiogastra has not stood the test of time, and each new, detailed re-examination of the bases for phylogenetic decision has only affirmed more strongly still the close relationship of the orussids to the xiphydriids and, especially, the siricids. Omitting at this point consideration of the food habits upon which Rohwer and Cushman placed such strong emphasis, it is difficult to draw any conclusion from the anatomy of *Orussus'* larva other than that it is very similar to the known larvae of siricids and xiphydriids, as Yuasa (1922), especially, and Bischoff (1926, 1927) have commented. Larvae of members of all three of these families agree among themselves, and differ from the larvae of all other sawflies, in lacking subanal appendages, ocellariae, and ocularia, and in

[6] Oddly enough, Rohwer (p. 145) thereafter remarked that orussids have habits similar to siricids, "being internal feeders in wood."

[7] The reader should bear in mind that Rohwer and Cushman did not establish any strong similarity between the larva of *Orussus* and that of any Apocritous larva. They placed enormous weight upon the alleged entomophagous food habit.

having modified mouthparts. Also, like the larvae of cephoid sawflies, they lack larvapods and have greatly reduced thoracic legs. The only pronounced morphologic difference is the degree of reduction of the thoracic legs in *Orussus,* where they are represented by no more than sclerotized discs. Yet even this suggests siricoid affinities for, as Yuasa has remarked, the orussid larva seems merely to have advanced further than xiphydriids and siricids along the same path of degenerative modification from the primitive pamphiloid type. All of these larvae live in burrows in wood, and the modifications for the most part obviously reflect the pecularities of such a life. The larva of *Orussus,* then, is actually strikingly similar to the larvae of siricoid forms. No anatomical peculiarity so far discovered warrants the setting apart of a new suborder Idiogastra.

The morphology of the adult insect overwhelmingly favors the same close alliance of the orussids with xiphydriids and siricids (*v.* Bischoff 1923, 1926, 1927; and especially Ross 1937). Ross (1937) has made a very extensive and searching inquiry into the comparative anatomy of adults of all groups of sawflies, and has disclosed many new correspondences of the orussids with syntectids, xiphydriids and siricids. The adult xiphydriids, siricids, and orussids all possess: (1) a genapontal head with subantennal grooves for the reception of the basal antennal segments in repose, (2) a long, spatulate labrum and 3-jointed labial palpi, (3) very large cervical sclerites, (4) a pronotum that is tilted markedly forward, (5) a triangular sternum undivided by a suture from the episternum, (6) an undivided epimeron, (7) a secondary transverse suture across the mesoscutum, (8) an absence of preapical tibial spurs, (9) a protrusion of cenchri from the mesometanotal suture, and (10) a more or less straight course to the wing veins, as well as other lesser attributes. Furthermore, the siricids and orussids alike have a solid, inflexible union of the thorax with the abdomen.

So far as the distinctive characters that mark off the Orussidae are concerned, those of the head (the drawn-in mouthparts, the shift of the antennal sockets, clypeus and labrum to the ventral aspect, and the atrophy of the supratentorial arms) are no more than the culmination of a tendency that is so marked in the Siricidae. The peculiarly distinctive attributes that remain, then, consist chiefly in the atrophy of vein 1r in the forewing, in the 4-jointed foretarsus and notably segmented foretibia of the female, the truly unique ovipositor, and the equally characteristic genital capsule of the male (*v.* Ross 1937). No exceptional weight need be given these characteristics, however. Vein 1r is also under reduction in some cephids, and the peculiar structure of the foretarsus and foretibia of the female is not shared by the male (which possesses the usual 5-jointed foretarsus). The remaining modifications seem of subordinate value taxonomically, and show no obvious relationship to those of other Hymenoptera outside of the Symphyta. Indeed, as Ross (1937) has remarked, the Orussidae as a group possess no more distinctive characters of their own than do the Siricidae. The Orussidae, then, are best joined with the Syntectidae, Xiphydriidae, and Siricidae, in the superfamily Siricoidea of the suborder Symphyta, as Ross (1937, 1951) has placed them.

We now come to the alleged entomophagous habit of the orussid larva, from which has stemmed so much of the interest in Orussidae. The feeding habits of the xiphydriids and siricids, morphologically and phylogenetically the closest living relatives of the orussids, have long been held to be lignivorous. There is no doubt that they mine through wood, but it is also likely that their diet actually includes a fungus or other microorganism. Buchner (1928, 1930, 1953) has most wonderfully shown that female *Sirex* regularly harbor a symbiotic fungus. Cartwright (1938) has corroborated this observation for *Sirex,* and demonstrated that female *Xiphydria* also carry symbiotic fungi belonging to the pyrenomycetes. The fungi are located in a special sac associated with the base of the ovipositor in the pupal and adult female woodwasp. Cartwright has proven that these woodwasps can and do introduce the fungus they carry into the dead wood in which they oviposit. Since the female woodwasp and the fungus are habitually associated, there is little doubt that the two organisms are now symbiotic, playing essential roles in one another's life economies. The possibility of such a relationship should be carefully explored in the female *Orussus.*

Unfortunately material now at my disposal does not make possible an examination of the contents of the accessory glands (especially the pouch) associated with *Orussus'* ovipositor. The nature of my earlier dissections leaves it entirely possible that still other glands, of a mycetosomal type, have been overlooked, for my examinations were directed chiefly at a general, gross description of the egg, ovary, oviducts, spermatheca, and the accessory glands of the genital chamber, proximal to the oviducts. The curious bodies (Plate II, Figure 3) found in the accessory glands of the genital chamber suggests microorganisms, but are quite possibly special products of the gland itself.

It would be unfortunate to place undue emphasis on the few oviposition burrows that Burke and I have examined, yet judging from these it does seem that oviposition is made into old, frass-containing burrows of buprestids and other beetles. The likelihood seems a small one that the newly hatched larva of *Orussus* works its way, without food, through the sawdust and the lengths of a mine until it locates an active segment containing a wood-boring coleopterous larva. It also seems a remote possibility that beetle larvae in active mines once again pass back through their old, abandoned burrows. Yet, if they do not, how is a parasitic or parasitoid relationship established? Surely the hypothesis that *Orussus* larvae feed upon wood frass, perhaps infested with fungi, yeasts or other microorganisms, is in accord with the facts of oviposition and the habits of *Orussus'* closest living relatives. And it is assuredly not out of harmony with Burke's observations.

Burke (1917) actually does not give adequate information for the conclusion to be drawn that *Orussus* is entomophagous, and it is perhaps unfortunate that his inference has now become so widely accepted. The occurrence of *Orussus* larvae, ready for pupation, in the outer burrows of buprestids, and even in buprestid pupal cells, is as consistent with the notion that *Orussus* feeds on wood frass (and microorganisms) as the idea that it is entomophagous. The critical demonstration of entomophagy must be the rearing of *Orussus* larvae on larvae of wood-boring beetles, and this Burke did not do. The ranger's observation of an *Orussus* larva "attacking" a larva of *Buprestis,* at least in the form Burke presents it, is open to interpretations that do not require belief in an entomophagous habit for *Orussus.*

It is quite possible that Burke did draw a correct conclusion, even though the basis for his inference—as he presents it—is incomplete and ambiguous. On the other hand it seems at least equally possible that larval *Orussus* feed on fungus-ridden wood, or less likely, on wood alone. Such a habit is consistent with the little we know of *Orussus'* oviposition habits, as well as with the larval feeding habits and symbionts of its closest relatives. Less likely, perhaps, is the possibility that a dietary transition from phytophagy to entomophagy occurs in *Orussus'* larval life, or that in the final instar the larval *Orussus* usurps a wood-mining bettle's pupal burrow—if necessary, even killing the original inhabitant.

The curious ovipositor of female *Orussus* has been taken by some to be a consequence (and proof) of parasitic habit, but it need only be thought of as the anatomical expression of *Orussus'* need to oviposit deeply in wood, whatever its larval food there. The stalked egg, like a long ovipositor so common among parasitic Hymenoptera, is likewise no more than an adaptation that makes possible the passing of relatively large protoplasmic masses (eggs) through relatively very narrow tubes. And the ovipositor's slight girth, as argued above (p. 56), is probably an adaptation that at the microscopic level makes easy passage into a material that is dense and refractory at the macroscopic level. Ovipositor and egg alike are no more than convergences in *Orussus'* evolutionary history.

Steps in the Evolution of Parasitism among Primitive Hymenoptera

Ashmead (1894) early suggested that orussids may have been the forerunners of some parasitic forms, such as the Megalyridae and Stephanidae. Brues (1921) and Wheeler (1928) also believe that the orussids may represent such a stem, accepting as they do an entomophagous habit for the larva, and emphasizing the interesting point that the most primitive families of parasitic Hymenoptera existing today are all associated with wood-boring insects.[8]

[8] Bischoff (1927) and Ross (1937) have shown that, among Symphyta, cephoid forms are most like the putative ancestors of parasitic Apocrita. There is little question that the orussids represent a very highly specialized symphytous type.

Such an association of primitive parasitic type with parasitism upon wood-boring forms seems to me reasonably understandable. For one thing, a sluggish, corpulent host of limited mobility, confined closely in space, would seem to present fewest difficulties in allowing the larva of the evolving parasite to maintain close contact with the host. Second, the length of larval life of the host-to-be should preferably be a long one, at least equal to that of the developing parasite, and preferably longer. Third, the two forms—future parasite and future host—ought to occur together naturally. Finally, if the two insects have the same or similar larval foods, the path to a parasite-host relationship becomes an open one.

Whatever the case may prove to be, the larval habits of *Orussus* no doubt still stand in a marked relationship to the origin of parasitism in the Hymenoptera, but as an example of how the transition from larval phytophagy to entomophagy may be initiated, and not as a progenitor to the parasitic habits of apocritous Hymenoptera. The usual picture of *Orussus* as a parasite portrays the larva of the primitive hymenopterous form as a larval wood-feeder that, habitually chancing upon beetle larvae mining through the wood, somehow took to feeding upon the larval beetle. It is supposed that selection thereafter somehow resulted in the fixation of a type that oviposited directly into the vicinity of the beetle larva, or into the beetle larva itself within its mine of wood.

To me, the steps appear smaller, and the change-over in larval feeding habits more readily understandable, if the original hymenopterous form is viewed as having successfully taken to feeding upon the woody frass of abandoned beetle mines.[9] If so, it would then have been free to lose (by "degeneration") its own mining proclivities and equipment, once it had come regularly to oviposit into the larval mine of the beetle, provided the mines into which it oviposited had first been proven to the wasp to have an opening to the exterior, or a larva within it that made such an opening a future likelihood. At this step, the woodwasp would have been tied only to the beetle's mine; it would have become a resident of the beetle's home, a "synoekete".

Now, feeding on frass, the potential parasite would of course have been feeding upon the beetle's excrement containing organic materials and compounds passed by the larval beetle. Suppose that the hymenopterous larva itself had normally synthesized one or more of these organic substances, and that they were not directly provided by wood (or fungus). If they now were provided in the new food in adequate amounts, then a next, very important step can be conceived to have occurred. Since the original food of the hymenopteran would not have provided these materials, gene mutations that blocked the syntheses giving them would necessarily have

[9] I have omitted mention of symbiotic fungi because of the unwieldy circumlocutions that are then needed. The argument need not be altered by this complication; indeed, the presence of the fungus adds still another factor that might assist in forever fixing the developing parasite to the ultimate host (*v.i.*).

resulted in lethal types, and would of necessity have been lost or would have remained infrequent in the population. But where these necessary substances were provided in the food, they would no longer have had to be synthesized by the woodwasp larva, and such mutational blocks would have been free to occur. Once such mutations had been spread throughout the population of woodwasps, the hymenopteran would have become virtually chained thereafter to the organic products from the beetle. Except by feeding upon frass passed from a beetle's intestine, the larval woodwasp would now be unable to obtain all of the special organic materials it needs for its development.[10] The remaining steps in the establishment of entomophagy seem relatively minor, perhaps even inevitable ones if given an indefinite time-stretch.

If *Orussus* is still a wood (and/or fungus) feeder, it may be thought to be a woodwasp that has attained only the first step in this evolutionary sequence, namely it has become an obligatory inhabitant of the old mines of larger woodboring beetles. The adult female must traverse and explore the extent of the subsurface mines in the wood (as she seems to do), not only bcause she must locate frass, but because she must also make certain that the mine will be open to the outside. On the other hand, if *Orussus* is now an entomophage, the elaborate exploration routine is required as a guarantee that the mine is inhabited.

SUMMARY

1. There are two species of *Orussus* in New York and New Jersey: *O. sayii* Westwood and an apparently undescribed form. The latter is easily recognized by its small size, uniform body coloration in both sexes, and characteristic wing pattern.

2. *Orussus sayii* may be found from late May to mid July on bark-free areas of dead, firm wood of a variety of trees. *O. sp.* also occurs on dead sugar maple and elm from late May through July.

3. The sex ratio in field captures of *Orussus sayii* (and *O. sp.*) is skewed so that females predominate in collections. Very likely, on the average, males emerge earlier than females.

4. The movements and behavior of *Orussus sayii* on tree surfaces are described, as well as a combat among males witnessed by female woodwasps.

5. The manner of selection of the site for egg laying is described, and the facts make plausible the notion that *Orussus* may, in part, locate the oviposition target by means of differentially reflected vibrations.

6. The oviposition borings that were examined ran into old, frass-filled abandoned mines of wood-boring beetles (probably *Dicerca*), lying an inch

[10] The symbiosis of *Sirex* and *Xiphydria* with a fungus is explicable in exactly the same formal manner. To Lwoff (1943) biologists owe a considerable debt for beautiful and satisfying analyses of precisely this sort for adaptions among microorganisms.

or so beneath the surface of the wood. It is argued that this may be the normal oviposition site, and Burke's single case is in agreement with this conclusion.

7. The length of the mature egg of *Orussus* may actually exceed the body length of the female that lays it. The arrangement of the egg in the ovary, its deformation during oviposition, and its adaptive attributes are discussed.

8. The elastic properties of the egg of *Megarhyssa* are described, and it is argued that the shape-changes undergone in oviposition of hymenopterous eggs can be accounted for in terms of different stable states, and physical properties akin to those of rubber.

9. Driving a hole 80 microns in diameter into hard wood is probably accomplished rather simply by *Orussus* (and other Hymenoptera with long, slender ovipositors), cell walls and woody fibers being dealt with individually or in small aggregates only.

10. The reproductive anatomy of male and female *Orussus sayii* is described and figured.

11. The orussids are assuredly symphytous forms closely allied to Siricidae, as most now agree. It is important, therefore, to investigate the possibility that they carry and transmit a symbiotic fungus, and feed upon fungus-and-wood as larvae.

12. Emphasis is given to the need for definite information about larval feeding habits of *Orussus*. The facts are inadequate to conclude that they are entomophagous, as they are universally believed to be.

13. The importance of wood-boring beetles as hosts of primitive parasitic Hymenoptera is discussed, and a pattern for the initial establishment of host-parasite relationships between lignivorous Hymenoptera and wood-boring insects is outlined.

14. Ovipositor length and girth, and egg shape do not bear on whether or not *Orussus* is a parasitic woodwasp. They represent evolutionary convergences common to forms that oviposit relatively deeply within macroscopically hard, refractory materials.

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THE CYPERACEAE OF MONROE AND ADJACENT COUNTIES, NEW YORK

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AND

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Fifty-seven years ago plants growing without cultivation in Monroe and adjacent counties were very ably catalogued by Florence Beckwith and Mary E. Macauley in the Proceedings of the Rochester Academy of Science, Volume III (1896). Fourteen years later appeared the first supplement (Beckwith, Macauley, and Baxter, 1910) recording new stations for plants considered rare in the 1896 list and adding new species discovered since. In 1917 a second supplement (Beckwith, Macauley, and Baxter) further expanded the list of the known flora of Monroe and adjacent counties and extended the known distribution of certain rare species.

The Botanical Section of the Rochester Academy of Science has long desired to revise the nomenclature of the 1896 list and to combine it with its two supplements and with the results of the activities in recent years which have increased the known flora of this particular area. This has been accomplished, in part, by several papers on local floras. However, a consolidation of existing records of the flora of the entire area was still to be desired. It is hoped that the present paper will be followed by others of similar purpose until all plant families in the 1896 list and subsequent supplements have been revised.

The scope of the present list of the *Cyperaceae* is approximately that of the 1896 list of plants, which, in general, was the drainage basins of the lower Genesee River, the Irondequoit Creek, and some smaller streams on the border of Lake Ontario. More specifically, the territory included all of Monroe County and parts of Orleans, Genesee, Livingston, Ontario, and Wayne counties. As transportation improved, however, boundaries were pushed back until one finds the subsequent supplements citing stations for plants throughout the adjacent counties.

More than four years have been spent checking all available records of the *Cyperaceae* in this area against specimens in the herbarium of the Rochester Academy of Science and the private herbaria of the authors. When it was reasonably certain that all available information had been collected, the present catalogue with keys was attempted. The introduction of keys in this work is experimental, inasmuch as we believe that what has been accomplished with this most difficult order can be repeated in subsequent papers on the flora of Monroe and adjacent counties. The key, with changes to adapt it to species occurring in this area, was taken in the

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main from *Gray's Manual of Botany,* seventh edition, by Robinson and Fernald. Some parts of the key to the Genera of the *Cyperaceae* were taken from *Flora of the District of Columbia* by A. S. Hitchcock and Paul C. Standley, and for descriptions of some species of Section *Bracteosae, The Flora of Cayuga Lake Basin* by Karl M. Weigand and Arthur J. Eames was used. The authors wish to express their thanks for the privilege of using the parts of the keys from these publications.

The nomenclature used in this paper is that of *Gray's Manual of Botany,* eighth edition, by M. L. Fernald. The botanical names are printed in bold face type and whenever these names or authorities differ from those of previously published lists by the Rochester Academy of Science, the prior names are italicised below the name now in use. Common names and those of introduced species are printed in small capitals.

The sequences of the genera, of the species of each genus, and of the sections of the Carices also follow those of the manual mentioned above. All members of a sequence have been numbered, beginning at one.

All species listed are represented by specimens in the herbaria of the Rochester Academy of Science, of the New York State Museum at Albany or of the authors. Specimens of practically all species are located in Rochester. With the exception of the most common species, all identifications have been verified by two or more competent authorities.

The descriptive matter pertaining to habitat and frequency of each species is based on the significance of collection data obtained from specimens in the herbaria mentioned above. Members of the *Cyperaceae* are largely inhabitants of low meadows, creek borders, swales and bogs. But, like other orders of plant life, every type of habitat represented in the area will have one or more species of the *Cyperaceae* in some degree of frequency. Frequency, while dependent in many instances on abundance and distribution of previously collected specimens, is supplemented by field observations of the authors. The following terms have been used to denote the known frequency of plants in the area. Only the first, signifying rare plants, is based on the recorded number of stations. The remaining terms are intended to classify plants on the basis of the possible extent of favorable habitats and the frequency of the plant in those habitats.

Rare	—plants known from three stations or less. Abundance of the plant in one or all three stations, seemingly the opposite of rare, does not remove it from this classification.
Scarce	—plants that occur sparsely in a habitat of limited extent
Infrequent	—plants that occur more plentifully in a habitat of limited extent.
Frequent	—plants that may be expected to be plentiful in a number of habitats.
Common	—plants that occur in quantity, in a wide variety of habitats.
Wayside	—plants that invade roadsides, waste places, and fields.

In the second paragraph, following the name of each species, an effort has been made to indicate its general distribution. Data for species distribution is ordinarily furnished by examination of collected material, which is lamentably scanty for many species. However, it is general practice to assume that in the area between two widely separated stations the plant may be sought in habitats similar to those of the stations where the collections were made. Collector's name, collection number, date of collection, habitat and specific locality, whenever known, are shown only for the most recent collections.

In the days when botanical field trips were limited to regions accessible only by means of railroads and interurban trolleys, the name of the railway station nearest the collecting area visited was often recorded as the station for the specimen collected even though it may actually have been found several miles distant. The names of these towns and villages still serve to establish the general distribution of the plant and are therefore used freely throughout the catalogue for this purpose.

Towns and villages mentioned as sites of collections, if situated in counties adjoining Monroe, are followed by the name of the county in which they are located; those without county designation are of Monroe County. United States Geological Survey maps or ordinary road maps may be used to determine the approximate collection site of a particular plant. Names used to designate collecting regions, however, are usually of local origin and may not be noted on maps. The following table will help locate these.

Bergen Swamp.—Situated three miles west of Bergen in Genesee County. See Proceedings of Rochester Academy of Science 7 : 209. 1937 and 9 : 64. 1946.

Black Creek near Chili Road.—Specific locality not known; possibly in the vicinity of West Chili.

Blue Pond.—Near northwest corner of Wheatland Center Road and North Road, in town of Wheatland.

Braddock's Bay.—Border of Lake Ontario in town of Greece.

Buck Pond.—Border of Lake Ontario in town of Greece.

Burroughs Audubon Conservation Station.—Near Railroad Mills, Ontario County.

Buttermilk Falls.—Where Oatka Creek flows over an escarpment formed by an outcropping of Corniferous limestone, one mile northeast of LeRoy, Genesee County.

Canadice Lake.—Two miles west of Canadice, Ontario County.

Cedar Swamp.—Site of an abandoned Lehigh Valley Railroad siding, three miles south of East Henrietta, on route 15A.

Cranberry Pond.—Border of Lake Ontario in town of Greece.

Crescent Beach.—Summer resort on Lake Ontario in town of Greece.

Crosman Pond.—Near Powder Mill Park on Fishers Road in town of Perinton.

Densmore Creek.—Drains the southeastern part of town of Irondequoit and flows through a deep ravine into Irondequoit Bay near Glen Haven.

Durand Eastman Park.—City of Rochester park, situated on the shore of Lake Ontario in town of Irondequoit.

Egypt Swamp.—On Victor Road near Egypt in town of Perinton.

Ellison Park.—Monroe County park, situated in the Irondequoit Creek valley, on Blossom Road in towns of Brighton and Penfield.

Float Bridge.—The route 104 crossing of Irondequoit Bay. The specific collecting region is unknown, probably on the east side of Irondequoit Bay in town of Webster.

Hamlin Beach Park.—New York State park on shore of Lake Ontario in town of Hamlin.

Hipp Brook.—Near Whalen Road in town of Penfield.

Honeoye Lake.—Near Honeoye, Ontario County.

Inspiration Point.—A projection into Irondequoit Bay having steep sandy bluffs, near village of West Webster.

Irondequoit Bay.—Situated in Monroe County, bounded on the east by town of Webster and on the west by town of Irondequoit.

Island Cottage.—Summer resort on Lake Ontario, town of Greece.

Jaeschke's Mill.—The mill site, abandoned many years ago, is in the Irondequoit Creek valley one mile west of Bushnell's Basin on route 96.

Jenkins' Woods.—In town of Pittsford, now the property of the Oak Hill Country Club.

Junius Ponds.—A series of marl bogs and ponds situated in town of Junius, Seneca County near the eastern border of Ontario County and draining north into the Clyde River.

Lake Bluffs in town of Webster.—Specific locality unknown, possibility in the vicinity of Nine Mile Point.

Lima Ponds.—A series of small ponds situated in Livingston County near the crossing of Honeoye Creek by route 20.

Little Black Creek.—Collecting region unknown, probably on route 33A near Howard Road in town of Gates.

Long Pond.—Border of Lake Ontario in town of Greece.

Manitou Beach.—Summer resort on Lake Ontario in town of Greece.

Mendon Ponds.—Now Mendon Ponds Park.

Mendon Ponds Park.—Situated in the southeastern part of Monroe County. See Proceedings of Rochester Academy of Science 8: 1943.

Messmer's Glen.—Specific locality unknown, possibly in vicinity of Allen Creek in town of Brighton.

Mud Creek in Wayne County.—Specific collecting region unknown. The creek is possibly the Mud Creek referred to in Proceedings of Rochester Academy of Science 3: 28. 1896 which drains the southeastern side of the area, the waters entering Lake Ontario by the Oswego River.

Mud Pond.—A large sphagnum bog approximately ten miles south of Sodus near the village of Zurich in Wayne County.

Norman Road.—The collecting locality is a low moist sandy tract bordering the east bank of Red Creek in town of Brighton.

Palmer's Glen.—A deep gully, coursed by a small stream flowing into Irondequoit Bay in the vicinity of Tyrone Park Sewage Disposal Plant.

Penfield Dugway.—The Penfield Road (route 441) crossing of Irondequoit Creek valley.

Pokamoonshine Gulf.—A deep ravine in the southern part of town of Springwater, Livingston County, through which flows a small branch of Springwater Creek.

Powder Mill Park.—Monroe County park situated in the southwest part of town of Perinton.

Reynolds Gulf.—A deep ravine three miles north of Springwater, Livingston County through which flows a small branch of Springwater Creek.

Riga Swamp.—A swamp-forest tract, drained by a branch of Black Creek, two miles east of Riga Center in town of Riga on route 33A.

Sand Point.—At Sodus Point, Wayne County.

Seneca Park.—City of Rochester park situated on the east bank of the Genesee River gorge in the northern part of Rochester.

Sullivan's Swamp.—A swamp-forest region, one half mile north of Fishers in Ontario County, drained by a branch of Irondequoit Creek.

The Gulf.—A deep ravine in the outcropping Corniferous limestone, near the corner of Flint Hill Road and Lime Rock Road in Genesee County.

Westbury Marsh.—Approximately five miles east of Wolcott in the eastern part of Wayne County.

Wooded hills south of Canadice.—An extensive wooded tract about four miles south of Canadice, Ontario County, having an average elevation of approximately 2,100 feet.

Works Road.—Bordered on the west by a thinly wooded tract on an escarpment formed by an outcropping of Corniferous limestone.

It is noteworthy that the present catalogue of the sedge family now contains eleven genera, two having been added since the last published lists. The number of species under each genus appearing in this paper is compared with the number in previous lists in the following table. The number of excluded species is also shown.

Genera included in the present catalogue	No. of species listed	No. of species in previous lists	Excluded species
1. Cyperus	12	9	
2. Dulichium	1	1	
3. Eleocharis	12	9	
4. Bulbostylis	1	0	
5. Fimbristylis	1	0	
6. Scirpus	17	15	
7. Eriophorum	6	6	1
8. Rhynchospora	3	2	
9. Cladium	1	1	
10. Scleria	3	3	
11. Carex	132	106	7

In the work of preparing this paper kind aid has been extended by several persons, to all of whom we are very grateful. Dr. Ellsworth P. Killip, former Head Curator of the Department of Botany at the Smithsonian Institution, has read the original manuscript on the genus *Carex* and offered many constructive suggestions. Dr. Killip has been keenly interested in the flora of Monroe and adjacent counties and actually began a revised list more than thirty years ago. We owe a special debt of gratitude to Dr. Babette I. Brown, of the Department of Botany at the University of Rochester for generously giving her time to read the entire manuscript and to supervise and encourage its publication.

Abbreviations and terms:

The herbarium at the U. of R.	—The herbarium of the Rochester Academy of Science now on deposit at the University of Rochester.
The area . . . this area	—Monroe and adjacent counties.
Proc. Roch. Acad. Sci.	—Proceedings of the Rochester Academy of Science.
N.Y.S. Mus. Bull. 254.	—New York State Museum Bulletin No. 254 by Homer D. House.

ANNOTATED LIST OF THE CYPERACEAE OF MONROE AND ADJACENT COUNTIES

KEY TO THE GENERA OF THE CYPERACEAE (SEDGE FAMILY) OF MONROE AND ADJACENT COUNTIES, NEW YORK

a. Achene inclosed in a membranaceous sac (the perigynium). Flowers unisexual; plants perennial .... **11. Carex.**

a. Achene not inclosed in a perigynium.

  b. Flowers unisexual, the staminate and pistillate spikelets crowded in the same inflorescence; achenes white, bony, globular .... **10. Scleria.**

  b. Flowers perfect; achenes not bonelike.

    c. Spikelets flat, the flowers 2-ranked.

      d. Inflorescence axillary; achene beaked; bristles longer than the achene .... **2. Dulichium.**

      d. Inflorescence terminal; achene beakless; bristles none .... **1. Cyperus.**

c. Spikelets terete, the flowers spirally imbricate.
e. Spikelets with one or two achenes.
f. Achene with a tubercle at the summit; bristles present . . **8. Rhynchospora.**
f. Achene without a tubercle at the summit; bristles absent . . . . . **9. Cladium.**
e. Spikelets with several to many achenes.
g. Culms leafless, terete or flattened; spikelet solitary, terminal. **3. Eleocharis.**
g. Culms leafy (the leaves sometimes bladeless); spikelets few to many, if solitary the spikelet lateral.
h. Bristles wanting; achenes minutely reticulate; inflorescence umbellate.
i. Achene with a minute tubercle, 3-angled; blades capillary **4. Bulbostylis.**
i. Achene not tuberculate; blades flat or concave . . . . . . **5. Fimbristylis.**
h. Bristles present; plants perennial.
j. Bristles numerous, long and silky, much exceeding the scales . . . . **7. Eriophorum.**
j. Bristles few (1–8), not long and silky, usually not exceeding the scales . . . . **6. Scirpus.**

1. CYPERUS L.

a. Plants annual, tufted.
b. Achenes lenticular; stigmas 2; spikelets flat, scales falling from the rachis at maturity.
c. Style branches many, usually exserted 2–4 mm.; scales dull, thin, mostly about 2.5 mm. long, rather loosely imbricated so that at least the base of the achene is visible in dried specimens . . . . **1. C. diandrus.**
c. Style branches few, usually exserted 1–1.5 mm.; scales lustrous, subcoriaceous, usually 2–2.4 mm. long, so closely imbricated that the achenes are hidden . . . . **2. C. rivularis.**
b. Achenes trigonous; stigmas 3.
d. Spikelets crowded on a very short axis, forming flabellate or round heads, these solitary or in short-rayed umbels.
e. Scale tips acuminate recurved. (Bruised plants have the odor of Slippery Elm.) . . . . **3. C. inflexus.**
e. Scale tips blunt, not recurved . . . . **4. C. fuscus.**
d. Spikelets pectinate on an elongate axis, umbel usually many-rayed.
f. Spikes 2–3 times as long as broad; rachilla continuous, the scales and achenes deciduous . . . . **5. C. erythrorhizos.**
f. Spikes about as broad as long; rachilla disarticulating, the achenes attached.
g. Scales drab to golden-brown, their tips definitely overlapping the bases of the scales next above . . . . **6. C. odoratus.**
g. Scales yellowish-brown to reddish, their tips scarcely reaching the bases of those next above . . . . **7. C. Engelmanni.**
a. Plants perennial.
h. Rachilla persistent after the fall of the scales and achenes.
i. Plants not stoloniferous, the rhizome hard, bearing tough cormlike branches.
j. Scales all acuminate, prominently awned, ascending, 3.5–4.5 mm. long; achenes 2.5–3.5 mm. long; spikelets 6–16 flowered . . . . **10. C. Schweinitzii.**
j. Scales blunt, or the uppermost acute, 1.8–3.5 mm. long.
k. Spikelets 6–16 flowered, 0.7–2 cm. long; scales 2.8–3.5 mm. long, strongly overlapping; achenes 1.8–2.3 mm. long . . . . **11. C. filiculmis.**
k. Spikelets 2–8 flowered, 0.3–1.5 cm. long; scales 1.8–2.8 mm. long, less imbricated; achenes 1.5–1.8 mm. long . . . . **12. C. filiculmis var. macilentus.**
i. Plants stoloniferous, the stolons terminated by hard tubers . . **8. C. esculentus.**
h. Rachilla falling from the axis of the spike; spikelets strongly flattened . . . . **9. C. strigosus.**

1. **Cyperus diandrus** Torr. LOW CYPERUS

Moist or wet ground and muddy shores of ponds and streams. Infrequent.

Most of the material in the herbarium at the U. of R. labeled *C. diandrus* has been referred to *C. rivularis,* leaving the records for *C. diandrus* limited to the following stations: Mendon Ponds Park; Adams Basin; Buck Pond; moist creek bottom on Bay Road in town of Webster, Sept. 21, 1941, W. A. Matthews 4432; and muddy shores of Long Pond at Crescent Beach on Lake Ontario, Sept. 8, 1949, D. M. White and W. A. Matthews 5265.

2. **Cyperus rivularis** Kunth SHINING CYPERUS.

C. diandrus Torr. var. *castaneus* Torr. of Proc. Roch. Acad. Sci. 3: 115. 1896.

In habitats of the preceding but more frequent.

Often mistaken for *C. diandrus* which it closely resembles except that *C. rivularis* has the spikelets closely imbricated while in *C. diandrus* the spikelets are loosely imbricated showing some space between the scales.

Caledonia and Greigsville in Livingston Co., Bergen Swamp, wet sand bar on shore of Irondequoit Bay near Sea Breeze, wet sandy banks of Densmore Creek on west side of Irondequoit Bay and muddy shores of Quaker Pond at Mendon Ponds Park are stations where *C. rivularis* has been found.

3. **Cyperus inflexus** Muhl. AWNED CYPERUS.

C. aristatus Rottb. of Proc. Roch. Acad. Sci. 3: 115. 1896.

Wet sandy shores. Rare.

Sodus Point in Wayne Co., where it was collected in 1868 and 1870, is apparently the only station for this species within the area. There are no records of its having been found since these early collections.

4. **Cyperus fuscus** L. BROWN CYPERUS.

The report in N.Y.S. Mus. Bull. 254; 133. 1924 "waste places at Rochester (Baxter)" is the basis for this listing. There is no specimen of the collection in the herbarium at the U. of R.

5. **Cyperus erythrorhizos** Muhl. RED-ROOTED CYPERUS.

Wet sandy shores of streams and along ditches. Infrequent.

The moist sandy banks of Salmon Creek at Pultneyville in Wayne Co., where it was collected Sept. 25, 1949 by W. A. Matthews 5258, is the only definitely known station for this species in the area. M. S. Baxter reported it from town of Hamlin in 1894 and town of Chili in 1917, but the records are without specific location.

6. **Cyperus odoratus** L. FLAT CYPERUS.

C speciosus Vahl of Proc. Roch. Acad. Sci. 3: 115 1896.

A specimen found by J. B. Fuller on the shore of Lake Ontario at Charlotte confirms, in part, the report in Proc. Roch. Acad. Sci. 3:115. 1896 "Frequent on the shores of Lake Ontario and Mud Creek flats in Wayne Co." A specimen from the latter station has not been seen. More recent collections of this species have been at Buck Pond by M. S. Baxter in 1917 and Irondequoit Bay by E. P. Killip in 1915. On Sept 8, 1949, D. M. White found it on the muddy shore of Long Pond outlet on the east side of the highway bridge at Crescent Beach.

7. **Cyperus Engelmanni** Steud. ENGELMANN'S CYPERUS.

Rare, known from two stations only.

Specimens in the herbarium at the U. of R. are from the wet muddy shore of Lily Pond at Bushnell's Basin collected by M. S. Baxter, Sept. 30, 1917 and the sand bar at Braddock's Bay collected by E. P. Killip, Sept. 7, 1921.

8. **Cyperus esculentus** L. YELLOW NUT GRASS.

Low sandy cultivated fields and waste places. Common over the area.

A troublesome weed if allowed to spread unmolested. The size of the spikelets is extremely variable in this species often making identification uncertain.

9. **Cyperus strigosus** L. STRAW-COLORED CYPERUS.

Low meadows and field borders. Common all over the area.

A number of varieties, which many authors consider of no taxonomic value, have been proposed to cover the extreme variations of this species.

10. **Cyperus Schweinitzii** Torr. SCHWEINITZ'S CYPERUS.

This species is frequent on the sandy shores of Lake Ontario from Braddock's Bay to Sodus Point in Wayne Co., particularly so on the wide sandy beach at Summerville.

11. **Cyperus filiculmis** Vahl SLENDER CYPERUS.

Dry sandy soil. Rare.

Inspiration Point on the east side of Irondequoit Bay is apparently the only known station for typical *C. filiculmis* in this area. It was collected there on the dry sand dunes in 1918 by M. S. Baxter and Sept. 26, 1930 by W. A. Matthews 3459. The var. *macilentus* is the common form in this locality.

12. **Cyperus filiculmis** Vahl var. **macilentus** Fern.

Thin woods, hillsides and abandoned fields, wherever the soil is light and sandy. Frequent.

Specimens in the herbarium at the U. of R. are from sandy hillsides bordering Irondequoit Bay, the barren sandy fields west of East Rochester, the sandy hillsides in the vicinity of Bushnell's Basin and Powder Mill

Park, the abandoned fields and hillsides at Mendon Ponds Park and the sandy barrens near Coldwater.

2. DULICHIUM. Pers.

1. **Dulichium arundinaceum** (L.) Britt.

D. spathaceum Pers. of Proc. Roch. Acad. Sci. 3: 115. 1896.

Sphagnum bogs, marshes and shores of ponds. Frequent. Found in these habitats throughout the area.

3. ELEOCHARIS R. Br. Spike-rush

a. Spikelets not thicker than the culm; scales of the mature spikelets persistent .... **1. E. equisetoides.**
a. Spikelets much thicker than the culm; scales of the mature spikelets deciduous.
b. Tubercle continuous with the achene, but with a slight difference in color.
c. Culms in small tufts, capillary, furrowed, firm, from creeping rhizomes .... **2. E. pauciflora var. Fernaldii.**
c. Culms in firm tussocks, flattened, wiry, the longer ones arching and rooting at the tips .... **3. E. rostellata.**
b. Tubercle definitely separate from the achene and usually articulated with it.
d. Annuals, with fibrous roots; culms tufted.
e. Culms capillary, very unequal, reclining or ascending, 1–3 dm. high; style 3-cleft; achene trigonus .... **9. E. intermedia.**
e. Culms slender to filiform, ascending, 0.3–7 dm. high; styles 2-cleft; achenes biconvex.
f. Achenes pale to deep-brown, lustrous.
g. Culms 0.3–7 dm. high; base of tubercle nearly or quite covering summit of achene .... **7. E. obtusa.**
g. Culms 0.3–5 dm. high; base of tubercle covering two-thirds of summit of achene .... **8. E. ovata.**
f. Achenes black to purple, lustrous .... **6. E. geniculata.**
d. Perennials, with horizontal rhizomes.
h. Achenes biconvex; style 2-cleft.
i. Rhizomes soft and filiform; culms sometimes tufted, very slender, 2–15 cm. high .... **5. E. olivacea.**
i. Rhizomes firm and elongated, reddish; culms subcespitose to scattered on stolons, 0.1–2 m. high.
j. Scales at base of spikelets usually 2 or 3.
k. Culms firm but not wiry, 0.5–5 mm. in diam.; tubercle lanceolate to conic-ovoid, much higher than broad.
l. Culms 0.1–4 dm. high, 0.5–2 mm. diam; spikelets 0.5–2 cm. long; achene 1.2–1.7 mm. long .... **10. E. palustris.**
l. Culms 0.5–2 m. high, 1.5–5 mm. diam.; spikelets 0.7–2.6 cm. long; achene 1.4–2.1 mm. long .... **11. E. palustris var. major.**
k. Culms firm and wiry, 0.5–2.5 mm. diam.; tubercle ovate, as broad as, or broader, than long .... **12. E. Smallii.**
j. Scale at base of spikelet solitary, usually completely encircling the base of the spikelet .... **13. E. calva.**
h. Achenes trigonous; style 3-cleft.
m. Culms capillary, less than 0.5 mm. thick, 0.2–2 dm. high (often elongated in water) .... **4. E. acicularis.**
m. Culms slender but not capillary.
n. Rhizomes firm and woody, 2–4 mm. thick; culms flat and wiry .... **14. E. compressa.**
n. Rhizomes slender, flexuous and cord-like, 1–3 mm. thick; culms slender, 4–8 angled.
o. Stem 4–5 angled or corrugated; achenes olive or drab; tubercle depressed, one-eighth to one-half height of achene .... **15. E. tenuis.**
o. Stem 6–8 angled; achene bright yellow to orange; tubercle depressed-deltoid with prominent central point .... **16. E. elliptica.**

1. **Eleocharis equisetoides** (Ell.) Torr. KNOTTED SPIKE-RUSH.

New York State Museum Bulletin 254:136. 1924, cites Mendon Ponds, Monroe Co. as the only definitely known station in the state for this species. It was found there in the margin of Hundred Acre Pond, July 24, 1921 by W. A. Matthews.

2. **Eleoharis pauciflora** (Lightf.) Link var. **Fernaldii Svenson** FEW-FLOWERED CLUB-RUSH.

E. pauciflora Link. of Proc. Roch. Acad. Sci. 3: 116. 1896.

Marly borders of ponds. Rare.

This species has been found at Sand Point on Sodus Bay in Wayne Co. and in Bergen Swamp but not in recent years. The only definite record for it is a specimen collected August 7, 1941 by R. H. Goodwin 2365 in the marsh bordering Quaker Pond at Mendon Ponds Park.

3. **Eleocharis rostellata** Torr. BEAKED SPIKE-RUSH.

Open marl bogs are its preferred habitat. Infrequent.

Herbarium specimens at the U. of R. are from Sullivan's Swamp near Fishers in Ontario Co., open marsh at Junius Ponds in Seneca Co., open marl bog in Bergen Swamp and marshy meadow north of Quaker Pond at Mendon Ponds Park.

4. **Eleocharis acicularis** (L.) R. & S. NEEDLE OR LEAST SPIKE-RUSH.

E. acicularis R. Br. of Proc. Roch. Acad. Sci. 3: 115. 1896.

Forming dense mats on muddy shores of ponds and streams. Infrequent.

Specimens in the herbarium at the U. of R. are from: shores of Canadice Lake in Ontario Co., marshy border of Lake Ontario in town of Hamlin, Sodus Point in Wayne Co., Bushnell's Basin and shores of Long Pond.

5. **Eleocharis olivacea** Torr. BRIGHT-GREEN SPIKE-RUSH.

This record is based on a single collection Sept. 26, 1897 by M. S. Baxter from "floating islands" in Hundred Acre Pond at Mendon Ponds Park. "Floating islands", as they were locally known, were formed during ice-cutting. In shallow water, the long saws cut the matted water lily (*Nymphaea odorata*) roots into squares which became loosened and rose to the surface. These squares often consolidated into floating masses 20 to 30 feet in diameter.

6. **Eleocharis geniculata** (L.) R. & S.

The only record for this species is a specimen collected July 8, 1944 in the marl bog at Bergen Swamp by Babette I. Brown and W. C. Muenscher 21222.

7. **Eleocharis obtusa** (Willd.) Schultes BLUNT SPIKE-RUSH.

Muddy shores, ditches and wet places. Common.

Records of this species indicate that it occurs throughout the area in its preferred habitats.

8. **Eleocharis ovata** (Roth.) R. & S. OVOID SPIKE-RUSH.

E. ovata R. Br. of Proc. Roch. Acad. Sci. 3: 115. 1896.

The herbarium at the U. of R. is without records to confirm the report in Proc. Roch. Acad. Sci. 3:115. 1896, "Low grounds and muddy shores. Common." It is considered common in most sections of the state in N.Y.S. Mus. Bull. 254:137. 1924 and doubtless has been overlooked in this area.

9. **Eleocharis intermedia** (Muhl.) Schultes MATTED SPIKE-RUSH.

E. intermedia Schult. of Proc. Roch. Acad. Sci. 3: 115. 1896.

Forming dense cespitose clumps in the muddy borders of ponds and streams. Frequent.

This species occurs much more frequently than indicated by herbarium records at the U. of R. It is abundant on the muddy shores of Quaker Pond at Mendon Ponds Park and the only other specimens are from Mill Creek at Honeoye in Ontario Co. and in the vicinity of Pittsford. The latter collection is without specific location.

10. **Eleocharis palustris** (L.) R. & S. CREEPING SPIKE-RUSH.

E. palustris R. Br. of Proc. Roch. Acad. Sci. 3: 115. 1896.

Shallow water, muddy shores and marshes. Frequent.

As with other species of this genus occurring more or less frequently, very few herbarium records have been made.

11. **Eleocharis palustris** (L.) R. & S. var. **major** Sonder

This record is based on a collection August 5, 1922 at Cranberry Pond by M. S. Baxter 5914.

12. **Eleocharis Smallii** Britt.

Reported in Proc. Roch. Acad. Sci. 8:313. 1943 from Bullhead Pond at Bushnell's Basin by R. T. Clausen and W. A. Hinkey (1939).

13. **Eleocharis calva** Torr. GLAUCOUS CREEPING SPIKE-RUSH.

Spring basins, thinly wooded swamps and marshes. Frequent.

Herbarium records of this species at the U. of R. are quite numerous from the shore of Lake Ontario west of the Genesee River. Other stations for it are: "The Gulf" in Genesee Co., Sullivan's Swamp near Fishers in Ontario Co., Bergen Swamp and Adams Basin. Recent collections have been: at Cedar Swamp in town of Henrietta, July 19, 1930 by W. A. Matthews 3162; in the marshy border of Round Pond at Mendon Ponds Park, July 21, 1944 by W. A. Matthews 4583; and at Burroughs Audubon Conservation Station, June 14, 1934 by E. P. Killip 31214.

14. **Eleocharis compressa** Sulliv. FLAT-STEMMED SPIKE-RUSH.

A specimen collected July 17, 1927 at Junius Ponds in Seneca Co., is the only definitely known record for this species in the area.

15. **Eleocharis tenuis** (Willd.) Schultes SLENDER SPIKE-RUSH.

E. tenuis Schult. of Proc. Roch. Acad. Sci. 3:115. 1896.

"Marshes; frequent" in Proc. Roch. Acad. Sci. 3:115. 1896 is not confirmed by herbarium specimens at the U. of R. The only definite record for it is a collection July 8, 1944 in the marl bog at Bergen Swamp by Babette I. Brown and W. C. Muenscher 21222.

16. **Eleocharis elliptica** Kunth

The basis for this record is a single collection in June 1919 in the vicinity of Mendon Ponds Park by M. S. Baxter.

4. BULBOSTYLIS (Kunth) C. B. Clarke

1. **Bulbostylis capillaris** (L.) C. B. Clarke var. **crebra** Fern.

This is the only report of the genus *Bulbostylis* in the state west of Lake Keuka (N.Y.S. Mus. Bull. 254:140. 1924 and N.Y.S. Mus. letter of Sept. 19, 1950). It was collected August 27, 1950 by W. A. Matthews 5295, in moist soil and cinders on the B. & O. railroad right of way, just west of the crossing of the Lime Rock Road in Genesee Co.

5. FIMBRISTYLIS Vahl

1. **Fimbristylis autumnalis** (L.) R. & S. var. **mucronulata** (Michx.) Fern.

This record is based on a single collection August 22, 1922 by W. A. Matthews 3489, from the shore of Irondequoit Bay on the Lake Road about 300 yards from the east side. The plant was growing in wet sand among *Typha latifolia.*

Although reported as "Frequent or locally common across the State south of the Adirondacks", in N.Y.S. Mus. Bull. 254:141. 1924, there is no previous record for the genus *Fimbristylis* in this area.

6. SCIRPUS L. Bulrush

a Spikelet solitary; involucral bract, if present, not over 6.5 mm. long.
- b. Plants aquatic; involucral bract filiform 0.5–6.5 mm. long; leaves of submersed plant capillary and very elongate, responding to depth of water ... **5. S. subterminalis.**
- b. Plants not aquatic; spikelet not subtended by a true persistent involucre.
  - c. Densely cespitose.
    - d. Leaves flat, soft and grass-like, 1–2 mm. wide, about equaling the culms. ... **1. S. verecundus.**
    - d. Leaves firm, terete or involute, bluntly callous-tipped, up to 1.5 cm. long, borne on basal sheaths .... **2. S. cespitosus var. callosus.**
  - c. Small tussocks with horizontal creeping rhizomes .... **3. S. hudsonianus.**

a. Spikelets normally more than one; involucral bracts, or leaves, one to several.
e. Involucral leaves one, bract-like.
f. Spikelets few, appearing lateral; involucral leaf 0.4–1 dm. long.
g. Plant annual, tufted; spikelets in clusters of 1 to 12 .... **4. S. Smithii.**
g. Plant perennial, rhizome elongate, stout and hard, dark brown; spikelets in clusters of 1 to 7 .... **6. S. americanus.**
f. Spikelets several or numerous, umbelled; involucral leaf bract-like, shorter than the umbel.
h. Rhizome reddish, stout, scaly, horizontal; culm soft and easily compressed; achene olive to brown .... **7. S. validus var. creber.**
h. Rhizome drab or brown; culm harder and firmer; achene becoming black and lustrous .... **8. S. acutus.**
e. Involucral leaves 2 to several.
i. Spikelets large, in a terminal umbel, solitary or 2 or 3 together at the ends of its long spreading or drooping rays, or the central spikes sessile. **9. S. fluviatilis.**
i. Spikelets small, very numerous in compound umbels or umbelled heads.
j. Bristles barbed downward; spikelets in umbelled heads.
k. Bristles barbed nearly to the base; sheaths red-tinged at base. **10. S. rubrotinctus.**
k. Bristles barbed only above the middle; sheaths uniformly greenish.
l. Bristles at least twice the length of the achene .... **13. S. polyphyllus.**
l. Bristles equal to or slightly longer than the achene.
m. Blades 10–18 mm. wide; lower sheaths nodulose-septate; bristles about equaling the achene .... **11. S. atrovirens.**
m. Blades 4–10 mm. wide; lower sheaths not nodulose; bristles shorter than, or as long as, the achene, sometimes wanting; plant more slender. **12. S. atrovirens var. georgianus.**
j. Bristles smooth or slightly pubescent; spikelets mostly in decompound umbels.
n. Bristles not exserted beyond the scales .... **14. S. lineatus.**
n. Bristles much exserted beyond the scales, strongly crimped or curled.
o. Spikelets mostly sessile, in glomerules of 3 to 15.
p. Involucels, scales and bristles, reddish-brown; spikelets all glomerate. **15. S. cyperinus.**
p. Involucels drab to blackish; bristles drab or smoke-colored; scales brownish to black, greenish tinged .... **16. S. cyperinus var. pelius.**
o. Spikelets nearly all pedicelled, in small clusters, pedicels of different lengths, with a central one sessile.
q. Involucels dull brown .... **17. S. pedicellatus.**
q. Involucels black .... **18. S. atrocinctus.**

1. Scirpus verecundus Fern. WOOD CLUB-RUSH.

S. planifolius Muhl. of Proc. Roch. Acad. Sci. 5: 79. 1917.

Dry woods and hillsides in sandy soil. Infrequent.

The dry sandy summit of eskers at Mendon Ponds Park, where it is abundant, is the only definitely known station for this species. It has been found on dry hillsides in town of Perinton and dry woods at East Bloomfield in Ontario Co., but specific locality is lacking.

2. Scirpus cespitosus L. var. **callosus** Bigel. TUFTED CLUB-RUSH.

S. caespitosus L. of Proc. Roch. Acad. Sci. 3: 116. 1896.

Sphagnum bogs. Infrequent.

This species is abundant in Bergen Swamp where it has been collected since 1866. Other stations for it are: Sullivan's Swamp near Fishers in

Ontario Co. (M.S. Baxter) and a sphagnum bog in town of Pittsford (June 4, 1911, M. S. Baxter).

3. **Scirpus hudsonianus** (Michx.) Fern. ALPINE COTTON-GRASS.
Eriophorum alpinum L. Proc. Roch. Acad. Sci. 3: 116. 1896.

Sphagnum bogs. Rare.

Specimens in the herbarium at the U. of R. are from two stations only in this area: Westbury Marsh in Wayne Co., collected June 24, 1917 by M. S. Baxter; and Mud Pond also in Wayne Co., collected in 1884 by E. L. Hankenson. More recent collections have been made at Mud Pond by M. S. Baxter, E. P. Killip and W. A. Matthews. R. Eliot Stauffer has reported it abundant in an unfrequented part of the bog.

4. **Scirpus Smithii** Gray SMITH'S CLUB-RUSH.

Shores of Lake Ontario. Rare.

Various reports have been made of this species from Sand Point at Sodus Point in Wayne Co. by early botanists, the last by E. L. Hankenson Sept. 12, 1872. Proc. Roch. Acad. Sci. 3:116. 1896, cites it from the shore of Lake Ontario at the outlet of Braddock's Bay (J. B. Fuller). It has not been collected from either station in recent years.

5. **Scirpus subterminalis** Torr. WATER CLUB-RUSH.

A very local aquatic. Rare.

Known from two collections only in Wayne Co. by E. L. Hankenson: one at Mud Pond July 18, 1857 and the other at Sodus Point Sept. 1, 1882. Collections have not been made at either station in recent years.

6. **Scirpus americanus** Pers. CHAIR-MAKERS RUSH.
S. pungens Vahl of Proc. Roch. Acad. Sci. 3:116. 1196.

Wet sandy shores and open bogs. Frequent.

The shores of Lake Ontario, Irondequoit Bay and the lower Genesee River are preferred habitats of this species. It also occurs in the open marl bog in Bergen Swamp.

7. **Scirpus validus** Vahl var. **creber** Fern. AMERICAN GREAT BULRUSH.
S. lacustris L. of Proc. Roch. Acad. Sci. 3: 116. 1896.

In ponds, swamps, marshes and along shores of lakes and slow streams. Common.

Specimens of this species in the herbarium at the U. of R. indicate its wide distribution throughout the area.

8. **Scirpus acutus** Muhl. WESTERN BULRUSH.
S. occidentalis Chase of Proc. Roch. Acad. Sci. 5: 79. 1917.

In habitats similar to those of the preceding. Frequent.

Places where it has been found are: Canandaigua in Ontario Co., Miss E. C. Webster; Sullivan's Swamp near Fishers in Ontario Co., August 12, 1917, M. S. Baxter; border Hundred Acre Pond in Mendon Ponds Park, July 24, 1941, R. H. Goodwin; marshes bordering Lake Ontario at Island Cottage, July 31, 1921, W. A. Matthews; and the marl bog in Bergen Swamp, August 22, 1917, E. P. Killip.

9. Scirpus fluviatilis (Torr.) A. Gray RIVER BULRUSH.

S. fluviatilis Gray of Proc. Roch. Acad. Sci. 3: 116. 1896.

Shallow water and marshy shores of ponds, lakes and streams. Frequent.

Reported from the lower Genesee River and pond borders along Lake Ontario west of the Genesee River. Also reported from a marsh at Sodus Bay in Wayne Co. by E. P. Killip and in shallow water in Ellison Park, July 1, 1919 by W. A. Matthews.

10. Scirpus rubrotinctus Fern. SMALL-FRUITED BULRUSH.

S. sylvaticus L. var. *digynus* Boech of Proc. Roch. Acad. Sci. 3: 116. 1896.

The report, "Low wet grounds, infrequent." in Proc. Roch. Acad. Sci. 3:116. 1896, is not confirmed by specimens in the herbarium at the U. of R. H. D. House is quoted by R. H. Goodwin in *Check List and Index to the Cyperaceae of Monroe Co.* as having seen the species growing just east of Victor in Ontario Co., which fact would make the above report not unlikely.

11. Scirpus atrovirens Willd. DARK-GREEN BULRUSH.

Low meadows, thinly wooded swamps and marshes. Common.

A very common species throughout the area.

12. Scirpus atrovirens Willd. var. **georgianus** (Harper) Fern.

Records regarding the occurrence of this variety in the area are indefinite and perhaps limited to a collection August 8, 1920 at Mendon Ponds Park by W. A. Matthews (N.Y.S. Mus. Bull. 254:149. 1924). The specimens in the herbarium at the U. of R., labeled *S. atrovirens* var. *georgianus* have been referred to the species (R. H. Goodwin, *Check List and Index to the Cyperaceae of Monroe Co.*).

13. Scirpus polyphyllus Vahl

This species is apparently rare in the area. Only two collections of it have been made: one, Sept. 1928, at Sullivan's Swamp near Fishers in Ontario Co. by M. S. Baxter 6920; and the other, July 27, 1940, north of Canfield Road in Mendon Ponds Park by Wm. Stepka.

14. **Scirpus lineatus** Michx. REDDISH BULRUSH.

Low meadows and borders of swamps. Infrequent or locally abundant.

Collections of this species have been made in all parts of the area. Some stations for it are: Bergen Swamp, Mendon Ponds Park, low meadow on Works Road in town of Rush, marshy creek border on Calkins Road in town of Henrietta, low meadow on Thornell Road in town of Pittsford and Sullivan's Swamp near Fishers in Ontario Co.

15. **Scirpus cyperinus** (L.) Kunth WOOL-GRASS.

Low meadows, thinly wooded swamps and marshes. Common.

A very common species in borders of the bays and ponds along the shore of Lake Ontario. Other stations for it are: Mendon Ponds Park, Mud Pond in Wayne Co. and Bergen Swamp.

16. **Scirpus cyperinus** (L.) Kunth var. **pelius** Fern.

In habitats similar to those preferred by the species except that it has not been reported from the bays and ponds along Lake Ontario.

Herbarium specimens at the U. of R. are from Lily Pond near Bushnell's Basin, Sept. 30, 1917, M. S. Baxter; Crosman Pond in town of Perinton, M. S. Baxter (collection date lacking); Mendon Ponds Park, Sept. 9, 1917, M. S. Baxter; and a wet depression west of Clover Road, Mendon Ponds Park, August 10, 1941, R. H. Goodwin 2446.

17. **Scirpus pedicellatus** Fern.

This species prefers the cooler habitats, such as, springy marshes and bogs. Infrequent.

Specimens have been collected at Bergen Swamp; a marsh on the wooded hills south of Canadice in Ontario Co., July 31, 1930 by W. A. Matthews 3259; open marsh at Mud Pond in Wayne Co., July 30, 1930 by W. A. Matthews 3240; Crosman Pond in town of Perinton, Sept. 1918 by M. S. Baxter; and a wet depression west of Clover Road, Mendon Ponds Park, August 2, 1941 by R. H. Goodwin 2366.

18. **Scirpus atrocinctus** Fern. NORTHERN WOOL-GRASS.

In habitats similar to those of the preceding species. Infrequent.

Collected in the marsh on the wooded hills south of Canadice in Ontario Co., July 31, 1930 by W. A. Matthews 3259; and at Adams Basin, August 1, 1916 by E. P. Killip.

7. ERIOPHORUM L. Cotton-grass

a. Spikelet solitary, involucral leaf none .... **1. E. spissum.**

a. Spikelets several, involucre of one to several leafy bracts.

b. Leaves 1–2 mm. wide, channeled their entire length, upper blade shorter than its sheath; involucral bract one.

c. Upper cauline leaf with the sheath longer than the blade .... **2. E. gracile.**
c. Upper cauline leaf with the sheath shorter than the blade .... **3. E. tenellum.**
b. Leaves 1.5–6 mm. wide, flat, at least, below the middle; involucral bracts more than one.
d. Spikelets on slender, simple or forked, minutely hairy peduncles; plants flowering in May and June ....**4. E. viridi-carinatum.**
d. Spikelets mostly crowded in a dense glomerule; plants flowering in August and September.
e. Bristles tawny or copper-colored .... **5. E. virginicum.**
e. Bristles whitish .... **6. E. virginicum forma album.**

1. **Eriophorum spissum** Fern. SHEATHED COTTON-GRASS.

E. vaginatum L. of Proc. Roch. Acad. Sci. 3: 116. 1896.

Sphagnum bogs. Rare.

The open sphagnum bog at Mud Pond in Wayne Co. is the only known station for this species in the area. E. L. Hankenson made the first report of it from there in 1866. It has since been collected at the same station by M. S. Baxter and W. A. Matthews.

2. **Eriophorum gracile** W. D. J. Koch SLENDER COTTON-GRASS.

Sphagnum bogs. Rare.

Known in this area from two stations only: Mud Pond in Wayne Co., June 24, 1889, E. L. Hankenson; and Kennedy's Bog at Mendon Ponds Park, August 16, 1941, R. H. Goodwin 2677.

3. **Eriophorum tenellum** Nutt. ROUGH COTTON-GRASS.

Sphagnum bogs. Rare.

The open sphagnum bog at Mud Pond in Wayne Co. is the only known station for this species in the area. It was collected there July 2, 1916 by E. P. Killip.

4. **Eriophorum viridi-carinatum** (Engelm.) Fern.
THIN-LEAVED COTTON-GRASS.

E. polystachyon L. of Proc. Roch. Acad. Sci. 3: 116. 1896.

Locally abundant in open sphagnum bogs. Infrequent.

Adams Basin, Bergen Swamp, border of Quaker Pond at Mendon Ponds Park and Mud Pond in Wayne Co. are stations for this species.

5. **Eriophorum virginicum** L. VIRGINIA COTTON-GRASS.

Sphagnum bogs. Infrequent.

This species is more or less abundant in Kennedy's Bog and the marsh bordering Quaker Pond at Mendon Ponds Park. It also occurs at Mud Pond in Wayne Co. and at Junius Ponds in Seneca Co.

6. **Eriophorum virginicum** L. forma **album** (Gray) Weig.

This form is represented by two specimens only in the herbarium at the U. of R.: one collected August 5, 1866 in the vicinity of Mendon Ponds Park by George T. Fish; and the other Sept. 5, 1872 in Wayne Co. by E. L. Hankenson.

8. RHYNCHOSPORA Vahl Beak-rush

a. Plant tufted; culms stout, 1–8 dm. high, leaves setaceous to linear, 0.5–2.5 mm. wide; inflorescence of turbinate fascicles, at first milky-white, whitish-brown when mature .... **1. R. alba.**

a. Plant forming tussocks; culms capillary, 0.5–4.5 dm. high, leaves setaceous or narrowly linear; inflorescence of small fascicles with 1–10 spikelets, brown.

b. Bristles retrorsey barbed .... **2. R. capillacea.**

b. Bristles smooth, not barbed .... **3. R. capillacea forma leviseta.**

1. **Rhynchospora alba** (L) Vahl — White beak-rush.

R. alba Vahl of Proc. Roch. Acad. Sci. 3: 117. 1896.

Open sphagnum bogs. Infrequent.

Bergen Swamp, Kennedy's bog at Mendon Ponds Park, Mud Pond in Wayne Co., and Junius Ponds in Seneca Co. are stations where this species occurs more or less abundantly.

2. **Rhynchospora capillacea** Torr. — Capillary beak-rush.

Marly bogs. Infrequent.

Open marl bog in Bergen Swamp, marl bog at Junius Ponds in Seneca Co., marl bog north of Quaker Pond in Mendon Ponds Park, Cedar Swamp in town of Henrietta and a marl bog on the Victor Road near Victor in Ontario Co. are stations where this species has been found in limited quantities, usually with *Scleria verticillata*.

3. **Rhynchospora capillacea** Torr. forma **leviseta** (E. J. Hill) Fern.

Marly bogs. Rare.

The open marl bog in Bergen Swamp is the only known station for this form in the area.

9. CLADIUM P. Br. Twig-rush

1. **Cladium mariscoides** (Muhl.) Torr.

C. mariscoides Torr. of Proc. Roch. Acad. Sci. 3: 117. 1896.

Marshes bordering ponds and streams. Infrequent.

Bergen Swamp, marshy borders of Quaker Pond in Mendon Ponds Park, Junius Ponds in Seneca Co. and Mud Pond in Wayne Co. are stations for this species.

10. SCLERIA Bergius Nut-rush

a. Achenes smooth, ovoid, about 3 mm. long including the basal disk **1. S. triglomerata.**

a. Achenes not smooth, globose, 1.5–2 mm. long.

b. Culms, leaves and scales, densely pubescent .. **2. S. pauciflora var. caroliniana.**

b. Culms, leaves and scales, essentially glabrous .... **3. S. verticillata.**

1. **Scleria triglomerata** Michx. — Tall nut-grass, whip grass.

Moist thickets. Rare.

Moist roadside thicket at Sullivan's Swamp near Fishers in Ontario Co., August 15, 1926, M. S. Baxter; and Mud Pond in Wayne Co., July 2, 1916, E. P. Killip are the only records for this species.

2. **Scleria pauciflora** Muhl. var. caroliniana (Willd.) Wood

The record in Proc. Roch. Acad. Sci. 3:117. 1896, "Rare. Greece, Bradley" is not confirmed by a specimen in the herbarium at the U. of R. N.Y.S. Mus. Bull. 254:156. 1924 cites this species from Monroe Co. using as authority: Torrey Fl. N. Y. 2:369, 1843– Paine Cat. Cat 150 and 1865– Proc. Rochester Acad. 3:117. 1896.

3. **Scleria verticillata** Muhl. LOW NUT-RUSH.

Marl bogs. Rare.

The open marl bog in Bergen Swamp, the marl bog at Junius Ponds in Seneca Co. and the marly depressions north of Quaker Pond in Mendon Ponds Park are the only known stations for this species in the area.

11. **CAREX** L. Sedge

Stigmas two; achenes lenticular to plano-convex, some biconvex; spikes usually composed of both staminate and pistillate flowers, the lateral spikes sessile. Subgenus I. *VIGNEA*.

Stigmas three; achenes triangular in cross section, or, if stigmas two, achenes lenticular to biconvex; spikes normally either all staminate or all pistillate, the lateral spikes peduncled .... Subgenus II. *EUCAREX*.

Subgenus I. *VIGNEA*

a. Culms arising singly or few together from long creeping rootstocks.
  b. Spikes one, either staminate, pistillate, or staminate above and pistillate below .... **Section 1. Dioicae.**
  b. Spikes more than one.
    c. Heads ovoid, 0.5–1.2 cm. long; culms becoming decumbent and branching; perigynia neither thin nor wing-margined, oblong-obovate, thick plano-convex, 2.5–3.75 mm. long; plants of sphagnum bogs ... **Section 2. Chordorrhizeae.**
    c. Heads elongate, 2–7 cm. long; culms not branching; perigynia wing-margined. **Section 3. Arenariae.**

a. Culms cespitose, the rootstocks sometimes short-prolonged with short internodes but not creeping.
  d. Terminal or all spikes composed of both staminate and pistillate flowers; perigynia not subterete.
    e. Perigynia tapering into the beak or, if abruptly contracted, culms flaccid and flattening in drying .... **Section 7. Vulpinae.**
    e. Perigynia abruptly contracted into the beak; culms not flaccid and not flattening in drying.
      f. Spikes few (generally 10 or fewer), usually greenish when mature. **Section 4. Bracteosae.**
      f. Spikes numerous, yellow or brownish at maturity; leaf sheaths often red-dotted ventrally.
        g. Perigynia plano-convex, thin, yellowish; bracts mostly much exceeding the spikes; leaf sheaths usually transversly rugulose ventrally. **Section 5. Multiflorae.**
        g. Perigynia thick plano-convex or unequally biconvex, brown; bracts mostly shorter than the spikes; leaf sheaths not transversely rugulose. **Section 6. Paniculatae.**
  d. Terminal or all spikes with upper flowers pistillate, lower ones staminate or, if composed of both staminate and pistillate flowers, perigynia subterete and spikes 1–3 flowered.
    h. Perigynia wing-margined .... **Section 11. Ovales.**

h. Perigynia not wing-margined, at most thin-edged.
i. Perigynia 2–4 mm. long.
j. Perigynia thin-edged, spreading, ovoid, usually broadest below the middle .... **Section 10. Stellulatae.**
j. Perigynia not thin-edged, ascending or appressed, elliptic. **Section 8. Heleonastes.**
i. Perigynia 4–5 mm. long, narrowly lanceolate, appressed. **Section 9. Deweyanae.**

Subgenus II. *EUCAREX*

a. Stigmas two; achenes lenticular to biconvex.
b. Culms 0.3 to 5.5 dm. high, slender; lowest bracts long-sheathing. **Section 18. Bicolores.**
b. Culms 0.2 to 1.5 m. high, coarser; lowest bracts sheathless or rarely short-sheathing.
c. Scales long-awned, much exceeding the perigynia .. **Section 19. Cryptocarpae.**
c. Scales not long-awned, obtuse to acute, shorter than to exceeding the perigynia. **Section 20. Acutae.**
a. Stigmas three; achenes triangular in cross section.
d. Spikes solitary, composed of both staminate and pistillate flowers. **Section 12. Polytrichoideae.**
d. Spikes more than one.
e. Style articulated with the achene, at length deciduous; achenes apiculate or blunt at the apex; perigynia closely enveloping the achene or moderately inflated.
f. Lower pistillate scales bractlike; achenes rounded at the apex, strongly constricted at the base .... **Section 13. Phyllostachyae.**
f. Lower pistillate scales not bractlike; achenes apiculate-tipped, not strongly constricted at the base.
g. Perigynia pubescent or scabrous.
h. Achenes closely enveloped by the perigynia; bracts sheathless or nearly so, (except in *Digitatae* which has the bracts sheathing), the blades scale-like or setaceous.
i. Plant glabrous.
j. Bracts sheathless .... **Section 14. Montanae.**
j. Bracts sheathing .... **Section 15. Digitatae.**
i. Plant pubescent .... **Section 17. Triquetrae.**
h. Achenes not closely enveloped by the perigynia; bracts with well developed blades.
k. Bracts sheathing .... **Section 32. Laxiflorae.**
k. Bracts sheathless.
l. Perigynia scabrous .... **Section 23. Anomalae.**
l. Perigynia pubescent.
m. Beak of perigynia strongly bidentate; leaves septate-nodulose. **Section 24. Hirtae.**
m. Beak of perigynia shallowly bidentate; leaves not septate-nodulose. **Section 25. Virescentes.**
g. Perigynia glabrous.
n. Achenes closely enveloped by the perigynia; bracts sheathing. **Section 16. Albae.**
n. Achenes not closely enveloped by the perigynia except at the base.
o. Lower bracts with a long sheath (except in *C. prasina* of section *Gracillimae*, a species with sharply triangular perigynia which are long—and flat-beaked, nerveless except for the prominent pair of lateral nerves).
p. Beak of perigynia entire, emarginate, or obliquely cut and at length bidentate.
q. Pistillate spikes short, oblong to linear, erect or, if drooping, either on long capillary peduncles or the perigynia sharply trigonous.

r. Perigynia with few to many strongly raised nerves.

s. Perigynia tapering at the base, triangular, achenes usually closely enveloped; rootstocks elongate, producing long horizontal stolons .... **Section 31. Paniceae.**

s. Perigynia rounded at the base, suborbicular in cross section; achenes loosely enveloped .... **Section 29. Granulares.**

r. Perigynia with numerous fine impressed nerves. **Section 30. Oligocarpae.**

q. Pistillate spikes elongate, linear to cylindric, slender-peduncled, the lower drooping; perigynia not sharply trigonous.

t. Perigynia beakless or short-beaked; terminal spike with upper flowers pistillate, lower ones staminate **Section 26. Gracillimae.**

t. Perigynia conspicuously beaked; terminal spike staminate (rarely with a few perigynia at the base).

u. Culms strongly reddish-tinged at the base. **Section 27. Sylvaticae.**

u. Culms not reddish-tinged at the base. **Section 28. Longirostres.**

p. Beak of perigynia bidentate .... **Section 33. Extensae.**

o. Lower bracts sheathless or with a very short sheath.

v. Terminal spike staminate; roots closely clothed with a yellowish felt. **Section 22. Limosae.**

v. Terminal spike with the upper flowers pistillate, lower ones staminate; roots not clothed with a yellowish felt. ..... **Section 21. Atratae.**

e. Style not articulated, continuous with the achene, persistent, indurated; perigynia moderately to strongly inflated (only slightly so in some species of *Paludosae* and section *Pseudo-Cypereae*).

A. Spike solitary; perigynia slender- beaked, reflexed at maturity. **Section 34. Orthocerates.**

A. Spike more than one.

B. Perigynia many and finely nerved, lanceolate, tapering into the beak. **Section 38. Folliculatae.**

B. Perigynia strongly ribbed, usually broader, generally abruptly contracted into the beak.

C. Perigynia subcoriaceous and firm .... **Section 36. Paludosae.**

C. Perigynia thin and papery, membranaceous.

D. Perigynia obconic or broadly obovoid, truncately contracted into a long subulate beak .... **Section 35. Squarrosae.**

D. Perigynia from lanceolate to ovoid or globose-ovoid, not truncately contracted.

E. Pistillate scales with scabrous awns equaling or longer than the blades; pistillate spikes elongate and densely flowered. **Section 37. Pseudo-Cypereae.**

E. Pistillate scales blunt to cuspidate, the awn if present less than half as long as the blade; pistillate spikes cylindric to subglobose, less densely flowered.

F. Perigynia 7–10 mm. long; achenes 2–3 mm. long, 1.25–2.5 mm. wide .... **Section 40. Vesicariae.**

F. Perigynia 10–20 mm. long; achenes 2.5–6 mm. long, 2–4 mm. wide .... **Section 39. Lupulinae.**

SUBGENUS I. VIGNEA

Section 1. Dioicae

1. **Carex gynocrates** Wormsk. NORTHERN BOG SEDGE.

On hummocks in swamps. Rare.

Bergen Swamp, where it has been collected since 1865, was the only known station for this species until found May 19, 1950 in Reed Road

Swamp in town of Chili by W. A. Matthews 5304. The report in Proc. Roch. Acad. Sci. 3:122. 1896, "Springy banks a few miles south of Rochester, Dr. C. Dewey," is not confirmed by specimens at Rochester or Albany.

Section 2. Chordorrhizeae

2. Carex chordorrhiza L. f. CREEPING SEDGE.

C. chordorrhiza Ehrh. of Proc. Roch. Acad. Sci. 3: 121. 1896.

Sphagnum bogs and shallow water. Rare.

Specimens in the herbarium at the U. of R. were collected at Mud Pond in Wayne Co., June 23, 1880 by E. L. Hankenson; and at Sodus Point also in Wayne Co., in 1895 by M. S. Baxter. Collections have not been made at either station in recent years.

Section 2. Arenariae

a. Perigynia wing-margined .... **3. C. foenea.**
a. Perigynia not wing-margined .... **4. C. Sartwellii.**

3. Carex foenea Willd. DRY-SPIKED SEDGE.

C. siccata Dewey of Proc. Roch. Acad. Sci. 3: 122. 1896.

Dry sandy soil in abandoned fields and thinly wooded borders. Infrequent.

Sand barrens west of East Rochester, Inspiration Point on east side of Irondequoit Bay and Mendon Ponds Park are stations for this species.

4. Carex Sartwellii Dewey SARTWELL'S SEDGE.

Marshy meadows and open bogs. Rare.

The only known stations in the area for this species are: Mud Pond in Wayne Co., (1870) E. L. Hankenson and M. S. Baxter; the marshy border of Junius Ponds in Seneca Co., (1918) M. S. Baxter; and the marsh bordering the outlet of Quaker Pond at Mendon Ponds Park, June 1, 1922, W. A. Matthews 2116.

Section 4. Bracteosae

a. Broadest leaves 1–4.5 mm. wide.
  b. Perigynia very spongy below the middle, the nerve-like margins inflexed.
    c. Perigynia with minutely serrulate margins; scales blunt; spikes mostly remote.
      d. Broadest leaves 2–3 mm. wide; sheaths at base of the culm 1.5–2 mm. in diam.; perigynia broadly elliptic ovoid, 3–4.2 mm. long, deep green, in the lower spikes 9–12 rarely 6–20 in number, the wall thin, the beak prominent, thin, plainly bidentate, strongly serrulate; stigmas stout, short curved; scales pale, obtuse .... **5. C. convoluta.**
      d. Broadest leaves 2.8–3.2 mm. wide; sheaths at base of the culm 0.7–1.2 mm. in diam.; perigynia 2.2–3.2 mm. long.
        e. Perigynia 2.8–3.2 mm. long, elliptic-oblong or oblong-ovoid, olive green, spreading, firm-walled, in the lowest spikes 5–8 (3–12) in number; apex abruptly acute, obscurely bidentate, minutely serrulate; base as broad as the body, conspicuously spongy; stigma long, slender, usually reflexed but not coiled; scales obtuse, often tawny; lowest bract short, 5–30 (60) mm. long; broadest leaves about 1.3–1.8 mm. wide, light green. **6. C. rosea.**

e. Perigynia 2.2–2.8 (3) mm. long, elliptic-ovoid, deep green, usually ascending, thin-walled, in the lowest spikes 2–6 in number; apex more beaklike, less firm, plainly bidentate, strongly serrulate; base more obscurely spongy; stigmas short, less slender, usually coiled; scales obtuse, acute, or subaristate, whitish, rarely slightly tawny; lowest bract more conspicuous 30–40 mm. long or a few on each plant shorter; broadest leaves 0.8–1.2 mm. wide, deep green .... **7. C. radiata.**

c. Perigynia with smooth margins; scales acuminate; spikes mostly approximate **8. C. retroflexa.**

b. Perigynia of essentially uniform (membranous) texture throughout, not conspicuously spongy below the middle; margins slightly if at all inflexed.

f. Perigynia 4–6 mm. long .... **9. C. spicata.**

f. Perigynia less than 4 mm. long.

g. Leaves and culms stiff and wiry; heads 2 (rarely 1.5)–4 cm. long.

h. Perigynia distinctly nerved .... **10. C. Muhlenbergii.**

h. Perigynia nerveless .... **11. C. Muhlenbergii var. enervis.**

g. Leaves and culms soft; heads 0.7–1.5 (rarely 1.8) cm. long. **12. C. cephalophora.**

a. Broadest leaves 5–10 (the narrowest rarely 4.5) mm. wide.

i. Perigynia wing-margined to the base, 3–3.5 mm. long, 1.8–2 mm. wide, broadly ovate-orbicular, the beak shorter than the body; inflorescence elongated, interrupted; plant glaucous green .... **13. C. sparganioides.**

i. Perigynia wing-margined only above the middle, 3.4–4 mm. long, 1.6–2 mm. wide, narrowly ovoid, the beak equaling the body; plant yellowish-green **14. C. cephaloidea.**

5. Carex convoluta Mackenz.

Woodlands; all collections in this area are from upland sandy soils. Frequent.

Localities where this species has been found are: vicinity of "Float Bridge" on route 104 in town of Webster, upland woods on farm of Walter Bohm on Clover Road in town of Pittsford, Mendon Ponds Park, woodland border of Bergen Swamp, upland woods at Sullivan's Swamp near Fishers in Ontario Co., and Mertensia in Ontario Co.

6. Carex rosea Schkuhr

In low or moist upland woods. Common throughout the area.

Specimens are in the herbarium at the U. of R. from many stations in the Irondequoit Creek valley. Other stations for it are: the banks of lower Genesee River, Mendon Ponds Park, Adams Basin, Bergen Swamp, "The Gulf" in Genesee Co., Honeoye Lake, East Bloomfield in Ontario Co. and Newark in Wayne Co.

7. Carex radiata (Wahlenb.) Dewey STELLATE SEDGE.

C. rosea Schkuhr var. *radiata* Dewey of Proc. Roch. Acad. Sci. 3: 121. 1896.

Moist thickets and thin woods. Infrequent, found occasionally throughout the area.

Banks of the Genesee River, Genesee River flats at West Rush, Forest Lawn, Mendon Ponds Park, East Avon in Livingston Co., wooded hills south of Canadice in Ontario Co., Bergen Swamp and Carlton in Orleans Co. are localities where this species has been found.

8. **Carex retroflexa** Muhl. REFLEXED SEDGE.

C. rosea Schkuhr var. *retroflexa* Torr. of Proc. Roch. Acad. Sci. 3: 121. 1896.

There is no record of this species in the herbarium at the U. of R. The N.Y.S. Mus. Bull. 254:167. 1924 reports a collection by L. Holzer, in the vicinity of Rochester which is the basis for this listing.

9. CAREX SPICATA Huds.

C. leersia Willd. of Proc. Roch. Acad. Sci. 5: 80. 1917.

Swales and meadows. Scarce.

Specimens collected at Egypt Swamp in town of Perinton and at Mud Pond in Wayne Co. by E. P. Killip, which were the basis for the report in the 1917 Supplement, have since been referred to *C. interior*. However, its occurrence in this area has recently been established by a collection July 16, 1948 at Bergen Swamp, in a field just north of Black Creek, by R. F. Thorne and W. C. Muenscher 22516.

10. **Carex Muhlenbergii** Schkuhr MUHLENBERG'S SEDGE.

Summits of ridges and hillsides. Frequent in dry sandy soil.

Frequently found on the sandy slopes and ridges in the Irondequoit Creek valley from Fishers in Ontario Co. to Lake Ontario. It is abundant on sand dunes at Inspiration Point on east side of Irondequoit Bay and sand barrens west of East Rochester. Braddocks Bay, Honeoye Lake, Works Road in town of Rush and abandoned fields on sandy soil at Mendon Ponds Park are other stations for this species.

11. **Carex Muhlenbergii** Schkuhr var. **enervis** Boott

The report of this species, "On open crests of the dry gravelly eskers; infrequent." in *The Flora of Mendon Ponds Park* by R. H. Goodwin (Proc. Roch. Acad. Sci. 8:259. 1943) is the only known occurrence of it in the area. It apparently may be present in all of the habitats of the preceding species.

12. **Carex cephalophora** Muhl. SOUTHERN SEDGE.

Thinly wooded knolls and thickets. Frequent in dry soil throughout the area.

Reported from many stations in the Irondequoit Creek valley and its branching glens and gullies. Also reported from Mendon Ponds Park, Adams Basin, Works Road in town of Rush, "The Gulf" in Genesee Co. and from Newark in Wayne Co.

13. **Carex sparganioides** Muhl. BUR-REED SEDGE.

Usually found in rich moist woods in sandy soil. Frequent.

Locally common in woods at Palmer's Glen and upland woods bordering Sullivan's Swamp near Fishers in Ontario Co. Also known from Long Pond, Bergen Swamp, East Bloomfield in Ontario Co., Macedon in Wayne Co. and Newark in Wayne Co.

14. **Carex cephaloidea** Dewey THIN-LEAVED SEDGE.

Low woods, alluvial soil. Infrequent.

Flats of the Genesee River at West Rush is the best known station for this species in the area; it has also been reported from Messmer's Glen.

Section 5. Multiflorae

a. Beak of the perigynia about equaling the body, perigynia membranaceous, 1.7–3 mm. long; leaves exceeding the culms; inflorescence green .. **15. C. vulpinoidea.**

a. Beak of the perigynia much shorter than the body, perigynia subcoreacious, 2.2–2.6 mm. long; leaves shorter than the culms; inflorescence stramineous at maturity **16. C. annectens var. xanthocarpa.**

15. **Carex vulpinoidea** Michx. FOX SEDGE.

Low open woods and wet meadows. Common.

One of the commonest sedges of marshy places throughout the area, often seen in roadside ditches.

16. **Carex annectens** Bickn. var. **xanthocarpa** (Bickn.) Weig.

In situations similar to the preceding. Rare.

Known in this area only from a collection at Junius Ponds in Seneca Co., June 18, 1918 by M. S. Baxter.

Section 6. Paniculatae

a. Perigynia ovoid, with rounded margins, tapering gradually to a beak; leaves 1–3 mm. wide; inflorescence 1.5–5 cm. long; spikes obscurely branched.

b. Inflorescence dark brown, stiff, dense, spikelike; perigynia ovoid, 2–2.5 mm. long, inner face convex; scales short, not concealing the perigynia **17. C. diandra.**

b. Inflorescence light brown, flexuous, loose, sub-paniculate; perigynia more appressed, more lanceolate, 2.5–3.5 mm. long, inner face flat or concave; scales 3 mm. long, nearly concealing the perigynia .... **18. C. prairea.**

a. Perigynia obovoid, narrow-margined, abruptly short-beaked; leaves 5–8 mm. wide; inflorescence 10–15 cm. long; spikes plainly branched; plant stout, exceedingly deep green, 0.5–1 m. high, in stools .... **19. C. decomposita.**

17. **Carex diandra** Schrank LESSER PANICLED SEDGE.

C. teretiuscula Good. of Proc. Roch. Acad. Sci. 3: 121. 1896.

Marly shores of ponds and wet meadows. Infrequent.

Edges of marl bog at Bergen Swamp, marl bog at Junius Ponds in Seneca Co., Riga Swamp, Mendon Ponds Park, Bullhead Pond at Bushnell's Basin and Mertensia in Ontario Co. are stations for this species.

18. **Carex prairea** Dewey PRAIREA SEDGE.

C. teretiuscula Good. var. *ramosa* Boott of Proc. Roch. Acad. Sci. 3: 121. 1896.

Boggy meadows and swamps. Infrequent.

Known from Mud Pond in Wayne Co., Bergen Swamp, Adams Basin and Junius Ponds in Seneca Co. Abundant in an open marsh bordering Round Pond at Mendon Ponds Park where it was collected June 20, 1948 by W. A. Matthews 4918.

Its loose, nodding inflorescence and the chaffy appearance of the spikes caused by the long scales are field marks which make it easy to distinguish from *C. diandra* with its strict bristly inflorescence and less conspicuous scales.

19. Carex decomposita Muhl. LARGE-PANICLED SEDGE.

In swamps. Rare.

This record is based on a single collection in July 1868 by E. L. Hankenson at Lima in Livingston Co. The specimen in the herbarium at the U. of R. is apparently the only report of the species made by Rochester botanists.

Section 7. Vulpinae

a. Perigynia tapering into a beak, 1–2 times the length of the body.
 b. Sheaths wrinkled, loose at the mouth; perigynia 4–5 mm. long .. **20. C. stipata.**
 b. Sheaths not wrinkled, tight at the mouth; perigynia 4.5–7 mm. long. **21. C. laevivaginata.**
a. Perigynia contracted into a beak not longer than the body, ovate, 3–4 mm. long, 1.5–2 mm. broad; spikes yellowish or tawny at maturity. .... **22. C. alopecoidea.**

20. Carex stipata Muhl. AWL-FRUITED SEDGE.

Wet meadows. Common.

An extensive area of marsh land on Wilmarth Road in town of Pittsford, is completely covered by this species. It also occurs at Black Creek near Chili Road, Adams Basin, Long Pond, Lower Genesee River, Palmer's Glen, Mendon Ponds Park, Egypt, Canadice Lake, Honeoye Lake and Bergen Swamp.

21. Carex laevivaginata (Kukenth.) Mackenz.

Occasionally found in wet meadows and swales. Infrequent.

Collections have been made at Palmer's Glen, Mendon Ponds Park, Bergen Swamp, Sullivan's Swamp near Fishers in Ontario Co. and at Junius Ponds in Seneca Co.

22. Carex alopecoidea Tuckerm. FOXTAIL SEDGE.

Ditches and meadows. Apparently very scarce.

Reported from Ontario Co. in 1871 by E. L. Hankenson. Recent collections are from the banks of Little Black Creek, June 29, 1941 by Royal E. Shanks 743; and Bergen Swamp June 11, 1948 by W. C. Muenscher 22420.

Section 8. Heleonastes

a. Staminate flowers at the apex of the spikes; perigynia subterete; spikes 1–3 flowered **29. C. disperma.**
a. Staminate flowers at the base of the spikes; perigynia plano-convex.
 b. Perigynia with serrulate beaks or margins; lowest bracts short bristle-like or wanting.
  c. Plant glaucous; leaves 2–4 mm. broad; spikes with many appressed-ascending glaucous obscurely beaked perigynia.

d. Spikes 6–10 mm. long, approximate or the lowest rarely 1–5 cm. apart; perigynia 2.3–3 mm. long .... **23. C. canescens.**

d. Spikes 4–7 mm. long, subapproximate or remote; perigynia about 2 mm. long. **24. C. canescens var. subloliacea.**

d. Spikes 6–12 mm. long, remote, the lowest 2–4 cm. apart; perigynia 2.3–3 mm. long. .... **25. C. canescens var. disjuncta.**

c. Plant green, not glaucous; leaves 1–2.5 mm. broad; spikes with few loosely spreading dark green or brown distinctly beaked perigynia **26. C. brunnescens.**

b. Perigynia smooth throughout; lowest bracts bristle-like, many times longer than the spike.

e. Leaves flat, 1–2 mm. broad; perigynia 3–3.5 mm. long ...... **27. C. trisperma.**

e. Leaves setaceous, 0.3–0.5 mm. broad; perigynia 2.5–3.3 mm. long; lowest inflorescence bracts hair-like and shorter than the preceding **28. C. trisperma var. Billingsii.**

23. Carex canescens L. SILVERY OR HOARY SEDGE.

Sphagnum bogs. Rare.

Known in this area from two stations only: Mendon Ponds Park and the wooded hills south of Canadice in Ontario Co.

24. Carex canescens L. var. **subloliacea** Laestad.

Open sphagnum bogs. Rare.

The *Vaccinium* bog on the north side of the Hopkins Point entrance to Mendon Ponds Park, where it is abundant, is the only known station for this variety in the area.

25. Carex canescens L. var. **disjuncta** Fern.

Muddy borders of bogs. Rare.

A single collection from the muddy border of Kennedy's Bog at Mendon Ponds Park, June 16, 1940 by W. A. Matthews 4142 is the basis for this record.

26. Carex brunnescens (Pers.) Poir. BROWNISH SEDGE.

Moist upland woods. Rare.

Two stations are known for this species in the area: Sullivan's Swamp near Fishers in Ontario Co., M. S. Baxter; and the wooded hills south of Canadice in Ontario Co., June 6, 1925, W. A. Matthews 2565.

27. Carex trisperma Dewey. THREE-FRUITED SEDGE.

Sphagnum bogs. Infrequent.

Kennedy's Bog at Mendon Ponds Park, Bergen Swamp, Manitou, Mud Pond in Wayne Co. and Sullivan's Swamp near Fishers in Ontario Co. are stations for this species.

28. Carex trisperma Dewey var. **Billingsii** Knight

Moist woods. Rare.

This variety of the preceding species has been reported from two stations only: Mendon Ponds Park by M. S. Baxter and H. D. House; and

North Hamlin Road near Hamlin Beach Park, Sept 13, 1945 by W. A. Matthews 4745.

29. **Carex disperma** Dewey. SOFT-LEAVED SEDGE.

C. tenella Schkuhr of Proc. Roch. Acad. Sci. 3: 121. 1896.

Found occasionally in cold spring fed swamps. Scarce.

Occurs at Bergen Swamp, Riga Swamp, Adams Basin, Mud Pond in Wayne Co. and Sullivan's Swamp near Fishers in Ontario Co.

Section 9. Deweyanae

a. Perigynia 1.6–1.9 mm. broad, faintly nerved or nerveless; scales ovate; spikes ovoid-oblong, silvery-green; leaves 2.5 mm. wide . . . . **30. C. Deweyana.**

a. Perigynia 1–1.3 mm. broad, strongly nerved; scales oblong; spikes linear in a loose cylindric inflorescence, tawny; leaves 1–2.5 mm. wide . . . . **31. C. bromoides.**

30. **Carex Deweyana** Schwein. DEWEY'S SEDGE.

Moist to dry woods throughout the area. Most common in beech-maple woods having moist soil.

Specimens in the herbarium at the U. of R. are from Holley in Orleans Co., Bergen Swamp, "The Gulf" in Genesee Co., Adams Basin, Brockport, beech-maple woods on Mill Road in town of Greece, Palmer's Glen, Union Hill, Hipp Brook in town of Penfield, Pittsford, Bushnell's Basin, Powder Mill Park, East Bloomfield in Ontario Co., Grimes Gully at Naples in Ontario Co., Macedon in Wayne Co. and Palmyra in Wayne Co.

31. **Carex bromoides** Schkuhr BROOME-LIKE SEDGE.

Swamps, marshes and low woods. Frequent.

Usually found in depressions that are wet in early spring and dry in summer. Herbarium specimens at the U. of R. are from Adams Basin, Bergen Swamp, East Bloomfield in Ontario Co. and Newark in Wayne Co. It was found abundant at the summit of drumlins on the shore of Lake Ontario north of Wolcott in Wayne Co., June 22, 1941 by W. A. Matthews 4348. Other recent collections are from a dense swamp on Pinnacle Road near East Rush, June 19, 1949 by W. A. Matthews 5157; and a low woods on Huffer Road in town of Parma, July 13, 1948 by W. A. Matthews 4970.

Section 10. Stellulatae

a. Spikes solitary and terminal, pistillate or staminate, or with flowers variously scattered; culms 2–7 dm. high in cespitose stools . . . . **32. C. exilis.**

a. Spikes 2–several.

  b. Perigynia broadest at base, beak rough or serrulate.

    c. Perigynia at most half as broad as long, finally yellowish, with slender beak nearly equaling the body; scales pointed.

      d. Perigynia ovate 3–4 mm. long.

        e. Spikes at most 12 flowered. Inflorescence 1–3 cm. long, the 2–6 spikes subapproximate; scales lustrous brown. . . . . **33. C. sterilis.**

e. Spikes with more flowers.
f. Leaves 1–2.5 mm. broad; spikes scattered, 12–20 flowered; perigynia less than half as broad as long .... **34. C. incomperta.**
f. Leaves 2–4 mm. broad; spikes mostly approximate, 15–40 flowered; perigynia half as broad as long .... **35. C. cephalantha.**
d. Perigynia lanceolate or ovate-lanceolate 2.5–3 mm. long; inflorescence of 2–6 approximate spikes, 3–15 flowered .... **36. C. angustior.**
c. Perigynia more than half as broad as long, firm, brownish or dark green, beaks ¼ to ½ as long as the body.
g. Scales sharp pointed; leaves 2.5.–4.5 cm. broad; inflorescence 1.5–3.5 cm. long; spikes 15–20 flowered; coarse plants .... **37. C. atlantica.**
g. Scales blunt; leaves narrower; inflorescence 1–2 cm. long; spikes 5–15 flowered; slender plants.
h. Leaves 1–2 mm. broad; perigynia faintly nerved or nerveless on the inner face, deltoid-ovate, spreading .... **38. C. interior.**
h. Leaves narrower; perigynia strongly nerved .... **39. C. Howei.**
b. Perigynia broadest near the middle, less than 2 mm. broad, very thin and conspicuously nerved, with short smooth beak; spikes remote .... **40. C. seorsa.**

32. Carex exilis Dewey. COAST SEDGE.

Open sphagnum bogs. Rare.

The marsh bordering Quaker Pond at Mendon Ponds Park and the sphagnum bog bordering Mud Pond in Wayne Co. are the only known stations for this rare species.

33. Carex sterilis Willd.

C. echinata Murray var. *microstachys* Boeckl. of Proc. Roch. Acad. Sci. 3: 122. 1896.

Marl bogs. Infrequent.

This species has been collected from the borders of Round Pond and Quaker Pond at Mendon Ponds Park, the open marl bog in Bergen Swamp, Sullivan's Swamp near Fishers in Ontario Co. and Junius Ponds in Seneca Co.

34. Carex incomperta Bickn. PRICKLY BOG SEDGE.

Thinly wooded swamps and bogs. Infrequent.

Known from Bergen Swamp, Riga Swamp, Mendon Ponds Park, Sullivan's Swamp near Fishers in Ontario Co. and Junius Ponds in Seneca Co.

35. Carex cephalantha (Bailey) Bickn. LITTLE PRICKLY SEDGE.

In sphagnum bogs. Scarce.

This species has not been collected in the past thirty years. Herbarium records are from Bergen Swamp, Adams Basin, Sullivan's Swamp near Fishers in Ontario Co. and Mud Pond in Wayne Co.

36. Carex angustior Mackenz. NORTHERN PRICKLY SEDGE.

C. stellulata Good. var. *angustata* Carey of Pro. Roch. Acad. Sci. 5:79. 1917.

Sphagnum bogs. Scarce.

Several collections have been made at Bergen Swamp. Also found at
in Wayne Co.
Mendon Ponds Park, Junius Ponds in Seneca Co. and at Westbury Marsh

37. **Carex atlantica** Bailey EASTERN SEDGE.

The only record for this species is a collection June 6, 1897 at Bergen Swamp by M. S. Baxter.

38. **Carex interior** Bailey INLAND SEDGE.

In sphagnum bogs, spring basins and thinly wooded spring fed swamps. Frequent.

Widely distributed throughout the area. Found at Mendon Ponds Park, Cedar Swamp in town of Henrietta, Adams Basin, Riga Swamp, Bergen Swamp, Seneca Park, Durand Eastman Park, Egypt Swamp in town of Perinton, Junius Ponds in Wayne Co. and Macedon in Wayne Co.

39. **Carex Howei** Mackenz. HOWE'S SEDGE.

On mossy hummocks in wet boggy swamps. Infrequent.

The swampy wooded border of Round Pond at Mendon Ponds Park is a typical habitat for this species and here it is quite abundant. Herbarium records are from Bergen Swamp, Riga Swamp, Sullivan's Swamp near Fishers in Ontario Co. and Junius Ponds in Seneca Co.

40. **Carex seorsa** Howe WEAK STELLATE SEDGE.

Rocky woods. Rare.

The only collections of this species in the area were made in the wooded hills south of Canadice in Ontario Co.

Section 11. Ovales

a. Perigynia less than 2 mm. broad.
- b. Perigynia 5 mm. or more long. Spikes ovoid pointed, approximate but not crowded, straw-colored or brownish; leaves at most 3 mm. wide **41. C. scoparia.**
- b. Perigynia less than 5 mm. long.
  - c. Perigynia thin, scale-like, scarcely distended over the achenes; leaves 3–8 mm. broad.
    - d. Tips of the perigynia appressed; inflorescence stiff; spikes not conspicuously clavate-based .... **42. C. tribuloides.**
    - d. Tips of the perigynia spreading; inflorescence flexuous, nodding; spikes clavate-based .... **43. C. projecta.**
  - c. Perigynia firm, obviously distended over the achenes.
    - e. Leaves 2.5 mm. or more wide.
      - f. Spikes compactly flowered; the mature perigynia with recurved or spreading tips concealing the scales. .... **44. C. cristatella.**
      - f. Spikes with ascending or slightly spreading perigynia; scales apparent.
        - g. Mature perigynia greenish or pale straw-colored, in loose spikes; inflorescence more than 2.2 cm. long; scales pale .... **46. C. normalis.**
        - g. Mature perigynia brown, in dense spikes, heads at most 2.2 cm. long; scales pale brown .... **45. C. Bebbii.**
    - e. Leaves 0.5–2 mm. wide. Spikes usually in a flexuous moniliform inflorescence, clavate at base .... **47. C. tenera.**

a. Perigynia 2 mm. or more broad.
- h. Scales lance-subulate; perigynia 4–5 mm. long, the body broadly obovoid, 2.8–3.7 mm. broad, abruptly narrowed at base; spikes green or finally dull brown **50. C. alata.**

h. Scales blunt or at most acutish; perigynia 4–5.5 mm. long; spikes straw-colored.
i. Perigynia ovate, inner surface few-nerved, broadest near the base and tapering into a beak .... **49. C. molesta.**
i. Perigynia broadly ovate to suborbicular, inner surface nerveless or nearly so, broadest near the middle and abruptly contracted into a beak .. **48. C. brevior.**

41. Carex scoparia Schkuhr POINTED BROOM SEDGE.

Wet grass lands. Frequent.

Although herbarium records at the U. of R. are limited to occurences at Churchville, Manitou, Bergen Swamp, Bushnell's Basin, East Palmyra in Wayne Co. and Junius Ponds in Seneca Co., there are, without doubt, few places in the area where this species cannot be found.

42. Carex tribuloides Wahlenb. BLUNT BROOM SEDGE.

Open swamps and marshes bordering streams. A very common sedge throughout the area.

43. Carex projecta Mackenz. NECKLACE SEDGE.

C. tribuloides Wahlenb. var. *reducta* Bailey of Proc. Roch. Acad. Sci. 5: 32. 1910.

Meadows, thickets and thin woods on low ground. Infrequent.

Specimens are in the herbarium at the U. of R. from Lima Ponds in Livingston Co., Canadice Lake, Bergen Swamp, Hamlin Beach Park, East Rochester and Sullivan's Swamp near Fishers in Ontario Co.

44. Carex cristatella Britt. CRESTED SEDGE.

Low ground along streams and swampy borders. Like no. 42, this species is very common, requiring slightly more shade.

45. Carex Bebbii Olney BEBB'S SEDGE.

C. tribuloides Wahlenb. var. *Bebbii* Bailey of Proc. Roch. Acad. Sci. 3:122. 1896.

Meadows and moist thickets. Frequent.

Like other common species of this group, *C. Bebbii* is found throughout the area in suitable habitats.

46. Carex normalis Mackenz. LARGER STRAW SEDGE.

C. straminea Willd. var. *mirabilis* Tuckerm. of Proc. Roch. Acad. Sci. 3:122. 1896.

The specimens on which the report in the 1896 list was based were collected at East Palmyra in Wayne Co. in 1868–9 by E. L. Hankenson. More recent collections have been made at Lima Ponds in Livingston Co. in 1921 by M. S. Baxter; open woods at Mendon Ponds Park in 1940 by R. H. Goodwin; and alluvial soil near Black Creek in Bergen Swamp, June 28, 1948 by B. I. Brown and W. C. Muenscher 22511.

47. Carex tenera Dewey SLENDER STRAW SEDGE.

C. straminea Willd. of Proc. Roch. Acad. Sci. 3: 122. 1896.

Low moist thickets and swamp borders. Rare.

The report of *C. tenera*, "westward to Genesee Co.", in N.Y.S. Mus.

Bull. 254:169. 1924, is apparently based on a collection made by Dr. H. D. House. There are no specimens of this collection in the herbarium at the U. of R. The occurrence of the species in the area has since been definitely established in three localities: Bergen Swamp, June 11, 1948 by W. C. Muenscher and R. F. Thorne 22448; low woods 3 mi. west of Hamlin Beach Park, July 13, 1948 by W. A. Matthews 4966–7; and moist sandy soil in thicket on Norman Road in West Brighton, June 4, 1949 by W. A. Matthews 5138.

48. Carex brevior (Dewey) Mackenz.

C. straminea Willd. var. *brevior* Dewey of Proc. Roch. Acad. Sci. 3: 123. 1896.

A collection by E. L. Hankenson from Newark in Wayne Co. is the basis of this report.

49. Carex molesta Mackenz.

Known in this area from two stations only: dry sandy fields near Mendon Ponds Park, July 1, 1945, W. A. Matthews 4685; and a moist sandy thicket bordering Red Creek near Genesee Valley Park, July 6, 1948, W. A. Matthews 4940.

50. Carex alata T. & G. BROAD-WINGED SEDGE.

Mud Pond in Wayne Co. is the only known station in the area for this species. M. S. Baxter found it there in June 1911 and again in 1918. H. D. House in N.Y.S. Mus. Bull. 254:171. 1924, considers *C. alata* a rare species but rather widely distributed across the state south of the Adirondack Mts.

SUBGENUS II. EUCAREX

Section 12. Polytrichoideae

51. Carex leptalea Wahlenb. BRISTLE-STALKED SEDGE.

Cold spring bogs and tamarack swamps. Infrequent.

Known from Bergen Swamp, Riga Swamp, Adams Basin, Mendon Ponds Park, Egypt Swamp in town of Perinton, a swamp on Boughton Hill Road in Mendon, Mud Pond in Wayne Co., Junius Ponds in Seneca Co. and Sullivan's Swamp near Fishers in Ontario Co.

Section 13. Phyllostachyae

52. Carex Jamesii Schwein. JAMES' SEDGE.

A specimen collected by E. L. Hankenson in 1880 in Wayne Co. (specific station unknown) was the only record for this species until May 1942 when Dr. Grace A. B. Carter and Miss Anne Hammon found it in a thin woods on rocky calcareous soil on Works Road, in town of Rush. It has since been found near the south west entrance to Bergen Swamp, June 11, 1948 by W. C. Muenscher.

Section 14. Montanae

a. Plants strongly stoloniferous, the elongate often leafless stolons scaly-bracted and creeping.
  b. Beak one fourth to one fifth as long as the body of the perigynium **53. C. pensylvanica.**
  b. Beak about as long as the body of the perigynium **54. C. pensylvanica var. distans.**
a. Plants cespitose or slightly stoloniferous, the basal leafy shoots strongly ascending.
  c. Fertile culms short, some bearing pistillate spikes only and partly hidden among the densely tufted basal leaves, a few bearing staminate and pistillate spikes.
    d. Leaf blades rather thin, not stiff, erect or ascending, 1.5–3 mm. wide; perigynia membranaceous, 2.25–4 mm. long, the body short puberlent above **55. C. umbellata.**
    d. Leaf blades thick, rigid, widely spreading at maturity, 2–4.5 mm. wide; perigynia subcoreaceous, 3.5–4.5 mm. long, the body glabrous or very sparsely pubescent above .... **56. C. tonsa.**
  c. Fertile culms elongate, bearing both staminate and pistillate spikes.
    e. Body of perigynia elliptic to oblong-ovoid, much longer than wide; leaves 1–2.5 mm. wide .... **57. C. artitecta.**
    e. Body of perigynia subglobose to somewhat obovoid, 2.5–4 mm. long, about as wide as long; leaves 3–5 mm. wide .... **58. C. communis.**

53. Carex pensylvanica Lam. PENNSYLVANIA SEDGE.

A common early spring sedge usually found in thin woods and thickets on sandy soil; occasionally in low moist thickets where the soil is light.

54. Carex pensylvanica Lam. var. **distans** Peck

H. D. House in N.Y.S. Museum Bulletin No. 254, p. 174, reports this species from Palmer's Glen. This was the first report of the species in our area and was evidently of his collection since there are no specimens of it in the herbarium at Rochester. It was found at "Rattlesnake Point", on the banks of the Genesee River, north of Rochester, May 2, 1944 by W. A. Matthews 4544 and no doubt occurs elsewhere but has not been recognized.

55. Carex umbellata Schkuhr UMBELLATE SEDGE.

Forming dense clumps in dry sandy soils. Infrequent.

Locally abundant at Bushnell's Basin and the east side of Irondequoit Bay at Inspiration Point. Also occurs in dry woods at Honeoye Lake.

56. Carex tonsa (Fern.) Bickn. DEEP-GREEN SEDGE.

Abundant on the dry sand barrens just west of East Rochester where like the preceding species it forms dense clumps on the sand dunes acting as a soil binder. It has also been reported from town of Penfield and on the abandoned Jaeschke's Mill property in town of Pittsford.

57. Carex artitecta Mackenz.

C. varia Muhl. of Proc. Roch. Acad. Sci. 3:121. 1896.

Upland woods on light sandy soils. Infrequent.

Widely distributed throughout the area east of the Genesee River. There are no herbarium records from west of the river.

58. Carex communis Bailey FIBROUS-ROOTED SEDGE.

Dry sandy soil on wooded hills and sides of ravines throughout the area. Frequent.

Collected from many places in the Irondequoit Creek valley and its adjoining glens and gullies. Also found at Union Hill in town of Webster, Honeoye Lake, Lime Rock in Genesee Co. and Bergen Swamp.

Section 15. Digitatae

a. Terminal spikes bearing some pistillate flowers; scales green to purple, truncate and cuspidate .... **59. C. pedunculata.**

a. Terminal spike staminate throughout; scales brown, with conspicuous white hyaline margins .... **60. C. Richardsonii.**

59. Carex pedunculata Muhl. LONG-STALKED SEDGE.

Low woods, ravines and on hummocks in swamps. Infrequent.

Reported from Riga Swamp, Bergen Swamp, Sullivan's Swamp near Fishers in Ontario Co., Rochester Junction, Adams Basin, Hipp Brook in town of Penfield, Jenkins Woods in town of Pittsford and Mud Pond in Wayne Co.

60. Carex Richardsonii R. Br. RICHARDSON'S SEDGE.

H. D. House in N.Y.S. Museum Bulletin 254; 177, 1924 reports the plant from this area with the following comment: "The only record for this state rests upon a collection made at Parma, Monroe County, many years ago by Bradley. The specimen from Bradley in the state herbarium is labeled 'Greece, Monroe County'."

Section 16. Albae

61. Carex eburnea Boott BRISTLE-LEAVED SEDGE.

The only known stations are boggy stream margins in arbor vitae swamps in town of Riga and at Bergen. An old report "Dry cliff along the Genesee River," cannot be verified.

Section 17. Triquetrae

62. Carex hirtifolia Mackenz. PUBESCENT SEDGE.

Thin woods on light sandy soil. Scarce.

Reported from Newark in Wayne Co. in 1883 by E. L. Hankenson; Bushnell's Basin in 1921 by M. S. Baxter; Works Road in town of Rush, June 15, 1941 by W. A. Matthews 4338; Bergen Swamp June 11, 1946 by W. C. Muenscher.

Section 18. Bicolores

63. Carex aurea Nutt. GOLDEN-FRUITED SEDGE.

Wet rocks and banks. Infrequent.

Specimens are in the herbarium at the U. of R. from the rocky banks of the Genesee River. Also from wet shores of Irondequoit Bay and

Lake Bluffs in town of Webster. Bergen Swamp, Mendon Ponds Park, Junius Ponds in Seneca Co. and Newark in Wayne Co. are other stations where collections have been made.

Section 19. Cryptocarpae

a. Culms sharp and rough or sometimes smooth; leaves 4–10 mm. wide; pistillate spikes flexuous and drooping; perigynia 2–3 mm. long .... **64. C. crinita.**

a. Culms harsher than the type; leaves 4–6 mm. wide; pistillate spikes suberect, the terminal one scarcely drooping; perigynia 3 mm. long. **65. C. crinita var. simulans.**

64. Carex crinita Lam. SICKLE SEDGE.

Thinly wooded swamps and moist thickets. Common.

Collections from Bergen Swamp, Canadice Lake, Honeoye Lake, Mud Pond in Wayne Co., Sullivan's Swamp near Fishers in Ontario Co., town of Irondequoit and town of Gates indicate its general distribution throughout the area.

65. Carex crinita Lam. var. **simulans** Fern.

The basis for this report is a single collection at Canadice Lake in 1925 by M. S. Baxter 6740.

Section 20. Acutae

a. Pistillate spikes spreading or drooping; beak of the perigynia twisted; culms rather stout at base .... **66. C. torta.**

a. Pistillate spikes erect; beak of the perigynia not twisted; culms somewhat more slender at base.

- b. Well developed leaves 8–15 on the fertile culms ..... **67. C. aquatilis var. altior.**
- b. Well developed leaves 3–5 on the fertile culms.
  - c. Leaves stiffish and deep green .... **68. C. stricta.**
  - c. Leaves glaucous; stems sharply three-angled with concave sides **69. C. stricta var. strictior.**

66. Carex torta Boott TWISTED SEDGE.

Reported in Proc. Roch. Acad. Sci. 3:119. 1896 as "Rare? Dr. C. M. Booth." This report is not confirmed by a specimen at Rochester or Albany. The occurrence of the species in this area has since been established by two collections in Ontario Co. by M. S. Baxter: one at Mertensia in 1918 and the other at Grimes Gully near Naples in 1924.

67. Carex aquatilis Wahlenb. var. **altior** (Rydb.) Fern.

NORTHERN WATER SEDGE.

C. aquatilis Wahlenb. of Proc. Roch. Acad. Sci. 3: 118. 1896.

Open bogs and marshes. Scarce.

Found occasionally in marshes at Mendon Ponds Park, Adams Basin, Mud Pond in Wayne Co. and at Junius Ponds in Seneca Co.

68. Carex stricta Lam. TUSSOCK SEDGE.

Marshes and swales bordering ponds and along streams. This common species has been collected in such habitats throughout the area. The large tussocks covering the marsh on the west side of Quaker Pond at Mendon Ponds Park were formed by this sedge.

69. Carex stricta Lam. var. **strictior** (Dewey) Carey

NORTHERN TUSSOCK SEDGE.

In habitats similar to the preceding but apparently not as common. It is abundant in the bog at the Burroughs Audubon Conservation Station.

Section 21. Atratae

70. Carex Buxbaumii Wahlenb. BROWN SEDGE.

C. fusca All. of Proc. Roch. Acad. Sci. 3: 118. 1896.

Found only in Sphagnum bogs. Scarce.

This species was once found on the banks of the Genesee River, but the station has long ceased to exist. It can be found sparingly in bogs at Mendon Ponds Park, Bergen Swamp, Mud Pond in Wayne Co. and Junius Ponds in Seneca Co.

Section 22. Limosae

a. Plant loosely tufted; leaves flat, 2–4 mm. wide, deep green; scales long attenuate exceeding the perigynia .... 71 **C. paupercula var. irrigua.**

a. Plant very stoloniferous; leaves involute, 1–3 mm. wide, glaucous; scales obtuse or acute, barely exceeding the perigynia .... **72. C. limosa.**

71. Carex paupercula Michx. var. **irrigua** (Wahlenb.) Fern.

Sphagnum bogs and cold wooded swamps. Rare.

Known from the open sphagnum bog at Mud Pond in Wayne Co. and the wet arbor vitae woods in Bergen Swamp.

72. Carex limosa L. MUD SEDGE.

Bogs and marshes. Scarce.

This species has been collected in Kennedy's Bog and the bog bordering Quaker Pond at Mendon Ponds Park since 1895. At Mud Pond in Wayne Co. it is quite abundant.

Section 23. Anomalae

73. Carex scabrata Schwein. ROUGH SEDGE.

Thinly wooded swamps and creek borders. Frequent.

Quite abundant in Riga Swamp also in lower Seneca Park. Herbarium records indicate its occurrence throughout the area.

Section 24. Hirtae

a. Leaves broad and flat 2–5 mm. wide; scales mostly equaling the densely hairy perigynia .... **74. C. lanuginosa.**

a. Leaves involute filiform; scales mostly sharper and longer; perigynia with dense stiff hairs .... **75. C. lasiocarpa var. americana.**

74. **Carex lanuginosa** Michx. WOOLY SEDGE.

C. filiformis L. var. *latifolia* Boeckl. of. Proc. Roch. Acad. Sci. 3:118. 1896.

Marshes and spring bogs throughout the area. Infrequent.

This species is known from the following stations: borders of Round Pond, borders of Irondequoit Bay, Mendon Ponds Park, Burroughs Audubon Conservation Station, Sullivan's Swamp near Fishers in Ontario Co., Mertensia in Ontario Co. and Mud Pond in Wayne Co.

75. **Carex lasiocarpa** Ehrh. var. **americana** Fern.

C. filiformis L. of Proc. Roch. Acad. Sci. 3:118, 1896.

Habitat and distribution same as the preceding, perhaps slightly more frequent.

Section 25. Virescentes

a. Terminal spike staminate, linear; perigynia faintly nerved **76. C. pallescens var. neogaea.**

a. Terminal spike staminate, with some pistillate flowers at the apex, clavate at the base; perigynia strongly nerved.

b. Perigynia very hairy; spikes more or less widely separated and peduncled.

c. Pistillate spikes linear, attenuate at base, the lowest 15–40 mm. long; perigynia oblong-elliptic or narrowly obovoid; leaves usually shorter than the culms. **77. C. virescens.**

c. Pistillate spikes oblong or oblong-globose, abrupt or rounded at base, the lowest 5–20 mm. long; perigynia broadly obovoid; leaves usually exceeding the culms .... **78. C. Swanii.**

b. Perigynia smooth, or when young slightly hairy; spikes contiguous or nearly so and sessile or subsessile. Staminate portion of terminal spike short; pistillate scales acute or short-acuminate, shorter than the perigynia **79. C. hirsutella.**

76. **Carex pallescens** L. var. **neogaea** Fern. PALE SEDGE.

Moist meadows. Scarce, but well distributed throughout the area.

Seneca Park, Little Black Creek in town of Gates, Penfield Dugway, Bergen Swamp, Sullivan's Swamp near Fishers in Ontario Co., moist shores of Honeoye Lake and East Bloomfield in Ontario Co. are stations for this species. It is abundant in a low area on Westfall Road just east of Genesee Valley Park.

77. **Carex virescens** Muhl. RIBBED SEDGE.

Thin upland woods on sandy soil. Infrequent.

Palmer's Glen; Coldwater; Carlton in Orleans Co.; Hogan Road in town of Greece; and Penfield Dugway, July 16, 1939, W. A. Matthews 5030 are stations where this species has been collected.

78. **Carex Swanii** (Fern.) Mackenz. SWAN'S SEDGE.

Moist thickets and open woods. Rare.

Known in this area from three stations only: Carlton in Orleans Co.; Cobbs Hill, Rochester; and a sandy beach at Sodus Bay in Wayne Co.

79. **Carex hirsutella** Mackenz. NORTHERN HIRSUTE SEDGE.

C. triceps Michx. var. *hirsuta* (Willd.) Bailey of Proc. Roch. Acad. Sci. 3:119. 1896.

The report of this species, "Rare. Vicinity of Rochester, Dr. C. M. Booth, L. Holzer." in Proc. Roch. Acad. Sci. 3:119. 1896, cannot be verified by specimens in the herbarium at the U. of R. A collection July 10, 1950 on Bare Hill near Canandaigua Lake in Ontario Co. by W. A. Matthews 5285, is apparently the only record for the species in this area.

Section 26. Gracillimae

a. Lowest bract short-sheathing, the upper reduced scarcely sheathing.
  b. Perigynia 3–4 mm. long 1.5 mm. wide, ascending triangular, the lateral nerves prominent; sheaths thin and white hyaline ventrally, smooth . . **80. C. prasina.**
  b. Perigynia 3–3.5 mm. long, 1.75 mm. wide, appressed ascending, flattened triangular, strongly nerved; sheaths yellowish brown tinged and red dotted ventrally, sparsely short pubescent and ciliate near the base. **81. C. aestivaliformis.**

a. Lowest bract sheathing and leaf-like, the upper sheathing but reduced.
  c. Perigynia 2 mm. or more thick.
    d. Scales blunt or cuspidate, much shorter than the perigynia . **82. C. formosa.**
    d. Scales long awned, usually equaling the perigynia . . . . **83. C. Davisii.**
  c. Perigynia less than 2 mm. thick . . . . **84. C. gracillima.**

80. **Carex prasina** Wahlenb. DROOPING SEDGE.

Wet springy places. Infrequent.

It is recorded from banks of the Genesee River in Irondequoit and at Charlotte. It has also been found at Adams Basin and at Mud Pond in Wayne Co. The most recent collection is from Briggs Gully near the head of Honeoye Lake in Ontario Co., June 5, 1949 by W. A. Matthews 5144.

81. **Carex aestivaliformis** Mackenz. (C. gracillima x aestivalis Bailey Torr. Club. Bull. 20:417. 1893.)

The basis for this record is a collection from the thinly wooded lowlands bordering the Genesee River at West Rush, May 23, 1921 by W. A. Matthews 2031.

82. **Carex formosa** Dewey HANDSOME SEDGE.

Dry woods and thickets. Scarce.

Several collections have been made at Seneca Park. It has also been found on the Genesee River flats at West Rush and at East Bloomfield in Ontario Co.

83. **Carex Davisii** Schwein. & Torr. DAVIS'S SEDGE.

Locally common in rich alluvial woods at West Rush, rare elsewhere. Collected at Lima Ponds in Livingston Co. by Mrs. Wm. G. L. Edson.

84. **Carex gracillima** Schwein. GRACEFUL SEDGE.

A very common species in lowland thickets and meadows. Records in the herbarium at the U. of R. indicate its occurrence throughout the area.

Section 27. Sylvaticae

a. Pistillate spikes oblong-cylindric 8–20 mm. long; leaf-sheaths and blades (at least toward the base) conspicuously pilose .... **85. C. castanea.**
a. Pistillate spikes narrowly linear or linear, 20–80 mm. long.
  b. Perigynia twice as long as the blunt scales; broadest basal leaves 3–5 mm. wide **86. C. debilis var. Rudgei.**
  b. Perigynia only slightly longer than the very sharp or cuspidate scales; broadest basal leaves 5–10 mm. wide .... **87. C. arctata.**

85. Carex castanea Wahlenb. CHESTNUT SEDGE.

Sphagnum bogs. Rare.

Our only station for this species is at Mendon Ponds Park, where it has been collected by E. P. Killip and M. S. Baxter.

86. Carex debilis Michx. var. **Rudgei** Bailey SLENDER-STALKED SEDGE.

Reported as "Rare. Near Rochester." in Proc. Roch. Acad. Sci. 3:119. 1896, but there are no herbarium records at Rochester or Albany to confirm this old report. It is, however, reported from several stations in both *The Flora of Cayuga Lake Basin* and *The Flora of the Niagara Frontier Region* and no doubt occurs here but has not been recognized.

87. Carex arctata Boott DROOPING WOOD SEDGE.

Dry woods and shady banks. Infrequent but widely distributed throughout the area.

Collections have been made from a low woods north of Union Hill in town of Webster, June 23, 1940 by W. A. Matthews 4160; several wooded areas on Clover Road in town of Pittsford; Palmer's Glen where it is frequent; Adams Basin in 1895; the hemlock knoll in Bergen Swamp; Reynolds Gulf in Livingston Co.; and near Newark in Wayne Co.

Section 28. Longirostres

88. Carex Sprengelii Dewey LONG-BEAKED SEDGE.

C. longirostris Torr. of Roch. Roch. Acad. Sci. 3:119. 1896.

There are no specimens in the herbarium at the U. of R. to confirm a report in Proc. Roch. Acad. Sci. 3:119. 1896 of the occurrence of this species in the western part of Monroe Co. A specimen collected at Newark in Wayne Co., June 3, 1881 by E. L. Hankenson was the only definite record for it until found in Penfield Dugway, May 26, 1948 by W. A. Matthews 4870.

Section 29. Granulares

a. Culms solitary from a slender stoloniferous base; plant low, strict, 0.5–4 dm. high; bracts scarcely exceeding the culm .... **89. C. Crawei.**
a. Culms closely cespitose, not stoloniferous; plant erect or spreading, 2.5–9 dm. high; bracts much exceeding the culm.
  b. Perigynia plump-ovoid, 1.5–2 mm. in diam .... **90. C. granularis.**
  b. Perigynia oblong, slightly more pointed, less inflated, 1–1.3 mm. in diam. **91. C. granularis var. Haleana.**

89. **Carex Crawei** Dewey CRAW'S SEDGE.

Marl bogs. Rare.

The only known station in the area for this species is the drier spots in the open marl bog in Bergen Swamp.

90. **Carex granularis** Muhl. MEADOW SEDGE.

Wet grassy places along streams. Infrequent.

Abundant in abandoned fields on Norman Road in town of Brighton, where it was collected July 6, 1948 by W. A. Matthews 4939. Other stations for it are: Adams Basin, Buttermilk Falls near LeRoy in Genesee Co., vicinity of Pittsford, Mendon Ponds Park, vicinity of East Bloomfield in Ontario Co. and Mud Creek in Wayne Co.

91. **Carex granularis** Muhl. var. **Haleana** (Olney) Porter

Low meadows where grass is thin. Common.

Herbarium records at the U. of R. indicate its wide distribution throughout the area.

Section 30. Oligocarpae

a. Perigynia closely enveloping the achenes, tapering at the base, constricted at the apex, definitely angled, obtusely triangular in cross-section.
- b. Sheaths pubescent; leaves 3–7 mm. wide; perigynia 4–5 mm. long; culms brownish-tinged at the base .... **92. C. Hitchcockiana.**
- b. Sheaths glabrous; leaves 2–4.5 mm. wide; perigynia 4 mm. long; culms reddish-tinged at the base .... **93. C. oligocarpa.**

a. Perigynia loose to close, rounded at both ends, obscurely angled, orbicular to orbicular-triangular in cross-section.
- c. Uppermost bract slightly if at all overtopping the staminate spike; leaves 2–4 mm. wide; perigynia oblong-conical, 3–4 mm. long .... **94. C. conoidea.**
- c. Uppermost bract much overtopping the staminate spike; leaves 3–7 mm. wide; perigynia oblong, 4.5–5.5 mm. long ...... **95 C. amphibola var. turgida.**

92. **Carex Hitchcockiana** Dewey HITCHCOCK'S SEDGE.

Thin woods in loose rich soil. Scarce.

Murray in Orleans Co., Newark in Wayne Co. and East Bloomfield in Ontario Co. are stations without specific location where early collections have been made. More recent collections are from a calcareous rocky woods on Works Road in town of Rush, the glen at Buttermilk Falls near LeRoy in Genesee Co. and Bergen Swamp.

93. **Carex oligocarpa** Schkuhr FEW-FRUITED SEDGE.

In woods and thickets. Rare.

Reported from two stations only: Black Creek by Dr. A. H. Searing and a woods south of Pittsford by H. D. House.

94. **Carex conoidea** Schkuhr FIELD SEDGE.

In open grassy marshes. Rare.

Occurs at Mendon Ponds Park in the marsh bordering Quaker Pond, also at Long Pond.

95. Carex amphibola Steud. var. **turgida** Fern. GRAY SEDGE.
C. grisea Wahl. of Proc. Roch. Acad. Sci. 3:119. 1896.

Thin woods and low alluvial thickets. Frequent.

Localities where this species has been found are: Bergen Swamp, Mud Creek near Palmyra in Wayne Co., Newark in Wayne Co. and Mertensia in Ontario Co. It is abundant in a thin woods on the flats of the Genesee River at West Rush, a calcareous rocky woods on Works Road in town of Rush, and a low woods on Brook Road in town of Chili. It was found in moist sandy loam on a steep wooded slope in Penfield Dugway (a most unusual habitat), June 8, 1948 by W. A. Matthews 4903.

Section 31. Paniceae

a. Perigynia with a straightish slender beak; spikes spreading or drooping, loosely few flowered . . . . **96. C. vaginata.**

a. Perigynia beakless or with beak strongly bent; spikes erect, close-flowered except in *C. Woodii.*

b. Perigynia beakless, the point straight or nearly so; leaves glaucous becoming involute . . . . **97. C. livida.**

b. Perigynia with the short beak strongly bent; leaves green, more or less revolute with age.

c. Lower sheaths purple, mostly bladeless; stolons superficial; plants of rich humus in woodlands. . . . . **98. C. Woodii.**

c. Lower sheaths pale, mostly blade-bearing; stolons deep-seated; plants of springy, marly places . . . . **99. C. tetanica.**

96. Carex vaginata Tausch SHEATHED SEDGE.

In swampy places. Scarce.

The only known stations for this species are: Powder Mill Park, Riga Swamp and Bergen Swamp. In the latter it was collected June 8, 1941 by W. A. Matthews 4311 and June 12, 1948 by W. C. Muenscher 22500. Its very slender and more or less diffuse habit of growth make it quite inconspicuous. Perhaps it has been overlooked elsewhere.

97. Carex livida (Wahlenb.) Willd. LIVID SEDGE.

Known in this area from a single station only: open bog bordering the north end of Quaker Pond in Mendon Ponds Park, July 8, 1917, M. S. Baxter, E. P. Killip and W. A. Matthews.

98. Carex Woodii Dewey WOOD'S SEDGE.

Rich upland woods. Scarce.

The only definitely known stations for this species are: an upland woods bordering a swamp on Pinnacle Road near East Rush, May 18, 1930, W. A. Matthews 3037; and rich woods near the Hessenthaler entrance to Bergen Swamp, May 16, 1948, R. F. Thorne and W. C. Muenscher 22396. Collections have also been made in the vicinity of the Burroughs Audubon Conservation Station and at East Bloomfield in Ontario Co. but the specimens lack specific location.

99. Carex tetanica Schkuhr

Marshy thickets and wet woods. Infrequent.

This species has been found at Bergen Swamp, Mendon Ponds Park, Junius Ponds in Seneca Co. and Sullivan's Swamp near Fishers in Ontario Co.

Section 32. Laxiflorae

a. Perigynia sharply triangular, short-tapering at the base.
- b. Spikes erect, sessile or nearly so; culms erect or arching.
  - c. Staminate scales dark brown to purple; bract-sheaths and base of culms strongly red-tinged; leaves evergreen.
    - d. Cauline sheaths bladeless, more or less purple-tinged; leaf-blades 1.5–3 cm. broad; staminate spike purple; perigynia 4–5 mm. long **100. C. plantaginea.**
    - d. Cauline sheaths blade-bearing, green; leaf-blades 0.8–1.7 cm. broad; staminate spike dark brown; perigynia 3–7 mm. long .... **101. C. Careyana.**
  - c. Staminate scales pale brown or straw-colored; bract-sheaths not red-tinged, base of culms rarely so; leaf-blades 1.2–3 cm. broad, less evergreen **102. C. platyphylla.**
- b. Spikes drooping on filiform peduncles; culms weak, strongly arching; sheaths and staminate spike pale brown or straw-colored.
  - e. Pistillate spikes, often with some staminate flowers at the base; leaf-blades 5–12 mm. wide, weak, glaucous green .... **104. C. laxiculmis.**
  - e. Pistillate spikes without staminate flowers at the base; leaf-blades 2–5 mm. wide, erect, green .... **103. C. digitalis.**

a. Perigynia obtusely angled, long-tapering at the base.
- f. Beak of perigynium straight or slightly oblique at the apex.
  - g. Bract-sheaths smooth on the edges or shallowly serrulate.
    - h. Beak of perigynium very short or minute; culms, bract-sheaths and leaves coarsely granular; culms usually reddish at base. .... **108. C. ormostachya.**
    - h. Beak of perigynium a conical tip and more conspicuous; culms, bract-sheaths and leaves not granular, culms not reddish at base .... **106. C. laxiflora.**
  - g. Bract-sheaths strongly serrulate on the edges; perigynia nerveless or faintly nerved .... **109. C. leptonervia.**
- f. Beak of perigynium abruptly bent at the apex, conspicuously many nerved.
  - i. Pistillate spikes approximate and close; perigynia crowded; staminate spikes white, rachis wing-angled, usually sessile; culms stout, winged. **107. C. blanda.**
  - i. Pistillate spikes interrupted, linear cylindric; perigynia remote; staminate spike pale green to whitish, alternate flowered, slightly shorter than, to slightly longer than the pistillate spikes; culms flattened and wing-margined. **105. C. albursina.**

100. Carex plantaginea Lam. PLANTAIN-LEAVED SEDGE.

Low moist, usually beech-maple woodlands. Frequent.

Abundant in a low moist woods near the corner of South Clinton St. and Westfall Road in town of Brighton, in an upland woods on the farm of Walter Bohm on Clover Road in town of Pittsford and in a low moist woods at Cedar Swamp in town of Henrietta. Other stations for it are: Palmer's Glen, a woods on calcareous rocky soil on Works Road in town of Rush, Bergen Swamp, Adams Basin and near Marion in Wayne Co.

101. Carex Careyana Torr. CAREY'S SEDGE.

Upland woods and thickets. Scarce.

Reports from 1865 to 1897 indicate that this species was collected more frequently during that period than at present. W. Booth reported it from a woods near the Genesee River four or five miles above Rochester; J. E. Paine, thickets in Henrietta; E. L. Hankenson, 2 miles west of Newark; and M. S. Baxter, near Brockport. The only collections since 1897 have been from an upland woods on the farm of Walter Bohm on Clover Road in town of Pittsford, in 1922 by M. S. Baxter; and in a rich woods near the Hessenthaler entrance to Bergen Swamp, May 16, 1948 by R. F. Thorne and W. C. Muenscher 22381.

102. Carex platyphylla Carey CAREY'S SEDGE.

Low moist woods and glens. Infrequent.

Known from thin woods on limestone rocks, Oatka Trail near LeRoy in Genesee Co., May 14, 1949, W. A. Matthews 5108; steep wooded slopes to the Genesee River, lower Seneca Park, May 21, 1949, W. A. Matthews, 5116; Adams Basin; vicinity of "Float Bridge" in town of Webster; Palmer's Glen; East Bloomfield in Ontario Co.; and Grimes Gully at Naples in Ontario Co.

103. Carex digitalis Willd. SLENDER WOOD SEDGE.

Wooded slopes and ravines; usually in rich sandy loam soil. Infrequent

Herbarium records of this species at the U. of R. are mostly from the Irondequoit Creek valley, where it finds many suitable habitats in the light sandy soils. The most recent report is from a moist wooded slope, east side of Irondequoit Bay, June 28, 1930, W. A. Matthews 3105. There is but one collection west of the Genesee River and this at Long Pond by M. S. Baxter in 1915.

104. Carex laxiculmis Schwein. SPREADING SEDGE.

Rich woods and ravines. Infrequent.

Collections of this species have been few but indicate that it can be found occasionally throughout the area. Known stations for it are: Bergen Swamp, June 11, 1948, R. F. Thorne and W. C. Muenscher 22457; Adams Basin; Charlotte; Palmer's Glen; Hipp Brook in town of Penfield, June 1, 1941, W. A. Matthews 4298; and Newark in Wayne Co.

105. Carex albursina Sheldon WHITE BEAR SEDGE.

C. laxiflora Lam. var. *latifolia* Boott of Proc. Roch. Acad. Sci. 3:120. 1896.

Rich woods and ravines. Frequent.

This species can be found throughout the area. Some stations where collections have been made are: moist ravine at "The Gulf" in Genesee Co., May 22, 1921, W. A. Matthews 2033; Bergen Swamp; Palmer's Glen; Goodberlet Road in town of Henrietta; Mendon Ponds Park; Works Road in town of Rush; East Bloomfield in Ontario Co.; and Grimes Gully at Naples in Ontario Co.

106. Carex laxiflora Lam. LOOSE-FLOWERED SEDGE.

Including *C. laxiflora* Lam. var. *patulifolia* Carey of Proc. Roch. Acad. Sci. 3:120. 1896 and *C. anceps* Muhl. of Proc. Roch. Acad. Sci. 9:84. 1946.

Moist woods and thickets. Infrequent.

This species has been found sparingly in all parts of the area.

107. Carex blanda Dewey WOODLAND SEDGE.

C. laxiflora Lam. var. *striatula* Carey of Proc. Roch. Acad. Sci. 3:120. 1896; *C. laxiflora* Lam. var. *varians* Bailey of Proc. Roch. Acad. Sci. 5:31. 1910 and *C. laxiflora* Lam. var. *blanda* (Dewey) Boott of Proc. Roch. Acad. Sci. 5:80. 1917.

Low moist woods and ravines to dry upland woods. Common.

Like the preceding, it has been found in all parts of the area.

108. Carex ormostachya Weig.

A specimen collected in Pokamoonshine Gulf in Livingston Co. in 1920, by M. S. Baxter is the only record for this species in the area.

109. Carex leptonervia Fern. NORTHERN WOODLAND SEDGE.

Usually found in thin woods and glens. Scarce.

Specimens in the herbarium at the U. of R. are from the wooded hills south of Canadice in Ontario Co., Pokamoonshine Gulf in Livingston Co. and Bergen Swamp. Also collected in a wood-lot pasture on Barnard Road near Mendon, May 30, 1925, by W. A. Matthews 2375.

Section 33. Extensae

a. Perigynia 4–6 mm. long, yellow when ripe, the beak equaling the body; spikes subglobose, 8–15 mm. in diam.
- b. Perigynia 5–6 mm. long; scales and tips of the perigynia brown; leaves 2–5 mm. wide .... **110. C. flava.**
- b. Perigynia 4 mm. long; scales and tips of the perigynia pale; leaves 1–3 mm. wide **111. C. flava var. fertilis.**

a. Perigynia 2–3 mm. long, greenish, the beak much shorter than the body; spikes oblong, 4–8 mm. in diam. .... **112. C. viridula.**

110. Carex flava L. YELLOW SEDGE.

Wet marly meadows and swamps. Infrequent.

Abundant in the meadow bordering Bergen Swamp; occasional in the marsh south of Quaker Pond at Mendon Ponds Park and the borders of Blue Pond near Scottsville. Also occurs at Junius Ponds in Seneca Co. and near Newark in Wayne Co.

111. Carex flava L. var. **fertilis** Peck SMALL YELLOW SEDGE.

C. cryptolepis Mack. of Proc. Roch. Acad. Sci. 9:84. 1946.

Same habitats as the preceding. Infrequent.

A specimen was collected on a sandy beach of Sodus Bay in Wayne Co. July 4, 1919, by E. P. Killip an unusual habitat.

112. Carex viridula Michx. GREEN SEDGE.

C. flava L. var. *viridula* Bailey of Proc. Roch. Acad. Sci. 3:119. 1896.

In marly marshes. Rare.

Known in this area from two stations only: the open marl bog in Bergen Swamp and at Sodus Point in Wayne Co.

Section 34. Orthocerates

113. Carex pauciflora Lightf. FEW-FLOWERED SEDGE.

"On sphagnum hummocks" Bergen Swamp, W. C. Muenscher (Proc. Roch. Acad. Sci. 9:85. 1946) is the only record for this species in the area.

Section 35. Squarrosae

114. Carex squarrosa L. SQUARROSE SEDGE.

Known in this area only from a collection near the south end of Big and Little Ponds, on the flats of the Genesee River at Golah in Livingston Co., by M. S. Baxter, dated August 1914.

Section 36. Paludosae

a. Perigynia glabrous, beak much shorter than the body, teeth less than 1 mm. long **115. C. lacustris.**

a. Perigynia hairy, beak about as long as the body, teeth more than 1 mm. long **116. C. trichocarpa.**

115. Carex lacustris Willd. LAKE-BANK SEDGE.

C. riparia Curtis of Proc. Roch. Acad. Sci. 3:118. 1896.

Marshes, swamps and on boggy borders of ponds, streams and Irondequoit Bay. Frequent.

Stations where collections have been made are: marsh on west side of Genesee River at Charlotte, pond borders at Mendon Ponds Park, border of Black Creek at Bergen Swamp, swamp at Egypt in town of Perinton, Adams Basin, Sullivan's Swamp near Fishers in Ontario Co. and Lima Ponds in Livingston Co.

116. Carex trichocarpa Muhl. HAIRY-FRUITED SEDGE.

Rare.

This species occurs sparingly at Sullivan's Swamp near Fishers in Ontario Co., the open bog at the Burroughs Audubon Conservation Station and the abandoned Jaeschke's Mill property in town of Pittsford.

Section 37. Pseudo-Cypereae

a. Perigynia scarcely inflated, closely enveloping the achene, at least the lower reflexed; spikes peduncled more or less drooping; blades strongly septate-nodulose.

- b. Perigynia teeth 0.5–1 mm. long, not prominently divergent, beak shorter than the body . . . . **117. C. Pseudo-Cyperus.**
- b. Perigynia teeth 1.2–2 mm. long, strongly arched-divergent, beak as long as or longer than the body. . . . . **118. C. comosa.**

a. Perigynia inflated, loosely enveloping the achene, spreading or ascending; blades only slightly septate-nodulose.
  c. Perigynia spreading, 15–20 nerved, only slightly inflated ...... **119. C. hystricina.**
  c. Perigynia ascending, 8–10 nerved, strongly inflated.
    d. Perigynia ovoid, tapering to a beak about equaling the body .... **120. C. lurida.**
    d. Perigynia subglobose, tapering abruptly to a beak equaling or longer than the body .... **121. C. Baileyi.**

117. **Carex Pseudo-Cyperus** L. CYPERUS-LIKE SEDGE.

Usually in shallow water or on hummocks at the edge of ponds. Frequent.

Marshes of the lower Genesee River, pond borders at Mendon Ponds Park, marshy borders of Irondequoit Bay, Sullivan's Swamp near Fishers in Ontario Co. and Bergen Swamp are known habitats for this species. It, without doubt, occurs elsewhere in the area but has not been collected.

118. **Carex comosa** Boott BRISTLY SEDGE.

C. Pseudo-Cyperus L. var. *americana* Hochst. of Proc. Roch. Acad. Sci. 3:118. 1896.

Thinly wooded sphagnum bogs and partially shaded marshes. Frequent.

Occurs in the bogs at Mendon Ponds Park, Bushnell's Basin, Bergen Swamp, Adams Basin and elsewhere in the area, but, like the preceding, has not been reported.

119. **Carex hystricina** Muhl. PORCUPINE SEDGE.

Herbarium records at the U. of R. indicate that this species is much more common than either of the preceding. Its usual habitat is swamps and boggy places. It frequently extends into open marshes.

120. **Carex lurida** Wahlenb. SALLOW SEDGE.

A very common sedge in marshy places, in swamps, along stream banks and in other wet habitats.

121. **Carex Baileyi** Britt. BAILEY'S SEDGE.

This record is based on a single collection by E. P. Killip from a marsh on the Thornell farm on Thornell Road in town of Pittsford.

Section 38. Folliculatae

— **Carex folliculata** L.

This species has never been found in this area and is listed as a memorandum only. It is reported from the Cayuga Lake Basin and the Buffalo area. Concerning its absence here, H. D. House once made the following comment, "Wish I knew why *folliculata* is absent from the Genesee Valley and adjacent region when it is found E. W. N. and S. of it." *Carex folliculata* can be expected in cold swampy borders and spring basins where shade is not too dense.

Section 39. Lupulinae

a. Pistillate spikes globose or nearly so.
  b. Pistillate spikes globose; perigynia spreading in all directions from a common center . . . . **122. C. Grayii.**
  b. Pistillate spikes nearly globose or short-ovoid.
    c. Pistillate spikes nearly globose; perigynia 10–15 mm. long, 5–8 mm. thick. **123. C. intumescens.**
    c. Pistillate spikes more ovoid, perigynia 12–17 mm. long, 3–5 mm. thick. **124. C. intumescens var. Fernaldii.**
a. Pistillate spikes cylindrical or thick-cylindric.
  d. Pistillate spikes 3–5, cylindrical, 3–8 cm. long; staminate spike usually peduncled. **125. C. lupuliformis.**
  d. Pistillate spikes 2–6, thick cylindrical, 3–6 cm. long; staminate spikes sessile or peduncled.
    e. Pistillate spikes approximate, clustered about the sessile staminate spike. **126. C. lupulina.**
    e. Pistillate spikes scattered, some or all peduncled; staminate spike more conspicuous, usually peduncled; perigynia more spreading. **127. C. lupulina var. pedunculata.**

122. Carex Grayii Carey — Asa Gray's sedge.

The preferred habitat of this species is low woods, quite wet in early spring. Infrequent.

Abundant in a low woods near the corner of South Clinton St. and Westfall Road in town of Brighton, August 25, 1930, W. A. Matthews 3362; a low woods on Brook Road in town of Chili, August 28, 1948, W. A. Matthews 5084; and the low woods northeast of the cabin on Canfield Road in Mendon Ponds Park, August 26, 1928, W. A. Matthews 2867. This species is also known from Glen Haven on Irondequoit Bay, Black Creek in town of Chili, Adams Basin, Carlton in Orleans Co., East Palmyra in Wayne Co. and Newark in Wayne Co.

123. Carex intumescens Rudge — Bladder sedge.

Borders of wet depressions in thin woods and swamps. Infrequent.

Specimens are in the herbarium at the U. of R. from the vicinity of Mendon Ponds in Monroe Co. and from Carlton in Orleans Co., both collected by M. S. Baxter in 1895. There are no other records of its occurrence in the area until July 31, 1930, when it was found in the wooded hills south of Canadice in Ontario Co. by W. A. Matthews 3261. Further collections of it in the area have been from a bog near the shore of Lake Ontario north of Wolcott in Wayne Co., June 22, 1941 by W. A. Matthews 4347; and at Cedar Swamp in town of Henrietta, August 24, 1941 by W. A. Matthews 4412.

124. Carex intumescens Rudge var. **Fernaldii** Bailey

The record for this species is a single collection (1917) from East Bloomfield in Ontario Co. by Mary F. Baker and determined by H. D. House. Its usual habitat is in the northern part of the state. However, it is considered common in the Cayuga Lake Basin and this fact makes its occurrence here not unlikely.

125. Carex lupuliformis Sartwell HOP-LIKE SEDGE.

C. lupulina Muhl. var. *polystachya* Schwien. & Torr. of Proc. Roch. Acad. Sci. 3:117. 1896.

Collections of this species have not been made in recent years. The report in the 1896 list of plants was based on collections of George T. Fish in Monroe Co. and E. L. Hankenson in Wayne Co. and the same material is the basis for this listing. It is considered absent from both the Cayuga Lake Basin and the Buffalo area. However, until other determinations are made of the Fish and Hankenson collections, the retension of this species in the present list seems justified.

126. Carex lupulina Muhl. HOP-SEDGE.

Very common in swales, swamps and low wet places all over the area. Its large soft spikes with slighly spreading perigynia give it a hop-like appearance, hence its name.

127. Carex lupulina Muhl. var. **pedunculata** Gray

C. lupulina Muhl. var. *pedunculata* Dewey of Proc. Roch. Acad. Sci. 3:117. 1896.

This report is based on a single collection by George T. Fish, July 27, 1865 in town of Henrietta. Several more recent collections have been referred to this variety but abnormal forms of the type seems to be a better disposition of them.

Section 40. Vesicariae

a. Plant stoloniferous; culms thick and spongy at base; leaves and sheaths nodulose.
  b. Perigynia 3–6 mm. long, abruptly contracted into a beak .... **128. C. rostrata.**
  b. Perigynia 5–10 mm. long, tapering gradually into a beak. **129. C. rostrata var. utriculata.**
a. Plant cespitose; culms scarcely spongy at base; leaves and sheaths scarcely or not at all nodulose.
  c. Leaves 4–12 mm. wide; sheaths scarcely nodulose; perigynia strongly reflexed; bracts much overtopping the culms .... **130. C. retrorsa.**
  c. Leaves 3–7 mm. wide; sheaths not nodulose; perigynia ascending; bracts usually prolonged and slightly exceeding the culms.
    d. Mature perigynia 7–9 mm. long, not more than 4 mm. thick...**131. C. vesicaria.**
    d. Mature perigynia 10 mm. long, 5–6.5 mm. thick .... **132. C. Tuckermani.**

128. Carex rostrata Stokes BEAKED SEDGE.

In marshes, bogs and on marshy shores. Scarce.

Several collections were made in the lower Irondequoit Creek valley by early botanists. A specimen from the area now Ellison Park, collected in 1919 by W. A. Matthews, is the only report of it in recent years.

129. Carex rostrata Stokes var. **utriculata** (Boott) Bailey

Specimens in the herbarium at the U. of R. collected by George T. Fish in Monroe Co. (1865) and by E. L. Hankenson at Newark in Wayne Co. (1868) are the only records for this variety.

130. **Carex retrorsa** Schwein. RETRORSE SEDGE.

Swales and wet meadows. Frequent.

Herbarium records at the U. of R. indicate that this species may be found throughout the area.

131. **Carex vesicaria** L. INFLATED SEDGE.

C. monile Tuckerm. of Proc. Roch. Acad. Sci. 3:117. 1896.

This report is based on specimens collected in a low woods on Brook Road in town of Chili, August 27, 1948 by W. A. Matthews 5083. Reports of it in the 1896 list of plants, collected by L. Holzer cannot be verified by specimens at Rochester or Albany.

132. **Carex Tuckermani** Boott TUCKERMAN'S SEDGE.

Swales and thinly wooded swamp land. Infrequent.

Abundant in a swampy area on Bull's Sawmill Road near Mendon Center, where it was collected July 20, 1941 by W. A. Matthews 4373. It was collected at Bergen Swamp July 16, 1948 by R. F. Thorne and W. C. Muenscher 22396. It occurs sparingly throughout the area.

EXCLUDED SPECIES

7. ERIOPHORUM L. Cotton-grass

1. **Eriophorum angustifolium** Honckeny

E. angustifolium Roth. of Proc. Acad. Sci. 8:255. 1943.

The report of this species in Proc. Roch. Acad. Sci. 8:255. 1943 is apparently based on collections by George T. Fish at Bergen Swamp, June 1, 1865 and June 3, 1866, which have been referred to *E. virdi-carinatum*.

11. CAREX L. Sedge

1. **Carex annectens** Bickn. YELLOW FOX SEDGE.

C. setacea Dewey var. *ambigua* (Barratt) Fern. of Proc. Roch. Acad. Sci. 5:80. 1917.

The specimen in the herbarium at the U. of R. on which this report was based, collected at Adams Basin by E. P. Killip, has since been referred to *C. vulpinoidea*.

2. **Carex nigra** (L.) Reichard

C. rigida Good. var. *Goodenovii* Bailey of Proc. Roch. Acad. Sci. 3:118. 1896.

The record in the 1896 list "Rare. Monroe Co. Dr. Anna H. Searing, Wayne Co." cannot be confirmed by specimens at Rochester or Albany (N.Y.S. Mus. Bull. 254:191. 1924). *C. nigra* is northern and coastal and doubtless the above record should have referred to other species.

3. **Carex gracillima** Schwein. x arctata Boott

Reported in Proc. Roch. Acad. Sci. 3:119. 1896 from Adams Basin by M. S. Baxter (1877). The report is not supported by specimens in the herbarium at the U. of R. and the hybrid is therefore excluded from this list.

4. **Carex atherodes** Spreng. AWNED SEDGE.

C. trichocarpa Muhl. var. *aristata* Bailey of Proc. Roch. Acad. Sci. 3:118. 1896.

The report in the 1896 list "Greece, eleven miles west of Rochester, six miles south of Lake Ontario", is not confirmed by a specimen at Rochester or Albany and this species is therefore excluded from the current list.

5. **Carex Houghtonii** Torr. HOUGHTON'S SEDGE.

The report in Proc. Roch. Acad. Sci. 3:118. 1896, "Rare, Long Pond Dr. Anna H. Searing", like the preceding, is not confirmed by a specimen at Rochester or Albany and this species likewise is excluded from this list.

6. **Carex Schweinitzii** Dewey SCHWEINITZ'S SEDGE.

The specimen, found on a sandbar near Forest Lawn by V. Dewing and M. S. Baxter, on which the report in Proc. Roch. Acad. Sci. 5:80. 1917 was based, has since been referred to *C. Pseudo-Cyperus*.

7. **Carex vulpinoidea** x **comosa** of Proc. Roch. Acad. Sci. 5:80. 1917.

This record is based on a specimen collected by M. S. Baxter (August 1911) and determined by Dr. Chas. H. Peck, Hybrids, except in a few cases, are merely mentioned, without description, in Gray's Manual, eighth edition. The above report is, therefore, not retained in this list.

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WARREN ARCHER MATTHEWS

F. R. A. S.

MAY 9, 1887—JANUARY 9, 1956

WARREN ARCHER MATTHEWS—1887-1956

Forty years a member of the Rochester Academy of Science, Warren Matthews was active in both our old and the new Botany Sections. With an engrossing interest in plant life and a highschool education in his birthplace, Pittsford, New York, as a background, he taught himself many facets of the science of botany. He achieved a proficiency seldom reached by a layman and maintained an enthusiasm seldom surpassed by the professional scientist. The fact that his major interest lay in the finding and identification of those most difficult and exacting groups, the grasses and sedges, bears out the relish with which he met the taxonomic challenge he set for himself. The Academy is fortunate in having been able to publish his fine paper: The Cyperacae of Monroe and Adjacent Counties, New York (Volume 10, Numbers 1-2, 1953).

A man's most fitting monument is the one he himself builds during his lifetime. And this paper can certainly be looked upon as the base. But the botanical storehouse he made of the top floor in his house must be considered too. Here, in systematically arranged, homemade drawers, he collected and identified thousands of herbarium specimens which he had gathered and also obtained by exchange from all part of the world. He had the finest personal collection in this part of the country. Mrs. Matthews has graciously presented it to the Academy.

Warren Matthews loved plants. Moreover, he sought the company of botanical associates. He alone of the older group of Rochester botanists joined the younger Section formed in the 1940's. To it he brought a rich, unassuming knowledge, generous counsel, unruffled calm and unfailing good humor. His advice on field trips was constantly sought. He had an uncanny memory for the stations where rare orchids and ferns, the Twin-leaf, *Trollius,* and the Stemmed White Violet could be found and, for such was his enjoyment of Nature's largesse, the spots for the best blueberries.

He was undaunted by rigorous ecological studies. Although somewhat handicapped physically, he was ever present when there was work to be done in the Washington Grove project of the Botany Section. In the Academy's herbarium, housed at the University of Rochester, he spent long hours revising the checklist of the plants of Monroe County (still incomplete). He culled many old collections for valuable specimens and painstakingly saw to their preservation.

So, to the scientific columns of his monument must be added his status as a friend and true gentleman. And it goes without saying that he was a beloved family man. His wife and children shared his trips, picnics and home-laboratory work with enthusiasm. He had many gardening ventures and during the war the family participated in an extensive vegetable-growing project on the old family farm.

A monument evokes memories. Many people will remember Warren Matthews crouching over a clump of sedge as he quietly points out characteristics for a companion to whom he has lent his magnifier. Or they will recall lively Section discussions as he displays herbarium sheets garnered from the Gaspé. Many will see his quizzical face while he decides that some herbarium specimen must be discarded for lack of data. Others will relive work in the Washington Grove and watch him again measuring cover under a huge black oak. Some will hear once more his accurate directions for locating a rare plant. Or they will smile when they see him crawling under a tangle of blueberry bushes with the same alacrity and anticipation at 60 as at 20. A few will remember his undefeated spirit as his excited face and lively head of rusty hair bobbed over bright blue pajamas in the bed from which he directed his new plumbing supply business (founded after "retirement") to the end of his life. His thirst for knowledge, his calm disposition, and his gentle love of living and people will never be erased from the memories of his family, friends and associates.

B. B. C., H. L. G.

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THE TABANIDAE OF NEW YORK

A DISTRIBUTIONAL STUDY

by

L. L. PECHUMAN, PH.D.

INTRODUCTION

This paper is based on records and notes accumulated during the past 25 years and which have been brought together when other duties permitted.

No account of New York State Tabanidae has been published although there have been some regional lists and papers dealing with the biologies and economic importance of a relatively few species. The present publication is primarily intended to make available in brief form our present knowledge of the distribution and habits of the various species of Tabanidae in New York with keys for their determination. No attempt is made to give detailed taxonomic descriptions of species. The reader will find most of these in the excellent papers of Brennan (1935) and Stone (1938). For a list of the nearctic species he is referred to Philip (1947 and 1950).

The first paper of importance on New York Tabanidae is that of Bequaert and Davis, "Tabanidae of Staten Island and Long Island, N. Y." (1923). Most of the records in that paper were incorporated in Leonard's "A list of the insects of New York" (1928), which for convenience is referred to throughout this paper as "State List". The writer has been able to study many of the specimens on which these 2 lists were based and has been able to make certain corrections. With few exceptions, when the writer has been unable to study questionable records, he has accepted the records of these 2 lists as valid. Pechuman's "Additions to the New York State list of Tabanidae" (1938) added some new records and species to the State List.

In the preparation of this paper it was decided to omit the list of localities where each species was collected by the Author or others. The distribution is shown by marking each collection locality on a separate map for most of the individual species. This shows, more graphically than a list, the distribution of each species found in the State. It should be remembered, however, that some sections of New York have been more heavily collected than others. Probably such species as *Chrysops vittata* and *Tabanus quinquevittatus* are found in every county in the State although a few show no records for these species. Probably the fewest records have been secured from the St. Lawrence Valley, east central New York and the counties east of the Hudson River north of Putnam County.

ECONOMIC IMPORTANCE

Because of their medical and veterinary importance, both by direct injury and the transmission of disease organisms, the economic importance of Tabanidae has received wide attention and much has been published concerning it. Webb and Wells (1924) and Philip (1931) give a large amount of this information.

In New York State as a whole the Tabanidae rank second only to mosquitoes as annoying pests of domestic and wild animals. In western New York they probably are a more important pest during their flight season than mosquitoes. As direct pests of man they are of secondary importance, certainly being exceeded by mosquitoes and black flies; nevertheless, under certain conditions they can be extremely annoying.

Dairy herds are severely attacked by Tabanidae and milk production drops considerably during periods of heavy attack. Not only is a considerable quantity of blood taken from the animals but the irritation and annoyance caused by the ravages of the flies in numbers results in interruption of feeding. The writer has seen herds of dairy cattle in Genesee County in a state bordering on panic due to the presence of hundreds of *Tabanus sulcifrons*. In the same county he has seen individual cattle streaming with blood due to the attacks of *T. lasiophthalmus* and *T. lineola scutellaris*. Since the blood does not immediately coagulate when the fly ceases to feed, there is a loss in addition to that taken by the fly.

Horses seem to be the particular object of attack by *Tabanus quinquevittatus* and fly nets appear to be of little value. Some farmers almost completely cover their horses with burlap as protection from fly attack and sometimes it is possible to work a team only during the cooler morning and evening hours at the height of the flight season of this species.

There have been several accounts of deer taking refuge in ponds and lakes as protection from the persistent attacks of various species of *Tabanus* and *Chrysops*.

Deerflies of the genus *Chrysops* are most annoying to man although *Tabanus nigrovittatus* is a pest on Long Island beaches, and other species such as *T. illotus, T. pumilus* and *T. nivosus* are bothersome under some conditions.

Deerflies cause considerable irritation to fishermen, lumbermen, road workers, horseback riders and others who spend any time in wooded or swampy areas. The writer has seen *Chrysops vittata* attacking so fiercely and in such numbers in swampy areas in Putnam County that it was necessary to find shelter for protection. Under such conditions, swinging an insect net around one's head for a few minutes would result in half a pint of flies being packed into the bottom of the net. *C. univittata* on Long Island, *C. lateralis* in the Adirondacks and *C. moecha* in Niagara County sometimes become nearly as abundant.

It is not likely that Tabanidae carry disease organisms under New York State conditions.

IMMATURE STAGES

Although extensive work has been done on the biology of a number of species of Tabanidae, a great deal is yet to be learned.

Eggs are laid in masses on vegetation above water (Fig. 1) or moist ground, although logs, rocks and bridge abutments are also used for this purpose. The egg mass is whitish when freshly laid but soon darkens to various shades of brown or jet black depending on the species.

The larval stages of most species are spent under moist conditions which vary from a completely aquatic habitat to moist soils and from rapidly flowing streams to stagnant ponds. The larvae of a few species are found in relatively dry soil and others have been found in rotten wood. Some species show great tolerance of variation in larval habitat. The larvae of many species, especially *Tabanus,* are predacious.

The larvae of the various species look much alike to the casual observer. They are usually white in color, tapering at each end. The larva of *Goniops chrysocoma* is bottle shaped. The larvae of many of the larger species of *Tabanus* have dark bands.

The pupae are brown or straw colored with a row of stiff spines encircling the apical third of each abdominal segment. At the apex of the abdomen are 6 stout, sharply pointed projections forming the pupal aster.

Under New York conditions, most species have one generation a year. There is some evidence, however, that *Tabanus lineola* and its subspecies *scutellaris* may occasionally develop from egg to adult in one season. Also, some individuals of *T. atratus* and other *Tabanus* species take 2 or 3 years to complete their development. The emergence of the males of a given species normally is slightly in advance of the main emergence of the females.

HABITS OF THE ADULTS

Most female Tabanidae suck blood and are easily collected when attacking humans or animals. The males do not suck blood and are generally collected from flowers or foliage. Tabanidae of both sexes frequently are encountered resting on paths and roads, especially where they run through wooded areas (Figs. 2 and 3). They are often quite wary under such conditions but considerable numbers may be collected. The writer has noted that *Tabanus sulcifrons* and *T. difficilis* have a decided proclivity for such situations. The females often enter buildings in considerable numbers, although they never seem to bite when indoors; large numbers may be found at the windows since they are attracted by light. The males of species of the *T. affinis* group often are found hovering in open glades in wooded areas and on the tops of hills and mountains. Both sexes of a number of species are taken at lights at night and almost all the males of *T. sackeni* and *T. pumilus* studied by the writer were taken in this manner.

Tabanidae are most active on warm sunny days when there is no wind. A slight drop in temperature or the springing up of a breeze will cut down the number of attacking females to a great extent. There are exceptions to this and the writer has been attacked by numbers of *Chrysops moecha* after dark and by *C. shermani* during a heavy rain. It appears that *Tabanus sackeni* is normally of crepuscular habits.

Moving objects and dark objects seem to be more subject to attack. The writer has noted that predominantly dark cattle in a herd usually have the most Tabanidae feeding on them.

Although the immature stages of most Tabanidae are passed under wet or moist conditions, adults are frequently present in numbers some distance from breeding areas.

Figure 4 presents topographical features for correlation with the individual maps shown further on.

TAXONOMIC CHARACTERS AND CLASSIFICATION

Distinctive structural characters are few in the Tabanidae and most of them are confined to the head and its appendages. Chaetotaxy, which is so useful in many groups of Diptera, cannot be used since macrochaetae are not present. Since distinguishing structural characters are so few, much dependence must be placed on color pattern and this must be used with caution on partly denuded specimens.

Since some of the characters of the head are restricted to the females, it is necessary to use separate keys to the males of *Chrysops* and *Tabanus*. Since males do not attack man or animals, they are much less common in collections than females and the male is still unknown for a number of North American species. Males are readily recognized by the contiguous eyes.

With the use of Figure 5, most of the characters used in the keys may be readily understood.

New York Tabanidae may be divided into three subfamilies. The Pangoniinae includes *Stonemyia* and *Goniops*. The Chrysopinae includes *Merycomyia* and *Chrysops*. The Tabaninae includes *Diachlorus, Chrysozona, Microtabanus, Atylotus* and *Tabanus*. A detailed discussion of the classification of nearctic Tabanidae may be found in Philip (1941) and of the Tabaninae in Stone (1938). The most modern classification, based on a study of the World fauna, is by Mackerras (1954).

In the Pangoniinae, *Stonemyia* is represented in New York by 3 species and *Goniops* by one species. The Chrysopinae is represented by one species of *Merycomyia* and by *Chrysops* with 39 species or subspecies. In the Tabaninae, neither *Diachlorus* nor *Chrysozona* has been collected in New York but may be represented by a single species each; there is one species of *Microtabanus*, 4 species of *Atylotus* and 54 species or subspecies of *Tabanus*.

ACKNOWLEDGMENTS

During the past 25 years, the writer estimates that he has examined well over 100,000 specimens of Tabanidae from New York State. No record was kept of the collectors of much of this material so at this time it is impossible to give other than a general acknowledgment to the several dozen private collectors and institutions, who without exception, have been extremely cooperative in providing him with material for study.

The extensive collecting of Prof. Henry Dietrich of Cornell University, especially in the Adirondacks, supplied many new records and the same can be said of Mr. Roy Latham of Orient, L. I. for eastern Long Island. The rearing and field collection studies of Dr. Clearhos Logothetis and Dr. Haruo Tashiro under the direction of Prof. H. H. Schwardt of Cornell University supplied a number of new localities for many species. Recent collections at lights by Prof. J. G. Franclemont of Cornell and his associates have resulted in the capture of the males of all New York species of *Chrysops* where this sex was previously unknown.

Special acknowledgment is due Dr. Alan Stone of the United States National Museum, Washington, D. C. and Dr. Cornelius B. Philip of the Rocky Mountain Laboratory, Hamilton, Montana who supplied or confirmed records of several species rare in New York. The cooperation of Dr. Donald L. Collins, State Entomologist of New York, is also appreciated.

KEY TO THE GENERA OF NEW YORK TABANIDAE

1. Hind tibiae with 2 apical spurs 2
   Hind tibiae without apical spurs 5
2. Flagellum of antenna with 8 distinct annuli 3
   Flagellum of antenna with 5 or less distinct annuli 4
3. Eyes of female with upper inner angles acute; frons broader than width of eye; wings with a dark pattern . . . . **Goniops** Aldrich
   Eyes of female normal; frons narrower than width of eye; wings hyaline **Stonemyia** Brennan
4. Flagellum of antenna with 5 annuli; smaller species with dark markings on wing . . . . **Chrysops** Meigen
   Flagellum with 2 or 3 annuli; larger *Tabanus*-like species with hyaline wings; hind tibial spurs very small . . . . **Merycomyia** Hine
5. First antennal segment longer than thick; frons of female widened below, broader than high; wing gray with white maculations . . . . **Chrysozona** Meigen
   First antennal segment usually scarcely longer than thick; frons of female higher than broad; wing pattern not as above or hyaline 6
6. Third antennal segment with no dorsal angle; frons of female narrow; median callus a narrow line; wings with a dark pattern; eyes bare; no ocellar tubercle; fore tibiae swollen; subepaulets bare . . . . **Diachlorus** O.S.
   Not with this combination of characters 7
7. Flagellum of antenna with 2 or 3 annuli and with articulations indistinct; small flies usually under 10 mm.; basal callus of females small or absent **Microtabanus** Fairch.

Flagellum with 4 distinct annuli; size variable, usually more than 10 mm.; frontal callus present or absent 8
8. Basal callus absent or vestigial; eyes pilose; no ocellar tubercle; eyes of male yellow-brown in dried specimens . . . . . **Atylotus** O.S.
Basal callus well developed, nearly as wide as frons; at least lower eye facets of male blackish in dried specimens . . . . . **Tabanus** Linn.

STONEMYIA Brennan

The species of this genus are not known to suck blood but are found on flowers and resting on the ground in openings in wooded areas. None of the species seem to be common. Nothing is known of the biology of this group.

Until this genus was erected the species under consideration were placed in various genera, most commonly in *Pangonia* and *Buplex*.

KEY TO THE SPECIES OF NEW YORK *STONEMYIA*

1. Yellowish species including antennae and legs . . . . . **isabellinus** (Wied.)
Antennae at least partly dark; legs reddish to black 2
2. Legs reddish brown; posterior margins of abdominal segments with grayish hairs . . . . . **rasa** (Lw.)
Legs black; posterior margins of segments with yellow hairs . . **tranquilla** (O.S.)

Stonemyia isabellinus (Wiedemann)

Moderate in size (12 mm.)*; yellow; wing membrane very faintly tinted, costal cell yellow.

This species was originally described in the genus *Silvius* and for many years was unrecognized, the specific name *pigra* being used. Osten Sacken's original series of *pigra* included a specimen from New York and the writer knows of no other specimens from the State. It seems to be uncommon throughout its range.

Stonemyia rasa (Loew) (New York localities shown in Fig. 6.)

Moderate in size (12.5 mm.); dark brown; abdominal tergites with grayish hind margins; legs reddish brown; wing membrane faintly tinted, costal cell yellow.

The writer has examined the specimens on which the various Adirondack records in the State List were based and found them to be *S. tranquilla*. Like other members of this genus, *S. rasa* flies fairly late in the season, most records being in late August. However, it has also been collected in July and September.

Stonemyia tranquilla (Osten Sacken) (Fig. 7)

Moderate in size (12.5 mm.); blackish brown; abdominal tergites

* In the brief description for each species a more or less arbitrary measurement of length is given in parenthesis. Most species would not vary more than 2 mm. longer or shorter than this figure; in small species the variation would be somewhat less and in the largest species of *Tabanus* variation of 3 or 4 mm. could occur. In general, measurements of a long series of any species would cluster close to the figure given.

with yellowish hind margins and considerable yellowishness or chestnut laterally; legs mostly black; wing membrance faintly tinted, costal cell yellow.

This species is more northern in distribution than *S. rasa* and most records are from the mountainous areas of the State. Closely related to *S. tranquilla* is *S. fera* (Will.), but it is separated by the longer proboscis and entirely black palpi. Some New York specimens might be considered *fera* but for the present the writer prefers to consider this form entirely western in distribution. In series, *fera* is more brightly colored than *tranquilla*.

There are 3 August records for *S. tranquilla*, all others being in July.

GONIOPS Aldrich

Goniops chrysocoma (Osten Sacken) (Fig. 8)

Stout species (12 mm.); yellowish; wings with a dark pattern. Male brownish; abdominal tergites with pale bands on the hind margins.

This is the only species known in the genus and neither sex is likely to be confused with any other Tabanidae. They are stout-bodied insects 10 to 15 mm. long with the fore part of the wings infuscated.

This species is not common in New York and the female is not known to attack man or animals. All collection records for New York are in July and August.

The eggs are laid on the underside of tree leaves above damp ground in wooded areas. The female normally remains with the eggs until they hatch and when disturbed often makes a loud buzzing sound. The larvae are found in the lower layers of deep leaf mould and in damp soil.

MERYCOMYIA Hine

Merycomyia whitneyi (Johnson)

Large (21 mm.); brownish; abdomen with a large white patch indented above on the fourth tergite and 2 white spots on the fifth tergite; wing membrane tinted with brown which is deeper toward the front margin and base and along the veins; costal cell yellowish brown.

Only 3 other species, all of which appear to be very rare, have been placed in this genus.

M. whitneyi is reported in the Bequaert and Davis list (1923) from Clove Valley, Staten Island. The writer has seen no New York specimens but specimens from northern New Jersey, western Connecticut and southern Ontario indicate that its range does include New York. This species, which resembles a rather large brown *Tabanus*, is very rare throughout its range and nothing is known of its habits or early stages. A synonym of this species is *M. geminata* Hine.

CHRYSOPS Meigen

This genus includes the common deerflies with dark wing markings. The eyes are bright green and gold with dark markings. The bright eye colors and dark markings disappear shortly after death. The deerflies are annoying pests of man but probably are of less importance as pests of livestock than the larger *Tabanus* species.

They are most abundant in wooded areas but may also be found in many other surroundings. Some species are very abundant in the vicinity of salt marshes on Long Island.

Deerflies first appear in mid May in New York and are rarely found after September first although on eastern Long Island occasional specimens may be found into October. The main flight season of each species is short, rarely over 2 weeks; nevertheless, individual specimens may be found throughout the season.

The males of all the species of *Chrysops* found or likely to be found in New York are now known. In the case of several species, however, the male is known from only a single specimen. Not enough male material of *C. beameri* and *C. hinei* has been collected to find a line of demarcation between them, if indeed, it exists.

In the brief descriptions of *Chrysops* which precede the discussion of each species, forms averaging 7 mm. or less in length are considered small, larger than 7 mm. and less than 9 mm. as moderate and 9 mm. or more as large. Characters given for the male include only those showing obvious differences from the female.

KEY TO THE SPECIES OF NEW YORK *CHRYSOPS*

I. Females

1. Apex of wing beyond the crossband hyaline 2
   Apex of wing beyond the crossband infuscated so that an apical spot is present .. 9
2. Second basal cell hyaline; frontoclypeus without median pollinose stripe 3
   Second basal cell at least half infuscated; frontoclypeus with a median pollinose stripe 4
3. Crossband saturate, black .... **nigra** Macq.
   Crossband dilute, faint, pale brown .... **nigribimbo** Whitn.
4. Abdomen entirely dark; sometimes an indefinite pattern of grayish pollinose areas 5
   Abdomen with pale areas on at least first 2 abdominal segments 7
5. Fifth posterior cell with hyaline area at base .... **carbonaria** Wlk.
   Fifth posterior cell infuscated at base 6
6. Pleura with yellow to orange-red pile; crossband broadly reaches hind margin of wing .... **celer** O.S.
   Pleura with grayish or pale yellowish pile; crossband narrowly or not at all reaches hind margin of wing .... **mitis** O.S.
7. Tergites with gray posterior borders; infuscation of second basal cell much less than first; apical portion of wing sometimes faintly infuscated **sordida** O.S.
   Tergites without gray posterior borders; infuscation of basal cells about equal . 8
8. Wing picture pale; pleura with gray pile; no median abdominal triangles **cuclux** Whitn.
   (Occasional specimens of *C. mitis* have small reddish spots laterally at base of abdomen, but the wing picture is dark).
   Wing picture dark; pleura with yellow or orange pile; median abdominal triangles usually present .... **excitans** Wlk.

9. (1) Frontoclypeus black with a median pollinose stripe 10
Frontoclypeus shining yellow at least in center; no median pollinose stripe 12

10. Apical spot paler than crossband with indefinite outline; dark species with pale borders and small triangles on abdominal segments; first 2 abdominal segments with small reddish lateral markings .... **sordida** O.S.
Not with above combination of characters 11

11. Abdomen completely black; hyaline triangle reaches costal margin of wing; pleura with bright orange pile .... **amazon** Daecke
Abdomen usually with contrasting black and yellow pattern; hyaline triangle rarely reaches beyond bifurcation of third longitudinal vein; pleura with yellowish pile .... **frigida** O.S.

12. Crossband and apical spot broken by dilute areas along veins; abdomen striate **shermani** Hine
Dark markings of wing not broken by dilute areas 13

13. Wing markings rather pale; a conspicuous spot which is often connected to strongly bowed crossband covers the bifurcation of the third longitudinal vein; apical spot fills second submarginal cell; dull blackish species .. **fuliginosa** Wied.
Not with above combination of characters; if a spot is present at bifurcation, apical spot is narrow 14

14. Apical spot dilutely extended around wing reducing hyaline triangle to a subhyaline area not reaching hind margin of wing; large brown species with swollen first antennal segment and little or no trace of abdominal markings **brunnea** Hine
Not with above combination of characters 15

15. Wing pattern pale and not distinctly outlined; usual hyaline areas dilutely infuscated; antennae short and somewhat swollen .... **atlantica** Pech.
Markings of wing clear cut; no infuscation of usual hyaline portions of wing except occasionally in anal area; antennae slender 16

16. First basal cell completely infuscated, rarely with a subhyaline spot at apex ... 17
First basal cell always at least half hyaline, sometimes almost entirely so 31

17. Hyaline triangle small but clear and distinct, restricted to apices of second and third posterior cells .... **moecha** O.S.
Hyaline triangle extending toward costal margin of wing beyond second posterior cell 18

18. Apical spot very narrow, entering only extreme upper corner of second submarginal cell; an isolated spot is present at bifurcation of third longitudinal vein; a small gray-black species .... **brimleyi** Hine
Apical spot broad, usually covering at least half of second submarginal cell; no isolated spot at bifurcation 19

19. Predominantly black or fuscous species with paler abdominal markings, if any, not conspicuous; hyaline triangle usually narrow and crescent shaped, reaching the second longitudinal vein but sometimes upper portion of hyaline triangle tinted so that it is indistinct 20
Abdomen conspicuously marked in yellow and black 23

20. A yellow or grayish stripe laterally on thorax above wing base 21
No thoracic stripe above wing base 22

21. Abdomen usually with three dull yellow stripes which are often much reduced, especially the lateral ones .... **obsoleta** Wied.
Abdomen dark without pattern or only traces of a pale median stripe **obsoleta** subsp. **lugens** Wied.

22. Hind legs predominantly dark; rarely with any trace of an abdominal pattern; apical spot normally not extending beyond second submarginal cell **parvula** Daecke
Hind legs predominantly yellow or brownish; abdomen usually with distinct traces of a pale median line and occasionally with traces of lateral lines; apical spot usually extends into the first posterior cell .... **dacne** Philip

23. Apex of hyaline triangle reaches second longitudinal vein 24
Apex of hyaline triangle does not reach second longitudinal vein 27

24. Frontal callus yellow 25
Frontal callus black or deep brown 26

25. Apical spot reaches into first and sometimes second posterior cell; fifth posterior cell usually with some infuscation; two central stripes of abdomen heavier and darker than lateral stripes .... **hinei** Daecke

Apical spot rarely reaches into first posterior cell except as a pale shadow; fifth posterior cell usually entirely hyaline; 4 stripes of abdomen of about equal intensity or central stripes only slightly accentuated .... **beameri** Brennan

26. Lateral abdominal stripes usually not present on first two segments; hyaline triangle blunt and rounded at apex .... **pikei** Whitn.
Lateral abdominal stripes normally complete; hyaline triangle crescent shaped and nearly pointed at apex .... **sequax** Will.

27. Abdomen with 4 more or less complete dark longitudinal stripes 28
Abdomen not striped or with less than 4 stripes 30

28. Most of fifth posterior cell infuscated; scutellum yellow .... **vittata** Wied.
Fifth posterior cell almost entirely hyaline; scutellum dark, with or without paler apex 29

29. Apical spot nearly fills second submarginal cell; 2 central stripes of abdomen rarely joined on second segment; frontal callus yellow .... **aberrans** Philip
Apical spot only about half fills second submarginal cell; 2 central abdominal stripes usually join on second segment; frontal callus usually black, sometimes brownish, rarely yellowish .... **striata** O.S.

30. Apical spot fills out most of second submarginal cell and extends into first and sometimes second posterior cell, usually connecting with crossband by an infuscated streak in the first posterior cell; abdomen with 2 stripes which are sometimes reduced to faint lines or enlarged to cover much of abdomen on each side of a yellow central stripe; scutellum usually with considerable yellow **univittata** Macq.
Apical spot fills only about half of second submarginal cell and does not extend further; abdomen not striped; scutellum dark .... **inda** O.S.

31. (16) Apical spot narrow including at most only extreme apex of second submarginal cell 32
Apical spot broad, entering second submarginal cell over at least one third of upper branch of third longitudinal vein 36

32. Apical spot just beyond where it leaves the crossband slightly wider than marginal cell; frontal callus usually yellow, often bordered with black or brown, occasionally black 33
Apical spot at base narrower or just as wide as marginal cell; frontal callosity black 34

33. Black spot on second abdominal segment practically joins with that on the first segment; second and third sternites with black sublateral spots; robust species **sackeni** Hine
Black spot on second segment usually does not attain the anterior margin of the segment; no sublateral spots on sternities; more slender species .. **pudica** O.S.

34. Crossband dilute and leaving about half of the discal cell hyaline; cheeks black; frontoclypeus with a large black spot on each side .... **delicatula** O.S.
Crossband saturate and covering discal cell; frontoclypeus and cheeks yellow or orange 35

35. Apical spot very narrow and more dilute than crossband; front little convergent at vertex; pale markings of abdomen usually grayish or dull yellow; on the second abdominal segment are black triangles, one on each side of the median dark marking, and they may or may not be connected with the latter by a dark band along the posterior margin of the segment ...... **aestuans** Wulp
Apical spot varies from one half to full width of marginal cell and is same density as crossband; front somewhat convergent at vertex; pale markings of abdomen yellow which sometimes is quite bright; dark median marking of second abdominal segment may have projections along posterior margin of segment but they do not form lateral triangles .... **callida** O.S.
(Some specimens of *C. sackeni* may key here but may be separated by the shape of the frontal callus which is almost as high as it is wide).

36. (31) Blackish species with a mid-dorsal yellow (rarely grayish) abdominal stripe and sometimes with shorter stripes on each side of the center stripe **wiedemanni** Krb.
Abdomen with a different pattern and showing more yellow 37

37. Hyaline triangle distinctly crosses second longitudinal vein, nearly separating apical spot from the crossband 38
Hyaline triangle at most reaches second longitudinal vein 39

38. Apical spot occupies almost all of second submarginal cell; crossband reaches hind margin of wing .... **geminata** Wied.
Apical spot occupies only about half of second submarginal cell; crossband usually does not reach hind margin of wing .... **lateralis** Wied.

39. Abdomen with 4 rows of spots, but lateral spots on second segment may be reduced or absent; median figure on second segment an inverted "V"; scutellum and frontal callus normally dark, but the latter sometimes brownish .. **montana** O.S.
Abdomen normally not with 4 rows of spots 40

40. Hyaline triangle reaches second longitudinal vein 41
Hyaline triangle does not reach second longitudinal vein 42

41. Crossband dilute and basal portion of discal cell pale or hyaline; frontal callus and hind femora yellow; usually no dark spot under scutellum .. **cursim** Whitn.
Crossband not very dilute and basal portion of discal cell usually concolorous with rest of crossband; frontal callus yellow or fuscous and hind femora usually dark at base; there is a dark spot under scutellum .... **pudica** O.S.

42. Abdominal markings black and median marking of second segment usually reaches anterior margin; frontal callus normally black but sometimes yellow; at least basal portion of hind femora black .... **dimmocki** Hine
Abdominal markings brown, often quite pale; median marking of second abdominal segment rarely attains anterior margin; frontal callus and hind femora yellow the latter sometimes brownish at base 43

43. Thorax greenish-gray with fuscous stripes; outer margin of crossband usually sinuous .... **flavida** subsp. **celata** Pech.
Thorax yellow-brown with dark brown stripes; outer margin of crossband straight or sinuous 44

44. Dark median marking of second abdominal segment reaching only about half way across segment leaving an anterior greenish-yellow area; outer margin of crossband sinuous .... **flavida** subsp. **reicherti** Fairch.
Dark median marking of second abdominal segment reaching about two thirds of way across segment and pale anterior area usually without greenish tinge; outer margin of crossband usually straight .... **flavida** Wied.

KEY TO THE SPECIES OF NEW YORK *CHRYSOPS*

II. Males

1. Apex of wing beyond the crossband hyaline, sometimes a vague cloud present in this area 2
Apex of wing infuscated beyond crossband so that an apical spot is present ... 8

2. Frontoclypeus black with a midfacial pollinose stripe which begins below antennae and runs at least half way to the oral margin 3
Frontoclypeus black or yellow without a midfacial pollinose stripe 7

3. Abdomen completely black 4
First 2 abdominal segments with small reddish or yellowish spots laterally 6

4. Fifth posterior cell with a hyaline area at base .... **carbonaria** Wlk.
Fifth posterior cell infuscated at base 5

5. Crossband broadly and distinctly reaches hind margin of wing; outer margin of crossband usually very straight .... **celer** O.S.
Crossband narrowly, indistinctly or not at all reaching hind margin of wing; outer margin of crossband usually irregular .... **mitis** O.S.

6. Wing pattern dilute; pleural pile grayish .... **cuclux** Whitn.
Wing pattern saturate; pleural pile yellowish .... **excitans** Wlk.

7. Wing pattern saturate; frontoclypeus yellow with a large black spot on each side; fairly robust species .... **nigra** Macq.
Wing pattern very dilute; frontoclypeus fuscous; small species **nigribimbo** Whitn.

8. (1) Frontoclypeus with a midfacial pollinose stripe which begins below antennae and runs at least half way to oral margin; integument of frontoclypeus usually entirely black 9
Frontoclypeus without a midfacial pollinose stripe; integument of face at least partly yellow 11

9. Species usually with considerable yellow on abdomen; legs usually with much yellow .... **frigida** O.S.
Black species with pale abdominal markings, if any, restricted to sides of first 2

segments and traces of small median and posterior markings; legs almost entirely dark 10

10. Abdominal tergites and sternites from second segment with pale posterior margins which on tergites expand to small median triangles; a small reddish spot laterally on second segment; apical spot extensive but paler than crossband, filling all of first submarginal cell and fading out in lower portion of second submarginal cell; first basal cell with small subhyaline area near apex; second basal cell completely infuscated .... **sordida** O.S.
    Abdominal tergites and sternites black without paler markings; both basal cells with a distinct hyaline area near apex .... **amazon** Daecke
    (If body completely black and apical spot paler than crossband and vague in outline, refer back to Couplet 3).
11. Abdomen black with no yellow markings; hind femora black 12
    Abdomen with yellow markings; hind femora variable 15
12. Apical spot narrow, including only part of second submarginal cell .. **brimleyi** Hine
    Apical spot including all of second submarginal cell 13
13. Hyaline triangle clear, restricted to apices of second and third posterior cells; thorax usually with at least a trace of a pale stripe above wing base; facial area with considerable yellow .... **moecha** O.S.
    Hyaline triangle dilutely infuscated; no trace of a pale stripe above wing base; yellow of facial area restricted to a narrow stripe in center of frontoclypeus .. 14
14. Pleurae with some pale markings; first 2 antennal segments and fore coxae and femora with considerable yellow .... **parvula** Daecke
    Pleurae, antennae and all coxae and femora black .... **fuliginosa** Wied.
15. Crossband and apical spot broken by dilute areas along veins .... **shermani** Hine
    Crossband and apical spot not broken by dilute areas although entire wing pattern may be pale 16
16. Wing pattern dilute and indefinite or hyaline triangle represented by a narrow subhyaline or hyaline area not reaching hind margin of wing; first antennal segment somewhat swollen 17
    Wing pattern clear-cut and hyaline triangle open at hind margin of wing; first antennal segment not especially swollen, often very slender 18
17. Dull yellowish species with pattern of dark spots on each abdominal segment except first; wing pattern dilute and indefinite; first antennal segment moderately swollen .... **atlantica** Pech.
    Brown species with no definite abdominal pattern, although dark markings may be indicated by dark shadows; hyaline triangle indicated by clear area along edge of crossband and not usually extended beyond center of third posterior cell; first antennal segment considerably swollen .... **brunnea** Hine
18. Black species; abdomen with a yellowish median longitudinal stripe, occasionally with a similar abbreviated stripe on each side; hyaline triangle crosses second longitudinal vein; apical spot rarely occupies more than half of second submarginal cell, often less .... **wiedemanni** Krb.
    Not with above combination of characters 19
19. Apical spot very little broader at its apex than at its origin, crossing upper branch of third longitudinal vein at its apex and occupying very little of the second submarginal cell 20
    Apical spot considerably broadened towards its apex, crossing at least half of upper branch of third longitudinal vein 23
20. Hyaline triangle not reaching second longitudinal vein .... **sackeni** Hine
    Hyaline triangle reaching or crossing second longitudinal vein 21
21. Frontoclypeus with a large black spot on each side .... **delicatula** O.S.
    Frontoclypeus entirely yellow or, at most, with some dark shading around frontoclypeal pits 22
22. Second abdominal segment with sublateral black triangles which join the median figure along the posterior border of the segment; fourth posterior cell usually hyaline at apex and fifth posterior cell with considerable infuscation especially basally; pale markings grayish yellow; apical spot very narrow .. **aestuans** Wulp
    Second abdominal segment without sublateral black triangles; fourth posterior cell usually entirely infuscated and fifth posterior cell often mostly hyaline; pale markings yellow .... **callida** O.S.
23. Abdomen bright yellow and black; large black figure of second abdominal segment broadly joined to black figure of first segment; median yellow triangles do not

reach the anterior border of the segments; apical spot occupying one half to two thirds of second submarginal cell 24
Not with above combination of characters 25

24. Abdomen with a sublateral row of black spots; median yellow triangles moderate in size; hyaline triangle extending beyond bifurcation of third longitudinal vein, sometimes reaching second longitudinal vein .... **montana** O.S.
Abdomen without a sublateral row of black spots; median triangles very small, sometimes obsolete; hyaline triangle ends at bifurcation of third longitudinal vein .... **inda** O.S.

25. Apical spot filling about half or less of second submarginal cell 26
Apical spot filling all or nearly all of second submarginal cell, sometimes extending into first posterior cell 32

26. Frontoclypeus with a black spot on each side; hyaline triangle crosses second longitudinal vein .... **lateralis** Wied.
Frontoclypeus entirely yellow; hyaline triangle does not cross second longitudinal vein 27

27. First basal cell infuscated, except for subhyaline area near apex; second basal cell at least half infuscated; hind femora usually partly black . **dimmocki** Hine
First basal cell usually not more than half and second basal cell one third infuscated; hind femora often entirely yellow; dark markings on second abdominal segment not reaching the anterior margin 28

28. Thorax yellow or brownish in ground color with brown stripes 29
Thorax greenish gray with fuscous stripes 30

29. Outer margin of crossband nearly straight; ground color of abdomen rather uniformly yellow .... **flavida** Wied.
Outer margin of crossband sinuous; base of second abdominal segment often with a greenish cast .... **flavida** subsp. **reicherti** Fairch.

30. Crossband dilute, base of discal cell nearly hyaline; ground color of abdomen bright yellow; hind femora entirely yellow .... **cursim** Whitn.
Crossband saturate or nearly so, discal cell not paler at base; ground color of abdomen dull yellow; hind femora variable 31

31. Hind femora usually dark at base; a black spot beneath scutellum; dark abdominal markings usually saturate .... **pudica** O.S.
Hind femora usually entirely yellow; black spot beneath scutellum very pale or absent; dark abdominal markings often faded .... **flavida** subsp. **celata** Pech.

32. Hyaline triangle crosses second longitudinal vein; yellow species with black median abdominal spots which are usually joined on the second segment; apical spot does not extend beyond second submarginal cell .... **geminata** Wied.
Not with above combination of characters 33

33. Hyaline triangle reaches or nearly reaches second longitudinal vein (if subhyaline beyond bifurcation of third longitudinal vein, predominantly black species with pale abdominal markings reduced) 34
Hyaline triangle scarcely extends beyond bifurcation of third longitudinal vein; predominantly yellowish species with dark abdominal markings 39

34. Blackish species, with reduced pale abdominal markings 35
Yellow species with black abdominal markings 37

35. Thorax with a yellow stripe on each side above wing base; lower border of second basal cell infuscated 36
Thorax without a yellow stripe above wing base; lower border of second basal cell not more heavily infuscated than adjoining portion of cell .. **dacne** Philip

36. Abdomen with a dull yellowish median stripe, frequently with a shorter stripe on each side .... **obsoleta** Wied.
Abdomen with only traces of longitudinal stripes . **obsoleta** subsp. **lugens** Wied.

37. Frontoclypeus and cheeks mostly yellow .. **beameri** Brennan **hinei** Daecke
Frontoclypeus with a large dark spot on each side and cheeks with considerable black 38

38. Lateral abdominal stripes incomplete; second basal and fifth posterior cells with reduced infuscation; hyaline triangle broadly open at base ... **pikei** Whitn.
Lateral abdominal stripes complete; second basal and fifth posterior cells mostly infuscated; hyaline triangle narrow at base and crescent shaped .. **sequax** Will.

39. Abdomen with a median yellow stripe with a longitudinal black band on each side; lateral margins of segments narrowly yellow .... **univittata** Macq.
Abdomen yellow with 4 more or less complete rows of black spots 40

40. Ground color of thorax and scutellum yellow . . . . **vittata** Wied.
Ground color of thorax plumbeus; scutellum sometimes with some yellow 41
41. Apical spot completely fills second submarginal cell; the sublateral rows of abdominal spots are about as dark as the median rows . . . . **aberrans** Philip
Apical spot not completely filling second submarginal cell; sublateral rows of abdominal spots paler than median rows . . . . **striata** O.S.

Chrysops aberrans Philip (Fig. 9)

Moderate in size (8 mm.); yellow and black; thorax greenish in ground color; black stripes on abdomen, the median pair rarely joining on the second tergite; first basal cell wholly infuscated; fifth posterior cell mostly hyaline; apical spot broad, usually nearly filling second submarginal cell; frontal callus yellow. Male with yellow areas reduced; second basal cell largely infuscated.

Many of the records in the State List for *C. striata* refer to *C. aberrans.* The two species are much alike and often fly together, but may be distinguished by the characters given in the key.

Although *C. aberrans* is found in various parts of the State, it is most common in and near the cat-tail swamps along the south shore of Lake Ontario. In such situations it is often an annoying pest. This species appears in late June and on Long Island has been collected into September. Its peak abundance is from mid July to mid August.

The larvae have been collected from mud on the edges of ponds and streams.

Chrysops aestuans van der Wulp (Fig. 10)

Moderate in size (8.5 mm.); black; abdomen with gray or yellowish gray markings not in form of stripes; both basal cells hyaline; apical spot very narrow; crossband often not reaching hind margin of wing. Male generally darker; both basal cells partly infuscated.

Normally this is not a common species in New York although from Ohio west it is a species of considerable economic importance. The only place in New York where the writer has encountered it in numbers is on Grand Island in the Niagara River. It is most commonly collected near Lake Ontario. It flies from June until August. In the older literature this species is sometimes called "*moerens* Walker."

The larvae have been reported from mud on the edge of temporary and permanent ponds and from marshes along Lake Erie. The eggs are laid on emergent vegetation, often over rather deep water.

Chrysops amazon Daecke

Large (10 mm.); black; pleurae with dense reddish or orange pile; frontoclypeus with a median pollinose stripe; both basal cells partly infuscated; apical spot broad, separated from crossband. Male with black pile only on pleurae; entire anal area of wing infuscated.

This species has not been reported from New York. Since it is found in New Jersey and southern New Hampshire, it is entirely possible that it occurs on Long Island.

Chrysops atlantica Pechuman (Fig. 11)

Rather large (9 mm.); dull yellow and brown; dark pattern of abdomen not clear cut but never in form of stripes; wing membrane dilutely infuscated with pattern showing as darker area; both basal cells partly infuscated; apical spot broad. Male usually darker than female with abdominal pattern more distinct.

This species has long been confused with *C. flavida* but the smoky wing and dark thorax serve to distinguish it. It is more common than *C. flavida* in New York and is often a pest in the vicinity of salt marshes.

The larvae are found in very wet situations, often under water, in salt marshes and brackish pools and since the species is never found inland, they probably are restricted to this habitat.

Chrysops beameri Brennan

Moderate in size (8 mm.); yellow and black; thorax greenish yellow in ground color; abdomen with black stripes; first basal cell infuscated; fifth posterior cell hyaline; apical spot broad but usually only barely reaching first posterior cell; frontal callus yellow. Male not surely distinguishable from *C. hinei.*

Specimens close to this form are occasionally collected on Long Island. The writer has seen such specimens from Peconic (July 30), Orient (August 5), Fishers Island (August 21) and Belmont Lake State Park (August 22), the specimen from the last locality being reported by the writer (1938) as *C. pikei.* These specimens do not exactly match specimens of *C. beameri* from near the type locality and it is quite possible they are a light form of *C. hinei* and these collection localities are shown in Fig. 27 as *hinei.* Additional material, especially males, will be necessary to determine the status of this species.

Chrysops brimleyi Hine (Fig. 12)

Small (6.5 mm.); dark grayish black; abdomen with traces of a grayish pattern; first basal cell infuscated, second hyaline; apical spot narrow. Male with both basal cells partly infuscated.

This small species is rare in New York where it apparently reaches the northern extent of its range on Long Island. It is found in June and July.

Chrysops brunnea Hine (Fig. 13)

Rather large (9 mm.); brown; abdominal pattern obsolete, sometimes with dark shadows and with faint pale median triangles; the broad apical spot continues around the wing and joins the cross-band by a lightly infuscated area along the hind margin isolating the hyaline triangle; both basal cells partly infuscated; first antennal segment swollen. Male differs from female only in sex characters.

This large brown species is almost entirely restricted to the vicinity of marshes along the south shore of Lake Ontario and probably will be found in similar situations along Lake Erie. It has not been found on Long Island but may be present since it is recorded from New Jersey.

C. brunnea attacks with a loud buzzing noise and is quite aggressive. It is sometimes annoying to fishermen in the bays along Lake Ontario. It is found in July and August.

Chrysops callida Osten Sacken (Fig. 14)

> Moderate in size (8 mm.); black and yellow; abdominal markings not in form of stripes; both basal cells hyaline; apical spot narrow; crossband reaching hind margin of wing. Male with pale markings less extensive; both basal cells partly infuscated.

This common species seems to have been collected in all portions of the State except the Adirondack area. It is active and aggressive and causes considerable annoyance to man and livestock. It is most abundant in June and early July but occasional specimens are found from May until August in upstate New York and on Long Island it has been collected as late as October.

C. callida belongs in a difficult taxonomic group which includes *C. dimmocki, C. pudica, C. sackeni* and some rarer forms. However, the majority of the specimens may be separated by the characters given in the key.

The larvae have been found in a variety of situations including stagnant mud on the edge of ponds, wet organic material and the edges of brackish pools. The writer has never found the egg masses over anything but water. These masses, which shortly after oviposition become dark and shining, are laid along the edges of creeks and ponds on emergent vegetation but none are found on similar adjacent growth over mud (Fig. 1). Since these egg masses are often quite abundant and noticeable, this selectivity is most striking to observe.

Chrysops carbonaria Walker (Fig. 15)

> Moderate in size (8 mm.); black; fifth posterior cell hyaline at base; no apical spot; both basal cells more than half infuscated. Male with both basal cells at least three quarters infuscated; considerable dilute infuscation in anal area of wing.

In New York, *C. carbonaria* usually is the first species to appear. It is found throughout the State and often is abundant. It appears from early to mid May and reaches a peak abundance in early June. Occasional specimens are found into July.

C. carbonaria belongs to a species group which sometimes show intergrading characters. It is especially close to *C. mitis* but most specimens may be separated by the characters given in the key. Certain specimens differ in that the crossband is very dark with a straight outer margin which runs to the posterior margin of the wing, and with grayish-yellow to bright yellow hairs on the pleurae. This form of *C. carbonaria* is especially common on Long Island where it has been confused with *C. celer*.

It is separated from this species by the presence of a hyaline area at the base of the fifth posterior cell. Although *C. carbonaria* belongs to the group without an apical spot, occasional males of this group show a tinting in the apical area which is often quite distinct. A form of *carbonaria* with apical tinting of the wing has recently been described by Philip (1955) as *"carbonaria nubiapex"* with the holotype male from Little Valley, N. Y. and paratype males from Ithaca, Oswego and Albany. The writer regards its status as uncertain and has not separated its distribution from that of the other forms.

The larvae are found in mud and plant debris on the edges of ponds and streams, often under several inches of water.

Chrysops celer Osten Sacken (Fig. 16)

> Rather large (9 mm.); black; pleurae with dense yellow to orange-red pile; fifth posterior cell infuscated at base; both basal cells more than half infuscated; no apical spot. Male lacks the orange pleural pile of the female; anal area of wing dilutely infuscated.

This species is widely distributed over New York but seems to be most abundant in the warmer portions of the State. It is annoying to man and livestock early in the season. *C. celer* flies from May until July and on Long Island it has been collected in August; it is most common in June.

The egg mass of this species is unique for a *Chrysops* since it is brown in color and in several layers much like a *Tabanus* egg mass. The writer has seen oviposition take place on emergent vegetation along Tonawanda Creek in Niagara County over about eight inches of water. The larvae are found in the muddy banks of ponds and streams.

Chrysops cuclux Whitney (Fig. 17)

> Moderate in size (8 mm.); black; abdomen with a grayish yellow area laterally near base; wing pattern pale; both basal cells more than half infuscated; no apical spot. Male with pale area of abdomen smaller than in female.

This species is related to the two preceding but is less common. Although it is widely distributed over New York, it rarely is abundant enough to be considered a pest. It flies in late May and early June with an occasional specimen being found in July.

The larvae have been found in very wet mud of streams and ponds.

Chrysops cursim Whitney

> Moderate in size (7.5 mm.); yellow and black with yellow predominating; abdominal markings not in form of stripes; crossband dilute and part of discal cell subhyaline; both basal cells hyaline; apical spot moderately broad. Male with both basal cells partly infuscated; crossband less dilute than in female.

This is a rare form in New York. It is related to *C. pudica* and some variations of that species approach *cursim* closely. The only undoubted *cursim* the writer has seen from New York are from extreme eastern Long Island, all collected by Mr. Roy Latham. Collection dates are from June 10 to July 20 at Riverhead, August 2 at Greenport and July 2 at Orient.

Chrysops dacne Philip (Fig. 18)

> Moderate in size (7.5 mm.); dark brown; no pale stripe above wing base; abdomen often with a narrow pale median line and rarely with obsolete sublateral lines; first basal cell infuscated; apical spot very broad; hyaline triangle narrow; legs with considerable yellow. Male with hyaline areas of wing somewhat tinted.

For many years this species was called *C. lugens* but the name *lugens* should be used for another form. *C. dacne* is rare in New York and of no apparent economic importance. All specimens on record were collected in July.

Chrysops delicatula Osten Sacken (Fig. 19)

> Moderate in size (7:5 mm.); black and pale yellow; abdominal markings not in form of stripes; both basal cells hyaline, discal cell partly hyaline; frontoclypeus with a black spot on each side; apical spot narrow. Male with both basal cells partly infuscated.

Although this has been considered a rare species in New York, it is occasionally abundant enough on Long Island to be considered a pest. It is essentially a coastal form in New York and is rarely found inland. On Long Island it has been collected from May until October with most records in late June and July. The few upstate collections were made in June and July.

Chrysops dimmocki Hine (Fig. 20)

> Moderate in size (8 mm.); black and yellow; abdominal markings not in form of stripes; both basal cells hyaline; apical spot quite broad. Male with both basal cells partly infuscated.

Members considered by the writer as belonging to this species seem to be restricted to Long Island and Staten Island in New York. He has been unable to locate the specimen on which the Grand Island, Erie County record in the State List is based and has been unable to collect other specimens at that locality. *C. dimmocki* is close to *C. pudica* and by some workers it is considered a synonym of that species. It seems best to retain the name until further work can be done on the group to which it belongs.

This species flies from April until September but most of the records are in June and early July.

Chrysops excitans Walker (Fig. 21)

> Large (10 mm.); black; abdomen with a yellow area laterally near

base and usually with median triangles on the second, third and sometimes fourth tergites; pleurae with dense yellowish pile; fifth posterior cell infuscated at base; both basal cells more than half infuscated; no apical spot. Male much darker than female with pale abdominal markings reduced or obsolete.

This northern species is largely restricted to the Adirondack area in New York. It has not been collected in the Catskills nor in the Allegheny area of western New York but may possibly be found there. *C. excitans* is the largest *Chrysops* found in New York. It is sometimes abundant enough in the higher Adirondacks to be a pest of humans. It is most common in late June and July with an occasional specimen being found into August.

The larvae have been found in the mud along the edges of ponds and lakes.

Chrysops flavida Wiedemann (Fig. 22)

Moderate in size (8.5 mm.); yellow and brown; brown markings of abdomen not in form of stripes; thorax yellow with brown stripes; both basal cells somewhat infuscated at base; apical spot broad. Male differs from female only in sex characters.

The typical form of *C. flavida* is not especially common in New York. Many of the earlier published records of this species refer to *C. atlantica* or to *C. flavida celata.* Where the writer has been unable to confirm the earlier records, they are omitted from Fig. 22. This species flies from June until October on Long Island but is most abundant in July. There are no inland records of *C. flavida* or its subspecies in New York.

The larvae are found in very wet situations, often in mud under a foot of water.

Chrysops flavida subspecies **celata** Pechuman (Fig. 23)

Moderate in size (8.5 mm.); much like typical form but both sexes have thorax greenish gray with dark stripes and outer margin of crossband usually sinuate.

This form appears to be more common in New York than typical *flavida* but rarely is abundant enough to be considered a pest. It flies from June to September with most records being in June.

Occasional specimens of *C. flavida* from Long Island are very close to subspecies *reicherti* but do not exactly match type material of this form studied by the writer.

Chrysops frigida Osten Sacken (Fig. 24)

Moderate in size (7.5 mm.); black and orange; extent of color pattern of abdomen variable, sometimes almost completely black or almost completely orange yellow but pattern never in form of longitudinal stripes; frontoclypeus with a median pollinose stripe;

> both basal cells partly infuscated; apical spot broad and broadly united with crossband. Male with infuscation in both basal cells greater than in female.

As will be seen on the map, this little species is widely distributed in New York. It probably is even more common than indicated on the map since it is of retiring habits and not at all aggressive. It prefers swampy woods and the writer has never found it abundant enough to be annoying. The body coloration is very variable and some specimens are nearly black. In spite of this variation, it is easily distinguished from other New York *Chrysops* by the combination of a large apical spot and a black face with a pollinose stripe. Occasional specimens have a considerable amount of yellow on the face and legs and an extreme of this form with almost completely yellow legs and face has recently been described as subspecies *xanthas* Philip. Some New York specimens studied by the writer probably could be considered this form.

In upstate New York it is an early season species appearing in May and being most abundant in June and early July. There are some August and September records from Long Island. The male is often found on flowers.

Chrysops fuliginosa Wiedemann (Fig. 25)

> Rather small (7 mm.); dark grayish black; sometimes with traces of paler pattern on abdomen; entire wing dilutely infuscated with usual dark pattern indicated by heavier infuscation; first basal cell infuscated; apical spot broad and nearly separated from crossband. Male darker than female; both basal cells almost completely infuscated.

This small dark species is found only in the immediate vicinity of salt marshes along the coast. It is sometimes abundant enough to be of considerable annoyance to man and animals. Although it has been collected in New York from May to September, it is present in numbers only in June.

C. fuliginosa breeds in salt marshes including areas which are daily swept by tides.

Chrysops geminata Wiedemann (Fig. 26)

> Small to moderate in size (7 mm.); black and yellow; abdominal markings usually not in form of stripes but black markings occasionally reduced and appear as broken rows of spots; both basal cells hyaline; apical spot broad and nearly separated from crossband. Male with some dilute infuscation in both basal cells.

This little species is widely distributed throughout New York. It is partial to wooded areas and the writer has found it most abundant along country roads running through woods. Although fairly common at times, it can not be considered a serious pest. *C. geminata* is related to *C. lateralis* but may be separated by the characters given in the key;

it is also smaller than that species. *C. geminata* shows considerable variation in the markings of the second abdominal segment. It flies from late June into August but is most abundant in mid July.

The larvae have been found in wet soil and plant debris along streams and in wet soil and mud under trees.

Chrysops hinei Daecke (Fig. 27)

> Moderate in size (8 mm.); yellow and black; thorax greenish in ground color; abdomen with black stripes; first basal cell infuscated; fifth posterior cell usually partly infuscated; apical spot broad reaching first posterior and sometimes second posterior cell; frontal callus yellow. Male with black abdominal stripes wider and sublateral ones more distinct than in female.

This species is not common in New York and to date has been found only on Long Island. It is a late flying species and most specimens are found in late August and early September. However, the writer has seen specimens collected in May, July and October as well as the two months mentioned above. Some of the paler specimens are close to *C. beameri*.

Chrysops inda Osten Sacken (Fig. 28)

> Moderate in size (8 mm.); yellow and black; abdomen with a row of rather large yellow median triangles; hind margins of tergites narrowly and lateral margins broadly yellow; first basal cell infuscated; apical spot broad; frontal callus black. Male with black areas much more extensive than in female; both basal cells and fifth posterior cell almost completely infuscated.

As will be seen on the map, this species is found throughout the State. It seems to be most common in the western portion of New York although the writer on one occasion found it extremely abundant in Bear Mountain State Park. It is aggressive and sometimes is quite annoying.

C. inda is an early season form appearing in May and reaching its peak abundance in June and is rarely taken after early July although an occasional specimen is collected in August.

The eggs resemble those of *C. callida* and are laid on vegetation over water. The larvae have been found in mud and plant debris along creeks and the edges of ponds.

Chrysops lateralis Wiedemann (Fig. 29)

> Moderate in size (8 mm.); yellow and black; abdomen with a yellow median stripe, usually black laterally but sometimes black reduced to form rows of spots; both basal cells hyaline; apical spot broad and nearly separated from crossband. Male with some dilute infuscation in both basal cells.

As indicated on the map, this species is found only in the mountainous and hilly areas of the State. The writer has never found it abundant except in the Adirondacks where it is probably the most common species of *Chrysops* during most of the season. At the peak of its flight in this area it is a very annoying pest of humans and animals. The males are often collected on flowers.

It flies from June into August but is most abundant from late June until mid July.

Chrysops mitis Osten Sacken (Fig. 30)

> Large (9.5 mm.); black; fifth posterior cell infuscated at base; no apical spot; both basal cells more than half infuscated. Male with considerable dilute infuscation in anal area of wing.

This species is close to *C. carbonaria* and some specimens can scarcely be differentiated. In general it is more northern than *C. carbonaria* and in the Adirondacks it is an early season pest. It is found from May until July and is most common in June. The larvae have been found on the edges of ponds and in swampy areas.

Chrysops moecha Osten Sacken (Fig. 31)

> Moderate in size (7.5 mm.); yellow and black; thorax greenish in ground color; black markings of abdomen usually in form of stripes; first basal cell infuscated; fifth posterior cell mostly hyaline; apical spot very broad; hyaline triangle extremely small but regular in outline; frontal callus usually black. Male black; wings almost entirely infuscated except for small hyaline triangle.

C. moecha is most common in the warmer portions of New York and has not been collected in the Adirondacks or Catskills. Although it is not often common enough to be a pest, the writer has seen it in hugh swarms along Tonawanda Creek in Niagara and Erie Counties in late June. Under these conditions it was a serious pest of humans and domestic animals in the area, attacking in maximum abundance late in the afternoon and still being present in small numbers after dark. It is aggressive in its habits.

The body pattern of this species is very variable, the abdominal stripes of some specimens being reduced to a series of dashes and in others the stripes are very extensive, the entire insect appearing quite dark.

C. moecha flies from mid June until early August but only an occasional specimen is encountered after mid July. The male is black and is rather frequently collected from leaves of trees overhanging streams.

Eggs are laid on the underside of leaves of trees overhanging streams, sometimes many feet above the water. The egg mass is unusual in that the individual eggs are deposited almost at right angles to the leaf and do not overlap each other as is usual in *Chrysops*. The larvae have been collected in wet mud, often under water, along ponds and streams.

Chrysops montana Osten Sacken (Fig. 32)

> Moderate in size (8 mm.); black and yellow; abdomen with a

geminate black spot and often with a sublateral black spot on the second tergite, and 4 rows of spots on the third, fourth and fifth tergites; first basal cell partly infuscated, second nearly hyaline; apical spot variable but usually broad. Male with yellow areas usually much reduced; both basal cells partly infuscated.

This species is found throughout New York but rarely is common anywhere. However, the writer once found it abundant and aggressive near Childwold in the Adirondacks. It is most commonly found in the vicinity of ponds and lakes.

Occasional specimens lack the small black lateral spots on the second abdominal segment or have them much reduced; such specimens are especially common on Long Island. The size and shape of the apical spot is also subject to considerable variation.

C. montana flies from late June until August but is most commonly collected in mid July.

The larvae have been collected in sand on the edges of ponds.

Chrysops nigra Macquart (Fig. 33)

Moderate in size (7.5 mm.); black; first basal cell infuscated, second hyaline; no apical spot. Male wing with both basal cells largely infuscated.

This widely distributed species is found throughout New York. It is an early season form and sometimes is extremely abundant. It is especially a pest of livestock but is also annoying to man.

The hyaline second basal cell will distinguish this species from related forms. It is, however, very variable and a trace of an apical spot can sometimes be seen in both sexes. Occasional specimens have a small spot at the bifurcation of the third longitudinal vein, in this respect resembling *C. brimleyi*. The anal area of the wing is sometimes dilutely infuscated.

C. nigra flies from May until September although it is rarely seen after mid July.

The larvae seem tolerant of many conditions and they have been collected from such varied situations as stagnant mud and plant debris on the edge of a pool, from mud on the banks of a small brook, from wet soil under trees, from the margin of a brackish pool and in sandy areas swept daily by tides.

Chrysops nigribimbo Whitney (Fig. 34)

Small (6 mm.); very dark brown to black; wing pattern very pale; first basal cell infuscated, second hyaline; apical spot absent or very faint. Male wing with lower basal portion of second basal cell and anal area dilutely infuscated.

This small species is rare in New York and seems to be restricted to Long Island. Its small size and very faint wing pattern serve to distinguish it. It has been collected in June and July.

Chrysops obsoleta Wiedemann (Fig. 35)

Moderate in size (8 mm.); dark brown to black; abdomen with 3 yellowish stripes which are often indistinct, especially the sublateral ones; a pale stripe above wing base; first basal cell infuscated; apical spot very broad; legs with considerable yellow. Male with part of second basal cell and anal area of wing dilutely infuscated.

This coastal form is rare in New York although it is quite common along the coast of New Jersey and Delaware. The writer has been unable to confirm a record from White plains in the State List and all specimens he has seen have been from Long Island. All specimens studied by the writer were collected in July except for single specimens, one each in May, August and September.

The extent of pale markings on the abdomen in this species is very variable. *Chrysops obsoleta lugens* Wied. seems to be an extreme form in which the abdomen is practically all dark; specimens approaching this form, which is the same as *C. ultima* Whitney, have been collected on Long Island. This subspecies should not be confused with *C. lugens* of authors which is now known as *C. dacne* Philip. It should also be noted that for many years the name *obsoleta* was applied to the species we now know as *C. wiedemanni* Kröber and during this time the name *C. morosus* was used for the species under discussion. *C. morosus* is a synonym of the typical form of *C. obsoleta* Wied.

The larvae of *C. obsoleta* have been found in very wet situations in salt marshes.

Chrysops parvula Daecke

Small (6.5 mm.); very dark brown or black; no pale stripe above wing base; first basal cell infuscated; apical spot very broad; legs mostly dark. Male wing completely infuscated with pattern showing as a darker area; both basal cells completely infuscated.

This species is reported from Callicoon in the State List but the writer has been unable to find the specimen on which the record is based. Since *C. parvula* is found in the New Jersey pine barrens it may be found in similar situations on Long Island.

Chrysops pikei Whitney (Fig. 36)

Rather small (7 mm.); yellow and black; thorax greenish yellow in ground color; abdomen with black stripes, the sublateral ones quite short; first basal cell infuscated; fifth posterior cell mostly hyaline; apical spot broad; hyaline triangle rounded above; frontal callus black. Male with second basal cell partly infuscated.

As indicated on the map, this species has been collected only in the northwestern portion of the State. It probably is a recent addition to the New York fauna since no specimens have been found in any of the early collections made in the area. Since it is not found in numbers in New York, it is of little economic importance but in the midwest and south it is reported as a persistent biter, usually attacking the ears of domestic animals.

In New York it flies from June through August but most records are for July.

The larvae are found in the banks of ponds and streams.

Chrysops pudica Osten Sacken (Fig. 37)

> Moderate in size (7.5 mm.); black and yellow; abdominal markings not in the form of stripes; both basal cells hyaline; apical spot narrow. Male with both basal cells partly infuscated.

Although occasionally collected at inland localities, this species is most common along the coast. In New York, all records but one are from Long Island and Staten Island. Although occasionally found in some numbers, it is not often abundant enough to be considered a pest.

New York records extend from April to September but most specimens were collected in June and July.

Chrysops sackeni Hine (Fig. 38)

> Moderate in size (8.5 mm.); black and yellow; abdominal markings not in form of stripes; both basal cells hyaline; apical spot narrow but at its origin slightly wider than marginal cell. Male usually with pale markings less extensive; both basal cells partly infuscated.

This species is most abundant in the western and southeastern portions of the State. Although not usually as abundant as the related *C. callida* it sometimes is found in sufficient numbers to be classified as a pest.

C. sackeni often flies with *C. callida* and occasional specimens are difficult to separate from that species. In cases of doubt, the shape of the frontal callus is usually the best character; the callus of *C. callida* is very narrow and is always black whereas in *C. sackeni* it is higher in proportion to its width and often yellow or brown. In coastal areas some specimens are close to *C. dimmocki, pudica* and other species of this group; in addition to the characters given in the key, *C. sackeni* has a row of sublateral spots on the venter of the abdomen which are rarely found in related species except in *C. callida* where it is a variable character. *C. sackeni* shows considerable variation in body and leg coloration and in the width of the apical spot.

This species is most abundant in late June and early July and specimens are rarely seen after August first.

The larvae have been collected in mud on the edges of permanent and temporary ponds and in organic material on the edge of salt marshes.

Chrysops sequax Williston

> Moderate in size (8.5 mm.); yellow and black; thorax greenish in

ground color; 4 black stripes run the length of the abdomen; first basal cell infuscated; fifth posterior cell often partly infuscated; apical spot broad; hyaline triangle narrowed above; frontal callus black. Male darker than female; second basal cell about half infuscated.

Although this species has been recorded from neighboring States, the accuracy of these records is questionable and it is doubtful if it is found in New York. Specimens from New York determined as *C. sequax* all seem to be *C. beameri* or *C. hinei*.

Chrysops shermani Hine (Fig. 39)

Rather large (9 mm.); yellow and black; abdominal pattern usually in form of stripes on a yellow background but there is a tendency for stripes to unite reducing yellow to a narrow median stripe and sublateral patches; wing pattern interrupted by hyaline areas along veins. Male differs from female only in sex characters.

This species with its fenestrate wings is not likely to be confused with any other species found in New York. This species is not represented in any of the early collections studied by the writer and it is possible that it has extended its range into the State in relatively recent years. Although considered a rare species it is now found in most of the mountainous areas of the State and in Allegheny State Park (New York) it is the most abundant and annoying deerfly in late June and July. The writer has seen it in numbers attempting to bite during a heavy rain. It is an aggressive species and attacks with a loud buzzing sound.

C. shermani is most abundant in late June and July and is found into August. The writer has seen a single specimen which was collected at Marcy Dam, Essex County on September 3rd.

Chrysops sordida Osten Sacken (Fig. 40)

Moderate in size (8.5 mm.); black; abdomen with small pale median triangles; tergites with narrow pale hind margins and a pale area laterally on the second or first and second; first basal cell about one half and second about one sixth infuscated; apical spot absent or present as an indefinite dark area. Male much darker; both basal cells almost entirely infuscated; apical spot more distinct than in female.

This northern form is confined to the higher Adirondacks and probably reaches its southern limit of distribution in this area. A record in the State List for western New York probably is an error. The coloration of the apical portion of the wings of this species is variable since sometimes this area is clear and in other specimens there is an indication of an apical spot.

Nothing is known of the biology of *C. sordida* and since most records are based on single specimens or short series, it probably is of slight economic importance. It has been collected in June, July and August, most of the records being in June.

Chrysops striata Osten Sacken (Fig. 41)

Moderate in size (8 mm.); yellow and black; thorax greenish in ground color; black stripes on abdomen, the median pair usually united on second tergite; first basal cell infuscated; fifth posterior cell mostly hyaline; apical spot broad but usually only about half filling second submarginal cell; frontal callus usually black or brown. Male with yellow areas reduced; second basal cell largely infuscated.

An examination of many of the specimens on which records in the State List are based show them to be *C. aberrans* and all records which the writer has been unable to confirm are omitted from the map. *C. striata* often flies with *C. aberrans* and resembles this species but the two forms may be separated by the characters given in the key. It seems to be somewhat less common than *C. aberrans* and like that species is most common in the cat-tail swamps along the shore of Lake Ontario.

It flies from June until late August and is most abundant in July.

Larvae have been collected in mud on the edge of ponds and in sandy soil swept by tides. It probably also breeds in the swamps where the adults are common.

Chrysops univittata Macquart (Fig. 42)

Moderate in size (7.5 mm.); yellow and black; thorax greenish gray in ground color; abdomen with yellow median stripe between 2 black stripes of varying width, laterally yellow; first basal cell infuscated; fifth posterior cell mostly hyaline; apical spot very broad; hyaline triangle small and irregular in outline; frontal callus black or dark brown. Male with broader black abdominal stripes; second basal cell half or more infuscated.

This is a common species in many parts of the State but has not been collected on the flat Ontario Plain west of the Genesee River and in general is rarely seen within twenty miles of Lake Ontario. In western New York it is largely restricted to hilly areas but in southeastern New York and Long Island it is generally distributed. On Long Island it is sometimes extremely abundant and during its flight season is a pest of humans and animals.

C. univittata flies from June until early September but is most abundant from late June through July.

The larvae have been collected in mud and plant debris from the edges of ponds and streams.

Chrysops vittata Wiedemann (Fig. 43)

Moderate in size (8 mm.); yellow and black; thorax yellow in ground color; black stripes on abdomen; first basal cell infuscated; fifth posterior cell largely infuscated; apical spot broad; frontal callus yellow. Male with yellow areas reduced; second basal cell largely infuscated.

This is the commonest deerfly in New York and there probably is no portion of the State where it is not seen. Although found in almost any habitat, the adults are most abundant in low lying wooded areas. It is a severe pest of livestock throughout the State but seems to show a definite preference for humans.

In upstate New York it flies from mid June until early September but is most numerous during July and early August. On Long Island is has been collected into October.

The larvae have been collected in wet soil and plant debris from the edges of streams, ponds and lakes as well as from saturated soil under trees.

Chrysops wiedemanni Krober (Fig. 44)

> Rather small (7 mm.); black or dark brown; abdomen with a median yellowish stripe and sometimes similar shorter sublateral stripes; both basal cells hyaline; apical spot broad and nearly separated from crossband. Male with first basal cell infuscated.

As indicated on the map this species is found throughout New York. It is often common enough to be considered a pest but never seems to reach the abundance found in *C. univittata* and *C. vittata*. Unlike most deerflies it is quiet in its attack and it has been the writer's experience that humans are more likely to be bitten by this species than by any other. Often the first indication of its presence is a sharp pain back of the ear or on the cheek; these two spots seem to be favorite points of attack. It is partial to wooded areas.

The body coloration of *C. wiedemanni* is very variable. The abdominal pattern varies from three distinct yellow stripes to only a trace of a median stripe. For many years this species was called *C. obsoleta,* a name properly belonging to a quite unrelated species.

This species is found from late May until early September but it is most abundant in July and early August.

The larvae have been found in wet soil and plant debris on the edge of both sluggish and swift streams, in mud at the edge of ponds and lakes and in marshes.

CHRYSOZONA Meigen

The name *Haematopota* Meigen is often used in the literature for this genus. No representatives of the genus have been reported from New York. *Chrysozona rara* (Johnson) has been collected in New Jersey and Pennsylvania but appears to be quite rare. It is probable that it will be collected eventually in southeastern New York and on Long Island.

C. rara is about the size of a small *Chrysops* and is distinguished from all other northeastern Tabanidae by the gray and white lace-like wing pattern.

DIACHLORUS Osten Sacken

Diachlorus ferrugatus (Fabricius) is found as far north as New Jersey and may eventually be collected on Staten Island or Long Island. Although it is in a different subfamily, it looks much like a *Chrysops* in general appearance. It is an annoying pest of man and animals in some of the southern states.

MICROTABANUS Fairchild

This genus contains a single species *M. pygmaeus* (Williston) which is rare throughout its range. A male of this species labeled "Erie Co., N.Y." is in the collection of Dr. C. B. Philip and has been studied by the writer. It matches quite well males of this species in the writer's collection from Florida and North Carolina. Unless an error in labeling is involved, it appears that this species is found in New York although previously it has not been recorded north of Delaware.

ATYLOTUS Osten Sacken

Four species of this genus are found in New York. All of them are rather small hairy insects of little economic importance. Although most specimens are easily placed to species, apparent intergrades are not uncommon and make definite determinations difficult.

KEY TO THE SPECIES OF NEW YORK *ATYLOTUS*

1. Pleural hairs bright yellow; basal portion of third antennal segment about as broad as long .... **bicolor** (Wied.)
   Pleural hairs gray; basal portion of third antennal segment variable, slender to broad 2
2. Hair of abdomen white; basal portion of third antennal segment stout with dorsal angle usually near middle of length; frons of female moderate in width **ohioensis** (Hine)
   Hair of abdomen yellow; basal portion of third antennal segment with dorsal angle basad of middle, shape variable, often somewhat slender; frons of female rather narrow 3
3. Abundant black hair on palpi and prescutal lobe; abdomen in female dark brown, narrowly yellowish on sides of first two tergites; hair of venter often white on first two segments; genae yellowish at least on upper portions **pemeticus** (Johns.)
   Only scattered black hairs on palpi and prescutal lobe; abdomen in female usually fuscous in center, broadly yellowish on sides; hair of venter mostly yellow; genae gray with gray hairs .... **thoracicus** (Hine)

Atylotus bicolor (Wiedemann) (Fig. 45)

> Small to moderate in size (11 mm.); yellow or light orange; abdomen with a median indefinitely outlined dark area; wings hyaline, costal cell hyaline or pale yellow; eyes hairy. Male eye facets differentiated; eyes hairy.

This species does not seem to be common although it is widely distributed. *A. bicolor* has been collected flying around livestock in New York but the writer has never observed it actually sucking blood. If it does occasionally attack animals, it is of minor importance. The adult is found in June, July and August with most collections being in July.

The larvae of *A. bicolor* have been collected from such diverse habitats as the muddy banks of ponds and streams, wet sod and from sod in salt marshes. Adults are often collected in sphagnum bogs so it is likely that the larvae are also found in sphagnum.

Atylotus ohioensis (Hine) (Fig. 46)

> Small in size (9 mm.); grayish black; abdomen often grayish laterally on first 2 tergites; wings hyaline, costal cell sometimes faintly tinged with yellow; eyes hairy. Male eye facets differentiated; abdomen laterally with a more extensive pale area than in female; eyes hairy.

A. ohioensis is the only *Atylotus* which on several occasions has been observed attacking man and animals in New York. It has been collected while feeding on cows and attacks man much like *Chrysops*. A few specimens have been collected in June but the majority of records are in July.

Larvae of this species have been collected in saturated pasture sod but since it, like other members of the genus, are commonly found in sphagnum bogs it is likely that the larvae will also be found in sphagnum.

Atylotus pemeticus (Johnson) (Fig. 47)

> Small to moderate in size (11 mm.); dark yellowish brown; abdomen usually paler laterally; wings hyaline, costal cell pale yellow; eyes hairy. Male eye facets differentiated; abdomen laterally often more extensively pale than in female; eyes hairy.

This species seems to be the rarest *Atylotus* found in New York. Except for one Long Island record in late June and another in early August, all collection records are in July. Occasional specimens are collected in sphagnum areas in association with *A. thoracicus* and others have been found in non-sphagnum marshes.

Nothing seems to be known of the early stages of *A. pemeticus*.

Atylotus thoracicus (Hine) (Fig. 48)

> Small in size (10 mm.); dull yellowish; abdomen with a median indefinitely outlined dark area which is broader posteriorly; wings hyaline, costal cell pale yellow; eyes hairy. Male eye facets differentiated; eyes hairy.

This species is closely related to *A. pemeticus* but most specimens may be separated by the characters given in the key. However, the line of demarcation between the two forms is not distinct and further study will be necessary to clarify it.

Although not a common species, *A. thoracicus* is sometimes found in relatively large numbers in sphagnum bogs and in such situations the males are as common as females. The flight of this species is weak and when disturbed it rarely flies more than a few yards. The species may be abundant in local areas but there are no reports of this species attempting to bite.

Almost all collection records are in July with a very few August records. Nothing is known of the biology of this species but the larvae probably are found in sphagnum.

TABANUS Linnaeus

The major pests of livestock belong to this genus, which includes some of the largest flies found in New York. Some species are irritating to humans under certain conditions. They are commonly called Horseflies and some species for obvious reasons Greenheads.

For the purposes of this paper it was considered best to retain in *Tabanus* most of the species placed there by earlier workers. Many attempts have been made to split *Tabanus* into a number of genera but the intergradation of characters has led to confusion when the World fauna is taken into consideration. *Tabanus,* in spite of its somewhat unwieldy size as a genus, is rather homogeneous and the writer prefers to adopt a conservative attitude toward splitting it.

There is considerable justification for considering those species with hairy eyes and an ocellar tubercle as distinct. Of late years the most commonly used name for this group is *Hybomitra* Enderlein used either in the generic or subgeneric sense. However, these two characters do not always go together. In the New York fauna *T. cinctus* and *T. difficilis* have practically bare eyes but both possess an ocellar tubercle; *T. reinwardtii* has bare eyes in the female and hairy eyes in the male and lacks an ocellar tubercle. Some nearctic species have hairy eyes in both sexes but lack an ocellar tubercle.

New York species which would fall in *Hybomitra* are *affinis* and its subspecies *aurilimbus, astutus, cinctus, daeckei, difficilis, epistates, frontalis* and its subspecies *septentrionalis, hinei, illotus, lasiophthalmus, metabolus, microcephalus, minusculus, nudus, trepidus, trispilus, typhus* and *zonalis*.

One species, *T. cymatophorus* O.S., recorded in the State List, is omitted. The writer has studied the specimens on which this record was based and they are all *T. reinwardtii*. Two other species, *T. rhombicus* and *T. longus,* are of doubtful occurrence but since the writer has been unable to locate the specimens used for these records, they are included in the key. The writer strongly suspects that the specimen of *T. fulvicallus* from Saranac Lake, now in the collection of The Ohio State University, is the one on which the *T. longus* record is based.

In the brief descriptions of *Tabanus* which precede the discussion of each species, forms averaging under 10 mm. in length are considered small, those from 13 to 17 mm. moderate in size and those 19 mm. or more as large. Characters given for the male include primarily those which are not present in the female or differ from the female. The identity of the male is unknown or doubtful for the following species: *atratus* subsp. *fulvopilosus, fulvicallus* and *longus.*

KEY TO THE SPECIES OF NEW YORK *TABANUS*

I. Females

1. Vertex without an ocellar tubercle; eyes bare or indistinctly hairy 23
   Vertex with an ocellar tubercle; eyes usually distinctly hairy .... (**Hybomitra**) 2
2. Black species with first 3 abdominal segments mostly bright orange .. **cinctus** Fab.
   Abdomen otherwise marked 3
3. Abdomen without median stripe or triangles but with posterior margins of all segments with yellowish or whitish bands .... **zonalis** Kirby
   Abdomen with median markings 4
4. Subcallus denuded and shining 5
   Subcallus pollinose 11
5. Subcallus swollen; whole face below eyes denuded and shining; small species with dark wing markings 6
   Subcallus normal; face below eyes not shining 7
6. Basal portion of third antennal segment orange; wing markings faint **hinei** John.
   Basal portion of third antennal segment mostly black; wing markings distinct **hinei** subsp. **wrighti** Whitn.
7. Abdomen broadly orange-brown laterally, the median black area usually constricted on the third segment 8
   Abdomen not broadly orange-brown laterally, if paler laterally the median dark area on the third segment is broad and not constricted 9
8. Basal callus shiny and protuberant; all cross veins strongly spotted with brown **lasiophthalmus** Macq.
   Basal callus flat and wrinkled; spots on cross veins if present not clear cut and distinct .... **nudus** McD.
9. Eyes apparently bare; basal portion of third antennal segment narrow; abdomen brownish, faintly reddish-brown laterally and with a median row of indistinct whitish triangles .... **difficilis** Wied.
   Eyes hairy and not with above combination of characters 10
10. Bifurcation of third longitudinal vein with a distinct brown spot; third antennal segment stout with distinct dorsal excision; prescutal lobe orange-brown **metabolus** McD.
    Bifurcation without a distinct spot; third antennal segment rather slender; prescutal lobe black .... **rhombicus** O.S.
11. (4) Abdomen broadly orange-brown laterally, the median black area usually constricted on the third segment 12
    Abdomen not as above, if paler laterally median dark area of third segment is broad and not constricted 16
12. Second palpal segment stout, especially at base 13
    Second palpal segment slender 14
13. Frons about 5 times as high as width at base, widened above; basal portion of third antennal segment mostly orange and about two thirds as wide as long **epistates** O.S.
    Frons about three and one half times as high as width at base, almost parallel sided; basal portion of third antennal segment usually at least half black and about as wide as long (coastal form) .... **daeckei** Hine
14. Second palpal segment unusually slender, at least 5 times as long as greatest width; basal portion of third antennal segment about four fifths as wide as long and annulate portion rather short; hind tibial fringe black .. **trepidus** McD.
    Second palpal segment moderately slender, not more than 4 times as long as greatest width; basal portion of third antennal segment not more than three fifths as wide as long and annulate portion relatively long; hind tibial fringe usually black but sometimes extensively yellow 15
15. Basal callus quadrangular, rarely joined to median callus; basal portion of third antennal segment rather deeply excised; palpi yellowish white, about 3 times as long as greatest width .... **affinis** Kirby

Basal callus rounded above and often joined to median callus; basal portion of third antennal segment rather slender and not deeply excised; palpi yellow, three and a half to 4 times as long as greatest width **affinis** subsp. **aurilimbus** Stone

16. Abdomen black with a median row of distinct white triangles and no sublateral spots .... **trispilus** Wied.
Abdomen otherwise marked 17

17. Second palpal segment slender, scarcely thickened at base 18
Second palpal segment stout, especially so at base 20

18. Femora, except base of hind femora, brown; sides of abdomen reddish brown **minusculus** Hine
Femora black 19

19. Prescutal lobe reddish; third antennal segment not especially slender; hair of palpi short and even .... **typhus** Whitn.
Prescutal lobe black; third antennal segment slender; hair of palpi long and uneven .... **astutus** O.S.

20. Bifurcation of third longitudinal vein with a distinct spot; third antennal segment stout .... **illotus** O.S.
Bifurcation without a distinct spot; third antennal segment more slender 21

21. Legs nearly uniformly brownish, rarely femora somewhat darker; third antennal segment very slender .... **microcephalus** O.S.
Femora black or grayish 22

22. Sublateral abdominal spots yellow, large and contiguous .... **frontalis** Wlk.
Sublateral spots if present grayish, small and not contiguous **frontalis** subsp. **septentrionalis** Lw.

23. (1) Abdomen unicolorous or with narrow indistinct posterior bands 24
Abdomen with one or more median triangles or a median stripe 31

24. Subcallus denuded; body and wings entirely or almost entirely black; abdomen often with a whitish bloom 25
Subcallus not denuded; wings at least partly hyaline 27

25. Mesoscutum with orange hair laterally .... **atratus** subsp. **fulvopilosus** John.
Mesoscutum entirely black 26

26. Wing uniformly dark brown to black .... **atratus** Fab.
Wing brown with a yellowish tinge along posterior border **atratus** subsp. **nantuckensis** Hine

27. Palpi dark brown to black 28
Palpi pale to reddish brown 30

28. Mesonotum dark brown .... **nigrescens** Palisot
Mesonotum white pollinose 29

29. Frons orange brown, moderate in width; wing veins not margined with brown although darker clouds may be present .... **stygius** Say
Frons gray, broad; wing veins margined with brown .... **subniger** Coqu.

30. Wing hyaline with dark brown costal cell; abdomen usually with narrow gray posterior bands .... **americanus** Forster
Wing uniformly dilutely infuscated; costal cell yellow; abdomen sometimes with traces of small median triangles .... **calens** L.

31. (23) Abdomen with a longitudinal median stripe which may or may not be somewhat widened at posterior margins of segments 32
Abdomen with median markings not forming an uninterrupted stripe 41

32. Lateral markings forming a stripe on each side of median stripe and parallel to it but often shorter than median stripe; spots forming median stripe nearly parallel sided 33
Lateral markings broken into separate, often roundish spots; spots forming median stripe usually widened at posterior margins of abdominal segments 37

33. Prescutal lobe usually paler than mesonotum; frons widened above; annulate portion of third antennal segment usually shorter than basal portion; costal cell usually hyaline; eye in life with 2 purple bands 34
Prescutal lobe concolorous with rest of mesonotum; frons nearly parallel sided; annulate portion of third antennal segment usually longer than basal portion; costal cell infuscated; eye in life with a single purple band 36

34. Scutellum and thorax concolorous .... **lineola** Fab.
Scutellum reddish, sometimes faintly, on posterior margin 35

35. Legs predominantly reddish .... **lineola** subsp. **scutellaris** Wlk.
Femora of at least fore and hind legs darkened .. **vittiger** subsp. **schwardti** Philip

36. Costal cell deep yellow; thorax bright yellow pollinose; palpi yellow **quinquevittatus** Wied.
Costal cell usually weakly colored; thorax grayish; palpi whitish **nigrovittatus** Macq.

37. Frons narrow, widened above 38
Frons broader, parallel sided 39

38. Gray-brown species; costal cell hyaline; basal portion of third antennal segment very narrow, dark yellow-brown; palpi white .... **sackeni** Fairch.
Yellowish species; costal cell colored; basal portion of third antennal segment broader, bright orange; palpi yellow .... **fulvulus** Wied.

39. Second palpal segment much swollen basally; median abdominal stripe broad **sagax** O.S.
Second palpal segment not very swollen basally; median abdominal stripe narrow 40

40. Pale markings of abdomen yellowish brown, the sublateral spots touching the hind margins of the segments .... **sublongus** Stone
Pale markings grayish, the sublateral spots small and separated from the hind margins .... **longus** O.S.

41. (31) Thorax white pollinose; abdomen dark with white triangles .. 42
Thorax not white or contrasting strongly with the abdomen 43

42. Large white triangles on third, fourth and fifth abdominal segments; fore tibiae bicolored .... **trimaculatus** Palisot
Small white triangles on the second to sixth abdominal segments; fore tibiae essentially unicolorous .... **superjumentarius** Whitn.

43. Abdomen with both median and sublateral spots 44
Abdomen without sublateral spots although abdomen may be paler laterally 52

44. Bifurcation of third longitudinal vein with a dark spot; grayish species . 45
Bifurcation without a dark spot; color variable 46

45. Median and sublateral spots broadly joined along base of abdominal segments; frons narrow, basal callus higher than wide .... **cymatophorus** O.S.
Median and sublateral spots narrowly or not at all joined along base of abdominal segments; frons broad, basal callus almost square .... **reinwardtii** Wied.

46. Small species, usually 12 mm. or less; frons widened above; costal cell hyaline 47
Larger species, usually 13 mm. or more and differing in at least one other character from above 49

47. Median callus large; palpi not swollen basally or sharply pointed; eye in life with 2 purple bands .... **pumilus** Macq.
Median callus slender; palpi swollen basally but with apex acute; eye in life unicolorous or with a single purple band 48

48. Eye unicolorous .... **sparus** Whitn.
Eye with a single purple band .... **sparus** subsp. **milleri** Whitn.

49. First antennal segment swollen above; sides of subcallus with a few hairs laterally **fairchildi** Stone
First antennal segment not swollen above; sides of subcallus without hairs 50

50. The sublateral white abdominal spots considerably larger than the small median triangles and usually reaching anterior border of second and third segments **nivosus** O.S.
The median triangles are relatively larger and sublateral spots smaller rarely extending to anterior border of segments 51

51. Vertex depressed with a swollen adjacent area; frons about 4 times as high as wide; last antennal annulus yellow; median triangle of third abdominal segment narrowly reaching anterior margin .... **fulvicallus** Philip
Vertex slightly depressed or flat; frons about three and one half times as high as wide; last antennal annulus black; median triangle of third abdominal segment not reaching anterior margin .... **vivax** O.S.

52. (43) Bifurcation of third longitudinal vein with a brown spot 53
Bifurcation without a brown spot although veins may have indistinct brown margins 55

53. Fore tibiae unicolorous; median abdominal spots long and narrow **recedens** Wlk.
Fore tibiae bicolored, the basal portion pale 54

54. Frons narrow, 5 times or more as high as wide; first posterior cell normally closed; all femora black . . . . **abdominalis** Fab.
Frons moderately wide, about 4 times as high as wide; first posterior cell normally open although often much narrowed at margin; at least middle femora brownish **sulcifrons** Macq.
55. Wings with a smoky tinge; costal cell heavily colored; large species with median triangles small or obsolete 56
Wings hyaline; costal cell hyaline or slightly tinted; smaller species with conspicuous median triangles 58
56. Fore tibiae bicolored . . . . **novae-scotiae** Macq.
Fore tibiae unicolorous 57
57. Third antennal segment reddish yellow; median abdominal triangles faint and arising from faint posterior bands; first posterior cell narrowed toward margin **calens** L.
Third antennal segment partly black; median triangles small but distinct and not arising from bands; first posterior cell not narrowed . . . . **catenatus** Wlk.
58. At least fore tibiae bicolored; first posterior cell much narrowed and sometimes closed at wing margin; subcallus pollinose; usually over 15 mm. **melanocerus** Wied.
Tibiae unicolorous although fore tibiae may be slightly paler at base; first posterior cell slightly or not at all narrowed at margin; subcallus thinly pollinose or denuded; usually under 15 mm. . . . . **nigripes** Wied.

KEY TO THE SPECIES OF NEW YORK *TABANUS*

II. Males

1. Stiff hairs along mid line between eyes . . . . **difficilis** Wied.
No stiff hairs along mid line between eyes 2
2. Eyes hairy 3
Eyes bare 27
3. Black species with first 3 abdominal segments mostly bright orange . . **cinctus** Fab.
Abdomen otherwise marked 4
4. Abdomen without median stripe or triangles but posterior margins of segments with yellowish or whitish bands . . . . **zonalis** Kirby
Abdomen with median markings 5
5. Small dark species with gray, protuberant frontal triangle; genae black, somewhat shining; a dark cloud on wing near stigma 6
Differing in one or more characters from the above 7
6. Basal portion of third antennal segment mostly orange; wing markings faint **hinei** John.
Basal portion of third antennal segment mostly black; wing markings distinct **hinei** subsp. **wrighti** Whitn.
7. Cross veins and bifurcation of third longitudinal vein with distinct dark spots . 8
Wings hyaline, tinted or with bifurcation only having a dark spot 9
8. Rather large grayish species with 3 rows of gray triangles on abdomen **reinwardtii** Weid.
Blackish species; sides of first 3 abdominal segments broadly orange **lasiophthalmus** Macq.
9. Abdomen with a conspicuous parallel sided median longitudinal white stripe and a similar stripe on each side of it . . . . **vittiger** subsp. **schwardti** Philip
Abdomen without a conspicuous parallel sided median stripe 10
10. First antennal segment strongly swollen above; hair on eyes sparse **fairchildi** Stone
First antennal segment not swollen above; hair on eyes usually heavy . . 11
11. Abdomen black, obscurely reddish laterally but no distinct sublateral spots; a conspicuous row of white median triangles . . . . **trispilus** Wied.
Abdomen otherwise marked 12
12. Small species not over 12 mm. with very small slender second palpal segment; sides of abdomen broadly dark orange but first segment usually completely black; third antennal segment with a very shallow dorsal excision . . . . **minusculus** Hine
Species usually over 12 mm. or if smaller, second palpal segment stout and dorsal excision distinct 13

13. Prescutal lobe black 14
Prescutal lobe reddish at least on disc 16
14. Femora brown .... **microcephalus** O.S.
Femora black 15
15. Second palpal segment stout, blunt; thorax black, somewhat shining **rhombicus** O.S.
Second palpal segment small, not much larger than first segment; thorax dull **astutus** O.S.
16. Abdomen broadly orange-brown laterally, median black area constricted on third abdominal segment 17
Abdomen not broadly orange laterally; orange sublateral spots may be present but black area on the third segment is not constricted 25
17. Median black area of abdomen vary narrow and usually finely divided by a narrow, pale longitudinal line; a large square dark area reaches completely across second abdominal sternite .... **daeckei** Hine
Median black area variable, not divided by a pale line 18
18. First abdominal sternite almost entirely black or with a small orange area sublaterally 19
First sternite orange, occasionally with a small dark area in the center 22
19. Frontal triangle protuberant; base of third antennal segment rather stout; palpi very stout, grayish brown; anterior portion of wing often infuscated along veins, in basal cells and at bifurcation of third longitudinal vein; costal cell tinted .. 20
Frontal triangle rather flat; base of third antennal segment slender; palpi moderately stout, yellowish brown; wing often dilutely infuscated but without intensification in anterior portion; costal cell dilutely tinted or clear 21
20. Claws of fore tarsi subequal; median black area of abdomen rather broad **metabolus** McD.
Outer claw of fore tarsi longer than inner claw; median black area of abdomen rather narrow .... **nudus** McD.
21. Hairs of venter of abdomen black with many golden yellow hairs on second, third and fourth sternites .... **frontalis** Wlk.
Hairs of venter mostly black with some pale hairs intermixed; paler on incisures; median black area of abdomen somewhat wider than in typical form **frontalis** subsp. **septentrionalis** Lw.
22. Third antennal segment including annuli reddish; second palpal segment very stout, only slightly longer than thick .... **epistates** O.S.
Third antennal segment with at least annuli black; second palpal segment moderately stout to slender 23
23. Large and small eye facets differentiated; second palpal segment at least twice as long as thick; usually under 15 mm. .... **trepidus** McD.
Almost no differentiation in size of eye facets; usually 16 mm. or more; second palpal segment variable 24
24. Second palpal segment yellowish white, about one and a half times as long as thick; base of third antennal segment distinctly excised .... **affinis** Kirby
Second palpal segment yellow, about twice as long as thick; base of third antennal segment slender and shallowly incised; median black area of abdomen usually much reduced .... **affinis** subsp. **aurilimbus** Stone
25. Second palpal segment slender, twice as long as thick; areas of large and small eye facets sharply differentiated .... **typhus** Whitn.
Second palpal segment robust, less than twice as long as thick; eye facets nearly uniform in size 26
26. Costal cell deeply tinted; claws of fore tarsi subequal; entire insect rather shining **metabolus** McD.
Costal cell moderately tinted; outer claw of fore tarsi about one third longer than inner claw .... **illotus** O.S.
27. (2) Abdomen unicolorous or with narrow indistinct pollinose bands 28
Abdomen with median markings 34
28. Palpi orange brown to yellow 29
Palpi dark brown to black 30
29. Wing dilutely infuscated, costal cell darker; hind tibial fringe black .... **calens** L.
Wing hyaline, costal cell deep yellow; hind tibial fringe orange **americanus** Forster

30. Wing heavily infuscated 31
Wing dilutely infuscated or clear, a black spot at bifurcation of third longitudinal vein 32
31. Wing completely black . . . . **atratus** Fab.
Wing brownish to black with a yellowish tinge along posterior border **atratus** subsp. **nantuckensis** Hine
32. Lower margin of area of large facets of eye somewhat sinuate and at lowest point about on level with top of antennal pits . . . . **subniger** Coqu.
Lower margin of large facets more nearly straight and somewhat higher than antennal pits 33
33. Integument of thoracic dorsum brown, contrasting strongly with black abdomen; wing membrane, except for spots, rather uniformly dilutely infuscated **stygius** Say
Integument of thoracic dorsum dark brown to black, usually contrasting but slightly with black abdomen; apex of wing, except for spots, almost hyaline **nigrescens** Palisot
34. Abdomen with a longitudinal stripe which may or may not be somewhat widened at posterior margins of segments 35
Abdomen with median markings not forming an uninterrupted stripe 42
35. Lateral markings of abdomen forming a stripe on each side of median stripe and parallel to it but usually shorter than median stripe; spots forming median stripe nearly parallel sided 36
Lateral markings broken into separate often roundish spots; spots forming median stripe usually wider at posterior margin of each segment 39
36. Prescutal lobe usually paler than mesonotum; annulate portion of third antennal segment usually shorter than basal portion; costal cell usually hyaline 37
Prescutal lobe usually concolorous with mesonotum; annulate portion of third antennal segment as long or longer than basal portion; costal cell infuscated . . 38
37. Scutellum and thorax concolorous . . . . **lineola** Fab.
Scutellum reddish, sometimes faintly, on posterior margin **lineola** subsp. **scutellaris** Wlk.
(If upper eye facets enlarged and femora dark see **vittiger** subsp. **schwardti**—Couplet 9)
38. Palpi and pleura deep yellow; costal cell heavily infuscated . . **quinquevittatus** Wied.
Palpi white, pleura grayish; costal cell lightly infuscated . . . . **nigrovittatus** Macq.
39. Hair and pollen of pleura yellow; area of large and small eye facets scarcely differentiated . . . . **fulvulus** Wied.
Hair and pollen of pleura gray; area of large and small facets distinctly differentiated 40
40. Hair of thoracic dorsum gray; sublateral abdominal spots grayish; costal cell hyaline . . . . **sackeni** Fairch.
At least short hairs of thoracic dorsum yellow; sublateral abdominal spots yellow; costal cell tinted 41
41. Median abdominal stripe broad; face below eyes with many black hairs, beard yellowish white; second palpal segment stout, yellow brown with many black hairs . . . . **sagax** O.S.
Median abdominal stripe narrow; face with almost no black hairs, beard pale gray; second palpal segment relatively slender, pale yellowish white with few black hairs . . . . **sublongus** Stone
42. Abdomen with median spots or triangles and at least some tergites with sublateral spots 43
Abdomen with median spots or triangles; no distinct sublateral spots although some tergites may be paler laterally 49
43. First antennal segment swollen above; third antennal segment entirely black; eyes sometimes with sparse hairs . . . . **fairchildi** Stone
First antennal segment not swollen; third antennal segment variable; eyes bare . . 44
44. Bifurcation of third longitudinal vein and cross veins with brown spots **cymatophorus** O.S.
Wings hyaline or with a faint spot at bifurcation 45
45. Fore tibiae entirely black; sublateral spots very large often crossing second and third tergites; third antennal segment black . . . . **nivosus** O.S.
Fore tibiae paler at base; sublateral spots smaller rarely crossing any tergite; third antennal segment not entirely black 46

46. Moderate sized species, 14–15 mm.; second palpal segment yellow brown about twice as long as wide; median triangles fairly large, sometimes crossing tergite; sublateral spots reaching posterior margin of at least second tergite; costal cell somewhat tinted .... **vivax** O.S.
   Small species, usually under 11 mm. second palpal segment whitish, less than twice as long as thick; median triangles small, never crossing tergite; sublateral spots small, rarely reaching posterior margins of tergites; costal cell hyaline 47
47. Tibiae same color as reddish brown to brown femora or slightly paler basally; antennae yellowish often with annulate portion somewhat darker; basal portion of third antennal segment 2 and one half to 3 times as long as wide; occipital tubercle prominent and often projecting above level of eyes ..... **pumilus** Macq.
   Tibiae distinctly paler than dark femora except apex of fore tibia which is dark; antennae uniformly dull brownish; basal portion of third antennal segment about twice as long as wide; occipital tubercle inconspicuous and compressed, usually not reaching level of eyes 48
48. Eyes in life without stripes .... **sparus** Whitn.
   Eyes in life with a single purple stripe .... **sparus** subsp. **milleri** Whitn.
49. Pale thorax sharply contrasting with dark abdomen which has distinct white median triangles on the third to fifth tergites; fore tibiae bicolored **trimaculatus** Palisot
   Not with the above combination of characters 50
50. Bifurcation of third longitudinal vein with a brown spot 51
   Bifurcation without a brown spot 53
51. Legs including fore tibiae uniformly brown; abdomen mahogany brown with very narrow alongate median white triangles .... **recedens** Wlk.
   Fore tibiae bicolored or at least paler at base; at least fore femora black; abdominal triangles if present broad 52
52. Pale median abdominal triangles conspicuous; middle femora often brownish; wing membrane lightly tinted .... **sulcifrons** Macq.
   Pale median abdominal triangles obsolete but with heavy median black spots: all femora deep black; wing heavily tinted especially anteriorly .. **abdominalis** Fab.
53. Frontal triangle denuded and somewhat protuberant; abdominal triangles often indistinct; smaller species, usually under 13 mm. .... **nigripes** Wied.
   Frontal triangle not denuded; larger species rarely smaller than 15 mm. and as large as 25 mm. 54
54. Facets of eyes all about same size; median triangles very small ..... **calens** L.
   Upper facets of eye larger than lower facets with line of demarcation distinct . 55
55. Median triangle usually absent from tergite 2 or very small if present; large eye facets occupying about half total eye area .... **superjumentarius** Whitn.
   Median triangle present on tergite 2 and about same size as those on tergites 3 and 4; large eye facets occupying about two thirds of total eye area 56
56. Femora dark brown or black; excision of third antennal segment moderate **melanocerus** Wied.
   Femora orange brown or chestnut brown; excision of third antennal segment deep 57
57. Legs almost uniformly brown, tarsi somewhat darker; genae brown; second palpal segment brown; abdomen uniformly dark brown with small median triangles **catenatus** Wlk.
   Middle and hind tibiae and base of fore tibiae paler than femora; genae grayish; second palpal segment yellow brown; abdomen reddish brown laterally with median triangles on a narrow black stripe .... **novae-scotiae** Macq.

Tabanus abdominalis Fabricius

Fairly large (20 mm.); orange to reddish brown; abdomen with a median row of black spots indented behind by indefinite pale or orange triangles; fore tibiae pale at base; all femora black; wing heavily tinted, with dark spots and dark yellow costal cell, discal cell paler than surrounding membrane; frons very narrow; eyes bare. Male with eye facets differentiated but line of demarcation not very distinct; eyes bare.

This species has not been recorded from New York but since it has been reported from Massachusetts, Connecticut, New Jersey and Pennsylvania, it may be found in the State. All New York specimens determined as *abdominalis* and seen by the writer are actually *T. sulcifrons* in his opinion and it is probable that at least some of the records from the States mentioned above are also *sulcifrons*.

Tabanus affinis Kirby (Fig. 49)

> Moderate in size (18 mm.); brownish; abdomen broadly orange brown laterally; wings usually with a faint tint which becomes heavier along longitudinal viens; costal cell yellow; eyes hairy. Male eye facets scarcely differentiated; eyes hairy.

What the writer considers to be the typical form of this species seems to be restricted to the Adirondack area in New York. In some parts of Canada this species is often abundant and of considerable economic importance but it has not been found in large numbers in New York. It is an early season species with most of the records in June and early July.

Tabanus affinis subspecies **aurilimbus** Stone (Fig. 49)

> Moderate in size (17 mm.); orange brown; abdomen broadly orange brown laterally, sometimes reducing dark median area on second and third tergites to a shadow; wing with a yellowish tint; costal cell dark yellow; eyes hairy. Male eye facets scarcely differentiated; black median area of abdomen more extensive than in most females; eyes hairy.

The writer has believed for some time that most specimens assigned to *affinis* from New York south of the Adirondacks represented a different form. The type of *T. aurilimbus* has a yellow hind tibial fringe but the writer has studied series of specimens showing complete intergradation to a black tibial fringe. It appears that the type of this species is an extreme variant and that specimens close to it in other respects probably belong here. For the present, the writer prefers to consider it a subspecies of *affinis*. In addition to the characters given in the key, *aurilimbus* in series is smaller than *affinis* and although its range is south of *affinis*, it flies later in the season.

Males are often collected hovering on hill tops and in openings in forested areas.

All New York specimens studied were collected in July.

Tabanus americanus Forster (Fig. 50)

> Large (27 mm.); reddish brown; abdomen with narrow pale bands on hind margins of tergites; wings hyaline with dark brown costal cell; eyes bare. Male eye facets distinctly differentiated; eyes bare.

T. americanus is the largest Tabanid found in North America, sometimes reaching a length of 30 mm. Only an occasional specimen is taken in New York although it is a common species in the south. The writer has seen specimens from Southold (Suffolk County), Bronx Park (Bronx County) and Monroe (Orange County), the latter specimen collected in August.

Tabanus astutus Osten Sacken (Fig. 50)

> Moderate in size (14 mm.); brownish black; abdomen with 3 rows of grayish triangles; prescutal lobe dark; wings hyaline, costal cell pale yellow; eyes hairy. Male eye facets scarcely differentiated; pale abdominal markings with an orange cast; eyes hairy.

This species is close to *T. typhus* and the specimens on which the records for *astutus* in the State List are based actually are *typhus*. The only New York specimens of *astutus* which the writer has seen were collected in August at Woodhull Lake (Herkimer County). It is a northern form and probably will be found at other localities in the Adirondacks.

Tabanus atratus Fabricius (Fig. 51)

> Large (24 mm.); black; abdomen sometimes with a whitish or bluish bloom; eyes bare; wings dark brown to black. Male eye facets distinctly differentiated; eyes bare.

This large black horsefly is common over most of New York except in the mountainous areas. Although it rarely appears in sufficient numbers to become a serious pest, its large size and the loud buzzing noise it makes when attacking is very disturbing to horses and cattle. It flies from May to September (October on Long Island) with a maximum abundance in mid summer.

The biology of this species has been studied by a number of workers. The eggs are laid on grass or leaves over marshy areas or streams and the writer has seen oviposition take place on cement bridge abutments. The larvae, which can be found throughout the year, are found in moist earth or in water and appear to tolerate a wide range of moisture conditions. The life cycle normally is completed in one year but some individuals require two years and possibly more.

Tabanus atratus subspecies **fulvopilosus** Johnson (Fig. 52)

> Like typical *atratus* except for orange yellow hair on all or some of the following areas: upper half of prescutal lobe, postalar lobe and a streak above base of wing. Occasional specimens have wings similar to *nantuckensis*.

This and the following subspecies of *T. atratus* seem to be restricted to coastal areas. The male of *fulvopilosus* has not been recognized, but it is possible that males collected at the same time as females of this form but indistinguishable from typical *atratus* males belong here. The amount of orange hairs is quite variable in the female.

Tabanus atratus subspecies **nantuckensis** Hine (Fig. 52)

Like typical *atratus* but averages a little smaller (21 mm.) and wing is yellowish or brown posteriorly.

Apparent intergrades between this form and typical *atratus* are not uncommon. Both forms fly from May until September.

Larvae of *nantuckensis* have been found in mats of plant debris in salt marshes.

Tabanus calens Linnaeus (Fig. 53)

Large (24 mm.); thorax brown with indistinct reddish lines; abdomen blackish, sometimes with faint pale median triangles; eyes bare; wings pale yellowish with costal cell darker. Male eye facets show little differentiation and line of demarcation not distinct; pale median triangles of abdomen when present usually larger than in female; eyes bare.

This large species is not common in New York. It is a late flying form and all collections except a single July record were made in August.

T. calens for many years was unrecognized and the species was called *T. giganteus* Degeer. However, Linnaeus' name seems to be correctly associated with this species (Philip, 1952, p. 311.).

Tabanus catenatus Walker (Fig. 54)

Large (23 mm.); dark reddish brown; abdomen with a median row of small pale triangles; fore tibiae entirely brown; wings pale yellowish, often darkened anteriorly along veins, costal cell deep yellow; eyes bare. Male eye facets distinctly differentiated; thorax and abdomen from reddish brown to very dark brown; median row of abdominal triangles often indistinct; eyes bare.

Although widely distributed, *T. catenatus* never seems to be very common. This species has sometimes been referred to under the name of *T. orion* O.S. *T. catenatus* flies in late July and August.

Tabanus cinctus Fabricius (Fig. 55)

Moderate to large in size (20 mm.); black with an orange band covering most of first three tergites; subcallus partly denuded; wing with dark yellow tint; eyes practically bare. Male eye facets little differentiated; eyes hairy.

It is not likely that this species with its brilliant yellow or orange band on the abdomen will be confused with any other species in New York. *T. criddlei* Brooks, which has been collected in Ontario, is similar but the subcallus is pollinose.

T. cinctus is not a common form. The males are sometimes found hovering in the manner described for *T. affinis* subsp. *aurilimbus*. *T. cinctus* flies from June to August with the majority of the collection records being in July.

Tabanus daeckei Hine

> Moderate in size (12 mm.); brownish; abdomen broadly orange brown laterally and with a faint pale stripe superimposed on a dark median stripe; second palpal segment somewhat swollen at base; wings including costal cell with a uniform yellow tint; eyes hairy. Male eye facets barely differentiated and without distinct line of demarcation; eyes hairy.

This species has previously been reported from Staten Island and the writer has seen a single male and a single female collected June 15 and June 24 respectively at Babylon (Suffolk County). It is a coastal form and probably breeds in salt marshes. In the coastal area of New Jersey and Delaware it is sometimes a serious pest of livestock.

Tabanus difficilis Wiedemann (Fig. 56)

> Moderate in size (13 mm.); dark brown; abdomen rather broad with a median row of inconspicuous pale triangles, obscurely reddish laterally; subcallus denuded; wings hyaline with yellow costal cell; eyes practically bare. Male eye facets scarcely differentiated; a row of stiff black hairs stand erect between eyes; frontal triangle grayish; eyes practically bare.

For many years this species was known as *T. carolinensis* but Macquart's name belongs to another species. It is rarely abundant enough to be a pest but occasionally it appears in local areas in large numbers. Under such circumstances it attacks wild and domestic animals and humans indiscriminately. It is an early season form appearing in late May, most abundant in June and only occasionally found in July.

Tabanus epistates Osten Sacken (Fig. 57)

> Moderate in size (14 mm.); brownish; abdomen broadly orange brown laterally; second palpal segment rather swollen; wings with a faint yellowish tinge which deepens anteriorly to include costal cell; eyes hairy. Male eye facets scarcely differentiated; eyes hairy.

T. epistates is found throughout New York but is rarely found in numbers. It is on the wing from May through August but is most common in June and early July.

Tabanus fairchildi Stone (Fig. 58)

> Moderate in size (14 mm.); blackish brown with three rows of pale spots on abdomen; antennae black with first segment swollen above; eyes bare or with short scattered hairs; wings hyaline. Male eye facets somewhat differentiated but line of demarcation not distinct; eyes often with short scattered hairs but sometimes apparently bare.

This species was long confused with *T. vivax* O.S. which is also found in New York and most references to *T. vivax* previous to 1938 actually refer to *T. fairchildi.* It is not commonly collected and does not seem to be a serious pest of livestock. It is most abundant in June although it is occasionally collected in July and August.

T. fairchildi differs from most Tabanidae in that the immature stages are spent in swift flowing streams. The eggs are placed on projecting stones or logs in riffles and the eggs of many females are often deposited on the same object resulting in an accumulation of several hundreds of egg masses. The larvae are found under stones, often in the swiftest part of the stream. Pupation probably takes place in mud on the edge of the stream.

Tabanus frontalis Walker (Fig. 59)

> Moderate in size (14 mm.); blackish brown; abdomen with faint grayish or yellowish median triangles and yellowish or reddish sublateral spots which, at least on the second and third tergites, reach the hind margins; wing hyaline, costal cell tinged with yellow; eyes hairy. Male eye facets slightly differentiated but line of demarcation indistinct; sublateral abdominal spots usually confluent and often forming a broad sublateral band; eyes hairy.

The writer has seen only 2 specimens of typical *frontalis* from New York. They were collected at Peru (Clinton County) in June and Fargo (Jefferson County) in July.

Tabanus frontalis subspecies **septentrionalis** Loew (Fig. 59)

> Moderate in size (14 mm.); blackish; abdomen with faint pale median triangles and rounded gray or pale grayish yellow sublateral spots which usually do not reach the hind margins of the tergites and often are small and faint; wing hyaline, the membrane sometimes with a brownish tint, costal cell tinted; eyes hairy. Male eye facets slightly differentiated but line of demarcation indistinct; sublateral spots larger and more reddish than in female; eyes hairy.

This form is found only in the northern part of the State where it has been collected in June, July and August.

Both *septentrionalis* and typical *frontalis* are serious pests of livestock and wild animals in many parts of Canada but at the southern portion of their range in New York they are not commonly found.

Tabanus fulvicallus Philip

> Moderate in size (14.5 mm.); dark brown; abdomen with 3 rows of pale spots with median spots reaching length of tergite on third to fifth segments; vertex notched and somewhat swollen; third antennal segment dark brown to black with last annulus orange brown; wings hyaline; eyes bare.

The writer has seen a single specimen of this rare species from New

York. It was collected at Saranac Inn (Franklin County) on July 27, 1900. Since *T. fulvicallus* has been collected in southern Ontario, it may eventually be found in western New York.

Tabanus fulvulus Wiedemann

Moderate in size (14 mm.); yellowish to orange; abdomen with a yellow median line of large contiguous triangles and sublateral yellow spots; frons very narrow and widened above; third antennal segment moderately broad, orange, annuli black; thoracic dorsum without stripes; wings hyaline; eyes bare. Male eye facets differentiated but not markedly so; eyes bare.

This species has not been collected in New York but since it is found in New Jersey it may be present on Long Island or Staten Island.

Tabanus hinei Johnson (Fig. 60)

Small to moderate in size (11 mm.); abdomen shining black with orange laterally; subcallus denuded; wing tinged with yellow, a dark poorly defined band in vicinity of discal cell, costal cell dark yellow; eyes with short hair. Male eye facets little differentiated; frontal triangle prominent, grayish; eyes hairy.

T. hinei is a coastal form which is also found in a small area near the eastern end of Lake Ontario. It is not likely to be confused with any other species found in New York. It flies from June to August with most records in July. It never appears to be abundant.

T. hinei subspecies *wrighti* is a southern form but occasional New York specimens approach it. It may be separated from the typical form by the characters given in the key.

Tabanus illotus Osten Sacken (Fig. 61)

Moderate in size (13 mm.); brownish black; abdomen with faint median triangles and grey or yellowish gray sublateral spots; wings hyaline with pale yellow costal cell and faint brownish spots; eyes hairy. Male eye facets scarcely differentiated; sublateral abdominal spots larger than in female and usually more yellowish; eyes hairy.

T. illotus is a northern form which does not seem to be found in southeastern New York or on Long Island. Although not usually common in New York it is very aggressive and attacks man as well as livestock. The writer once found both sexes in abundance along the shores of Irondequoit Bay (Monroe County) and mating pairs were collected at this time.

The peak abundance of this species is in middle and late June but there are New York records for May and July.

The larvae are found under debris and in moist earth on the edges of ponds and swamps.

Tabanus lasiophthalmus Macquart (Fig. 62)

Moderate in size (14 mm.); brownish; abdomen broadly orange brown laterally; subcallus denuded; wings hyaline or faintly tinted, with conspicuous dark spots and yellow costal cell; eyes hairy. Male eye facets little differentiated; frontal triangle grayish; eyes hairy.

As is indicated on the map, this species is found throughout the State. It is a serious pest of livestock early in the season and is one of the major economic forms in New York. It first appears in late May and reaches its peak in mid June. Occasional specimens are found until early August.

The eggs are laid on various plants over moist ground but not over open water; the egg mass is small and shining black resembling a drop of tar on the leaf. The larvae are found in moist and wet sod. One year is normally required for the life cycle.

Tabanus lineola Fabricius (Fig 63)

Moderate in size (13 mm.); yellowish, brown or nearly black; abdomen with a pale median stripe and variable sublateral stripes; wings hyaline; frons narrow and distinctly widened above; median callus slender; hind femora mostly dark; scutellum entirely dark; eyes bare. Male eye facets distinctly differentiated; eyes bare.

Typical *lineola* is primarily a coastal form in New York being replaced upstate to a large extent by subspecies *scutellaris*. It is a pest of considerable economic importance since it often appears in large numbers and will attack both man and animals. It is often called Greenhead although that name applies to other species as well.

A melanistic variant of *T. lineola* is the form commonly seen in upstate New York. Long Island specimens often are quite pale. It is on the wing from May to October and is most common in June and early July.

The larvae are found in mud on the edges of ponds and streams but occasionally they are discovered in relatively dry areas. Larvae are also found in salt marshes and this species seems to be quite tolerant of varied conditions of moisture and salinity. Its life cycle normally requires one year but its wide seasonal range indicates the possibility that some individuals at least may complete their development in one season in the warmer portions of the State.

Tabanus lineola subspecies **scutellaris** Walker (Fig. 64)

Moderate in size (13 mm.); brownish to almost black; abdomen with a pale median stripe and sublateral stripes; wings hyaline; frons broader than in typical form, widened above; median callus somewhat broadened; hind femora reddish; scutellum reddish brown at tip; eyes bare. Male eye facets differentiated but size difference is small and line of demarcation often indistinct; general color usually brownish; eyes normally bare but sometimes with a few scattered hairs.

This is the common inland form of *T. lineola*. Probably most of the inland records in the State List refer to this subspecies. Although often quite abundant and frequently a pest of livestock, it never seems to reach the abundance of *T. quinquevittatus*. It is found from June into August with its peak in late June and early July filling the gap between the peaks of *T. lasiophthalmus* and *T. quinquevittatus*.

The larvae have been collected from the edges of ponds, in wet sod and in cultivated ground so apparently it is tolerant of a wide range of moisture conditions.

Tabanus longus Osten Sacken

> Moderate in size (14 mm.); dark brown; abdomen with a pale median line of continguous or nearly contiguous triangles and yellowish gray sublateral spots which usually do not touch the hind margins of the tergites; frons moderately broad and parallel sided; third antennal segment fairly slender; wings hyaline; eyes bare.

In the State List this species is reported from Saranac Inn in July but since this is somewhat out of the normal range of the species, the record is doubtful. It is entirely possible that this is the same specimen on which the record of *T. fulvicallus* is based. However, *T. longus* is rare throughout its range and it may possibly be found in New York.

Tabanus melanocerus Wiedemann

> Moderate in size (17 mm.); dark brown to blackish; abdomen with a median row of pale triangles and tergites with narrow, sometimes obsolete, pale bands on the hind margins; fore tibiae pale, dark at apex; wings hyaline or tinged faintly yellowish and costal cell sometimes yellow; eyes bare. Male eye facets distinctly differentiated; eyes bare.

This species has been recorded from Connecticut and New Jersey and the writer expected it would be found on Long Island. However, no specimens were seen until 1953 when a single female was collected by Mr. Roy Latham at Riverhead on June 11. On July 30, 1954 he collected three females and two males at the same locality and since the specimens were teneral there is no doubt that it is established on Long Island.

Tabanus metabolus McDunnough (Fig. 65)

> Moderate in size (13 mm.); brownish black; abdomen with faint median triangles and yellowish sublateral spots on the second, third and fourth tergites; wings hyaline with a dark yellow costal cell, faint brownish spots and a tendency for the veins toward the base of the wings to be outlined in yellowish brown; subcallus denuded; eyes hairy. Male eye facets scarcely differentiated; thorax and abdomen rather shiny; eyes hairy.

This northern form is rare in New York. All New York records are in June.

Tabanus microcephalus Osten Sacken (Fig. 66)

> Moderate in size (14 mm.); grayish black; abdomen with 3 rows of grayish or pinkish gray spots which are largest on the second tergite; legs uniformly brown or reddish; wings hyaline with yellowish costal cell and tendency for veins to be outlined in pale yellow; eyes hairy. Male eye facets scarcely differentiated; sublateral abdominal spots often reddish; eyes hairy.

This species is not common although widely distributed over the State except for the extreme southeastern portion and Long Island. In the writer's experience it usually is found in hilly and mountainous areas. The great majority of the records are in July with a few August finds and one September record.

Tabanus minusculus Hine (Fig. 67)

> Small to moderate in size (11 mm.); rather shining blackish brown; abdomen with considerable orange brown laterally; wings tinted with tendency for veins to be outlined in a deeper tint, costal cell yellow; second palpal segment very slender; eyes hairy. Male eye facets scarcely differentiated; eyes hairy.

All the collections of this small species made by the writer have been in sphagnum bogs. Both sexes, which are found in about equal numbers, make short flights between clumps of vegetation and are easily collected. It is found in July and August.

The larva of this species has been found in sphagnum.

Tabanus nigrescens Palisot de Beauvois

> Large (22 mm.); black; wing pale yellowish with dark spots and dark costal cell and a deeper color in the basal cells and base of discal cell; eyes bare. Male eye facets distinctly differentiated; thorax often with a brownish tinge; eyes bare.

The writer has seen no specimens of this species from New York and has been unable to locate the specimens from Rochester, Nyack and Staten Island on which the records in the State List are based. A record of this species from Lockport published by the writer (1938) actually is *T. stygius*. However, there is no reason to doubt the occurrence of *T. nigrescens* in New York.

Tabanus nigripes Wiedemann (Fig. 68)

> Small to moderate in size (12 mm.); blackish brown; abdomen with a median row of pale triangles and tergites with narrow pale bands on the hind margins; wings hyaline, occasionally with traces of spots and yellow costal cell; subcallus thinly pollinose or partly denuded; eyes bare. Male eye facets distinctly differentiated; frontal triangle prominent, denuded; eyes bare.

This small species is normally found only in the southeastern portion of the State and on Long Island. The writer has also seen specimens collected while feeding on a cow at Ellis Hollow (Tompkins County). For many years this species was called *T. coffeatus* Macquart.

The larvae have been found in salt marshes and along the margins of small streams.

Tabanus nigrovittatus Macquart (Fig. 69)

> Moderate in size (12 mm.); brownish yellow; abdomen with a pale median stripe superimposed on a wider dark stripe, tergites yellowish laterally; pollen of head grayish white, sometimes faintly tinged with yellow; wings hyaline with pale yellow costal cell; frons with sides essentially parallel; eyes bare. Male eye facets distinctly differentiated; eyes bare.

This species is the Saltmarsh Greenhead and is restricted to the coastal area of New York; records in the State List for Ramapo and Gloversville probably are in error. It occurs in great numbers and is of considerable economic importance because of its attacks on man and domestic animals. It is especially attracted to bathers and is a source of considerable annoyance during its flight season, which extends from June to September with a maximum abundance in July and early August.

A considerable amount has been written on the biology and attempted control measures of this species. Most of the larvae are found under marsh straw and mats of other vegetation.

Another "greenhead" *Tabanus lineola* often flies with *T. nigrovittatus* but is readily distinguished in life by two purple eye bands whereas *T. nigrovittatus* has a single eye band.

A larger form of this species with grayer mesonotum and with a greater extension of large eye facets in the male is found with the typical form. This is *Tabanus simulans* Walker (*conterminus* Walker) but because of apparent intergrades wih the typical form, it is not generally recognized as distinct. However, this name might be retained with subspecific rank as a convenient name for this form.

Tabanus nivosus Osten Sacken (Fig. 70)

> Moderate in size (13 mm.); blackish brown; abdomen with 3 rows of pale spots, the median row being much smaller than the sublateral rows; wings hyaline; eyes bare. Male eye facets distinctly differentiated; sublateral abdominal spots of even greater extent than in female; eyes bare.

T. nivosus is widely distributed in New York but rarely is abundant enough to be considered a serious pest although it attacks man as well as livestock. It is most common in the hilly and mountainous areas of the State. Except for one August record, all collection records are in June and July.

Tabanus novae-scotiae Macquart (Fig. 71)

Fairly large (20 mm.); reddish brown with thorax sometimes fuscous; abdomen with a median dark longitudinal band which may be broad and distinct or nearly obsolete and a median row of small pale triangles; basal half of fore tibiae yellowish; wing hyaline or faintly tinged with yellowish especially in the costal cell; eyes bare. Male eye facets distinctly differentiated; eyes bare.

For many years this species has gone under the name of *Tabanus actaeon* O.S. but it has been suspected for some time that *novae-scotiae* was an earlier name for this form. This has been confirmed by Philip (in correspondence) who has studied Macquart's type. It resembles *T. catenatus* but may be separated by the characters given in the key.

T. novae-scotiae seems to be rare in New York and has been recorded only 3 times here. Two specimens were taken in late August and one in September. It is a late flying species and it is likely that late season collecting will add additional New York localities, especially near the coast.

Tabanus nudus McDunnough (Fig. 71)

Moderate in size (15 mm.); brownish; abdomen broadly orange brown laterally; subcallus denuded; basal callus rather dull and wrinkled; wings hyaline with veins near base and anteriorly outlined in dark yellow; costal cell yellow; second palpal segment greatly swollen and pale in color; eyes hairy. Male eye facets scarcely differentiated; eyes hairy.

This northern form has been collected in New York only in the Adirondacks. However, the writer has seen specimens from northern New Jersey and it is probably present in the adjoining portion of New York. It is of considerable economic importance in portions of Canada but it is not abundant enough to be a pest in New York. The males have been found hovering on mountain tops and in clearings in wooded areas. A series of hovering males was collected by Dr. Henry Dietrich on the top of Mt. Joe (Essex County) on June 12 and 14, 1949. All records except one in July are in June.

Tabanus pumilus Macquart (Fig. 72)

Small in size (9.5 mm.); dark brown to grayish black; abdomen with a row of faint median triangles and roundish sublateral spots; median callus subquadrate; second palpal segment rather slender and apex not sharply pointed; frons somewhat widened above; wings hyaline; eyes bare. Male eye facets distinctly differentiated; occipital tubercle conspicuous; eyes bare.

T. pumilus is the smallest *Tabanus* found in New York. It is widely distributed but has not been reported from the colder parts of the State. It attacks both man and animals and occasionally is abundant enough to cause considerable annoyance.

This species flies from June to August but is most abundant in July. Both sexes are attracted to lights at night.

The larvae have been found in water-saturated soil near brooks.

Tabanus quinquevittatus Wiedemann (Fig. 73)

> Moderate in size (12.5 mm.); yellowish; abdomen with a yellow median stripe bordered with black, lateral margins usually yellowish; pollen of head yellow; wings hyaline with a dark yellow costal cell; frons with sides essentially parallel; eyes bare. Male eye facets distinctly differentiated; eyes bare.

This greenhead is common throughout the State south of the Adirondacks and is probably our most important economic species. In western New York it is especially abundant and a severe pest of horses and other livestock during the flight season. It first appears in late June and is found well into August with a period of maximum abundance about the middle of July. At the height of its flight period it is not unusual to find fifty or more of this species feeding on a single animal with many more flying about it.

It is less common on Long Island than it is upstate, being largely replaced by the related *T. nigrovittatus*. Unlike *T. nigrovittatus,* it rarely attacks humans and is less aggressive in its attack.

T. quinquevittatus is referred to in much of the earlier literature as *T. costalis* Wiedemann and less extensively as *T. vicarius* Walker. It is separated from related species by the yellowish color which includes the palpi and pleurae and the deep yellow tint of the costal cell.

The larvae of *T. quinquevittatus,* unlike most species of Tabanidae, are found most commonly in relatively dry situations. Moist but not wet pastures and hay fields seem to be most suited but apparently tolerance to variations in moisture is considerable since larvae have been collected in dry cultivated fields and in mud along the margins of brooks. The high populations of this species probably result from this ability to breed in varied situations. Tashiro and Schwardt (1949) estimate that 19,360 potential feeders (females) could emerge from an acre of suitable breeding area in New York.

Because of the wide range of larval habitat it is doubtful if practical control measures could be devised for the control of the larvae.

Tabanus recedens Walker (Fig. 74)

> Large (23 mm.); brown; thorax with gray pollen; abdomen with a median row of very narrow pale triangles; fore tibiae uniformly brown; wing hyaline with dark yellow spots and costal cell; eyes bare. Male eye facets differentiated but line of demarcation sometimes indistinct; eyes bare.

This species is largely restricted to the southeastern portion of New York and never seems to be common. It is found in June and July.

Tabanus reinwardtii Wiedemann (Fig. 75)

> Moderate in size (17 mm.); grayish black; abdomen with gray median triangles and larger pale sublateral spots; basal callus large and shining; frons broad and essentially parallel sided; wings spotted with brown; eyes bare or with short scattered hairs. Male eye facets somewhat differentiated but line of demarcation not distinct; eyes hairy.

This moderately large species is generally distributed throughout New York although there are few collection records for the Adirondack and Catskill areas. This species is frequently collected in its immature stages but is less commonly collected as an adult; this is probably due to its retiring and non-aggressive habits although it does occasionally attack livestock.

The larvae are found in mud along streams and ponds, usually in situations where the water is cool and the area shaded.

Tabanus sackeni Fairchild (Fig. 76)

> Moderate in size (13.5 mm.); brownish; abdomen with a pale median line of contiguous triangles and pale sublateral spots which rarely reach the hind margins of the tergites; frons narrow and widened above; third antennal segment very slender; wings hyaline; eyes bare. Male eye facets distinctly differentiated; pale sublateral spots often reaching hind margins of tergites; eyes bare.

This species belongs to the *"longus"* group of *Tabanus* and probably most of the records for *T. longus* from north of Pennsylvania actually should refer to *sackeni*. It is a late season species, flying from mid July to early September. It probably is crepuscular and both sexes have been collected at lights in some numbers.

Tabanus sagax Osten Sacken

> Moderate in size (14 mm.); orange brown; abdomen with a median line of contiguous triangles and rather indistinct sublateral spots; frons parallel sided and quite broad; third antennal segment variable but usually slender, dark orange with annuli black; second palpal segment swollen; wings hyaline; eyes bare. Male eye facets distinctly differentiated; eyes bare.

This species is uncommon throughout its range. The only New York records known to the writer are Copake Falls (Columbia County) in July and Riverhead (Suffolk County) as follows—7 July: 1 female, 1 September: 1 female, 2 September: 1 female and 14 September: 1 male. All the Riverhead specimens were collected by Mr. Roy Latham. Probably late season collecting will result in additional New York records.

Tabanus sparus Whitney (Fig. 77)

> Small in size (10 mm.); blackish; abdomen with a row of small median triangles and oval sublateral spots which often reach the

hind margins of the tergites; median callus very narrow; second palpal segment swollen at base and sharply pointed; frons narrow and widened above; wings hyaline; eyes bare. Male eye facets distinctly differentiated; occipital tubercle inconspicuous and usually laterally compressed; eyes bare.

Although this species has been taken at inland localities in other states, in New York it seems to be restricted to Long Island and Staten Island. It attacks both man and animals but only occasionally is it abundant enough to be a pest. It flies from June through August.

Tabanus sparus subspecies **milleri** Whitney (Fig. 77)

No characters have been found to separate dried specimens of this form from typical *sparus* but living specimens and dried specimens which have been moistened and relaxed have a purple diagonal band across the eye whereas in typical *sparus* the eye is plain. The related *T. pumilus* has 2 diagonal bands across the eye and may be separated by other characters given in the key.

T. sparus subspecies *milleri* is typically southern in its range and Long Island seems to be its northern limit. On Long Island it is about as abundant as typical *sparus* and has the same flight season.

Tabanus stygius Say (Fig. 78)

Large (22 mm.); pile of thorax grayish white; abdomen black; frons brown and rather narrow; wings yellowish with dark spots, costal cell deep yellow; eyes bare. Male eye facets distinctly differentiated; pile of thorax dark brown; third antennal segment dark orange; eyes bare.

This rather striking species is not common in New York and seems to be restricted to the warmer portions of the State. It is most common in July and it also has been collected in June and August.

The egg masses are laid on aquatic plants, chiefly *Sagittaria*, growing in shallow water and the larvae are found in mud along ponds and streams. Two years is often necessary for this species to complete its life cycle.

Tabanus sublongus Stone

Moderate in size (13 mm.); dark orange brown; abdomen with a median line of contiguous pale triangles and grayish yellow to orange sublateral spots which usually reach the hind margins of the tergites; frons moderately broad with parallel sides; third antennal segment moderately slender; wings hyaline; eyes bare. Male eye facets distinctly differentiated; eyes bare.

The single New York record of this species is a paratype from Ithaca (Tompkins County) collected in June (Stone, 1938).

Tabanus subniger Coquillett (Fig. 79)

Large (23 mm.); pile of thorax grayish white; abdomen black; eye normally bare; wings pale yellowish with dark spots, costal cell yellow; frons broad and gray, narrowed above and notched at vertex. Male eye facets distinctly differentiated; pile of thorax dark brown; third antennal segment dark brown or black; eyes bare.

This large species superficially resembles *T. stygius* but is easily distinguished by the characters given in the key. It is rare throughout its range. All specimens studied were collected either the last week in June or in early July.

Tabanus sulcifrons Macquart (Fig. 80)

Fairly large (21 mm.); reddish brown; abdomen with a median row of pale rather broad triangles and hind margins of tergites with pale bands which broaden laterally; fore tibiae pale at base; wing somewhat tinted, with dark spots and dark yellow costal cell; eyes bare. Male eye facets distinctly differentiated; eyes bare.

Because of its late flight season, this species is sometimes called the "Autumn Horsefly". It is a conspicuous form and is especially common in western New York; there are no records from the Adirondacks.

In western New York it is sometimes extremely numerous and because of its large size and capacity for blood, it is a serious pest. It is most abundant when the other economically important species are gone for the season or on the decline. The writer has seen as many as thirty-five of these large flies on a single cow with many others flying about. The adults of both sexes are frequently seen resting on country roads in considerable numbers and when disturbed the females will follow automobiles even when they are moving rather rapidly. They are active until dark and sometimes are found at lights at night.

Little is known about the immature stages of this species in nature. Egg masses have been found on small branches of trees and larvae have been found in dry and slightly moist soil as well as from the edges of ponds in saturated mud and plant debris. There is some evidence that the larvae will feed on white grubs and Japanese Beetle larvae. The life cycle normally is one year but sometimes takes 2 years.

Tabanus superjumentarius Whitney (Fig. 81)

Moderate in size (16 mm.); pile of thorax grayish white; abdomen black with small median white triangles on second to fifth tergites, the one on the second being very small or sometimes absent; fore tibiae uniformly dark; wings yellowish becoming deeper colored anteriorly especially along the veins and in the costal cell; eyes bare. Male eye facets distinctly differentiated; pile of thorax brownish; eyes bare.

This species has not been recorded from the Catskill or Adirondack areas. It is usually rather rare but occasionally is abundant enough to annoy cattle. It flies from June until August with the great majority of the collection records being in July.

Tabanus trepidus McDunnough (Fig. 82)

> Moderate in size (14 mm.); brownish; abdomen broadly orange-brown laterally; basal portion of third antennal segment rather broad, annulate portion relatively short; palpi very slender; wing faintly tinted, costal cell yellow; eyes hairy. Male eye facets rather distinctly differentiated; second palpal segment very small; eyes hairy.

T. trepidus is a northern form most common in New York in the Adirondack area. There are no records in New York west of Oswego and Tompkins Counties. It is not common enough to be considered of economic importance. Except for two June records, all New York records are in July.

The larva has been found in sphagnum moss but it is likely that it will be found in other habitats as well.

Tabanus trimaculatus Palisot de Beauvois (Fig. 83)

> Moderate in size (16 mm.); pile of thorax grayish white; abdomen dark with median white triangles on third, fourth and fifth tergites and occasionally 2 small sublateral white spots on second tergite; basal half of fore tibiae white; wings nearly hyaline except for dark costal cell and dark spots; eyes bare. Male eye facets distinctly differentiated; eyes bare.

This is a southern form which is noticed only occasionally in the southeastern portion of New York. It is found in June and July.

The egg masses are usually deposited on vegetation near the edge of ponds and slow streams and the larvae are found in the mud near the margin of the water.

Tabanus trispilus Wiedemann (Fig. 84)

> Moderate in size (15 mm.); blackish; abdomen black with a median row of grayish white triangles; wings tinted, costal cell dark yellow; eyes with fine inconspicuous hairs. Male eye facets scarcely differentiated; sides of abdomen often tinted with orange brown; eyes hairy.

This species is found throughout the State and apparently is as much at home on Long Island and in western New York as in the higher Adirondacks. Although commonly collected, it rarely is abundant enough to be considered a serious pest. The writer has often collected both sexes of this species on flowers especially on *Ceanothus americanus* and *Spiraea latifolia*. It flies from June until mid August but is most abundant in July.

The larvae have been found both in very wet soil near the edge of a stream and in relatively dry sod. The writer collected a freshly emerged adult on the base of a tree growing in a well-kept lawn.

Tabanus typhus Whitney (Fig. 85)

> Small to moderate in size (11 mm.); blackish; abdomen with a median row of grayish triangles and larger sublateral pale spots which are sometimes pinkish in ground color; prescutal lobe reddish; wings hyaline with a dark yellow costal cell and occasionally faint spots; eyes hairy. Male eye facets differentiated; eyes hairy.

This rather small species is found throughout the State but seems most common in the hilly and mountainous areas. It will attack both man and livestock but only occasionally is it numerous enough to cause much trouble.

T. typhus is a very variable species in general body color, color of legs and in shape and extent of basal and median calli. However, most specimens may be separated by the characters given in the key.

This species is most abundant in July but occasional specimens are collected in June and August.

Tabanus vittiger subspecies **schwardti** Philip (Fig. 86)

> Moderate in size (13 mm.); dark brown to blackish; abdomen with a pale median stripe and sublateral stripes; wings hyaline; hind femora mostly fuscous; frons fairly broad, widened above; scutellum reddish at tip; eyes bare. Male eye facets distinctly differentiated, upper facets much larger than lower; eyes hairy.

The writer has seen specimens of this form only from western New York and Long Island as indicated on the map. Possibly some of the earlier records of *T. lineola scutellaris* should refer to this species since the females are difficult to separate. However, *schwardti* is a much less common form than *scutellaris* in New York. The males of *scutellaris* and *schwardti* are readily separated by the much enlarged upper eye facets and hairy eyes of *schwardti*.

All New York collection records for this form are from late June to mid July.

Tabanus vivax Osten Sacken (Fig. 87)

> Moderate in size (14.5 mm.); dark blackish brown; abdomen with 3 rows of pale spots, the median triangle on second tergite not reaching the anterior margin; wings hyaline; eyes bare. Male eye facets distinctly differentiated; eyes bare.

This species seems to be rather rare throughout its range and for many years was confused with what is now called *T. fairchildi*. Most records previous to 1938 actually refer to *fairchildi*. One New York specimen was collected on June 12 and another on July 4 but all other specimens studied were collected between mid-July and mid-August. The adult is occasionally taken at lights at night.

The writer has seen a single specimen reared from a larva collected in pasture sod from along the edge of a permanently wet area.

Tabanus zonalis Kirby (Fig. 88)

Moderate in size (18 mm.); black; abdominal tergites with yellow bands along hind margins; eyes hairy. Male eye facets barely differentiated with no definite line of demarcation; eyes hairy.

This is a northern form and is rarely encountered except in the Adirondack area and it is unusual even there. It is a common form in many parts of Canada. Besides Adirondack specimens, the writer has seen a single specimen from Tompkins County. He has also seen a single specimen from northern New Jersey so it is likely *T. zonalis* will be found in adjoining portions of New York and possibly in the Catskills. It is found in June and July.

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ROCHESTER ACADEMY OF SCIENCE

THE TABANIDAE OF NEW YORK

by

L. L. PECHUMAN, Ph.D.

FIGURES 1 to 88

Illustrations

and

Maps Showing

New York Localities

Proceedings of the Rochester Academy of Science, Vol. 10, No. 3

FIGURE 1. **Upper.** Lower portion of Oak Orchard Creek (El. 255 ft.). Cat-tails lining stream and bearing many egg masses of *Chrysops callida* and fewer masses of *C. celer*. Adults of both species as well as *C. brunnea*, *striata* and *aberrans* present in numbers. **Lower.** Closeup of cat-tails shown above. Egg masses of *C. callida* present only on cat-tails actually growing in water.

FIGURE 2. **Upper.** Road across Pine Hill, Steuben County (El. 2000 ft.). Males of *Tabanus lasiophthalmus*, *T. sulcifrons* and *T. pumilus* collected here; also females of several species of *Tabanus* and *Chrysops* including *C. lateralis* and *C. shermani*. **Lower.** Road along upper portion of Oak Orchard Creek, Orleans County near Genesee County line (El. 615 ft). *Chrysops pikei* collected in here in numbers; other species, such as *C. moecha* and *C. vittata*, and *Tabanus quinquevittatus* and *T. sulcifrons* also abundant at times.

FIGURE 3. **Upper.** Road near edge of Labrador Lake, Onondaga and Cortland Counties (El. 1200 ft.). Males of *Chrysops lateralis*, *Atylotus thoracicus* and *Tabanus lasiophthalmus* collected at puddles in road. **Lower.** Marsh near head of Irondequoit Bay, Monroe County (El. 250 ft.). Species found here commonly include *Chrysops aberrans*, *brunnea*, *striata*, *vittata* and *wiedemanni*. Both sexes of *Tabanus illotus* abundant on July 10, 1941.

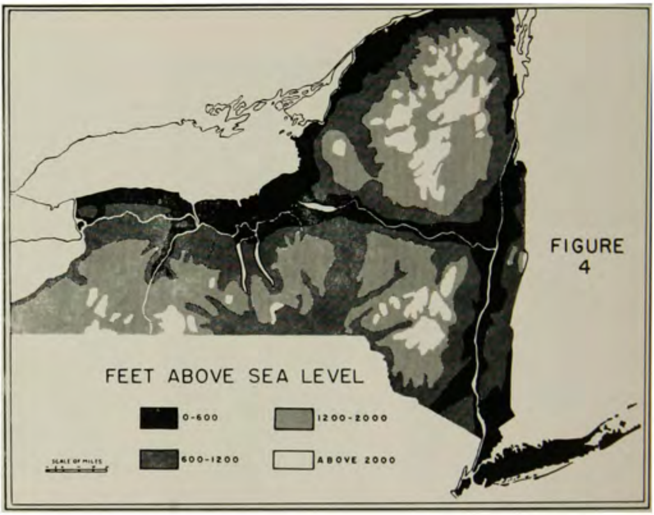


FIGURE 4

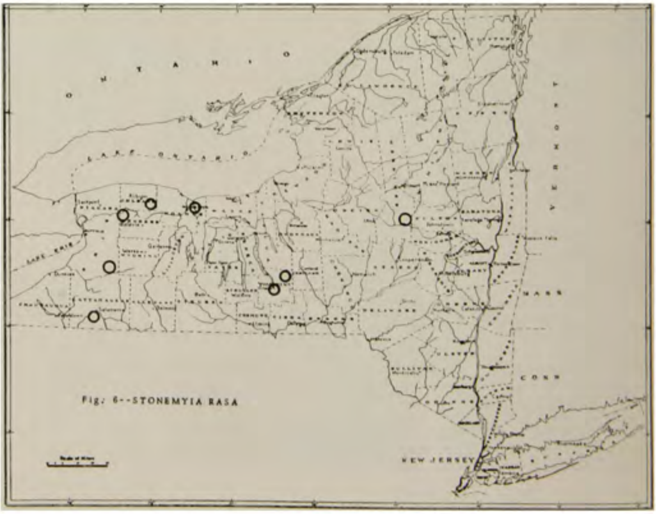
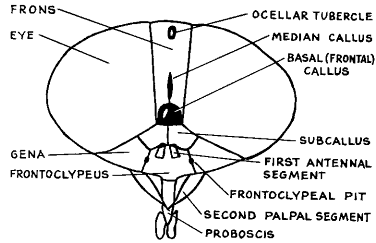
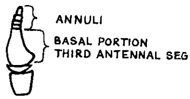


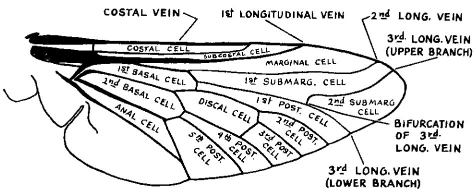
Fig. 6--STONEMYIA RASA



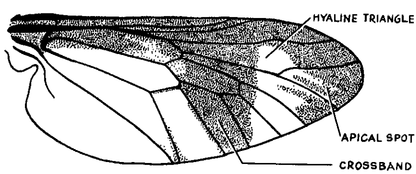
ANTERIOR VIEW OF HEAD OF *Tabanus illotus.*



ANTENNA OF *Tabanus illotus.*

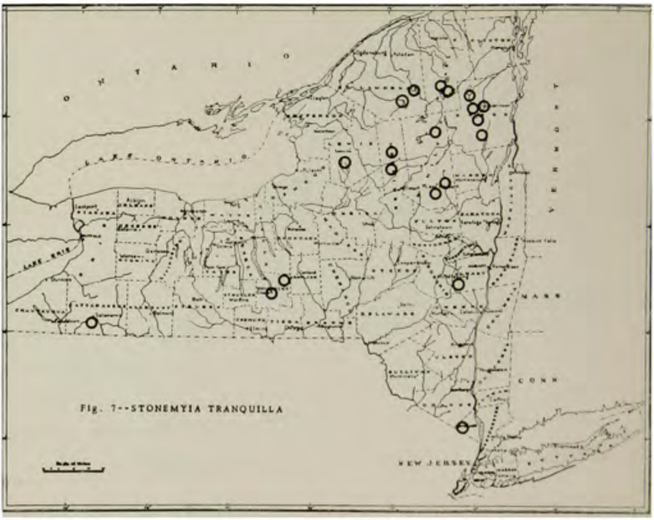


WING OF *Tabanus illotus* (Markings not shown).



WING OF *Chrysops pikei.*

FIGURE
5



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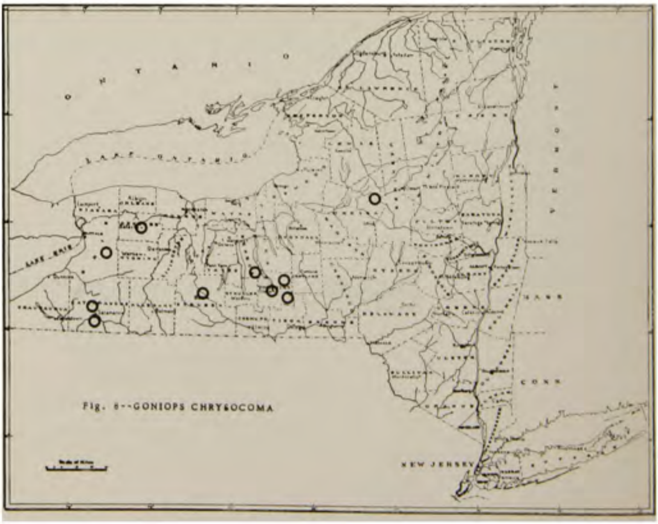
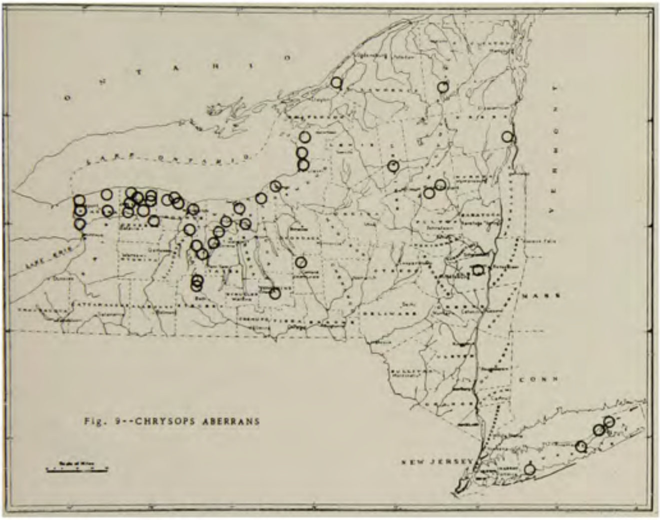


Fig. 8--GONIOPS CHRYSOCOMA



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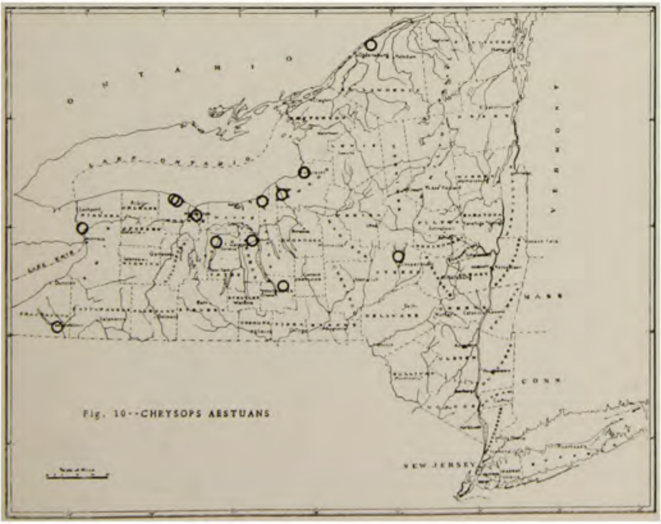

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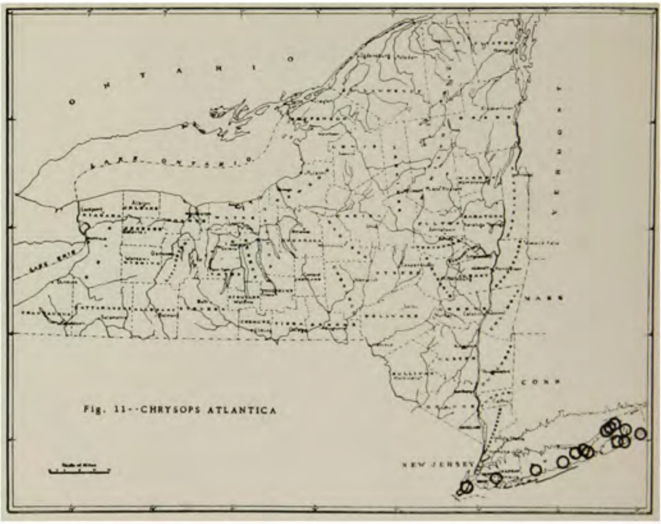
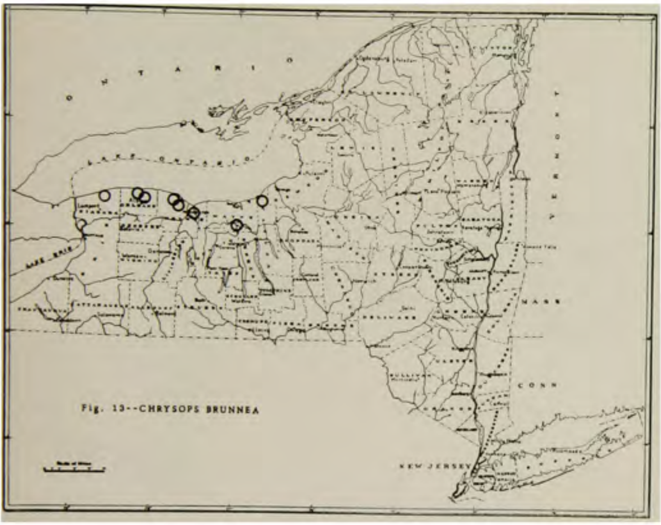


Fig. 11--CHRYSOPS ATLANTICA

Fig. 12--CHRYSOPS BRIMLEYI



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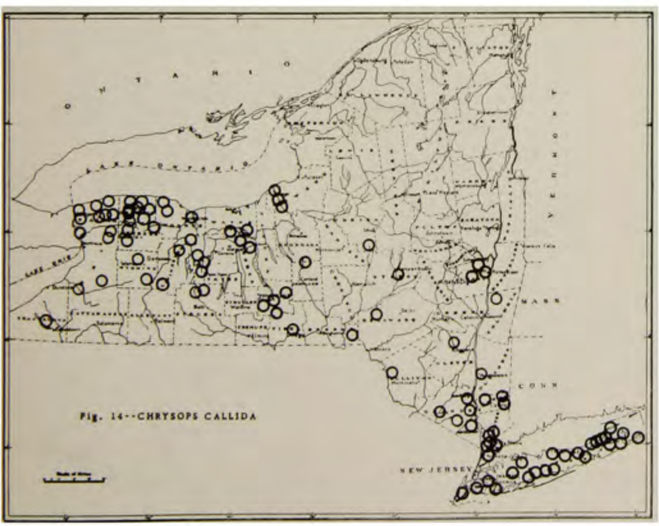

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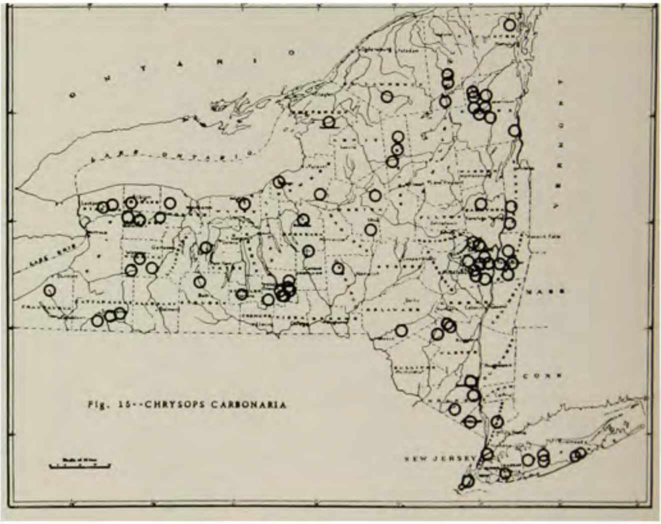

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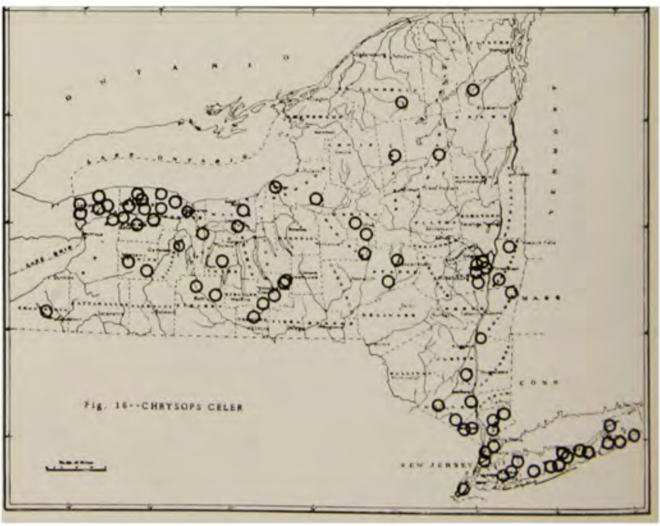

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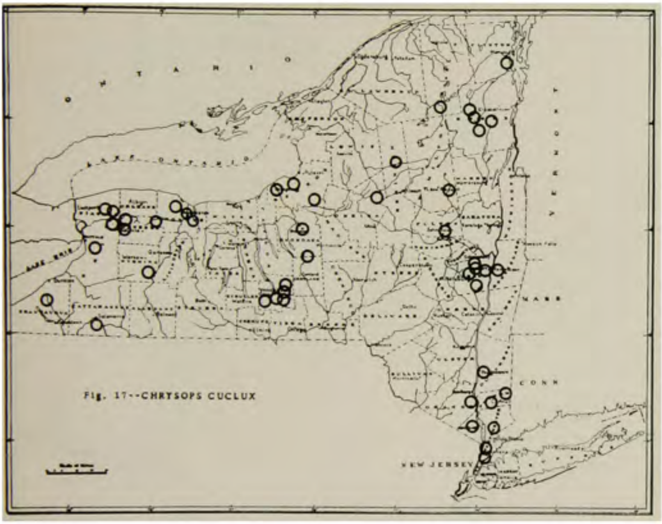
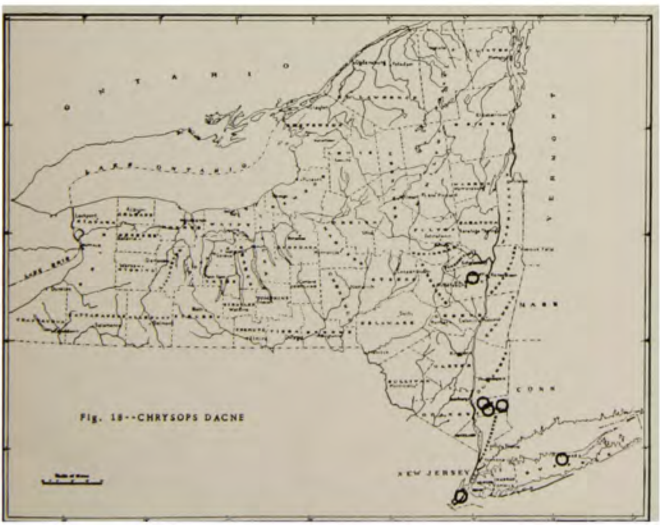


Fig. 17--CHRYSOPS CUCLUX



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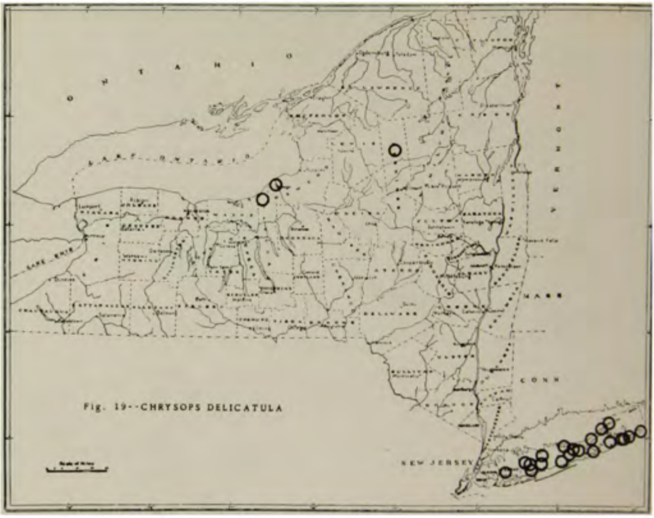

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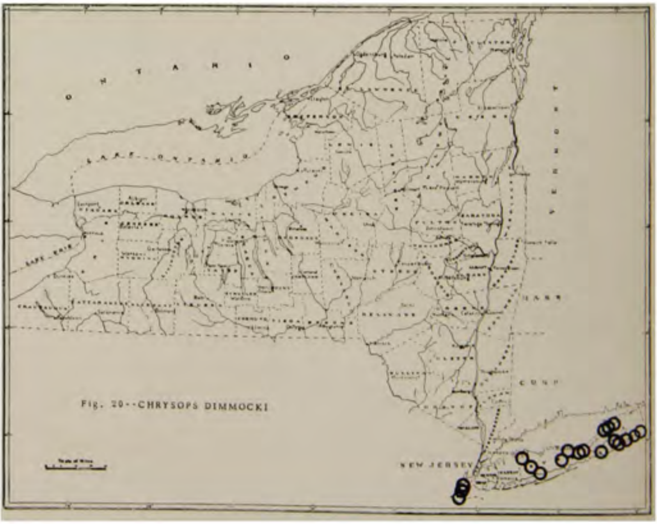

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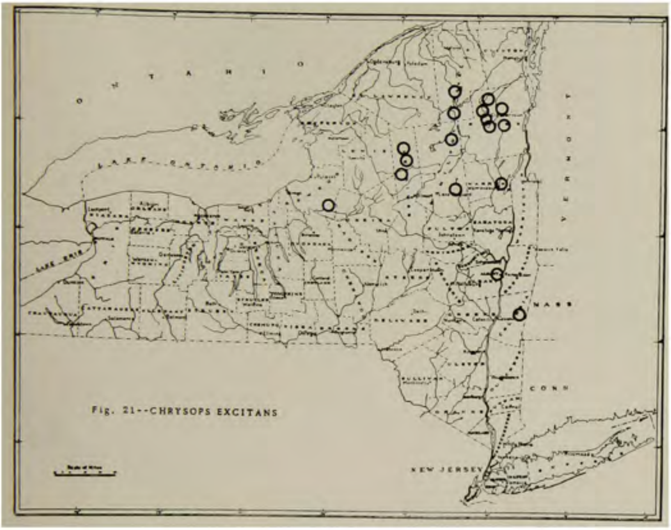

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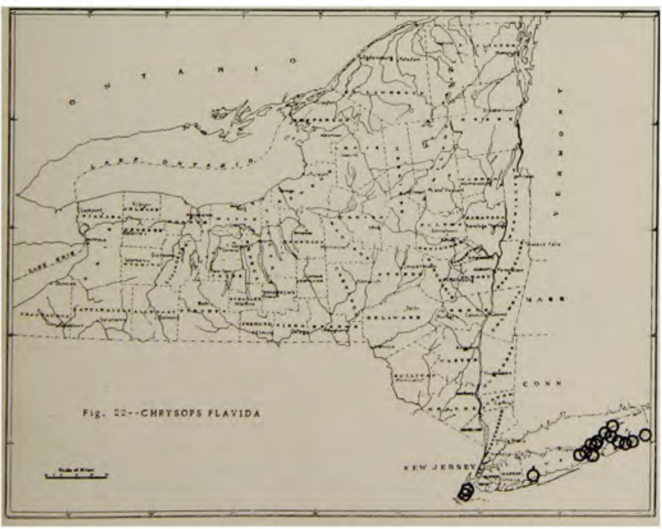

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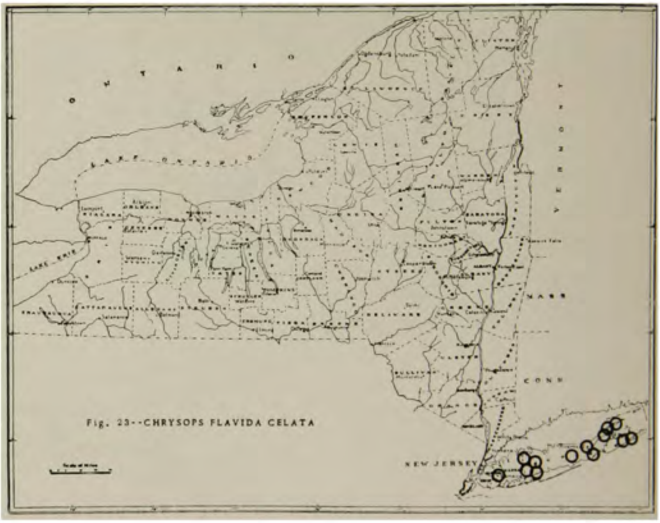

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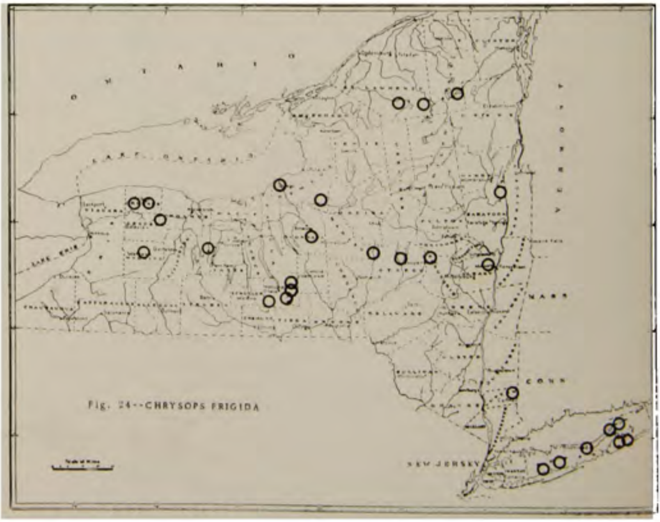

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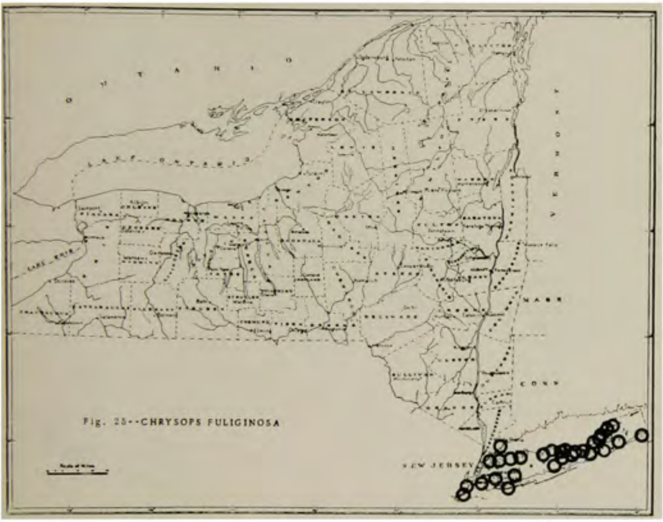

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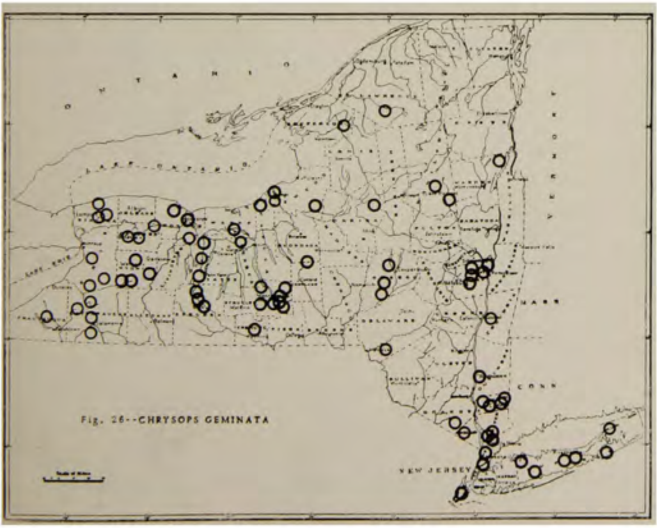

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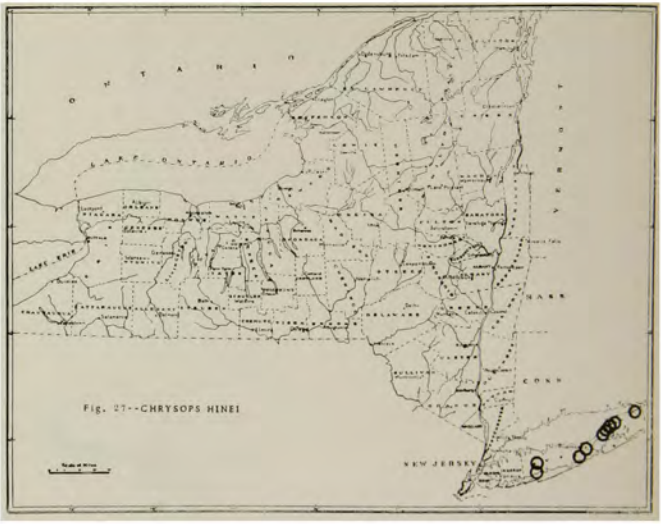

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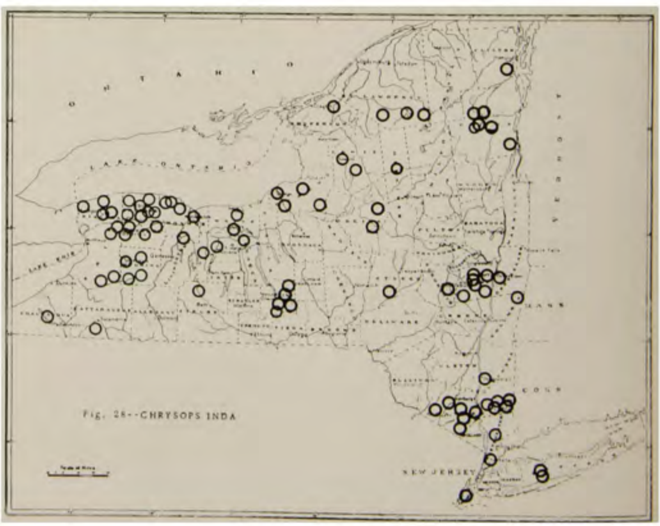

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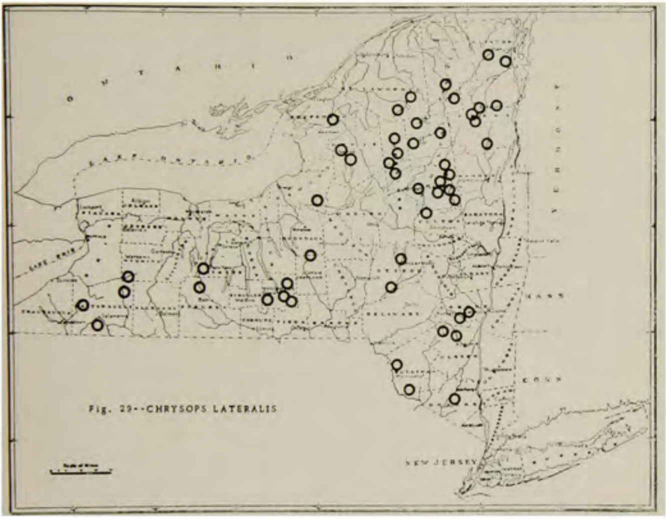

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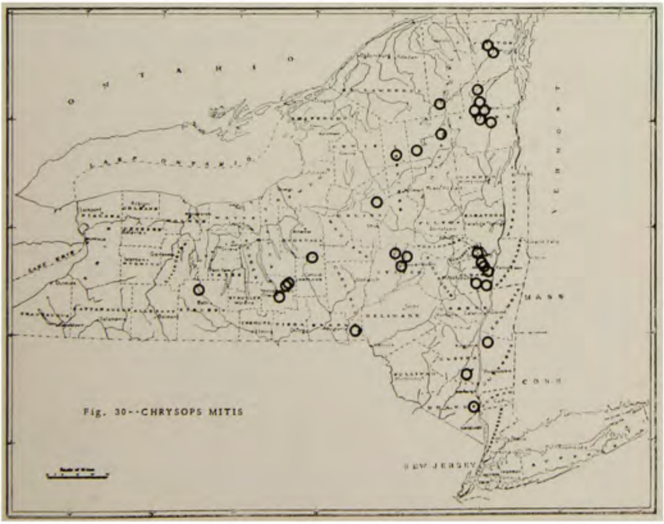

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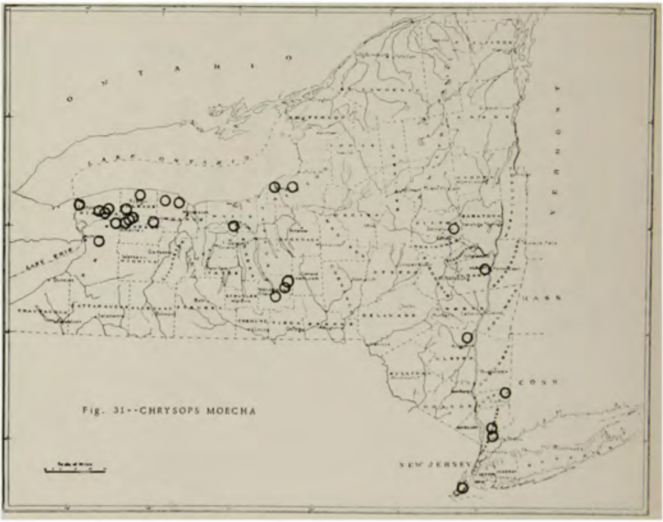

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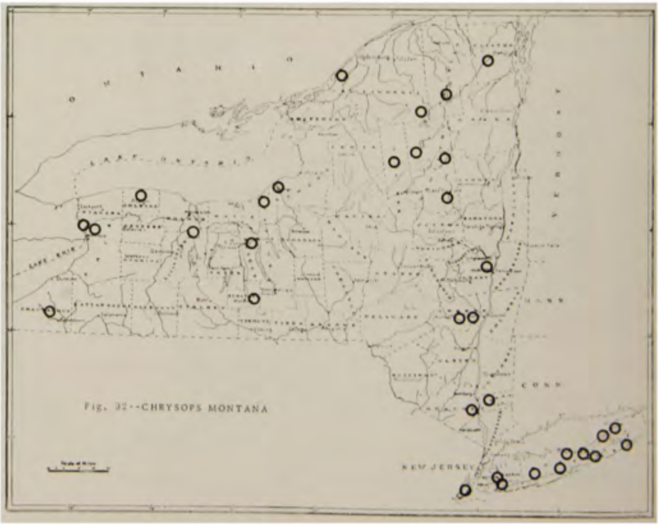

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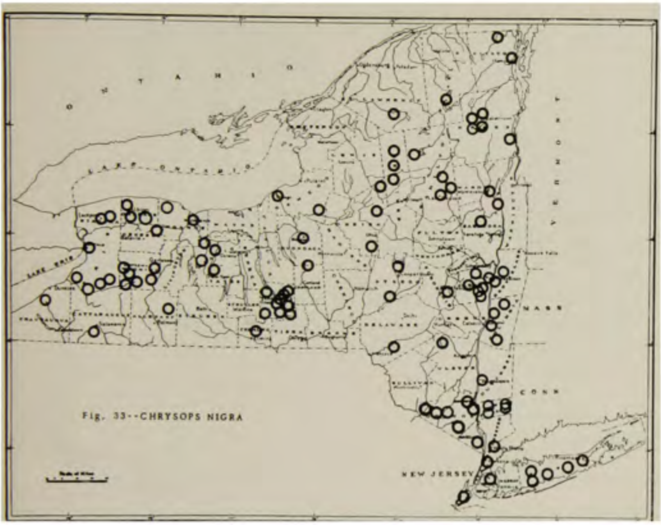

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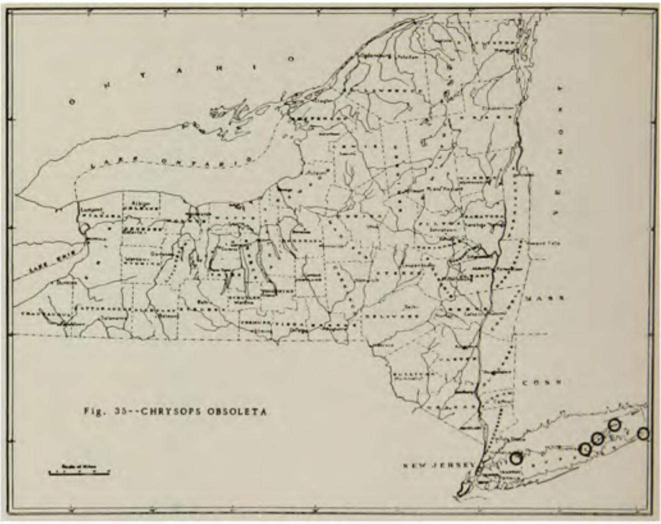

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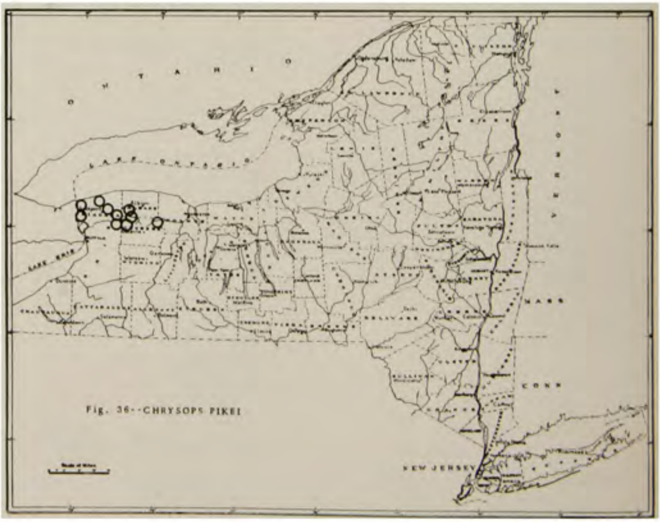

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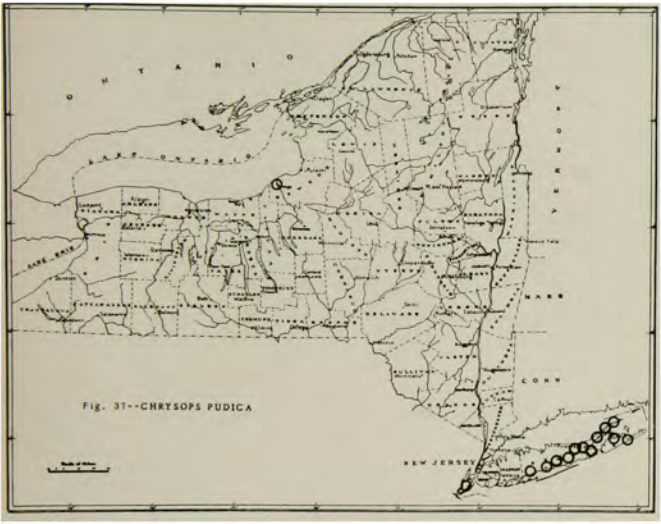

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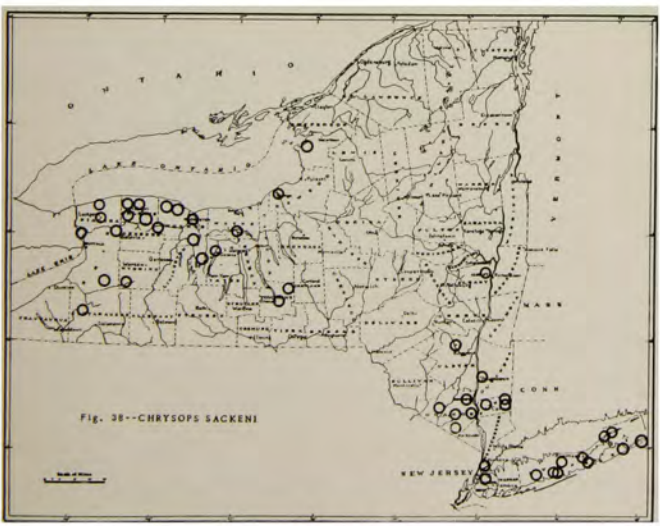

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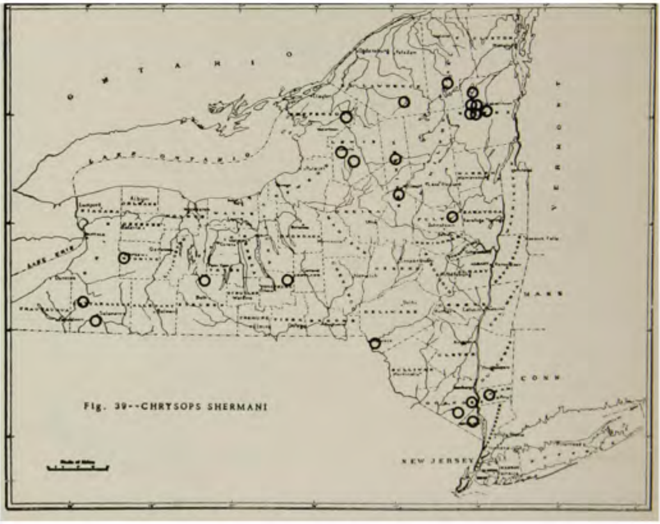

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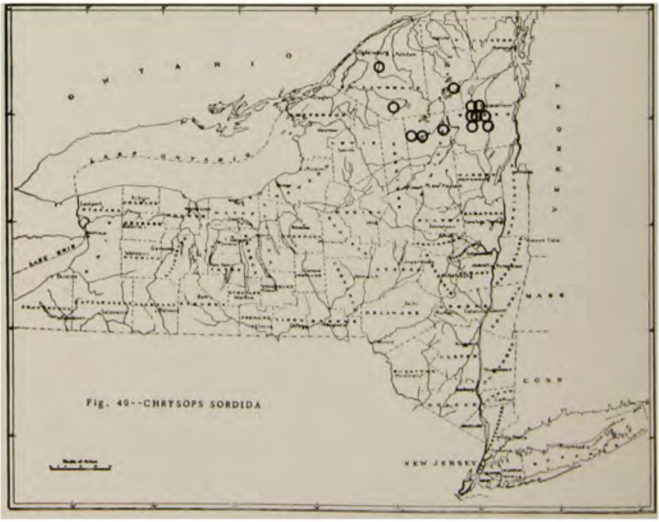

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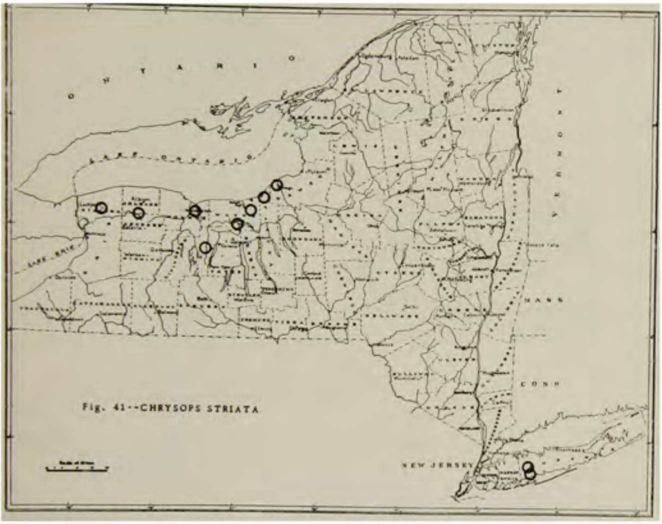

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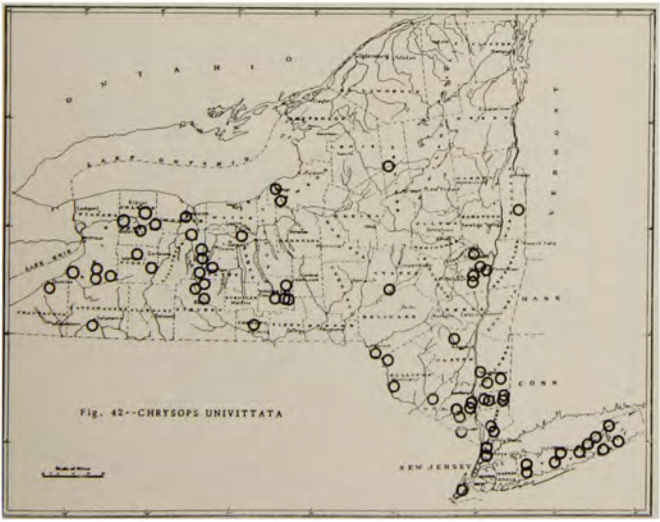

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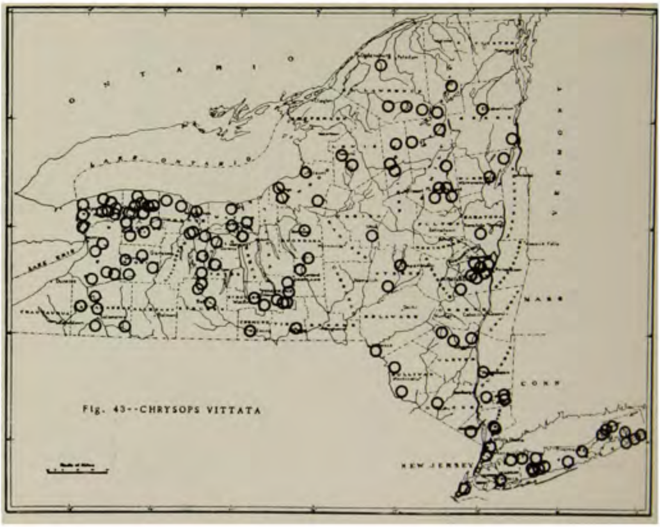

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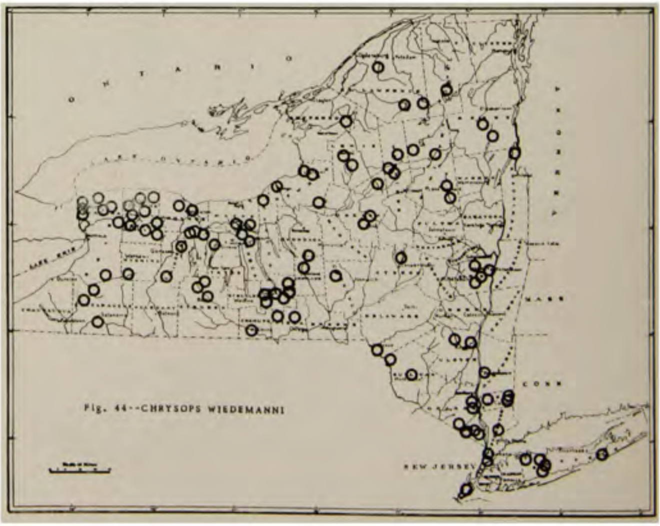

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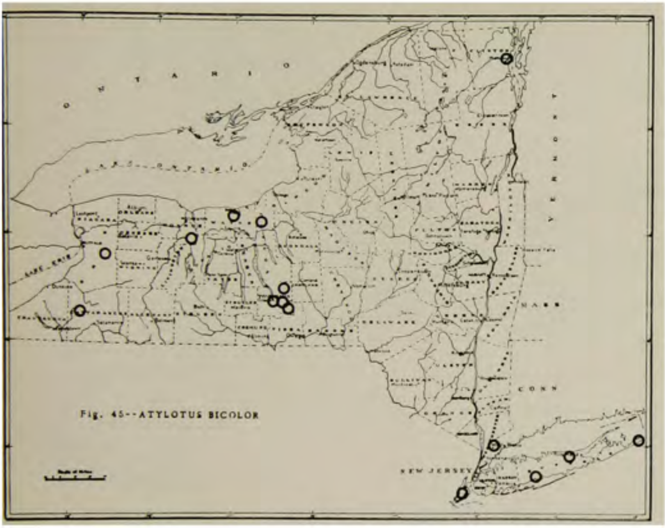

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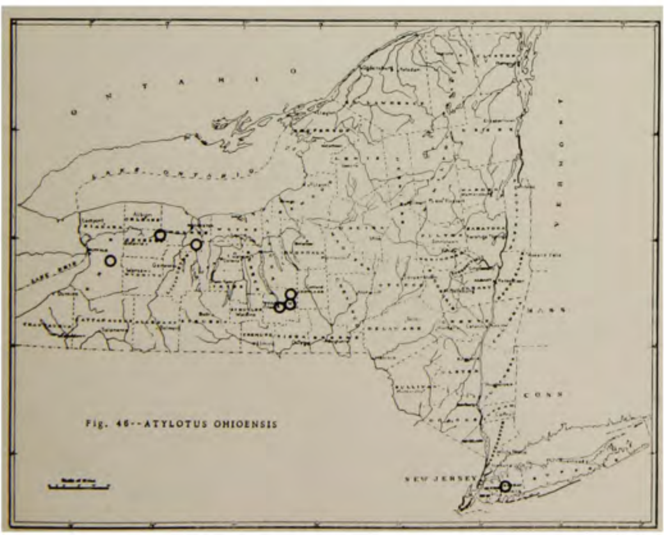

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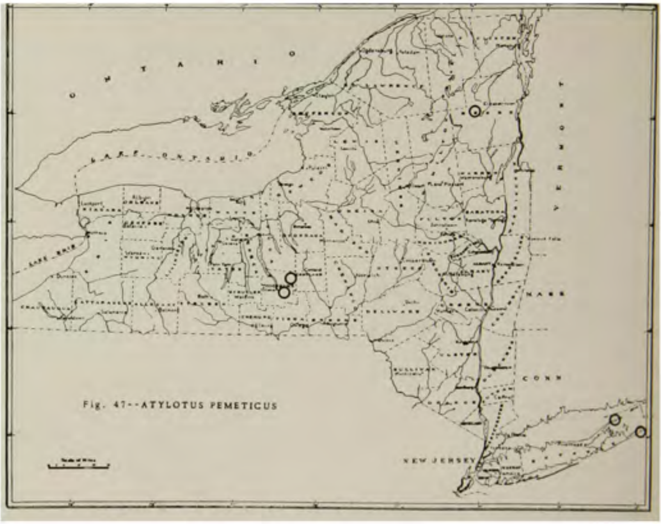

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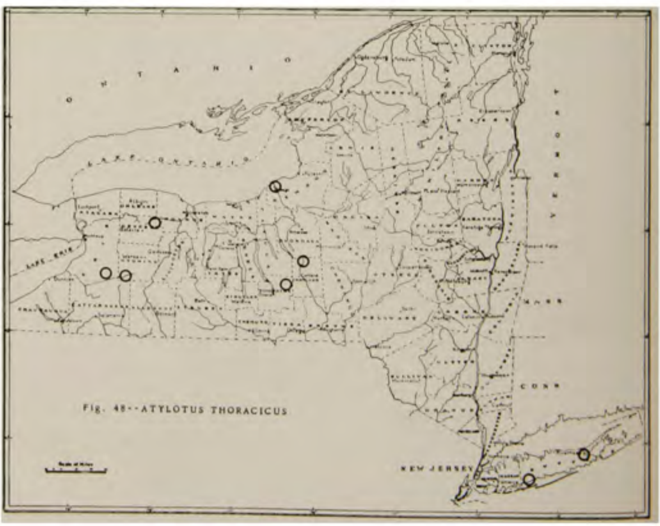

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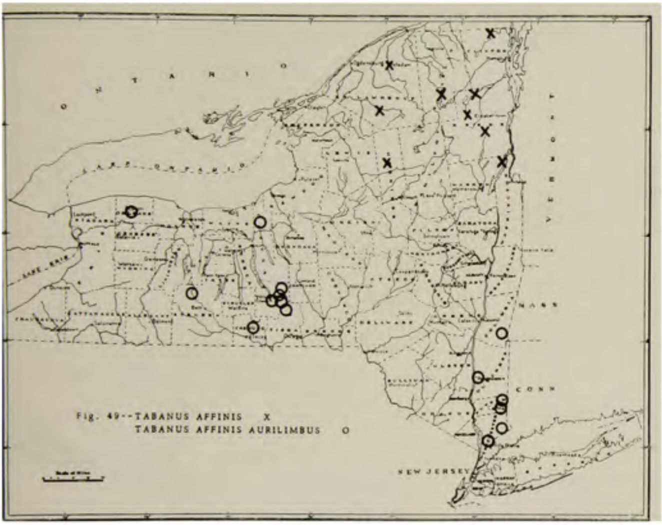

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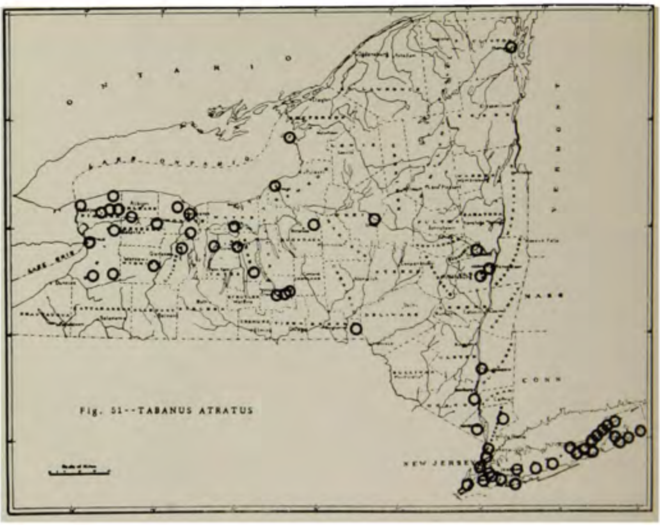

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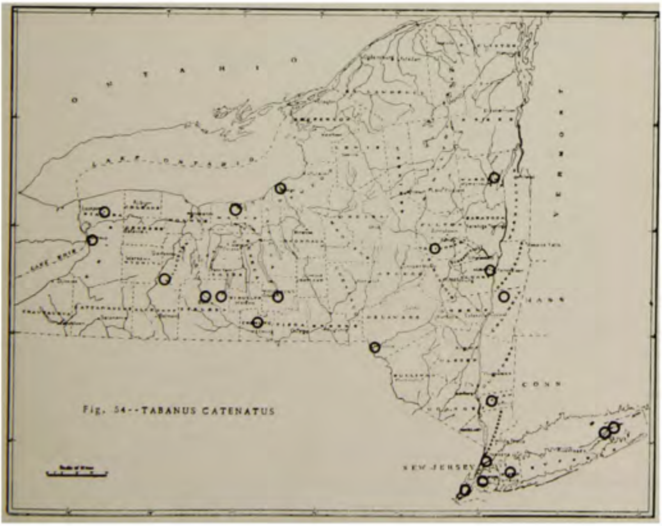

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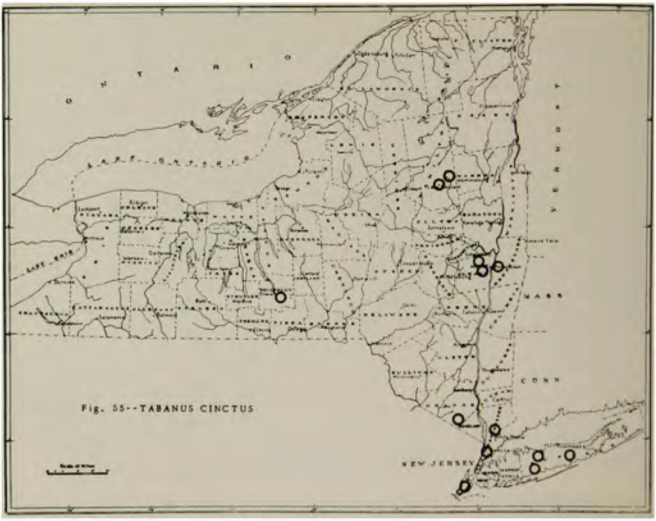

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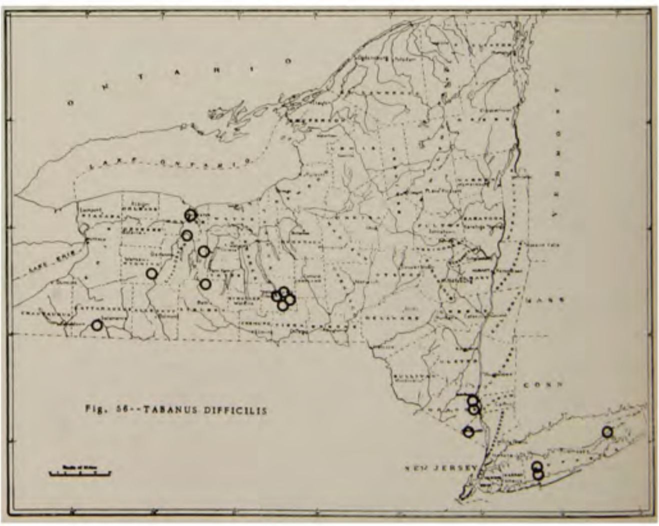

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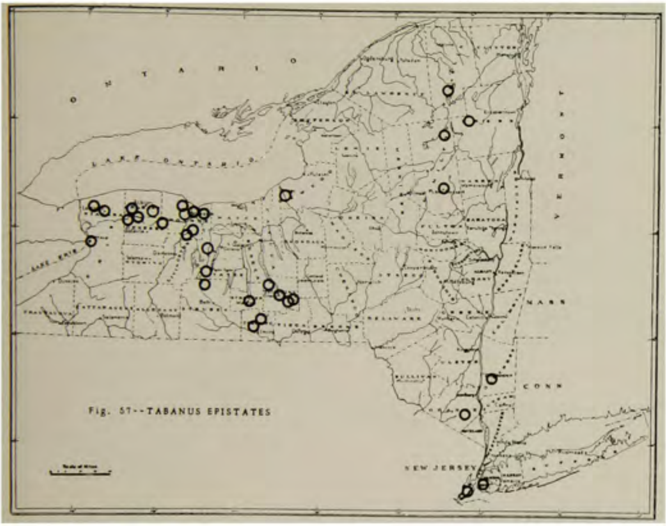

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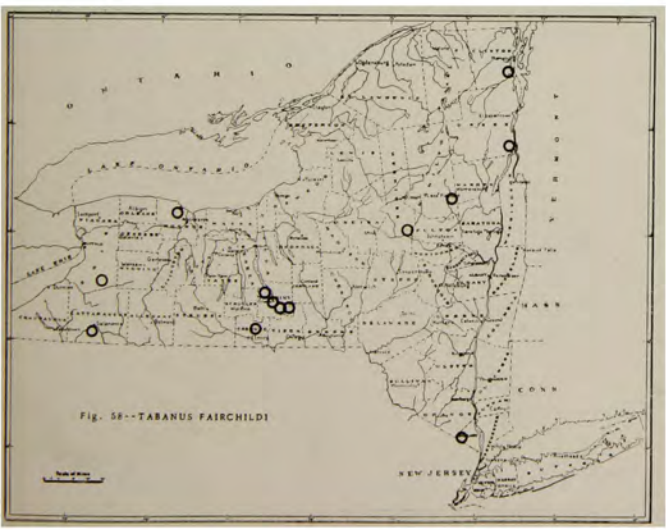

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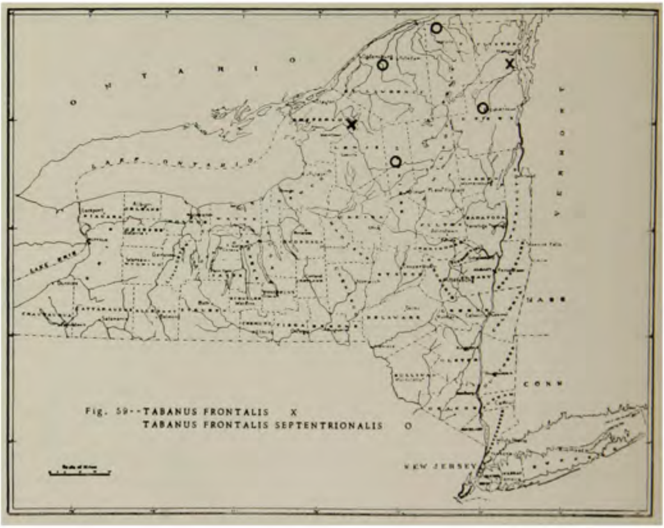

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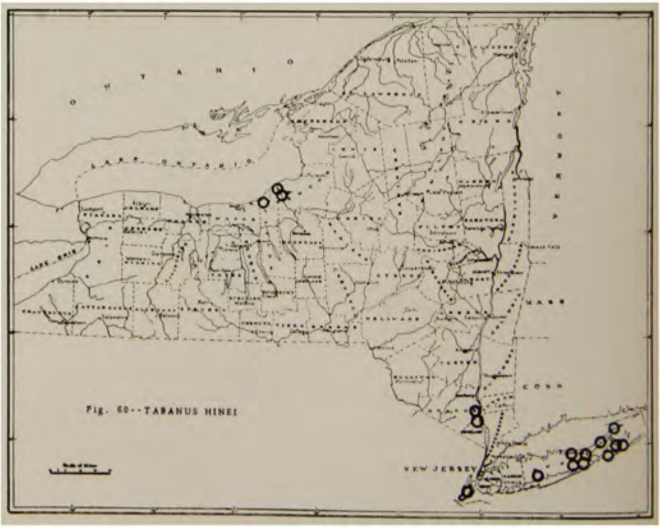

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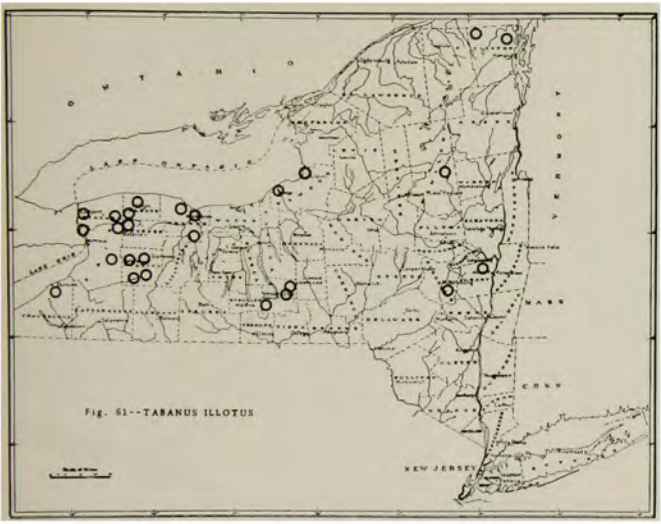

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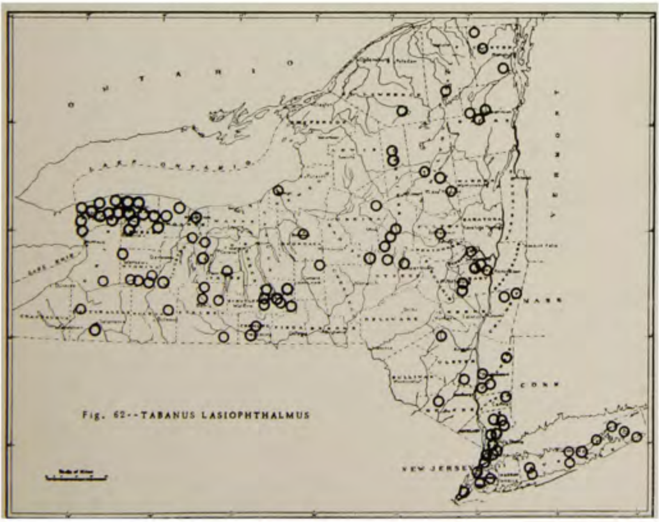

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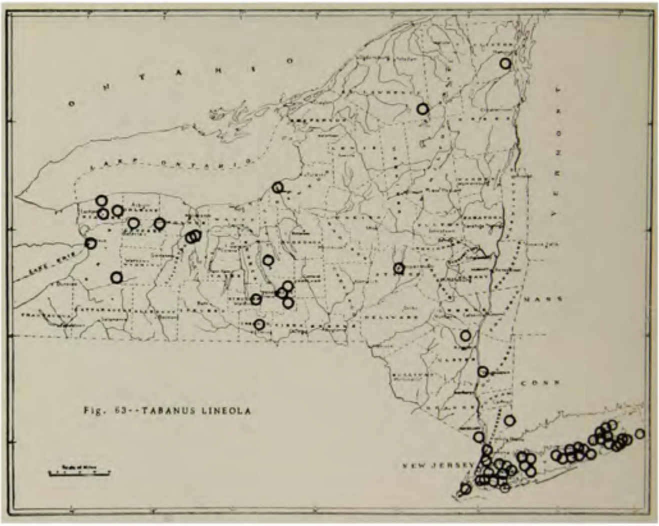

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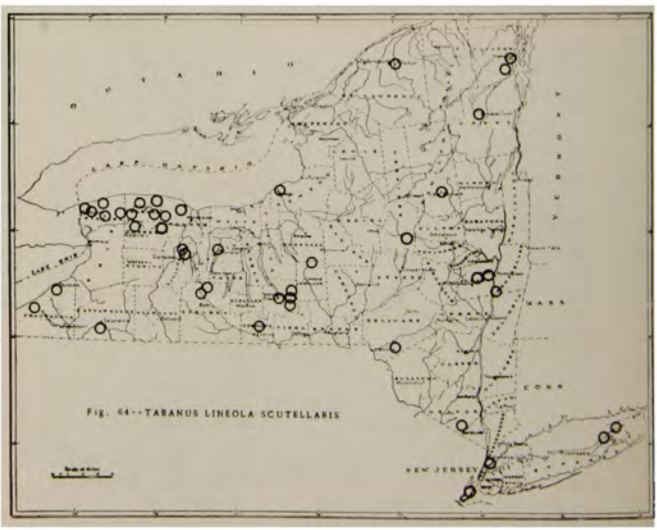

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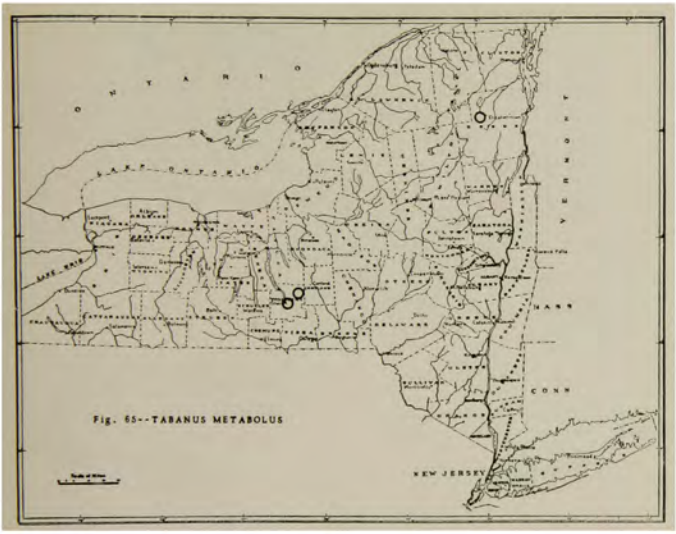

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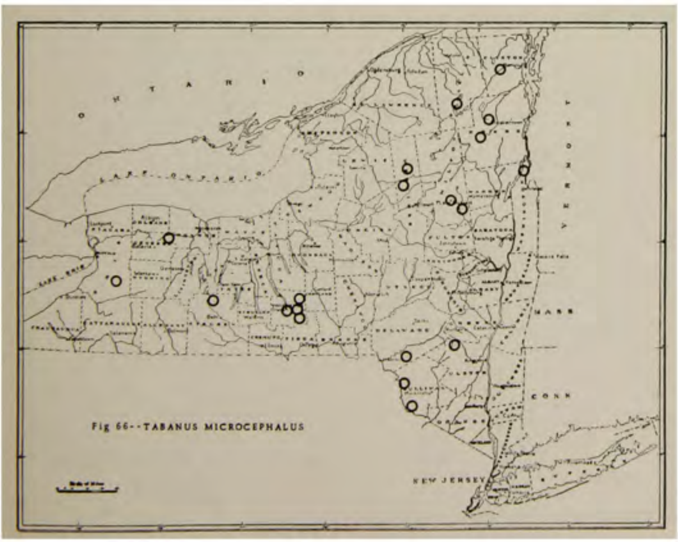

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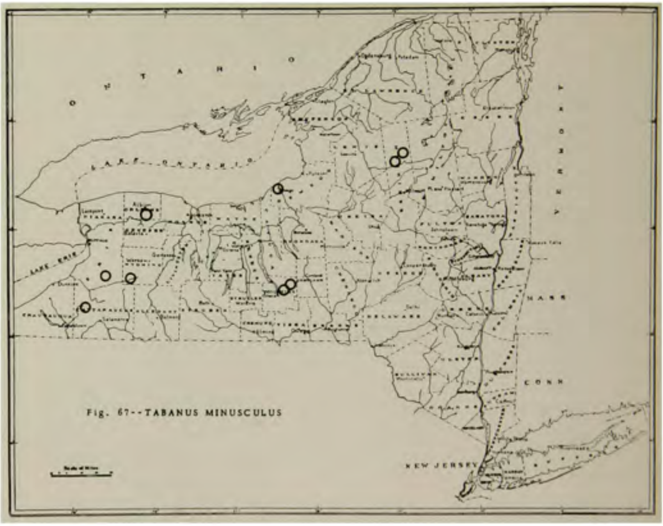

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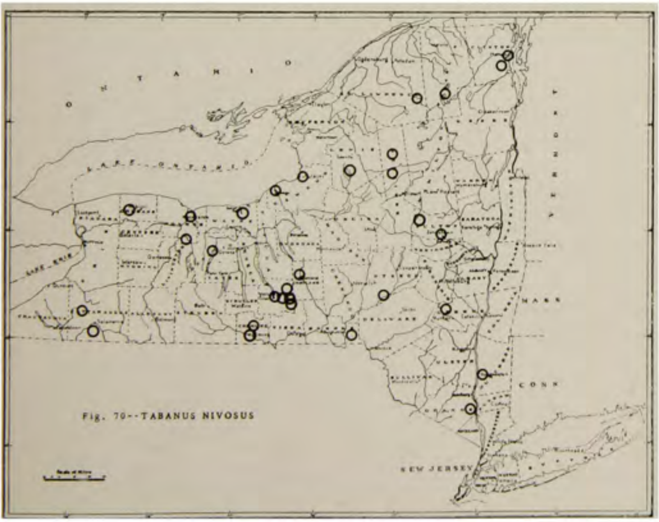

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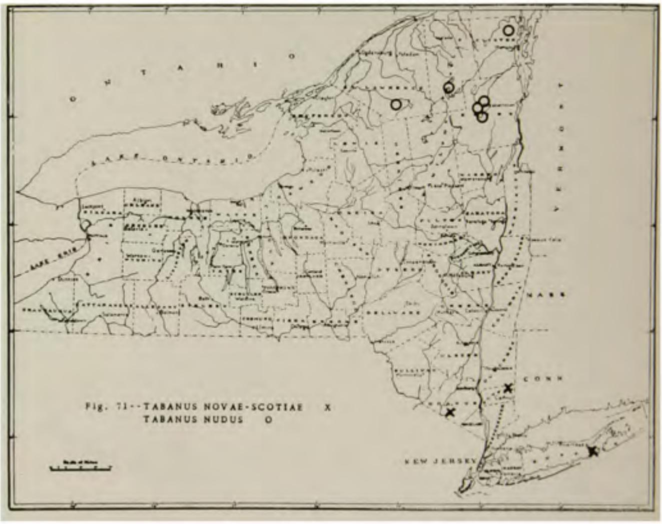

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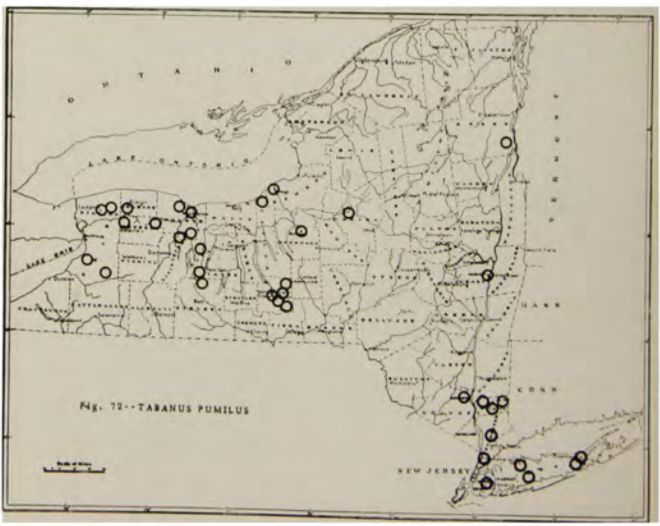

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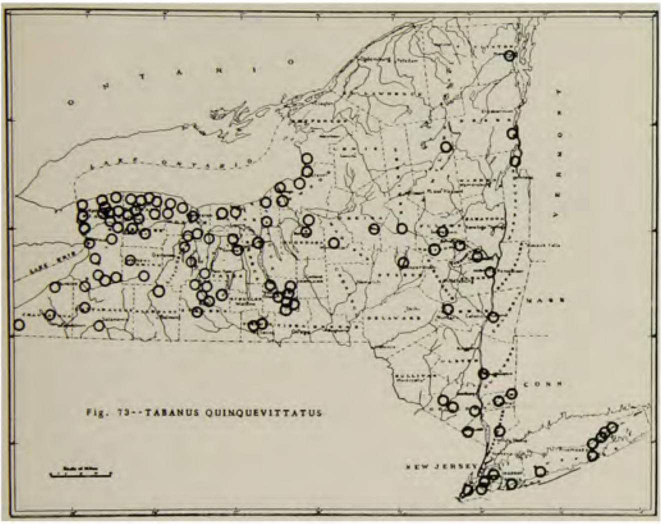

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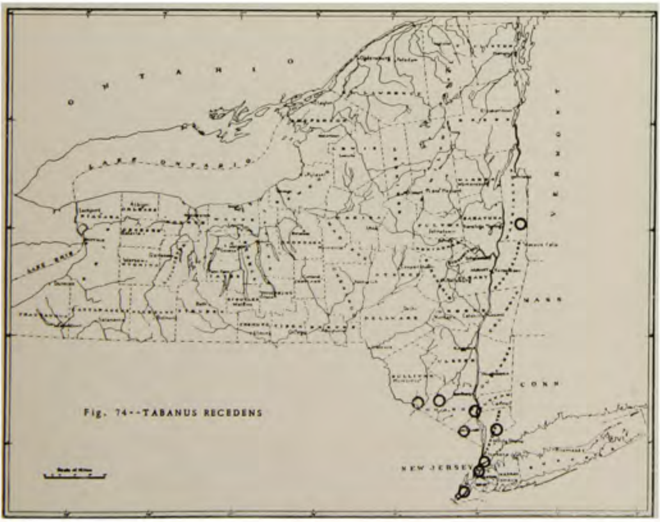

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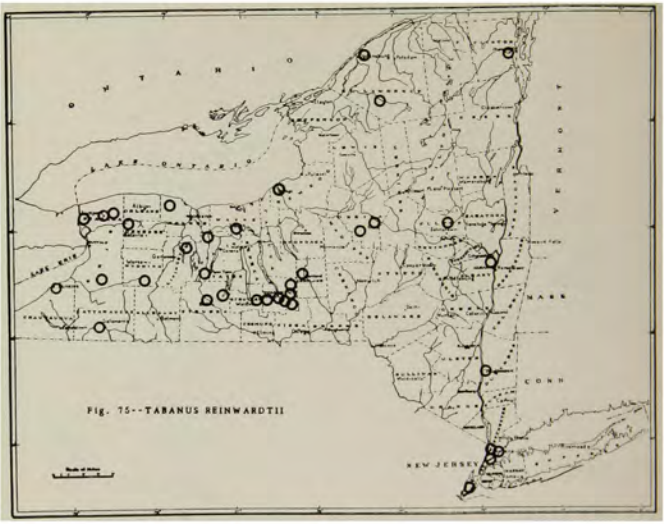

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ONTARIO
LAKE ONTARIO
LAKE ERIE
VERMONT
MASS
CONN
NEW JERSEY
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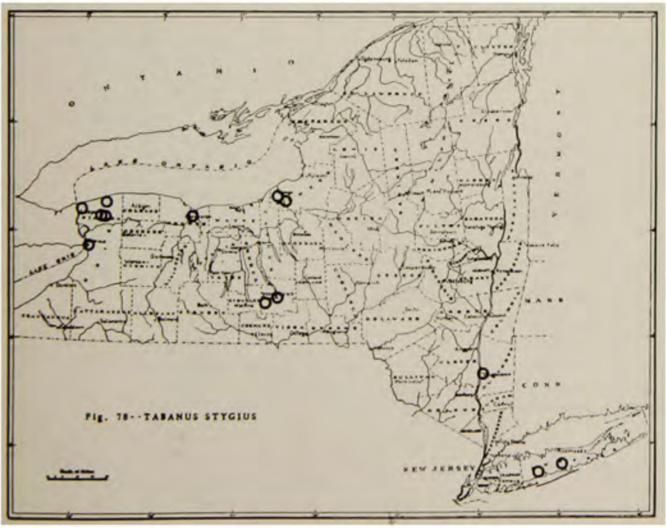
TABANUS SPARUS MILLERI X


ONTARIO
LAKE ONTARIO
LAKE ERIE
VERMONT
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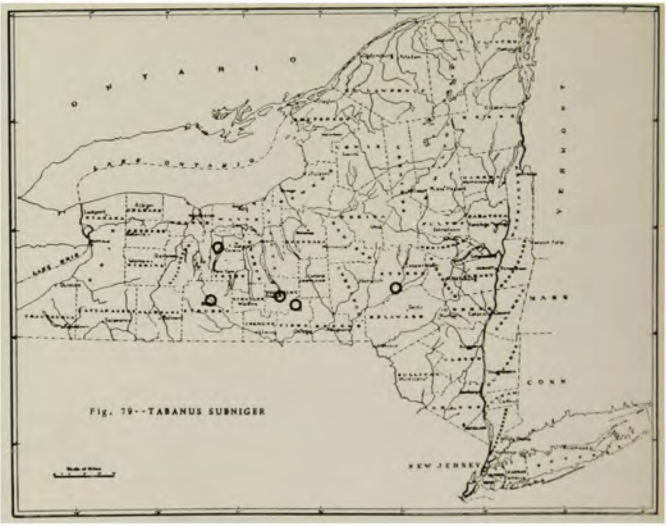

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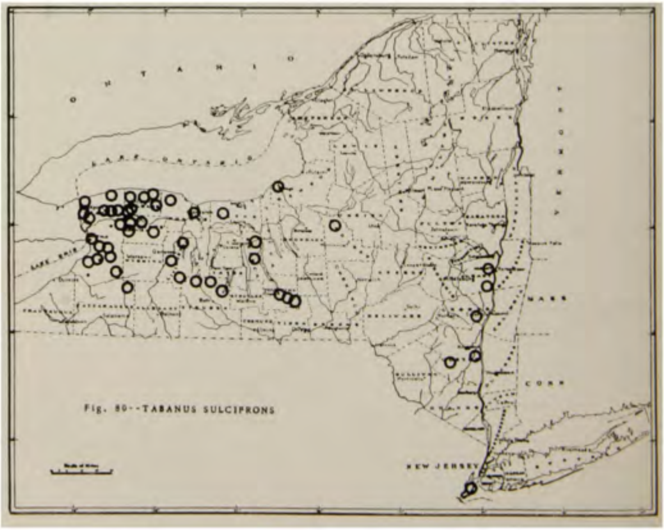

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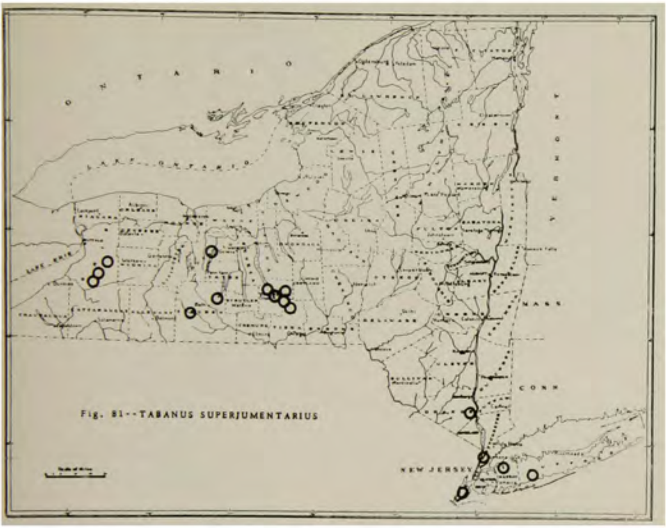

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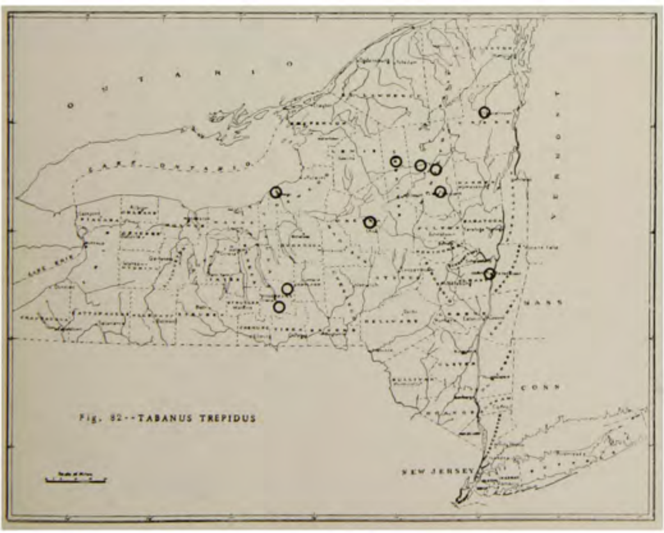

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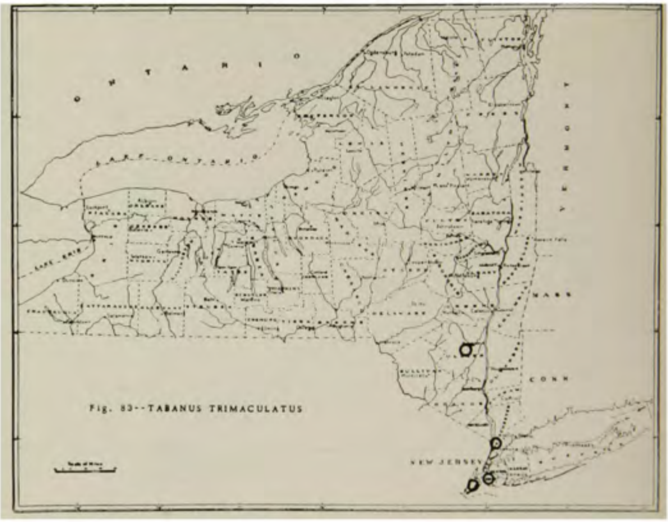

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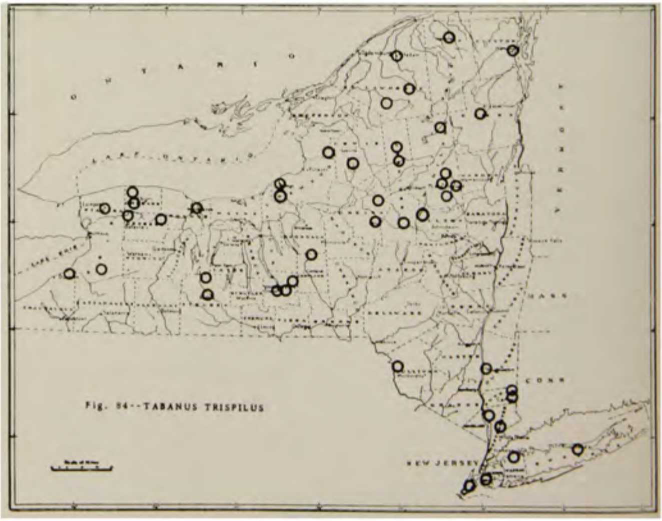

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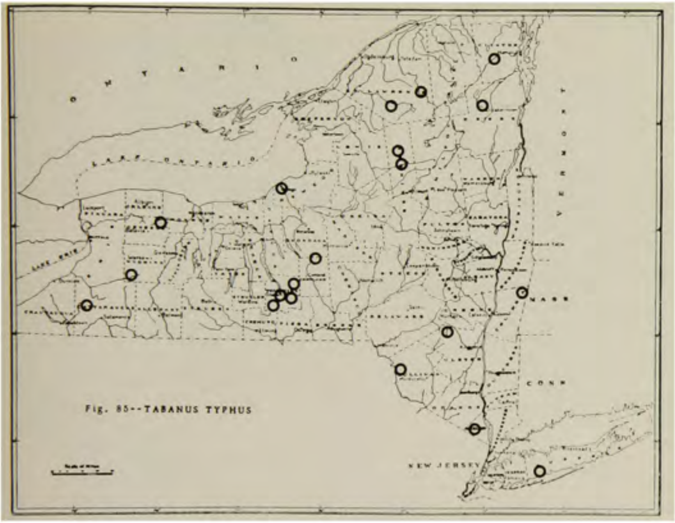

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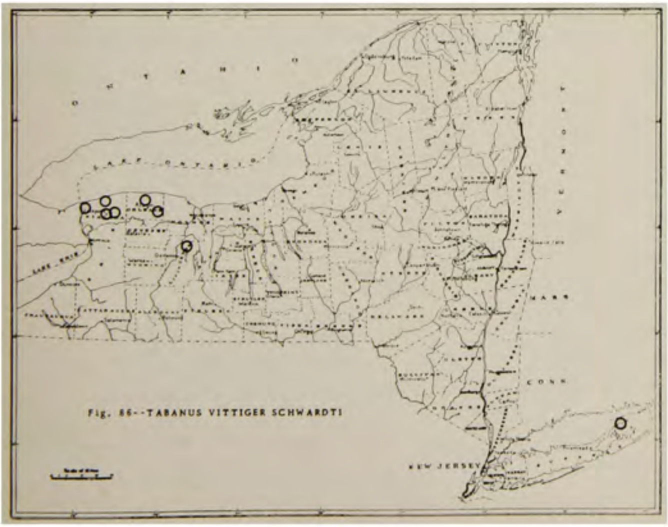

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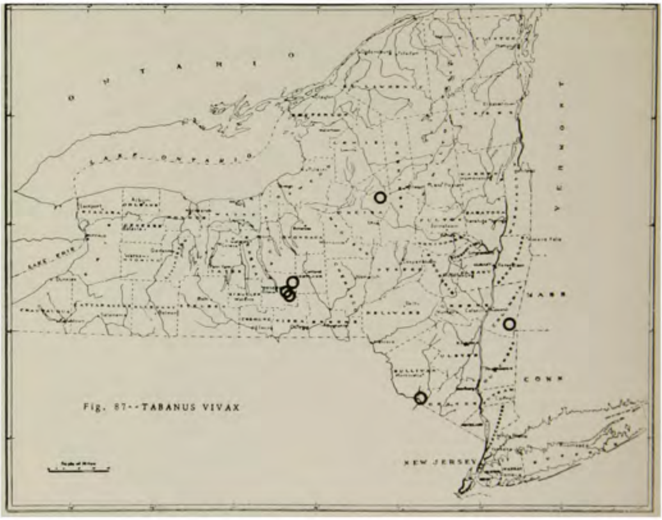

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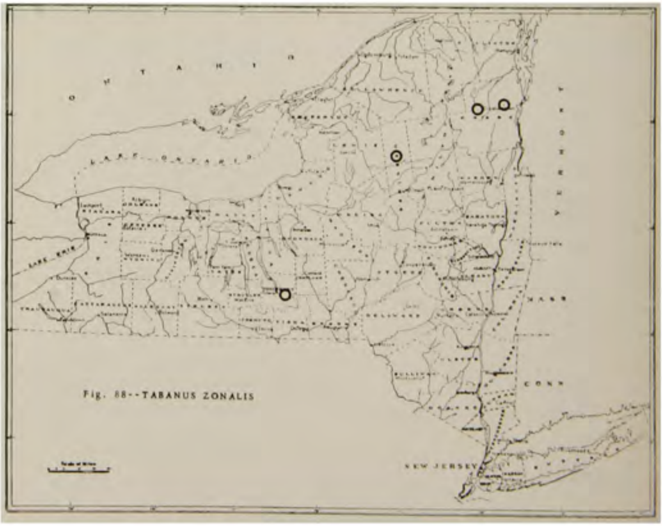

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PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE

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A STUDY OF THE FRESH-WATER CRUSTACEA (EXCLUSIVE OF THE COPEPODA) OF THE ROCHESTER AREA

by

ALICE A. LARSEN

Submitted in partial fulfillment of the requirements for the degree of Master of Science at the University of Rochester, Rochester, New York, 1956.

Supervised by William B. Muchmore, Ph.D., Department of Biology.

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INTRODUCTION

The recent fresh-water Crustacea of the Rochester area heretofore have not been investigated intensively, either taxonomically or ecologically. A limnological investigation of Irondequoit Bay in 1939–1940 by Tressler and Austin (1953) resulted in only a short list of Cladocera. Biological surveys of the Lake Ontario watershed and Irondequoit Bay conducted by the New York State Conservation Department have been concerned with the plankton as fish food and have not specifically identified the Cladocera nor noted ecological items. Any species of the various orders known from the area have been collected incidentally, and no intensive survey has been attempted.

The only comprehensive surveys conducted in New York State known to the writer are one by DeKay (1844) in which lists of Crustacea were compiled from the entire state, and one by Paulmier (1907) for the New York City area. Smaller isolated studies, such as Sibley's (1926) biological survey of the Lloyd Cornell reservation and Wilson's work (1929) have been conducted, but nothing extended has been done in recent years. It is to correct this lack for the littoral regions that the present study has been undertaken in the Rochester area.

The purpose of this study is to present a preliminary survey of the littoral species of Crustacea (exclusive of the Copepoda) of the Rochester area including distributional and ecological notes. No attempt has been made to study seasonal fluctuations quantitatively or to measure detailed physical and chemical factors of the environment.

The survey is based on collections made in the spring, summer, and fall of 1954. A few other isolated collections by others have been included as is indicated in the discussions of each order. The area covered extended on the north to Lake Ontario, west to Cedar Springs, east to Irondequoit Bay, and south to Mendon Ponds, Plate I. A variety of habitats was covered as is shown by the descriptions of the collecting stations.

The following species were collected in this work. Due to the confinement of the sampling to littoral areas, and the omission of spring collections, the list is incomplete. It is particularly poor for the Anostraca, Conchostraca and Decapoda.

Crustacea of the Rochester Area, Species List

Anostraca

Chirocephalopsis bundyi

Conchostraca

Lynceus brachyurus

Cladocera

Sida crystallina
Daphnia pulex
Daphnia longispina
**Simocephalus expinosus*
Simocephalus serrulatus
Simocephalus vetulus
Scapholeberis mucronata
Ceriodaphnia reticulata
Bosmina longirostris
Ilyocryptus sordidus
Ilyocryptus spinifer
**Macrothrix rosea*
Macrothrix laticornis
Eurycercus lamellatus
Camptocercus rectirostris
Kurzia latissima
Graptoleberis testudinaria
**Leydigia acanthocercoides*
Leydigia quadrangularis
†*Alona affinis*
†*Alona costata*
Alona guttata
†*Alona rectangula*
Alona quadrangularis
†*Chydorus globosus*
Chydorus sphaericus
Pleuroxus denticulatus
Pleuroxus hamulatus
Pleuroxus procurvatus
Pleuroxus striatus

Ostracoda

**Candona punctata*
**Candona fluviatilis*
**Candona simpsoni*
**Candona decora*
**Candona n. sp.*(†)
**Cyclocypris forbesi*
Cyclocypris sharpei
**Cyclocypris ovum*
**Cypria turneri*
**Physocypria pustulosa*
Cypricercus splendida
Cypridopsis vidua
**Potamocypris smaragdina*

Isopoda

Asellus communis Say
**Asellus militaris Hay*
Lirceus lineatus Say

Amphipoda

Hyalella azteca
Gammarus limnaeus
Gammarus fasciatus
Crangonyx gracilis

Decapoda

Cambarus bartoni robustus
Orconectes limosus
Orconectes propinquus
Orconectes immunis

* First record from New York State.
† Probably first record from New York State.

MATERIALS AND METHODS

In the selection of collecting sites an attempt was made to choose randomly, whether the area looked favorable for crustacean life or not. At each station, samples were taken from open water as well as among aquatic plants. However, collections were made only in the littoral areas of ponds and lakes; consequently there are no exclusively limnetic species in the study. Since the survey was a qualitative one, several sweeps of a fine mesh dip net through the water sufficed. The contents were washed into appropriately labelled collecting jars. In addition samples of vegetation were collected, noted and washed to collect any animals on them. Crayfish were collected by hunting under rocks and along the banks.

At almost every site the temperature of the shallow water was taken; likewise, hydrogen-ion concentrations were determined at most stations through the use of *Accutint* pH test papers. The accuracy of these papers is not great but they sufficed to give an indication of the pH range within .5 of a point. At each station notes were also made of the type of habitat with a short description of the vegetation.

Samples of animals were usually sorted under a binocular dissecting microscope and killed within two days of collecting. When it was not possible to kill the animals on the same day the sampling was done, they were placed in open glass containers in the food compartment of a refrigerator where they kept in reasonably good condition.

Unless otherwise noted in the specific preparation methods for each order, all the animals were killed and preserved in 70% ethyl alcohol until identifications could be made. In general, identifications were made from dead animals, living members of the same species serving for reference. This was not possible for the ostracods, however.

Specific details of the preparation of the animals for identification varies considerably for each order and are included in a special section under the discussion of each order.

COLLECTING STATIONS

A variety of ecological habitats were covered by the Author: stagnant marshes, temporary pools, permanent ponds and lakes, swift clear streams, sluggish creeks, ditches, part of Lake Ontario, and Irondequoit Bay. The collecting areas are roughly arranged according to the type of habitat. A brief description of the stations follows, usually with the temperatures and pH readings on the dates collections were made (1954, unless otherwise stated). Tables I and II tabulate the species found at each station, and Plate I gives the geographical locations. Restricted and minor areas and the stations of other collectors are noted in the specimen lists.

TABLE I.

DISTRIBUTION OF THE CRUSTACEA IN THE PONDS, LAKES, AND MARSHY AREAS OF ROCHESTER

	Cladocera																										Ostracoda												Isopoda	Amphipoda		
	Sida Crystallina	Daphnia longispina	Simo. serrulatus	Simo. vetulus	Scaph. mucronata	Cerio. reticulata	B. longirostris	I. sordidus	I. spinifer	Macrothrix rosea	E. lamellatus	Camp. rectirostris	Kurzia latissima	G. testudinaria	L. quadrangularis	Alona affinis	Alona costata	Alona guttata	A. rectangula	A. quadrangularis	Chydorus globosus	Chydorus sphaericus	P. denticulatus	P. hamulatus	P. procurvatus	P. striatus	Candona punctata	Candona fluviatilis	Candona simpsoni	Candona decora	Candona n. sp.	Cyclo. forbesi	Cyclo. sharpei	Cyclo. ovum	Cypria turneri	Physo. pustulosa	Cypridopsis vidua	Potamo. smaragdina	Asellus communis	Hyalella azteca	Gammarus fasciatus	Crangonyx gracilis
1. Mt. Hope Pond	x					x																x															x					
2. Lily Pond			x	x	x	x																x	x													x	x			x	x	x
3 Riley Pond			x	x		x	x												x																	x	x	x	x			
4. Black Creek Marsh			x	x																		x	x													x	x			x		
5. Blue Pond				x							x											x	x						x	x		x					x		x	x		
6. Deep Pond			x	x					x	x		x																					x	x	x	x	x			x		
7. 100 Acre Pond																													x	x					x							
8. Tobin Rd. Pond			x	x		x									x							x													x	x						
9. Ellison Marsh		x	x	x	x	x																x														x	x					
10. Buell Pond																						x							x						x		x		x	x		x
11. Ridgewood Pond					x			x										x	x			x							x							x	x	x		x		
12. Durand Lake				x				x						x			x	x				x	x						x						x	x	x		x	x		
13. Ponds S. Durand Lake			x	x		x																x	x		x						x						x		x	x		
14. Eastman Lake													x				x	x				x	x		x		x				x		x		x		x		x	x	x	
15. Marsh S. Eastman Lake																						x							x	x				x	x		x		x	x		x
16. 2 ponds W. Eastman Lake			x																			x													x					x	x	
17. Buck Pond marsh			x	x		x					x							x							x		x	x	x						x	x	x		x	x		x
18. Buck Pond entrance	x			x			x				x										x	x	x		x								x				x			x	x	
19. Buck Pond (Long Pond Rd.)				x	x																			x	x	x									x		x			x		
20. Round Pond			x	x		x							x							x			x													x				x		
21. Long Pond	x							x			x					x																				x	x		x		x	

Ponds, Lakes, and Marshy Areas

Pond in Mount Hope Cemetery.

This is a small stagnant pond full of green algae and balls of blue-green algae as well as other aquatic vegetation. Collections were made in the shallow edges at a depth of about six inches, in areas replete with tadpoles and larval mosquitoes. Temperature: 24°C, June 17. W. B. Muchmore made collections on September 23.

Lily Pond in Highland Park off South Avenue.

A small pond thick with green algae, water lilies, Elodea, duckweed, and dead leaves. The mud bottom is overgrown with Myriophyllum, and animals were collected from among this vegetation along the shore. Temperature: 23.5°C, June 17 and 19.

Riley Pond below Cobbs Hill.

A fairly shallow pond, it contains much Elodea, Potamogeton, Eleocharis and a variety of green algae. Collections were made among the vegetation and along the mud bottom. Temperature: 21°C, pH ca. 6–7, August 18.

Marsh area from Black Creek on Scottsville Road.

Collections were made in small pools in the muddy edge of a pond-like area. Cattails, decaying leaves, wood and other vegetation abound. Temperature: 7°C, November 5.

Blue Pond near Cedar Springs Park.

Collections were made from the shallow edges of this large pond. All the animals were found among the thick Anacharis which forms large masses near the bottom. Temperature: 7°C, pH 6.6–6.8, November 8.

Deep Pond in Mendon Ponds Park.

A large pond south of One Hundred Acre Pond. Its western shore line is a marshy area overgrown with cattails. Collections were made in the muck and small pools amid much duckweed. Temperature: 17–22°C, June 30 and July 10.

One Hundred Acre Pond in Mendon Ponds Park.

Collections were made along the shore of this large pond in shallow pools. November 17. Most of the animals collected were lost with the exception of the ostracods listed in Table I.

Pond at the corner of Tobin and Clover Roads near Mendon Ponds Park.

A shallow stagnant pond covered with green algae and lumps of blue-green algae, cattails, duckweed and other decaying vegetation. Collections were made along the shore in little pools present. Temperature: 10°C, November 17.

Marsh along main road of Ellison Park.

The area is covered with cattails and the bottom muck is full of duckweed and grasses. Collections were made in little pools of water found in between the plants. Temperature: 24° and 28°C, June 23 and July 28.

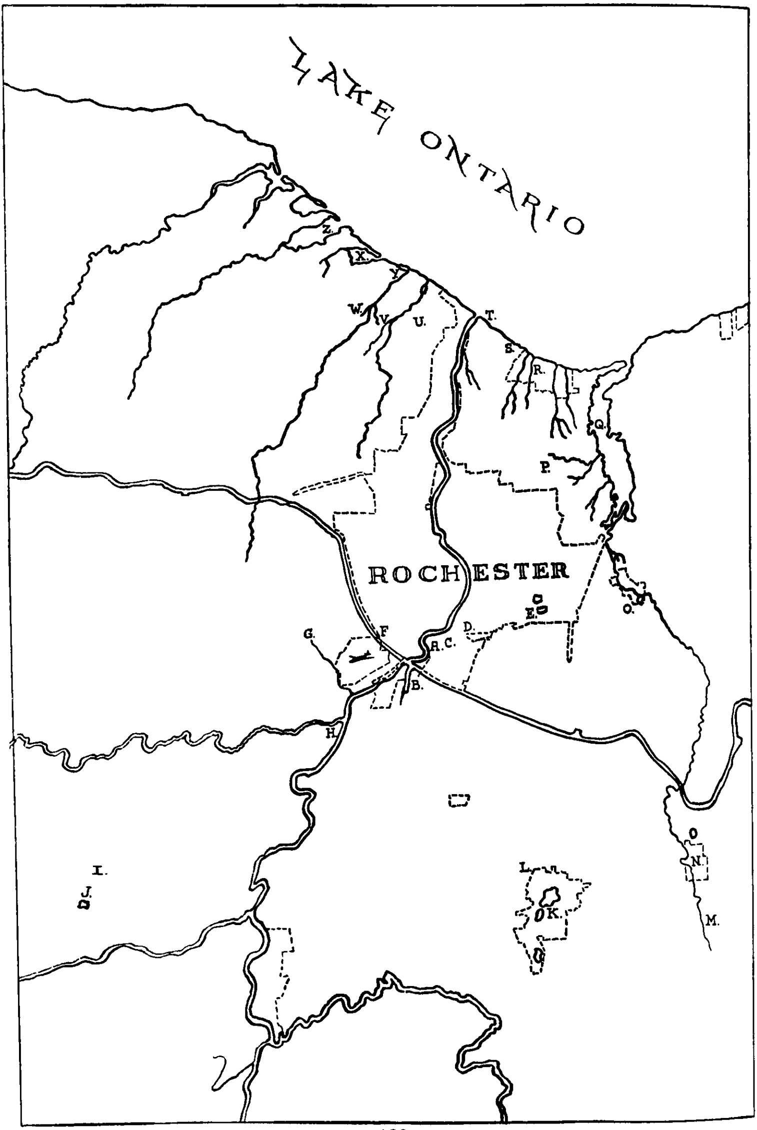
LAKE ONTARIO
ROCHESTER
A.
B.
C.
D.
E.
F
G.
H.
I.
J.
K.
L.
M.
N.
O.
P.
Q.
R.
S.
T.
U.
V.
W.
X.
Y.
Z.

Plate I

COLLECTING SITES

A. Genesee River Area
B. Red Creek (Hawthorne Drive and East River Road)
C. Mount Hope Cemetery Pond
D. Lily Pond (South Avenue)
E. Riley Pond (Below Cobbs Hill)
F. Barge Canal (Brooks Avenue)
G. Little Black Creek
H. Little Black Creek marsh (Scottsville Road)
I. Cedar Springs Area
J. Blue Pond
K. Sites in Mendon Ponds Park
L. Pond at Tobin and Clover Roads
M. Irondequoit Creek at Fisher Road and Main Street-of-Fisher
N. Sites at Powder Mill Park
O. Ellison Park sites
P. Buell Pond and Hobbie Creek east of pond
Q. Little and Big Massaug Coves (west shore of Irondequoit Bay)
R. Sites in Durand-Eastman Park
S. Two ponds west of Eastman Lake
T. Site at Lake Ontario
U. Flemming Creek area
V. Slater Creek
W. Round Pond Creek
X. Sites at and near Buck Pond
Y. Round Pond
Z. Long Pond

Buell Pond on Culver Road north of Ridge Road.

A small stagnant pond with duckweed cover, algal masses, Ceratophyllum, and cattails along the shore. Collections were made in the shallow areas among the vegetation. Temperature: 23°C, August 18.

Ridgewood Pond north of Ridge Road.

A shallow pond with some aquatic vegetation, and parts of its shore are lined with cattails and duckweed. Temperature: 28°C, pH 8.2–8.5, September 7.

Durand Lake in Durand-Eastman Park.

Collections were made from the shore line of this large lake in sections where green algae, duckweed, Ceratophyllum, Rumex and other vegetation grows in abundance. Temperature: 13°–19°C, pH 6.6–7.6, September 16 and October 21.

Ponds, southern extensions of Durand Lake.

These are small ponds with marshy shores lined with cattails. Some duckweed, Elodea, and Pontamogeton were present in fairly clear water, and collections were taken from among them. Temperature: 12°C, pH ca. 6.5, October 21.

Eastman Lake in Durand-Eastman Park.

Collections were made from the shores of this lake amid water lilies, algal mats, Ceratophyllum, Rumex and other aquatic vegetation. Temperature: 15°–18°C, pH 6.5–7.0, September 16 and October 21.

Marsh south of Eastman Lake.

The area has the typical marsh vegetation: cattails, duckweed, mosses. Collections were made in small pools present. Temperature: 12°C, October 21.

Two Ponds West of Eastman Lake along shore of Lake Ontario.

Both ponds are similar to Eastman Lake in vegetation and type of water. Collections were made along the shore by rotting logs. Temperature: 12°C, October 21.

Marsh east of Buck Pond near Island Cottage Road.

An area full of cattails, duckweed, algal mats, lilies, and clumps of Sagittaria. Collections were made in the shallow margins near shore. Temperature: 15°C, September 21 and 30.

Buck Pond at its entrance to Lake Ontario.

Collections were made in the shallow water among clumps of aquatic vegetation. The water, although there is some duckweed, is fairly clear. Temperature: 15°C, pH ca. 7, September 30.

Buck Pond east of Long Pond Road.

Collections were made along the marshy shore among cattails and duckweed. Temperature: 15°C, September 30.

Round Pond.

A section of Round Pond has cattails and a duckweed cover. Collections were made in water about two feet deep among clumps of Ceratophyllum. Temperature: 15°C, pH 6.5–7.5, September 21 and 30.

Long Pond at its entrance to Lake Ontario.

Collections were made in the shallow still water in which algae, Myriophyllum, and duckweed are found. Temperature: 15°C, September 30.

Rivers

Genesee River opposite Faculty Road along River Boulevard.

This protected area is pond-like, located between shore and an arm of land jutting into the Genesee. The water is still and overgrown with algae, cattails, Elodea and other aquatic vegetation. Collections were made in the shallows. Temperature: 23°C, June 17.

Genesee River near Elmwood Avenue.

Collections were made among the rocks on the eastern shore. The water is moderately still, for many rocks act as small breakwaters. Some dead leaves and rotting wood are present, but the water is fairly clear. Animals were obtained from depths up to two feet. Temperature: 24°C, June 22.

Genesee River by Bridge E149 in Genesee Valley Park.

Collections were made along the shore in shallow water full of Elodea. The water is still and clear, and the bottom is muddy. Temperature: 20.5°C, pH 6–6.2, September 11.

Moderately Flowing Creeks

Red Creek off Hawthorne Drive in Genesee Valley Park.

A small leisurely running creek of clear water with a mud bottom and grassy banks. Aquatic vegetation lines the shores, and collections were made in this vegetation. Temperature: 20°C, pH 6.2–6.4, September 11.

Red Creek at East River Road.

Collections were made in a marshy area created by the creek's invasion of a small wooded area. Animals were obtained from little pools in the mud, which is overgrown thickly with Sagittaria. Temperature: 20°C, pH ca. 6, September 11.

Little Black Creek as it crosses Brooks Avenue.

A small creek with clear water which during rains runs swiftly. The creek has a pebbled bottom over dark soil. Collections were made among the grasses, twigs, and some duckweed, although amphipods were found sparsely in clear midstream areas. The depth of the creek does not exceed two feet. Temperature: 6°–7°C, pH 6–6.4, September 14 and November 5.

Irondequoit Creek in Ellison Park.

A moderately swift clear creek about fifteen feet across with a sandy bottom. The depth does not exceed four feet, and collections were made among the shore-line vegetation, and among some water plants in mid-stream. Temperature: 25°C, pH 6.6, July 28.

Hobbie Creek east of Buell Pond.

A tiny creek with clear running water over a sandy bottom. Collections were made about the scant vegetation. Temperature: 20°C, pH 6, August 18.

Slater Creek, west of Dewey Avenue on Latta Road.

A small sluggish creek full of algal mats, Elodea, cattails, and other vegetation. At the time the collections were made it was less than eight inches deep. It apparently has dry spells, for when it was revisited (June, 1955) a mere trickle of water was present. Temperature: 15°C, September 21 and September 30.

Round Pond Creek on Island Cottage Road southwest of Round Pond.

A moderately sluggish creek about ten feet wide. There are large beds of Elodea, some green algae, Potamogeton, Ceratophyllum, and scattered clumps of Sagittaria. Collections were made about the vegetation. Temperature: 15°C, pH ca. 7, September 21 and 30.

Swift Clear Creeks

Streams in Cedar Springs Park.

The park, at the time the collections were made, was crisscrossed with swift, clear, cold streams, many of them full of trout. The area about the brooks was heavily overgrown with sphagnum, and this moss, along with some bushes, often lined the banks. The depth of the mud-bottomed streams ranged from along one-half to one foot where the collections were made. Most animals were gotten from the protected banks. Some amphipods were found in mid-stream. Since the time of these collections the park has been greatly changed because of its conversion to a fish hatchery. Temperatures: 9°–10°C, pH 6.2–7.2, October 23 and November 8.

Irondequoit Creek along Main-Street-of-Fisher and Fisher Road (south of Powder Mill Park).

This part of the creek is about fifteen feet across with swift, clear water. It has a clay bottom and some rocks, with a depth of less than three feet. Much Elodea is present and some other grasses. Samples were taken around the vegetation. Temperature: 5.5°C, pH 7.0–7.4, November 17.

Creek south of Eastman Lake.

A small, moderately swift creek with some aquatic vegetation. Collections were made mid-stream and shore among the plants. Temperature: 12°C, pH 6.6–6.8, October 21.

Flemming Creek, east of Dewey Avenue on Latta Road.

The creek, about six feet wide, contains swiftly running clear water over a gravel and sand bottom. Amphipods and crayfish were in abundance swimming about the rocks and shore-line vegetation. Collections were made in mid-stream as well as along the shore. The same type of animals were collected in both places. Temperature: 14°C, pH 6.8–7.2, September 21.

Irondequoit Bay

Little Massaug Cove of Irondequoit Bay.

A large protected cove of the Bay with fairly sandy soil. The shore contains some Elodea, rotting wood, and a few cattails. On September 7 the water was clear. Temperature: 28°C, pH about 8.

Big Massaug Cove of Irondequoit Bay.

This cove is immediately south of the preceding one and is characterized by a rather marshy area on one side. This section has cattails, duckweed, and other vegetation, and collections were made here. Temperature: 26°C, pH 8, September 7.

Others

Barge Canal by Brooks Avenue Bridge.

Collections were made along the edge of a concrete wall which has an unidentified green moss-like plant growing on it. The canal is very deep here so animals were gotten only from the surface and among the vegetation. Some collecting was done from a pebbled embankment along which water washes. The pH 6, September 14.

Swimming Pool at Cedar Springs Park.

Here some swift, clear streams are dammed and the resulting pool is used for swimming. It was lined with some aquatic vegetation and collections were made from these areas. The water was very cold and clear. Temperature: 7°C, pH about 7, November 8.

Ditch by main road in Mendon Ponds Park.

This is a temporary pond by a wooded area and overgrown with vegetation. July 10 (Richard L. Heinemann).

Powder Mill Park Stations.

Sporadic collections were made in various areas of the park. No record of the different orders of animals collected from each spot was kept. Below are listed the animals recorded from the park, the place of their collection and the date. These are listed here to facilitate the presentation of Table II.

Anostraca

Chirocephalopsis bundyi

Temporary pond, Park Road; March, 1954 and Spring, 1955.

Conchostraca

Lynceus brachyurus

Temporary pond, Park Road; March, 1954 and Spring, 1955.

Cladocera

Ceriodaphnia reticulata

Beech Grove; May 1955.

Cypricercus splendida
Beech Grove; April 1954.

Daphnia pulex
Beech Grove; April, 1954 and May, 1955.

Isopoda

Asellus militaris
Shores of ponds; April, 1954 and April, 1955.

Amphipoda

Crangonyx gracilis
Stream; April 1954.

Gammarus fasciatus
Stream; October 13, 1953.

Gammarus limnaeus
Stream; October 13, 1953.

Decapoda

Cambarus bartoni robustus
Streams; September 12, 1952 and November 27, 1954.

Lake Ontario by the Summerville Coast Guard Station.

A very scanty sample was taken from the water by the breakwater. Waves keep the water quite turbulent here but some animals were found about vegetation clinging to the concrete wall. Temperature: 13.5°C, pH 6–7, October 21.

Animals of the Area

DIVISION EUBRANCHIOPODA

The Eubranchiopoda are exclusively fresh-water animals resident in temporary ponds and pools usually during the spring and early summer. Only a few genera and species of this group are cosmopolitan. In fact, many species listed from the United States by Pennak (1953) are reported only from one isolated locality. Both species found in the Rochester area are common and widely distributed in the United States.

There have been many studies on the species of this group, one of the earliest in America being included in Underwood's monograph (1886). This work reports the following species from New York: *Eubranchipus holmani* (from Long Island), *E. vernalis,* and *Streptocephalus seali.* Shantz (1905) and Pearse (1912) published extensive notes on this group, and Pearse (1918) summarized the known species. The most comprehensive work on the world species of Anostraca and Conchostraca is a series by Daday published successively in 1910, 1915, 1923, 1925, 1926, 1927. He reports the following species from Long Island, New York: *Lynceus brachyurus, E. holmani,* and *S. seali.* Creaser (1930b) published a paper on the North American phyllopods of the genus *Streptocephalus* in which he, too, reported *S. seali* from New York, and in his earlier paper (1930a) he published a revision of the genus *Eubranchipus* in which he recorded *Chirocephalopsis bundyi* and *E. vernalis* from this state. Mattox (1939) in a study of the Phyllopoda of Illinois, and Dexter and Kuehnle (1951) in a survey of the fairy shrimp population of northeastern Ohio have summarized much distributional information. Mackin (1952) did much to clarify the specific names of some North American species of Branchinecta, and Linder (1941) clarified a great number of uncertain and controversial taxonomic questions in the group. Dexter (1953) reviewed the geographical distribution of the known Anostraca, giving some records on multiple species of Anostraca living together.

The following section lists only two members of the group Eubranchiopoda collected from two localities. Since most of the collections for this survey were made from June to November, most of the species of this group had disappeared with the vernal ponds. The members of the species which were collected were found in March and April. No significant ecological information was recorded for this sub-class.

List of Species

Division Eubranchiopoda

Order Anostraca

Family Thamnocephalidae

Genus Chirocephalopsis

Chirocephalopsis bundyi Forbes, 1876

Branchipus gelidus Hay
Eubranchipus gelidus Hay

March, 1954: Park Road, Powder Mill Park (W. B. Muchmore); April, 1954: Genesee Valley Park pond (W. B. Muchmore); April, 1955: Powder Mill Park.

All the specimens were collected early in the spring in pools and ditches among grasses. Whenever found the members of the species were present in abundance, and in the April, 1955 collection *C. bundyi* was associated with *Lynceus brachyurus.*

Order Conchostraca
Family Lynceidae

Genus Lynceus O. F. Müller
Limnetis Loven
Hedessa Lièvin

Lynceus brachyurus O. F. Müller

Hedessa Sieboldii Lièvin
Hedessa brachyura Siebold
Limnetis brachyurus Grube
Limnetis brachyura Leydig
Limnetis gouldii Baird
Limnetis mucronatus Packard
Limnetis zichyi Daday

March, 1954: Park Road, Powder Mill Park (W. B. Muchmore); April, 1955: temporary pond in ditch, Powder Mill Park.

Whenever members of this species were found they were present in great numbers. In the April, 1955 collection *L. brachyurus* was found associated with *Chirocephalopsis bundyi.*

ORDER CLADOCERA

This order has been intensively studied both taxonomically and ecologically, perhaps because of its availability in nearly all types of fresh-water habitats. Early comprehensive records of taxonomy and distribution in North America include Herrick and Turner's work (1895), and Birge's complete notes (1893, 1910). A very masterful treatment of this group by Birge (1918) has retained its authority until the present, for surprisingly little has been added to our knowledge of cladoceran taxonomy and distribution (Pennak, 1953). Recent listings of Cladocera for areas in the same ecological life zone are found in Langlois' book (1954) and in Ward's paper (1940).

Limnological studies throughout New York have resulted in a fairly complete list of genera for the state. As a result of biological studies conducted by the New York State Conservation Department, cladoceran genera have been listed for Cayuga, Seneca, and Oneida Lakes; lakes in the St. Lawrence watershed; Silver Lake and Conesus Lake; Lake Champlain (Muenscher, 1928, 1931, 1927, 1930); Oswegatchie and Black

River systems (Burkholder and Tressler, 1932); Mohawk-Hudson watershed; lower Hudson area lakes; Chautauqua Lake; lakes in the Raquette River watershed; lakes in the Delaware and Susquehanna watersheds; four Long Island lakes; Lake Ontario watershed, excluding Genesee River and its tributaries (Tressler and Bere, 1935, 1937, 1938, 1934, 1936, 1939, 1940); and lakes of the upper Hudson watershed (Burkholder and Bere, 1933). Since none of these studies include species identifications or much ecological data, their value is limited. However, individuals of all the genera recorded have been collected in this survey with the exception of two limnetic genera, *Holopedium* and *Leptodora,* and the following littoral genera: *Alonella, Acroperus, Acantholeberis, Diaphanosoma, Moina, Ophryoxus, Parophryoxus,* and *Polyphemus.*

Rimsky-Korsakoff (1930) in a study of the food of fishes in the Champlain watershed has recorded a detailed list of cladoceran species. Only four of the species listed have not appeared in this Rochester survey: *Leptodora kindtii, Holopedium gibberum, Acroperus harpae,* and *A. angustatus.* Of these, the first two are limnetic species and thus individuals could not have been collected by the methods employed in this survey. Sibley (1926) in a biological survey of the Lloyd-Cornell reservation collected members of eleven species of Cladocera, all of which occur in Rochester. The macroplankton in Eastern Lake Erie have been studied by Wilson (1929) and twenty-seven cladoceran species reported. Specimens of nineteen of these have been collected in the Rochester area. The following have not been found: *A. harpae, Ceriodaphnia pulchella, Chydorus gibbus, H. gibberum, Latona setifera, L. kindtii, Moina rectirostris* and *Pleuroxus adunctus.*

Of the surveys listing species, a limnological investigation of Irondequoit Bay conducted by Tressler and Austin (1953) in 1939–1940, is the only previous one known to the writer which includes waters sampled in the present study. Here *Alona* sp., *Bosmina longirostris, Daphnia longispina, D. pulex* (including *D. retrocurva*), *Leptodora kindtii* and *Sida crystallina* were reported. Individuals from all except the limnetic *L. kindtii* and the retrocurva variety of *D. pulex* have been collected fairly commonly throughout the Rochester area.

The following section lists specimens of the littoral species of Cladocera collected in this area. It is preceded by details of preparation and annotated with ecological and distributional data.

Methods of Preparation.

The specimens were usually killed in 95 per cent ethyl alcohol soon after collections were made. When *Sida crystallina* was found, it was killed by adding 70 per cent ethyl alcohol to the water in order to prevent too great a distortion caused by the swift contraction of its strong muscles. All specimens were preserved in 70 per cent alcohol until identifications could be made.

No dissections were necessary, but the animals were mounted on slides to facilitate identification. Slides were first ringed with Murrayite cement and allowed to dry thoroughly. CMC-10, a non-resinous mounting medium, was added to the cavity and the animal was put directly from alcohol into the medium and oriented. A cover slip was then applied and after a few days it was ringed with the cement. This new mounting medium has the advantage of being a clearing agent and is soluble in water, formalin, and alcohol. A disadvantage was observed, however, in its long drying time. It also tended to dissolve the Murrayite giving the completed slide a brown streaked appearance. It might be more advantageous to use Höyer's Medium.

List of Species

Order Cladocera
Suborder Calyptomera
Tribe Ctenopoda
Family Sididae

Genus Sida Straus, 1820

Sida crystallina (O. F. Müller, 1785)

> June 17: Genesee River near university; June 22: Genesee River near university; September 11: stream off Hawthorne Drive in Genesee Valley Park, stream off bridge on East River road; September 23: Mt. Hope Pond (W. B. Muchmore, collector); September 30: Long Pond at its entrance to Lake Ontario, Buck Pond at its entrance to Lake Ontario.

Temperature range: 15–24 degrees centigrade, pH 6–7.4. Members of this species were found in the littoral areas of ponds, Genesee River and creeks, among weeds and often rotting wood. They were associated with many Cladocera, and appear to be quite common in this area. This species has been reported from Irondequoit Bay (Tressler and Austin 1953), as well as other parts of New York State.

Suborder Calyptomera
Tribe Anomopoda
Family Daphnidae

Genus Daphnia O. F. Müller, 1785

Daphnia pulex (de Geer, 1778)

> April 6: Park Road, Powder Mill Park; June 22: Genesee River, shallows near Elmwood Avenue Bridge; June 17: Genesee River, shallow inlet opposite Faculty Road; April 4, 1955: Powder Mill Park.

Temperature range: 23–24°C. Specimens have only been found in the spring and early summer, and then not in very great abundance. They have been found in littoral areas among cattails, algae, and other aquatic vegetation among individuals from many other cladoceran species.

This is a very common species, being truly cosmopolitan (Pennak, 1953).

Daphnia longispina (O. F. Müller, 1785)

April 7: drainage ditch near railroad tracks behind University of of Rochester (W. B. Muchmore); July 28: Ellison Park marsh near main road.

Temperature: 28°C. Only a few specimens were found in two localities where samples were taken. This lack of specimens might be due to the confinement of sampling areas to littoral regions full of vegetation, for Woltereck (1932) says ". . . *D. longispina* prefers the open water of the same ponds and of fresh water lakes."

This is a common, widely distributed species in America. It has been reported from Irondequoit Bay (Tressler and Austin, 1953).

Genus Simocephalus Schoedler, 1858

Simocephalus expinosus (Koch, 1841)

July 10: temporary pond off main road at Mendon Ponds Park.

Only a few animals were found at this one pond, which was stagnant and thickly overgrown with algae and duckweed. They were found associated with *Pleuroxus denticulatus,* and *Chydorus sphaericus.*

This species is reported by Birge (1918) to be "not common; reported from Massachusetts, Wisconsin and the Southern states." However, Ward (1940) reports it as a common species from Ohio, so its range has not been defined as yet.

Simocephalus serrulatus (Koch, 1841)
Daphnia serrulata Koch

June 17: Genesee River, shallows opposite Faculty Road and River Boulevard; June 19: Lily Pond; June 23: Ellison Park marsh along main road; June 30: Deep Pond in Mendon Ponds Park; July 28: Ellison Park, marsh and pond both along main road; August 18: pond below Cobbs Hill; September 7: Big Massaug Cove, stagnant area; September 11: Genesee Valley Park stream off Hawthorne Drive, same stream by East River Road bridge, Genesee River in Genesee Valley Park by bridge E149; September 21: O'Neil Point marsh (Island Cottage Road and Edgemere Drive); September 28: Genesee River near Elmwood Avenue bridge (Dick Heineman), drainage ditch in Genesee Valley Park; September 30: Round Pond at entrance to Lake Ontario; October 21: pond south of Durand Lake, pond near Sunshine Camp entrance west of Eastman Lake; November 5: Little Black Creek (Brooks Road), Black Creek marsh off Scottsville Road near Genesee River; November 17: pond at Tobin and Clover Roads.

Members of this species are very abundant and have been found in temperatures ranging from 6°–28°C, and pH 6–8.4. They have been collected in all littoral areas, usually associated with aquatic vegetation. They frequent stagnant and clear running water alike, and are associated with individuals of many different species of Cladocera.

This species has been widely reported from New York State and is common everywhere (Birge, 1918).

Simocephalus vetulus (O. F. Müller, 1776)
Daphnia vetula Baird
Daphnia sima Müller

June 17: Lily Pond; June 19: Lily Pond; June 22: Genesee River shore near Elmwood Avenue; June 23: Ellison Park marsh by main road; June 30: little pools among reeds of Deep Pond, Mendon Ponds Park; August 18: pond below Cobbs Hill, Buell Pond; September 7: Big Massaug Cove along stagnant area; September 30: Round Pond Creek (off Island Cottage Road), beside Buck Creek, Buck Pond near Long Pond Road, Round Pond, Buck Pond where pond enters Lake Ontario; October 21: pond south of Durand Lake, Durand Lake; November 8: Blue Pond near Cedar Springs; November 5: Black Creek marsh off Scottsville Road near Genesee River; November 17: pond at Tobin and Clover Roads, creek along Main Street-of-Fisher and Fisher Road.

Temperature range: 5.5°–26°C, pH 6–8.4. Specimens found every month collections were made. Individuals were found abundantly in the vegetation of the shoreline of creeks, ponds, rivers, and marshes, in running or stagnant water. It is difficult to differentiate this species from *S. serrulatus,* for often the head spines of the latter are very inconspicuous, thus removing a diagnostic feature. Very often members of these two species were found living together. Pennak (1953) reports that *S. vetulus* is not common although widely distributed. However, in the collections made in this area large numbers have been found in rather widespread areas.

This species has been reported from eastern Lake Erie, Lloyd-Cornell reservation and other parts of New York State.

Genus Scapholeberis Schoedler, 1858

Scapholeberis mucronata (O. F. Müller, 1785)
Daphnia mucronata Müller

June 17: Genesee River shore near Faculty Road and River Boulevard, Lily Pond; June 22: Genesee River shore near Elmwood Avenue bridge; June 23: Ellison Park marsh along main road; July 28: Ellison Park marsh along the main road; September 7: pond near Ridgewood school, Big Massaug Cove stagnant area; September 11: Genesee River bridge E149 in Genesee Valley Park, stream off East River Road; September 30: Buck Pond near Long Pond Road.

Temperature range: 15–28°C, pH 6–8.4. Specimens have been found abundantly in stagnant and clear still waters from early spring to late fall.

They have been associated with individuals from many other cladoceran species around aquatic vegetation.

This species has been commonly reported from New York State.

Genus Ceriodaphnia Dana, 1853

Ceriodaphnia reticulata (Jurine, 1820)

Monoculus reticulatus Jurine
Daphnia reticulata Baird
Ceriodaphnia quadrangula Schoedler
Ceriodaphnia fischeri Leydig

June 19: Lily Pond; June 23: Ellison Park marsh along main road; August 18: Pond below Cobbs Hill; September 23: Mt. Hope Cemetery pond (W. B. Muchmore); September 30: marsh off Buck Creek, Round Pond near Island Cottage Road; October 21: pond south of Durand Lake; November 17: pond at Tobin and Clover Roads.

Temperature range: 10–24°C, pH 6–8.4. Individuals were found throughout the time when collections were made in marshes and along the littoral areas of ponds and lakes among aquatic vegetation. With one exception (Mt. Hope Cemetery pond) all the collections which included members of this species also included *Simocephalus vetulus* and *S. serrulatus*. Individuals from other species were found associated with these, but none with such regularity. Whenever *C. reticulata* was found a fair number of individuals was collected.

This species has been reported from other parts of New York State and specimens are common and widely distributed (Birge, 1918).

Ceriodaphnia quadrangula (O. F. Müller, 1785)

C. scitula Herrick
Daphnia quadrangula O. F. Müller
Daphnia reticulata Baird

April 4, 1955: Powder Mill Park pond.

A single specimen was found associated with some *Daphnia pulex* in a pond from which frog eggs were collected (littoral area).

This species has been recorded from other parts of New York State (Sibley, 1926) and is common in all regions (Birge, 1918).

Family Bosminidae

Genus Bosmina Baird, 1845

Bosmina longirostris (O. F. Müller, 1785)

June 17: Genesee River opposite Faculty Road and River Boulevard; August 18: pond below Cobbs Hill; September 30: Buck Pond at entrance to Lake Ontario.

Temperatures: 15°, 22° and 24°C, pH 6.9–7.4 (at Buck Pond). A single specimen was found in each collection listed above, all of which were taken from the weeds of shallow water. *B. longirostris* was outnumbered by a great variety of the more abundant Cladocerans.

This species is commonly reported from many areas in New York State (including Irondequoit Bay) and surrounding areas.

Family Macrothricidae

Genus Ilyocryptus Sars, 1861

Ilyocryptus sordidus (Lièvin, 1848)
Acanthocerus sordidus Lièvin

July 28: Irondequoit Creek in Ellison Park; September 7: pond near Ridgewood School, Big Massaug Cove stagnant area; September 11: stream off East River Road; September 16: Durand Lake; September 30: Long Pond entrance to Lake Ontario.

Temperature range: 18–28°C, pH 6.2–8.4. Specimens were found in July and September in both clear running water and stagnant marshy water associated with weeds on muddy bottoms. Pennak (1953) reports these animals as uncommon, but in this vicinity they are found singly or in small numbers, crawling on mud bottoms, their red bodies covered with debris. Whenever they have been collected in this area they have always been found with other Cladocerans.

This species has been reported from the eastern end of Lake Erie (Wilson, 1929).

Ilyocryptus spinifer Herrick, 1884
I. longirimus Sars
I. halyi Brady

June 30: mud shore of Deep Pond, Mendon Ponds Park.

Temperature: 23°C. A few specimens were found crawling in the mud of the pond's shore, which is lined with cattails and duckweed. They were found along the same shore with *Simocephalus serrulatus, S. ventulus, Camptocercus rectirostris* and *Macrothrix rosea.*

This species has previously been reported from New York State.

Genus Macrothrix Baird, 1843

Macrothrix rosea (Jurine, 1820)
M. tenuicornis Kurz
M. elegans Sars

June 30: mud of shore of Deep Pond, Mendon Ponds Park.

Temperature: 23°C. One specimen was found in the muddy area of the pond in association with members of the species mentioned under *Ilyocryptus spinifer.*

Although Birge (1918) says that this species is "common everywhere in marshy pools and margins of lakes", this is the first recent report of its presence in New York.

Macrothrix laticornis (Jurine, 1820)

September 11: stream near Hawthorne Drive, Genesee Valley Park; November 17: creek running along Main Street-of-Fisher and Fisher Road.

Temperatures: 20° and 5.5°C, pH 6.2–6.4 and 7.0–7.4. Specimens were found in clear running water, swimming among the aquatic vegetation. They were associated with members of several other cladoceran species in both collections. Only one individual was collected at each place.

This species has previously been reported from New York State (Wilson, 1929). Birge (1918) says it is widely distributed.

Family Chydoridae

Subfamily Eurycercinae

Genus Eurycercus Baird, 1843

Eurycercus lamellatus (O. F. Müller, 1785)

June 17: Genesee River shore opposite Faculty Drive and River Boulevard; June 22: Genesee River near Elmwood Avenue; September 11: Genesee River in Genesee Valley Park near bridge E149; September 21: O'Neil Point, marsh at Island Cottage Road and Edgemere Drive; September 30: Long Pond at entrance to Lake Ontario, Buck Pond near Long Pond Road; November 8: Blue Pond near Cedar Springs.

Temperature range: 7°–23°C, pH 6–8.4. Specimens were found in shallows of river, ponds, lakes, and marshes among vegetation. They were always collected with other large bodied forms as well as the smaller sizes of Cladocerans and were present in collections in large numbers.

This species has commonly been reported from New York and surrounding areas.

Subfamily Chydorinae

Genus Camptocercus Baird, 1843

Camptocercus rectirostris (Schödler, 1882)

June 17: Genesee River shore opposite Faculty Drive and River Boulevard; June 22: Genesee River near Elmwood Avenue; June 30: Deep Pond at Mendon Ponds Park; September 7: Little Massaug Cove.

Temperature range: 23°-27°C. Individuals were collected in shallow water among weeds and associated with members of many different species of Cladocera. A few were found in each collection listed above; these animals were often outnumbered by the members of other species.

This species is common in New York State.

Genus Kurzia (Dybowski and Grochowski, 1894)

Kurzia latissima (Kurz, 1874)

September 16: Durand-Eastman Park; September 30: Round Pond near Island Cottage Road.

Temperatures: 19° and 15°C, pH 6.6–7.2. This species was found among weeds in shallows and associated with several different species of Cladocera. Only one or two were obtained in each collection, both collections, however, being made in September.

This species has been reported from New York and is found in all regions (Birge, 1918).

Genus Graptoleberis Sars, 1863

Graptoleberis testudinaria (Fischer, 1848)
Lynceus testudinarius Leydig
Lynceus reticulatus
Alona testudinaria Schoedler
Graptoleberis inermis Birge

September 16: Durand Lake.

Temperature: 19°C, pH about 7.5–7.8. Representatives of this species were found only in Durand Lake, but were abundant, greatly outnumbering individuals of accompanying species. *G. testudinaria* was found at the shore line among lilies, duckweed and rotting wood.

Genus Leydigia Kurz, 1874

Leydigia acanthocercoides (Fischer, 1854)
Lynceus acanthocercoides Fischer
Eurycercus acanthocercoides Schoedler
Alona acanthocercoides Müller

June 17: Genesee River shore opposite Faculty Drive and River Boulevard; September 7: Little Massaug Cove, Big Massaug Cove stagnant area.

Temperature range: 23°–27°C, pH at both coves was 8.2–8.5. One or two specimens were found in each collection listed above, and these were greatly outnumbered by members of several other species. All these collections were made in shallow water among cattails. According to Birge (1918) this species is rare, found only in Louisiana. It is a European species, so perhaps it was introduced from there. Because of the Cladocera's resistant ephippial eggs, individuals are easily transported to new habitats. One *L. quadrangularis* was found along with members of this species in the Genesee River collection.

Leydigia quadrangularis (Leydig, 1860)
Lynceus quadrangularis Leydig
Alona leydigia Schoedler

June 17: Genesee River shore opposite Faculty Drive and River

Boulevard; July 28: Irondequoit Creek in Ellison Park; November 17: pond at Tobin and Clover Roads.

Temperature range: 10°–23°C, pH 6–6.6. Specimens were collected singly among the weeds of both a clear running stream and a stagnant pond. Associated with individuals of many varied species in the pond and river shoreline, it was found only with *Ilyocryptus sordidus* in Irondequoit Creek.

This species has commonly been reported from New York State.

Genus Alona Baird, 1850

Alona affinis (Leydig, 1860)

September 7: Little Massaug Cove; September 30: Long Pond at entrance to Lake Ontario.

Temperatures: 28°C and 15°C, pH 8.2–8.4 and 6.9–7.4. One or two were found associated with individuals of many other species of Cladocera among weeds at the margins of the cove and pond listed above. In no collection made were members of the species abundant as has been reported by other collectors for other regions (Birge, 1918).

This species was reported in abundance in Ohio (Ward, 1940), as well as being very common in all regions.

Alona costata Sars, 1862

September 16: Durand Lake; October 21: Durand-Eastman Park.

Temperatures: 19° and 15°C, pH 7.5–7.8 and ca. 6.6. Individuals were found singly in littoral areas among lily pads and rotting logs associated with *A. guttata* and members of several other species. Specimens of this species were not found abundantly as has been reported from other places (Pennak, 1953).

Birge (1918) reports this species as being found everywhere in abundance.

Alona guttata Sars, 1862

September 7: pond near Ridgewood School; September 14: Little Black Creek (Brooks Avenue); September 16: Durand Lake, and other ponds in Durand-Eastman Park; September 30: marsh along Island Cottage Road; October 21: Durand-Eastman Park.

Temperature range: 14°–28°C, pH 6.2–8.5. Specimens were found among weeds in running and still water associated with members of several species of Cladocera and two of its own genus, *A. costata, A. rectangula.* Only a few individuals were found in each collection, although this scarcity may be due to the season.

Birge (1918) reports this species as "not uncommon everywhere".

Alona rectangula Sars, 1861

June 22: Genesee River near Elmwood Avenue; August 18; pond near Cobbs Hill; September 7: pond near Ridgewood School, Little Massaug Cove; September 11: Genesee River near bridge E149 in Genesee Valley Park; September 28: Genesee River near Elmwood Avenue.

Temperature range: 20°–28°C, pH 6–8.5. This species, the most common of its genus in the collections of this area, was found in still water among weeds of the margins of ponds, river, and a cove of Irondequoit Bay. Many species of Cladocera were associated with the several individuals obtained in each sample, those of their own genus being *A. guttata, A. affinis,* and *A. quadrangularis.*

This species has commonly been reported from many parts of New York State.

Alona quadrangularis O. F. Müller, 1785

Alona oblonga Müller
Alona sulcata Schoedler

June 17: Genesee River opposite Faculty Drive and River Boulevard; September 11: creek near Hawthorne Drive in Genesee Valley Park; September 28: Genesee River near Elmwood Avenue; September 30: Round Pond.

Temperature range: 15°–23°C, pH 6.2–7.2. Specimens were found under a duckweed cover as well as among weeds of a sluggish creek, in both stagnant and clear running water. Only a few individuals were collected in each sample along with members of many different species of Cladocera. On September 28 *A. rectangula* was found with individuals of this species but no other members of its genus.

Genus Chydorus

Chydorus globosus Baird, 1850

June 17: Genesee River opposite Faculty Drive and River Boulevard; June 22: Genesee River near Elmwood Avenue; September 7: Little Massaug Cove, Big Massaug Cove; September 11: Genesee River near bridge E149 in Genesee Valley Park; September 30: Buck Pond near bridge.

Temperature range: 15°–27°C, pH 6–8.5. One or two specimens (from each sample) were found in still water among the weeds, sometimes with a duckweed cover, along the margins of ponds, in the Genesee River and in coves off Irondequoit Bay. It was found associated with several other species, and often with another member of its genus, *C. sphaericus.*

Birge (1918) reports this species as being common everywhere.

Chydorus sphaericus O. F. Müller, 1785

June 17: *Genesee River opposite Faculty Drive and River Boulevard, Lily Pond; June 19: *Lily Pond; June 22: *Genesee River near Elmwood Avenue; July 10: temporary pond on side of road at Mendon Ponds Park; July 28: *marsh on side of road at Ellison Park; August 18: Buell Pond; September 7: *pond near Ridgewood School, *Little Massaug Cove; September 11: *creek off Hawthorne Drive in Genesee Valley Park, *same creek as it crosses East River road, Genesee River at bridge E149 in Genesee Valley Park; September 16: *Durand Lake, *other ponds in Durand-Eastman Park; September 23: Mt. Hope Cemetery pond; September 28: drainage ditch in Genesee Valley Park; September 30: *Buck Pond at entrance to Lake Ontario, Round Pond Creek; October 21: *pond (extension of Durand Lake) south of Durand Lake, *Durand Lake, *pond west of extension to Durand Lake, pond near Sunshine Camp entrance west of Eastman Lake, creek south of Eastman Lake; November 5: Black Creek off Scottsville Road near Genesee River; November 8: Blue Pond near Cedar Springs; November 17: creek running along Main Street-of-Fisher and Fisher Road, pond at Tobin and Clover Roads; April 1955: Cedar Springs Park.

(* *See remarks below.*)

Temperature range: 5.5°–28°C, pH 6–8.5. This species is the most common of all Cladocera in this region as well as all over the world. It is found abundantly in all habitats in which extensive collections were made, even in the swift cold streams of Cedar Springs Park in which no other Cladocera were found. The size range of this species varied greatly and in the localities marked with an * a variety of *C. sphaericus* appears which has a reticulated shell and three or less rows of round depressions regularly spaced. This variety appears alone or with the other type of *C. sphaericus.*

Birge (1918) reports this species as being found all over the world.

Genus Pleuroxus Baird, 1843

Pleuroxus denticulatus Birge, 1877

June 19: Lily Pond; July 10: temporary pond off road in Mendon Ponds Park; September 7: Little Massaug Cove, Big Massaug Cove; September 11: stream off Hawthorne Drive in Genesee Valley Park, same stream near East River Road bridge, Genesee River near bridge E149 in Genesee Valley Park; September 16: Durand Lake, other ponds in Durand-Eastman Park; September 30: Round Pond, Buck Pond at entrance to Lake Ontario; October 21: Durand Lake, pond southwest of Durand Lake, pond (extension of Durand Lake) south of Durand Lake; November 5: Black Creek at Scottsville Road near Genesee River; November 8: Blue Pond near Cedar Springs; November 17: creek along Main Street-of-Fisher and Fisher Road; Spring 1955: Genesee River near University of Rochester (W. B. Muchmore).

Temperature range: 7°–27°C, pH 6–8.5. Specimens were found abundantly among weeds in clear running water as well as stagnant water in littoral areas. They always were found associated with many other Cladocera. Other species of the same genus with which they were often found were *P. hamulatus, P. procurvatus.*

This species is commonly reported from New York State, and is common everywhere in aquatic vegetation (Pennak, 1953).

Pleuroxus hamulatus Birge, 1910

June 17: Genesee River opposite Faculty Drive and River Boulevard; June 22: Genesee River near Elmwood Avenue; September 7: Little Massaug Cove; September 14: Barge Canal (Brooks Avenue); September 28: Genesee River near Elmwood Avenue; September 30: Buck Pond near Long Pond Road.

Temperature range: 15°–27°C, pH 6–8.5. Members of this species have been found among weeds in littoral areas of still water. A fair number of individuals was collected in each locality mentioned above along with other Cladocera, those of its own genus being *P. denticulatus, P. procurvatus* and *P. striatus.* Most of the individuals collected were not conspicuously reticulated, although striations were always evident.

Birge (1918) reports this species from New England and southern states and says it is probably a coastal form. However, Ward (1940) reports it from Ohio and so its range must be extended.

Pleuroxus procurvatus Birge, 1878

September 7: Little Massaug Cove; September 16: Durand-Eastman Park; September 30: Buck Pond before Long Pond Road, Buck Pond near bridge, beside Buck Creek; October 21: pond southwest of Durand Lake, other ponds of Durand-Eastman Park.

Temperature range: 12°–27°C, pH 6.6–8.5. Individuals were found in duckweed cover, among cattails and other weeds on the margins of ponds, a creek and a cove off Irondequoit Bay. The collections listed above included several individuals in each sample associated with many other Cladocera. At times it was found with the other representatives: *P. denticulatus, P. hamulatus,* and *P. striatus.*

Pennak (1953) reports this species as common in vegetation in the northern states.

Pleuroxus striatus Schoedler, 1863
P. gracilis Hudendorf
P. unidens Birge

September 30: Buck Pond near Long Pond Road.

Although Pennak (1953) lists this species as common in aquatic vegetation, only one specimen was found. This was associated with *P. hamulatus, P. procurvatus, Scapholeberis mucronata,* and *Simocephalus vetulus* among cattails and duckweed.

This species has been reported from New York.

ORDER OSTRACODA

The free-living ostracods of the Rochester area have received little attention from zoologists. In a plankton survey of the Lake Ontario watershed (Tressler and Austin, 1940) no ostracods were listed. New York State, in its entirety, has only reports from sporadic collections. Sharpe (1908, 1918) lists *Physocypria dentifera* (Sharpe), *Cyclocypris laevis* (O. F. Müller)—actually *C. sharpei* Furtos—and *Cypria dentifera* Sharpe. Furtos (1933, 1935) adds *Cyclocypris cruciata* Furtos and *C. ampla* Furtos. Tressler (1947) reports *Candona crogmaniana* Turner, *Eucypris reticulata* (Zaddach), *E. fuscata* (Jurine), *Cypricercus splendida* Furtos and *Cypridopsis vidua* (O. F. Müller). Only these ten species have previously been reported from New York. This survey lists thirteen ostracods, eleven of which are new records for the state; one of the eleven is probably new to the literature. The only other areas in North America in which fresh-water ostracods have received any extended treatment are Ohio, Illinois, Massachusetts, Florida, Washington, South Carolina, Iowa, Texas, Mexico, Mississippi and Louisiana.

Historically, the first comprehensive list of described species of North America was published by Underwood (1886) in which fifteen species were listed. Although Turner (1899), Weckel (1914) and Sharpe (1918) all published studies of the known ostracods, very little was clear with respect either to taxonomy or to distribution. Sars (1926) gave an account of the ostracods of southeastern Canada and Klie (1931) listed three ostracods from Indiana. However, it was not until Furtos introduced comprehensive statewide studies of ostracods for Ohio (1933), Massachusetts (1935), Florida and North Carolina (1936a), and Yucatan (1936b), that a new era of ostracod study was begun. Dobbin (1941) extended the coverage to Washington and nearby western localities. Hoff's (1942) is the first major work in this field, for not only are the species of Illinois extensively surveyed by him, but most of the publications relative to North American Ostracoda are compiled. Tressler (1947) has published a check-list of all the known species of North American fresh water Ostracoda. Major works since then have included a list of Iowa Ostracoda (Danforth, 1948), a synopsis of the genus *Cypricercus* (Tressler, 1950), a report on Orange County, South Carolina ostracods (Ferguson, 1952) and a survey of fresh water species from Texas and Mexico (Tressler, 1954).

The following section is a list of the Ostracoda identified in the Rochester area with their local distribution and pertinent ecological notes. Seven genera and thirteen species are recorded, one species of which is possibly new to North America.

Methods of Preparation.

The specimens were killed by dropping them into 50 per cent alcohol so their valves would remain open after death. They were then preserved in 70 per cent ethyl alcohol. Dissections were made under the high power of a binocular microscope with sharpened sewing needles fused into glass rods. The valves were removed from the animal in glycerine after which they were transferred to a drop of Höyer's medium on a slide and a cover glass supported by glass chips was placed over them. The soft body was removed from the glycerine to a drop of Höyer's medium containing some eosin and aniline blue. In this medium the appendages were dissected and covered with a coverslip, or a whole mount was made. Both entire and dissected specimens of every species encountered were mounted permanently, when possible. There were only three exceptions. *Cypridopsis vidua* (O. F. Müller) and *Potamocypris smaragdina* (Vávra) are readily identifiable under the binocular dissecting microscope after some experience. *Physiocypria pustulosa* (Sharpe) was easily recognized when temporarily mounted and dissected in glycerine.

List of Species

Order Ostracoda
Suborder Podocopa s. str.
Family Cypridae
Subfamily Candoninae
Genus Candona Baird, 1845

Candona punctata Furtos, 1933

September 30: Buck Pond, near Buck Creek; October 21: Eastman Lake.

Temperature: 15°C, pH 6.6–7.8. Only one female was found from each locality cited. Both were smaller than either Hoff (1942) or Furtos (1933) describe, the length of both was about 0.65 and the height 0.35 millimeters. The literature reports the length as 0.80–0.90 and height 0.45–0.51 millimeters. These may have been immature specimens, for no eggs were found in them. One female was found among duckweed, dead leaves and other aquatic vegetation in the shallows of Eastman Lake; the other in a marshy area among duckweed and cattails. This agrees with Furtos (1933) who reports this species to be "common in temporary or permanent ponds, marshes, and lakes. March to May, and November." Members of this species were found associated with other ostracods, two of its own genus, *C. simpsoni* and a new species of *Candona* reported later.

This species has been reported from Illinois (Hoff, 1942), Ohio (Furtos, 1933) and Massachusetts (Furtos, 1935).

Candona fluviatilis Hoff, 1942

September 21: marsh between Round and Buck Ponds (Island Cottage Road); October 21: creek south of Durand Lake.

Temperatures: 14°C, 12°C, pH 6.6–7. One female was found in a small sandy-bottomed creek among many aquatic plants, while another was found in a marsh among duckweed and cattails and was associated with other Ostracoda. Previously Hoff (1942) reports finding them only in vernal streams over a muddy bottom.

This species has been reported from Illinois (Hoff, 1942).

Candona simpsoni Sharpe, 1897
Candona relexa Sharpe, 1897
Candona exilis Furtos, 1933

> August 18: Buell Pond, Hobbie Creek; September 7: pond near Ridgewood School; September 16: Durand Lake; September 21: marsh between Round and Buck Ponds (Island Cottage Road); September 30: Round Pond Creek (Island Cottage Road), marsh between Round and Buck Ponds (Island Cottage Road), Buck Pond beside Buck Creek; October 21: marsh south of Eastman Lake; November 8: Blue Pond; November 17: 100 Acre Pond at Mendon Ponds Park.

Temperature range: 7°–28°C, pH 6.6–8. Members of this species have been the most abundant of the genus in this area. They have been found among vegetation, in permanent ponds, marshes and sluggish creeks, often associated with other ostracods. Many collections contained only one animal, while some contained several of the species. Only females have been collected, and some of these range in length about 0.60 millimeters, height about 0.30 millimeters, which is slightly smaller than Hoff (1942) reports. In one locality, September 21 collection, one female was found with S-shaped claws of the "exilis" type.

This species has been reported from Illinois (Sharpe, 1918; Hoff, 1942) and Iowa (Danforth, 1948).

Candona decora Furtos, 1933
Candona candida (part.) Brady and Norman, 1889

> October 21: marsh south of Eastman Lake; November 8: Blue Pond; November 17: 100 Acre Pond in Mendon Ponds Park.

Temperature: 7°C, 15°C, pH 6.6–6.8. Furtos (1933) reports this species as occurring in temporary leafy pools and occasionally in ponds and lakes in the spring. This appears to be the first report of its occurrence in the late fall. Eleven males and four females were found among duckweed and rushes in a marshy area, October 21; two males were found in the littoral area of a pond. A single unusually large female was found among Anacharis in Blue Pond, the length being 1.69 millimeters and the height 0.74 millimeters. The normal size is length 1.3 millimeters and height 0.70 millimeters. The specimen contained the characteristic reticulations in the posterior portion of the valves.

This species has been reported from Ohio (Furtos, 1933), Massachusetts (Furtos, 1935) and Michigan (Tressler, 1947).

Candona n. sp.

October 21: Eastman Lake; pond in Durand-Eastman Park (a southern extension of Durand Lake).

Temperature: 13°–15°C, pH 6.4–6.6. A single female was found in each of the two localities mentioned above. Both were collected in clear water among duckweed, reeds, and dead leaves along the shallow edges of these permanent ponds. These individuals resemble *C. suburbana* Hoff, 1942 in many respects, particularly in the shape of the valves. However, *C. suburbana* has been reported only from temporary ponds in the spring, quite different from the above locations. A complete description of the specimens and contrasts between them and members of *C. suburbana* are contained in the Memorandum, page 226.

Subfamily Cyclocyprinae

Genus Cyclocypris Brady and Norman, 1889

Cyclocypris forbesi Sharpe, 1897

November 8: Blue Pond.

Temperature: 7°C, pH 6.6–6.8. Eighteen males were taken from an Anacharis bed covered by clear shallow water. Associated with these were *Candona simpsoni, Cypridopsis vidua,* and the giant *Candona decora.* Members of this species have previously been found in ponds and lakes collected from mats of vegetation, as Chara, Myriophyllum and Potamogeton.

These animals differ slightly from the description offered by Furtos (1935). The valve surfaces are covered with quite a number of well defined tubercles each with a slender hair, many more than Furtos shows in her diagram. Further, there has been a slight but consistent difference in the height to length ratio. Furtos reports the size to be 0.58 millimeters in length, 0.38 millimeters in height. The following chart shows the measurements of four males:

	RIGHT		LEFT	
Animal	Length	Height	Length	Height
1	0.58	0.43	—	—
2	0.60	0.46	0.58	0.44
3	0.58	0.45	0.56	0.43
4	0.61	0.47	0.58	0.45

The prehensile palps are very much elongated as Furtos describes, but the larger propodus differs somewhat in the amount of sinuation of the outer and inner margins. The neck-like region formed by these sinuations is much broader than that described by Furtos. Furtos' diagram shows the neck to be one-third as long as the widest part of the propodus, while the Rochester specimens measure three-fourths of the widest part of the propodus. Also, the inner margin of the short moderately inflated dactylus (larger propodus) is slightly curved, not straight as shown by Furtos (1935).

The shortest terminal seta of the third foot is not one-half the length of the terminal propodus as Furtos (1935) reports, but the ratio in the four specimens examined more often approaches two-fifths.

These differences are small, however, that they may well be just isolated variations, for only four specimens were examined from one collection.

This species has previously been reported from Illinois (Sharpe, 1897 and Hoff, 1942), Massachusetts (Furtos, 1935), and South Carolina (Ferguson, 1952).

Cyclocypris sharpei Furtos, 1933
Cyclocypris laevis Sharpe, 1908, 1918 (non O. F. Müller, 1785)

June 30: Deep Pond in Mendon Ponds Park; September 30: Buck Pond at entrance to Lake Ontario; October 21: Eastman Lake.

Temperatures: 28° and 15°C, pH 6.6–7.4. Only five females were found, two in the first and last localities, one at Buck Pond. All were found associated with other ostracods among vegetation mats, especially duckweed, above mucky bottoms. Members of this species have previously been found in ponds, marshes and lakes, and there seems to be no seasonal restriction (Hoff, 1942).

The forms found bear the typically brown banded appearance as described by Furtos (1933). However, Furtos makes no mention of a conspicuous hyaline flange on the anterior margin of the right valve. The forms found in the Rochester area show such a flange which bears a slightly scalloped appearance. This resembles that described for *Cyclocypris cruciata* Furtos (Furtos, 1935), except that scallops are not as pronounced in these forms. Except for this flange, this species fits exactly the characteristics described for *C. sharpei* by Furtos (1933).

This species has previously been reported from Illinois, Indiana, New York, and New Jersey (Sharpe, 1908, 1919), Ohio (Furtos, 1933), Illinois (Hoff, 1942), Louisiana (Hoff, 1943d), New Brunswick, Iowa (Tressler, 1947), Iowa (Danforth, 1948).

Cyclocypris ovum Jurine, 1820
Cypris laevis (part.) O. F. Müller, 1776
Monoculus ovum (part.) Jurine, 1820
Cypris scutigera (part.) Fischer, 1851
Cypris serena Brady and Norman, 1889
Cyclocypris pygmaca Croneberg, 1895
Cyclocypris laevis Kaufmann, 1900
Cyclocypris laevis pygmaca Elman, 1907
Cyclocypris ovum G. W. Müller, 1912

June 30: Deep Pond, Mendon Ponds Park; October 21: marsh south of Eastman Lake; November 8: swimming pool in Cedar Springs Park.

Temperatures: 28°C, 15°C, 8°C, pH 6.6–7.0. Males and females were both collected along the marshy edges of permanent ponds among duckweed and reeds, while some were collected in the vegetation of a cool clear creek. Several individuals were collected at each station cited associated with other ostracods. Furtos (1933) also finds members of this species common "in marshes, occasionally in cold streams. April to November."

This species has previously been reported from Ohio (Furtos, 1933) and Washington (Dobbin, 1941).

Genus Cypria Zenker, 1854

Cypria turneri Hoff, 1942

Cypris striolata Herrick, 1887
Cypria exculpta Turner, 1894
Cypria exsculpta Sharpe, 1897
Cypria elegantula Furtos, 1933 (non Lilljeborg, 1853)

June 30: Deep Pond at Mendon Ponds Park; July 10: ditch on side of road in Mendon Ponds Park; August 18: Buell Pond; September 21: marsh between Round and Buck Ponds (Island Cottage Road); September 30: Buck Pond before Long Pond Road; October 21: Durand Lake, marsh south of Eastman Lake, pond near Sunshine Camp west of Eastman Lake, Eastman Lake; November 8: swimming pool in Cedar Springs Park; November 17: 100 Acre Pond, pond at Tobin and Clover Roads near Mendon Ponds Park.

Temperature: 8°–29°C, pH 6.6–8.4. Males and females were collected sometimes in groups of three or so, and in some collections many specimens were found. Individuals of this species were taken in ponds, lakes, marshes, and along the edge of a dammed up creek. They were associated with other ostracods among vegetation such as grass, duckweed, and algae. Hoff (1942) reports members of this species to be "abundant from March to late June but sometimes found in the serotinal and autumnal seasons." The largest numbers of individuals were collected in October and November in this area, however. The species appears common in this area.

This species has previously been reported from Newfoundland (Alm, 1914), Delaware (Turner, 1897), Washington, Alaska (Dobbin, 1941), Illinois (Hoff, 1942, 1943a), Alabama (Herrick, 1887), Ohio (Furtos, 1933 and Turner, 1897), Tennessee (Hoff, 1943b), Mississippi (Hoff, 1943d), Wisconsin, Michigan, Utah, Virginia (Tressler, 1947), Iowa (Danforth, 1948), South Carolina (Ferguson, 1952).

Genus Physocypria Vávra, 1897

Physocypria pustulosa (Sharpe, 1897) G. W. Müller, 1912

Cypria pustulosa Sharpe, 1897
Cypria (Physocypria) pustulosa Sharpe, 1897
Physocypria pustulosa (Sharpe, 1897) G. W. Müller, 1912
Physocypria globula Furtos, 1933

June 17: Genesee River opposite Faculty Drive; June 19: Lily Pond on South Avenue; June 22: Genesee River by Elmwood Avenue; June 23: marsh on main road in Ellison Park; June 30: Deep

Pond, Mendon Ponds Park; August 18: Pond below Cobbs Hill, Hobbie Creek; September 7: pond near Ridgewood School, Little Massaug Cove, Big Massaug Cove; September 11: creek off Hawthorne Drive in Genesee Valley Park, same creek where it crosses East River Road, Genesee River at bridge E149 in Genesee Valley Park; September 14: Little Black Creek (Brooks Avenue); September 16: Durand Lake; September 21: marsh between Round and Buck Ponds (Island Cottage Road); September 30: Round Pond Creek (Island Cottage Road), marsh by Buck Pond, Round Pond, Long Pond as it enters Lake Ontario; October 21: marsh south of Eastman Lake; November 4: marsh from Black Creek off Scottsville Road near Genesee River bridge; November 17: pond at Tobin and Clover Roads (Mendon Ponds Park).

Temperatures: 10°–28°C, pH 6.0–7.8. Males and females of this species were found abundantly in almost every collection cited. They were always found in quiet waters full of vegetation and usually associated with other ostracods.

Most of the individuals of the scores collected were extremely variable in shell shape, length to height ratio of the shell and the number, position and size of the tubercles on the shell. Often single populations contained members exhibiting the inflated shell and distinct tubercles on the anterior margin, as well as those of the "Globula" type (Furtos, 1933) with the tubercles lining the posterior margin also. Most of the specimens showed submarginal tubercles readily visible only under high magnifications. All of the representatives, however, showed the typical large flattened pustules posterio-ventrally. The great variety in the populations here bears out Hoff's findings in Illinois (Hoff, 1942).

This species has previously been reported from Ohio (Sharpe, 1897 and Furtos, 1933), Illinois (Furtos, 1933 and Hoff, 1942), Missouri (Ferguson, 1944), Alaska, Washington, Mississippi (Hoff, 1943d), Michigan, Virginia, Oklahoma (Tressler, 1947), South Carolina (Ferguson, 1952a), Iowa (Danforth, 1948), Georgia (Ferguson, 1952b).

Subfamily Cyprinae s. str.

Genus Cypricercus Sars, 1895

Cypricercus splendida Furtos, 1933(?)

April 6: Beech Grove, Powder Mill Park (W. B. Muchmore).

A single female with only the right valve present in poor condition was found. One large purple band ran dorso-laterally on the shell, and no marginal tubercles were seen. The specimen differed from Furtos' (1933) description of *C. splendida* in the shell size and location of the dorsal seta of the ramus. *C. splendida* has a reported length of 1.75 millimeters, a height of 0.98 millimeters, while this specimen measured 1.40 in length and 0.90 in height. *C. splendida* has the dorsal seta of the ramus removed from the subterminal claw a distance equal to the width of the ramus, while the dorsal seta of this female was a distance of two and one-half times the width of the ramus away from the subterminal claw. In spite of these two distinctions, the specimen has tentatively been recorded as *C. splendida*.

This species has previously been reported from Ohio (Furtos, 1933), Massachusetts (Furtos, 1935), New York (Tressler, 1947).

Subfamily Cypridopsinae

Genus Cypridopsis Brady, 1867

Cypridopsis vidua (O. F. Müller, 1776) Brady, 1867

Cypris vidua O. F. Müller, 1776
Cypridopsis vidua (O. F. Müller, 1776) Brady, 1867
Cypridopsis vidua obesa Furtos, 1933 (non Brady and Robertson, 1869)
Cypridopsis pustulosa Furtos, 1933

June 17: Genesee River opposite Faculty Drive; June 19: Lily Pond; June 23: marsh beside the main road of Ellison Park; June 30: Deep Pond, Mendon Ponds Park; July 10: ditch in Mendon Ponds Park; July 28: marsh in Ellison Park; August 18: pond below Cobbs Hill, Buell Pond, Hobbie Creek; September 7: pond near Ridgewood School, Little Massaug Cove, Big Massaug Cove; September 11: creek off Hawthorne Drive in Genesee Valley Park, same creek at East River Road, Genesee River at bridge E149 in Genesee Valley Park; September 14: Barge Canal (Brooks Avenue), Little Black Creek (Brooks Avenue); September 16: Durand Lake, Eastman Lake; September 21: Round Pond Creek, marsh between Round and Buck Ponds (Island Cottage Road); September 23: Mt. Hope Cemetery Pond (W. B. Muchmore); September 30: Round Pond Creek (Island Cottage Road), marsh between Round and Buck Ponds (Island Cottage Road), marsh near Buck Pond, Buck Pond where it enters Lake Ontario, Long Pond where it enters Lake Ontario, Buck Pond near Long Pond Road; October 21: Eastman Lake, marsh south of Eastman Lake, Durand Lake, pond south of Durand Lake; November 4: Little Black Creek (Brooks Road), marsh of Black Creek off Scottsville Road near Genesee River Bridge; November 8: Blue Pond.

Temperature: 10°–28°C, pH 6.0–8.4. Only females of this species were noted. They were found abundantly in every type of habitat, marshes, ponds, lakes, and streams. Hoff (1942) reports, "Not only is it found everywhere, but there are few ostracods which are found in such great numbers of individuals in single collections."

Genus Potamocypris Brady, 1870

Potamocypris smaragdina (Vávra, 1891) Daday, 1900

Cypridopsis smaragdina Vávra, 1891
Potamocypris smaragdina (Vávra, 1891) Daday, 1900
Potamocypris smaragdina (Vávra, 1891) var. **compressa** Furtos, 1933

August 18: pond below Cobbs Hill; September 7: pond near Ridgewood School, Little Massaug Cove; September 11: creek off

Hawthorne Drive in Genesee Valley Park, same creek as it crosses East River Road; November 17: creek at Main Street-of-Fisher and Fisher Road.

Temperature: 5.5°–28°C, pH 6.2–8.4. All the specimens collected were found associated with vegetation in permanent waters. Males and females were found both in still waters as well as in clear running streams.

This species has previously been reported from Ohio, Lake Erie, Illinois (Furtos, 1933), Illinois (Hoff, 1942), Missouri (Ferguson, 1944), Mississippi (Hoff, 1943d), Tennessee (Hoff, 1943b), Illinois (Sharpe, 1918), Washington (Dobbin, 1941), Mexico (Sharpe, 1897), Texas, Louisiana (Tressler, 1947), South Carolina (Ferguson, 1952), Iowa (Danforth, 1948) and Texas (Tressler, 1954).

ORDER ISOPODA

Although the literature dealing with the taxonomy of the order Isopoda is extensive, relatively little is known of its distribution and life history in America. Comprehensive monographs about localities on the continent or about some sections of America have been published. One of the earliest works was that by Say in 1818. Richardson (1905), Van Name (1936, 1940, 1942) and Mackin and Hubricht (1938, 1940, 1949) have covered sections of North America.

Some regional studies also have been made: Longnecker (1924) for Iowa, Johanson (1926) and Walker (1927) for Canada, Blake (1931) for the New England States, Miller (1938) for California, Hatchett (1947) for Michigan and Mackin (1940) for Oklahoma. No such regional survey for the Rochester area, or New York State in general, is known to the writer. DeKay (1844) reports *Asellus communis* Say from New York. Paulmier (1905) in his survey of the higher Crustacea of New York City reports this species as the only fresh water isopod found in New York City. Van Name (1936) records *A. communis* Say as, "by far the most abundant and widely distributed fresh water isopod in the eastern half of the United States." The other fresh water isopod recorded from New York State is *Lirceus lineatus* Say, which Johanson has reported from Jefferson County: Alexandria Bay, Thousand Islands (Hubricht and Mackin, 1949). Bayliff (1938) reported *Exosphaeroma papillae* from Nassaquatuck Creek which empties into the "Inner Harbor" of Cold Spring Harbor, Long Island, New York. However, this species is essentially a marine form, and its presence in "fresh" water may be accounted for by the tides forcing salt water into this part of the creek.

This section reports three species of isopods found in temporary and permanent waters of the Rochester area. Pertinent ecological notes are included.

Methods of Preparation.

The isopods collected were killed and preserved in seventy per cent ethyl alcohol. Identifications were made using the binocular dissecting microscope. When necessary, dissections were carried out in glycerine and temporary slides were made with this medium for study under higher magnification. No attempt was made to stain the animals in any way.

List of Species

Order Isopoda
Suborder Asellota
Family Asellidae
Genus Asellus Geoffrey

Asellus communis Say, 1818
Asellus vulgaris Gould, 1841

September 1941: Genesee River (W. B. Muchmore); July 28: Irondequoit Creek at Ellison Park; August 18: pond below Cobbs Hill, Buell Pond; September 14: Little Black Creek (Brooks Avenue); September 16: Durand Lake; September 21: marsh off Island Cottage Road; September 30: Buck Creek, Long Pond at entrance to Lake Ontario; October 21: Durand Lake, pond south of Durand Lake, creek south of Eastman Lake, marsh south of Eastman Lake; November 5: Little Black Creek; November 8: Blue Pond.

Temperature: 7°–23°C, pH 6.0–7. Members of this species were found in ponds, marshy areas, and in sluggish as well as swift streams. They generally were associated with vegetation and rocks. No other fresh water isopods were ever found in the same collecting area. The range of this species has previously been reported to extend over most of the eastern half of the United States, also in southern Canada (Ontario, Quebec, Nova Scotia) (Van Name, 1936). It has previously been reported from New York State.

Asellus militaris Hay, 1878

April 6, 1954: Powder Mill Park (W. B. Muchmore); April 1, 1955: Powder Mill Park (W. B. Muchmore).

Representatives were found in the spring ponds at Powder Mill Park, and members of no other fresh water isopod species were found along with them.

These animals are almost identical with *A. communis* except for the size of the endopodite of the uropod, and the size relationship between the endopodite and the exopodite of the male second pleopod. Mackin (1940) establishes this as a valid species apart from *A. communis* by the following criteria: "Endopodite of the uropods broadly lanceolate in form, pointed. The endopodite of the male second pleopod short, only slightly more than half as long as the exopodite and ending in a blunt lobe." Van Name (1942) reports this species as an inhabitant of lowland temporary ponds. The animals found in Powder Mill Park agree with all the preceding characteristics.

Mackin (1940) reports that this species has a considerable distribution in the interior parts of the United States. It may have been seen by previous investigators in New York State, but since *A. militaris* was, previous to 1940, included as a synonym for *A. communis,* this is difficult to ascertain.

Genus Lirceus Rafinesque, 1820
Asellopsis Harger, 1874
Mancasellus Harger, 1876

Lirceus lineatus (Say, 1818)
Asellus lineatus Say, 1818
Asellus tenax Smith, 1871
Asellopsis tenax (Smith, 1874)
Asellopsis tenax var. **dilata** Harger, 1874
Mancasellus tenax (Smith, 1876)
Mancasellus sp. n. Herrick, 1887
Mancasellus lineatus (Say, 1900)
Mancasellus danielsi Richardson, 1902
Mancasellus tenax dilata (Smith, 1905)
Mancasellus dilatus (Smith, 1936)
Mancasellus herricki Van Name, 1936

September 21: Slater Creek.

Temperature: 15°C. Only one specimen was collected in this small creek in an algal mat. No other specimens were found when looked for in June, 1955. This may have been due in part to the almost complete drying of the creek. Members of no other isopod species were collected from this station.

Johanson (1926) has previously reported this species from New York State (Hubricht and Mackin, 1949). It has a reported distribution in the Great Lakes region and southeastern United States from Virginia to Florida and Alabama (Hubricht and Mackin, 1949).

ORDER AMPHIPODA

Most of the members of this order are marine forms, for, of the three suborders, only one, the Gammaroidea, has representatives in the American fresh waters. Ada L. Weckel (1907) published the first comprehensive American listing of this group. Since 1907, the list of fresh water species has grown from sixteen to fifty, of which five have been reported from New York State. De Kay (1844) and Weckel (1907) listed *Gammarus fasciatus* Say from the Hudson River and Niagara Falls, and *G. limnaeus* Smith from Caledonia, New York. Paulmier (1905) lists *G. fasciatus* Say as "common in fresh-water ponds . . . and in the brooks." He also adds *Hyalella azteca* (Saussure) as occurring frequently throughout the city. *H. azteca* has also been reported from Mud Pond in the Lloyd-Cornell reservation (Sibley, 1926), the Oswego River system (New York State Conservation Department, 1927), the Raquette watershed (Creaser, 1934), the Hudson River (De Kay, 1844, Weckel, 1907, Townes, 1937) and Lake Chautauqua (Townes, 1938). *G. fasciatus* Say, *G. limnaeus* Smith, and *Crangonyx gracilis* Smith have all been reported from localities in New York State (Creaser, 1934). A common deep water form, *Pontoporeia affinis* (Lindstrom), has been recorded from the Finger Lakes region (Wilson, 1929, and Pennak, 1953) and from Lake Ontario (Nicholson, 1872).

Of these previously reported common species, individuals of all except *P. affinis* have been collected in this survey of the Rochester area. Since no deep waters were dredged, it is possible that *P. affinis* exists in this area as well. This section lists these reported species, their localities, and significant ecological data.

Methods of Preparation.

The amphipods were killed and preserved in seventy per cent ethyl alcohol until identifications could be made. The animals were mounted in glycerine and examined under the high power of a binocular dissecting microscope. To facilitate identification, temporary slides using glycerine as a mounting medium were employed for dissected specimens. All dissections were carried out with sewing needles as described in the Ostracoda section. No staining of the specimens was attempted.

List of Species

Order Amphipoda
Family Talitridae

Genus Hyalella S. I. Smith, 1874

Hyalella azteca (Saussure, 1858)
Amphitoe aztecus Saussure, 1858
Hyalella azteca (Saussure, 1888)
Hyalella knickerbockeri (Bate, 1907)

June 17: Lily Pond; June 22: Genesee River by Elmwood bridge; June 23: marsh at entrance of Ellison Park; June 30: Deep Pond; July 28: pond and marshes at Ellison Park; August 18: Buell Pond; September 7: Ridgewood School pond, Little Massaug Cove, Big Massaug Cove; September 11: stream off Hawthorne Drive in Genesee Valley Park, continuation of same stream at East River Road; September 14: Barge Canal by Brooks Avenue, Little Black Creek by Brooks Avenue; September 16: Durand Lake, Eastman Lake; September 21: Round Pond Creek, marsh between Round and Buck Ponds (Island Cottage Road), Round Pond, Buck Pond at entrance to Lake Ontario, and Buck Pond near Long Pond Road; October 21: Eastman Lake, Durand Lake, pond south of Durand Lake, creek south of Eastman Lake, marsh south of Durand Lake, pond west of Eastman Lake, pond near entrance to Sunshine Camp; November 5: Little Black Creek (Brooks Avenue), Black Creek marsh off Scottsville Road; November 8: Blue Pond; November 17: creek along Main Street-of-Fisher and Fisher Road.

Temperature range: 5.5°–28°C, pH 6.0–8.0. Members of this species are the most common and abundant in this area. Individuals are found in every habitat sampled, from stagnant ponds and marshes to clear swift streams. They are most often associated with aquatic vegetation and may frequently be collected with other members of their genus.

This species has previously been reported from New York State and is recognized as being widely distributed and common (Pennak, 1953).

Family Gammaridae

Genus Gammarus Fabricius, 1775

Gammarus limnaeus S. I. Smith, 1874

Gammarus lacustris Smith, 1871
Gammarus limnaeus Smith, 1874
Gammarus robustus Smith, 1875

October 13, 1953: Powder Mill Park (C. Aggeler); September 21: Flemming Creek at Latta Road; October 21: creek south of Eastman Lake; October 23: springs and streams at Cedar Springs Park; November 7: Cedar Springs Park.

Temperature range: 8°–14°C, pH 6.2–7.2. The least common of the amphipods found, individuals of this species were collected only from clear swift brooks and streams, never from ponds or marshes. They were often found associated with other members of the genus around rocks and aquatic vegetation.

It has previously been reported from New York State, and Pennak (1953) reports this species as "common and widely distributed in springs, spring brooks, and small spring fed lakes."

Gammarus fasciatus Say, 1818

October 13, 1953: Powder Mill Park (A. Lewis); November 12, 1953: Genesee River pond by Faculty Road (W. B. Muchmore); June 22: Genesee River at Elmwood Avenue; June 17: Genesee River near Faculty Road; July 28: Irondequoit Creek in Ellison Park; September 7: Little Massaug Cove; September 11: stream off Hawthorne Drive in Genesee Valley Park, Genesee River at bridge E149 in Genesee Valley Park; September 14: Barge Canal (Brooks Avenue); September 16: Eastman Lake; September 21: Slater Creek; September 30: Slater Creek, Long Pond at entrance to Lake Ontario, Buck Pond; October 21: pond west of Eastman Lake, Lake Ontario by Coast Guard Station; October 23: streams of Cedar Springs Park; November 5: Little Black Creek (Brooks Avenue); November 17: stream along Main Street-of-Fisher and Fisher Road.

Temperature range: 5.5°–27°C, pH 6.0–8.0. This is a very common species; individuals were often found along with *Hyalella azteca* and *Crangonyx gracilis,* less often with *G. limnaeus.* Members have been collected from ponds, marshes, and sluggish and swift streams in which they are found about rotting debris or aquatic vegetation.

This species has previously been reported from New York State. Pennak

(1953) says it is "common in lakes, ponds, streams, and springs in the Atlantic drainage, sporadic farther west and southwest as far as New Mexico."

Genus Crangonyx Bate, 1859
Eucrangonyx Stebbing, 1899

Crangonyx gracilis S. I. Smith, 1871
Eucrangonyx gracilis (S. I. Smith, 1899)

September 1951: Genesee River (W. B. Muchmore); October 13, 1953: Powder Mill Park (C. Aggeler); April 6, 1954: Beech Grove, Powder Mill Park (W. B. Muchmore); June 17: Lily Pond, Genesee River off Faculty Road; June 19: Lily Pond; June 22: Genesee River at Elmwood Avenue; August 18: Buell Pond; September 14: Little Black Creek (Brooks Avenue); September 21: Round Pond; September 30: Buck Creek; October 21: marsh south of Eastman Lake; November 5: Little Black Creek (Brooks Avenue); November 8: dammed up creeks for swimming pool at Cedar Springs Park.

Temperature range: 6°–24°C, pH 6.0–8.0. Specimens were found in quiet ponds full of aquatic vegetation and in moderately swift brooks. These animals were often found associated with other members of the order.

This species has previously been reported from New York State. Pennak (1953) says members are "generally distributed in caves, pools, ponds, springs, and brooks, east of the Mississippi River, but reported as far west as Oklahoma and Kansas."

ORDER DECAPODA

The vast majority of the members of this order are marine. "In the United States only the Astacidae (crayfishes), about eleven species of Palaemonidae (fresh water prawns and river shrimp) and four species of Atydidae are found in fresh waters" (Pennak, 1953). The following discussion shall only concern itself with the Astacidae, for no members of the other families were collected in this survey.

An early monograph of the Astacidae was published by Hagen in 1870. Underwood (1886) listed the known crayfishes from America, north of Mexico. In 1918, Ortmann summarized the described decapods. Pennak (1953) has included all of the common decapods in his work.

A comprehensive list of crayfish species is known from New York State. De Kay (1844) and Paulmier (1905) both recorded *Cambarus bartoni* from New York. Hagen (1870) reported *Orconectes obscurus*, while Underwood (1886) added *C. bartoni robustus*, *O. virilis*, *O. immunis*, and *O. propinquus* to the list. Creaser (1931) recorded *C. diogenes* from New York. In 1934, Creaser, in his study of the larger Crustacea of the Raquette watershed listed: *O. virilis*, *O. propinquus*, *C. bartoni robustus*, *C. bartoni*, and *O. immunis*. Sibley (1926) reported *C. bartoni* from the Lloyd-Cornell reservation, Townes (1938) recorded *O. obscurus* from Lake Chautauqua. Pennak (1953) reports *Procambarus blandingi* and *O. limosus* from the Great Lakes drainage.

The crayfish reported in this section are only the result of incidental collections by the writer and other collectors, for no effort was made to get a complete sampling from the area. The list is thus incomplete. All the species recorded have previously been listed from New York State. The classification system followed in this section is one proposed by Hobbs in 1942 in which the Subfamily Cambarinae is divided into six full genera (Pennak, 1953).

List of Species

Order Decapoda
Family Astacidae
Subfamily Cambarinae
Genus Cambarus

Cambarus bartoni robustus Girard

September 12, 1952: Powder Mill Park (W. B. Muchmore); November 27, 1954: Powder Mill Park (W. B. Muchmore); September 21, 1954: Flemming Creek.

Genus Orconectes

Orconectes limosus (Rafinesque, 1817)

Fall, 1954: Cedar Springs Park stream (?) (Richard L. Heineman).

It is doubtful that this specimen came from Cedar Springs. All that is certain is that it came from the Rochester area.

Orconectes propinquus (Girard, 1852)

September 16, 1949: Seneca Park Lake (R. Yaeger); September 21, 1954: Flemming Creek; June 22: Genesee River; July 28: Irondequoit Creek at Ellison Park.

Individuals of this species have been collected associated with *Cambarus bartoni robustus.* The animal collected from the Genesee River was a female, so the identification is not certain.

Orconectes immunis (Hagen)

July 20, 1931: creek in Mendon Ponds Park (C. Thayer).

MEMORANDUM

CANDONA N. SP.

Durand-Eastman Park, October 21, 1954.

Description.

Measurements, in millimeters, of the valves (see Plate II) mounted in Höyer's Medium are as follows:

	RIGHT		LEFT	
	Length	Height	Length	Height
Pond specimen:	1.00	0.50	1.00	—
Lake specimen:	1.08	0.52	1.12	0.53

From the side, the white shell is elongated; the height is equal to, or slightly less, one-half the length. The greatest height of the shell is posterior to the middle. The anterior and posterior margins of both valves are smoothly rounded, the posterior being slightly more pointed than the anterior. In the left valve the dorsal margin is nearly evenly rounded, passing more or less insensibly into the anterior and posterior margins, although a very slight sinuation is indicated in the antero-dorsal margin. In the right valve the antero-dorsal and postero-dorsal sinuations are more evident. The dorsal margin of this valve is not as smoothly rounded as that of the left valve. The ventral edges of both valves show a definite sinuation near the middle. The pore canals are relatively inconspicuous, short and each forming a 45° angle posteriorly with the margin from which it emerges. A slight hyaline border extends from the dorso-posterior edge ventrally to the dorso-anterior edge. The anterior and posterior edges bear delicate hairs of which a few do appear in the ventral sinuation. The valves are sparsely hairy, each weak hair being set on a rather prominent papilla. The muscle scars are somewhat anterior to the center of the shell and are very definite in arrangement. There are five scars forming a rosette with a single isolated one above the group and two isolated scars slightly anterior-ventral to the rosette. The left valve, shown in Plate II, has an additional scar. It is uncertain whether this is a regular feature, for the left valve of the second specimen was cracked before close examination could be made.

The medial distal seta of the penultimate podomere of the mandibular palp is smooth. The mandibular teeth consist of five heavy teeth and three small ones.

The second leg has the second podomere slightly longer than the sum of the lengths of the third and fourth podomeres. The second podomere has a distal seta shorter than the distal width of the podomere. The ultimate podomere is nearly twice as long as it is wide; it has a distal seta about equal in length to the podomere, another about three-fourths as long and a claw slightly less than equal to the sum of the last three podomeres. The third thoracic leg has its penultimate podomere divided. The shortest distal seta of the ultimate podomere is slightly more than three and one half times the length of the ultimate podomere. The ultimate podomere is nearly square. The oppositely directed seta of the ultimate podomere is two and one third times longer than that of the shorter seta of the pair.

The furcal rami are slightly curved. The length of the ventral margin of the ramus is about nine times the least width; the length of the dorsal seta is three and four sevenths times the length of the dorsal margin from the distal end of the ramus. The terminal claw is finely toothed and is about one-half as long as the ramus. The length of the terminal seta is about one and one-half times the least width of the ramus. The genital lobe is well developed, conical in shape with the margins being continuous from the body of the animal. This lobe closely resembles that of *Candona sigmoides.* A short seta is located on the body dorsal to the furca.

Comparison with C. suburbana

	Candona n. sp.?	*Candona suburbana*
Pore Canals	Inconspicuous	Conspicuous
Second leg second podomere	Slightly longer than the sum of lengths of podomeres 3 and 4. Distal seta shorter than distal width of podomere	Almost equal in length to the sum of the lengths of podomeres 3 and 4
Claw, distal	Length approximately equal to sum of distal podomeres	Length slightly less than sum of distal three podomeres
Third leg Shortest distal seta	Slightly more than $3\frac{1}{2}$ times the length of the ultimate podomere	Four times the length of the ultimate podomere
	Oppositely directed seta $2\frac{1}{3}$ times longer	Oppositely directed seta 2 times longer
Length ventral margin of ramus	9 times least width	11 times least width
Dorsal seta of ramus	Removed from subterminal claw by distance equal to $\frac{1}{4}$ the ventral margin. Length is slightly over 3–$3\frac{1}{2}$ times least width of the ramus	Removed from subterminal claw by distance equal to slightly less than $\frac{1}{3}$ the ventral margin. Length is $3\frac{1}{2}$ to nearly 4 times least width of ramus
Genital lobe	Thick, cone-like continuation of body with no dorsal sinuation	Triangular with dorsal sinuation
Body seta dorsal to furca	Present	No mention of one in Hoff (1942)

Discussion.

This species, along with *C. suburbana,* appears to belong to the group of related species reported by Hoff (1942). This group includes *C. caudata* (Kaufmann, 1900), *C. sigmoides* (Sharpe, 1897), *C. indigena* (Hoff, 1942), *C. fossulensis* (Hoff, 1942), and *C. acuta* (Hoff, 1942). Since no eggs were discovered in either specimen it is difficult to ascertain whether this is an immature member of a known species or a new species. However, the combination of characteristics appears to point away from any previously known American *Candona.* A review of the more common

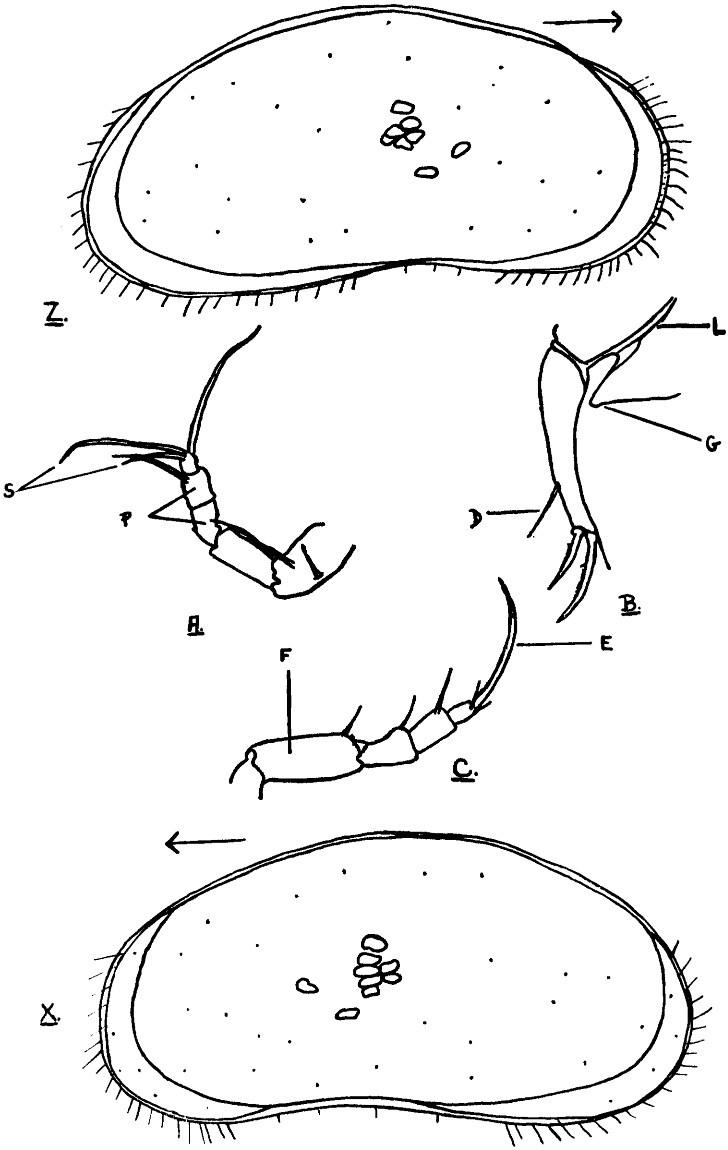
Z.
L
G
S
P
D
A.
B.
E
F
C.
X.

Plate II

CANDONA new species?

All the drawings were made with the aid of a camera lucida.

Z. RIGHT VALVE

The arrow points toward the anterior end of the animal

X. LEFT VALVE

The arrow points toward the anterior end of the animal

A. THIRD THORACIC LEG

- S. Companion setae of the ultimate podomere
- P. Divided penultimate podomere

B. FURCAL RAMUS AND GENITAL LOBE

The furcal claws are equal in length

- D. Dorsal seta
- G. Genital lobe
- L. This "double line" separation is found more dorsal to the genital lobe than it appears in this drawing. The specimen shown here was pushed out of position in this respect.

C. SECOND THORACIC LEG

- E. Claw
- F. Second podomere

European species in this genus fails to reveal any counterpart. Superficial resemblances exist between this undetermined species and *C. candida*, but the penultimate podomere of the third thoracic leg is undivided in the European specimens.

From the above considerations it is clear that further work needs to be done to ascertain whether these specimens constitute a species new to literature, a European one, or varietal examples.

DISCUSSION

Occurrence of Species

Of all the new records for New York State, only one species, *Leydigia acanthocercoides,* would not be expected in this general area. This is a warm water form reported in the United States only from Louisiana (Pennak, 1953). However, it is found in Europe, South America, India, China, and South Africa. It seems probable that the species was introduced into the area from another location, probably Europe. The representatives collected here were all from temperatures above 22°C and some from rather alkaline waters.

Of the other cladocerans, *Simocephalus expinosus* has been reported from Ohio (Ward, 1940), *Macrothrix rosea* is reported by Birge (1918) as "common everywhere", and the additional species, *Alona* and *Chydorus*, have been reported from Ohio and other proximal areas. The new records of ostracods are many because of the dearth of collections in New York State. All, except the tentatively new *Candona* have been reported from Ohio, Illinois or Massachusetts, and so are not unexpected in this region. The lack of a record for *Asellus militaris* in New York is probably due to its earlier synonomy with *A. communis*.

Habitat Preferences

By far, the most abundant numbers and kinds of species were found about vegetation in the littoral areas of ponds, lakes, rivers and marshes (Table I). Irondequoit Bay (Massaug Coves) appears to have similar species in kind and number to that of the lakes and ponds of the area. This type of habitat agrees with the results of a limnological study of the bay (Tressler and Austin, 1953).

Swift, clear creeks have very few species of Cladocera or Ostracoda (Table I) and those which were collected were found clinging to aquatic vegetation. Amphipods (except *Crangonyx gracilis*) and crayfish were present in abundance. A species which appeared only in this habitat was *Gammarus limnaeus,* found at cold temperatures (below 18°C) with a pH close to 7. It was particularly abundant at Cedar Springs, in the creeks and the swimming pool. Aside from the crayfishes, members of every other species were found in another type of habitat as well. This scarcity of Cladocera and Ostracoda may be due in part to the swift running water which renders it impossible for the animals to live. Larger forms such as amphipods, isopods, and decapods are certainly more able to withstand greater currents.

Moderately flowing, clear creeks evidenced a larger number of Cladocera and Ostracoda than the swift streams. *Macrothrix laticornis* was the only crustacean limited to streams (swift and moderate) in these collections. However, representatives of this species were found so rarely (in two collections) that they may well be lacustrine as Ward (1940) reports for Ohio. The other member of its genus, *M. rosea,* was found in Deep Pond. *Crangonyx gracilis,* not collected in swift streams, was found once in Little Black Creek, a moderately flowing creek. By far, *C. gracilis* was more commonly collected in ponds, lakes, and the Genesee River.

The occurrence of *Lirceus lineatus* in the sluggish Slater Creek is of interest, especially since this creek has almost disappeared into a marshy area during at least one dry spell. Efforts were made, unsuccessfully, to collect more animals at such a time. Its appearance in a drainage area where *Asellus communis* seems dominant (nearby Buck Pond, Long Pond) is of note since workers have often reported the entrenchment of only one isopod species over fairly large areas. *L. lineatus* has been reported from the Thousand Islands region of New York, so its existence in this part of the country is not unexpected.

The few vernal ponds sampled yielded typically spring species, such as the *Anostraca, Conchostraca, Asellus militaris* (if this is a valid species), and *Cypricercus splendida.* Animals common to other habitats appeared also, such as *Physocypria pustulosa, Cypria turneri, Pleuroxus denticulatus,* and *Chydorus sphaericus.*

As the list of Rochester species is surveyed, it is evident that most of the animals are not limited to strictly one type of environment, but are quite adaptable to several.

Temperature and Chemical Factors

The limitations of temperature and acidity or alkalinity on individuals of a species was not testable by the methods employed in this study. In order to test these effects, a series of collections from specific sites is required with a record of the pH fluctuations, or laboratory experimentation. The mere absence of members of a species from an environment does not indicate an intolerance to the prevailing pH or temperature. Only in cases of an abundant species which consistently disappears below or above a certain temperature or pH range can an inference be suggested, and even then it is without assurance. *Gammarus limnaeus,* for example, was found only at cold temperatures where the pH of the water was about neutral. These factors are usually associated with swift streams, the only habitat where members of this species were found. It is difficult to demonstrate which is the dominant factor in the survival of representatives of this species, or how many factors are related to their favorable environment. Only indications can be derived from such a study; laboratory experimentation provides more precise information.

The best conclusion which unequivocally can be drawn from the data is that the representatives of many of the common species show tolerance of a wide range in temperature and pH. The information gathered here may be of some value in future studies in this realm.

A Discussion of the Ostracods

In view of the inadequate attention this group has received previously in this area, a separate consideration here is warranted. As shown in Tables I and II, the most common ostracods in the Rochester area are *Candona simpsoni, Cypria turneri, Physocypria pustulosa, Cypridopsis vidua,* and *Potamocypris smaragdina.* These species have been found from summer and fall collections in a variety of temperatures. However, as Hoff (1942) reports for Illinois, *Cypria turneri* is never found in moving streams, but is quite abundant in marshes and ponds. The only ostracods found in streams are *Candona fluviatilis, Physocypria pustulosa, Cypridopsis vidua,* and *Potamocypris smaragdina,* all of which have previously been reported from such a habitat by other collectors (Hoff, 1942, Furtos, 1933).

The seasonal appearance of representatives of certain species of *Candona* in Rochester has differed from previous reports. *C. fluviatilis, C. decora,* and *C. punctata* have all been reported only from waters in the spring (Hoff, 1942 and Furtos, 1933). Here, members of all three species were found in the late fall, *C. fluviatilis* and *C. punctata* in September and October, *C. decora* in October and November. All the collections were from water 15°C or less. This may indicate a temperature relation, individuals of the species having a critical survival temperature. This suggestion is further strengthened by reports of *C. punctata, C. truncata, C. distincta,* and *C. crogmaniana,* all of which have been found abundantly in Ohio in the spring and in November with no reports of collections during the summer months (Furtos, 1933). In fact, the only ostracods found at temperatures higher than 15°C in this survey were *Candona simpsoni, Cyclocypris sharpei, Cyclocypris ovum, Cypria turneri, Physocypria pustulosa, Cypridopsis vidua* and *Potamocypris smaragdina* all of which have been found during the summer months by other collectors. Any claim of limiting temperatures can only be adequately substantiated in the laboratory.

The appearance of the giant *Candona decora* in Blue Pond opens the question of whether this is a new variety, an unusual individual, or the product of an environmental factor. Little more than speculation can be offered since only one individual was found, but the problem invites further investigation.

Individuals comprising an apparently new species of Candona require closer examination to ascertain whether this is a new American species or a previously described European one.

In some of the ostracods reported, differences were noted between the collected specimens and some part of their description in the literature. Some of the differences certainly may be ascribed to individual or group variations. Until type specimens can be examined for comparison, these differences in the classified individuals must be kept in mind. One of these is the presence of a flange on the right shell of *Cyclocypris sharpei*. None of the diagrams in the literature of *C. sharpei* were large enough to show this expansion, which may be present in some degree in the described species. The flange observed was not as pronounced as that of *C. cruciata* which caused comment by Furtos (1935), so it may be found on the type specimens.

More individuals must be collected to identify definitely the animals tentatively classified as *Cypricercus splendida*. The loss of a left valve and the bleached condition of the right one were hindrances in describing the single individual collected.

SUMMARY

(1) The free-living fresh water Crustacea of the Rochester area have received relatively little attention by Biologists. Any specimens of the various orders known from the area have been collected incidentally, for no general survey has previously been attempted.

(2) This survey is based on collections made in the spring, summer and fall of 1954. The area covered extended on the north to Lake Ontario, east to Irondequoit Bay, west to Cedar Springs, and south to Mendon Ponds.

(3) Collections were made from a variety of ecological habitats, ponds, lakes, creeks, marshes, a river, and temporary pools. Ecological notes were made at each site.

(4) Ecological and distributional remarks are given for representatives of the fifty-six species of Crustacea which were collected in the area. Fourteen of these are definitely new records for New York State, and for four additional species the writer has found no previous New York record.

(5) A tentative description of a probable new species of *Candona* is offered.

(6) An attempt is made to analyze the field data to find approximate habitat preferences and their relation to temperature and pH factors.

(7) A special discussion of the ostracods is given which includes a consideration of habitat distribution, seasonal appearance and its relation to temperature, and systematic problems of the ostracods collected.

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HEAVY MINERALS IN THE GLACIAL DRIFT OF WESTERN NEW YORK

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INTRODUCTION

The purpose of this study is to determine the heavy mineral assemblages present in the glacial drift of western New York.

Heavy minerals can be used to indicate the provenance (the source and its environment) of the sediments in which they occur. From the provenance of the heavy minerals in the glacial drift, the source of the ice that deposited the drift may be inferred.

Using the character of the heavy mineral assemblages present and the provenance inferred from these assemblages, some of the various drift deposits present in western New York are differentiated by means of statistical analysis.

Stability relationships between heavy minerals having the same provenance, but occurring in deposits of different ages, are determined.

Pettijohn (1957, pp. 514–520) in a survey of the literature on heavy minerals, observed that the frequency with which heavy minerals occur is inversely proportional to the age of the deposit. He attributed this increasing complexity of younger assemblages to intrastratal solution, which removes or alters the less stable minerals with time.

In the literature reviewed by Pettijohn however, a second factor is noted: increasing age corresponds to increasing depth of burial. Provenance and distance of transport are also definitive factors for any given heavy mineral assemblage.

To date, it has not been possible to determine which factors are operative. Surficial Pleistocene glacial deposits do not involve depth of burial as a factor, so that if the inferred provenance is a constant, transportation distance can be determined and the time factor will be the only variable. Thus, any change observed in the heavy minerals of this study, which is based on a time-sequence of deposits, will indicate instability due only to increasing age.

GEOLOGIC SETTING

PLEISTOCENE CHRONOLOGY

During the Pleistocene epoch of the Quaternary period, much of the territory in the northern latitudes of the world was subjected to glaciation. Four separate glaciations were represented during this epoch. Each glaciation was followed by an interglacial climate, warmer than that of today. The four glaciations have been designated, from oldest to youngest, as Nebraskan, Kansan, Illinoian, and Wisconsin.

The Wisconsin glaciation has been further subdivided into stadia. Between these were intrastadia; during their existence the individual ice lobe fronts of each stadium retreated and the climate warmed enough to support a limited flora (Leighton, 1958). The stadia of the Wisconsin have been designated as Farmdale (oldest), Iowan, Tazewell, Cary, Mankato, and Valders (youngest). For an excellent discussion of the evolution of the classification of glaciations and stadia, see Leighton (1958).

The evidence for postulating the former presence of a glacier may be conveniently broken down into two categories: evidence of glacial erosion, and evidence of glacial deposition. The sedimentary deposits are formed from the material that the glacier eroded and transported.

GLACIAL DEPOSITS OF WESTERN NEW YORK

Evidence of glacial erosion in western New York is limited to fragments of local bedrock incorporated in glacial deposits, and to striations on the bedrock (Flint, 1959). As most of the striations have been buried by subsequent glacial deposits, interpretation of glacial activity in western New York must rest almost entirely on depositional evidence.

The two types of deposits of an advancing glacier that are most easily recognized and interpreted are drumlins and terminal moraines, both composed of unsorted and unstratified sediment called till. Till has its origin in the material that a glacier erodes and pushes along in front of (or under) it. A terminal moraine is composed of the till that has been left at the point of maximum extension of the glacier. Drumlins are formed when a glacier overides the till which it has been pushing, and may be used to infer the direction in which the glacier flowed.

The most common depositional features of a receding glacier are kames, kame terraces, eskers, and outwash plains. These are found either in belts called recessional moraines, or in places, as isolated deposits. The deposits formed during the recession of a glacier are composed of water-borne sediment and are termed stratified drift. Here it will suffice to describe kames, eskers, and kame terraces as deposits of coarse, stratified sediment from superglacial, subglacial, and ice marginal streams, respectively. These deposits are formed in contact with the ice margin. An outwash plain is a deposit of finer sediment that has been transported and deposited farther from the margin of the glacier. For a complete description of glacial deposits, see Flint (1945, pp. 102–160).

It becomes obvious that no matter how pronounced a record of drumlins and moraines a glacier may leave, subsequent glaciation will tend to obliterate the traces of the older one. In western New York the terminal moraines of four individual ice sheets lie, preserved, beyond the terminus of the last glacier to cover this area. Even though no remnants of Nebraskan or Kansan glaciation have been recognized in this area, the display of Illinoian and Wisconsin deposits make New York an excellent locality for the study of glacial stratigraphy.

During the glaciation of western New York much of the melt water from the ice was ponded in front of the glacier, due to the relative increase in elevation of the land from north to south. These glacial lakes, formed only in New York and Ohio, led to the building of large moraines, for much of the sediment that poured from the glacier was deposited under water. This also led to the semistratification of even the terminal moraines.

Although this paper is not directly concerned with glacial lakes, the writer would like to note here the excellent work of Dr. Herman L. Fairchild, on the correlation of the succession of glacial lakes in New York State (Fairchild, 1932a).

GLACIAL STRATIGRAPHY

The problems of correlation, and dating off glacial deposits are those common to any terrestrial deposits. Due to the topographic expression of the environment of deposition, the drift may be irregularly distributed and in places missing from the higher elevations. Also the deposits have been subjected to subsequent erosion. Thus, the only methods by which the principal of superposition may be determined are: recognizing non-glacial deposits between drift sheets and studying zones of decomposition, indicative of a soil profile between two tills.

In areas where older drift has been almost completely destroyed by younger glaciation, more indirect methods for correlation must be used. One that has been frequently used is drift lithology, which is determined from the type of rock fragments incorporated in the drift. This procedure however, can only be used to differentiate tills within a limited area, for the provenance of the rock fragments is generally quite close to the site of deposition. The reason is because rock fragments, in contrast to individual grains, are unstable and tend to break down rapidly during transportation. Thus, deposits found in the same locality will have a similar lithology, regardless of their relative ages.

Another method commonly used, for sediments younger than 40,000 years, is radio-carbon dating. The scarcity of fossil wood fragments, the material from which the dates are obtained, limits the usefulness of this method in New York State.

Other methods that have been used involve varve chronology, correlation by means of fossil spores and pollens, examination of the depth to which leaching has occurred in drift sheets, and heavy minerals. All the aforementioned factors are limited in their use because they investigate only one or two aspects, such as glacial flow direction. Therefore they must be used in relation with one another in order to obtain an accurate stratigraphic representation of any given area. Holmes (1952) has determined flow direction by means of drift lithology, MacClintock (1954) determined relative age from the depths to which deposits have been leached, and Ernest Muller (personal communication) is preparing a revised map of the drift of New York State. This paper therefore, adds to the knowledge of glacial stratigraphy in western New York by presenting analyses of the heavy mineral assemblages present in the drift.

HEAVY MINERALS

Heavy mineral assemblages are a useful tool in the study of glacial stratigraphy. As heavy minerals are found in the sand-size fraction of a sediment, they survive long distances of transportation with much less loss than rock fragments (Plumley, 1948, pp. 570–576). Thus their provenance can be used to infer a relatively distant source for the glacial ice that formed a given deposit. Another advantage to studying heavy minerals is that they generally comprise less than 15 percent by weight of the sand fraction of a sediment and therefore representative samples are easy to store and work with in the laboratory.

Dreimanis, Reavely, Cook, Knox, and Moretti (1957) have examined the heavy minerals in tills of Ontario and adjacent areas in Canada. The results of their studies indicate that heavy minerals give excellent evidence of the source of the glaciers depositing these tills, and may be used to differentiate one till sheet from another. With this work, and more recent work of Dreimanis (personal communication), as a basis, the writer has undertaken a heavy mineral study of the glacial drift of western New York State. Before the writer's field work and results are discussed the character and location of the New York State deposits will be reviewed.

PREVIOUS WORK IN WESTERN NEW YORK

Previous work of Fairchild (1932b) and MacClintock and Apfel (1944) has shown that there are five terminal moraines and at least two recessional moraines represented in New York State (see Plate 1). The southernmost terminal moraine is of Illinoian age, while the more northerly ones are Wisconsin. The Olean drift, Binghamton drift, Valley Heads moraine, and Hamburg-Batavia-Victor moraine all are terminal moraines which represent the Tazewell, Lower Cary, Upper Cary, and Mankato (or Valders) stadia, respectively, of the Wisconsin glaciation. The Waterloo-Auburn and Albion-Rochester are recessional moraines, formed during periods of stagnation while the Mankato glacier was retreating from the terminal position.

"The Terminal Moraine" was the first belt of moraine to be recognized in New York State and was described in papers by Upham (1879), Chamberlin (1883), and Lewis (1884). This moraine was actually the terminus of the Olean drift sheet of MacClintock (1944), along with patches of Illinoian till which project out from beneath it. The two drifts were undifferentiated and given the name of "The Terminal Moraine". No interpretation of the moraine was made until Leverett (1895) attempted to correlate the New York State moraines.

The second moraine to be described was the Albion-Rochester moraine. Fairchild (1895) described the Pinnacle Hills, the Rochester segment of this moraine, as a kame-moraine. Later, he (1932b) included all the morainal material from Albion to Sodus Bay in a single moraine for which he proposed the name Albion-Rochester moraine.

The Waterloo-Auburn moraine of Fairchild (1932b) was first described by Fairchild (1896) as an isolated kame-area south of Irondequoit and Sodus Bays. In the same paper, Fairchild also described the kame deposits which in 1932 he incorporated in the Hamburg-Batavia-Victor moraine.

No accurate map, or description of the Valley Heads moraine was available until Fairchild reported it in his paper in 1932. This moraine was recognized before 1932, however its description by Tarr (1905) was too sketchy for positive identification.

Thus in 1932, Fairchild summarized almost forty years of superb work on the glacial moraines of western New York with his paper: "New York Moraines". The Valley Heads, Hamburg-Batavia-Victor, Waterloo-Auburn, and Albion-Rochester moraines were described and named. Fairchild's work has served as a basis for all work north of the Valley Heads moraine.

The complex problem of "The Terminal Moraine" was resolved by MacClintock and Apfel (1944). Working on the Salamanca Re-entrant, they recognized three distinct deposits: the Binghamton drift, the Olean drift, and deposits of Illinoian till. Although Fairchild (1932b) noted a few isolated kame deposits between the Valley Heads and "Terminal" moraine, which he correctly correlated with the kames of the Susquehanna River valley near Binghamton, it was not until the work on the Salamanca Re-entrant in 1944 that the Binghamton drift was recognized as a distinct terminal moraine.

The work of MacClintock and Apfel (1944) is significant because it was the first time that the moraines of western New York had been proposed as terminal deposits for separate glaciations. The theory of multiple glaciations in New York State was first proposed by Fairchild (1913), but until the work of MacClintock and Apfel, the moraines of northern New York were all thought of as being recessional moraines deposited after "the glacier" receded from the location of "the Terminal Moraine". As a result of their studies, MacClintock and Apfel (1944) proposed three hypotheses for the age of the Wisconsin deposits. They favored the third of these, which dates the Olean drift as Tazewell, the Binghamton drift and Valley Heads moraines as early and late Cary, respectively, and the Hamburg-Batavia-Victor moraine as Mankato. MacClintock (1954) later strengthened this hypothesis by testing the depth to which leaching has occurred in the glacial deposits of New York.

A Canadian source for the glacial ice which overrode New York has been inferred from various lines of evidence (see Flint, 1945 pp. 233–235). The belts of terminal moraine found across the northeastern part of the United States separate the unglaciated area to the south from the northern part of North America, all of which shows evidence of glacial erosion.

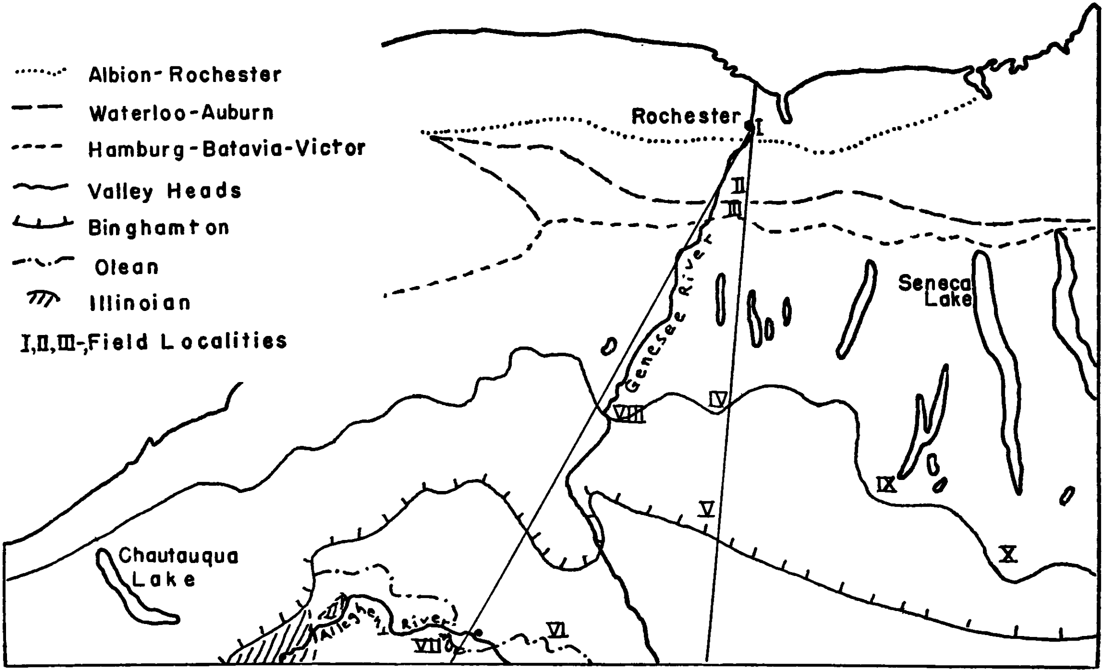
The evidence of glacial erosion in Canada consists of striations on the bedrock and gross topographic forms, both of which indicate a flow direction from north to south. Also, fragments of crystalline rock, the source of which is in Canada, are found in the morainal belts of the United States.

The first major attempt at a provenance study in western New York was made by Holmes (1952). From this study valuable information was gained about the dispersal of glacial debris from the basin now occupied by Lake Ontario. Holmes found that concentrations of characteristic rock types could be used to show that the ice of recent glaciations spread radially outward from the Ontario basin, even though the primary source was north or east of the basin itself. The flow pattern is supported by one of the sets of striations reported by Fairchild (1895).

AREAS SUITABLE FOR STUDY

The area from Rochester south to Olean (see Plate 1), lends itself very well to a study of glacial stratigraphy and heavy mineral stability, for two reasons. The primary reason is that seven distinct moraines may be observed in this area. The other reason is that the glacial stratigraphy of the Salamanca Re-entrant, representing the three southernmost moraines, was thoroughly studied by MacClintock and Apfel (1944).

PLATE 1



Outline Map of Western New York. The map shows the location of the terminus of each of the seven drift sheets and the sample localities (Roman numerals) in each drift sheet. Note the sector, from Rochester to the southern border, in which the initial samples were taken.

The building of distinct moraines, whether terminal or recessional, represents a distinct time interval during which the glacier was stagnant. Therefore seven separate time intervals are represented in the moraines of western New York. The sediments in these moraines, then, represent seven discreet samples from the glacial sediment supplied during the Illinoian and the latter part of the Wisconsin glaciations. By deducing the provenance of the material which comprises these moraines, at the specific times represented, it should be possible to build up a continuous picture of the changes in the centers of glacial outflow during this time interval. It should also be possible to note the effect of any progressive change in the material, due to the length of time it has been exposed to the process of, intrastratal solution. Consequent to the two aforementioned factors, it should be possible to define the moraines in the area chosen for study, and thereby to identify moraines in areas where the stratigraphic sequence is indeterminate from other evidence.

Due to the early reconnaissance of Fairchild (1932b) and to the subsequent work of MacClintock and Apfel (1944) and MacClintock (1954), there is at least a working hypothesis as to the specific stadium to which each moraine belongs. Gross correlation with the deposits of the Midwest and the small amount of radio-carbon work that has been done in New York, facilitate the calculation of the actual time interval that is represented between two various deposits. To carry this one step further, it should be possible to calculate the actual time necessary to cause changes in the heavy minerals of glacial drift.

GLACIAL FLOW DIRECTION

In an effort to take into account any difference between deposits that might be caused by differences in the amount of transportation undergone by each, the samples were taken in a line parallel to the flow direction of the glaciers. In this way the difference in the length of transportation can be taken as the actual map difference for two deposits having a common provenance, if the flow directions are coincident.

Evidence as to the direction of glacial flow during the deposition of the three southernmost moraines has either been destroyed or has gone unnoticed to the date of this writing. However, the flow direction for the Valley Heads moraine was inferred by the work of Holmes (1952). He pointed out that the flow direction is consistent with that indicated by the orientation of the drumlins observed on the southern shore of Lake Ontario, north of the Hamburg-Batavia-Victor moraine. The direction is also consistent with that inferred from the set of striations previously mentioned. Because the work of MacClintock (1954) showed that the three northern moraines are the result of

Mankato glaciation rather than recessional moraines of Cary age, the flow direction as determined by Holmes is valid for at least four of the seven moraines, and represents a constant flow direction for the two youngest stadia.

Holmes felt that the Ontario lake basin was the center of distribution for the Valley Heads and younger glacial lobes. If this is the case, then it is possible that the older glaciers flowed out from this same center. Thus control is established over distance of transportation for at least four of the seven moraines. A second set of striations, different from the first, were reported by Fairchild (1895) and later by Adams (1956, pp. 5–6) and will be discussed below.

As the drumlin orientation south of the northernmost moraine indicates a flow direction between S5°W and S25°W, the samples from the more southerly moraines were taken from the area bounded by these two limits as extended from the Pinnacle Hills, in Rochester (see Plate 1). Upon completion of the laboratory work on the first seven sets of samples, the study was extended to include analyses of lateral variations in a given moraine.

FIELD SAMPLING

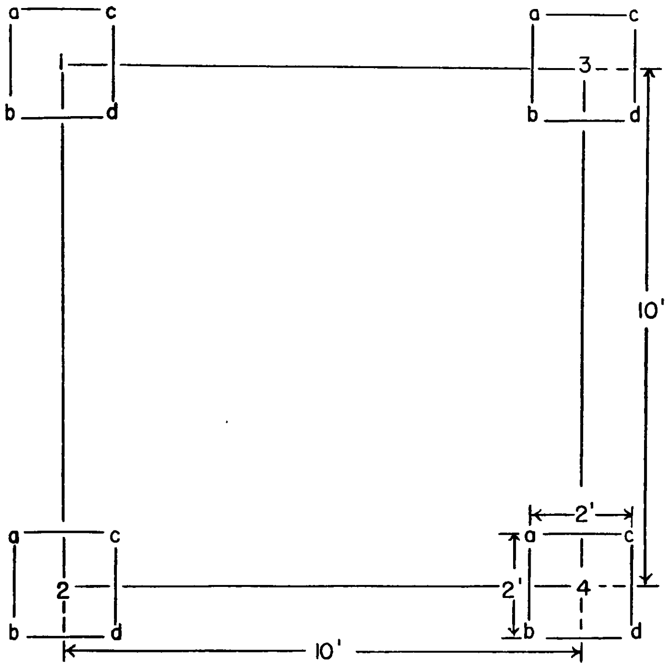
Most of the field work was done during the summer of 1958, with supplementary samples being taken in the spring of 1959. During the summer field work, seven localities were visited and sampled, one in each moraine. Each locality is situated at or near the terminus of each drift sheet. After completion of the laboratory work on the first seven sets of samples, three more samples were taken in the Valley Heads moraine.

One-quart samples of dry sediment were taken from the corners of a vertical grid which was superimposed on the face of each outcrop. Each sample was collected in a cylindrical ice cream container.

SAMPLING METHOD

The sampling method used was that of taking four composite samples from each locality, each composite sample being taken at the corner of a grid which measured 10 feet on a side. Each composite sample represents four spot samples which were subsequently combined. The spot samples were taken from the corners of a smaller two-foot grid. The center of each small grid was a corner of the larger 10-foot grid (see Plate 2). The method was found satisfactory for all the localities except II and VI (see Plate 1). The only available outcrop at locality II was too small in vertical extent to enable the taking of composite samples 2 and 4. The outcrop at locality VI would not yield fresh samples for sample 3 on the grid.

PLATE 2



Grid Pattern. The grid used in field sampling as it would appear in a vertical position. The composite samples are 1, 2, 3, and 4, while the spot samples are a, b, c, and d.

For the lateral check samples the method was altered so that one composite sample was taken by combining four spot samples from the corners of the larger grid.

The purpose of collecting samples for combination into a series of composite samples (Krumbein and Pettijohn, 1938 pp. 13–20) was to get a series of four average samples for each locality. The composite sample presents the advantage of masking any unique variations that might be present in small pockets within a deposit or within single laminae of the cross-stratification common to the moraines of this area. By taking four such composite samples on a grid larger than that of the spot samples, major variations in a single deposit will not be ignored. These major variations will reveal the lack of homogeneity of the deposit.

The purpose of taking samples from the corners of a superimposed grid pattern is to insure the randomness of the samples. Without the grid, the writer would have been strongly tempted to collect only those samples which were most easily attainable, or those which possessed uniform characteristics. This would have created a bias which might have been reflected in the results of the statistical analysis.

The grid, in a vertical position, was traced on the face to be sampled. Thus variations due to lateral changes within a single bed, or to vertical changes due to a relative difference in the time of deposition would be observed over the grid interval.

Due to the instability of some minerals, care was taken to extract the uppermost samples well below the overlaying zone of weathering. Unaltered drift (zone 5 of Leighton and MacClintock, 1930) was easily recognized in all localities except VI. The oxidized zone was characterized by brown iron stains on the pebbles and sand grains, so samples were taken only where stains were absent. The writer was not assured of the freshness of the samples from locality VI until they were subjected to microscopic examination in the laboratory.

Because the samples had to be taken below the zone of weathering and well above the base of the outcrop to avoid contamination from slumped sediment, exposures of drift extensive enough to allow the use of the grid were limited to actively worked gravel pits. Therefore very little material had to be removed from the face of the outcrop in order to insure the freshness of the samples.

A one-quart container was bored into the prepared face with a rotary motion, until it was filled with sediment. Next, the material was removed from around and under the container and the latter was removed, capped, and sealed.

LOCALITIES SAMPLED

The location of the pits to be sampled was determined by noting all the suitable pits situated within the moraines of the area to be studied, and choosing the most recently worked from among these. For the location of the sample localities see Plate I.

The selectivity of the writer, in choosing localities to be sampled, was necessary in order to use a grid for assuring randomness in the actual sample collecting. The writer feels that any bias created by selectivity is negligible.

Locality I is situated 500 yards NW of the intersection of Highland and Clinton avenues in Rochester (latitude 43°08′N, longitude 77°35′30″W) and is either a kame or an esker (Anderson, 1956) in the Albion-Rochester moraine. The outcrop face is 75 feet high with cross-bedded sand at the top and a gravel-bearing sand at the base. The light-tan sand at the top, from which the samples were taken, exhibits small scale cross-bedding (for an illustrated example see Plate 3a). The attitude of the beds could not be observed.

Locality II is situated 7 miles south of Rochester, 700 yards SW of the intersection of Pinnacle and Lyons Roads (latitude 43°N, longitude 77°37′30″W), in the Waterloo-Auburn moraine. The deposit is an esker fan. The outcrop face is 20 feet high and composed of cross-bedded sandy gravel dipping 20°SW (see Plate 3b). Boulders of cross-bedded sandstone and pebbles of graphite-bearing limestone were noted in the deposit.

Locality III is situated east of Five Points on Five Points road, 200 yards east of Works Road (latitude 43°57′30″N, longitude 77°38′W) in the Hamburg-Batavia-Victor moraine. The topographic expression of the deposit is kame-like, however the internal stratification (see Plate 4a) suggests a deltaic origin. The outcrop face is 45 feet high and is composed of coarse sand, gravel, and clay beds dipping 24°SW. Pebbles and boulders of igneous and metamorphic rocks were noted.

Locality IV is situated one mile south of Dansville on the west bank of Stoney Creek (latitude 42°32′30″N, longitude 77°42′30″W) in the Valley Heads moraine. The deposit is a horizontally bedded kame terrace (see Plate 4b). The outcrop face is 40 feet high and composed of interbedded cobbles, and fine tan or gray sand. The sand beds exhibit small scale cross-bedding similar to that noted at locality I. Festooned cross-bedding and intrastratal contortion (Pettijohn, 1957 p. 190) indicative of soft sediment deformation are present in the upper beds (see Plate 5a). Because the contortions tend to flatten out toward the top and base of the bed, the structure is interpreted as intrastratal flowage. This could be a type of ice-contact structure (Flint, 1945 pp. 143–147) caused by readjustment of the sediment to a change in slope due to the retreat of the ice from direct contact with the deposit.

Locality V is situated at the north end of the town of Almond (latitude 42°19′30″N, longitude 77°44′W) in an isolated group of kames (see Plate 5b) belonging to the Binghamton drift sheet. The deposit consists of beds of gravel, fine and coarse sand which dip 10°S, and are exposed on an outcrop 160 feet high. Small-scale cross-bedding was noted in the fine sand.

Locality VI is situated one mile SW of Little Genesee on the west bank of Little Genesee Creek (latitude 42°19′30″N, longitude 77°44′W) in a terminal deposit of the Olean drift. The outcrop face is 40 feet high and exhibits a rough stratification which dips 32°W. Each "bed" however, exhibits a till structure (see Plate 6a). Although boulders and cobbles are predominant, no crystalline rocks were noted, most of the rocks being gray shales of a local character.

Locality VII is situated south of Salamanca, at the Bird Creek gravel pit (latitude 42°05′N, longitude 78°32′30″W) in a kame terrace composed of Illinoian drift. The outcrop face is 80 feet high and exhibits the foreset bedding of MacClintock and Apfel (1944) as well as small scale cross-bedding. The beds are horizontal and are composed of tan-colored sand, gravel, and light-brown silt or clay. Many small-scale faults (see Plate 6b) are also present and are interpreted as ice-contact structure. This deposit was originally described by MacClintock and Apfel (1944) as a kame of Tazewell age, however E. H. Muller (personal communication) and this writer, believe this may be an Illinoian kame terrace. An Illinoian age is proposed because igneous rock fragments are present here; they are rare in Tazewell drift, and the deposit is situated at a higher altitude than that at which Tazewell is known to occur.

Localities VIII, IX, X are situated in kames, or kame terraces, in the Valley Heads moraine. Locality VIII is one mile SE of Portageville and one mile east of the Genesee River. Locality IX is at the north end of the town of Hammondsport. Locality X is two miles SW of Ithaca on Route 13.

LABORATORY PROCEDURES

Preparation of the samples entailed drying, combining the spot samples into composite samples, sieving the composite samples to obtain the desired sand size, and splitting the sand fraction into samples of about 10 grams. During each step (see Plate 7) in the preparation of the sample, a portion equal to that portion used was stored for future examination or for reruns in case of experimental error. In each case, the portion to be used was determined by a toss of a coin.

PREPARATION OF SAMPLES

The four spot samples (a, b, c, and d in Plate 2) were unsealed, dried, and halved using a Jones Sample Splitter (Krumbein and Pettijohn, 1938, p. 45). One fraction of each spot sample was used for the composite sample. The two-quart composite sample was then thoroughly mixed and quartered, one quarter being used for sieving.

From preliminary laboratory analyses, the writer found that 80 percent of all the heavy minerals in the sand (Wentworth-Udden grade scale) of the Pinnacle Hills kames occur in the sizes between .062 mm. and .350 mm. These size limits were used because the grains could easily be identified by microscopic examination. Also, transportation of similar sediment (*e.g.*, to the position of the more southerly moraines) could only reduce constituent grain size (see "Provenance", below). Therefore at least 80 percent of the heavy minerals in the sand fraction of the more southerly moraines, which represent the same provenance that the Pinnacle Hills sand represents, should also be studied.

The desired sand fraction was obtained by sieving each sample for 10 minutes in a Ro-Tap automatic shaking machine (Krumbein and Pettijohn, 1938, pp. 137–141).

The sand obtained after sieving was then split with a microsplit until a fraction weighing between 6.5 and 13 grams was obtained. A sample of 6.5 grams yielded a sufficient quantity of heavy minerals for study, so samples over 13 grams were split into finer fractions. Next the sample was weighed on an analytical balance, accurate to one milligram, and stored in a stoppered bottle, ready for separation.

HEAVY MINERAL SEPARATION

The heavy fraction of the sand was separated using purified bromoform ($CHBr_3$) having a specific gravity of 2.87 at 20°C. The separation was carried out by the standard method for heavy liquids outlined in Krumbein and Pettijohn (1938, pp. 335 and 343).

A funnel, stoppered at the bottom with a length of rubber tubing and a stop-cock, was filled to within a centimeter of the top with bromoform. The prepared sand was poured onto the surface of the liquid and gently agitated until all the heavy minerals collected at the bottom of the funnel. When the separation was complete the stop-cock was opened long enough to allow only that portion of the liquid seen to contain the heavy minerals to pass through. The heavy mineral grains dropped onto a conical filter paper, and the bromoform was allowed to drain off. The grains were then washed with ethyl alcohol (C_2H_5OH) and allowed to dry.

The dry mineral grains were transferred to a 50 ml beaker and weighed on an analytical balance. From these figures as compared with the weight of the unseparated fraction, the percent by weight of the heavy minerals present in the sample was calculated (see Table 1).

SEPARATION OF MAGNETICS

The magnetic grains in the heavy fraction were removed for two reasons. The primary reason was to concentrate the non-opaque minerals for optical study. More than 99 percent of the heavy minerals that were attracted to the magnet were opaque, so this separation eliminated many of the opaques, which were treated as an undifferentiated group. The secondary reason is that the percent by weight of the magnetic grains could easily be determined in this manner.

The heavy minerals were spread evenly on a flat filter paper, adjacent to a clean filter paper. A small hand magnet, covered with a clean filter paper, was passed over the heavy mineral grains and then over the adjacent filter paper. The magnet was removed from behind the covering paper and the magnetic grains were allowed to fall to the clean filter paper. This process was repeated until all the magnetic grains had been removed. The magnetic fraction was then weighed on an analytical balance and stored for future reference. From these figures the percent by weight of the magnetic grains present in the heavy minerals was calculated (see Table 1).

IDENTIFICATION

The heavy minerals, minus the magnetic fraction were quartered and three of the quarters were examined, the fourth being stored. The sample was quartered by spreading the grains evenly on the center of four overlapping pieces of cardboard. When the pieces were separated three of the quarters were chosen for examination by tossing a coin.

The remaining three quarters were mounted individually on separate petrographic slides using Canada Balsam ($n=1.54$) cooked on a small hot plate.

The minerals were identified with a petrographic microscope using crystal form, cleavage, fracture, color, pleochroism, extinction, elongation, interference figure, optical sign, and 2V as definitive characteristics. Positive identification was made by comparing the observed properties with descriptions of minerals given by Krumbein and Pettijohn (1938), Rogers and Kerr (1942), and with the chart from the report of the Committee on Sedimentation, National Research Council (1942).

The minerals identified were:

Common	**Less common**	**Trace**
Garnet	Chlorite	Zircon
Hornblende	Apatite	Sillimanite
Hypersthene	Tremolite	Titanite
Monoclinic pyroxenes		Tourmaline
Opaques		Rutile
		Epidote
		Monazite

Garnet is present as grains which exhibit conchoidal fracture and very little rounding. Red, orange, pink, purple and colorless varieties are all present. The garnets are divided into two categories for the purpose of indicating provenance. The red, orange and pink varieties exhibit a distinct color and were counted as red garnet, while the colorless and purple garnets appear to grade into one another and were counted as purple garnet. The garnet was distinguished by its color and isotropism.

Hornblende is present as prismatic grains with rounded ends and an extinction angle less than 20°, or in some instances as irregular grains. The grains vary from those that are translucent to those that are opaque in the center and translucent only on the edges. All the grains exhibit pleochroism, with most of the grains being light green to dark green or light brown to dark green-brown. A few grains were noted that possessed yellow-green to blue-green pleochroism.

Hypersthene, and enstatite, are members of the isomorphous series of orthorhombic pyroxenes. This series is present as stubby prismatic grains predominantly pleochroic from light green to pink or red (hypersthene) or in a few instances colorless (enstatite). Some of the grains of hypersthene possess inclusions of brown plates in parallel alignment (schiller structure) which distinguish the variety; bronzite. The series was counted under the heading of hypersthene and was recognized by the pleochroism and by parallel extinction.

Monoclinic Pyroxenes, including augite and diopside, are included in one group and are present as worn elongate cleavage fragments. The grains are light green in color and have an extinction angle of about 55° with respect to elongation. Some of the grains have a fine ruling structure (herringbone structure) at an angle with elongation. The grains were distinguished by their extinction angle and lack of pleochroism.

Opaque Minerals were counted as a group and were identified individually only for localities VI and VII. In these two localities the difference between red grains of hemetite and yellow-brown grains of limonite was noted.

Chlorite is present as light green or green basal plates which yield an off-center optic axis figure. The grains were distinguished by their low birefringence and incomplete extinction.

Apatite is present as worn prismatic grains or as nearly circular grains with a pitted surface. The grains were distinguished by their white color and their extremely low birefringence.

Tremolite, and actinolite, are end members of an isomorphous series and were counted as a group under the heading tremolite. Tremolite is present as colorless or very light green prismatic grains exhibiting an extinction angle less than 20°.

Trace Minerals: Zircon is present as colorless, unzoned euhedral prisms and sillimanite as irregular or prismatic, fibrous grains. Titanite (yellow-brown), tourmaline (pleochroic from light brown to dark brown), rutile (deep red), epidote (lemon-yellow) and monazite (white) are present as well rounded grains.

MINERAL FREQUENCY

Between 400 and 1700 grains were counted for each sample. The frequency with which each of the above described categories was present was recorded and converted to a percentage. The percentages are recorded in Table 2; note that for all trace minerals present in quantities less than 0.5 percent, the figure 0.1 percent has been entered.

The counting was done with the aid of a petrographic microscope and a square grid pattern superimposed on the face of the slides. It was sufficient to count the grains in every third square of the grid. The particular pattern of squares to be counted was determined by drawing numbers for each slide. The grains on all three slides were counted for each locality and the combined figures were used for each sample.

STATISTICAL INFERENCE

The broad field of statistics can be divided into two areas, descriptive statistics and statistical inference. The field of descriptive statistics comprises the collecting and calculating of data which defines or describes a population sample. Statistical inference is the field in which descriptive statistics are used to deduce information about a population.

The result obtained by the use of statistical inference is dependent on the randomness of the sample used. A random sample is one that is taken from a population in such a way that every individual (observation) in the population has an equal chance of being represented. From such random samples, descriptive statistics, such as sample mean, sample variance, etc., may be computed. By statistical inference the descriptive statistics, which define a random sample taken from a population, may be used to approximate, within limits, the parameters which define the entire population.

For each statistic which defines a population sample there is a corresponding parameter which defines the population. A statistic, *e.g.* sample mean, is not necessarily equal to its corresponding parameter (population mean). One of the methods, however, that may be used to approximate, within limits, the population parameter is the calculation of a confidence interval.

Confidence Interval

The method used in this study is the calculation of a 90 percent confidence interval about the sample mean. This interval is calculated from the sample mean and an unbiased estimate of population variance. The confidence coefficient 90 percent, indicates the degree of belief that the interval contains the population mean. In other words there is a 90 percent probability that the population mean lies within the interval.

The confidence interval presents the advantage of being easily represented graphically by a bar chart. The confidence interval is plotted vertically, on the ordinate, with the sample mean as its center. The sample localities are plotted on the abscissa. If a real difference exists between two population means, the respective bars will not overlap. If the difference is only apparent, the respective bars will overlap.

FORMULAS

First the sample mean "$\bar{y}$", must be computed from the formula

$$\bar{y} = \Sigma y / n \tag{1}$$

where "Σy" is the sum of all the sample observations, and "n," is the number of sample observations.

Next an unbiased estimate of population variance "s^2", is computed from the formula

$$s^2 = \Sigma (y - \bar{y})^2 / v \tag{2}$$

where "v," is the degrees of freedom (Li, 1957, p. 66),

$$v = n - 1 \tag{3}$$

From the sample mean (1) and the unbiased estimate of population variance (2) the limits for the 90 percent confidence interval about the sample mean may be computed. This computation is based on the inequality

$$-t_{.05} < (\bar{y} - \mu) / \sqrt{s^2/n} < t_{.05} \tag{4}$$

where "$-t_{.05}$", and "$t_{.05}$", are statistics that may be obtained from a table for Student–t distribution (Li, 1957, p. 87 & 520) for a given "v," (3), and "μ" is the population mean. The .05 probability level for "t", is used to obtain a 90 percent confidence interval.

By manipulation, formula (4) becomes

$$\bar{y} - t_{.05}\sqrt{s^2/n} < \mu < \bar{y} + t_{.05}\sqrt{s^2/n} \tag{5}$$

from which the 90 percent confidence interval for the population mean "μ", may be computed by substituting the actual value for "t."

Results for the analyses of the percent of heavy minerals in the samples, and the percent of magnetic grains in the heavy fraction, are given in Table 3. The graphic representation of these results is given in the chart of Table 4, where the arrows indicate the sample means.

PROVENANCE FACTORS

In a study of the provenance of heavy minerals, it must be possible to differentiate between those minerals which have been derived from the primary source of the sediment and those which have been added while the sediment was in transit. When dilution of the assemblages occurs, the provenance may be masked by the minerals that have diluted the primary assemblage.

DILUTION

As noted previously, much of the glacial ice that covered New York State had its origin in Canada. Thus the metamorphic bedrock of Canada will be reflected in heavy mineral assemblages having this area as their provenance. The assemblages will consist mainly of garnet, amphiboles, and pyroxenes (Dreimanis, *et al.*, 1957). The area between the Canadian metamorphic provinces and the sites of deposition of the four northern moraines of western New York is underlain by a sequence of fine-grained Paleozoic sedimentary rocks. With the exception of the Silurian Grimsby sandstone, these rocks could contribute only negligible quantities of sand-size mineral grains by which glacial sediments could be diluted.

Hoyt (1943) reported that the dominant non-opaque heavy minerals in the Grimsby were tourmaline and zircon. As these minerals comprise less than one percent (see Table 2) of the assemblages found in the glacial sediments of western New York, dilution of the major constituents is taken to be negligible.

The southern part of western New York is also underlain by fine-grained Paleozoic siltstones and shales. With one exception, these rocks are also unable to contribute significant quantities of sand-size mineral grains. The heavy fraction of the samples from the Binghamton drift (V), Olean drift (VI), and Illinoian till (VII) are progressively diluted by opaque minerals. An examination of the opaque minerals from these samples shows that the assemblages are diluted by fine-grained aggregates of hematite and limonite. The source for these fine-grained rock fragments must be the siltstones of southern New York.

If the heavy fraction is being diluted by these rocks, the light fraction must also be affected. As illustrated by the data in Table 1, the percentages for heavy minerals in the southern moraines are less than the percentages for the northern moraines. A cursory examination of the light fraction, under a binocular microscope, reveals that the light minerals of the southern moraines are also diluted. The light fraction is diluted by fine-grained fragments of siltstone and shale. This dilution is as great as 50 percent in the Binghamton drift and Illinoian till, and almost 100 percent in the Olean drift.

TRANSPORTATION DISTANCE

To be sure that the decrease in the percent of heavy minerals in the southern moraines is due to dilution and not to differential transportation, the writer examined the rounding of the grains in the light fraction. The degree of rounding is similar for all seven moraines, implying the absence of preferential transportation.

The sorting of the sediments was also examined in a super-composite sample, made from the composite samples for each locality. These samples were sieved on a Ro-Tap automatic shaking machine. The sieves were nested according to half-sizes of the Wentworth grade scale. The percent by weight of sediment present in each half-size class of the sand fraction was recorded (Krumbein and Pettijohn, 1938, pp. 138–142) and a cumulative frequency curve was constructed for each locality. From these curves a geometric sorting coefficient (So; of Krumbein and Pettijohn, 1938, pp. 232–236) was computed for each locality. These sorting coefficients are:

Locality	So
I	2.54
II	4.05
III	3.07
IV	2.58
V	3.65
VI	9.64
VII	2.60

Localities I–V and VII show essentially no difference in their degree of sorting, while locality VI shows much less sorting than the others. Therefore, with the exception of locality VI, transportation distance appears to have caused little, if any, difference between sediments of different deposits.

GARNET RATIOS

Dreimanis, *et. al.*, (1957) found that the tills of western Ontario could be differentiated by heavy mineral content. The ratio of purple garnet to red garnet was employed to differentiate these tills. In studying the tills immediately adjacent to the metasediments of the Grenville province, northeast of Lake Ontario, the garnet ratio was found to be greater than 1.0. In studying the tills adjacent to the meta-igneous rocks of the Canadian shield area north-to-northwest of Lake Ontario, the garnet ratio was found to be less than 0.5. When this study was extended to other tills, the garnet ratios were consistent with the known source.

In 1958, Dreimanis (personal communication) found that the tills from a source south of (or in) the Adirondack mountains had a garnet ratio less than 1.2. Dreimanis also analyzed a sample of sediment from the

Olean drift and found that the garnet ratio was 1.0. On the basis of this analysis, and an analysis of the calcite and dolomite content of the sample, Dreimanis concluded that the provenance of the Olean drift is south of the Adirondacks.

With this previous work as a basis, the writer determined the provenance for the samples taken in New York State. The mean garnet ratios (purple/red) are listed below.

Locality	Purple/red
I	1.92
II	1.96
III	1.66
IV	1.58
V	2.02
VI	.30
VII	2.41

From these ratios the writer concludes that samples I–V and VII have a provenance in the Grenville meta-sediments, northeast of Lake Ontario. The ratio for sample VI, the Olean drift, illustrates a provenance either in the Canadian shield or south of the Adirondack mountains. If the provenance of this deposit is north of Lake Ontario, then the sediment can be expected to exhibit the same degree of sorting and dilution as the other deposits. However, the poor sorting evidenced in the Olean drift suggests a closer provenance than that of the other deposits. Also, the greater dilution noted in the light fraction of sample VI suggests that the Tazewell glacier traversed the sedimentary rock of southern New York for a greater distance than the other glaciers.

The evidence, although incomplete, suggests a provenance south of the Adirondacks for the heavy minerals of the Olean drift.

If the source of the ice which deposited the Olean drift is in the Adirondacks then the flow direction indicated by the second set of striations reported by Fairchild (1895) are explained. These striations trend N120°W and may be erosional evidence of the Tazewell glaciation.

INCORPORATION OF OLDER DEPOSITS

In order to determine the validity of the above conclusions, the possibility of incorporation of older deposits in the deposits of younger glaciers must be examined. This possibility can not be discounted altogether; however, the writer feels that the effect is minimal in this study.

Incorporation of older deposits takes place beneath the glacier so that till deposited under a glacier may be expected to show this to some degree. However, the samples in this study were taken from stratified material which had its origin (except locality II) in superglacial streams, thus

PLATE 3

a: *Small Scale Cross-Stratification.* A bed, 14 inches thick, in a kame at locality V, which exhibits small scale cross-stratification.

b: *Large Scale Cross-Stratification.* Cross-stratification on a large scale in the esker fan at locality II.

PLATE 4

a: *Deltaic Bedding.* A northwest view of the internal stratification seen at locality III. Note the tractor tire in left foreground for scale.

b: *Horizontally Bedded Kame Terrace.* A north view of the kame terrace at locality IV. Contortion is seen in the upper beds.

PLATE 5

a: *Intrastratal Contortion.* A section, three feet thick, of the contorted bedding at locality IV. Note the flattening of the contortion toward the base of the bed.

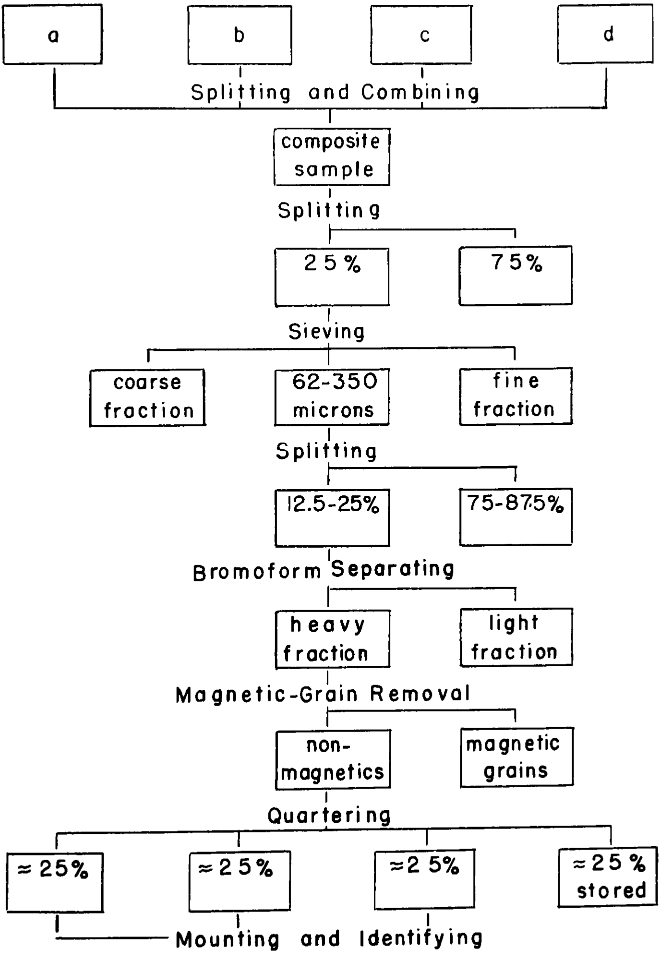
b: *Kame Topography.* A southerly view of the gently rolling kame topography at locality V.

PLATE 6

a: *Till Structure.* A west view of the rough stratification in the till-like beds at locality VI. The face is about 30 feet high. Note the flat shale boulders that are present in the deposit.

b: *Ice-Contact Structure.* Faulted beds of sand in the horizontally bedded kame terrace at Locality VII.

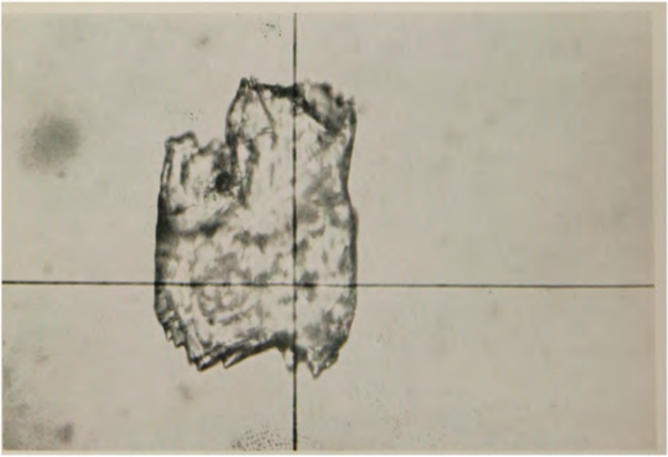
PLATE 7



Flow Sheet for laboratory work on the dried samples.

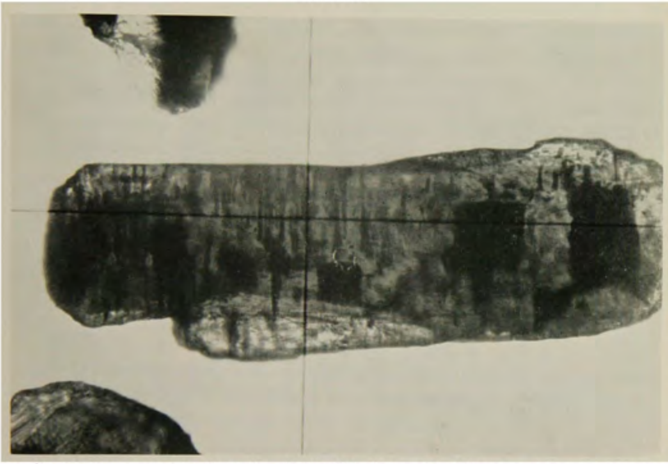
PLATE 8

a: *Monoclinic Pyroxene* (1000 X) from the Albion-Rochester moraine. Note the well-rounded ends and the fresh appearance.

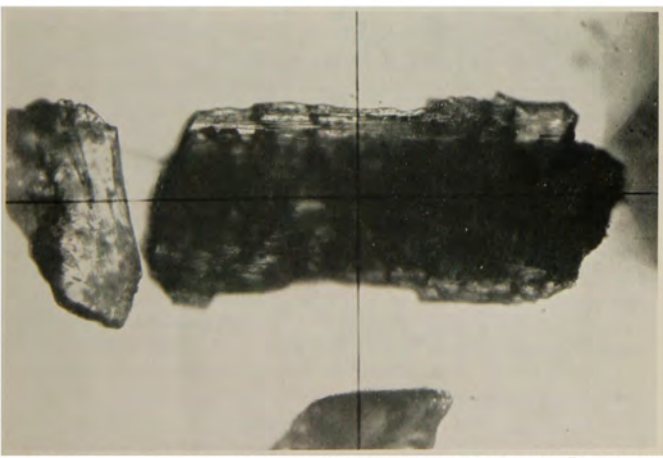


b: *Monoclinic Pyroxene* (1000 X) from the Binghamton drift. Note the dentate ends which are attributed to intrastratal solution.

PLATE 9

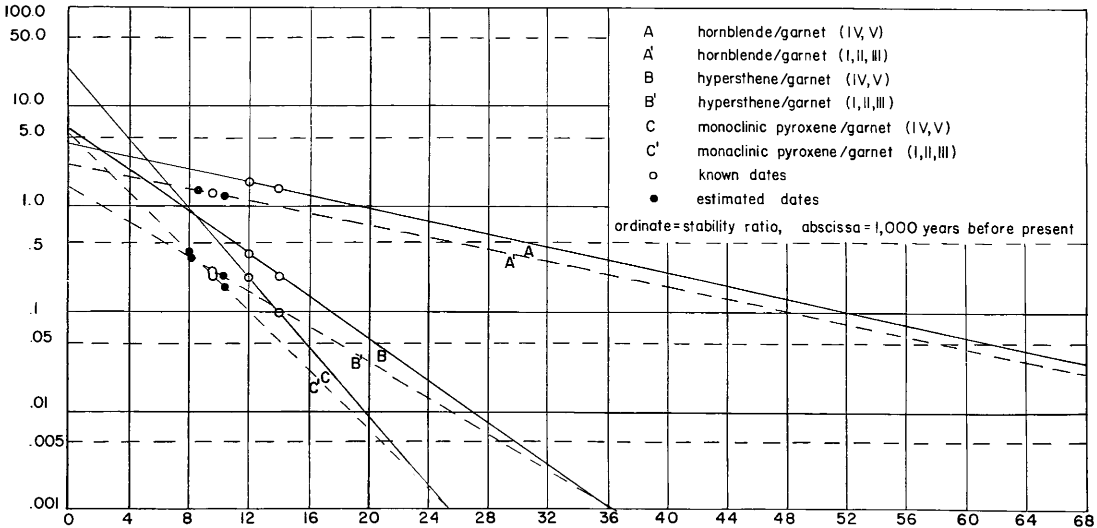


a: *Hypersthene, variety bronzite* (1000 X) from the Waterloo-Auburn moraine. Note the fresh appearance of the parallel inclusions.



b: *Hypersthene, variety bronzite* (1000 X), partially altered, from the Binghamton drift. Note the clouding in the center of the grain which obscures many of the inclusions.

PLATE 10



Stability Curves for hornblende, hypersthene, and monoclinic pyroxene plotted on a semi-logarithmic graph.

minimizing any such contamination. This reasoning is supported by the garnet ratios of the various deposits. If Olean drift (VI) was incorporated in Binghamton drift (V), then dilution of the dominantly purple garnet in the Binghamton, by the dominantly red garnet in the Olean, would lower the garnet ratio in the Binghamton drift. The garnet ratio in the Binghamton drift however, is the second highest (2.02) among all the deposits.

STABILITY

As stated above, there is a noted decrease in stability of certain heavy minerals with respect to the age of the deposit in which they are found. If a stability relationship is present in the glacial deposits of western New York, it is due only to the increasing age of the various deposits.

APPARENT STABILITY

To examine assemblages for a possible stability relationship, it is necessary to study sediments of differing ages, that have been similarly affected by transportation, and have a common provenance.

It has been shown that transportation had little differential effect on the sediment examined in this study. Because the garnet ratios show a common provenance the stability relationships for the heavy minerals in the sediments of localities I–V and VII can be determined. Locality VI represents a different provenance and is not included in this analysis.

The percentages of the more common heavy minerals in Table 2 reveal a decrease (in percent) of the less stable minerals. Hornblende, hypersthene, and monoclinic pyroxene are examples. Moreover, these data reveal that various minerals decrease at different rates.

A change in form is displayed by hypersthene and monoclinic pyroxene. In the younger deposits monoclinic pyroxene (Plate 8) appears as rounded prismatic grains with smooth ends. In the older deposits however, monoclinic pyroxene occurs as stubby prisms with dentate ends. The dentate ends are attributed to intrastratal solution by Ross, Miser, and Stephenson (1929). The change in hypersthene is less striking but occurs chiefly in the variety, bronzite (Plate 9). In the older deposits the parallel inclusions in bronzite grains have been altered until they are almost obscured by clouding in the central portion of the grains.

STABILITY RATIOS

Although the decrease in percentages of the less stable minerals is evident, there is also a decrease in the percentage of more stable garnet. Due to the dilution of the heavy mineral assemblages by opaque minerals, the absolute frequency of the minerals is of little value.

To eliminate the effect of dilution, stability ratios are computed for the major constituents. These ratios are computed by dividing the amount of hornblende, hypersthene, and monoclinic pyroxene by the total amount of garnet (red and purple) in each sample. The mean ratio for each locality and their 90-percent confidence intervals are recorded in Table 5.

Garnet is used because it is the most stable mineral present in the assemblages studied; however, a progressive decrease in the ratios represents instability in relation to garnet only. There is no apparent change in the garnet in the older deposits. However if garnet is unstable in the time interval studied, the ratios underestimate a decrease in persistence rather than accentuate it. In the charts for the stability ratios (Table 6), two trends are noted. The break between the two trends is interpreted as the slight shift in the center of glacial outflow proposed by Dreimanis and Terasmae (1958) during the latter part of the Wisconsin glaciation.

In examining the trend illustrated by samples IV and V (Table 6) a real difference in the ratios is noted for hypersthene and monoclinic pyroxene. A trend for the hornblende ratios is only suggested, as the confidence intervals overlap by a considerable margin. However the fact that the hornblende ratios follow the same trend as the other ratios suggests that a real difference exists between hornblende ratios also. The same reasoning can be applied to the trend illustrated by the younger samples (I, II, and III) as this trend is the same as for samples IV and V. It is not possible to tell which trend is followed by sample VII.

It seems clear from the stability ratios that there is a definite stability relationship evidenced between localities of differing ages.

USE OF STABILITY RATIOS

Fortunately radiocarbon dates for the Valley Heads moraine and the Binghamton drift have been determined. These dates are approximately 12,000 (Geological Research in New York State, 1957) and 14,000 (Rubin and Alexander, 1957) years, respectively. By plotting the relationship between the stability ratios for these deposits it is possible to extrapolate back to that point in time at which the less stable minerals should disappear from similar sediments.

Only two points are available so that the type of relationship which exists between the ratios is not apparent. As a linear relationship shows the ratios approaching zero at a very rapid rate, the writer proposes an exponential decay relationship between the ratios.

The three sets of ratios are plotted against age on semi-logarithmic graph paper (Plate 10) and extrapolated back to .001. As an average of only 800 grains were counted for each sample, one grain in 1,000 grains would be essentially zero. From the curves for these three ratios, the ages at which hornblende, hypersthene, and monoclinic pyroxene should be completely removed from similar sediments are 25,000 years, 36,500 years, and 120,000 years respectively. If the composition of the monoclinic pyroxenes is taken to be that of diopside, the order of decreasing stability (garnet, hornblende, hypersthene, monoclinic pyroxene) corresponds to that observed by Pettijohn (1941) in the geologic column as a whole.

By extrapolating the curves forward to the present, the ratios of the minerals can be observed before mineral decay started. Thus the ratios for the assemblages in the provenance for the heavy minerals can be approximated. These ratios are:

Hornblende/garnet	4:1
Hypersthene/garnet	6:1
Monoclinic pyroxene/garnet	28:1

Stability ratios may also be used to date a sequence of deposits where only one date is known. Flint (1956) reported a radiocarbon date of approximately 9,600 years for Lake Warren, in New York State. Fairchild (1932b) showed that the Waterloo-Auburn moraine was deposited in the water of Lake Warren. Thus the date of 9,600 years may be used to approximate the deposition of the Waterloo-Auburn moraine (locality II). The dates for the other two moraines (I and III) are unknown, but can be determined from the stability curves (Plate 10).

By using the zero points determined above for the three ratios, and the date for locality II, the curves may be extrapolated forward to the ratio for locality I. By interpolating the date for locality III both unknown dates are obtained. These dates are:

	Locality I	**Locality III**
Hornblende/garnet	8,500 years	10,000 years
Hypersthene/garnet	8,200 years	10,000 years
Monoclinic pyroxene/garnet	8,000 years	10,300 years

It is realized that these dates are a little younger than may seem reasonable, however this may be attributed to the uncertain position for the 9,600-year date. Nevertheless, the range of dates for the last pre-Iroquois deposit (I) and for the Valders maximum (III) does not exclude these as valid dates. The consistency of the dates from the three sets of ratios lends considerable support to the proposal that a real stability trend exists between the assemblages of the deposits.

It is obvious that the curves decrease far faster than the relationships indicated by Pettijohn (1941). However, glacial deposits are unique in the geologic record and should not be expected to follow the trends exhibited by other sedimentary deposits. It is clear from the above data that heavy minerals do decrease in persistence, with age as the only variable operative. This is probably due to the fact that older deposits have been subject to physical attack by such forces as ground-water solution, for longer periods of time.

As previously mentioned, glacial deposits are subject to erosion from the time of their deposition. Therefore it may be that the decay rate for unstable minerals in glacial deposits (particularly stratified drift) represents a maximum value. Thus the decay rates observed in other sedimentary deposits are lower due to prohibition by such factors as depth of burial, rather than accentuation by them.

It is not possible to accurately determine what processes actually cause the decay of unstable heavy minerals. However, it is clear that the amount of time that the processes are allowed to operate is reflected in the stability ratios. It also seems probable that the rate at which decay occurs is related to the depositional environment of the sedimentary deposit and the conditions under which it was preserved. The writer realizes that the construction of stability curves based on only two points, relatively close together, can not be expected to yield accurate values. However, the agreement of the values obtained from these curves indicates that a stability relationship can be demonstrated from these curves whether or not true values have been obtained.

DIFFERENTIATION OF DRIFTS

It is evident that the Olean drift (VI) can be differentiated from the other glacial deposits by any one of the methods used in this study. The Olean drift differs from the other deposits in sorting, composition of the light fraction, and garnet ratio. It is also evident that there is a real difference between the Binghamton drift (V), the Valley Heads moraine (IV), and the other deposits. These two moraines may be differentiated on the basis of the stability ratios for hypersthene and monoclinic pyroxene.

It is also probable that the Illinoian drift can be differentiated from all the other deposits using stability ratios, even though these ratios do not fit into either of the two patterns established in this study.

The overlapping confidence intervals (Tables 2 and 4) for the three youngest moraines make it doubtful that they could be differentiated by the methods outlined in this study. However, it may well be that a larger number of samples will reduce the confidence intervals for these moraines. It appears that these moraines differ, but the degree of difference is only crudely established here.

The above discussion does not hold true for all of western New York, as more than one source may have supplied sediment to different parts of a single moraine. To examine the possible variation within a single moraine, lateral samples were taken from the Valley Heads moraine. As the Upper Cary ice moved through each of the north-south valleys in western

New York, and was essentially isolated within each valley, differences between assemblages, if they are present, should be manifested in this moraine. The values obtained for the lateral samples are listed in Table 7.

The values all fall within the confidence interval determined for locality IV. Thus the provenance of these assemblages, and probably the ice source itself, was constant throughout the area studied. From these results it becomes clear that the Valley Heads moraine can be defined by stability ratios for much, and possibly all of its length. These results suggest that the other moraines in western New York may also be defined by stability ratios, and thereby differentiated.

CONCLUSIONS

1. The Albion-Rochester, Waterloo-Auburn, Hamburg-Batavia-Victor, and Valley Heads moraines, the Binghamton drift, and the Illinoian till have a common provenance which is illustrated by the dominance of purple garnet over red garnet. The source of the ice that deposited these sediments was northeast of Lake Ontario.

2. The provenance of the Olean drift is different from that above as illustrated by a distinctive garnet ratio, sorting coefficient, and the composition of the light fraction. The source of the ice that deposited this sediment may be south of (or in) the Adirondack mountains as proposed by Dreimanis (1957).

3. The morainal deposits in western New York increase in age from north to south. Accompanying this age increase is an increasing alteration of hypersthene and monoclinic pyroxene which is manifested in the appearance of the grains. There is also a decrease in the relative amount of the unstable minerals from north to south. From the above observations it is concluded that a lack of stability is demonstrated by hypersthene, monoclinic pyroxene, and hornblende, with respect to the age of the deposit in which they occur.

4. The instability of the minerals can best be represented by stability ratios. These ratios are computed by dividing the amount of unstable mineral by the amount of stable mineral (garnet in this study).

5. From the stability curves, dates may be obtained, beyond which the unstable minerals should cease to persist in similar deposits. These dates are 25,400 years for monoclinic pyroxene, 36,500 years for hypersthene, and 120,000 years for hornblende. The order of persistence observed in this study (garnet, hornblende, hypersthene, monoclinic pyroxene) is consistent with that noted by Pettijohn (1941).

6. From the stability curves, the dates for the deposition of the Albion-Rochester and Hamburg-Batavia-Victor moraines may be obtained. These

dates are between 8,000 and 8,500 years and between 10,000 and 10,300 years respectively.

7. The stability ratios remain constant throughout most of the length of the Valley Heads moraine and may be used to define this moraine.

8. The results from the Valley Heads moraine suggest that stability ratios may be used to define all the moraines in New York State.

FURTHER STUDY SUGGESTIONS

The writer feels that the results of this study justify expansion of the study to cover lateral samples in all moraines, at much closer intervals than those used here for the Valley Heads moraine. From an expansion of the present study it should be possible to determine any lateral changes, if present, in the source of the glaciers. It should also be possible to reduce the confidence interval about the population mean in the stability studies.

Particular attention should be paid to the Tazewell drift and Illinoian till. From lateral studies of the Tazewell drift the possibility of an Adirondack source can either be supported or discounted. Further study of the Illinoian till may make it possible to date the deposits by means of refined curves for the stability ratios.

A study, similar to the one presented here, could be completed on the Oswego moraine to determine possible equivalence with the deposits of this study.

A study of the stability ratios in the till of the drumlins of western New York might be used to establish the stadium in which the till was originally deposited. From a study of this type, information may be gained as to the origin of drumlins.

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TABLE 1

Locality	Percent of Heavy Fraction in Sample	Percent of Magnetics in Heavy Fraction
I-1	5.26	9.35
I-2	1.99	9.15
I-3	4.72	11.75
I-4	1.52	12.58
II-1	5.58	15.15
II-3	5.05	17.26
III-1	4.70	14.25
III-2	4.65	15.51
III-3	4.52	15.34
III-4	4.64	14.05
IV-1	4.18	11.92
IV-2	3.29	10.36
IV-3	2.61	9.04
IV-4	3.09	8.82
V-1	2.25	10.45
V-2	3.53	14.90
V-3	4.31	11.68
V-4	3.51	13.91
VI-1	1.18	4.27
VI-2	1.51	1.94
VI-4	1.25	3.23
VII-1	2.80	6.27
VII-2	2.32	8.33
VII-3	2.62	8.58
VII-4	2.90	9.84
VIII	2.42	25.89
IX	2.83	15.79
X	1.79	23.07

Table 2

Percentage of Mineral in Locality

Mineral	I–1	I–2	I–3	I–4	II–1	II–3	III–1	III–2	III–3	III–4	IV–1	IV–2	IV–3	IV–4	V–1	V–2	V–3	V–4	VI–1	VI–2	VI–4	VII–1	VII–2	VII–3	VII–4	VIII	IX	X
Red Garnet	8.7	10.7	8.4	9.5	9.1	10.3	12.3	11.0	13.8	9.9	10.6	10.7	8.0	9.3	10.1	8.4	8.5	7.4	2.6	3.3	2.8	3.7	3.3	3.5	4.3	4.3	4.7	5.7
Purple Garnet	14.3	16.8	19.5	19.2	19.1	18.8	18.3	19.1	18.3	20.2	17.0	14.1	13.9	15.4	16.5	21.7	18.0	16.1	.1	1.3	.9	7.8	8.8	9.0	10.4	10.5	12.5	14.5
Hornblende	28.3	40.0	41.3	43.3	42.5	37.0	40.4	37.3	40.1	41.8	40.6	43.7	48.3	46.8	42.3	40.8	44.5	40.9	22.4	17.5	8.2	17.2	18.0	14.7	14.3	24.31	29.6	35.3
Hypersthene	10.8	8.8	6.1	4.7	5.0	6.0	7.9	5.2	6.6	6.0	8.0	8.7	9.3	7.5	5.6	5.6	6.8	4.6	.9	.1	—	1.1	1.6	1.7	.6	5.1	6.7	8.1
Monoclinic Pyroxenes	12.2	9.6	7.7	6.6	5.0	6.6	4.5	6.7	4.6	4.4	4.8	4.5	5.9	7.5	2.8	2.7	3.3	2.7	.1	.1	—	1.2	.5	.1	1.0	4.2	4.8	5.7
Opaques	14.8	6.9	8.5	5.9	9.6	6.4	8.8	11.9	9.7	9.3	10.4	10.7	9.3	9.0	18.2	17.5	14.8	26.5	72.8	76.0	86.5	68.6	66.5	70.0	68.5	51.7	41.8	30.8
Chlorite	9.3	4.7	5.5	7.2	4.6	7.2	5.4	6.0	4.4	6.1	5.2	3.9	1.5	1.6	.1	.1	.6	—	.1	—	—	—	—	—	—	—	—	—
Apatite	.6	2.3	1.1	2.2	3.2	3.0	.7	.1	—	.7	.1	1.0	.8	.1	—	.1	.6	—	—	.1	.1	—	—	—	—	—	—	—
Tremolite	.1	—	.1	—	.1	.5	1.3	1.4	1.9	.1	.7	1.6	1.3	.9	3.8	1.0	.8	1.5	—	—	—	—	—	—	.1	—	—	—
Zircon	—	.5	.1	.1	1.0	1.5	.1	.1	.1	.1	1.0	.1	.1	.1	—	.1	—	.1	.1	.6	.1	.1	.1	.1	.1	—	—	—
Sillimanite	.1	.1	.1	.1	.7	.1	—	.1	.9	.1	.1	.1	.6	.1	.5	.5	.6	.1	—	—	—	—	—	—	—	—	—	—
Titanite	.1	.1	.1	.1	1.0	1.0	.1	.1	—	.1	.1	.1	—	—	—	.1	—	—	—	.1	—	—	—	—	—	—	—	—
Tourmaline	—	—	.1	—	—	—	—	—	—	.1	.1	.6	.1	—	—	.1	.6	—	.1	.1	.1	—	.1	.1	—	—	—	—
Rutile	—	—	—	—	—	.1	—	—	—	.1	.1	—	—	.1	—	.1	.6	—	—	—	—	—	.1	.1	.1	—	—	—
Epidote	—	—	—	—	—	—	—	—	—	.1	.1	.6	.1	—	—	—	—	—	—	—	—	—	—	—	.1	—	—	—
Monazite	—	—	—	—	—	—	—	—	—	.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

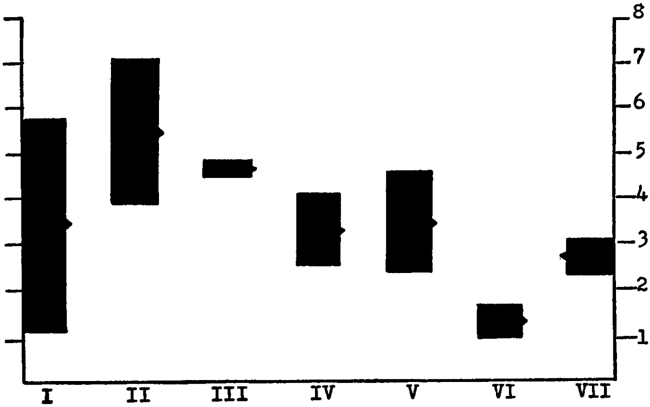
TABLE 3

Locality	Percentage of Heavy Fraction: Sample mean	Percentage of Heavy Fraction: Confidence interval	Percentage of Magnetics: Sample mean	Percentage of Magnetics: Confidence interval
I	3.37	1.17–5.61	10.71	8.67–12.75
II	5.32	3.65–6.99	16.20	9.54–22.86
III	4.63	4.54–4.72	14.85	13.96–15.72
IV	3.29	2.52–4.06	10.04	8.36–11.72
V	3.40	2.37–4.43	12.74	10.35–15.13
VI	1.31	1.02–1.60	3.15	1.54– 4.76
VII	2.74	2.42–3.06	8.26	6.42–10.10

TABLE 4

BAR CHARTS FOR TABLE 3

Percentage of heavy fraction in sample
90 percent confidence interval



Percentage of magnetics in heavy fractions
90 percent confidence interval

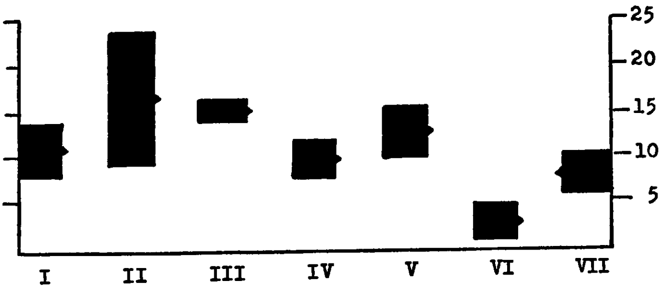


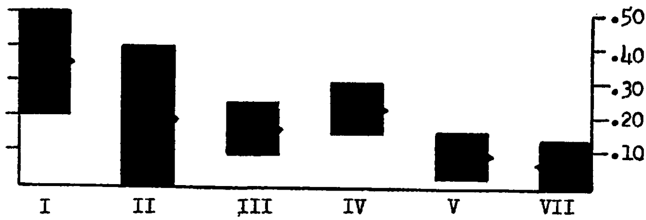
TABLE 5

Locality	Mean	90 percent confidence interval
	HORNBLENDE/GARNET	
I	1.43	1.28–1.58
II	1.38	.72–2.04
III	1.36	1.19–1.41
IV	1.84	1.52–2.16
V	1.60	1.39–1.81
VII	1.41	1.10–1.72
	HYPERSTHENE/GARNET	
I	.30	.15– .45
II	.22	.02– .42
III	.21	.14– .28
IV	.34	.27– .41
V	.21	.14– .28
VII	.09	.02– .16
	MONOCLINIC PYROXENE/GARNET	
I	.35	.20– .50
II	.20	.00– .40
III	.16	.09– .23
IV	.23	.16– .30
V	.10	.03– .17
VII	.06	.00– .13

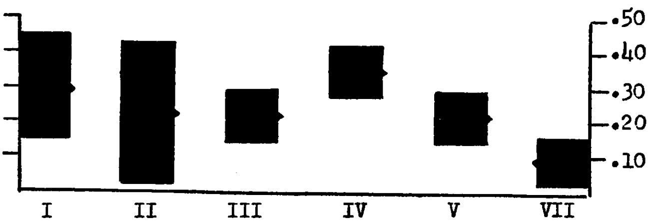
TABLE 6

BAR CHARTS FOR TABLE 5

Monoclinic pyroxene/garnet



Hypersthene/garnet



Hornblende/garnet

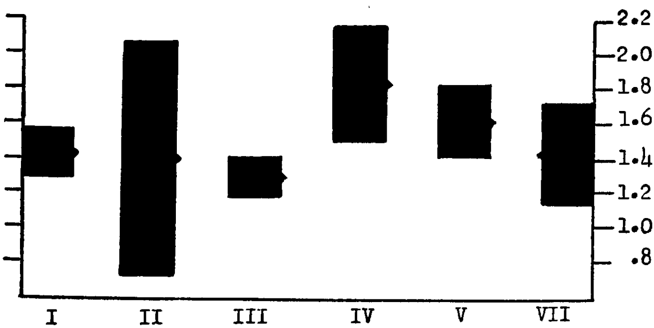


TABLE 7

HORNBLENDE/GARNET

Locality	Mean	90 percent confidence interval
IV	1.84	1.52–2.16
VIII	1.66	
IX	1.73	
X	1.76	

HYPERSTHENE/GARNET

Locality	Mean	90 percent confidence interval
IV	.34	.27– .41
VIII	.37	
IX	.39	
X	.40	

MONOCLINIC PYROXENE/GARNET

Locality	Mean	90 percent confidence interval
IV	.23	.16– .30
VIII	.28	
IX	.28	
X	.28	

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Smithsonian Astrophysical Observatory

Western Satellite Research Network

The worldwide Moonwatch project was organized in 1956 by the Smithsonian Astrophysical Observatory for the acquisition of newly launched earth satellites. As part of this program, the Rochester station was established in 1957 with fifteen 5 x 50mm instruments with 11° fields arranged in a meridian fence, and so used in 1958. Experience proved the setup was inadequate in several respects. The optics were not powerful enough to pick up the faint U.S. satellites for which the station had been established. Further, the brighter satellites of the U.S.S.R. rarely crossed the "fence" since their tracks were nearly parallel to it.

In late 1958, the Moonwatch program was extended beyond the end of the I.G.Y. with new objectives: in addition to acquisition of newly launched satellites, teams were requested to undertake regular visual tracking, particularly of fainter satellites, and to develop techniques for special assignments. The Rochester team re-registered in April, 1959, and initiated major changes to improve its performance. Substantial results were achieved. The 116 observations obtained in 100 sessions during 1959 are listed in the appendix [not included here—Ed.] along with appropriate comments on the various satellites.

Sites: The original site, 047, at the home of Dr. Alexander Dounce on Edgewood Avenue, Brighton, was augmented by an additional site, 8564, at the home of Clark Butler, Alpine Road, Greece. Due to the uncertain Rochester weather, team members always are called out on less than 2 hours' notice even for the predawn sessions, making it imperative to have conveniently located sites.

Techniques: The meridian fence was dismantled in May. The small instruments were remounted on portable tripods with elevation circles, and divided between the two sites. They have been used for observing the Sputnik III and Discover VI satellites which are relatively bright and in generally North-South orbits.

Refined techniques were developed for observing the fainter satellites with high power, narrow field telescopes. First, Rochester circumstances are derived from general orbital elements in the form of a "tracking schedule" in which the optical fence is shifted with time to bracket the satellite track in the sky. Considerable skill is required in pointing the telescopes since the fence often has been 2° or less for the fainter satellites such as 1958 Epsilon. Circles have been added to aid the pointing operation but reference to a star chart is made on meridian observations.

Stop watches and radio time signals are used to time the transits to an accuracy of 0.1 seconds.

Satellite positions are measured in celestial coordinates obtained from star charts with an accuracy of 0.1°.

Our results are reported by airmail or telegraph to the Smithsonian Astrophysical Observatory in Cambridge, Massachusetts as soon as they have been obtained.

A weekly report is telephoned to the Western Satellite Research Network in Downey, California. Late in the year, the Rochester team was invited to join this network which is a group of Moonwatch teams organized to facilitate satellite tracking. The teams included are, Rochester, N. Y., Sacramento, California, China Lake, California, Albuquerque, N. M., Stockton, California, Walnut Creek, California, Whittier, California, Spokane, Washington and San Jose, California. The Aero-Space Laboratory of North American Aviations Missile Division supplies Rochester circumstances computed by an IBM 704 as the various satellites become visible to us. They also supply weekly corrections for erratic orbital accelerations. These data have increased the performance of the team remarkably since the number of observations had been limited by the involved computation required for each transit.

Acknowledgments

Director: The Moonwatch Team was established by Ralph Dakin in 1957 and competently directed by him through the hectic early days of the Space Age. His mounting responsibilities in the Astronomical League led him to resign as director in May, 1959, but he has continued active in the program, particularly in instrumentation for apogee observing of faint satellites. Russell Jenkins has directed the team since his resignation with invaluable help in various phases of the program as acknowledged below:

Team Leaders: Richard Karlson, George Schindler, Clark Butler, Dr. Alexander Dounce.

Computations: Richard Karlson, George Schindler, William Graves, Clifton Field.

Instrumentation: Ralph Dakin, Dr. Alexander Dounce, Walter Whyman, Richard Karlson, George Keene, Herb Searles, Clark Butler.

Observers: Those above, Jack Smith, Ben Cleveland, Edwin Root, Stanley Wright, Eric Dounce, Kenneth Brown, Ralph Sutherland, Jackson Thomas, Ephriam Robbins, Donald Zimmerman, William Haynie, William Hollingsworth, Paul Haka, Martin Josephs and Myron Cucci.

Financial support from the Rochester Academy of Science was used for mailing expenses and miscellaneous supplies. The telescopes and timing equipment are owned by team members.

CITATIONS IN THE ROCHESTER ACADEMY OF SCIENCE

1959

ROBERT L. NICHOLS, PH.D.

Honorary Member

GEOMORPHOLOGIST—EXPLORER—TEACHER

Morphology has to do with shape, and until we have a satellite that will permit us to back off and study the Earth, geomorphology has to be done down here. Such a pursuit has taken this candidate over many terrains. He has conducted field work in Patagonia and the Antarctic and compared their bleak evidence with that of Alaska, Greenland and the Arctic. He has also taken advantage of indications in regions of the United States like New Mexico, where geologic formations open the book to the Earth's story.

He believes in going to the source of the latest information, because his particular interest is vulcanology. And for those who want science to be practical, we should note that he is a specialist in the subject of alumina clays.

He is Professor of Geology at Tufts College, where he obtained a Bachelor's degree in 1926. His work for the doctorate was done at Harvard. He now shares his experiences and information with many students, thus gaining one of the chief rewards of the explorer. Satisfaction can also be his from membership and fellowship in the leading organizations for geophysicists and geology teachers.

For his contributions to science and education through his important role in these fields, we are pleased to confer Honorary Membership in the Rochester Academy of Science upon Robert L. Nichols.

H. EVEREST CLEMENTS

Fellow

CONSERVATIONIST

With this single word the multifarious avocational energies of our candidate for honor in the Rochester Academy of Science can be reduced to its essence. His efforts go beyond action as trustee, officer and member of numerous nature and ornithologic groups. He has lead drives for forest preservation and for purchasing such areas as the Reed Road Sanctuary and tracts in the Bergen Swamp. He owns

Bass Island and leases Gull Island, operating them as wildlife refuges. The latter supports the only inland colony of double-crested cormorants in New York.

He succeeded in moving the National Grange to endorse the model Hawk and Owl Law proposed by the National Audubon Society—it is now incorporated in the Conservation Law of New York State.

Members of our Academy are thankful for his endeavors. Amid the pressures of a necessary and inevitable civilization, a wildlife refuge becomes also a sanctuary for the human spirit. Uncertainties subside at the sureness of a trillium's reappearance. Or we can be reassured by the long streamers of flying geese and realize that some forms of Life know where they are going. Accordingly, we are cordially welcoming H. Everest Clements as Fellow.

ALEXANDER L. DOUNCE, PH.D.

Fellow

BIO-CHEMIST—AUTHOR—TELESCOPE BUILDER

Man lies in size about midway between the molecule and the universe. This gives us plenty of scope for intellectual curiosity. Seldom do we find, however, a man like the next candidate—for he is investigating both limits. He obtained his doctorate at Cornell University. He is now Associate Professor of Bio-chemistry at the University of Rochester and is the producer of numerous papers in the field. His current research deals with his specialty, cyto-chemistry. He has gained world renown for his work with nucleic acids and in the synthesis of proteins.

He has won top awards for his 7½- and 8-inch telescopes, and is particularly adept in designing and constructing mountings. This has aided him in obtaining excellent photographs of the moon and Mars. He has even finished a 16-inch mirror and is building the rest of the telescope. This is truly an ambitious project for an amateur telescope maker.

He donated his backyard to the Rochester moonwatch team during the IGY. For his abilities and skills and for his generous companionship with other members of the Astronomy Section, we are happy to elect Alexander L. Dounce a Fellow in the Rochester Academy of Science.

ROBERT M. EATON

Fellow

AMATEUR MINERALOGIST AND PALEONTOLOGIST

One of the characteristics of our Academy Members is the urge to learn from their hobbies. This is highly exemplified by the activities of the next elected Fellow. He has not been content with collecting minerals and local fossils, for he has made himself an expert on them. He has passed valuable information along to his fellow collectors all over the world through papers, exchanges, lectures and discussions with Scout groups. He has loaned many of his specimens for displays and has prepared and filled exhibits for the Rochester Museum of Arts and Sciences.

His interest is avocational; he is the Manager of a large photo-finishing plant in Rochester. So far there is no record of his having fogged a batch of films by enthusiastically turning an ultraviolet mineral light in one of the darkrooms.

In addition to the scholarly manner in which he pursues his hobby, he is tireless in his support to our Mineral Section. He has been a member for many years and has held every office in it. He is currently Chairman of the Field-trip Committee and will surely maintain the interest of the Section. Robert M. Eaton fully deserves our official Fellowship.

Mary Metzger Slifer

Fellow

Conservationist—Botanist

Conservation is a "portmanteau" activity; and Alice's expressive word best describes the interests of our next candidate. She has been wholeheartedly involved with the preservation of wildernesses, forests, national park areas, landmarks, nature, birds and wildflowers. In addition, her devotion to the profession of nursing shows that hers is not a detached pastime but a true desire to promote the awareness of the balm of nature in her fellows.

The best place to begin is in the home, and she has shown how wildflowers in danger of being engulfed by the bulldozer can be transplanted to bring nature into the city. She has gained the recognition of garden, nature, and conservation societies for her efforts.

It is only to be expected that we should find her helping to provide the next step in the appreciation of nature. She has served as Chairman of the Conservation Committee of the Burroughs-Audubon Nature Club. And it was she who provided the driving force which lead to the formation of the Bergen Swamp Preservation Society Incorporated in 1936.

As an articulate and energetic member of our Botany Section, Mary Metzger Slifer fully deserves our gratitude and the election to the Academy's Fellowship.

1960

MELISSA E. BINGEMAN

Life Member

HUMANITARIAN—POET—AMATEUR SCIENTIST

The sciences and the humanities are becoming increasingly aware of their interdependence. It is rare, nevertheless, to find an intense concentration of both outlooks in one person. This candidate, after primary schooling at her birthplace—Ontario, Canada—and special courses at Cornell University, served as assistant secretary of the Rochester Chamber of Commerce. There, almost fifty years ago, she pioneered projects like womens' classes in first aid, diet, and home nursing. She had a keen international appreciation and organized exhibitions of the works of ethnic groups in Rochester and directed programs of information, naturalization and legislation for aliens.

Retirement in 1945 enabled her to intensify her scientific activities, especially in the hydrology of the Great Lakes. And too, she did not abandon sociological awareness in a cleaned-out desk. She is even now concerned with the practical means for ameliorating juvenile behavior codes. Those who have known her keen enthusiasm and have been revived by her abundant energy are not surprised to learn that, characteristically, her voice in both matters has reached as far as governmental hearings.

Her "Two Studies Concerning the Levels of the Great Lakes" appeared in Volume 10, Number 1, 1953 of our Proceedings. These extensive papers have been quoted in several important articles since. She is a member of the Rochester Poetry Society and a regular contributor to its annual anthology, The Gleam.

Needless to say, she has given much time to Academy affairs, serving on the Council and officiating in the Mineral and Weather Science Sections. Because of the work she has done for the Rochester Academy of Science and for the prestige she has brought to it, we wholeheartedly welcome Melissa E. Bingeman to Life Membership.

LAVERNE L. PECHUMAN, PH.D.

Honorary Member

ENTOMOLOGIST—ARCHAEOLOGIST—BOTANIST

Professional pressures and the increasing complexities of any given scientific field make the avoidance of a constricting specialization difficult. It is stimulating, then, to find a scientist like this candidate, for he is not only a world authority on horseflies, but also active as an archeologist and expert on local wild plants. And he has accomplished all this since completing his doctorate at his Alma Mater, Cornell University, in 1939, and while advancing to the district managership for an important chemical spray corporation.

He has published forty papers in eighteen different scientific journals. Members will recall his intensive work on the Tabanidae of New York State which appeared in Volume 10, Number 3, 1957, of our Proceedings. It recorded twenty-five years of painstaking collection and study of horseflies and deerflies. Nine species of insects have been named in his honor. He is often called upon to identify specimens in museum and other collections.

He is a pick-carrying member and former officer of the Morgan Chapter of the New York State Archeological Association. He also is on the rolls of eight other learned international, national and local societies. Perhaps the rarest tribute for a man of this stature is his welcome as a guest at Tonawanda and Tuscarora ceremonies, although his contact with 4-H Clubs and high school science groups must give him great satisfaction too.

One of his hobbies is collecting trilliums and he has naturalized many rare mutations. He has also exchanged specimens with botanists in Japan and it is intriguing to see these flowers growing in his native Lockport.

We cordially confer the Honorary Membership of the Rochester Academy of Science on Laverne L. Pechuman.

Russell E. Jenkins, M.Sc.

Fellow

Amateur Astronomer—Moonwatcher

Seldom have the eyes of the scientist and the eyes of the layman been so intently focused on the same object as they have been on earth satellites. It is natural then, that the Rochester Moonwatch Team should be nonprofessionals. And it is gratifying that, as the most northerly post, they play a very important role in providing unique and accurate data for the program. That they are active and successful is due largely to the sound directorship provided by this candidate.

He was born in Sharon, Massachusetts and graduated from Worcester Polytechnic Institute, 1946, and continued for a M.Sc. in chemical engineering. He joined the Astronomy Section in 1955 and was Chairman during the 1957–58 season. He has represented the Section in many presentations to scout troops, high school classes, and adult groups. He participated in a television series dealing with the universe.

For his scientific achievements and for his advancement of the aims of the Rochester Academy of Science and his additional personal interest in civic education, we are pleased to extend Fellowship to Russell E. Jenkins.

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE
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The Rochester Academy of Science, on behalf of Members who will enjoy the intriguing presentation of aphid biology and of entomologists who will value the completeness of the records in Dr. Leonard's A List of The Aphids of New York, *extends its thanks to the Shell Chemical Company, whose interest and generosity help make possible its publication.*

A LIST OF THE APHIDS OF NEW YORK

MORTIMER DEMAREST LEONARD, Ph.D.
Washington, D. C.

Received for Publication January 1962

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ACKNOWLEDGMENTS

In the fall of 1932, while I was spending a few weeks on vacation at Cornell University, Professor C. R. Crosby of the Department of Entomology suggested that I take up the collection and study of aphids. A little sample collecting around Ithaca revealed plant lice to be abundant on many kinds of plants at the time. This experience and the extensive bulletin of Hottes and Frison on "The Aphiidae, or Plant Lice, of Illinois", which had just appeared, aroused my attention. This interest has continued, albeit somewhat intermittently, throughout these 30 years.

Because of my prior interest in the insects of New York, my principal objective at once became a study of the distribution and food plants of the New York aphids. During the first 4 years—until Professor Crosby's death early in 1937 and cessation of my own frequent trips into the state—both Crosby and I collected aphids, together and separately, at every opportunity and rather widely in New York. In these ways I got started on the work leading to this paper.

I want to thank Dr. Clyde F. Smith, Head of the Department of Entomology, North Carolina State University. He has made or verified determinations of over 750 collections from New York during 1959 and 1960. His cooperation is greatly appreciated; he is identified in the text as CFS.

Miss Louise M. Russell, specialist in the identification of aphids in the Agricultural Research Service, United States Department of Agriculture, has made many determinations and supplied many records of New York aphids and has given much help in unravelling problems of synonymy. She has reviewed the manuscript of this paper. Her help has been invaluable. She is identified in the text as LMR.

Dr. Geddes W. Simpson, Head of the Department of Entomology, University of Maine, has supplied a number of valuable early records of aphids from New York determined by Dr. Edith M. Patch.

My sincere thanks are due to Mr. Paul Russell, Collaborator, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, who has reviewed most of the botanical and common names of the plants in the food plant list. He is not responsible, however, for changes of a few of the names or for errors that may have crept in.

I cannot refrain from expressing to my wife my appreciation for her never-failing encouragement of my interest in aphids and for her creating and maintaining an environment in which I have been able to pursue their study.

I acknowledge with many thanks a grant from the Grace H. Griswold Fund of the Department of Entomology, Cornell University, to aid in the preparation of the manuscript of this paper.

INTRODUCTION

This paper lists as completely as possible the species of aphids known to occur in New York and to record their distribution within the state and the plants on which they feed and breed. The extent of the damage done by those which are injurious is described. For general interest there is also included a discussion of the remarkable and often complicated life histories of aphids together with certain other pertinent information about them.

The aphids, or plant lice, belong to the Family Aphidae of the Sub-order Homoptera, which is one of the two major groups of sucking bugs. They are rather small insects, ranging in size when full-grown, from a little less than 1 millimeter to a little over 5 millimeters in length—about 1.5 to 2.5 millimeters being an average size. They feed by extracting the juices from plants and often become so abundant that the plants are stunted or even killed. Wherever ferns and flowering plants grow in the world, aphids have been found feeding and breeding on a large number of them. All parts of plants are subject to infestation.

Although aphids have been recorded as feeding on many hundreds of kinds of plants throughout the world, many other plants are surely yet to be found supporting aphids. New plants are continuously being added to the list and further collecting will undoubtedly add more. Theoretically almost all plant species are potential aphid food plants. Some aphids are confined to only one species of plant; some to several plants of the same family; others are more general feeders and some have been found on several hundred plant species belonging to varied plant families.

It is difficult to say how many different kinds of aphids there are in the world. New species are being named and described each year from many countries. There has been confusion of names and identities so that the present number of valid species cannot be stated with certainty. However, Mr. V. A. Eastop of the British Museum (Natural History) estimated in 1961 that the total of known species is about 2700.

The number of aphid species actually occurring in New York is also difficult to determine. However, judging from the number recorded from several other states which have been extensively collected, and considering the topography, climate and flora of the state, it might not be surprising if at least 450 eventually should be found. New York lies in a region of almost optimum climatic conditions for the development of aphids and this is combined with a rich and varied flora. The whole state is well watered with many rivers, streams, lakes and ponds. It also contains a number of swamps and bogs which, although at a low altitude, show much more northern plant and insect characteristics.

Within New York's nearly 50,000 square miles lies the great region of the Adirondack Mountains, which are as high as 5,300 feet. Those which are higher than 3,500 feet rise into the Hudsonian zone and present conditions much like those of Labrador. The tops of at least three peaks are Alpine in character. On the other hand the Coastal Plain, which comprises Long Island, Staten Island and the vicinity of New York City, contains many southern elements. The number of flowering plants in the state is estimated to be about 3,000 species and subspecies, distributed in about 800 genera. Aphids have been determined, at least to genus, from a little over 700 plants distributed in a little over 300 genera, although they have been collected from a somewhat larger number of plants. It is thus seen that a great many more plants are yet to be examined for the possibility of their harboring specific or general aphid guests.

Aphids have been collected in New York with any real intensity in only four sections—the extreme three or four western counties near Lake Ontario; south of Buffalo around Dunkirk, Sheridan and Fredonia near Lake Erie; at Ithaca and in its general vicinity in Central Western New York; and on Long Island, especially the eastern end and to a somewhat lesser extent just north of New York City at West Nyack, Mt. Kisco and Yonkers. However, aphids known to occur in each of these areas can be presumed to be widely distributed in the state wherever their food plants occur. Aphids are almost unknown from the whole region of the Adirondacks and north of there to the Canadian border. This area should be explored.

The present list gives records of 303 aphids specifically determined as occurring in New York. There are 14 others determined with a query and still 34 others determined only to the genus. Assuming each aphid in this last group to be a different species and to be in addition to the others, the grand total indicates that 351 aphids are now known to occur in New York. Of these 51, 15% of the total, are recorded only twice and 127, 36% of the total, have been recorded but once. It is thus seen that a great deal more collecting and study will be required before any really adequate idea can be had of the occurrence and distribution of aphids in the state. All available records through 1960 are included.

SOME ASPECTS OF APHID BIOLOGY

LIFE HISTORIES

The life histories or life cycles of aphids, taken as a whole, are so intricate that it is rather difficult to prepare a concise and understandable account of their remarkably intriguing habits. In rereading the summary of the life histories of aphids published by Hottes and Frison in their well-known "Aphiidae, or Plant Lice of Illinois" (Bull. Nat. Hist. Surv. 19:130–135, 1931), it struck me as being so well done that I do not feel I can improve upon it. Since too, every statement they make about Illinois aphids applies equally to those of New York, and since all the species of aphids they cite as examples also occur in New York, their account is quoted in full:

"Aphids have so many and varied ways of existence that no one generalized account can cover all of their interesting and often complicated life histories. Information about the life history of a species all too often begins and ends on a given host, leaving us in complete ignorance of the events transpiring between the time in the spring or early summer when the species leaves the host on which it overwinters and the time when it returns to the same host again in the fall after a summer's sojourn, upon some unknown host. Thus in the past, and even now perhaps, it has happened that a species of plant louse was known by one name when taken on its winter (primary) host and by another name when taken on its summer (secondary) host. This has been particularly true of those migratory species in which structural differences exist between the various forms of the same species and it is especially in such cases as these that biological studies are indispensable to a thorough and accurate picture of the relationships or classification of these insects. Dr. Edith M. Patch (in 1920) has admirably stated the difficulty: 'To attempt to epitomize the life cycle of the aphid is like trying to draw an orderly sketch of chaos. But after all, the confusion may be more seeming than real and certain rules, beset though they may be with exceptions, govern the life of even the aphid.'

"An aphid's behavior is governed very largely by its food preferences. A species that passes its entire life history on one host is said to be monophagous. If, however, a species requires two or more kinds of food, it may change its diet in early summer by migrating from the host on which it overwinters to a new host, called the summer or secondary host, and such a species is said to be polyphagous. Some aphids, such as *Myzus persicae* (Sulzer), are practically omnivorous in that they accept as a secondary host almost any plant which offers sufficient nourishment and succulence for their ever-increasing numbers. Strangely enough, this ability to live on many different secondary hosts does not carry over to the sexual forms, for at the approach of cold weather in temperate and northern climates, such plant lice return to their specific primary hosts like so many tourists returning to their homes from vacations spent in foreign places.

"Generalized Life Cycles

"In Illinois [as well as in New York] most aphids under natural conditions spend the winter in the egg stage. As a rule, the primary host upon which the eggs are laid is a tree or shrub, the woody twigs or branches of which offer a greater degree of permanence for the preservation of eggs than the more fragile, pithy stems of annual and herbaceous plants, which are often broken off at the ground and carried away by various agencies. The eggs, which are small, ovoid, and usually black, are laid either on the twigs near the dormant buds, or upon the bark of the limbs, or in some cases even on the trunk. The hatching of the eggs in spring is usually correlated with the opening of the buds of the host.

"If the species is a leaf-feeding form, the newly hatched aphids, which are called stem mothers, wander about on the stems and branches until they reach the opening buds. Once they find these, they settle down and begin to feed. This feeding continues for about two weeks (the exact time depending on the temperature and species), and during this period the young aphids find it necessary to molt or shed their skins four times in order to provide for their rapidly increasing size. At the end of the fourth molt these first aphids appear to become full grown.

"The stem mother is almost invariably apterous (wingless) and gives birth to living young parthenogenetically (without fertilization, there being no males at this time of the year). The production of living young is known as viviparous reproduction. A stem mother normally lives for about thirty days and gives birth to numerous young during this time. These progeny, when they become mature, closely resemble the stem mother and also give birth to living young parthenogenetically.

"The third and fourth generations may or may not be apterous. Usually, however, especially if the species is migratory (polyphagous), a large proportion of the aphids are winged (alate) and are called spring migrants. If the species is not migratory, continuous generations of agamic females, either alate or apterous, are produced until the appearance of the sexual forms. The time of appearance of the sexual forms varies in accordance with the seasonal adjustments of the various species but usually they are produced in the fall of the year.

"If the species is migratory, the spring migrants fly to the secondary host of the species and there establish themselves and their progeny for the summer. Usually a migrating species entirely deserts its primary host for the summer, but occasionally the spirit of the wanderlust fails to develop in all individuals, so that some of them remain upon the primary host throughout the year. On the secondary host several generations of alate and apterous females are produced during the remaining portion of the summer, each generation passing through the various stages of nymphal life before becoming mature. Summer generations usually require less time to mature than the stem mothers, and some individuals may become adults on the sixth or seventh day after birth. Each of them may produce from 60 to 100 progeny before dying at an age of 20 to 30 days. In the fall of the year alate females, known as fall migrants, and occasionally alate males, are produced on the summer host. These alate females return to the primary host and there give birth to oviparous females (egg-laying females) and males in case the latter are not produced on the secondary host. The oviparous females, after mating, lay fertilized eggs as described above, and in this stage the species usually over-winters.

"The cabbage aphid, *Brevicoryne brassicae* (Linn.), may be cited as a good example of an economic species with a rather generalized or orthodox life history. In Illinois this plant louse passes its entire life history, that is, from stem mothers in spring to sexual forms and eggs in autumn, on cabbage or related plants. There is no true or rhythmic migration from, or desertion of, the spring food plant, but simply a dispersion of individuals from time to time to other cruciferous plants.

"Many other aphids, such as the various species of *Cinara* that feed on pine and certain species inhabiting oaks and birches, do not migrate from their primary host plants to secondary ones, but spend the entire life upon a single host or at least upon very closely allied hosts. The alate forms of these monophagous aphids serve only to distribute the species, and not to satisfy a desire for a change in diet as do those of polyphagous species. Certain species, such as *Myzus essigi* Gillette and Palmer, living on larkspur, find their hosts becoming unsuited for them very early in the summer, but instead of developing a migratory habit to more suitable hosts they meet this adversity by producing sexual forms, and laying eggs, at an early date.

"A step further, but still a more or less generalized life cycle, is presented by the rusty plum aphid, *Hysteroneura setariae* (Thomas). This plant louse, which over-winters on plum, migrates in early summer to various grasses upon which it spends the remainder of the summer. In fall certain alate viviparous females, the fall migrants, again return to plum in order that the life cycle may be completed on the primary host. Other examples of species with secondary hosts but still with more or less generalized life histories are: *Rhopalosiphum prunifolii* Fitch [*R. fitchii* Sand. is here referred to—note by MDL], which migrates between apple and cereal crops;

Hyalopterus pruni Geoffroy [now called *H. arundinis* (Fab.)]; and *Aphis illinoisensis* Shimer, which migrates between viburnums and grapes.

"Specialized Life Cycles

"Many plant lice have gone so far in the development of generations living under difficult conditions, that the forms frequenting the secondary host have changed structurally and are markedly different from those on the primary host. For example, most of the plant lice producing galls on the primary host plant have very complicated life histories. Some of the common species producing galls in spring and early summer on poplars (*Pemphigus populi-transversus* Riley and *P. populicaulis* Fitch) migrate to the roots of various grasses for at least part of the summer. The alate females which return to the poplars in late fall or early spring are called sexuparae and give birth to odd appearing sexual forms.

"Very complicated life histories are exhibited also by several species in Illinois which migrate between distinctly related plants. Among these may be named *Hamamelistes spinosus* Shimer, *Hormaphis hamamelidis* (Fitch) and *Prociphilus tessellata* (Fitch), which is one of the few aphids known to hibernate in temperate climates as nymphs.

"*Hamamelistes spinosus* Shimer hibernates on white birch in the form of greatly modified individuals resembling coccids more than they do aphids; descendants of these hibernating coccid-like aphids fly in early spring to witch-hazel, upon which the sexual forms are produced. The eggs are soon produced but do not hatch until May or June of the following year. Descendants of the individuals hatching from the over-wintering eggs on witch-hazel migrate to birch, where other generations soon modify themselves into the coccid-like individuals mentioned above. Thus the species spends the winter on both of its hosts but in two different ways.

"*Prociphilus tessellata* (Fitch) migrates between maples and alders. The sexual forms are produced on maples by migrants leaving the alders in fall. The over-wintering eggs produce stem mothers in spring, which produce generations (*acerifolii* Riley) destined to return in summer to alders. Although interrupted on its probable original host, the maple, the life cycle may continue on alders until the colony is destroyed by accident, disease, death of the host plant, or attack by enemies.

"In warm climates, and under greenhouse conditions in colder climates, the life histories of aphids may be so modified that they may go on indefinitely reproducing viviparously for years. Certain subterranean species, too, like *Geoica squamosa* Hart [Palmer calls this *G. utricularia* (Pass.)—note by MDL], have become modified to an entirely subterranean type of life, so that the aerial forms have dropped out of existence, at least in certain geographic areas."

PRODUCTION OF WINGED FORMS

It is a matter of common observation that in a colony of wingless aphids some of them will begin to develop wings. It was long supposed that this was a defense mechanism for survival produced by overcrowding. If the aphids continued to reproduce, their numbers would become so great that the individual shoot or even the whole plant upon which they were feeding would die and consequently they themselves would die also. However, overcrowding alone does not entirely explain this since dense colonies can often be found persisting up to the time of wilting of the plant without producing alates. It has been found that certain changes of the sap of the leaves and stems, no longer healthy due to excessive feeding, somehow tend to trigger the production of winged forms. It appears, however, from recent observations that the principal factor is the duration of sunlight in combination with temperature. There is some evidence to indicate that if the aphids are subjected to less than 12 hours of sunlight per day in combination with a temperature lower than 68 degrees F., they will start to produce winged forms irrespective of other factors such as crowding or the condition of the plants.

ECONOMIC IMPORTANCE

Aphids are among the most serious pests of agricultural crops as well as of shade, woodland and forest trees and of flowers and ornamental plants. They not only suck the juices but infect many plants with virus diseases. Their capacity for rapid and enormous reproduction under favorable conditions of temperature and moisture permit them frequently to cause serious losses. These amount annually to many millions of dollars in the United States to food crops such as fruits, vegetables, grains and grasses and forage crops. Cotton, tobacco, sugarcane and fibre plants are also attacked. So persistent and wide-spread are aphids that great losses still occur even with the use of our highly effective and economical modern insecticides and efficient ground and air equipment with which to apply them. The annual cost of these control measures plus the still inevitable losses sustained, is very considerable. A number of crops must be regularly treated for aphids every year, using from one to several applications; certain other crops only require control measures when aphids threaten to become too abundant.

From the extracted plant juices aphids excrete quantities of a sticky liquid called "honeydew". When they become abundant on the shade trees of city streets, such as maples, elms, lindens, oaks and others, the production of honeydew may become so great as to disfigure the sidewalks and automobiles parked under the trees. Honeydew, when deposited in large quantities becomes a serious hindrance in harvesting certain crops, such as alfalfa and sorghums, and the sooty mould which grows in it interferes with photosynthesis and with the normal pollenation of flowers.

PRODUCTIVITY OF APHIDS

It is not surprising that aphids are so frequently able to increase to epidemic numbers. An extreme form of viviparity prevails in most aphids. Embryonic development of her young begins before the mother's birth in the grandmother's body. Post embryonic development is correspondingly rapid and so is oviposition, which begins soon after the last moult. Individual fecundity of the viviparous females is modest, 100 offspring being quite a high total. It is the telescoping of the generations which gives aphids their unequalled rates of multiplication. To quote Hottes and Frison again: "The short time that it takes these insects to mature associated with their tremendous reproductive capacity (there may be ten or more generations a year, even outdoors in temperate climates) led Huxley [in 1958] to the calculation that the progeny of a single stem mother would by the fall of the year after 10 generations equal in weight the total weight of the population of China." The statement was made in respect to the common rose aphid, *Macrosiphum rosae* (L.). As Hottes and Frison suggest: "This, fortunately, is purely hypothetical and never happens because enormous numbers of aphids are destroyed by other insects depending upon them for food, by unfavorable weather conditions and by many other means."

HOW APHIDS FEED

A great deal of attention has been paid to the way in which aphids feed. One of the reasons for the extraordinary productivity of aphids is their feeding method, shared by a group of Homopterous insects including the Psyllidae and Coccidae. This is a tapping of the plant's own nutrient sap stream in the phloem sieve tubes. In a turgid plant the sap is under pressure. When the beaks of three common aphids—*Aphis fabae*, the bean aphid, *Myzus persicae*, the green peach aphid and *Lachnus salignus*, the giant willow aphid—were severed while the aphids were feeding, sap was observed to exude from their stylet stumps left in the plant. Mittler (J. Exptl. Biol. 34:334–341, 1957), working in England, found that the rate of exudation in this way was not appreciably less than the rate of honeydew output by the intact aphids feeding on the same stems. The flow is maintained for hours or even days. The term "Sucking Insects" thus appears to be a misnomer for most aphids. A plant cell tapped by *L. salignus* is refilled by its neighbors approximately 100,000 times per hour. The work done by this remarkable and little-understood plant pump in the plant accounts for the very high rates of food ingestion recorded for some aphids compared with that of some of the most voracious of the chewing insects. For example: the weight ratios of food to insect for a fourth instar cabbageworm and a fourth instar giant willow aphid has been found to be about 2 and 10; for the first instar willow aphid it was up to nearly 320 (Ann. Rev. Ent. 4:141, 1959). Plant sap is deficient in protein so that aphids have to take up large quantities to get enough. Since the sap is rich in sugars, there is a filter system in the walls of the gut which enables the aphid to retain amino acids and excrete the sugars as honeydew.

Excretion is accomplished at the anus as honeydew—this substance is not exuded through the cornicles as had earlier been supposed. In fact, the cornicles used to be called "honey tubes"; however, rather recent experiments have shown that the oily droplets they pass from time to time have some repellent effect upon insect enemies. Cornicles are peculiar to aphids. The technical reader will find the paper by F. C. Hottes interesting: "Concerning the structure, function and origin of the cornicles of the family Aphididae." Proc. Biol. Soc. Wash., 41:71–84, 1928.

APHIDS AS VECTORS OF PLANT VIRUSES

Many aphids have been shown to be responsible for the transmission of numerous kinds of plant viruses in various parts of the world. The damage to the plants by the diseases these viruses cause may often be greater than that produced by extensive feeding. The vector role played by aphids is an insidious one since the feeding of only a few aphids for a short time is all that is required to effectively innoculate the plants

In order to provide some indication of how widespread is the problem caused by aphid transmission of plant viruses there follows a list of some of the aphid virus vectors that occur in New York. (Source is V. F. Eastop's "A Study of the Aphididae (Homoptera) of East Africa"). Their general distribution is given along with the number of viruses known to be transmitted by each in some parts of its range. Several of these aphids have been shown to transmit viruses of potatoes, cereals, strawberries, raspberries, etc. in New York.

Anuraphis cardui (L.) A vector of the yellow dwarf virus of onions in the United States.

Anuraphis helichrysi (Kalt.) World-wide distribution—5 virus diseases.

Anuraphis tulipae (Fonsc.). World-wide distribution—a vector of 2 tulip viruses.

Aphis fabae Scop. Almost world-wide—about 30 virus diseases.

Aphis gossypii Glov. World-wide—about 40 viruses.
Aphis nerii (Fonsc.). World-wide—a vector of sugarcane mosaic.
Breviocoryne brassicae (L.). World-wide—about 23 virus diseases.
Hysteroneura setariae Thos. Occurs only in America and West Africa, a vector of 2 virus diseases.
Idopterus nephrelepidis Davis. Circumtropical distribution and in greenhouses in temperate regions; in California suspected to be a vector of a fern virus.
Macrosiphoniella sanborni (Gill.). World-wide distribution; a vector of a potato virus.
Macrosiphum dirhodum (Walker). Occurs in Europe, North America and East Africa; a vector of cereal yellow-dwarf virus in North America.
Macrosiphum euphorbiae (Thos.). World-wide—about 35 virus diseases.
Macrosiphum granarium (Kirby). Occurs in many parts of the world; a vector of cereal yellow-dwarf virus in North America.
Macrosiphum pisi (Harris). World-wide—about 25 virus diseases.
Macrosiphum rosae (L.). Present throughout the world almost everywhere that roses are grown; a vector of 5 plant viruses.
Myzus circumflexus (Buckton). Occurs in Europe and North America (in greenhouses) and in South America and Indonesia; a vector of about 30 viruses.
Myzus persicae (Sulz.). World-wide—100 virus diseases.
Myzus porosus (Sand.). Occurs in North and South America, the Middle East, Taiwan, Indonesia, Europe and East Africa; a vector of a strawberry virus.
Myzus solani (Kalt.). World-wide—about 30 virus diseases.
Nasonovia ribisnigri (Mosley). Occurs in Europe, North and South America and in Indonesia; a vector of 2 virus diseases.
Pentatrichopus fragaefolii (Ckll.). Occurs in North America (widespread), Argentina, Europe, Africa and New Zealand; a vector of 8 or 9 viruses; of major importance in transmitting those affecting strawberries.
Pentatrichopus minor (Forbes). Occurs in all of the states east of the Mississippi River and in Missouri, Arkansas and Louisiana; in Canada it occurs in New Brunswick and British Columbia; of major importance as a vector of strawberry viruses.
Pentatrichopus thomasi (H.R.L.). Occurs throughout North America except in the southeastern states; of major importance as a vector of strawberry viruses.
Rhopalosiphum maidis (Fitch). Widespread in North and South America and throughout the warmer parts of the world; a vector of 10 virus diseases.
Rhopalosiphum nymphaeae (L.). Occurs in North America, Europe, Africa and New Zealand; a vector of 5 virus diseases.
Rhopalosiphum pseudobrassicae (Davis). Almost world-wide in its occurrence; a vector of 14 virus diseases.

Toxoptera graminum (Kirby). In the wheat-growing areas of North America, Russia and Africa; a vector of sugarcane mosaic, cereal yellow-dwarf virus and wheat mosaic.

Toxoptera violae (Perg.). Occurs in North America, New Zealand, Bermuda, and in South and East Africa; a vector of celery calico virus in violets.

Four other aphids: *Aphis rubicola* Oestl., *Amphorophora rubi* (Kalt.), *Amphorophora sensoriata* Mason and *Masonaphis rubicola* (Oestl.), have been shown to transmit, to a greater or less extent, raspberry mosaics in New York.

NATURAL CONTROLS AND ANTS

There are many natural factors which tend to limit the numbers of aphids. Without their action the practical reduction of the crop losses they cause would be very much more costly, if not indeed sometimes impossible. Cool rainy weather slows reproduction and encourages the development of several fungous diseases which can rapidly wipe out enormous numbers of aphids. Hot dry spells are also unfavorable to reproduction. Parasites and predators are nearly always present among colonies of aphids and often become so abundant as to entirely eliminate them. Only a few of these tiny wasp-like parasites (mostly Chalcids and Braconids) have been so far reared and identified from aphids in New York. The predators are chiefly various species of the ladybird beetles and their larvae, nabid bugs, syrphus fly larvae and the larvae of lacewing flies and of ant-lions. Many kinds of birds feed on aphids and their eggs thus tending to keep their numbers down.

In a 3-year (1958–60) as yet unpublished study of the ecology of *Macrosiphum euphorbiae* (Thos.) and *Myzus persicae* (Sulz.) on potatoes at Riverhead, Long Island, W. A. Day and W. A. Rawlins observed the predators which were feeding on these two aphids. They have kindly given me the names of these for inclusion in this paper. Coccinellids (ladybird beetles) made up most of the total, the dominant species of which were *Coccinella 11-punctata* L. (55%) and *C. 9-notata* Hbst. (19%). Other insects observed were: lacewing flies (Chrysopidae), *Chrysopa* spp. (*plorabunda* group); the nabid bug, *Nabis ferus* (L.); and the flower-flies or Syrphidae, *Mesograpta marginata* (Say) and *Metasyrphus weidemanni* (Johnson). The potato aphid was parasitized to a much greater extent than the peach aphid; but fungi, *Entomopthora* spp., attacked the green peach aphid almost to the exclusion of the potato aphid.

The close association of aphids and ants has long been known and almost every account of the habits of aphids mentions them as the ants' "cows". The ants feed on the sweet honeydew secreted by the aphids and often carry them to other parts of the plant, or even to other plants, and so aid in the destruction of the host. Some aphids are said to be entirely dependent upon ants. For example, in the case of the corn root aphid, the association is so close that the ants even care for its eggs during the winter. Although ants associated with colonies of aphids have been collected from time to time in New York, few of these insect husbandmen have been determined.

SOURCES OF INFORMATION

Many persons over a period of many years have contributed to our knowledge of the aphids of New York. Those who have done only incidental collecting or have only occasionally made observations are mentioned in the text in connection with individual records. There follows the names of those who have paid more than superficial attention to aphids in the state with a brief statement of the nature of the contribution of each. These are given chronologically in order to show the historical sequence of their activities. The appreciation of the writer is here expressed to all of those, past and present, who have made this List possible.

C.S.R. Rafinesque. The earliest aphids studied in New York, and indeed in the United States, are those collected by the brilliant young French naturalist, Constantine Samuel R. Rafinesque (1783–1840). He was living at the time near Newburgh in the lower Hudson River Valley and his collections were made in that vicinity and on western Long Island. As a result he described 36 new species in two papers in the American Monthly Magazine and Critical Review—species Nos. 1 to 12 under the title of "Specimens of several new American species of the genus aphis.", in Vol. 1 No. 5:360–361, 1817; and species Nos. 13 to 36 under the title of "A second memoir on the genus aphis containing the descriptions of 24 new American species.", in Vol. 3 No. 1:15–18, 1818.

Dr. F. C. Hottes has carefully analyzed Rafinesque's two papers in an attempt to determine the validity of these species. The results of this study were published in a paper entitled "Notes concerning the first papers dealing with the aphid fauna of America.", (Proc. Biol. Soc. Wash. 44:61–69, 1931). Hottes concluded that 9 species are unrecognizable aphids and one is not an aphid. Thirteen of the remaining 26 names he considered to be synonyms, so that the net number of definitely or probably valid species becomes 13.

Asa Fitch, M.D. (1809–1878), when acting as State Entomologist, was the next to pay some attention to aphids in New York. He described 39 new species, all except 3 of which are recognizable. In many instances he gave detailed observations on their habits or injuriousness. This was done in his "Catalogue of the Homoptera of New York", 1851; and in his First & Second Reports (combined), 1856; Third Report, 1856; Fourth Report, 1858; Fifth Report, 1859, and the Thirteenth Report,

1870. Louise M. Russell of the United States Department of Agriculture has clarified the references to Dr. Fitch's Reports and Catalogues in her valuable paper in Ann. Ent. Soc. Amer. 53 (3):326–327, May 1960.

Paul Hayhurst (1878–1946), while a graduate student in entomology at Cornell, 1905–1906, made about 50 collections of aphids mostly around Sheridan, Fredonia and Dunkirk on Lake Ontario in western New York. These were determined in 1936 by Dr. A. N. Tissot of the University of Florida. About 36 species were involved, 10 of which had not previously been known to occur in New York.

C. P. Gillette, Ph. D. (1859–1941) of Colorado State University, collected aphids at several localities in New York in 1909. He gave notes on about 34 species, several of which are our earliest records for the state, in the Jour. Econ. Ent. in 1909 and 1910.

Chris E. Olsen (1880–) when on the staff of the American Museum of Natural History, collected aphids during the seasons of 1913 and 1914 around his home at Maspeth, Long Island. Determinations were made for him by J. J. Davis and the late Edith M. Patch. He published these records in the Bull. Brooklyn Ent. Soc. 16:14–19, 1921. Here are listed 53 species, together with their food plants, several of which have not since been collected in the state. Slides are in the American Museum of Natural History.

At the writer's suggestion he resumed collecting in 1947 and 1948, this time at his home in West Nyack. During these years, and again in 1958 through 1960, he made at least 75 collections. Slides are in Cornell University.

Harold Morrison, Ph.D. (1880–), while a graduate student in entomology at Cornell University, collected aphids at Ithaca and vicinity from the fall of 1912 into the summer of 1914. This work involved about 30 valid species; several first records, or early records, for the state were included.

Ephraim Porter Felt, Ph.D. (1868–1943), when State Entomologist of New York, started about 1914 to compile the list of aphids for the proposed "List of the Insects of New York". Although this was not finally published until 1928 ("A List of the Insects of New York", Cornell Univ. Agr. Exp. Sta. Mem. 101, 1928), the basic list of aphids is Dr. Felt's, even though it was later modified by Baker and Mason, Patch and Leonard. This was the first attempt to inventory the aphids of the state. In it 128 species are treated (pp. 184–192).

Grace H. Griswold, Ph.D. (1872–1946), a member of the Department of Entomology at Cornell University, started collecting and studying aphids around Ithaca in 1921 and continued until her tragic death early in 1946. She also encouraged members of the staff and graduate students to collect. She made hundreds of slides and many determinations (often verified by Patch and Essig). It is quite probable she made a greater over-all contribution to knowledge of the aphids of New York than any other single person.

John L. Horsfall, Ph.D. (1888–), while at the Boyce Thompson Institute for Plant Research at Yonkers, collected about 18 species (on 87 slides). These are among the earliest records for Westchester Co.

M. D. Leonard, Ph.D. (1890–) and *C. R. Crosby, B.S.* (1879–1937), starting in the fall of 1932 and continuing through 1946, made more than 300 collections, separately and together, in several parts of the state. Most of these were determined by Dr. A. N. Tissot of the University of Florida and represented about 80 species. The records were published by Leonard in a paper entitled "Additions to the New York State List of Aphids with notes on other New York Species.", (Jour. N. Y. Ent. Soc. 44:177–185, 1936). In this, 42 species are recorded as new to the state, thus bringing the total up to 170. Slides are in Tissot's collection and that of Cornell University.

Franklin S. Blanton, Ph.D. (1902–) made about 50 aphid collections while stationed for the United States Department of Agriculture at Babylon, Long Island in 1932–34. Determinations were made by P. W. Mason and A. N. Tissot and slides are in the collections of Tissot, United States National Museum and Cornell University.

Kenneth E. Maxwell, Ph.D. (1908–) while on a special assignment made a number of collections in and near Locust Valley, Long Island in 1934–36. Tissot and the writer made the determinations and the slides are in the collections of Tissot and Cornell University.

Paul J. Chapman, Ph.D. (1900–) and *Foster L. Gambrell, Ph.D.* (1900–), of the New York (Geneva) Agricultural Experiment Station, made about 35 collections from woody shrubs and shade trees in and near Geneva in 1946. About two-thirds of these represented different species, several of which had previously been little known in the state. Mason made the determinations and the slides are in the United States National Museum.

Roy Latham (1880–), of Orient, Long Island, is a vegetable grower and a self-taught naturalist. He has operated an extensive truck farm at Orient for most of his adult life. In addition, starting as a young man, he has built up enormous collections covering the whole fauna and flora as well as the archaeology of Eastern Long Island. Although he had long collected a few aphids from time to time, the writer induced him to pay particular attention to these insects in 1946. During this year through 1949 and from 1957 through 1960, Roy Latham made something over 1,200 collections. These represent about 140 determined species of aphids on about 250 plants from which aphids have been determined. A number of his collections still remain to be determined. About 40% of the aphids known to occur in New York have been collected by Latham on Long Island. His contribution to our knowledge of the aphids of New York is certainly second only to that of Grace Griswold. The slides are mostly in Cornell University but many from his 1959 and 1960 collections are also in the collection of Dr. Clyde F. Smith. (It may be of interest to note that during 1961 Roy Latham made about 340 additional collections, almost entirely around Orient, with most of the others at Greenport, less than 10 miles to the west).

Laverne L. Pechuman, Ph.D. (1913–) when residing in Lockport, collected aphids in the northwestern part of the state, chiefly in Niagara, Genesee, Orleans and Monroe Counties, from 1958–1960. During these three years he made nearly 600 collections, representing about 114 determined species (32% of the total), on a great many plants in a section of the state from which only a few aphids had previously been recorded. Many of his aphids and their food plants were new to New York and a number of others were little known. Most of this material has been determined or verified by Dr. C. F. Smith and the slides are in his collection and that of Cornell University. Dr. Pechuman, as of July 1962, is Curator of Insects at Cornell University.

John Graham, M.Sc. (1930–), while a graduate student in biology at Cornell University, made a few collections at Ithaca in 1958 and in 1959 at Mount Kisco and at Shackleton Point on Lake Oneida. His collections contain several things of interest, including the first record for the state of *Periphyllus americanus* (Baker). In 1960 he collected further at Mt. Kisco and on Shelter Island, Long Island. In all he made about 85 collections. Slides are in the collections of Dr. C. F. Smith and of Cornell University.

Edwin Rundlett, B.S. (1896–), for sometime past has been Horticulturalist for the Parks of Staten Island. Because there were so few records of aphids from Staten Island, the writer induced him to make some collections. Although he only started in October 1960 he made about 15 collections from several different plants in addition to more than 50 alates in a Moericke trap. Slides are in Cornell University.

John A. Wilcox, M.Sc. (1921–) of the Office of the State Entomologist of New York, made 14 collections of aphids in 1959 from Albany and vicinity and from Catskill and vicinity, and several others in 1950, 1951 and 1955. The records are of value largely because so little collecting has been done around Albany or in the Catskills. Slides are in Cornell University.

LIST OF APHIDS

In the following notes a general attempt has been made to arrange the records for each aphid geographically, starting in the western part of the state, working eastward and then down the Hudson River Valley, ending up with Staten Island and Long Island. Within this pattern, the records are generally given chronologically. Consistency in such an arrangement, however, has not been adhered to when logical factors intervene.

The names of the aphids are arranged alphabetically, by genera and by species in each genus. The listing thus provides its own index, although the List of Food Plants appearing after the aphid list may sometimes offer a quicker way to find many of the species.

The following abbreviations are used in the listing: Cornell University, CU—Long Island, LI—Staten Island, SI—United States National Museum, USNM—Special Survey of Ports of Entry by the United States Department of Agriculture Plant Quarantine Inspection, Sp Port Surv—New York List of Insects 1928, NYL—American Museum of Natural History, AMNH—United States Department of Agriculture, USDA.

Amphorophora crataegi (Monell) Four-spotted Hawthorn Aphid

ITHACA 18 Sept 1934, CAYUTA LAKE 13 Sept 1934 (oviparous females present) and BARRINGTON 19 Sept 1934, on leaves of *Crataegus* sp., (all Leonard and Crosby coll). ITHACA 8 Oct 1933, common on *Crataegus* sp., (Crosby coll). SI: PORT RICHMOND 1 Sept 1943, on leaves of *Crataegus* sp., (Sp Port Surv). LI: GREENPORT 27 Sept 1957, 22 Ju 1958, SOUTHOLD 17 Oct 1957 (males present), on *C. crusgalli*, 13 Jl 1958, on *C. anomala*, and GREENPORT 2 Aug 1959, on *C. macrosperma*, (all Latham coll—det MDL).

W. H. Wellhouse (Cornell Univ. Agr. Exp. Sta. Mem. 56:1063–4, 1922) states: "The apterous females of *Macrosiphum crataegi* [syn.] may be found from late May until October on the native hawthorns at Ithaca, and during July and August the species may become so abundant as to seriously injure the trees. During the summer of 1919 the writer saw a small *Crataegus pruinosa* tree killed and a very large *C. punctata* tree almost entirely defoliated due to the sucking of the sap by myriads of these aphids. They are rather large, yellowish-green aphids, with long cornicle, and their most recognizable character is the presence of four dark green spots arranged in a rectangle on the dorsum of the abdomen. The entire life history is passed on *Crataegus* trees. The black winter eggs are placed on the twigs and the smaller branches. They begin to hatch in May, after the leaves are well opened. The young aphids move to the lower surface of the leaves, and their feeding, as the colony increases, causes the leaves to curl downward. In late June an alate brood appears and migrates to nearby branches or trees to start new colonies. It is after this appears that the species becomes so injurious."

Amphorophora laingi Mason

SHERIDAN Jl 1905, on *Onoclea sensibilis*, (Hayhurst coll; PARACOTYPE in USNM marked "Hayhurst No. 209, Pergande No. 9986"). TONAWANDA INDIAN RES. Erie Co. 9 Aug, on *O. sensibilis*, 18 Jl 1960, on *Pteretis nodulosa*, (Pechuman coll—CFS det).

Amphorophora nabali Oestlund

LI: EAST HAMPTON, SAG HARBOR 22 Sept 1946, on *Prenanthes trifoliata*, (Latham coll).

Amphorophora nervata Gillette?

LI: Riverhead 27 Sept 1946 (1 alate and several nymphs), on *Arto-staphylos urvi-ursa,* (Latham coll).

Amphorophora rhododendronia Mason?

LI: Farmingdale 7 Dec 1948, on *Rhododendron* sp., (G. V. Johnson coll; 1 slide in USNM det with query).

This species was described from a single slide bearing 4 apterae which were collected by Dr. Edith M. Patch at Orono, Maine, 21 Jl 1922. There are apparently no other records of its occurrence.

Amphorophora ribiella (Davis) Ornamental Currant Aphid

Ithaca 18 Sept 1936, on *Ribes nigrum,* (Crosby coll—LMR det).

Amphorophora rossi Hottes and Frison

LI: Mattituck 10 Jl 1958, Orient 30 Jl 1959, on *Geum canadense,* (Latham coll).

Amphorophora rubi (Kaltenbach) European Raspberry Aphid

"Hudson River Valley" no date, on raspberry, (S. W. Harman coll ex Patch; 1 slide in USNM), 23 Apr, 5 Jl, on red raspberry, (W. H. Rankin coll; 1 slide in USNM). New Paltz, Highland 5 Ju 1924, on red raspberry, (W. H. Rankin coll; 1 slide in USNM). Geneva 30 Sept 1922, on red raspberry, (2 slides in USNM), 18 Apr, 1, 8, 15, 29 and 31 May 1925 (W. H. Rankin coll; 4 slides in USNM) and 20, 21, 24 and 26, Oct 1947 (F. G. Mundinger coll; 6 slides in USNM). North Fairhaven 2 Jl 1939, on *Rubus ideaus* var. *strigosus,* (Griswold coll—Griswold and Essig det; 1 slide of 1 aptera verified by LMR). Orient 26 Jl 1951 (Latham coll—LMR det), 22 Jl 1960, on *R. phoenicolasius,* (Latham coll—det CFS with query).

From L. M. Cooley, N.Y. (Geneva) Agr. Exp. Sta. Bull. 655:4–5, 1936, during a study of raspberry mosaics in Western New York (1931–35): "*Amphoraphora rubi* (Kalt.) was found to be the chief vector . . . maintaining a steady population in most of the red raspberry stocks [*Rubus idaeus* principally *strigosus*] quite in contrast to its widely fluctuating populations on cultivated raspberries . . . . On wild raspberries peak infestation was reached in mid-June each season with a secondary peak in October . . . . Counts made near Brant and North Collins June 12, 1933, showed 23 *A. rubi* per shoot on extra vigorous wild red raspberries growing in partial shade, 8 per shoot on medium growth, and only 3 per shoot on low stunted growth in an open pasture lot.

"Wild black raspberries [*Rubus occidentalis*] appear to be much less favorable hosts of this aphid. Single specimens and small colonies were found occasionally on young shoots in late May and early June of each season, but strong colonization of this host was never observed, and in no instance was the infestation on a given plant seen to survive through the summer. No winged forms were found. No *A. rubi* were ever observed occurring naturally on wild blackberries [mostly *Rubus allegheniensis*]. A number of attempts to transfer the aphids artificially from cultivated red raspberries to the tips of wild blackberry shoots failed to establish colonies."

Amphorophora sensoriata Mason

ITHACA 12 Aug 1933, 9 Sept 1934, FREEVILLE 15 Sept 1934, on wild raspberry canes, (Leonard and Crosby coll). RINGWOOD Tompkins Co. 24 Sept 1933, on wild raspberry, (Crosby coll).

As a result of a study of virus diseases of raspberries in western New York from 1931–1935 L. M. Cooley stated that *Amphorophora sensoriata* was found only occasionally. It was observed only on the undersides of trailing black raspberry shoots (*Rubus occidentalis*) in late summer and fall, feeding only on the canes proper. He did not consider it an important factor in general mosaic spread in western New York.—N.Y. (Geneva) Agr. Exp. Sta. Bull. 665:5, 1936.

Amphorophora sonchi (Oestlund) Sowthistle Aphid

In Can. Ent. 94 (7): 781, 1962 W. R. Richards gives this species as a synonym of *Nasonovia* (*Hyperomyzus lactucae* (L.)), following V. F. Eastop in Aphididae of West Africa, p. 35, 1961.

ITHACA 9 Sept 1933, on *Lactuca canadensis,* (Crosby coll), 17 Sept 1934, on *Sonchus asper,* (Leonard coll), 9 Oct 1932, on currant, (Leonard and Crosby coll) and 29 Jl 1939, on *S. oleraceus,* (Griswold coll). GENEVA 20 Oct 1946 (male, and a female ovipositing), on ornamental *Ribes* sp., (P. J. Chapman coll—Mason det). LOCKPORT 9 Aug 1958, 12 Jl 1959 and 16, 23 Ju 1960, on *Sonchus oleraceus,* 9 Aug 1958, on *S. asper,* 8 Oct, on *Ribes dowingiana,* 17 Oct, on *R. hirtellum,* 9 Oct 1959, on *R. sativum,* (fall migrants included in *Ribes* collections) 4, 23 Oct 1959 (fall migrants), on *Saxifraga* (*Bergenia*) *crassifolia* and 16 Ju 1960, on *Sonchus oleraceus,* (all Pechuman coll—CFS det). ALBION 20 Aug 1959, on *S. arvensis,* 5 Oct 1959 (fall migrants), on *Saxifraga* (*Bergenia*) *crassifolia,* (both Pechuman coll). LI: ORIENT 14 Jl 1946, QUOGUE 10 Oct 1948, on *Sonchus oleraceus,* (Latham coll).

On 22 May 1960 Dr. Pechuman wrote of the Lockport collections that these species of *Ribes* "are covered with the aphids and those on *R. hirtellum* cover the terminal growth but none are present on the terminals of *R. sativum,* being restricted to the leaves".

Anoecia corni (Fabricius)

ITHACA Aug, Sept 1932, 1934, on *Cornus stolonifera, C. amomum,* 4 Sept 1933, on roots of *Dactylis glomerata,* (Leonard and Crosby coll). WEST DANBY Oct 1932, on *C. amomum,* ETNA Oct 1932, on *C. stolonifera,* (Leonard and Crosby coll). MCLEAN, CAYUTA LAKE and BARRINGTON Sept 1934, on *C. candidissima;* BATAVIA Sept 1934, TAUGHANNOCK 4 Sept 1933, on *Cornus* sp., (Leonard and Crosby coll) and 26 Sept 1938, on *C. candidissima,* (Griswold coll). GENEVA 20 Sept 1946, on *Cornus* sp., (Chapman coll—Mason det). LOCKPORT 16 Sept 1946, 17, 25 and 29 Oct 1959, 10 Oct 1960 (with query) and 1 Nov 1958, ZOAR VALLEY Erie Co 20 Sept 1959 and OAKFIELD 11 Sept 1958 "very abundant", all on *Cornus stolonifera,* (all Pechuman coll). LOCKPORT 10 Oct, on *C. florida;*

OLCOTT Keg Creek 5 Oct, on *C. rugosa,* and GASPORT 24 Sept 1960, on *C. alternifolia,* (Pechuman coll; det CFS with query). SI: CASTLETON CORNERS 20 Nov 1960 (1 fall migrant and 1 summer alate in "Moericke trap"; Rundlett coll—J.O. Pepper det).

Anoecia querci (Fitch)

NYL – Ithaca, very common on leaves of red oak.

ITHACA 3 Sept 1933, on roots of foxtail grass, (Leonard and Crosby coll). GENEVA 17 Oct 1945, on *Cornus foemina,* (Gambrell coll—Mason det). LI: WESTBURY 12 Apr 1935, on oak, (Bartlett Tree Res. Labs.); ORIENT 12 Oct 1958, on roots of *Eleusine indica,* (Latham coll).

Fitch's original account of this aphid is as follows: "306, Oak Blight, *Eriosoma querci,* new species. (Homoptera, Aphidae). A species of blight, or a woolly aphis on oak limbs, puncturing them and exhausting their sap, was met with in Northern Illinois, but I have never seen it in New York." (Fifth Rept., p. 804, 1859).

Anuraphis bakeri (Cowen) Clover Aphid

EAST AURORA 10 Aug 1933, on clover, (Leonard and Crosby coll). ITHACA 24 Oct 1932, alates on apple leaves, (Leonard coll—Tissot det), 1 Dec 1938, on clover *Trifolium* sp. in greenhouse, (Griswold coll; in CU). GENEVA 18 Oct probably 1918, from apple, (F. H. Lathrop coll—Patch det; Me. Agr. Exp. Sta. Lot Book). YONKERS 21 Ju 1921, on *Trifolium hybridum,* (J. L. Horsfall coll). GRAND ID. Erie Co. 7 Ju 1959, on *Crataegus* sp., (Pechuman coll—CFS det). MT. KISCO 1 Aug 1960, on *Trifolium pratense,* (John Graham coll—det MDL with query). LI: DELWOOD 28 Jl 1933, on clover, (Leonard coll—Tissot det); SHELTER ID. 28 Jl 1960, on *Trifolium pratense,* (Graham coll—CFS det).

Presumably widely distributed in the state and probably locally common on red clover and also occurring on apple but few substantiating records.

Anuraphis carduella (Walsh)

ITHACA – about the middle of October 1913 (winged males and oviparous females were obtained on *Cirsium vulgare;* often occurred in company with *A. cardui* L.; presumably the first record of this aphid in the state, Morrison coll).

Anuraphis cardui (Linnaeus) Thistle Aphid

NYL – In addition to annotated localities given below SCHOHARIE Ju and RENSSELAER are also listed.

RICHFIELD SPRINGS 2 Sept (male and ovip. female in copula), 1, 6 Oct 1887 (? Pergande coll; in USNM), 27 Aug 1887, on plum, (Wm. D. Alwood coll; in USNM). ONEIDA 18 May 1889, on plum, (J. Lawrence coll; in USNM). SHERIDAN Jl 1905, on *Cirsium (Cnicus) vulgare,* (Hayhurst coll). GENEVA 29, 30 Ju 1909, on *Carduus* sp., (Gillette,

J. E. E. 3(5): 404, 1910). ITHACA about middle and last of October 1913 (winged males and oviparous females were present), on *Cirsium vulgare,* (Morrison coll), 18 Jl 1928, on *Centaurea* sp., (Griswold coll—Patch det). ST. REMY 26 May 1921, on Burbank plum, (Crosby coll; in USNM). NORTH FAIRHAVEN 2 Jl 1939, on Italian prune *Prunus domestica,* (Hansberry coll—Essig det). ITHACA 13 Ju 1939, on *Onopordum acanthium,* (Griswold coll—Russell det, 1960). WILSON 13 Ju 1946, on *Prunus domestica,* MEDINA 10 Jl 1958, on *Cirsium vulgare,* (Pechuman coll). LYNDONVILLE 28 Sept 1960, on *Prunus armeniaca,* (Pechuman coll—CFS det). LI: ORIENT 8 Jl 1959, 23 Jl 1960, respectively on unopened buds and in top of plants of *Cirsium vulgare,* GREENPORT 17 Jl 1959, on *C. vulgare,* 1 Sept 1957, on *C. discolor,* (all Latham coll).

Quaintance and Baker (US Farmer's Bull. 1128, p. 14, 1926 revise) state that in some localities this aphid is abundant on plum trees and that trees have been observed in the vicinity of Washington, D. C., with the underside of nearly every leaf thickly covered with the insects. Although widely distributed the thistle aphid has not been recorded as becoming abundant on plums in New York.

Anuraphis helichrysi (Kaltenbach) Leaf-curl Plum Aphid

LI: ORIENT 12 Ju 1958, on *Erigeron annuus,* (Latham coll—LMR det).

Anuraphis maidiradicis (Forbes) Corn Root Aphid

NYL – ALBANY, on *Aster* sp..

ITHACA 12 Aug 1933, on roots of yellow sweet clover, (Leonard and Crosby coll). LI: HICKSVILLE 27 Sept 1943, on beet roots, (Tuthill coll—Mason det; Sp Port Surv); ORIENT 7 Sept 1947, on roots of *Cosmos bipinnatus,* (Latham coll); WEST NYACK Nov 1960 (many "pupae", several apterae, 3 alates), on roots of carrot, (Olsen coll—MDL det).

Anuraphis persicaeniger (Smith) Black Peach Aphid

OLCOTT 17 Nov 1892, on stems and roots of peach trees, (J. O. Lockwood coll—Tissot det; in CU). IRONDEQUOIT 14 Jl 1938, on roots of *Prunus persicae,* (E. M. Hildebrand coll—Essig det).

"A correspondent in Niagara Co. has introduced this pest into his orchard from a nursery in Delaware. So far as we know this is the first instance of occurrence of the insect in the state"; (M. V. Slingerland, Cornell Univ. Agr. Exp. Sta. Bull. 49, 1892). The Lockwood slide substantiates this statement. L. E. Strickland reports on 19 June [year looks like 1921] "normal abundance" of this aphid in Niagara Co.. "Found on peach in small numbers in Ulster Co." (C.C. Wagoner, May 24, 1924). R.G. Palmer, 15 Jl 1923 reports "quite abundant this season" in Monroe Co.. Sidney Jones, 14 May 1928 reports "Black peach aphid found quite abundantly on young peach trees near Warwick". E. E. Frane reports 10 Jl 1928 that this aphid was not observed in Wayne Co.

Anuraphis rosea Baker Rosy Apple Aphid

Stroyan in "The British Species of Sappaphis Matsumura", p. 24, 1957, states that the correct name of this species is *plantaginea* Passerini (1860), which he places in the genus *Sappaphis*. Because it is so thoroughly entrenched in American economic literature Baker's specific name is here retained.

It appears that the earliest reference to the occurrence of the rosy apple aphid in New York is by Prof. J. H. Comstock in the Report of the Entomologist, Cornell Univ. Agr. Exp. Sta. Ann. Report 6 (1893): 20–21, 1894. It is here stated that "work is now in progress on a monographic account of the apple aphids (*A. mali*) [=*Aphis pomi*] and the apple leaf aphis (*A. sorbi?*) [=*Anuraphis rosea*]; the latter has heretofore been treated as a variety of *A. mali* in this country. Both species have been carefully traced on the apple tree and all the forms occurring there studied." Dr. Robert Matheson (Cornell Univ. Agr. Exp. Sta. Mem. 24: 720, 1919) says in regard to this statement: "His reference to *Aphis sorbi* is given with a question mark. However, through the kindness of J. J. Davis, who has recently examined the Monell Collection, the writer can state that the species to which Comstock referred is *Aphis sorbi* Kalt. Mr. Davis found specimens of this species sent by M. V. Slingerland in September, 1893 to Monell and Comstock's reference is certainly to this material."

The rosy apple aphid is undoubtedly present every season on apples wherever they occur in the state and in some years is a serious pest in commercial apple orchards. It is the most important aphid attacking the fruit and foliage of the apple. To quote Quaintance and Baker (U.S.D.A. Farmers' Bull. 1128, pp. 3–4, 1926, rev.): "The rosy aphid infests especially the foliage surrounding the blossom or fruit clusters and causes the leaves to curl badly. The insects when abundant also infest the fruit stalks and newly set fruit. The little apples on the infested fruit spurs often fail to thin out, remain small, and as the season progresses become knotty and distorted according to the degree of infestation. In the fall these 'aphid apples' may be much in evidence, especially on the lower parts of the tree, during worst aphid seasons amounting to from 15 to 30 per cent of the crop." Very young trees are often twisted and deformed from excessive feeding on the young shoots.

The seasonal history of this injurious aphid in New York may be summarized as follows: After producing three or four generations on apple, winged forms begin to appear which migrate, usually late in June at Ithaca, to their summer food plants, the narrow-leaved plantain or ribgrass (*Plantago lancolata*) and the broad-leaved or common plantain (*P. major*), the former being much preferred in New York. At least six generations are produced on plantain following which special winged forms appear which return to the apple. These consist of viviparous females and males. In the region of Ithaca they begin to appear late in September, the winged females developing first, and continue to return to the apple throughout the whole of October, reaching the maximum about the middle of the latter month. Production of oviparous females soon begins on the apple. The males begin appearing somewhat later and continue migrating to the apple well into November. Mating soon occurs and the resulting eggs are attached to the bark of the twigs and sometimes the branches where they remain until hatching time in the spring. (The foregoing is taken from "A Study of the plant lice injuring the foliage and fruit of the apple" by Robert Matheson; Cornell Univ. Agr. Exp. Sta. Mem. 24, June 1919).

In July 1961, Dr. P. J. Chapman, Entomologist of the New York (Geneva) Agricultural Experiment Station, wrote me in respect to this aphid in New York on apples: "Generally but unevenly distributed throughout the state; varying widely in annual abundance. Seriously dwarfs fruit and may render up to 90% of crop unsaleable in outbreak years. Susceptible apple varieties receive 'preventive' control measures annually."

Anuraphis rumexicolens Patch

NEW YORK Botanical Gardens 17 Jl 1932, on *Dahlia* sp., (Philip Brierley coll—? Mason det; in USNM).

Anuraphis tulipae (Fonscolombe) Tulip Bulb Aphid

ALBANY 18 Jl 1908, on gladiolus bulb, (Felt coll—Patch det; Me. Agr. Exp. Sta. Lot Book). NEW YORK Botanical Gardens 21 Oct 1932, on *Dahlia* sp., (Philip Brierley coll; in USNM). SI: Mar or Apr 1954, 1 Oct, 7 Nov 1960, on leaf bases of bearded iris; also 2 in Moericke trap 1, 7 Nov 1960 (E. A. Rundlett coll—J. O. Pepper det). LI: BAYSIDE 16 Apr 1932, on *Iris susianna,* (Fields, Plummer and Griffith coll; Sp Port Surv); BROOKLYN 7 Apr 1932, on bulbous iris *Hollandia hispanica,* (USNM), 19 Nov 1938, abundant in leaf sheaths and on surface of leaves near ground of *Iris* spp. including *I. ensenata,* (L. Gordon Utter coll—Mason det); BABYLON 27 Oct 1939, on iris bulbs in storage, (Blanton coll—Mason det; in USNM); ORIENT 7 Nov 1947, on bulbs, roots and leaves of *Gladiolus gandevensis* var., (Latham coll); FARMINGDALE 30 Nov 1948, on bulbous iris, (G. V. Johnson coll; in USNM).

Described by Dr. Felt under the name of *Aphis gladioli* n. sp. from Berlin on gladiolus (24th Rept. N.Y. State Ent. for 1908, p. 19, Sept 1909). In J.E.E. 1:330, 1908 Dr. Felt says "large numbers on base of bulbs around origin of roots starting in spring in storage house—gets very abundant."

Anuraphis viburnicola (Gillette) Snowball Aphid

ITHACA 17 Oct 1932 (Leonard coll), 18 Sept 1934 (Leonard and Crosby coll), on *Viburnum opulus;* 15 May 1939, on *V. lentago,* (Hansberry coll), 20, 24 May and 1, 10 Ju 1936, on *V. acerifolium,* (Otelia Francis coll—Patch det; Me. Agr. Exp. Sta. Lot Book). FREEVILLE 15 Sept 1934, on *V. dentatum, V. lentago,* (Leonard and Crosby coll). NEW YORK Central Park 18 May 1941, on *V. opulus,* (AMNH). HAINES FALLS 17 Jl 1959, on *V. recognitum,* (J. A. Wilcox). LI: MASPETH 21 Ju 1914, on *Viburnum* sp., (Olsen coll); BABYLON 31 May 1939, common on wild *Cornus* sp., (Blanton coll); ORIENT 26 May 1959, on *Viburnum plicatum,* 4 Jl 1959, on *V. dentatum,* MATTITUCK 8 Nov 1947, on *V. opulus,* (all Latham coll).

Undoubtedly occurs throughout the state, curling the leaves of the snowball on which it spends the winter.

Anuraphis viburniphila (Patch) Viburnum Aphid

ITHACA 12 Ju 1936, NORTH FAIRHAVEN 21 Ju 1936, on *Viburnum acerifolium,* (O. Francis coll—Patch det; Me. Agr. Exp. Sta. Lot Book). ITHACA 22 May 1939, MCLEAN 27 Ju 1939, on *V. dentatum,* (Hansberry coll—Essig det). SCARSDALE Ju 1925, on *Viburnum* sp., (S. W. Bromley coll). GENEVA 20 Oct 1946 (scarce, ovipositing), on *V. dentatum,* (Chapman coll—Mason det). ROCHESTER 1943, on *V. opulus,* (Gambrell coll—Mason det). LOCKPORT 8 Ju 1959, on *V. opulus,* (Pechuman coll—CFS det). LI: ORIENT 21 Ju 1946, common on *V. opulus,* (Latham coll); MT. KISCO 8 Jl 1960, on *V. recognitum,* (Graham coll—CFS det).

Aphis spp.

The following records, though incomplete, are here included because of the uniqueness or rareness of the plants as aphid food hosts:

ITHACA 29 Jl 1929, on Shasta daisy *Chrysanthemum maximum,* (Griswold coll—MDL det; 1 slide with 5 apterae in CU); only aphid record on this plant for NY; I find none elsewhere.

ITHACA 20 Jl 1939, on caraway *Carum carvi,* (Griswold coll; 3 slides with alates and apterae in CU); only aphid record on this plant for NY; very few elsewhere.

LI: ORIENT 19 Jl 1959, on watercress *Nasturtium officinale,* (Latham coll—MDL det); I find no record of an *Aphis* on watercress elsewhere in this country.

LI: GREENPORT 26 Jl 1929, on roots and base of stem of *Sanicula canadensis,* (Latham coll—MDL det); only NY record on this plant; elsewhere I find only *Aphis signatus* H. and F. in Illinois described from *Sanicula* sp.

On August 26, 1916, M. D. Leonard wrote Edith M. Patch as follows: "I am sending you under separate cover a small vial containing a few specimens of a plant louse which I found very abundant in large golden seal patches at Fulton, N. Y. (these were cultivated plantings grown under slats), and although they do not seem to be injuring the leaves to any appreciable extent I should like to know very much what this species is." In Miss Patch's reply of Sept 1, 1916, she states that "the species is new to me and is apparently undescribed for America at least." She gave it the manuscript name of *Aphis hydrasticolens.* Unfortunately the slide made from this material was later discarded by Miss Patch so that the true identity of the aphid can never be determined. There seems to be no other record of an aphid occurring on golden seal, *Hydrastis canadensis.*

Aphis armoraciae Cowen Western Aster Root Aphid

ITHACA 7 Aug 1933, on roots of phlox, (MDL coll—det Tissot as *middletoni* but with a query since all specimens were immature). LI: ORIENT 7 Jl 1959, on roots of *Rumex obtusifolia* and *Erigeron canadensis;*

MATTITUCK 16 Oct 1959, on roots of *Aster laterifolius* and *A. simplex*, (Latham coll).

Essig, in Hilgardia 1(9): 473, 1938, states that this species occurs in New York although the source of this information is not given.

Aphis asclepiadis Fitch

Fitch, as a n. sp. in Cat. Homop. N. Y., p. 65, 1851: "on lower surface of young leaves of the common silk-weed. No. 845, male." Three slides from Fitch collection are in the USNM.

SHERIDAN Jl 1905, 1906, on *Asclepias syriaca* (*cornuti*), (Hayhurst coll). GENEVA 1 Jl 1909, on *Asclepias* sp., (Gillette, J. E.E. 3(5): 404, 1910). EAST AURORA 10 Aug, ITHACA 12 Aug 1933, on milkweed, (Leonard and Crosby coll). ITHACA 14 Jl 1939, on *Asclepias syriaca*, (L. Cutcomp coll—Essig and Griswold det), 1934, on *Apocynum cannabinum*, (Nellie C. McAllister coll—Patch det; Me. Agr. Exp. Sta. Lot Book). LYNDONVILLE 5 Jl 1960, on *Asclepias syriaca*, (Pechuman coll—det CFS with query). LI: BRIGHTWATERS 13 Jl 1934 on *Asclepias* sp., (Blanton coll; in USNM); GREENPORT Ju 1958, Jl 1959, ORIENT 1 Jl 1958, on *Apocynum cannabinum*, 3 Jl 1959, on *Asclepias syriaca*, and MATTITUCK 18 Ju, 2 Jl 1959, on *A. syriaca*, (all Latham coll).

Aphis asterensis Gillette and Palmer Little Black-veined Aster Aphid

LI: GREENPORT 17 Jl 1957, on *Aster novae-belgi* in flowerheads, (alates and apterae; Latham coll). This beautiful little aphid is presumably recorded elsewhere only from Colorado on *A. ericoides*, rather rare.

Aphis cephalanthi Thomas

W. SHELBY 6 Sept, TONAWANDA INDIAN RES. Erie Co. 9 Aug, 3 Sept, LOCKPORT 1 Oct, GASPORT 24 Sept and BARRE Burma Woods 1960, all on *Cephalanthus occidentalis*, (all Pechuman coll—CFS det). LI: WADING RIVER 30 May 1913, on *C. occidentalis* (Olsen coll); SOUTHOLD 11 Aug, EAST HAMPTON 8 Sept, SAG HARBOR 8 Sept 1946, GREENPORT 27 Sept 1957, 27 Jl 1958, ORIENT 31 Jl (on twigs), RIVERHEAD 11 Ju, AQUEBOGUE 11, 17 Jl and FLANDERS, EAST QUOGUE 17 Jl 1959, all on *C. occidentalis*, (all Latham coll).

Aphis cerasifoliae Fitch Chokecherry Aphid

TYPE from Fitch Collection (as *A. cerasivora* Fitch) on 1 slide in the USNM, mounted by Pergande. Described as a new species by Fitch in First and Second Reports, p. 131, 1856.

NYL – gives ALBANY Ju, in addition to several of the localities listed in more detail below.

GENEVA 29, 30 Ju 1909, "Very abundant on *Prunus pennsylvanica*", (Gillette, J. E. E. 3(5):405, 1910). ITHACA 8, 11 Ju 1914, common on chokecherry *Prunus virginiana,* curling the leaves severely, (Morrison coll). YONKERS 16 Ju 1927, on chokecherry, (J. L. Horsfall coll—MDL det).

Probably widely distributed in the State and often abundant on chokecherries, the leaves of the terminal twigs often being severely curled. By midsummer this aphid is said to leave the chokecherries on which it has spent the winter, and according to Quaintance and Baker (U.S. Farmers' Bull. 1128, p. 17, 1926 revise), migrate to grains and grasses where they remain until fall and then return to their winter plants. This aphid has been identified in New York only from chokecherry.

Aphis coreopsidis (Thomas)

SHERIDAN Aug 1905, on *Bidens frondosa,* (Hayhurst coll; also 3 slides in USNM, no date, det as *A. frondosa* Oestlund). ITHACA Sept 1930, on *Cosmos* sp., (Griswold coll—MDL det; 10 slides in CU), 4 Sept 1933, on *Bidens* sp., (Leonard and Crosby coll). LYNDONVILLE 17 Ju 1959, on *Nyssa sylvatica* "extremely abundant, tree and ground below soaked with honeydew", 20 Ju 1959, also on *N. sylvatica* "this aphid produces an interesting distortion and variegation of the foliage of the host plant", (both Pechuman coll). In checking determinations CFS notes that the *Nyssa* material is atypical—has long cornicles. WEST NYACK 10 Oct 1960, on *Bidens frondosa,* (Olsen coll). LI: MASPETH 2 Aug 1914, on *B. frondosa,* (Olsen coll); MATTITUCK 5 Jl 1946, ORIENT 11 Aug 1946, 4, 23 Jl 1958 and 3 Jl 1959 and GREENPORT 18 Jl 1959, all on *Baccharis halmifolia,* (all Latham coll); GREENPORT 28 Ju, 2 Aug 1958, ORIENT 5 Jl 1958, 26 Ju 1959, all on *Nyssa sylvatica,* (Latham coll); GREENPORT 18 Jl, ORIENT 30 Aug 1959, common on stems of *Bidens frondosa,* and ORIENT 10 Aug 1959, common on stems of *B. vulgata,* (Latham coll).

Aphis cornifoliae Fitch Dogwood Aphid

Fitch as n. sp. "On the under surface of the leaves of *Cornus paniculata* (now *racemosa*). No. 846, female." (Cat. Homop. N. Y., p. 65, 1851). A slide in USNM is labelled "Type – Fitch 846" and another slide is marked by Pergande (9020 – 157/3) as "Type, on *Cornus paniculata.*"

EAST AURORA 10 Aug 1933, on *Cornus* sp., BARRINGTON 9 Sept 1934, on *C. candidissima,* (Leonard and Crosby coll). N. FAIRHAVEN 2 Jl 1939 (Griswold coll—Essig det). ROCHESTER 11 Oct 1945, on *Cornus* sp., (F. L. Gambrell coll; 1 slide in USNM). LYNDONVILLE 20 Jl 1959, on *C. rugosa,* (Pechuman coll). LOCKPORT 1 Oct 1960, on *C. stolonifera,* (Pechuman coll—CFS det).

Aphis coweni Palmer?

LI: GREENPORT 6, 28 Ju 1958, 22 Jl 1960, on *Veratrum viride,* (Latham coll—MDL det).

Aphis craccivora Koch Cowpea Aphid

Recent studies by European workers indicate that *Aphis medicaginis* Koch, the Cowpea Aphid, has been misidentified in American collections and that all such records should be assigned to *A. craccivora* Koch, since *A. medicaginis* occurs only in Europe. In further support of this Dr. Clyde F. Smith wrote me on Oct. 3, 1960 that he had checked all of his material of *"medicaginis"* from legumes, as well as other hosts, against the key by Eastop in his paper; "A Study of the Aphididae of East Africa" (1958), and "according to this key, all of my material falls into *craccivora*." Therefore all records of *medicaginis* in New York have been transferred to *craccivora.*

West Nyack 26 May 1959, on a golden chain tree *Laburnum anagyroides* (*vulgare*), 7 years in garden, (Olsen coll—MDL det). Ithaca Dr. Gyrisco of Cornell University wrote in April 1961 that this aphid gives trouble on *Lotus* spp. in the greenhouse but that he has never seen it on *Lotus* in the field. Ithaca CU campus 4 Jl 1959, on *Chenopodium album*, (Graham coll—det MDL with query). Ilion Aug 1960, a heavy infestation on *Ch. album* growing in a cabbage-cauliflower field, (A.A. Muka—MDL det). SI: New Brighton 31 Aug 1943, on *Gleditsia trichanthos*, (Tuthill coll—Mason det; Sp Port Surv). LI: Riverhead 20 Jl 1933, on lima beans, (Leonard coll—det Tissot as *laburni* Kalt.); Peconic Bay 5 Aug 1943, on lima beans, (Anderson coll—Mason det; Sp Port Surv); Carle Place 1 Oct 1943, on *Bouvardia* sp., (Plummer coll—Mason det); Jackson Heights 30 Ju 1939, abundant on *Deutzia scabra*, (MDL coll); Orient 22 Jl 1958, 18, 30 and 31 Jl 1959, on twigs of *Robinia pseudaccacia*, (Latham coll—MDL and CFS det); Orient 31 Jl 1959, on *Thalictrum revolutum*, 23 Jl 1960, on branches of *Mirabilis jalapa*, 1 Dec 1960, on flowers of *Lepidium virginicum*, and 20 Jl 1960, on lima beans "whole plants covered", (all Latham coll); Babylon 3 Jl 1938, on *Chenopodium album*, (Ed. Kurtz coll; slide in USNM); Mineola 18 Jl 1917, on beans (Gerson Garb coll—Patch det; Me. Agr. Exp. Sta. Lot Book); E. Marion 1 Jl 1959, on *Ch. album*, (Latham coll); Greenfort 26 Jl, Orient 23 Jl 1959, on twigs of *Robinia viscosa*, 29 Jl 1960, common on tips of branches of *R. pseudaccacia*, 22 Jl 1960, on lima beans, and 28 Jl 1960, on twigs of *R. pseudaccacia*, (all Latham coll); Orient 18, 30 Jl 1959, on *R. pseudaccacia*, (Latham coll—CFS det); Riverhead 12 Aug 1959, on tips of bracts of *R. pseudaccacia*, (Latham coll); Shelter Id. 28 Jl 1960, on *Trifolium arvense*, (Graham coll—CFS det).

The "Cowpea Aphid" has been collected at only two localities in western New York (Ilion and Ithaca) but has been taken in the lower Hudson River Valley (West Nyack), on Staten Island and a number of times on Long Island. It is probably distributed throughout the state since it has a number of widely differing food plants. It has not been collected on cowpeas in New York, nor for that matter, has any other aphid. Slides in the USNM indicate this aphid to be widely distributed in the United States and that it occurs widely also in the rest of the world.

Aphis crataegifoliae Fitch — Long-Beaked Clover Aphid or Hawthorn Aphid

Fitch, as n.sp. "On the leaves of *Crataegus punctata,* corrugating them. No. 847, male." (Cat. Homop. N.Y., p. 66, 1851).

ITHACA 20 Sept 1918, on *Crataegus macrosperma,* (Wellhouse coll—Patch det; in Me. Agr. Exp. Sta. Lot Book), 19 Oct 1932, 18 Sept 1934, on *Crataegus* sp., (Leonard and Crosby coll). FREEVILLE 10 Oct 1932, BARRINGTON 19 Sept 1934 and CAYUTA LAKE 13 Sept. 1934, all on leaves of *Crataegus* sp., (all Leonard and Crosby coll).

"In early May 1918 the *Crataegus coccinea* trees at Ithaca began to show the terminal rosettes of curled leaves caused by *Aphis crataegifoliae.* The rosettes turned red and the aphids within them were also red. The infested branches remained deformed and somewhat stunted throughout the season, although the aphids departed from the trees about May 20 to seek leguminous hosts. No aphids of this species were observed the next year." (W. H. Wellhouse, Cornell Univ. Agr. Exp. Sta. Mem. 56, p. 1064, 1922).

Aphis decepta Hottes and Frison

MCLEAN 15 Sept 1934, a "drift on *Cornus* sp., (Leonard and Crosby coll).

Aphis euonymi Fabricius

LI: ORIENT 29 May 1925, on *Oenothera biennis,* (Latham coll—Mason det; in USNM).

Aphis fabae Scopoli — Bean Aphid

This black aphid is widespread and at times is abundant on a number of kinds of plants in New York. For many years it was identified as *A. rumicis* until it was shown that the latter is confined to dock, *Rumex* spp..

Records in the Insect Pest Survey files of the U.S. Dept. of Agriculture indicate that it has been observed in New York on lima beans for more than 40 years and that in some seasons during that period it has been moderately to sometimes very injurious in Erie, Wayne, Livingston, Cayuga, and Nassau Counties and especially so in Suffolk County. Its occurrence on other kinds of beans has been but rarely recorded. Among its more favored food plants, on which it often becomes abundant, are burdock, lamb's quarters or pigweed and *Euonymus.* It can usually be found to some extent on the stems and flowers of garden nasturtiums to which it often becomes injurious, especially in the latter part of the season. Latham states that it is very common on *Yucca filamentosa* all over Eastern Long Island.

Fitch, in his 13th report, on pp. 495–512, 1870, gives a long account of "the bean aphis, *Aphis rumicis* L." This consists mostly of its activities in England on various plants. Assuming that records on plants other than *Rumex* refer to *A. fabae* Scop. the following New York notes by Fitch are quoted:

"I suppose this to be also the aphis which sometimes invades our buckwheat, *Polygonum fagopyrum* Linn?, *Fagopyrum esculentum* of our present botanists [now called *F. saggittatum*], completely covering particular stalks of this grain and so exhausting them of their juices that probably none of their kernels become filled. The middle of September 1866 a letter from the late Robert Howell of Nichols, Tioga County, stated that in that vicinity many of the stalks of the buckwheat were then covered with aphids, which were of different sizes, some of them having wings. [The only other record on buckwheat in New York is by Crosby, who reported that this aphid was badly infesting buckwheat at Elmira in Sept 1925].

"Upon that common weed in our gardens and plowed fields, the pigweed *Chenopodium album*, it has occurred to my notice very much oftener than on any other plant. During the latter part of the season a slight search anywhere will usually reveal some of these weeds infested with these aphids . . . crowded compactly together and covering all the upper part of the stalks . . . .

"Shepard's Purse, *Thlaspi* (*Capsella*) *bursa-pastoris*. Next to the pigweed I have most frequently met with this insect upon this plant. The stalks of this weed and the underside of its leaves may be frequently seen towards the close of the summer, coated over and black with lice; ants also being usually present with them.

"An aphis has infested a thrifty young burning bush or spindle tree *Euonymus americanus* growing in my yard [Salem, N.Y.] whereby I have enjoyed a most favorable opportunity for studying it and observing its habits the whole season through. It is clearly the species named *Aphis euonymi*, by Fabricius . . . and it is also the *Aphis rumicis*, the insect now under consideration."

Dr. Fitch describes in great detail the peculiar and characteristic manner in which this aphid distorts the leaves.

The bean aphid has been recorded from a little over 50 plants in New York. About half of these are from Long Island, due mostly to Latham's collecting. On all but about 10 of the total plants this aphid has been recorded only once or twice. The food plants are as follows:

Arctium lappa, A. minus, Armoracia lapathifolia (horseradish), *Atriplex patula, Beta vulgaris* (beet), *B. vulgaris* var. *cicala* (Swiss chard), *Brassica napobrassica* (rutabaga), *Calendula* sp., *C. officinalis, Campsis radicans, Capsella bursa-pastoris, Celastrus orbiculatus, C. scandens, Chenopodium* sp., *Ch. album, Cosmos* sp., *Cynara cardunculus* (cardoon), *Dahlia* sp., *D. pinnata, Daucus carota* var. *sativa* (garden carrot), *Erechtites hieracei-folia, Euonymus* sp., *E. atropurpureus, E. europaeus, Fagopyrum saggitatum* (buckwheat), *Gladiolus* sp., *Hibiscus moscheutos, H. syriacus, Hypericum* sp., *Lepidium virginicum, Ligusticum scothicum, Malus pumila* (apple), *Matricaria matricariodes, Onopordum acanthicum, Phaseolus lunatus* (lima bean), *Ph. vulgaris* (kidney bean), *Philadelphus hirsutus* var. *intermedius, Philadelphus* sp., *Polyanthes tuberosus, Polygonum aviculare, P. cuspidatum, Rheum rhaponticum* (rhubarb), *Sambucus canadensis, Sium* (*cicutaefolium*) *suave, Tithonia* (*tagetiflora*) *rotundifolia, Tropaeolum majus, Valeriana officinalis, Viburnum lentago, V. opulus, V. opulus* var. *americanum, V. plicatum, Yucca filamentosa* and *Tulipa* sp. (in greenhouse).

Aphis feminea Hottes (*tuberculata* Patch) Red and Black Cherry Aphid

This colorful and rare little aphid was described from Maine (in Me. Agr. Exp. Sta. Bull. 233, p. 261, 1914). As far as I know it has been reported elsewhere only from Mass., D. C. and Ill..

SI: 31 Aug 1943, on bark of *Prunus serotina*, (C. S. Tuthill coll—det

Mason as *tuberculata* with query; Sp Port Surv; 1 slide in USNM). LI: BAY VIEW 10 Oct 1960, clustered thickly around the young stems of *P. serotina,* ("no alates; red with black heads and look like very young potato beetle larvae; none on leaves"; Latham coll).

Aphis folsomii Davis

ITHACA 12 Ju 1939, on Virginia Creeper *Parthenocissus tricuspidata,* (Hansberry coll—Essig det; in CU).

Aphis forbesi Weed Strawberry Root Aphid

LI: MASPETH 13 Ju 1914, on *Fragaria virginiana.* "This was found abundantly scattered in a strawberry patch in common with *Myzus fragaefolii* Ckll." (Olsen coll).

Aphis frangulae Kaltenbach

LI: RIVERHEAD 21 Jl 1933, on *Nepeta cataria,* (Leonard coll—det Tissot as *A. rhamni* Boyer).

Aphis gossypii Glover Cotton Aphid, Melon Aphid

This plain little aphid is yellowish-green to dark mottled green in its wingless stages and only about 1 to 1.8 mm. in length.

It can undoubtedly be found in every part of the state and is a serious pest of cucumbers and melons; in some seasons it does great damage to commercial plantings of these crops. It has also been recorded as severely infesting celery. When infesting greenhouse crops it is known as the familiar "black fly". Eastop stated in "A Study of the Aphididae (Homoptera) of East Africa", p. 73, 1958, that throughout its world-wide range this aphid has been recorded as a vector of about 40 plant virus diseases.

The method of spending the winter of this common and widespread aphid was unknown until recently when Kring (Ann. Ent. Soc. Am. 52 (3): 284–286, 1959) working in Connecticut, was able to show that it overwinters as eggs on catalpa and rose-of-sharon but it has been found on these plants in New York only during the active growing season. In this connection the following note by the writer is of interest: Washington, D.C., on 30 April 1959 a long, head-high rose-of-sharon hedge still had, since the first growth in mid-April, almost every terminal shoot with young leaves encrusted with this aphid; only an occasional alate was present. Two-spotted ladybird beetles were abundant. On Nov 20 1961 a few sexual alate males and wingless oviparous females were found on the underside of some of the few leaves still remaining on this hedge.

The melon aphid has been collected on at least 40 plants in New York. All except about 10 of these represent one collection each and, except for melon and cucumber, on the rest the aphid has been taken only from 2 to 5 or 6 times. Besides on melons and cucumbers the melon aphid has been collected about 60 times in New York. Of these, almost 40 collections have been made on Long Island, mostly by Latham, from about half as many plants. The remaining 20 or so have been made on about as many plants. There follows a list of the food plants within New York:

Ambrosia sp., *Anthemis cotula, A. tinctoria, Apium graveolens* var. *dulce* (celery), *Asclepias syriacus, Begonia* sp., *B. semperflorens, Brassica* *oleracea* var. *gonglyodes* (kohlrabi), *Capsella bursa-pastoris, Catalpa bignonioides, Chenopodium album, Chrysanthemum* sp., *Cicuta maculata, Citrullus vulgaris* (watermelon), *Cucumis melo* (muskmelon), *C. sativa* (cucumber), *Cucurbita maxima* (squash), *C. moschata* (cushaw), *C. pepo* (pumpkin), *C. pepo* var. *ovifera* (a gourd), *Dahlia* sp., *Daucus carota* var. *sativa* (garden carrot), *Erigeron canadensis, Eupatorium aromaticum, E. maculatum, E. purpureum, Galium aparine, Gerbera* sp., *Hibiscus esculentis* (okra), *H. syriacus, Lycopersicon esculentum* (tomato), *Petroselinum crispum* (parsley), *Phaseolus lunatus* (lima bean), *Philadelphus hirsutus* var. *intermedius, Plantago lanceolata, Pyrus communis* (pear), *Raphanus sativus* (garden radish), *Valeriana officinalis* and *Zanthoxylon americanum.*

Aphis helianthi Monell

NYL – ITHACA [1913 or 1914], on sunflower, (Morrison); BLISSVILLE Oct, Nov, on *Helianthus rigidus.* Probably widely distributed.

ITHACA 1913 or 1914, on *Helianthus* sp., probably the cultivated sunflower, curling the leaves very badly and was thickly clustered over the undersides; presumably the first record for the state, (Morrison coll): 9 Sept 1935, on *H. annuus,* (CU).

LI: BLISSVILLE 17 Oct 1914, 6 Sept 1913, on *Helianthus rigidus,* (Olsen coll). The name *H. rigidus* cannot be substantiated.

Aphis heraclella Davis? Wild Parsnip Aphid

LYNDONVILLE 1 Jl 1959, on *Heracleum lanatum* very abundant on a single leaf, (Pechuman coll—det MDL with query). LI: ORIENT 24 Sept 1957, on *H. lanatum,* (Latham coll—det MDL with query).

Aphis illinoisensis Shimer Grapevine Aphid

NYL – TROY Jl (Leonard), MIDDLETOWN Aug (Chapman).

MIDDLETOWN Ju 1921, on grape, (CU coll—Tissot det). ITHACA 24 Aug 1938, on grape, (Crosby coll). ALBANY Co. 13 Jl 1935, on wild grape, (Wilcox; in NYSM). MILTON 13 Jl 1938, on *Vitis* sp., (J.A. Evans coll). YONKERS 16 Ju 1927, on grape, (J. A. Horsfall coll). LI: MASPETH Ju, Jl 1913, 1914 "Sometimes injurious to grape" (Olsen coll); BABYLON 1932–4, on grape, (Blanton coll—Mason det), 3 Jl 1939 (Kurtz coll; in USNM); BROOKLYN Jl 1933 (Sigalow Bros. coll; in USNM); MATTITUCK 11 Jl 1959, GREENPORT 14 Sept 1958, on *V. aestivalis,* and GREENPORT 2 Aug 1959, on *V. labrusca,* (all Latham coll). KINGS PARK, PORT JEFFERSON STATION 10, 12 Aug 1943, on young stems and leaves of grape, (J. A. Herrick coll—Mason det; Sp Port Surv).

This large dark brown aphid infests the tender shoots and leaves of the grape and sometimes the fruit clusters, which may cause the berries to drop. It is undoubtedly found throughout the state on the cultivated grape and wild species of *Vitis* but apparently is not of much economic importance. According to Baker (Jour. Agr. Res. 11(3): 184, 1917) it spends the winter in the egg state on the black haw, *Viburnum prunifolium*, but the spring forms have not been identified from this plant in New York.

Aphis impatientis Thomas

Although Hottes and Frison (Aphiidae of Illinois, p. 185, 1931) give this as a synonym of *A. cephalanthi* Thomas, Clyde F. Smith considers it as distinct.

ITHACA 13 Sept 1934, TAUGHANNOCK 4 Sept 1933, on *Impatiens* sp., (Leonard and Crosby coll). GASPORT 24 Sept (7 collections), W. SHELBY 6 Sept, LYNDONVILLE Jl 15, Sept 2, TONAWANDA INDIAN RES. Erie Co 18 Sept, 8 Oct and BERGEN SWAMP Genesee Co. 2 Aug, all 1960, on *I. biflora*, (all Pechuman coll—CFS det). LI: GREENPORT 2 Aug 1959, in clusters on underside of leaves, 30 Sept 1960, on *I. biflora*, (Latham coll); SOUTHOLD 11 Oct 1960, on *I. biflora*, (Latham coll—CFS det).

Aphis ligustici Fabricius ?

LI: ORIENT 4 Oct 1959, on *Ligusticum scothicum*, (Latham coll—det MDL with query).

Aphis maculatae Oestlund

SHERIDAN Jl 1905, on *Salix* sp., (Hayhurst coll). ITHACA 12 Aug 1933, on poplar leaves and shoots, (Leonard and Crosby coll). LI: BROOKLYN 12 Jl 1921, on *Populus* sp., (L.C. Griffith coll; 1 slide in USNM labelled as *A. davisi* Patch); HEMPSTEAD PLAINS 6 Jl 1941, on *Populus* sp., (AMNH).

Aphis medicaginis Koch — Cowpea Aphid

See *A. craccivora* Koch.

Aphis monardae Oestlund

ITHACA 10 Ju 1938, on *Monarda didyma*, (V.T. Phillips coll—Essig det). LOCKPORT 14 Ju 1958, on *M. fistulosa*, (Pechuman coll—MDL det).

Aphis nasturtii Kaltenbach (*rhamni* Fonsc., *abbreviata* Patch) — Buckthorn Aphid

ITHACA Oct 1936 (Hayhurst coll), 18 Sept 1934 (Leonard and Crosby coll) and 30 May 1938 (Griswold coll), on *Rhamnus cathartica*; Ju, Jl 1952, alates "near potato fields", (S. H. Kerr coll). WILLIAMSON 24 Sept 1924, on celery, ("There are many more of these aphids than I have ever seen, which probably accounts for an increase in celery mosaic over the previous season."; Crosby coll—Mason det). GENEVA 19 Oct 1946, 29 Oct 1949, on *Rh. cathartica*, (Chapman coll; slides in USNM). RINGWOOD Tompkins Co. 10 Sept 1934, on *Epilobium coloratum*, (Leonard and

Crosby coll). CAYUTA LAKE 13 Sept 1934, on *Crataegus* sp. leaves, (alates only; Leonard and Crosby coll). CROSBY 13 Sept 1934, on *Oenothera biennis,* (Leonard and Crosby coll). BARRINGTON 19 Sept 1934 on *Crataegus* sp. leaves, (alates only; Crosby coll). YONKERS Nepera Point 23 Sept 1931, on *Dahlia* sp., (Philip Brierley coll). NEW YORK N.Y. Botanic Gardens Jl, Aug and Sept 1931, on *Dahlia* sp., (Philip Brierley coll; slides in USNM). LI: BAITING HOLLOW Wildwood State Park 23 Jl 1933, on leaves of cat brier *Smilax* sp., (a number of alates taken singly; M.D. and D. P. Leonard coll); RIVERHEAD 21 Jl 1933, on *Nepeta cataria,* (Leonard coll); PECONIC May 1959, on *Rhamnus cathartica,* (many alates included; coll by Latham, who writes: "Buckthorn is an extremely rare plant around here now. I have not seen a tree before in 30 years. It used to grow in woods near this farm [Orient Point] but the woods were cleared off years ago. I found this tree in the border of woods.")

The winter and spring host of this aphid is the buckthorn (*Rhamnus* sp.) from which the migrant forms spread in the spring to a large number of summer food-plants, only a few of which have been determined as hosts to this aphid in New York.

Dr. Karl H. Fernow, Dept. Plant Pathology, Cornell University, wrote me in October 1961 that this aphid "is not very often encountered on potatoes, but I have seen rather severe infestations in the neighborhood of low swampy areas." Two instances of such occurrence were near Waterloo on muck soil, where on 23 Aug 1926 he inspected a one acre field of early Ohios and noted: "Vines mostly dead. Impossible to detect disease. Aphids very abundant." In the same year and on the same date he inspected another field of 9 acres of Irish coblers and noted: "Conditions for inspection poor. Aphids very abundant. Counted 700 on one leaf. In another field, inspected the same date, I recorded aphids as few. This agrees with my recollection that the occurrence of this particular type of aphid was rather localized." It seems reasonably certain that Dr. Fernow is referring to the buckthorn aphid even though no specimens were preserved to substantiate this. Fernow says this aphid is a vector of leaf roll of potatoes in Maine but not a very efficient one because it does not move about much.

Aphis neogillettei Palmer

LYNDONVILLE 20 Jl 1959, on *Cornus rugosa,* (Pechuman coll—CFS det).

Aphis nerii Fonscolomb (*lutescens* Mon.) Oleander and Milkweed Aphid

ITHACA Sept 1921, on oleander, (Leonard coll—Baker det; in USNM). MEDINA 8 Jl 1959, on *Asclepias syriaca* "abundant on flowerheads, a few on leaves", (Pechuman coll—MDL det). LI: WINFIELD 8 Ju 1913, on *A. syriaca,* (Olsen coll).

Aphis nostras Hottes

ITHACA Brooklawn, CAYUGA HEIGHTS 4 Aug about 1914, on joepye-weed *Eupatorium maculatum,* (O. A. Johannsen coll—Patch det; in Me. Agr. Exp. Sta. Lot Book as *Aphis eupatorii* Oestl. to which Hottes gave the name *A. nostras* in his "Homonyms"—Biol. Soc. Wash. Proc. 43:180, 1930). This appears to be only the second record of this aphid.

Aphis oenotherae Oestlund

FREDONIA no date but year is probably 1905, on *Oenothera biennis,* (Hayhurst coll; 1 slide in USNM). GRAND ISLAND Erie Co. 2 Ju 1959, GENESEE Co. 4 Aug 1959, on *Oenothera* sp., (Pechuman coll—CFS det). CATSKILL 17 Jl 1959, on *Oenothera* sp., (J. A. Wilcox coll—MDL det). LI: MATTITUCK 5 Jl 1946, 18 Ju 1959, GREENPORT 22 Sept 1957, 28 Ju, 25 Sept 1958 and ORIENT 24 Ju 1959, all on *O. biennis,* (Latham coll).

Aphis oestlundi Gillette

FREDONIA Ju 1904 or 1905, on *Oenothera biennis,* (Hayhurst coll). TAUGHANNOCK 4 Sept 1933, on *O. biennis;* ITHACA Forest Home 4 Sept 1934, on *Oenothera* sp., (Leonard and Crosby coll). LYNDONVILLE 20 Jl 1959, BARRE Burma Woods 22 Ju 1960, on *Oenothera* sp., (Pechuman coll—CFS det). MT. KISCO 21, 22 Aug 1960, on *Oenothera* sp., (Graham coll—CFS det).

Aphis pomi DeGeer — Apple Aphid

The earliest record for New York is by Fitch as follows: "*Aphis mali* (Fab). Common on the underside of the leaves and the tips of the young branches of the apple tree." (Cat. Homop. N.Y., p. 65, 1851). There are 5 slides in the USNM numbered 9749 from apple from the Fitch collection.

The next specific one is by Sirrine (14th Rept. N.Y. (Geneva) Agr. Exp. Sta. for 1895, p. 602, publ. 1896), who in reference to Long Island says: "The Apple Louse (*Aphis mali*) has occurred in injurious numbers on apple, quince, hawthorne and Spiraea. Messrs. Kearne and Foulk of Flushing treated part of their apple stock."

A note which undoubtedly refers to the apple aphid in New York is given by Chapman and Avens (J.E.E. 41(2):190, 1948) who state that Lodeman (N.Y. (Cornell) Agr. Exp. Sta. Bull. 60:292–293, 1893) conducted spraying experiments against "the common green plant louse" on quince. There is a slide in the USNM presumably by Pergande from Zena, 7 Jl 1897, from apple.

Central New York (W. H. Wellhouse, "The Insect Fauna of the Genus Crataegus", Cornell Univ. Agr. Exp. Sta. Mem. 56, p. 1065, 1922): "During June and July the succulent sprouts of European and native hawthorns are badly infested by green apple aphids. Whenever the weather becomes unfavorable for their enemies they increase rapidly and infest entire trees or hedges, but fair weather checks them again."

The apple aphid is undoubtedly present wherever apples grow and often does considerable injury in commercial apple orchards, so that control measures are required every season. The aphids infest the tender terminal growth, causing the leaves to curl. In young orchards the leaves and shoots may be so infested that growth is checked. Much damage is done to apple nursery stock in this way. The entire year may be spent on the apple although in the summer many of the winged aphids migrate and produce summer colonies on several other plants, chiefly *Crataegus* spp., *Prunus* spp., pear and certain other Rosaceae.

Dr. P. J. Chapman, Entomologist of the New York (Geneva) Agricultural Experiment Station, gave me the following statement (Jl 1961) as to this aphid in respect to apples in New York: "The apple aphid, *Aphis pomi* DeG. is generally distributed and present almost every year on nursery stock and in commercial apple plantings that are maintained in a strong vegetative state; often requiring control measures in midsummer."

Available records as to the occurrence of this aphid on plants other than the apple are as follows:

TONAWANDA INDIAN RES. Genesee Co. 5 Jl 1958, on *Malus coronaria*, (Pechuman coll—MDL det). LOCKPORT 31 May 1959, on Van Eseltine crab *Malus* sp., 6 Ju 1959, on Bechtel's crab *M. ioensis* var. *plena*, (Pechuman coll—MDL det). LYNDONVILLE 1 Jl 1959, on *Mespilus germanica*, (Pechuman coll—MDL det). OWLENBERG Catt Co. 20 Ju 1959, on chokecherry *Aronia melanocarpa*, (Pechuman coll—MDL det). WEST NYACK 7 Aug 1947, on flowering quince *Chaenomeles* sp., (Olsen coll—MDL det). HAMLIN 2 Aug 1959, on pear, (Muka coll). MCLEAN 27 Ju 1959, on *Aronia arbutifolia*, (Hansberry coll—MDL det). LI: WESTBURY 11 Jl 1934, on crab apple, (Blanton coll; in USNM); ORIENT 25 Ju 1946, on *Crataegus intricata*, 23 Ju 1958, on *Pyrus communis*, 21 Ju, on *Malus baccata*, 22 Ju 1959, on crab apple *Malus* sp., 30 Ju 1959 (many specimens), on *Sorbus americanus*, 11 Ju 1960, on *Crataegus chrysocarpa*, and 28 Ju 1960, on new leaves of pear, GREENPORT 21 Ju 1959, on pear, 20 Aug 1960, on twigs and new leaves of *Cydonia oblonga*, (all Latham coll).

Aphis sp. near **pomi** DeGeer

LYNDONVILLE 15 Jl 1960, on *Clethra barbincovis*, (Pechuman coll—CFS det). "From terminal touching apple tree with infestation of green aphids; if this is same aphid as on apple, mother aphid may have made a mistake but colony large and apparently doing very well." (Note by Pechuman).

Aphis pseudohederae Theobald — Ivy Aphid

NEW YORK May 1933, on ivy plants in a window box, (Mrs. B. Blanks coll; 1 slide in USNM). LOCKPORT 19 Oct 1958, 13 Sept 1959, on *Hedera helix*, (Pechuman coll—MDL det). SI: CASTLETON CORNERS 7 Nov 1960, on *H. helix*, outdoors, (Rundlett coll—MDL det). LI: BABYLON 7 May 1932, Ju 1933, on English ivy, (Blanton coll); WANTAUGH 10 Apr 1948, on *H. helix*, (F. F. Smith coll; 1 slide in USNM).

Not too common in this country.

Aphis rociadae Cockerell — Russet-colored Larkspur Aphid

LOCKPORT 5 Jl 1958, 11 Jl, 11 Oct 1959, on *Delphinium* Cult., (Pechuman coll).

Aphis rubicola Oestlund

NYL – ASHOKAN RESERVOIR, Ju [1920 or 1921], abundant on wild raspberry plants affected with mosaic, (Leonard and Crosby coll—det Patch as *Rhopalosiphum rubiphila*).

GENEVA 30 Mar 1923, on cultivated red raspberry in greenhouse, (det Patch as *A. rubiphila* which Louise Russell determines as *A. rubicola;* slide in Me. Agr. Exp. Sta.), 14 May 1925, on cultivated red raspberry, (Rankin coll—LMR det). ERIE Co. Aug 1928, reported by M.N. Taylor as less abundant than usual and in Nov. 1932 Crosby and Taylor reported no severe damage to raspberries in Erie Co. during the year (Insect Pest Survey Reports to USDA). ITHACA 3 Ju 1939, on *Rubus idaeus, R. idaeus* var. *strigosus,* (Griswold coll), 23 Ju 1939, on *R. idaeus,* (Hansberry coll).

ULSTER Co. 5 Jl 1925, on red raspberry, (Rankin coll—LMR det). TONAWANDA INDIAN RES. 3 Jl 1959, on *R. occidentalis,* (Pechuman coll—det LMR with query). POUND RIDGE Westchester Co. Aug 1960, on *Rubus* sp., (Graham coll—det LMR with query).

During a study of raspberry mosaics in western New York (1931–35) it was found that *A. rubicola* was the sole vector of the leaf curl diseases. These diseases, however, were rather rare. In the wild brambles only four widely separated instances were found: three in red raspberries (*R. idaeus* var. *strigosus*) and one in black raspberries (*R. occidentalis*). (L. M. Cooley, N. Y. (Geneva) Agr. Exp. Sta. Bull. 665:10, 1936).

Aphis rubifolii (Thomas)

ITHACA 6 Aug 1933, badly curling blackberry leaves, (MDL coll—Tissot det). ALTAMONT 28 Aug 1937, on blackberry, (Griswold coll—Essig det). SCARSDALE 31 Aug 1958 (Olive coll—CFS det). POUND RIDGE Westchester Co. Aug 1960, on *Rubus* sp. in tightly curled leaves, (Graham coll). LYNDONVILLE 14 Sept, 29 Oct 1959, on blackberry, (Pechuman coll—det LMR with query). LI: MASPETH 28 Ju 1914, on wild blackberry *Rubus* sp., (Olsen coll—Patch det; verified by LMR); MATTITUCK 16 Oct 1959, on *R. laciniata,* (Latham coll—det LMR with query); ORIENT 15 Jl 1946, on *R. frondosus,* CALVERTON 31 Aug 1946, on *R. argutus,* (Latham coll); RIVERHEAD 7 Jl 1933, bad curling of blackberry leaves in a good sized patch, (MDL coll—Tissot det).

This minute yellowish green aphid is widely distributed in New York. It twists and curls the leaves of both cultivated and wild blackberries, sometimes injuring the foliage to a considerable extent.

Aphis rumexicolens Patch

LI: BABYLON 23 May 1933, on *Rumex* sp., (Blanton coll—Tissot det).

Aphis rumicis Linnaeus — Dock Aphid

The earliest record of this aphid in New York appears to be by Fitch. In his Thirteenth Report he included in a long account of the "bean aphid", pp. 495–512, 1870: "I have seen the stalks of *Rumex acetosella*, the common field sorrel or "red top" of the country, covered with it."

Although this black aphid is probably widely present on its exclusive food plants, species of *Rumex* which it often heavily infests, the only available records are the following:

ITHACA Sept 1945, on *Rumex crispus*, (H. Aburto coll; in CU). ALBANY 27 Sept 1951, on *R. crispus*, (J. A. Wilcox coll—MDL det). LOCKPORT 6 Ju 1959, on *R. crispus*, (Pechuman coll). SHACKELTON POINT Oneida Co. 10 Jl 1959, on *R. obtusifolius*, (Graham coll). SI: CASTLETON CORNERS 19 Nov 1960, on *R. crispus*, (Rundlett coll). LI: BABYLON May 1932, Ju 1933 and 5 May 1934, on *Rumex* sp., (Blanton coll); ORIENT May 1946, on *R. crispus*, 26 Ju 1946, 18 Sept 1957, on *R. obtusifolius*, 24 Ju 1959, on *R. crispus*. RIVERHEAD 6 Ju 1949, on *R. obtusifolius*, (all Latham coll).

Aphis saliceti Kaltenbach — Green and Pink Willow Aphid

GENEVA 30 Ju (sexual forms; Gillette coll; Can. Ent. 50:89, 1918). ALBANY 1 Jl 1909, on willow as *A. salicicola* Thos., (Gillette, J.E.E. 3(5): 403, 1910). ITHACA 9 Ju 1924, on *Salix* sp., (Hebert Pack coll—Patch det; Me. Agr. Exp. Sta. Lot Book). LI: ORIENT 16 Sept 1946, on *S. lucida*, MANORVILLE 12 Ju 1948, on *S. humilis*, (Latham coll).

Aphis sambucifoliae Fitch — Elder Aphid

As a n.sp. "on the underside of the leaves of the elder. No. 850, male." (Fitch Cat. Homop. N.Y., p. 66, 1851).

ITHACA 13 Sept 1933 (Crosby coll), 18 Sept 1934 (Leonard and Crosby coll), both on *Sambucus canadensis*; 6 Oct 1937, on *S. racemosa*, (Griswold coll—MDL det). LI: ORIENT 18 Oct 1947, 3 Jl 1951 (slide in USNM), 17 Oct 1958 and 29 Jl 1959, on *S. canadensis*, (Latham coll); RIVERHEAD 30 Ju 1949, GREENPORT 7 Sept 1957 (alate viviparae and oviparae; Latham coll).

Aphis sanborni Patch — Green Gooseberry Aphid

E. WILLIAMSON 20 Sept 1933, 13 Oct 1933, on celery, (? Crosby coll—Tissot det). LI: MASPETH 20 May 1914, on *Sambucus canadensis*, (Olsen coll).

Patch who studied the biology of this aphid in Maine states that it alternates between *Ribes* and *Epilobium*. It is probable that our records on celery are only accidental.

Aphis sedi Kaltenbach — Sedum Aphid

ITHACA 26 Ju 1939, on *Sedum telephium* var. *purpureum*, (M. E. Phillips coll—Essig det; 2 slides in CU), Nov 14, 1935, on *S. hispanicum* in greenhouse, (Whetzel coll—det Tissot as *gossypii*). LI: ORIENT 26

Ju 1946, GREENPORT 7 Jl 1947, 8 Jl 1948, on *S. purpureum*, E. MARION 22 Jl 1960, on *S. telephium* var. *purpureum*, (all Latham coll).

In sending the Whetzel specimens for determination Crosby notes: "The lice were depositing many eggs among the leaves on *Sedum*. I looked the sample over very carefully under the microscope and was able to get only a single winged form."

Aphis near **signatus** Hottes and Frison

LI: GREENPORT 26 Jl 1959, on roots and base of stem of *Sanicula canadensis*, (Latham coll—MDL det).

Aphis solidaginifoliae Williams

ITHACA 13 Aug 1933, on *Solidago* sp., (Leonard and Crosby coll).

This aphid causes the leaves of goldenrod to fold longitudinally and become pod-like and since they retain their green color, infested plants are apt to be overlooked. It should be found in more localities in the state.

Aphis spiraecola Patch — Spiraea Aphid

The available detailed records are as follows: GENEVA, ALBANY and NEW YORK 29 Ju to 2 Jl 1910 (Gillette, J.E.E. 3(5):440, 1910). ITHACA 25 Ju 1937, 24 Ju 1938 and 19 Jl 1927, on *Spiraea vanhouttei*, (Griswold coll), 6 Ju 1939, on *S. prunifolia*, (Cutcomp coll). GENEVA 20 Oct 1946, abundant and ovipositing on *S. vanhouttei*, (Chapman coll—Mason det). SODUS 13, 14 Jl 1950 on ? wild cherry, (2 slides in USNM). REMSEN 11 Oct 1953, on *S. prunifolia* and *S. vanhouttei*, (G.N. Wolcott coll—Russell det). LOCKPORT 5 Jl 1958, 25 May 1959, on *S. vanhouttei*, (Pechuman coll). LYNDONVILLE 19 Ju 1959, on *Amelanchier laevis*, 1 Jl 1959, on *A. sanguinea*, *A. florida*, *Acanthopanax sieboldiana* and *Zanthoxylum americanum*, (Pechuman coll—CFS det). LI: ORIENT 26 Ju 1946, common on *Spiraea japonica*, 12 Ju 1946, on *Cosmos bipinnatus*, 6 Ju 1958, 26 May 1959, on *Spiraea vanhouttei*, 8 Jl 1959, on *S. bumalda* var. *Anthony Waterer* and 8 Jl 1959, on *Cosmos bipinnatus*, (Latham coll—some det CFS some MDL); GREENPORT 21 Sept 1957, on *Phytolacca americana*, 4 Jl 1959, on *Apocynum cannabinum*, and 23 Jl 1959, on *Spiraea bumalda* var. *Anthony Waterer*, (Latham coll); SOUTHOLD 16 Ju 1947 (common), E. MARION 27 Ju 1959, on *S. vanhouttei*, (Latham coll); MATTITUCK 4 Ju 1959, on *S. prunifolia*, 18 Ju 1959, on *Celastrus scandens*, (Latham coll—the latter det by MDL with query); BABYLON 10 Ju 1936, on *Spirea* sp., (Blanton coll; 1 slide in USNM).

G. N. Wolcott writes me it occurs also at Clinton, Whitesboro, Forestport, Boonville and Steuben Hill (presumably on *Spiraea* spp.).

This little greenish or yellowish-green aphid undoubtedly is generally distributed throughout the state. It occurs on a number of different kinds of plants but often becomes so abundant on the tender shoots and twigs of ornamental *Spiraea* as to interfere with the new growth and the flowers. It is so closely related to the apple aphid as to be almost indistinguishable in its viviparous forms. It is usually considerably smaller.

Aphis spiraephila Patch — Brown Spiraea Aphid

ITHACA 16 Ju 1939, on *Spiraea latifolia,* (T.R. Hansberry coll—Essig det; slides in CU).

Aphis varians Patch — Variable Currant Aphid

FREDONIA Ju 1905, on black currant, (Hayhurst coll).

Aphis vernoniae Thomas?

LYNDONVILLE 20 Jl 1959, on *Eupatorium maculata,* (Pechuman coll).

Asiphonaphis pruni Wilson

ITHACA 9 Jl 1937, on *Prunus virginiana,* (Essig coll—Griswold det).

Asiphum pseudobyrsum (Walsh) — Poplar Leaf-purse Gall

LI: ORIENT 26 Sept 1946 accidental since only 2 alate fundatrigenae were collected, on *Acer platanoides,* (Latham coll).

Brevicoryne brassicae (Linnaeus) — Cabbage Aphid

The earliest record of the cabbage aphid in New York is by Fitch (Cat. Homop. N.Y., p. 65, 1851) who states: "common on the underside of cabbage leaves". He later writes: "On the leaves of cabbage and rutabaga throughout the season. . . . J. L. Edgerton of Waverly, N.Y. states (Country Gentleman, July 1857, p. 80) that his patch of cabbage the year before, comprising 350 large, thrifty plants, were attacked by lice just before they were beginning to head, and in three weeks every plant was covered by the vermin, and he lost the whole. . ." (Eleventh Report, p. 55, 1867).

An early account of this injurious aphid in New York is by Herrick and Hungate (Cornell Univ. Agr. Exp. Sta. Bull. 300, 1911 entitled "The Cabbage Aphis"), who state: "In 1890, 1903 and 1908, this aphid was very numerous, widespread and destructive in New York, the year 1903 being particularly an aphis year. Moreover, our records show we received more inquiries during 1909 and 1910 regarding the cabbage aphis than any other insect pest. It was exceedingly abundant and seriously injurious in nearly all parts of New York State during the season of 1909. It appeared again in 1910, but did not prove nearly so injurious as during the preceding year. Not only were large numbers of cabbages actually destroyed by it, but many fields of cabbage were either abandoned or plowed up early in the season of 1909 from apparent inability to cope with the pest . . . ."

The cabbage aphid is undoubtedly generally distributed on plants of the family *Cruciferae.* It is seasonally or locally abundant on the cultivated species and often does great damage especially to cabbage, cauliflower, broccoli, and Brussels sprouts. Before the availability of modern insecticides and efficient equipment for applying them, in some seasons great losses were incurred by commercial growers of these crops. It also infests to some extent radish, kohlrabi, kale and rutabaga. Although it is known to infest turnip elsewhere, no definite record seems to be available on this plant for New York.

The winter is passed in the egg stage on old cabbage stumps and the tougher parts of other crucifers that remain in the field. The lice that hatch out in the spring migrate to the growing plants and the waxy colonies they establish may become so thick that in past years growers have often plowed them under early in the season.

Available records other than on cabbage are as follows: CROSBY 19 Sept 1934, on *Brassica nigra*, (Leonard and Crosby coll). ITHACA 14 Sept 1934, on *B. kaber* (*arvensis*), (Leonard and Crosby coll), 26 Aug 1938, on *B. napus* in greenhouse, (Griswold coll) and 3 Mar 1939, on *Mathiola incana*, (Griswold coll—MDL det). SKANEATELES 17 Sept 1934, on broccoli, (Leonard and Crosby coll). ERIE Co. 1957, on broccoli and cauliflower, (Muka coll). LOCKPORT 14 Aug 1959, on broccoli, 1 Oct 1960, on *Brassica nigra* and 5 Jl 1958, on *B. rapa*, (Pechuman coll). TONAWANDA INDIAN RES. Genesee Co. 3 Sept 1960, on *B. nigra*, (Pechuman coll—CFS det). LI: MASPETH 17 Sept 1913, on *Raphanus sativus*, (Olsen coll); ORIENT 28 Ju 1946 (common), 28 Nov 1957, 29 Sept 1958, 11 Ju 1959, 1, 8 Jan and 8 Nov 1960, common on Brussels sprouts, 16 Oct 1957, on *Brassica nigra*, 28 Nov 1957, on *Raphanus raphanistrum*, 12 Nov 1958, very common on broccoli, 13 Nov 1958, common on rutabaga, 11 Jl 1958, on *R. sativus*, 21 Jl 1959, on kohlrabi, 30 Aug 1959, 12 Jl 1960, on kale, and 1 Jl 1947, on *Thlaspi arvense*, (all Latham coll).

Calaphis alnosa Pepper

Described from many specimens at State College, Pa. in 1950. It is a rather small (about 1.5mm.), very pale green (alates) or creamy white apterae aphid with antennae and legs black. Dr. Pepper says that apterae adhere closely to the midrib and other larger veins on the underside of the leaves and are difficult to see.

TONAWANDA INDIAN RES. Erie Co. 29 Oct 1960, on *Alnus rugosa*, (Pechuman coll—Ole Heie det).

Calaphis betulae (Buckton)?

ALBANY Jl, GENEVA Ju 1909, probably this species and presumably on *Betula* sp., (Gillette in J.E.E. 3(4):369, 1910).

Calaphis betulaecolens (Fitch)

Aphis betulaecolens n.sp. "Birch inhabiting Aphis. No. 848, male." (Fitch, Cat. Homop. N.Y. p. 66, 1851).

BUFFALO, ROCHESTER, POUGHKEEPSIE, NEWPORT and GENEVA Ju 29, 30 1909, on *Betula pendula* var. *gracilis*, (by Gillette).

NYL – besides most of the foregoing reported also from E. GREENBUSH, KARNER Aug 1923, on gray birch, (Leonard coll—Patch det). NEWARK, CRANBERRY LAKE Ju, on yellow birch, (Osborn).

ITHACA 15 Ju 1937, on *Betula* sp., 9 Jl 1957, on *B. populifolia*, (Griswold coll—Essig det). GENEVA 1 Sept 1939, on *B. papyrifera*, (Griswold coll—MDL det). ALBANY 17 May 1930, on *B. populifolia*, (K. F. Chamberlain coll—MDL det). SODUS 14 Jl 1950, an alate on ? wild cherry, (S.H. Kerr coll—Granovsky det 1958; 1 slide in USNM). LYNDONVILLE 15 Jl, on *B. papyrifera,* 28 Sept 1960, on *B. maximowicziana,* (Pechuman coll—CFS det). BARRE Burma Woods 1 Aug 1960, on *B. lutea,* (Pechuman coll—Ole Heie det). LI: DIX HILLS 11 Jl 1934, on *B. nigra,* (Blanton coll); LOCUST VALLEY 26 Jl 1936, on *Betula* sp., (Maxwell coll—MDL det); GREENPORT 4 Oct, ORIENT 3 Oct 1946 and RIVERHEAD 13 May 1949, on *B. populifolia,* (Latham coll).

Calaphis betuelella Walsh

GENEVA 20 Oct 1946, abundant and ovipositing on *Betula papyrifera,* (Chapman coll—Mason det).

Calaphis castaneae (Fitch)

"Chestnut Gay-Louse, *Callipterus castaneae,* new species. On the underside of the leaves [chestnut], puncturing them and sucking their juices in August and September." (Fitch – Third Rept., p. 471, 1856).

NYL – ALBANY. ITHACA 1–12 Ju 1914, very common on the underside of the leaves of *Castanea dentata,* (Morrison coll).

BROOKTONDALE 17 Jl 1939, on *C. dentata,* (M. E. Phillips coll—Griswold det). TONAWANDA INDIAN RES. Genesee Co. 3 Sept 1960, on *C. dentata,* (Pechuman coll—CFS det). MT. KISCO Westchester Co. 10, 11 Jl 1960, on *C. dentata,* (Graham coll—CFS det). LI: HUNTINGTON, 6 Aug 1934, a "drift" on hickory foliage, (Blanton coll—Tissot det).

Calaphis granovskyi Palmer

NEW YORK Central Park 27 Ju, 28 Aug 1958, on *Betula (verrucosa) pendula,* (Granovsky coll and det; 2 slides in USNM). LYNDONVILLE 19 Ju 1959, 28 Sept 1960, on *B. maximowicziana,* 15 Jl 1960, on *B. papyrifera,* (Pechuman coll—Ole Heie det).

Calaphis n.sp. Granovsky

ITHACA 23 Ju 1952, alate "near potato fields", (S. H. Kerr coll; 1 slide by Granovsky in USNM). SI: NEW SPRINGVILLE 15 Sept 1943, no plant recorded, (coll by Sp Port Surv; 1 slide, by Granovsky det in USNM). LI: DIX HILLS 11 Jl 1935, on *Betula nigra,* (Blanton coll; 1 slide by Granovsky in USNM, previously labelled *C. betulaecolens* (Fitch).

Capitophorus sp.

RINGWOOD Tompkins Co. 9 Oct 1934, on *Monarda* sp., (Crosby and Leonard coll—Tissot det 1936; verified by LMR 1960). One poorly made slide containing 1 alate, 2 apterae and 1 nymph. I can find no other records of a *Capitophorus* on a *Monarda.*

Capitophorus archangelskii (Del Guercio)

LYNDONVILLE 28 Sept 1960, on *Eleagnus angustifolia,* OLCOTT Keg Creek 5 Oct 1960, "accidental" on *Abutilon theophrasti,* (Pechuman coll—Hille Ris Lambers det).

It was suggested by Dr. Smith that these latter were "drifts" from *Eleagnus* but Pechuman says he knows of no *Eleagnus* in the area and it is more likely that they came from *Shepherdia* even though this species had not been identified from this plant.

Capitophorus braggii (Gillette) Oleaster Thistle Aphid

BUFFALO Oct 1897, on *Eleagnus* sp., (3 slides in USNM). SHERIDAN 23 Jl 1905, on *Cnicus arvensis,* (Hayhurst coll—det Tissot as *flaveolus* (Wlk)). WALLACE 10 Sept 1933, on thistle, (? collector—Tissot det). GENEVA 20 Sept 1946, on *Eleagnus multiflora,* (P. J. Chapman coll—Mason det). LOCKPORT 26 Sept 1959, "leaves covered with masses of the aphids" on *Cirsium arvense,* (Pechuman coll—MDL det). LYNDONVILLE 29 Oct 1959, on *Eleagnus angustifolia,* (Pechuman coll; writes: "abundant—I looked at this tree on and off all summer but never found an aphid till this late date."). LI: ORIENT 3 Jl 1959, on stems and leaves of *Cirsium arvense,* (Latham coll).

Capitophorus eleagni (Del Guercio)

LYNDONVILLE 29 Oct 1959, 28 Sept 1960, on *Eleagnus angustifolia;* OLCOTT Keg Cr. 5 Oct 1960 ("abundant – most alates were dead and stuck to leaves."), on *Shepherdia canadensis,* and LOCKPORT 17 Oct 1959, on *Cirsium arvense,* (all Pechuman coll—CFS det).

Capitophorus hippophaes (Walker) Polygonum Aphid

OLCOTT Keg Cr. 5 Oct 1960 ("abundant – most alates were dead and stuck to leaves."), on *Shepherdia canadensis,* (Pechuman coll—CFS det). ETNA 30 Sept 1933, on *Polygonum* sp., (Crosby coll—det Tissot as *gillettei* Theob.). SI: CASTLETON CORNERS 1, 7 and 20 Nov 1960, a number of alate males in a Moericke trap, (Rundlett coll—J. O. Pepper det). LI: MASPETH 19 Sept 1914, on *P. pennsylvanicum* (Olsen); FLUSHING N. Y. World's Fair Grounds, heavy populations frequently built up on a continuous series of potted plants of *P. pennsylvanicum* being grown in wire cages outdoors as food for Japanese beetles in both 1949 and 1950, chiefly during July and August (Leonard).

Capitophorus hippophaes var. **javanicus** Hille Ris Lambers

LOCKPORT 17 Oct 1959, on *Cirsium arvense,* LYNDONVILLE 29 Oct 1959, on *Eleagnus angustifolia,* (Pechuman coll—Hille Ris Lambers determined for CFS).

Capitophorus ribis (Linnaeus) Currant Aphid

NYL – Widely distributed throughout the state and destructive to currants, recorded from St. Lawrence Co. southward to Westchester Co. and across the state.

Fredonia Ju 1905, on currant, (Hayhurst coll). Ithaca found rather commonly on both wild and cultivated *Ribes,* particularly during the spring of 1914, and in the fall, (Morrison). Yonkers 8 Ju 1927, on currant, (Horsfall coll—MDL det). Ithaca 3 Jl 1928, on currant, (R. Matheson coll), 5 Jl 1928, 2 Ju 1938, on *Ribes sativum,* (both Griswold coll) and 9 Oct 1932 (Crosby and Leonard coll). Lockport 19 May 1960, on *R. sativum,* (Pechuman coll—CFS det).

This aphid causes a characteristic curling and puffiness of the terminal leaves of currants which turn reddish. Badly infested leaves fall and the fruit deteriorates. It is recorded that in the spring some of the winged aphids leave the currants to develop colonies during the summer on other plants, such as motherwort and others, but this has not been observed in New York.

Capitophorus thomasi Hottes and Frison

Medina 11 Oct 1960, on *Potentilla norvegica* var. *hirsuta,* (Pechuman coll—CFS det).

Cavariella sp.

LI: Orient, E. Marion 13, 17 Sept 1960, on *Daucus carota* var. *sativa,* Southold 14 Oct 1960, on *Sium cicutaefolium,* (Latham coll—CFS det).

Cavariella aegopodii (Scopoli)

Sheridan 31 Jl 1904 or 1905, on *Salix* sp., (Hayhurst coll—Tissot det). Ithaca 15 Oct 1925, on *Angelica* sp., (A. S. Mills coll; 1 slide in USNM), 2 Ju 1952, an alate "near potato fields", (S. H. Kerr coll; 1 slide in USNM) and 24 Oct 1939, on carrot, (T. C. Watkins coll—MDL det). Orange Co. 29 May 1937, (W. E. Ewart coll—det Griswold with query; in CU). Poughkeepsie 12 Dec 1936, common on celery in storage, (S. C. Wilbur coll through Crosby—det Tissot as *C. capreae* (Fab.)). Geneva 20 Oct 1946 (ovipositing), on leaves of *Salix* sp., (det Mason as *C. capreae* (Fab.)). Bedford Westchester Co. Ju 1935, on *Salix* sp., (S. W. Bromley). LI: Maspeth 18 Jl 1914, on cultivated parsnips, (as *Siphocoryne capreae* (Fab.); Olsen coll); Lynbrook (L. C. Griffith coll), Elmhurst Nov 1918, on knob celery, (C. Burkhart coll); Riverhead 26 Ju 1949, on *Osmorhiza claytoni,* (Latham coll); Greenport 15 Ju 1958, on *O. longistylus,* 26 Jl 1958, on carrots and 22 Jl 1960, on *Cicuta maculata,* (Latham coll).

Cavariella essigi Gillette and Bragg

Athens 6 Nov 1935, on *Salix alba,* (Crosby coll—MDL det). LI: Orient 24 Ju 1959, on *Heracleum lanatum,* (Latham coll—MDL det).

Cavariella hendersoni Knowlton and Smith

LYNDONVILLE 5 Jl 1959, on *Cicuta maculata,* (Pechuman coll—CFS det). LI: GREENPORT 26 Jl 1959, on *C. maculata,* (Latham coll—CFS det).

Cavariella pastinaceae (Linnaeus)

RICHFIELD SPRINGS 16 Sept 1887, on wild celery, (Pergande; 1 slide in USNM). ITHACA fall 1914, very common on *Pastinaca sativa,* the males and viviparous females being present in abundance, and both being winged; presumably this species on an ornamental honeysuckle, (Morrison). EAST ITHACA 19 Oct 1913 (Morrison coll; 1 slide in USNM). NEW YORK Botanical Gardens 5 Jl 1921, on parsnip, (Sanford and Griffith coll; 1 slide in USNM). ITHACA 29 Oct 1925, on wild carrot, (A. S. Mills coll; 1 slide in USNM). FREEVILLE 16 Oct 1932, on *Salix* sp., EAST AURORA 10 Aug 1933, probably on *Cicuta* sp., (Leonard and Crosby coll). ORANGE Co. 29 May 1939, on celery under sash, (W. E. Ewart coll—Griswold det). LI: MASPETH 1 Nov 1914, on *Lonicera japonica,* (Olsen coll); ORIENT 5 Jl 1959, on *Heracleum lanatum,* (Latham coll—MDL det).

Cavariella theobaldi (Gillette and Bragg)

GENEVA 1 Jl 1909 (TYPES), on *Heracleum* sp., (Gillette and Bragg; Can. Ent. 50:92, 1918; 1 slide in USNM). GENEVA, ALBANY 29 Ju to 1 Jl (1909) (alate and apterous summer viviparae), on *Heracleum* sp., (Gillette coll). ITHACA 8 Jl 1942, on *H. lanatum,* (Cutcomp coll—Griswold det; slides in CU), 14, 27 Ju 1952, an alate "near potato fields", (S. H. Kerr coll; 2 slides in USNM). LI: ORIENT 4 Jl 1951, 1, 5 Jl 1958, 24 Ju 1959, on *H. lanatum,* (Latham coll; 2 slides in USNM), 9 Jl, on parsley, 17, 31 Jl, on tops and peduncles of cultivated parsnip, (Latham coll); GREENPORT 1, 5 Jl 1958, on *H. lanatum,* (Latham coll). LOCKPORT 18 Sept 1960, on *Geranium robertianum, Heracleum lanatum,* (Pechuman coll—CFS det).

Cepegillettea myricae (Patch)

SARANAC LAKE 8 Aug 1959, on *Myrica asplenifolia* [now *Comptonia peregrina* var. *asplenifolia*], (CFS et al coll). LI: CALVERTON 18 Oct 1949, on *M. cerifera,* (Latham coll—det MDL with query; 1 slide with 1 mature and 1 immature aptera); RIVERHEAD 17 Aug 1952, on *M. asplenifolia,* (Latham coll—Granovsky det 1958; 4 slides in USNM).

Cerataphis lataniae (Boisduval) Lantana Aphid

NYL – ITHACA Dec to Mar, annually in greenhouse on *Sobralia macrantha,* (Griswold coll—Patch det).

Chaitophorus sp.

"A small yellowish-green *Chaitophorus* with head a little dusky, was fairly common upon the underside of *Malva rotundifolia* on the grounds of the Experimental Station at GENEVA (28 to 30 Ju 1909). Apterous viviparae only were seen. The body length varies between 1.10 and 1.25 mm. and the antennae between .77 and .90 mm. in the specimens taken. The species seemed rather sporadic in habit." (Gillette in J.E.E. 2(6):388, 1910).

Chaitophorus betulae Buckton

"ALBANY 1 Jl, GENEVA 29, 30 Ju 1909, very abundant on the leaves of *Betula alba* [now *B. pendula*]. Buckton's description of this species was from fall apterous forms only and does not characterize very correctly the summer form of the louse that I am referring to by this name. I believe it is the only *Chaitophorus* that has been referred to the birch." (Gillette in J.E.E. 3(4):367, 1910).

Chaitophorus nigrae Oestlund

TUPPER LAKE 8 Aug 1959, on *Salix* sp., (Smith-Smith-Tuatay coll—CFS det). MT. KISCO 14 Aug 1960, on *Salix* sp., (Graham coll—CFS det).

Chaitophorus nigrae subsp. **tranaphoides** Hille Ris Lambers

ITHACA 1 Aug 1959, on *Salix* sp.; TUPPER LAKE 8 Aug 1959, on *Salix* sp., (both Smith-Smith-Tuatay coll—CFS det).

Chaitophorus populellus Gillette and Palmer?
Clear-winged Cottonwood Leaf Aphid

LI: GREENPORT 18 Oct 1957, on *Populus heterophyllus,* (a male?; Latham coll—det MDL with query).

Chaitophorus populialbae Fonscolombe

LYNDONVILLE 20 Jl, 29 Oct 1959, on *Populus alba,* (Pechuman coll—CFS det).

Chaitophorus populicola (Thomas)
Cloudy-winged Cottonwood Leaf Aphid

(Formerly in *Neothomasia* or *Periphyllus*. *P. bruneri* Wms. is a synonym.)

NYL—KARNER Jl, abundant on the common aspen *Populus tremuloides*.

ITHACA ? Oct 1913, sexual forms on young Carolina poplars and during the next spring at three places on the campus, the winged migrants of the second generation were forming colonies on the stems of the poplar, (Morrison). TUPPER LAKE 6 Sept 1933, on poplar, (H. Dietrich coll—

Tissot det). ALTAMONT 13 Sept 1939, on *Populus tremuloides,* (Griswold coll and det). ALBANY 22 Ju 1956, CATSKILL 17 Jl 1959, on *P. deltoides,* (J. A. Wilcox coll—MDL det; NYSM). ITHACA 12 Aug 1933, 19 Sept 1935, on *Populus* sp., (Crosby and Leonard coll); 30 Ju, on *P. canadensis,* (H. C. Barrett coll) 23 Jl 1938 (Griswold coll) and 13 Jl 1939, on *P. grandidentata,* (Hansberry coll). LYNDONVILLE 19, 22 May, GASPORT 2 Jl 1959, on *P. tremuloides,* (Pechuman coll). SI: RICHMOND 2 Sept 1943, on leaves of balm of Gilead *P. gileadensis* but recorded as *P. balsamifera,* (C. S. Tuthill coll—Mason det; Sp Port Surv). LI: MASPETH 7 Sept 1913, on *Populus* sp., (Olsen coll); ORIENT 25 Ju, GREENPORT 25 Ju, SAG HARBOR 26 Ju, NORTHWEST 26 Ju and RIVERHEAD 11 Ju 1947, on *P. grandidentata,* (Latham coll); ORIENT 31 Jl, GREENPORT 2 Aug 1959, in clusters at base of leaves of *P. deltoides,* (Latham coll). GASPORT 2 Jl 1959, on *P. tremuloides,* 7 Jl 1959 ("drifts"), on *Juglans nigra,* (both Pechuman coll—CFS det). WEST NYACK 11 Ju 1960, on *Populus grandidentata,* (Olsen coll—MDL det). JAY 8 Aug 1959, on *P. balsamifera,* (Smith-Smith-Tuatay coll—CFS det).

Chaitophorus populicola subsp. **patchae** Hille Ris Lambers

TUPPER LAKE 7 Aug, SARANAC LAKE 9 Aug 1959, on *Populus balsamifera,* JAY 8 Aug 1959, on *P. tremuloides,* (Smith-Smith-Tuatay coll—CFS det). TONAWANDA INDIAN RES. 28 May, LYNDONVILLE 19 Ju and OWLENBURG BOG, Catt. Co. 20 Ju 1960, on *P. temuloides;* BARRE Burma Woods 9 Jl 1960, on *P. grandidentata,* (all Pechuman coll—CFS det). WESTCHESTER Co. 11 Jl 1960, on *P. grandidentata,* 1 Aug, on *Populus* sp., *P. tremuloides,* (Graham coll—CFS det). LI: ORIENT 31 Jl, GREENPORT 2 Aug 1959, on *P. deltoides,* (Latham coll—CFS det).

Chaitophorus populifolii subsp. **simpsoni** Hille Ris Lambers

TONAWANDA INDIAN RES. Genesee Co. 4 Aug 1959, on *Populus grandidentata,* 3 Sept, 8 Oct 1960, on *P. tremuloides,* (Pechuman coll—CFS det).

Chaitophorus pusillus Hottes and Frison

LOCKPORT 12 Aug 1959, on *Salix nigra,* (Pechuman coll—CFS det). ITHACA 1 Aug 1959, on *Salix* sp., (Smith-Smith-Tuatay coll—CFS det).

Chaitophorus saliciniger (Knowlton)?

WEST NYACK 11 Ju 1960, on *Salix cordata,* (Olsen coll—CFS det).

Chaitophorus stevensis Sanborn

LYNDONVILLE 19 Ju, 5, 7 Jl and 2 Sept, 1959, on *Populus candicans,* (Pechuman coll—CFS det). MT. KISCO Westchester Co. 1, 10 Aug 1960, on *Populus* sp., (Graham coll—CFS det). LI: GREENPORT 14 Oct 1960, on *P. heterophylla,* (Latham coll—CFS det).

The following records were formerly assigned to *Chaitophorus populifoliae* Oestlund or Davis, the Clear-winged Aspen Aphid:

ITHACA ? Oct 1914 winged males and oviparous wingless females on small Carolina poplar trees, (Morrison). MONTEREY Schuyler Co. 19 Sept 1934 (both viviparous females and males present), on poplar, (Leonard and Crosby coll). AMENIA 27 Sept 1934 (males only), collected on poplar, (Leonard coll—Tissot det). ITHACA Arnot Forest 21 Aug 1927, on *P. tremuloides,* (L. P. Wehrle coll—MDL det; in CU); 21 Jl 1938 (Griswold coll—Essig det) and 15 Ju 1952, an alate "near potato fields", (S. H. Kerr coll; slide in USNM). WATKINS GLEN 18 Ju 1939, on *P. grandidentata,* (Cutcomp coll—MDL det; in CU). CATSKILL 17 Jl 1959, on *P. grandidentata,* (J. A. Wilcox coll—MDL det).

Chaitophorus viminalis Monell

Little Black and Green Willow Leaf Aphid

SHERIDAN Jl 1905, on willow, (Hayhurst coll—Tissot det; in CU also 1 slide in USNM). GENEVA 1 Jl 1909 "both alate and apterous viviparae were taken on willow leaves, specially abundant" (Gillette in J.E.E. **2**(6): 388, 1910). ITHACA 6 Aug 1933, on *Salix* sp., (Leonard and Forbes coll—Tissot det), 12 Oct 1939 (males), on *Salix* sp., (Griswold coll—MDL det) and 2 Ju 1952, an alate "near potato fields", (S. H. Kerr coll; 1 slide in USNM). CROSBY 13 Sept 1934, very abundant on basket willow *S. purpurea,* FREEVILLE, on leaves of *Salix* sp., (both Leonard and Crosby coll). SLATERVILLE 24 May 1939, on *Salix* sp., N. FAIRHAVEN 2 Jl 1939, on *S. nigra,* (T. R. Hansberry coll—Griswold det). CADOZIA (near Hancock) 11 Aug 1955, on willow, (J. A. Wilcox coll—MDL det). SHACKELTON POINT Oneida Co. 9 Jl 1959, on *Salix* sp., (Graham coll—MDL det). LYNDONVILLE at Seneca Falls, 8 Jl 1959, 5 Jl 1960 and 10 Oct 1960, on *S. babylonica,* (Pechuman coll—CFS det). SI: PORT RICHMOND 2 Sept 1943, on *Salix* sp., (C. S. Tuthill and Lantz coll—Mason det; Sp Port Surv). LI: GREENPORT 29 Ju 1958, on *S. discolor,* (Latham coll—MDL det).

Chromaphis juglandicola (Kaltenbach) Walnut Aphid

GASPORT 2 Jl 1960, on *Juglans regia,* (Pechuman coll—CFS det).

Cinara sp.

GENEVA 6 Dec 1946, on *Thuja orientalis,* (Gambrell coll—Mason det).

Cinara banksiana Pepper and Tissot

LI: RIVERHEAD 20 Ju 1934, on *Pinus banksiana,* (Crosby coll—Palmer and Hottes det; 1 slide with 3 apterae in CU).

Cinara carolina Tissot

CANANDAIGUA 26 Sept 1946, on *Pinus nigra,* (Chapman coll—Mason det). LI: BABYLON 12 Ju 1939, on *P. rigida,* (F. S. Blanton; in USNM), 1 Jl 1939, on *Pinus* sp., (Ed Kurtz; in USNM).

Cinara costata Zetterstedt

SYRACUSE, TULLY 16 Ju 1955, on Norway Spruce *Picea abies,* (J. O. Pepper coll and det).

Cinara curvipes Patch — Bow-legged Fir Aphid

NYL – (as *Lachnus*) OLD FORGE Aug, on balsam, (Felt).

TANNERSVILLE 2 Oct 1951, on balsam fir, (C. W. Maris coll; fr. Wilcox of NYSM; Hottes det).

Cinara hyalina Koch

RYE Ju 1935, on *Picea abies,* (S. W. Bromley coll). It is apparently recorded elsewhere in this country only from Maine and California.

Cinara laricis (Hartig) — Larch Aphid

BARRE Burma Woods Orleans Co. 9 Jl 1958, on *Larix laricina,* "on twigs; numerous colonies attended by big black ants; no winged forms present; examined again on Aug 8, fewer smaller colonies but still no winged forms; also same locality 3 June 1959." (Pechuman coll).

Cinara palmerae (Gillette) — Spotted Spruce Aphid

TULLY 17 Ju 1955, on Norway spruce *Picea abies,* (J. O. Pepper det and coll). LI: ORIENT 2 Aug 1959, on *P. pungens,* (Latham coll—det J. O. Pepper with query).

Cinara piceicola (Cholodkovsky) — Dark Brown Spruce Aphid

GENEVA 29 Ju 1909, on *Picea excelsa,* (Gillette coll—Palmer det; Ann. Ent. Soc. Am. 38(3):447, 1945).

Cinara pilicornis (Hartig)

LYNDONVILLE 19 Ju 1959, accidental on *Juglans* sp., (Pechuman coll—J. O. Pepper det).

Cinara pinea (Mordwilko)

LOCKPORT 6 Ju 1959, on *Pinus sylvestris,* (Pechuman coll—Hottes det).

Cinara pini (Linnaeus)

YONKERS 15 Oct 1935, on *Pinus thunbergi;* TARRYTOWN Ju 1939, on shoots of Japanese table pine *Pinus* sp., (S. W. Bromley coll). LI:

LOCUST VALLEY May, on Austrian pine, GLEN HEAD Ju 1936, on needles of red pine *P. resinosa,* (K. E. Maxwell coll—Tissot det).

Cinara pinicola (Kaltenbach)

GENEVA 18 Nov 1946, on *Picea glauca,* (F. L. Gambrell coll—Mason det).

Cinara pinivora (Wilson)

"Lectotype alate viviparous female indicated by arrow on slide indicated as 'Type' by Wilson. Host *Pinus* sp. New York 1908. Hopkins 7422. Slide on deposit in the United States National Museum." (Hottes, Proc. Biol. Soc. Wash. 71:191–196, 1958). *C. pinivora* is here redescribed.

Cinara sabinae Gillette and Palmer Rocky Mountain Juniper Aphid

BEDFORD Westchester Co. 28 May 1935, no plant given, (Bromley). LI: LOCUST VALLEY May 1936, on *Juniperus virginiana,* (K. E. Maxwell coll—Tissot det); WESTBURY 23 May 1928, on red cedar *J. virginiana,* (Bartlett Tree Res. Labs.).

Cinara strobi Fitch White-Pine Aphid

"*Eriosoma strobi* n.sp. Common on the branches of the white pine, giving to the bark of infested trees a peculiar black appearance. Belongs to a nondescript genus, intermediate between this and *Lachnus.* No. 867, male; 868, female." (Fitch, Cat. Homop. N.Y. p. 69, 1851).

WEST DANBY 9 Oct 1932, on *Pinus strobus,* (Crosby and Leonard coll). ITHACA presumably this species on the white pine along Fall Creek Drive, 2 winged have been obtained (?1914), (Morrison); 30 Ju, 19 Oct (ovip. females), on *P. strobus,* (Griswold coll). GENEVA 20 Oct 1946 (ovipositing), on *P. strobus,* (Chapman coll—Mason det). ARMONK Ju 1935, on white pine, (S. W. Bromley). LI: WADING RIVER 30 Ju 1913, on pine, (Olsen coll); GLEN COVE Ju 1936, on *P. strobus,* (Maxwell coll—Tissot det); BABYLON 1 Nov 1943, on needles and stems of white pine, (Plummer coll—Mason det; Sp Port Surv).

Cinara tujafilina (Del Guercio)

NEW YORK 8 Oct 1922, no food plant given, (Shillers coll; USNM). LI: WESTBURY 23 May 1928, on red cedar *Juniperus virginiana,* (Bartlett Tree Res. Labs.).

Cinara watsoni Tissot and Pepper

LOCKPORT 6 Ju 1959 (apterae and immatures), on *Pinus sylvestris;* JOHNSONBURG 5 Ju 1960, on *P. sylvestris,* (both Pechuman coll—J. O. Pepper det).

Colopha ulmicola (Fitch) Elm Cockscomb-gall Aphid

Originally described by Dr. Fitch from New York (without definite locality) as *Byrsocrypta ulmicola* new species.

NYL – Known to occur in ONONDAGA, GENESEE, ERIE, ONTARIO, WASHINGTON, ALBANY, RENSSELAER and WESTCHESTER Counties and probably moderately abundant and generally distributed throughout the state (Felt); also as *Tetraneura graminis* Mon., ALBANY, Sept, on heads of rice cut-grass *Leersia* (*Homalocentrus*) *oryzoides*. Other records are: GENEVA 29, 30 Ju 1909 (as *Tetraneura*) "galls very common, some turning red and in these were many alate lice and pupae; in green galls all were nymphs." (Gillette, J.E.E. 2(5):353, 1909). NEW YORK and vicinity (Beutenmueller). BRONX 2 Ju 1935, on *Ulmus* sp., (P. A. Readio coll; in CU). WEST NYACK Oct 1958, dried galls on leaves of *U. americana*, (Olsen coll). LI: (as *Colopha graminis* Mon.) WINFIELD 8 Ju 1914, MASPETH 25 Ju 1913, 14 Ju 1914, on elm, (Olsen coll); SAG HARBOR 29 Jl 1946, on *Leersia virginica*, (Latham coll—det Russell as *Tetraneura graminis* Mon. with query).

The account of Dr. Fitch is as follows: "In June, an excrescence or follicle like a cockscomb, arising abruptly from the upper surface of the leaf, usually about an inch long and a quarter of an inch high, compressed at its sides, wrinkley perpendicularly at its summit, irregularly gashed and toothed, of a paler green color than the leaf and more or less red on the sides exposed to the sun; opening on the underside of the leaf by long slit-like orifice; inside wrinkled perpendicularly into deep plates and occupied by one female and a number of her young, some of which are strictly outside upon the upper surface of the leaf. Minute oval yellowish white lice 0.02 [?] long with blackish legs, the female more or less coated with white meal on the back, 0.007 long, oval and pale yellowish with blackish legs and antennae. Though I have not yet met with winged individuals, in all probability they pertain to the genus to which I have referred this species above. The galls may frequently be noticed on elm leaves. By the middle of summer they become tenantless, dry and hard and of a blackish color." (Fitch's 5th Rept. pp. 843–849, 1859).

Colopha ulmisacculi Fitch Elm Sack Gall

NYL (as *Tetraneura*) – KENWOOD May, gall on *Ulmus montana* [now *glabra*], (H. D. House coll—Felt det). LI: MASPETH, ROSLYN Ju 1914, on elm, (Olsen coll).

SHELTER ID. 17 Ju 1914, on English elm, (USNM); FAR ROCKAWAY, no plant, (USNM).

Dactynotus sp.*

ITHACA Brooklawn on Cayuga Heights 21 Aug about 1914, on wild

* Dr. A. T. Olive of the Department of Biology, Wake Forest College, Winston-Salem, N. Carolina, in a study of Macrosiphum-like aphids, has transferred certain species from *Macrosiphum* to *Dactynotus*. Seven of these and one variety in addition to five other species are included in this list, which will be published earlier than Dr. Olive's paper. Dr. Olive has therefore asked me to indicate the "new combinations."

lettuce, (O. A. Johannsen coll—Patch det; record in Me. Agr. Exp. Sta. Lot Book).

Dactynotus sp.

LI: ORIENT 7 Sept 1957, on *Hieracium scabrum,* (Latham coll—Olive det); RIVERHEAD 17 Aug 1957, on *H. pratense,* (Latham coll—Olive det); SAG HARBOR 21 Sept 1946, on *Impatiens biflora,* 16 Aug 1946, on *Aster umbellatus,* (Latham coll—Olive det); ORIENT 7 Sept 1957, on *Prenanthes trifoliata,* (Latham coll—Olive det).

Dactynotus n. sp. No. 5 Olive

TUPPER LAKE 8 Aug 1959, on *Aster* sp.; ITHACA 1 Aug 1959, on *Solidago* sp., (Smith-Smith-Tuatay coll—Olive det). WEST NYACK 22 Ju 1960, on *S. canadensis,* (Olsen coll—Olive det). MT. KISCO 11, 12, Jl 1960, on *Solidago* sp., (Graham coll—Olive det). LI: MATTITUCK 5 Jl 1946, on *S. arguta, S. aspera,* EAST MARION 26 Ju 1946, on *S. rugosa* and QUOGUE 10 Oct 1948, on *Erechtites hieraceifolia,* (all Latham coll—Olive det); GREENPORT 17 Jl, EAST QUOGUE 23 Jl 1959, on *Solidago altissima,* ORIENT 5 Jl 1959, 17 Jl 1960, on *S. altissima,* 13 Jl, 11 Oct 1960, on *S. rugosa,* (all Latham coll—Olive det).

Dactynotus n. sp. No. 7 Olive

ITHACA 18 Sept 1934, on *Lactuca spicata,* (Leonard and Crosby coll—Olive det). LYNDONVILLE 19 Jl 1959, on *Solidago canadensis;* LOCKPORT 10 Aug, 22 Sept 1959, on *Lactuca serriola,* 19 Sept 1959 on *L. sativa;* TONAWANDA INDIAN RES. Genesee Co. 3 Sept 1960, on *Prenanthes alba,* and BARRE Burma Woods 22 Ju 1960, on *Chrysanthemum leucanthemum,* (all Pechuman coll—Olive det). WESTCHESTER Co. 29 Ju, on *Chrysanthemum* sp., 11 Aug 1960, on *Sonchus oleraceus,* (Graham coll—Olive det). LI: GREENPORT 28 Jl 1946, on *Cirsium discolor,* ORIENT 16 Sept 1946, on *Lactuca sativa,* QUOGUE 10 Oct 1948, on *Gnaphalium polycephalum,* LAUREL 19 Jl 1948, on *Lactuca canadensis,* and RIVERHEAD 10 Oct 1948, on *Aster ericoides,* 19 Oct 1948, on *Lactuca serriola,* (all Latham coll—Olive det); BAY VIEW 9 Ju, on *Hypochoeris radicata,* 29 Ju, on *Cichorium intybus* and 10 Oct 1960, on *Gnaphalium polycephalum.* ORIENT 28 Ju, on *Cichorium intybus,* 23 Jl 1960, on Van Fleet cult. rose, (all Latham coll—Olive det).

Dactynotus n.sp. No. 3 Olive

LI: ORIENT 16, GREENPORT 22 Jl 1960, on *Helianthus tuberosus,* (Latham coll—Olive det).

Dactynotus n.sp. No. 1 Olive

LI: MATTITUCK 5 Jl 1946, on *Chrysopsis falcata;* SAG HARBOR 8 Sept 1946, on *C. mariana,* (both Latham coll—Olive det).

Dactynotus n.sp.

Ithaca Comstock Garden 2 Aug 1926 (6 slides, apterae and alates), 22, 26 Jl 1939 (8 slides, apterae and alates), on *Heliopsis helianthoides*, (Griswold coll; in CU). Dr. Olive says this is definitely a new species but he hesitates to describe it without color notes.

Dactynotus ambrosiae (Thomas) n. comb. Brown Ambrosia Aphid

(Formerly placed in *Macrosiphum*.)

This dark blood-red, rather large aphid is common and wide-spread in New York, occurring on a number of different plants. It has often been misidentified with closely related species so that it is difficult to say on just how many plants the true *ambrosiae* is known to occur. It has not been recorded as doing any appreciable injury.

Although *Dactynotus ambrosiae* was described as a new species by Thomas from Iowa in 1878, it had actually been recorded from New York just 60 years earlier. In 1818 Rafinesque, in the American Naturalist and Critical Reviews, Vol. 3:17 described as new an aphid he called *Aphis ambrosia* of which he states: "Found on Long Island on several species of the genus *Ambrosia*. They are raised and bred by a new species of ant, which I have called *Formica fasciata*." This, Hottes says (Proc. Biol. Soc. Wash. 44:67, 1931) is probably a synonym of *A. jacobea-balsamita* Raf. (l.c.) which latter "is unquestionably the first description of the species long since known as *Macrosiphum ambrosiae* (Thomas)." Rafinesque records it on *Jacobea balsamita* and *Senecio jacobea* (both now called *Senecio pauperculus*) and on *Solidago nemoralis*.

For many years numerous collections of aphids in New York, as well as in other states, have been identified as *ambrosiae*. Recent critical studies by Dr. A. T. Olive while at North Carolina State College, working for his Ph.D. under the direction of Dr. Clyde F. Smith, have shown, however, that in many cases closely related species are involved, including two new species. At least 80 collections in New York have been assigned to *ambrosiae*. I have divided these records, which follow, into two categories: those which have been substantiated by Drs. Smith and/or Olive and those which have not been reviewed by them.

The slides upon which the following records are based have been determined by Drs. Smith and/or Olive:

Ithaca 11 Aug 1938, on *Ambrosia trifida*, (H. I. Scudder coll—Olive det). Yonkers 28 Ju 1938, on *Vernonia* sp., (E. P. Imle coll—LMR and Olive det). Mt. Kisco Aug, on *Eupatorium perfoliatum*, 22 Aug, on *Ambrosia trifida*, 6 Jl, 6 Aug, on *Rudbeckia hirta* and 1 Aug, on *Solidago sempervirens*, (all 1960 Graham coll—Olive det). Tonawanda Indian Res. Genesee Co. 4 Aug, on *Ambrosia trifida*; Zoar Valley Erie Co. 20 Sept, on *Helianthus decapetalus*; Lockport 26 Sept, on *Cirsium arvense*, and Lyndonville 14 Sept, on *Solidago canadensis*, (all 1959

Pechuman coll—det Olive and/or CFS). ROCHESTER 19 Jl 1960, on *Rudbeckia hirta,* (H. Lou Gibson coll—Olive det).

LI: ORIENT 22 Jl 1946, on *Achillea millefolium,* (Latham coll—Olive det); ORIENT 17 Jl 1960, on *Solidago sempervirens,* SAG HARBOR 30 Ju 1955, on *Eupatorium purpureum* and *Aster macrophyllus,* GREENPORT, ORIENT 17 Jl 1959, common on the tips of the branches of *Iva oraria,* GREENPORT 23 Jl 1958, 3 Jl 1959, ORIENT 25 Ju 1942 are presumably *ambrosiae,* on *I. oraria,* ORIENT 23 Jl 1960, on *Dimorphotheca* sp., 26 Sept 1959, on *Tagetes erecta,* and EAST MARION 17 Jl 1960, on *Solidago sempervirens,* (all of foregoing Latham coll—det Olive and/or CFS); SHELTER ID. 28 Jl 1960, on *Rudbeckia hirta,* (Graham coll—Olive det). GREENPORT 2 Aug 1959, on *Aster novi-belgii,* 22 Jl 1960, on *Rudbeckia laciniata, Cicuta maculata,* (Latham coll); ORIENT 28 Ju 1960, on pear, (Latham coll); (a slide from GREENPORT 25 Ju 1958, on pear, Latham coll, det LMR as "*ambrosiae* complex", is presumably *ambrosiae*).

The following records have not been substantiated by either Dr. Olive or Dr. Smith:

ITHACA 21 Jl 1885, host unrecorded, (E. H. Sargent coll—Tissot det; in CU), 3 Sept, on *Solidago* sp., 9 Sept, on *Arctotis* sp. and *Lactuca* sp., 19 Sept, on *Arctotis* sp., (all 1933 Crosby coll—Tissot det 1936), 13 Sept, on *Aster puniceus,* 14 Sept, on *Eupatorium urticaefolium,* 15 Sept, on *Lactuca* sp., 18 Sept ("with cornicles almost too long for *M. ambrosiae*"), on *L. spicata,* (all 1934 Leonard and Crosby coll—Tissot det 1936), 20 Oct 1932, on *Calendula* sp., (Leonard coll—Tissot det), 11 Aug 1939, on *Eupatorium* sp., (MDL det; in CU), 21 Jl 1929, on *Aster* sp. cult., (Griswold coll; in CU), 20 Oct 1932, on *Calendula* sp., (Leonard coll), 3 Sept 1932, on *Solidago* sp., (Leonard and Crosby coll), 19 Jl 1938, on *S. canadensis* var. *hargeri,* (Griswold coll—Griswold and Essig det; in CU). MCLEAN 15 Sept (at least one male present); on joe pye-weed *Eupatorium* sp.; RINGWOOD Tompkins Co. 10 Sept, on *Aster umbellatus, Lactuca* sp. and everlasting *Helichrysum* sp., (all 1934 Leonard and Crosby coll). SHERIDAN 30 Jl 1905, on *Lactuca serriola,* (Hayhurst coll). ALBANY 8 Oct, on *Ambrosia trifida,* 14 Sept 1959, on *Iva xanthifolia,* (Wilcox coll—MDL det). CATSKILL 17 Jl 1959, on *Rudbeckia serotina,* (Wilcox coll—MDL det). SI: 14 Sept 1943, abundant on seeded lettuce plants, (M. J. Ramsey coll—Mason det; Sp Port Surv). BARNEVELD 12 Ju 1922, on everlasting *Helichrysum* sp., (G. N. Wolcott coll; 1 slide in USNM).

LI: WADING RIVER 30 May 1913, on *Iva oraria,* (as *frutescens;* Olsen coll; det as *Macrosiphum* sp. is presumably *ambrosiae*); HUNTINGTON 6 Aug 1934, on *Lactuca canadensis,* (Blanton and Borders coll—Tissot det 1936); BABYLON 26 Sept 1934, on *Aster* sp., 7 Jl 1935, on *Sisymbrium officinale,* and 3 Jl 1939, on *Veronica* sp., (Blanton coll; 1 slide each in USNM; ? Mason det); BABYLON 25 Aug 1933, on *Ambrosia* sp. and

Lactuca canadensis, (Blanton coll—Tissot det 1936); GREENPORT 2 Jl 1951, on *Aster umbellatus,* (1 slide in USNM), 7 Jl 1959, on *Lactuca serriola,* ORIENT 8 Ju, on *Solidago rugosa,* 27 Ju, on *Lactuca serriola* and 8 Ju, on *S. sempervirens,* MATTITUCK 15 Ju, on *S. altissima,* and PECONIC 9 Jl, on *Rudbeckia hirta,* (all Latham coll—MDL det).

Dactynotus chrysanthemi (Oestlund) n. comb.

(Formerly placed in *Macrosiphum.*)

SHERIDAN Aug 1905, on *Bidens frondosa,* (Hayhurst coll—det Tissot with query). ITHACA 14 Sept 1934, RINGWOOD Tompkins Co. 10 Sept 1934, on *Bidens* sp., (Crosby and Leonard coll—Tissot det). SI: 3 Sept 1943, on stem of *Solidago* sp., (Sp Port Surv; Mason det). MEDINA 23 Sept 1960, on *Bidens frondosa;* GASPORT 24 Sept 1960, on *B. cernua,* OLCOTT Keg Creek 5 Oct 1960, on *B. cernua,* (all Pechuman coll—Olive det). LI: CALVERTON 1 Sept 1947, GREENPORT 22 Sept 1957, on *B. comosa,* (Latham coll); ORIENT 10 Aug 1959, common on stems of *B. vulgata,* (Latham coll).

Dactynotus erigeronensis (Thomas) n. comb. Canadian Fleabane Aphid

(Formerly placed in *Macrosiphum.*)

In 1818 Rafinesque described as new, two aphids which he called *Aphis erigeron-philadelphicum* and *A. erigeron-canadense* (p. 17 No. 34), the latter from Long Island. Hottes (Proc. Biol. Soc. Wash. 44:63 and 67, 1931) considers these to be the same and both the same as *Macrosiphum erigeronensis* (Thomas).

TAUGHANNOCK 4 Sept 1933, on *Erigeron* sp., EGGLESTON'S GLENN 12 Sept 1934, on *E. canadensis,* (Leonard and Crosby coll). ITHACA 9 Oct 1933, on goldenrod, (Crosby coll—Tissot det). YONKERS 30 Ju 1927, on *E. pulchella,* (J.L. Horsfall coll—MDL det). LI: ORIENT 3, 17 Jl 1959, respectively on *E. annuus* and top stems of *E. canadensis,* (Latham coll—det MDL with query), 11 Oct 1960, on *E. canadensis,* (Latham coll—Olive det); RIVERHEAD 24 Jl 1933 (MDL coll—Tissot det).

Dactynotus gravicornis (Patch) n.comb.

(Formerly placed in *Macrosiphum.*)

BATAVIA 14 Sept 1934, on *Arctium lappa,* ITHACA, on *Erigeron annuus,* (Crosby and Leonard coll). ITHACA Cayuga Heights 9 Aug about 1914, on sunflower, (O.A. Johannsen coll—Patch det; slide in Me. Agr. Exp. Sta.). LOCKPORT 8 Oct 1959, on *E. strigosus,* (Pechuman coll—Olive det). ROCHESTER 19 Jl 1960, on *E. speciosus* showy fleabane, plant from Colorado, (H. Lou Gibson coll—Olive det). MT. KISCO 9, 12 Jl, on *E. annuus,* 11 Aug, on *Eupatorium purpureum,* and 21 Aug 1960, on *Solidago juncea,* (Graham coll—Olive det). LI: BABYLON 26 Aug, on *Solidago* sp., Dix Hills 11 Jl 1934, on *Erigeron strigosus*, (Blanton coll—Tissot det); Riverhead 21 Jl, on *E. canadensis*, (MDL coll), 29 Jl 1933 on *Erigeron* sp., (Leonard and Crosby coll); Greenport 26 Jl 1959, on *E. strigosus*, 22 Jl 1960, on *Hieracium aurantiacum*, (Latham coll—Olive det); Riverhead 18 Sept 1946, on *Solidago puberula*, Orient 25 Jl 1946, 3 Jl 1959, on *Erigeron annuus*, Bay View 2 Jl 1960, on *E. annuus*, and East Marion 17 Jl 1960, on *E. strigosus*, *Tanacetum vulgare*, (all Latham coll—Olive det); Shelter Id. 28 Jl 1960, on *Erigeron annuus*, (Graham coll—Olive det).

Dactynotus idahoensis (Miller) n.comb.

(Formerly placed in *Macrosiphum*.)

Ithaca 19 Ju 1927, on *Anaphalis margaritacea*, (Griswold coll—MDL det; in CU).

Dactynotus illini (Hottes and Frison) n.comb.

(Formerly placed in *Macrosiphum*.)

Ithaca 9 Sept 1933, on *Helianthus annuus*, (Crosby coll—Tissot det). LI: Blanton 8 Jl 1934, on sunflower leaves, (Blanton coll—Mason det; 1 slide in USNM marked "compared with type").

Dactynotus illini var. **sagamonensis** (Hottes and Frison) n.comb.

(Formerly placed in *Macrosiphum*.)

Ithaca 3 Sept 1933 (Leonard and Crosby coll).

Dactynotus impatiensicolens (Patch) n.comb.

(Formerly placed in *Macrosiphum*.)

Ithaca 3, 14 Sept 1934, on *Impatiens* sp., (Leonard and Crosby coll). LI: Greenport 16 Sept, Sag Harbor 21 Sept 1946, on *Impatiens capensis*, (Latham coll—MDL det).

Dactynotus luteolus (Williams) n.comb.

(Formerly placed in *Macrosiphum*.)

Monkey Run, Tompkins Co. 10 Aug 1938, on *Solidago* sp., (T.R. Hansberry coll; in CU).

Dactynotus rudbeckiae (Fitch) n.comb. Goldenglow or Coneflower Aphid

(Formerly placed in *Macrosiphum*.)

This is a large brick-red to blood-red aphid which may at times be found clustered on the upper part of the stems of goldenglow with the heads of each individual pointed downwards. Although it is probably widely distributed in New York, available collecting records would indicate that it is not nearly so common as in Illinois.

In 1818 in the American Monthly Magazine and Critical Review, Vol. 3, p. 17, Rafinesque described as a new species, from NEWBURGH, New York, an aphid he called *Aphis gibbosa*. This is considered by Hottes (Proc. Biol. Soc. Wash. 44:66, 1931) to be the same as Fitch's *rudbeckiae*. Rafinesque states that he found it "on several species of *Solidago*, particularly on *S. odora*, *S. altissima* etc." Fitch described this as "*Aphis rudbeckiae* n.sp. No. 853, male" in his Cat. Homop. N.Y., p. 66, 1851 and states that it "infests the upper part of the stalks of *Rudbeckia laciniata*, *Solidago* (*serotina*) [now *gigantea*] and *S. gigantea*."

NYL – Probably widely distributed throughout the State. ALBANY, BEMIS HGTS., Ju; NASSAU and several Long Island records by Olsen which are given below. ITHACA, Nov 1913 sexual forms on *Solidago;* (Morrison coll). Leonard states in Jour. N.Y. Ent. Soc. 44:184, 1936: "we have made several collections from Ithaca and vicinity as well as on Long Island from goldenrod, goldenglow and *Aster umbellatus*, (coll Leonard and/or Crosby 1933 and 1934)."

LOCKPORT 1 Jl 1958, on *Rudbeckia laciniata*, (Pechuman coll—MDL det). ITHACA 29 Jl 1926, on *R. laciniata*, (Griswold coll; in CU), 4 Aug 1938 (F.H. Butt coll—Essig det) and 19 Sept 1935 (Crosby coll—det Olive 1961). MICHIGAN HOLLOW Tompkins Co. 11 Aug 1939, on *R. laciniata*, (W.M. Middlekauff coll—MDL det 1960). SI: PORT RICHMOND 1 Sept 1943, on stem below flower of *Cirsium* sp., (C.S. Tuthill coll—Mason det; Sp Port Surv). LI: MONTAUK POINT 30 Jl 1933, on *Rudbeckia laciniata*, (Leonard coll—Tissot det); BABYLON 12 Jl 1934, on *Vernonia noveboracensis*, (Blanton coll; 2 slides in USNM); also on same date, a collection by Blanton on *Pyrrhopappus carolinianus*, det Tissot with a query, but a slide in the USNM with the same data is determined without a query. LI records by Olsen: MASPETH Ju–Nov 1913–14, on *Silene noctiflora*, cultivated aster, goldenrod, *Lactuca* sp., *Xanthium canadense*, *Rudbeckia laciniata* and cultivated lettuce; at ROCKAWAY BEACH, on goldenrod; WADING RIVER, on *Antennaria neodioica*.

Dactynotus russelae Hille Ris Lambers

TUPPER LAKE 8 Aug 1959, on *Anaphalis margaritacea*, (Smith-Smith-Tuatay coll—CFS det).

Dactynotus sonchellus (Monell) n.comb.

(Formerly placed in *Macrosiphum*.)

ITHACA 30 Oct 1939, on *Taraxacum officinale* in greenhouse, (P.S. Bartholomew coll—Essig det). WEST NYACK 7 Aug 1947, on *Lactuca canadensis*, (Olsen coll). LI: RIVERHEAD 29 Jl 1932, on *Lactuca* sp., (Leonard and Crosby coll), 10 Oct 1948, on *Lactuca serriola*, (Latham coll), 28 Jl 1946, 28 Jl 1948, on *Lactuca spicata*, Oct 1948, 17 Sept 1957 and 24 Aug 1958, on *L. canadensis*, and 19 Oct 1948, on *L. serriola*, (all Latham coll—Olive det).

Dactynotus taraxaci (Kaltenbach) n.comb. Dark Dandelion Aphid

(Formerly placed in *Macrosiphum.*)

ITHACA 25 Ju 1914 (Johannsen coll—Patch det; in Me. Agr. Exp. Sta. Lot Book). GENEVA 29 Ju 1917 (no collector; Patch det; in Me. Agr. Exp. Sta. Lot Book). ERIE Co. Oct 1937 (Henry Page coll—MDL det). LI: MASPETH 27 Ju 1914 (Olsen coll); BABYLON Ju 1933 (Blanton coll). All records for this aphid from *Taraxacum officinale.*

Dactynotus tardae (Hottes and Frison) n.comb.

(Formerly placed in *Macrosiphum.*)

ITHACA (presumably) 22 Jl 1926, on *Helenium* sp. outdoors, (Griswold coll—MDL det; 5 alate slides in CU). Note – only noticeable difference from the Hottes and Frison description is that the cauda is yellowish.

Dactynotus tissoti (Boudreaux) n.comb.

(Formerly placed in *Macrosiphum.*)

LOCKPORT 8 Oct 1959, on *Erigeron strigosus,* (Pechuman coll—CFS det). JOHNSONBURG 5 Ju 1960, on *Aster puniceus,* (Pechuman coll—Olive det). ITHACA 1 Aug 1959, on *Solidago* sp., (Smith-Smith-Tuatay coll—Olive det). MT. KISCO 9, 12 Jl 1960, on *Solidago* sp., 20 Aug 1960, on *S. rugosa* and *S. juncea,* (all Graham coll—Olive det). WEST NYACK 22 Ju 1960, on *S. altissima,* 8 Ju 1960, on *Erigeron annuus,* (Graham coll—Olive det). LI: ORIENT 3 Jl 1959, on *E. annuus,* 13 Jl 1960, on *Solidago rugosa,* GREENPORT 28 Jl 1959, on *Erigeron strigosus,* 22 Jl 1960, on *Solidago rugosa,* and E. MARION 23 Jl 1960, on *S. altissima,* (all Latham coll—Olive det); SHELTER ID. 29 Jl 1960, on *Solidago* sp., (Graham coll—Olive det).

Drepanaphis n.sp. (*monelli* complex)

TONAWANDA INDIAN RES. Niagara Co. 1 Oct 1960, on *Acer nigrum,* (Pechuman coll—CFS det).

Drepanaphis acerifolii (Thomas) Painted Maple Aphid

NYL – A common though rarely abundant species on soft maple leaves, probably widely distributed throughout the state since it has been recorded or reported from ALBANY, DUTCHESS, HERKIMER, RENSSELAER, SARATOGA, TOMPKINS, and WESTCHESTER Counties.

ITHACA 1913 or 1914 ?, very common, but not abundant on the maples in this city, (Morrison), Jl, Aug, Sept 1933, 1937 and 1938, on *Acer saccharinum,* and Ju, Jl 1937, 1938, on *A. rubrum,* (Griswold coll; in CU) and 27 Ju 1959, on *A. rubrum* var. *trilobum* and *A. saccharum,* (Graham coll—CFS det). LOCKPORT 2 Jl 1960, on *A. saccharinum,* (Pechuman coll—CFS det). GENEVA 20 Sept 1946, on *A. saccharinum,* (Chapman coll—Mason det). LI: MASPETH Ju, Oct, on *A. saccharinum,* (Olsen coll); FLUSHING New York World's Fair Grounds 11 Ju 1939, on *A. rubrum,* (scarce; Leonard coll).

Drepanaphis carolinensis Smith

ITHACA Forest Home Sept 1934, on *Acer saccharum,* (Crosby and Leonard coll). LOCKPORT 5 Sept 1960, TONAWANDA IND. RES. 1 Oct 1960, on *A. nigrum,* MEDINA 22 Sept 1960, on *A. saccharum,* (all Pechuman coll—CFS det).

Drepanaphis kansensis Smith

GENEVA 20 Sept 1946, on *Acer saccharum,* (Chapman coll—Mason det). MEDINA 22 Sept 1960, on *A. saccharum,* LOCKPORT 5 Sept 1960, a "drift" on *Spiraea,* (Pechuman coll—CFS det).

Drepanaphis monelli (Davis)

CROSBY 10 Sept 1934 a "drift" on milkweed, (Leonard and Crosby coll).

Drepanaphis parvus Smith

McLEAN 15 Sept 1934 (oviparous females present), on *Acer saccharum,* (Leonard and Crosby coll).

Drepanaphis sabrinae Miller

GASPORT, LOCKPORT, Sept 1960 ("drifts"; Pechuman coll—CFS det). ITHACA 13 Sept 1933, on *Acer saccharum,* (Crosby coll—Tissot det).

Drepanaphis simpsoni Smith

LOCKPORT 5 Sept 1960 ("drifts"; Pechuman coll—CFS det). ITHACA 1 Aug 1959, one alate on *Acer saccharum,* (Smith-Smith-Tuatay coll—CFS det). MEDINA 22 Sept 1960, on *A. saccharum,* (Pechuman coll—CFS det).

Eriosoma americanum (Riley) Woolly Elm Aphid

NYL – Probably generally distributed throughout the state, available records including from ST. LAWRENCE and ESSEX COUNTIES southward to WESTCHESTER COUNTY and MASPETH, LI. Probably to blame for the early summer curling of American elm leaves (Felt).

GENEVA and ALBANY "many alate lice and nymphs in rolled leaves of American elm, 29–30 Ju and 1 Jl 1909 respectively." (Gillette, J.E.E. 2(5):356, 1909).

ITHACA 10 Ju 1939, in curled leaf of *Ulmus americana,* (P. A. Readio coll), 27 Ju 1939, on *Amelanchier canadensis,* (Hansberry coll). MONROE 8 Ju 1925, on elm, (USNM). SODUS 28 Jl 1950, one alate "drift" on wild cherry, (S.H. Kerr coll; in USNM). LI: WINFIELD 8 Ju 1913, on elm, (Olsen coll); GREENPORT 14 Jl 1957, on *Ulmus americana,* ORIENT 26 May 1958, on *Amelanchier canadensis,* (Latham coll).

Eriosoma crataegi (Oestlund)

ITHACA "The woolly aphids first became noticeable in early June as small white spots on the tender twigs of *Crataegus.* In a favorable season, such as the summer of 1918, they become very conspicuous and cover entire branches by late summer. The writer has not found the roots of *Crataegus* infested." (Wellhouse, W.H., Cornell Univ. Mem. 56:1064–1065, 1922). Note by MDL – Although the foregoing is under *Eriosoma lanigerum* (Hausm.) it is assumed *E. crataegi* (Oestl.) is referred to.

SYRACUSE 12 Sept 1917, on *Crataegus* sp., (USNM). YONKERS 25 Aug 1931, on *C. oxycantha,* (Sp Port Surv; USNM). ITHACA 15 Sept 1933, on *Crataegus* sp., (Crosby coll). BATAVIA Sept 11, BARRINGTON Sept 18, 1934, abundant on *Crataegus,* (Leonard and Crosby coll). SI: ROSEBANK 24 Aug 1943, extremely heavy infestation on stems of *Crataegus* sp., (Tuthill coll; Sp Port Surv; USNM). LI: BROOKLYN Botanic Gardens 1, 8 Jl 1921, on *Crataegus* sp., (USNM); LOCUST VALLEY Sept 1936, on *C. crusgalli,* (Maxwell coll); BAY VIEW 29 Ju 1960, on *C. chrysocarpa,* (Latham coll).

Eriosoma lanigerum (Hausmann) Woolly Apple Aphid

NYL – Widely distributed throughout the State from ST. LAWRENCE and ESSEX COUNTIES southward to MASPETH, LI. Apple, *Crataegus* and elm, often injurious.

GENEVA, NEW YORK Central Park, "noticed at these places on 29–30 June and 2 July 1910, respectively." (Gillette, J.E.E. 3(5):356, 1910). SYRACUSE 1 Ju 1925, on elm (USNM). ITHACA 8 Oct 1933, on apple, (Crosby coll), 10 Ju 1939, in curled leaf of *Ulmus americana,* (Readio coll). LOCKPORT 24 Aug, 22 Sept 1960, on *Crataegus oxycantha* var. *paulii,* (Pechuman coll—det CFS with query). SI: CASTLETON CORNERS 20 Oct 1960, in bark wounds of *Malus floribunda,* (Rundlett coll). LI: MASPETH 19 Aug 1914, on apple, (Olsen coll); SOUTHAMPTON 17 Ju 1943, on elm, (A. T. Gaul coll; Sp Port Surv); GREENPORT 6 Ju 1958, in curled leaves of *Ulmus americana*, MATTITUCK 21 May 1959, on apple twigs, (both Latham coll).

"On the bark of the young branches of the apple, to which tree in Europe it has been a great pest. Commonly only solitary individuals are here found, but in one instance have I met with it clustered and covering a limb as described by foreign writers. No. 861, male." (Fitch, Fourth Rept. p. 67, 1851). Dr. P. J. Chapman, Entomologist of the New York (Geneva) Agricultural Experiment Station wrote me (July 1961) as follows in respect to this aphid on apples in New York: "Widely distributed but not considered an economic pest in commercial orchards. Occasionally causes serious damage to nursery stock."

Eriosoma lanuginosa Hartig Pear Root Aphid

LI: WINFIELD 15, 27 Ju 1914, MASPETH 19 Jl 1914, on elm, (Olsen coll).

Eriosoma rileyi (Thomas) Woolly Aphid of the Elm Bark

NYL – Probably generally distributed throughout the State, but recorded only from WATERTOWN, NORTHVILLE, on elm, (Felt).

ITHACA 8 Ju 1915, a small colony on a young elm, (Morrison coll), 28 Ju 1928, on *Ulmus* sp., (L.P. Wehrle coll—Griswold det).

Eriosoma ulmi (Linnaeus)

NYL – The distribution of this species within the state is probably coincident with that of *E. americanum* Rly. but *E. ulmi* is probably less common (Baker and Mason). Common on certain English elms (Patch).

Essigella pini Wilson Speckled Pine Needle Aphid

LI: RIVERHEAD 29 Sept 1946, on *Pinus rigida,* (Latham coll).

Euceraphis betulae (Koch) European Birch Aphid

A large yellowish aphid occurring singly on the underside of the leaves of several species of birch, dropping readily when disturbed and having long whitish cottony threads on antennae and legs. Presumably occurs wherever birches grow, having been recorded from Northern New York to Eastern Long Island.

Fitch, as *Aphis cerasicolens* n.sp. "When irritated, the legs and antennae instantly emit from their pores a bluish white cotton-like substance, which remains adhering to them, resembling fine mould. On the common black cherry tree (*Cerasus serotina* D.C.), No. 841, male." (Cat. Homop. NY, p. 65, 1851). (Note – this occurrence on cherry was accidental.) "*Geneva* 29–30, Ju 1909, common on white birch," (Gillette, J.E.E. 3(4): 371, 1910).

WHITE PLAINS 27 Sept 1914, on *Betula lutea,* (Olsen). ITHACA May (Patch), Ju, Oct (males) 1937, 1938, on *B. populifolia,* (Griswold coll); Sept 1934, on *Betula* sp., (Crosby and Leonard coll). COVEY HILL GULF, PERU Clinton Co. Sept. 1936, on *B. alba,* (Crosby coll). LYNDONVILLE 17 Ju 1959, on *B. lenta* and *B. papyrifera,* (Pechuman coll). ALBANY Jl, Oct 1927, on roof of the State Education Building (Felt and Chamberlain). LI: GREENPORT, SOUTHOLD Ju, Jl 1958, on *B. lenta,* MATTITUCK May 1959, on *B. pendula,* and GREENPORT Jl 1959, on *B. lenta,* (all Latham coll).

Euceraphis brevis Baker

ITHACA 15 May 1911, on *Betula* sp., (Patch coll; A. C. Baker, J.E.E. 10: 426, 1917).

Euceraphis deducta Baker

BEDFORD Westchester Co. Ju 1935, on leaves of *Betula lutea,* (S.W. Bromley coll). LI: ORIENT 1 Jl 1932, food plant unrecorded, (Latham coll—Mason det; in USNM).

Euceraphis gillettei Davidson

LYNDONVILLE 19 Ju 1959, on *Betula maximowicziana,* (Pechuman coll—Ole Heie det).

Palmer records it as common throughout the Rocky Mountain region.

Euceraphis lineata Baker

NYL – KARNER (1923), on gray birch, (Leonard coll—Patch det).

Euceraphis mucida Fitch

Fitch, as *Aphis pinicolens* n.sp. "Solitary on pine. No. 851, male." (Fitch, Cat. Homop. N.Y. p. 66, 1851). A COTYPE slide in USNM is marked "Fitch 842 from Fitch collection, Pergande 9391." Also 2 TYPE slides in USNM Nos. 9315-1 and 9315-2 as *Calliptaphis* (*Callipterus*) – 1 alate each, on apple. (Note – the occurrence on pine was accidental.) LYNDONVILLE 17 Ju 1959, on *Betula lenta,* (Pechuman coll—Ole Heie det). WEST NYACK 5 Ju 1958, on *B. lenta,* (Olsen coll). LI: BABYLON 22 Ju 1932, on birch, (Blanton coll); GREENPORT 4 Jl 1959, on *B. lenta,* (Latham coll—Ole Heie det).

Euceraphis punctipennis (Zetterstedt)

LYNDONVILLE 17 Ju 1959, on *Betula papyrifera,* (Pechuman coll—Ole Heie det).

This is probably the first record for the United States.

Eulachnus agilis (Kaltenbach)

ALBANY City Park 1 Jl 1909, on pine leaves, ("Both alate and apterous forms of this louse were taken. Lice very active and difficult to capture." Gillette, J.E.E. 2(6): 385, 1910). PORT CHESTER 15 Oct 1935, on *Pinus sylvestris,* (S.W. Bromley coll). RYE 15 Oct 1935, on needles of *P. resinosa,* (S.W. Bromley).

Eulachnus rileyi (Williams). Powdery Pine Needle Aphid

ITHACA 5 Ju 1937, on *Pinus nigra,* (Gerberg coll—Essig det; in CU), 15 May 1939, on *P. nigra,* (Griswold coll and det; in CU); 16 Ju 1915, on Austrian pine, (Morrison coll) and RYE 1 Oct 1935, on needles of red pine, (S.W. Bromley coll). LI: HAMPTON BAYS 25 Ju 1946, RIVERHEAD 21 Sept 1957 (ovip. and males), on *P. rigida,* (Latham coll—Hottes det).

Forda sp.

SYRACUSE Sept 1911, on aster roots, (Pergande det).

Forda formicaria Heyden Grain Root Aphid

COLONIE Albany Co. 19 May 1952, on roots of *Oenothera biennis,* (J.A. Wilcox coll—det Maxson 1960 as near *occidentalis*). LI: MASPETH 21 Ju 1913, on roots of *Polygonum* sp., (Olsen coll).

Forda olivacea Rohwer

ITHACA 8 Sept 1921, on roots of *Aster* sp., (Crosby coll; in USNM).

Geoica lucifuga (Zehntner)?

Slides det with query by Maxson in 1960 from Latham's collecting 1959 (1 in 1958), all on roots: LI: ORIENT 15 Jl 1958, 6 Nov 1959, on *Calendula officinalis**, 16 Jl, on *Tragopogon porrifolius,* 9, 30 Oct, on *Aster levis,* 9 Oct, on *Helianthus grosserratus,* 24 Oct, on *H. annuus,* 1 Nov, on *Tithonia,* sp.*, 6 Nov, on *Beta vulgaris**, *Tagetes erecta** and *Cosmos bipinnatus**, and 7, 11 Jl, on *Galinsoga parviflora;* E. MARION 10 Oct, on *G. parviflora;* MATTITUCK 16 Oct, on *Ambrosia artemisifolia.* (*Aphids on these plants attended by ant *Lasius* (*Acanthomyops*) *claviger* (Rog.) M. R. Smith det).

Geoica utricularia (Passerini) (*squamosa* Hart)

CLYDE 23 Oct 1909, on wheat roots, (H.E. Wilson coll and det; in USNM). ITHACA 8 Jl 1952, in flight near potato field, (S.H. Kerr coll; in USNM).

Georgiaphis ulmi Wilson

LYNDONVILLE 7 Jl 1960, GRAND ISLAND Erie Co. 2 Ju 1959, on *Ulmus rubra;* LOCKPORT 4 Ju 1960, on *U. thomasi,* (Pechuman coll—CFS det).

Widely distributed in Illinois, where it sometimes so badly curls the leaves of certain elms as to stunt the growth of the trees.

Gobaishia ulmifusa (Walsh and Riley)

NYL – Reported from WARREN, ONTARIO, FULTON, GREEN and WESTCHESTER COUNTIES, but is presumably widely distributed in the state though rarely abundant. Produces a good sized, somewhat irregular gall on leaves of slippery elm (Felt). Described from New York and Southern Illinois in 1869.

Hamamelistes spinosus Shimer Spiny Bud-Gall of Witch-Hazel

As *Hormaphis papyraceae* (Oestl.) in NYL – CRANBERRY LAKE on willow birch (Osborn) – this plant name cannot be substantiated.

NYL – Probably widely distributed, though not usually abundant excepting possibly on birch, its alternate food plant. ALBANY Jl (Gillette), HUDSON (Felt), CANANDAIGUA Aug, and TARRYTOWN Ju. Produces a spiny bud-gall of witch-hazel.

SARATOGA Sept 1879, on witch-hazel, (W.S. Barnard coll—Tissot det). ALBANY 1 Jl 1910. "The powdery apterous form of this louse was taken in abundance upon the underside of the leaves of white birch." (Gillette, J.E.E. 3(5):353, 1910). NEW YORK and vicinity, reported very common on witch-hazel (Beutenmueller). YONKERS 8 Ju 1927, on birch, (J.L. Horsfall coll). ITHACA 2 Jl, in curled leaves of *Betula populifolia,* 25 Jl 1939, on *Hamamelis virginiana,* (Griswold; in CU). LI: LOCUST VALLEY Aug 1936, "a spiny bud gall on witch-hazel," (Maxwell coll); BABYLON 13 Nov 1943, galls on witch-hazel, (Plummer coll—Mason det; Sp Port Surv); NASSAU Co. 10 May 1952, on white birch, (Tuthill coll; in USNM); NORTHWEST 12 Jl 1951, on *Betula alba,* (Latham coll; in USNM); GREENPORT 22 Jl, on *B. populifolia,* 27 Ju 1958, "drifts" on *Prunus cerasus,* (Latham coll). LYNDONVILLE 17 Ju 1959, on *Betula lenta,* 19 Ju, on *B. nigra,* (Pechuman coll). HIGHLAND FALLS 9 Ju 1942, galls on stems of *B. populifolia,* (in AMNH).

Hoplochaitophorus n.sp.

ITHACA 26 Jl 1937, on *Quercus montana,* (4 slides, no alates, Griswold coll; labeled as *Stegophylla* n.sp.; Granovsky wrote 18 Feb 1959: this is *Hoplochaitophorus* n.sp. near *S. quercicola* (Mon.)).

Hoplochaitophorus quercicola (Monell)

ITHACA 14 Sept 1933, "a large white oak tree dripping with honeydew," (Crosby coll). LI: GREENPORT 5 Oct 1946, SOUTHOLD 18 Sept 1946, on *Quercus bicolor,* (Latham coll).

Hormaphis hamamelidis (Fitch)

The complicated life history of this aphid, which alternates between witch-hazel and birch, was worked out by Pergande and published by him (USDA, Div. Ent., Tech. Series 9, pp 1–44, 1901) after, as he says in the introduction to this paper, "nearly twenty-two years of patient labor." It has been recorded only once from birch in New York. Fitch, as *Byrsocrypta hamamelidis,* n.sp. "Inhabits conical follicles on the upper surface of witch-hazel leaves; each follicle contains about a dozen individuals, and has a small orifice on the under surface of the leaves. No. 869, male; 870 larva; 871, its follicle." (Fitch, Cat. Homop. N.Y. p. 69, 1851).

NYL – A common and probably widely distributed species producing a characteristic conical gall on the leaves of witch-hazel. NEWPORT, ONEONTA, NASSAU and LI: WADING RIVER.

ITHACA (about 1914) the galls are very common on nearly every witch-hazel bush in this vicinity, (Morrison coll). NEW YORK Botanical Gardens 5 Jl 1921, on birch, (Sanford and Griffiths; in USNM). HAINES FALLS 26 Ju 1937, on witch-hazel, (L.B. Lange coll; in USNM). ITHACA 10 Sept 1933, on witch-hazel, (Crosby coll), 16 Jl 1938, on witch-hazel, (Griswold coll), 13 Aug 1952, in flight in vicinity of potato fields, (S.H. Kerr coll; in USNM); ITHACA Beebe Lake 2 Ju 1958, galls only, (Graham coll). LI: WADING RIVER May 1913, 1914, on witch-hazel, (Olsen); SOUTHAMPTON 25 Ju 1946, cone galls on witch-hazel, (Latham coll—Weld det).

Hyalomyzus eriobotryae (Tissot)?

TONAWANDA INDIAN RES. Genesee Co. 3 Sept, 10 Oct 1960, scarce on *Colinsonia canadensis*, (Pechuman coll—CFS det with query). Although Tissot described this species (1935 under *Myzus*) from *Eriobotrya*, it is recorded in Florida also from *Crataegus* and apple. It may therefore be one of those species that overwinters on these two latter plant genera and migrates to Labiatae to spend the summer.

Hyalopteroides humilis (Walker) (**dactylidis** Hayhurst)

Orchardgrass Aphid

LI: BABYLON 23 May 1933, on *Panicum* sp., (Blanton coll); ORIENT 7, 8 Dec 1960, common on blades of *Dactylis glomerata*, (Latham coll).

Hyalopterus arundinis (Fabricius) Mealy Plum Aphid

This aphid is undoubtedly distributed throughout the state since it has been recorded from all of the fruit counties in western New York, and has been observed in the Hudson River Valley and on Staten Island and on Eastern Long Island.

Definite collections include the following: FREDONIA, 1888 (Pergande coll). SHERIDAN 22 Jl 1905, on cult. plum, (Hayhurst coll). ROCHESTER in 1917, on *Prunus* sp., (Geo. A. Francis coll—Patch det; Me. Agr. Sta. Lot Book). ALBANY, alate on roof of State Ed. Bldg., 8 Oct 1927 (Felt and Chamberlain). LOCKPORT 29 Jl, MIDDLETOWN 13 Ju 1939, on plum, (slides in CU). CATSKILL 17 Jl 1959, on *Phragmites communis*, (Wilcox coll). BERGEN SWAMP Genesee Co. 9 Aug 1959, 2 Aug 1960, ZURICH BOG Wayne Co. 16 Jl 1960, on *P. communis*; TONAWANDA INDIAN RES. Genesee Co. 18 Jl 1960, on *Desmodium canadensis*, (all Pechuman coll—CFS det). SI: 2 Sept 1943, on blades of marshgrass *Spartina* sp., (Tuthill coll—Mason det); CASTLETON CORNERS 1, 7 Nov. 1960, a number of males caught in a "Moericke Trap", (Rundlett coll—J.O. Pepper det). LI: HUNTINGTON 7 Ju 1938, very abundant and injurious to several plum trees, (Leonard and Haude coll); BABYLON 3 Jl 1939, on reedgrass, (Ed Kurtz coll—Mason det); ORIENT 24 Sept 1946, 17 Ju, 26 Jl, 1960, RIVERHEAD 29 Sept 1946, MANORVILLE 1 Aug 1947, GREENPORT 28 Ju 1958, SOUTHOLD 3, 8 Jl 1960 and BAYVIEW 10 Jl 1960, all on *Phragmites communis,* (all Latham coll). ORIENT 15, 27 Ju 1958, on *Prunus avium,* 5 Jl 1959, on *P. hortulana,* 17 Ju 1960 on *P. domestica,* 10 Oct 1960, on *P. seiboldi,* (all Latham coll); MASPETH 1 Nov 1914, on *P. serotina,* (Olsen coll).

This aphid frequently becomes abundant on the foliage and new growth of plums and prunes and is sometimes very injurious to the trees. It spends the winter as eggs on the plum but in the early summer most of the aphids migrate to breed on their summer hosts, chiefly *Phragmites,* the descendants of these returning in the fall to lay eggs on the plum.

From 1921 to 1941 the extension entomologists of the New York State College of Agriculture made many observations on the occurrence of this aphid throughout western New York on plums and prunes. These showed it to be seasonally and locally light to abundant. J. A. Evans reported that during 1941 an unusually heavy infestation occurred in a number of plum orchards in Western New York and some growers were forced to apply a special spray. La Plant reported it of local importance on plum and prunes in Rockland and Orange Counties in 1952.

Hyapopterus atriplicis (L.) Boat Gall Aphid

This cosmopolitan aphid causes a severe leaf curling or podlike folding of the leaves of lamb's quarters and probably occurs wherever this plant grows in the state although not many collections have been made.

NYL – FREDONIA [parasitized by *Lysephlebius eragrostaphidis* Ashm]. LILY DALE Jamestown, on *Chenopodium* sp., (Hayhurst coll).

CHAUTAUQUA Aug 1908 (Hayhurst coll). GENEVA, NEW YORK Central Park Ju 29, 30, 1910, 2 Jl 1910 respectively, presumably on *Chenopodinum* sp., (Gillette, J.E.E. 3(5): 405, 1910). EAST AURORA 10 Aug 1933, on *Ch. album,* (MDL coll). LOCKPORT 20 Jl 1960, on *Ch. album,* (Pechuman coll—CFS det). LI: MASPETH 17 Jl 1913, 2 Aug 1914 (Olsen coll); RIVERHEAD 21 Jl 1933, on *Ch. album,* (MDL coll); EAST MARION 22 Ju, ORIENT 14 Jl 1946, common on *Ch. album,* (Latham coll).

Hypermyzus pallidus Hille Ris Lambers

LOCKPORT 10 Oct 1960, on *Saxifraga* (*Bergenia*) *crassifolia,* (Pechuman coll—CFS det). Described in 1935 from Holland and England on *Sonchus oleraceus,* this aphid is apparently rather widely distributed in Europe. This may be the first record for the United States.

Hysteroneura setariae (Thomas) Rusty Plum Aphid

ULSTER Co. 24 Ju 1929, serious injury to plums, (Crosby). GENESEE Co. 2 May 1935, on plums, (D.L. Hayes). NIAGARA Co. 3 Jl 1939, severe on plums, (R.W. Leiby). BRONX 19 Oct 1943, on *Prunus yedoensis* var. *yoshino,* (J.R. Adams coll—Mason det; in USNM). LI: MASPETH 19 Sept 1914, on *Digitaria sanguinalis,* (Olsen coll).

Idiopterus nephrelepidis Davis

ITHACA 28 Apr 1914, one collection on ferns in the greenhouses of the Ag. College at Cornell. Presumably not previously reported from the state, (Morrison coll).

NYL – ITHACA Feb, Mar and Dec 1927, in greenhouse on *Adiantum, Nephrolepis exaltata* var. *bostoniensis, Cyrtomium* and *Pteris,* (Griswold coll—Patch det).

STELLA NIAGARA 30 Aug 1926, no plant given, (Mother M. Alfonse coll—Mason det; in USNM).

Kakimia sp.

GENEVA 20 Oct 1946, ovipositing on an ornamental *Ribes,* (Chapman coll—Mason det).

Kakimia cynosbati Oestlund — Dogberry Aphid

ITHACA 9 Oct 1932, on currant, (Leonard and Crosby coll). LOCKPORT 4 Nov 1958, on *Ribes hirtellum,* (Pechuman coll).

Kakimia essigi Gillette and Palmer — Black-backed Columbine Aphid

FREDONIA Ju 1905, on *Aquilegia vulgaris,* (Hayhurst coll). ITHACA 7, 20 Sept 1937, on *A. chrysantha,* (Griswold coll and det).

Kakimia houghtonensis (Troop) — Gooseberry Witchbroom Aphid

LEWIS Jl 1918, on *Ribes rotundifolium,* (P. Spaulding coll—Mason det; in USNM).

Kakimia purpurascens (Oestlund)

OWLENBURG BOG Catt. Co. 20 Ju 1959, BARRE Burma Woods 22 Ju 1960, on *Thalictrum polygonum,* (Pechuman coll). LI: NORTHWEST 26 Ju 1947, SAG HARBOR 21 Ju 1948, on *T. revolutum,* (Latham coll); GREENPORT 8, 25 Ju 1958, on *T. revolutum, T. polygonum* respectively, (Latham coll).

Lachnus laricifex Fitch

Original description by Fitch under heading "Larch Insects": "Solitary upon the smaller twigs, stationed in the axils of the tufts of leaves. Many of the lice were noticed on a particular tree the latter part of May but no winged ones were to be found . . . many of them were accompanied by four or more young." (Fitch, Fourth Rept. p. 752, 1859).

ITHACA 5 Ju 1914, a few stem mothers on a certain larch on which it is reported to sometimes become very common, (Morrison coll).

Lachnus salignus (Gmelin) Giant Willow Aphid

This is one of our largest aphids – 4.5 to 5.5 mm. in length. It is blackish and bears a prominent tubercle on the dorsum of the thorax. It is probably locally and seasonally abundant on willows throughout the state but the only definite records are those that follow:

NYL – POUGHKEEPSIE, OSSINING May, on willow. LI: FLUSHING Sept, on willow.

MOUNT VERNON 2 Jl 1928, on *Salix* sp., (Bartlett Tree Res. Labs.). LOCKPORT 8 Sept, 12 Nov 1960, on *S. bebbiana* "Very abundant in large patches on trunk and larger branches.", GENEVA 22 Oct 1960, in flight, (Pechuman coll—CFS det). LOCKPORT 18 Sept, 12 Nov 1960, on *S. matsudana* var. *tortuosa,* 20 Nov 1960, on *S. babylonica,* (Pechuman coll—CFS det). SI: CASTLETON CORNERS 31 Oct 1960, on *S. babylonica,* (Rundlett coll). LI: ORIENT 5, 15 Oct 1950, on *S. incana,* (Latham coll; in USNM).

Longistigma caryae (Harris) Hickory Aphid

This is our largest aphid. It often appears in large clusters on the limbs of several kinds of trees sometimes becoming so numerous as to seriously affect the health of such city shade trees as sycamores.

ITHACA (presumably this aphid), second week in Nov 1913; a few oviparous females on young trees of the common beech *Fagus americana;* no eggs observed, (Morrison coll).

NYL – SOUTH BYRON Ju (J. F. Rose coll).

LETCHWORTH PARK 2 Ju 1933 ("flying"; Dietrich coll). NEW YORK 22 May 1946 ("on wing"; AMNH). GENEVA 20 Oct 1946, ovipositing on *Tilia europea,* (Chapman coll—Mason det). LOCKPORT 13 Ju 1954, "free flying", (Pechuman coll). LI: LOCUST VALLEY 1 Sept 1934, on birch (Maxwell coll); BABYLON 18 Jl 1934, on twigs of a dead maple, (Blanton coll); FLORAL PARK Oct 1932, on sycamore, (R.T. Ennis coll—Crosby det); WESTBURY Aug 1932, on hickory, (Bartlett Tree Res. Labs); WESTBURY 6 Oct 1943, on *Quercus palustris,* LYNBROOK 11 Oct 1943, on Oriental Plane Tree, (Plummer coll; Sp Port Surv); MATTITUCK 26 Ju 1946, (1 alate; Latham coll).

Macrosiphoniella sp.

LI: GREENPORT 29 Ju 1947, on *Polygonum convolulus,* (Latham coll—Olive det).

Macrosiphoniella n.sp.?

LOCKPORT 4 Aug 1960, on *Artemesia schmidtiana* var. *nana,* (Pechuman coll—det CFS with query).

Macrosiphoniella absinthii (L.)

ITHACA in student garden, 12 Ju 1928, on *Artemesia absinthium,* (Griswold coll—MacGillivray det; 5 slides, 3 apterae each, in CU).

I find no other records for the U.S.A. Dr. MacGillivray writes she has collected this aphid in New Brunswick, Canada.

Macrosiphoniella artemesiae (Gillette)

MT. KISCO 22 Aug 1960, on *Artemesia vulgaris,* (Graham coll—CFS det). Previously recorded only from Colorado, Utah and Southern Idaho.

Macrosiphoniella ludovicianae (Oestlund)

Dark-leaved Wormwood Aphid

(Formerly placed in *Macrosiphum.*)

ITHACA 4 Ju, 22 Sept, on Costmary Chrysanthemum *Chrysanthemum (balsamita) majus;* 5 Ju 1939, on *Tanacetum vulgare,* (both Griswold coll). LI: GREENPORT 13 Jl 1947, SOUTHOLD 1 Jl 1959, in heads of *T. vulgare,* (Latham coll).

Macrosiphoniella millefolii (DeGeer)

(Formerly placed in *Macrosiphum.*)

TULLY 18 Jl 1952, on yarrow *Achillea millefolium,* (J. O. Pepper coll and det). APALACHIN 15 Oct, OLCOTT Keg Creek 5 Oct 1960, on *A. millefolium,* (Pechuman coll—CFS det). MT. KISCO 24 Ju, 11 Jl and 21 Aug 1960, PINEBROOK 22 Ju 1960, on *A. millefolium,* (Graham coll—CFS det). WEST NYACK 9 Ju 1960, on *A. millefolium,* (Olsen coll—CFS det). LI: ORIENT 22 Jl 1946, on *A. millefolium,* GREENPORT 7 Jl 1959, on *A. lanulosa,* (Latham coll—Olive and CFS det); SHELTER ID. 28 Jl 1960, on *Achillea* sp. (Graham coll—CFS det).

Macrosiphoniella sanborni (Gillette) Chrysanthemum Aphid

Undoubtedly present on chrysanthemums throughout the state, often becoming sufficiently numerous to stunt the growth of the plants and flowers. Very few definite records, due no doubt to the fact that it is so common it has seemed hardly worthwhile to make collections.

NYL – ITHACA Feb presumably in greenhouse (Patch det).

SEA BREEZE Monroe Co. 10 Nov 1933 (J. M. Van Dorn coll). LOCKPORT 17 Sept 1946 (Pechuman coll), 10 Oct 1960, on *Chrysanthemum morifolium,* (Pechuman coll—CFS det). LI: MASPETH 13, 18 Jl 1914 (Olsen coll); ROCKVILLE CENTER 5 Mar 1919 (MDL coll); CORONA 27 Ju 1931 (USNM); BABYLON 7 Ju, 18 Dec 1934 (Blanton and F. J. Spruijt coll respectively); ORIENT 6 Jl 1959 (Latham coll).

Macrosiphoniella tanacetaria Kaltenbach

ALBION 22 Ju, LOCKPORT 4 Aug and LYNDONVILLE 15 Sept 1960, on

Tanacetum vulgare, (Pechuman coll—CFS det). LI: ORIENT 16 Jl 1960, on *T. vulgare,* (Latham coll—CFS det).

Macrosiphum sp.

FREDONIA 2 Sept 1905, on *Rosmarinus officinalis,* (Hayhurst coll).

Macrosiphum sp.

SI: NEW BRIGHTON 30 Aug 1943, on flowering parts of *Lactuca serriola* var. *integrata,* (C. S. Tuthill coll—det Mason who states: "I have seen this species before on *Lactuca* in the East. It is probably undescribed."; Sp Port Surv).

Macrosiphum sp.

RINGWOOD Tompkins Co., on *Matricaria chamomilla,* (Leonard and Crosby coll).

Macrosiphum sp.

LI: ORIENT 9 Dec 1960, on *Glecoma hederacea,* (Latham coll).

Macrosiphum agrimoniellum (Cockerell)

LI: GREENPORT 20 Jl 1958, ORIENT 17 Jl 1959, on *Agrimonia gryposepala,* (Latham coll).

Macrosiphum albifrons Essig — Essig's Lupine Aphid

ITHACA in Miss Mimm's garden 17 Ju 1927, on *Lupinus polyphyllus,* (Griswold coll). DRYDEN 10 Ju 1938, on *L. polyphyllus,* (Griswold coll). WEST NYACK 17 Jl 1959, 28 Jl 1960, abundant on cult. *Lupinus* sp., (Olsen coll). LOCKPORT 17 Oct 1960 (Pechuman coll). LI: "LONG ISLAND" no date, on lupine, (C. F. Doucette coll—Mason det); BABYLON, no date, on lupine, (C. A. Weigel coll—Mason det; slides in USNM).

Macrosiphum anomalae Hottes and Frison?

ITHACA 29 Sept 1933, on *Aster novae-angliae,* (Crosby coll—det Tissot with query). MEDINA 30 Oct, LOCKPORT 26 Sept, 3, 8 and 18 Oct 1959, on *A. novae-angliae,* (Pechuman coll—det Olive with query).

Macrosiphum baccharidis (Clarke)

LI: ORIENT 26 Jl 1960, on *Baccharis halmifolia,* (Latham coll—Olive det).

Macrosiphum californicum Clarke (*laevigatae* Essig)

SHERIDAN 30 Jl 1905, on *Salix* sp., (Hayhurst coll—Tissot det).

TONAWANDA INDIAN RES. Genesee Co. 13 Ju 1959, LOCKPORT 30 Ju 1958, on *Salix* sp., (Pechuman coll). LI: ORIENT 18 Jl 1958, on *S. caprea*, (Latham coll).

Macrosiphum carpinicolens Patch

ITHACA 3 Aug 1937, on *Carpinus caroliniana*, (Griswold coll). LYNDONVILLE 8 Jl 1959, "a nice colony" on *C. caroliniana*, (Pechuman coll).

Macrosiphum dirhodum (Walker) Rose Grass Aphid

ITHACA 18 Mar 1913, in the plant breeding greenhouses on rose; (Morrison coll), 9 Sept 1927, on lamb's quarters in greenhouse, (2 apterae; P. J. Chapman coll—det MDL with query).

Macrosiphum euphorbiae (Thomas) Potato Aphid

The potato aphid has long been widely known in American literature as *M. solanifolii* Ashmead. It is a fairly large aphid about 3 mm. in length, which has both green and pink forms and is distributed throughout the state on a wide variety of food plants botanically unrelated. In some years in New York it becomes very destructive to potatoes and tomatoes in commercial plantings and has been recorded as locally abundant and injurious to eggplant, lettuce and spinach. It is sometimes fairly common on iris and gladiolus.

The potato aphid passes the winter primarily as eggs on the rose and reportedly on certain other Rosaceae such as *Agrimonia* and *Potentilla*. This has not been substantiated in New York. In New Jersey the eggs are found in greater or less numbers from year to year in several localities on swamp rose *Rosa palustris*. Probably two or three generations are produced following egg hatching, which occurs about the time the leaf buds are opening, and these aphids migrate to potato, tomato and other herbaceous plants. In warm weather a female reaches maturity in ten days or two weeks and may give birth to more than fifty young over a period of about fourteen days.

Probably the most destructive outbreak ever recorded on potatoes in New York occurred in 1917, becoming serious in early July. Many large fields were observed in which all the plants were killed to the ground. (Manual of Vegetable Garden Insects by Crosby and Leonard, p. 152, 1918). Besides the direct injury it does by extracting the plant juices, the potato aphid is implicated throughout its entire range in the transmission of as many as 35 plant viruses. Among these are potato leaf-roll.

Dr. Karl H. Fernow of the Department of Plant Pathology, Cornell University wrote me in September 1961 that since this aphid has been reported as a vector of leaf-roll of potatoes in Maine, although not a very efficient one, the same situation probably occurs in New York. Since the Maine workers indicate it is particularly efficient in the transmission of Virus A-mild mosaic it probably was formerly a vector also in New York. He states that this virus used to be a considerable problem in New York in the potato variety Green Mountain but this variety has almost completely been replaced by varieties which are apparently resistant to this virus so we do not very often see it or recognize it anymore.

During the seasons of 1958–60 W. H. Day and W. A. Rawlins of Cornell University made a study (as yet unpublished) of the parasites and predators of the potato aphid on potatoes in connection with control by the use of insecticides. This was done at Riverhead, Long Island. They have kindly permitted me to include the names of the parasites and predators in this List. The parasites are as follows:

Braconidae: *Aphidius nigripes* (Ashm.), *A. nigritelcus* Smith, *A. rosae* Hal. and *Praon simulans* (Prov.), given in their order of importance. Eulophidae: *Aphelinus semiflavus* How.. Secondary parasites reared from the *Aphidius* species are Ceraphronidae: *Lygocerus niger* (How.) and *incompletus* Mues.; Cynipidae: *Charips* sp.; Encyrtidae: *Apidencyrtus aphidivorus* (Mayr.); Pteromalidae: *Pachyneuron siphonophorae* (Ashm.), *Asaphes fletcheri* (Cwfd.).

For the predators see the section on "Natural Control and Ants".

The potato aphid has been observed on nearly 60 plants in New York belonging to widely separated families as follows:

Agrimonia gryposepala, Amaranthus hybridus, A. retroflexus, Anthemis cotula, Apocynum cannabinum, Asclepias sp., *A. syriacus, Aster* sp., *Atriplex patula, Baptisia tinctoria, Balamcanda chinensis, Brassica oleracea* var. *botrytis* (cauliflower), *B. oleracea* var. *gemmifera* (Brussels sprouts), *Calendula officinalis* (pot marigold), *Callisthephus chinensis, Capsicum frutescens* (red pepper), *Chenopodium album, Cichorium endivia* (endive), *C. intybus, Cobea scandens, Convolvulus sepium, Coreopsis* sp., *Cosmos* sp., *Cucurbita maxima* (squash), *C. pepo* var. *ovifera, Dahlia* sp., *D. pinnata, Eupatorium perfoliatum, Fagopyrum saggitatum* (buckwheat), *Galinsoga parviflora, Gladiolus* sp., *Hibiscus esculentus* (okra), *Iris* sp., *Iva frutescens, Lactuca* sp., *L. sativa* (garden lettuce), *Lilium canadense, L. longiflorum, Lonicera japonica, Lychnis alba, Lycopersicon esculentum* (tomato), *Narcissus* sp., *Oenothera biennis, Oxalis* sp., *Petunia* sp., *P. axillaris, Polygonum scandens, Potentilla recta, Rosa* sp., *Senecio vulgaris, Solanum melogena* (eggplant), *S. pseudocapsicum, S. tuberosum* (potato), *Spinacia oleracea* (spinach), *Trifolium pratense, Tulipa* sp., *Yucca filamentosa, Zea mays* (corn) and *Zinnia elegans.*

Macrosiphum granarium (Kirby) English Grain Aphid

Dr. W. F. Rochow of the Dept. Plant Pathology, Cornell University, wrote me in May 1960 that he finds this aphid very common on oats and barley in the Ithaca area but indicated that he has also found it in other parts of the state; also that in 1959 the aphid was particularly abundant in oat fields during the middle of June. According to Dr. Rochow it is by far the most important vector in New York of the barley yellow dwarf virus disease of oats. The virus also affects wheat and barley.

NYL – Doubtless widely distributed throughout the state. CANASERAGA, CHATHAM, HUDSON, KINDERHOOK, NIVERVILLE, STONE RIDGE and LI: GLEN COVE.

YONKERS 12 Feb 1927, on wheat in greenhouse, (Horsfall coll). ITHACA 10 Mar 1928, on corn in greenhouse, (L. F. Randolph coll; in CU), 10 Jl 1926, on oats in greenhouse, (Patch det). RUSH 22 Ju 1938, on wheat heads, (J. E. Longfellow coll—Russell det; in CU). LI: RIVERHEAD 13 May 1925, on rye, (Huckett coll—Patch det; in Me. Agr. Exp. Sta.).

Macrosiphum lilii (Monell) Purple-spotted Lily Aphid

Described from New York by Monell in Rept. U. S. Comm. Agr., p. 221 for 1879. His brief description and the notes which preceded it were reprinted in the Valley Naturalist 2(4):49–50, Dec 1880.

This beautiful aphid, which in life is yellow with a large purple spot on the dorsum, has been found outside of New York only in a few localities, as far as I know: Connecticut, the vicinity of District of Columbia, South Carolina, and Georgia.

Specific New York records are: ITHACA 13 Sept 1938, on *Lilium longiflorum*, (Griswold coll). YONKERS 9, 30 May, 3, 23 Aug 1938, on *L. formosanus, philippinense* and *speciosum;* BRONXVILLE 15 Ju 1938, on *L. regale,* (all E. P. Imle coll—Griswold det). LI: ORIENT Aug 1913, on *Lilium* sp. probably *canadense,* (Latham coll—Patch det); "LONG ISLAND" summer 1927, on lily, (Griswold coll—Patch det); ORIENT 21 Sept 1957, 23 Jl 1958, 2 Sept 1946 and 18 Jl 1959, GREENPORT 26 Jl 1959, CALVERTON 18 Sept 1946, RIVERHEAD 16 Sept 1946, PECONIC 17 Aug, EAST MARION 26 Jl 1958, on *Lilium superbum,* (all Latham coll); GREENPORT 27 Jl 1958, 31 Jl 1959, on *Lilium canadense,* ORIENT 14 Aug 1959, on *L. tigrinum,* (both Latham coll).

Because of the rarity of Monell's papers, the Valley Naturalist account is here reproduced in full:

"The Japan Lily Aphis." (*Siphonophora lilii,* n. sp., Monell.)

"Feeding upon the under sides of the leaves of the Japan lily and tulip, a red and yellow aphid 2mm (1/12 inch) in length.

"In July, 1879, specimens of a handsome aphid were received from Mr. Peter B. Mead, of New York City, who had studied them for some time upon the Japan lilies in his greenhouse. The following notes upon habits accompanied the specimens:

"'I first noticed this aphis in the spring of 1878 on some Japan lilies, the bulbs of which, as well as the earth in which they were grown, were received from Japan during the preceding winter. My attention was first attracted by an unusual appearance of the under surface of the leaves, which looked as if thickly dotted with small brown specks. A closer examination proved them to be plant-lice of a species entirely new to me. They were about half grown, but very soon attained maturity. Thickly grouped together on the leaves, they certainly presented a picturesque appearance, being the only aphis I have ever seen that could be called handsome. They multiplied with astonishing rapidity, and soon covered the plants. I am confident that they increase more rapidly than the green aphis. When disturbed they all seem to unite in a swaying motion, more marked than that of the green aphis.

"'Notwithstanding their great numbers, they do not injure or disfigure the plant to the same degree as other Aphides. At least this is the result of my observations thus far. If not disturbed, they literally cover the whole plant, buds and all. They seem thus far to confine themselves exclusively to the Japan lily, with but one exception. I have repeatedly examined all my other garden and pot plants, both last summer and this, without detecting this aphis on any of them, except for a few on the tulip.

"'After watching them for a few weeks last summer I began their destruction; but in September they all suddenly disappeared without further effort from me. Whether they will do so this year remains to be seen. During the winter a very few made their appearance on a tulip in the greenhouse, but were immediately killed, and no more were seen.

" 'In consequence of the cold and backward spring, they made their appearance quite late this year (1879). At the time of writing (July 26) they cover the plants on which they have not been disturbed; but, as was the case last year, they are confined exclusively to the Japan lilies. I have traveled about not a little, but have failed to discover this aphis, except in one place, which I can trace immediately to my own plants or more strictly, to the same lot. Hence I conclude that it came from Japan with the lilies or the soil.

" 'Specimens were sent to Mr. Monell for identification. He considered it to be a new species of the genus Siphonophora, and forwarded the following specific description for insertion in this report · *Siphonophora lilii* (n. sp.).

" 'General color yellow; basal half of abdomen brownish red. Antennae mounted on conspicuous tubercles. Style yellow, a little over half as long as the nectaries. Nectaries dusky, yellowish just at base, about four times as long as the tarsi. Venation normal. Length 2mm. Alar expanse 7mm. On flowers of Lilium.' "

Macrosiphum liriodendri (Monell) Tuliptree Aphid

NYL – Sometimes common on tuliptree leaves, at least in the vicinity of New York City.

ITHACA 15 Sept 1933 (Crosby coll), 13 Sept 1934 (Leonard and Crosby coll), 27 Ju 1939 (T. R. Hansberry coll); GENEVA 20 Sept 1946 (P. J. Chapman coll—Mason det); ROCHESTER 18 Jl 1959 (Pechuman coll)—all on tuliptree. OWLENBURG BOG Catt. Co. 20 Ju, LOCKPORT 4 Jl and LYNDONVILLE 17 Ju 1959, on *Magnolia acuminata*, (Pechuman coll). ROCHESTER 18 Jl 1959, on *M. slavani*, LOCKPORT 4 Jl 1959, on *M. soulangiana*, (Pechuman coll—MDL det; verified by CFS, who suggested there may be more than one species). MAMARONECK 8 Jl 1935, on *Tilia* sp., (S. W. Bromley coll). MEDINA 11 Jl 1960, on *Liriodendron tulipifera*, LYNDONVILLE 28 Sept 1960, on *Magnolia acuminata*, (Pechuman coll—CFS det). LI: BROOKHAVEN 18 Ju 1943, on tuliptree, (A. T. Gaul and Smith coll—Mason det; Sp Port Surv).

Macrosiphum luteum Buckton

May 14 1913, on orchids in a greenhouse, (P. J. Parrott coll—Patch det). Note in Me. Agr. Exp. Sta. Lot Book: "Recently brought in from the South". Note by G. W. Simpson in transmitting this record to MDL: "One would expect this was taken at GENEVA but not so stated in record."

Macrosiphum pelargonii (Kaltenbach) Geranium Aphid

Described as *M. cornelli* n. sp. from ITHACA by Patch in: Griswold, Ann. Ent. Soc. Am. 19:334, 1926.

ITHACA throughout the year in greenhouse on *Pelargonium domesticum, graveolens, odoratissimum, peltatum, quercifolium* and *radula*. Parasitized by *Praon simulans* Prov., *Aphelinus jucundus Gahan, A. semiflavus* How. and *Aphidencyrtus inquisitor* (How.); the latter may be a hyper parasite. "*P. hortorum*, the commonest of all geraniums, has never had these aphids on them. The aphids are found principally on the under surface of the leaves where they feed along the midrib and other large veins. They also cluster on the petioles and on the stems of new growth." (Griswold loc. cit.).

West Nyack 20 Oct 1960 (a number of apterae), on a potted Martha Washington Geranium, (Olsen coll). Lockport 18 Aug 1960, on *Geranium robertianum*, (Pechuman coll—Olive det).

Macrosiphum pisi (Harris) Pea Aphid

The status of the pea aphid in New York, which is present throughout the state, is probably best summarized by quoting from a letter of 4 April 1961 from Dr. George G. Gyrisco of the Department of Entomology, Cornell University:

> "Pea aphid is common on alfalfa and red clover where about once in 5 years it is of economic importance. We have found pea aphids on red clover, birdsfoot trefoil (*Lotus corniculatus*), black medic, vetch, crimson clover, alsike clover, white clover and zig-zag clover. I know of only two fields of sweet clover in New York—one in Ontario County and one in Cayuga County where it is used for green manure. We have found pea aphid on yellow sweet clover in these two fields, and I have seen it on white, which grows as a weed in much of central New York. The aphid is most abundant on field peas, alfalfa, red clover, vetch and birdsfoot trefoil—more or less in that order. The other host plants are of minor importance."
>
> It is interesting to note that Evans and Gyrisco (J.E.E. 49(6):878–879, 1956) have shown the pea aphid in New York to be a true "migratory" species. "The winter is passed in the egg stage on alfalfa (or other perennial legumes) and the resulting aphids produce several generations starting in the spring until the alfalfa slows in growth and matures, when they leave for more succulent annual legumes. Later as these mature and dry out, fall migrants develop and fly back to alfalfa (or other perennial legumes) and produce the sexual forms which deposit the overwintering eggs. Small populations of the pea aphid can, however, be found on alfalfa during the summer."

Several specific records of further interest are as follows: Ithaca 26 Jl 1926 (Oliver coll—Patch and Griswold det), 17 Jl 1939 (Griswold coll—Essig and Griswold det), on sweet peas; 30 Oct 1939, on red clover in the greenhouse, (W. A. Rawlins coll); 8, 9 Jl 1937, on sweet peas, (M. E. Phillips coll). LI: Wading River 30 May 1913, on *Medicago lupulina*, (Olsen coll); Orient 20 Jl 1946, on sweet peas, (Latham coll); Eastport 18 Ju 1943 ("many nymphs"), on bean foliage, (A. T. Gaul coll—Mason det; Sp Port Surv); this is the only record for the state on beans.

Macrosiphum pseudodirhodum Patch

NYL – "Ithaca Apr, May and Nov 1926, in greenhouse on rose, (Griswold coll—Patch det; [slides in CU]).

Common on indoor roses here at Ithaca;" (Cornell Ext. Bull. 162:6, 1927). Ithaca 16 Ju 1939, on *Spiraea latifolia*, (T. R. Hansberry coll; several slides of both apterae and alatae; in CU). Miss Louise Russell stated in July 1961 that this "appears to be close to *M. pseudodirhodum* Patch but we have no examples of this species and it is not recognizable from its description."

Macrosiphum pseudorosae Patch

TAUGHANNOCK GLEN 12 Sept 1933, on *Impatiens* sp.; EGGLESTON'S GLEN 12 Sept 1934, on *Eupatorium perfoliatum,* and CROSBY 13 Sept 1934, on *Oenothera biennis,* (all Leonard and Crosby coll). LI: BABYLON 5 May 1932, on *Gerbera* sp., (Blanton coll—Tissot det).

Macrosiphum rosae (Linneaus) Rose Aphid

The rose aphid is distributed throughout the state where it may be found every year, in greater or less numbers on cultivated and wild roses outdoors and on cultivated roses in greenhouses.

> This large aphid, which has both pink and green forms, frequently becomes so numerous on the leaves, tender shoots and buds of garden roses that growth of new shoots and flowers is retarded. The entire life history is presumably confined to the rose. Although the rose aphid has been recorded elsewhere from several other plants it has been found in New York only on teasel and once on tulips.
>
> Actual collections of the rose aphid in New York have been far from numerous, presumably since it is so common and widespread that they have been hardly considered worthwhile. However, besides collections simply labelled "rose" or *Rosa* (Cult.) from various parts of the state, it has been recorded from Long Island from "hybrid teas," sweet brier rose and moss rose besides.

LI: ORIENT Ju 1959, on *Rosa hugonis,* EAST MARION Oct 1959, on *R. rugosa,* (Latham coll). SI: The only specific record from here is by Rundlett Oct 1960, on hybrid tea rose. There are five recent records from *Dipsacus:* RINGWOOD Sept 1932, Oct 1934 on *Dipsacus* sp., (Leonard and Crosby coll); ITHACA 11 Jl 1939, on *D. sylvestris,* (Griswold coll); LOCKPORT 18 Ju, 8 Jl 1958, on *D. sylvestris* (Pechuman coll). The only other record I can find in this country is by Essig in 1916 in California on *D. fullonum.* The earliest collection in New York appears to be 2 slides in the USNM by Pergande from Rochester, 17 Ju 1902 (presumably on rose). Hayhurst collected it on rose at Fredonia, 14, 29 Ju 1905.

Macrosiphum sibericum (Mordvilko)

LOCKPORT 1 Oct 1960, on *Urtica gracilis,* "abundant, forming solid mats on undersides of leaves, no alates." A further note states that the aphids were so thick that the plants actually bent down with their weight; (Pechuman coll—Olive det). Palmer states that this aphid is rather common throughout the Rocky Mountain Region on the leaves and stems of *U. gracilis,* where it has been collected from May into October.

Macrosiphum tiliae (Monell)

This aphid is recorded as widely distributed in Illinois where it exhibits a fondness for the tender new shoots of linden, particularly around the base of the tree. The only record in New York is from ITHACA Forest Home 14 Sept 1934, on basswood, (Leonard and Crosby coll).

Masonaphis (Ericobium) azaleae Mason

LI: ORIENT 4 Jl 1924, on blueberry *Vaccinium atrococcum,* (Latham coll—LMR det; 1 slide in USNM).

Masonaphis (Ericobium) pepperi MacGillivray

BARRE Burma Woods 22 Ju 1960, on *Vaccinium* sp., (Pechuman coll—CFS det).

Masonaphis (Masonaphis) rhokalaza Tissot and Pepper

BERGEN SWAMP Genesee Co. 2 Aug 1960, on *Rhododendron nudiflorum* var. *roseum* (Pechuman coll—CFS det).

Masonaphis (Oestlundia) rubicola (Oestlund)

Spotted-winged Raspberry Aphid

(Previously in *Amphorophora.*)

As a result of a study of virus diseases of raspberries in western New York from 1931–35 L. M. Cooley stated that this aphid was found only occasionally, occurring in colonies on the fruit-spur foliage of wild red raspberries early each spring. He did not consider it an important factor in general mosaic spread in Western New York. (N. Y., Geneva, Agr. Exp. Sta. Bull. 665:5, 1936).

ITHACA 11 Jl 1939, N. FAIRHAVEN 2 Jl 1939, on *Rubus idaeus* var. *strigosus,* (Griswold coll—Essig and Griswold det; LMR det; slides in CU). TONAWANDA INDIAN RES. Genesee Co. 4 Aug 1959, on *R. occidentalis,* (Pechuman coll—LMR det).

Melanocallis caryaefoliae (Davis) Black Pecan Aphid

W. R. Richards, in Can. Ent. 92(3):224, 1960, puts this in *Myzocallis.* In his Reports 1 and 2, p 166, 1855, Fitch described *Aphis fumipenellus* as a new species and included this among those aphids that occur on hickory and walnut. This has been suggested as a synonym of the black pecan aphid, but Dr. Bissell says it is not and that Fitch's species is not recognizable.

ITHACA Ju 10, 12 (?1913), common on the hickories *Carya microcarpa* (now *ovalis*), (Morrison coll), 29 Sept 1933, on hickory, (Crosby coll) and summer of 1936 in lit. from T. H. Bissell: "The black pecan aphid was much in evidence on hickories with its yellow spotting of leaves." ROCHESTER, as *Myzocallis,* 29 Ju 1909, on "upper surfaces of the leaves of *C. alba,* fairly common." (Gillette, J. E. E. 3(4):369, 1910).

Melaphis rhois (Fitch) Sumac Gall-Aphid

Dr. Fitch's original account of this aphid referred to it as: "The Sumach Gall-Aphis (*Byrsocrypta rhois* new species)".

NYL – Besides several localities specifically listed below, Dr. Felt gives LITTLE FALLS and CANANDAIGUA. He also says: "Has been observed in LOWER HUDSON VALLEY and is generally distributed though comparatively rare."

THREE-MILE BAY 7 Sept 1928, in sumach gall, (Crosby coll—Patch det; 8 slides in CU). MONKEY RUN Tompkins Co. 10 Aug 1938, in leaf gall of *Rhus typhina,* (T. R. Hansberry coll—Essig det).

Fitch: "On referring to my MSS, I find that I, nine years ago, drew up for publication a description of the red ball-like galls on the sumach leaves and the insects which produce them—which galls Mr. Wm. M. Smith appears to have noticed about the same time at Manlius, N. Y. . . .I withheld this matter from the press, hoping to meet with other specimens, whereby to be better assured as to the genus to which this insect properly belongs. I remember going the next year to the spot where these galls grew and feeling much disappointed on discovering that none of them were produced there that season. Although in my rambles I have passed the same place, I presume, every autumn since that time, no further specimens have occurred to my notice. I therefore send you the notes upon this insect, which have been lying on hand such a length of time." There then follows the description of the insect and its galls. (Jour. N. Y. State Agr. Soc. 16(8): 73, 1886).

Micromyzus formosanus Takahashi? Onion Aphid

ITHACA Dec 1923, on onion, (Crosby coll; 1 slide in USNM). Another report: 12 Feb 1926, on onion in CU Plant Path. greenhouse, gave no collector, but probably Griswold, 5 slides in CU; since these did not seem to fit the description of *M. formosanus*, I sent 2 slides of 1 alate each (these were the only alates) and 1 slide with 4 apterae to Prof. Essig for his opinion. He writes these were never received by him. The specific determination of this onion aphid therefore remains uncertain.

Micromyzus violae (Pergande) Violet Aphid

POUGHKEEPSIE 14 Dec 1898, on violets, (2 slides in USNM). LI: PATCHOGUE 15 Oct 1901 (1 slide in USNM, No. 8035).

Microparsus variabilis Patch

TONAWANDA INDIAN RES. Genesee Co. 4 Aug 1959, 18 Jl and 5 Aug 1960, on *Desmodium canadense*, (Pechuman coll—CFS det).

Mindarus abietinus (Koch)

NYL – STAR LAKE St. Lawrence Co., LAKE CLEAR, PAUL SMITH'S Franklin Co., ELIZABETHTOWN, WATERTOWN, Jl and MT. KISCO Ju, on balsam and Scotch pine. WARWICK Jl.

LI: The only other record for the state is LOCUST VALLEY 25 May 1936, on white fir *Abies concolor,* (K. E. Maxwell coll—MDL det).

Monellia caryae (Monell) American Walnut Aphid

POUGHKEEPSIE 1 Aug 1933, moderately common on leaves of black walnut, (Leonard coll—Tissot det). ITHACA (no date given but is 1904 or 1905), on *Carya amara,* (Hayhurst coll; 1 slide in USNM). LYNDONVILLE 19 Ju 1959, on *Juglans nigra* "very abundant and eventually defoliated the trees", 19 Ju, on *J. sieboldiana,* and 17 Ju 1959, on *Carya ovata,* (Pechuman coll). GASPORT 2 Jl 1959, on *Juglans nigra,* TONAWANDA INDIAN RES. Genesee Co. 4 Aug 1959, on *Carya ovata,* (Pechuman coll). MIDDLEPORT 19 Sept 1960, on *C. cordiformis,* LYNDONVILLE 15 Jl 1960, on *Juglans nigra,* (Pechuman coll—CFS det). WHITE PLAINS 8 Jl 1935, accidental on *Corylus* sp., (S. W. Bromley coll). LI: MATTITUCK 2 Jl, PECONIC 9 Jl 1959, on *Juglans nigra,* on latter date "common, much honey-dew", (Latham coll).

Monellia caryaella (Fitch)

In describing this as a new species Fitch merely indicates it occurs on hickory. There is 1 COTYPE slide in USNM from Fitch coll., by A. C. Baker, No. 1542; 1 slide same as above by Baker 1539; 2 slides marked "1540 Fitch (TYPE) on hickory" in Pergande's writing.

SHERIDAN 3 Aug 1905, on *Carya amara,* (Hayhurst coll—Tissot det). ITHACA very common on the underside of the leaves of nearly every hickory around the University campus, (Morrison coll). LI: MATTITUCK 5 Jl 1946, on *Juglans regia,* (Latham coll).

Monellia costalis (Fitch) Black-Margined Aphid

In describing this as a new species Fitch merely indicates it occurs on hickory; 1 slide in USNM labeled "Type, from Fitch coll.," made by Baker.

NYL – WATERVLIET Aug 1934, abundant on pignut, (Leonard coll—Patch det).

ITHACA 17 Sept 1933, on *Carya* sp., (Crosby coll). EGGLESTON'S GLEN Yates Co. 13 Sept 1934, on shagbark hickory, (Leonard and Crosby coll). SODUS 13 Jl 1952 (alate), on ? wild cherry, (S. H. Kerr coll; slide in USNM). PALMYRA 2 Aug 1959, on beech (accidental) and hickory, (Pechuman coll—CFS det). TONAWANDA INDIAN RES. 9 Aug, on *C. glabra,* LYNDONVILLE 17 Ju 1959, LOCKPORT 1 Oct 1960, on *C. ovata,* and MIDDLEPORT 19 Sept 1960, on *C. cordiformis,* (Pechuman coll—CFS det). LI: NORTHWEST 12 Sept 1948, on *C. cordiformis* from galls, (Latham coll); RIVERHEAD 31 Jl 1956, "alate in water trap in potato field", (P. J. Chapman coll; 2 slides in USNM); GREENPORT 2 Aug 1959, on *C. glabra,* PECONIC 9 Jl 1959, on *Juglans nigra,* (Latham coll).

Monellia nigropunctata Granovsky

ITHACA 13 Sept 1933, on hickory, (Crosby coll), 28 Jl 1938, on *Carya* sp., (Griswold coll—Mason det; 2 slides in CU). EGGLESTON'S GLEN Yates Co. 13 Sept 1934, on shagbark hickory, (Leonard and Crosby coll). TONAWANDA INDIAN RES. Genesee Co. 4 Aug 1959, on *C. ovata,* MIDDLEPORT 19 Sept 1960, on *C. cordiformis,* and LOCKPORT 4 Jl 1959, "drift" on *Magnolia acuminata,* (Pechuman coll—CFS det). LI: MONTAUK 30 Jl 1933, on hickory, (Leonard coll); PECONIC 9 Jl 1959, on *Juglans nigra,* (Latham coll—CFS det).

Mordvilkoja vagabunda (Walsh) Poplar Vagabond Aphid

ROCHESTER 29 Ju 1909, "A single gall, quite immature, was taken from cottonwood", (Gillette in J.E.E. 3(5):356, 1910).

NYL – Reported from MONROE, WASHINGTON, SARATOGA and RENSSELAER COUNTIES and is probably rather generally present in sections of the state where poplars grow. Produces a very irregular, frequently massed, deformation of poplar leaves.

EAST AURORA 10 Aug 1933, dried up galls common on *Populus* sp., (Crosby and Leonard coll). N. FAIRHAVEN 2 Jl 1939, from twig gall on *P. canadensis,* (T. R. Hansberry coll—Griswold det; 10 slides in CU).

Myzaphis rosarum (Kaltenbach)

NYL – as *Francoa rosarum* (Kalt.) – ITHACA Oct, on rose in greenhouse, (Griswold coll—Patch det).

"Common on indoor roses at Ithaca", Cornell Univ. Ext. Bull. 162:6, 1927. ITHACA 27 Oct 1927, on *Rosa,* (Griswold coll—Patch det; Me. Agr. Exp. Sta. coll).

ITHACA sexual forms (only) on cultivated rose in late Oct and Nov (?1913), on the underside of the leaves, (Morrison coll).

Myzocallis sp.

LYNDONVILLE 2 Sept 1960, on *Quercus* sp., MIDDLEPORT 19 Sept 1960, on *Q. bicolor,* (Pechuman coll—Ole Heie det).

Myzocallis alhambra Davidson

ITHACA 26 Ju 1936, abundant on leaves of a large oak, (MDL). GENEVA 20 Oct 1946, abundant and ovipositing on *Quercus bicolor,* (Chapman coll—Mason det). LYNDONVILLE 25 Aug 1959, on *Q. bicolor,* (Pechuman coll); LYNDONVILLE 19 Ju 1959, 2 Sept 1960, on *Quercus* spp.; LYNDONVILLE 15 Jl, 2 Sept 1960, BARRE Burma Woods 1 Oct 1960, TONAWANDA INDIAN RES. Niagara Co. and LOCKPORT 10 Aug 1960, on *Q. bicolor;* LYNDONVILLE 15 Jl 1960, on *Q. coccinea* and *Q. velutina,* 2 Sept 1960, on *Q. bicolor;* LOCKPORT 1 Oct 1960, on *Q. macrocarpa,* (all Pechuman coll—Ole Heie det). LI: GREENPORT 27 Sept 1957, 22 Ju 1958, on *Q. bicolor,* 15 Ju 1958, as "drifts" on *Osmorhiza longistylus,* (Latham coll); FARMINGDALE 7 Ju 1938, on *Q. alba,* (Leonard and Haude coll); SOUTHOLD 27 Ju 1958, on *Q. bicolor,* (Latham coll).

Myzocallis alnifoliae (Fitch)

"*Lachnus alnifoliae* n. sp. On alder leaves. No. 857 male." (Fitch, Cat. Homop. N.Y., p 67, 1851). ITHACA 11, 20 Oct 1906, on *Alnus glutinosa* and *A. rugosa,* (Hayhurst coll—Tissot det), 31 Jl 1939, on *A. incana,* (Griswold coll and det).

Myzocallis annulata (Hartig)

ITHACA 29 Aug 1939, on *Quercus robur,* (Griswold coll—Essig det; 3 slides in CU).

Presumably the first record of this aphid in the United States.

Myzocallis asclepiadis (Monell)

SHERIDAN 16 Jl 1905, on *Asclepias syriaca,* (Hayhurst coll and det). GENEVA 29, 30 Ju 1909, "both alate and apterous in good numbers", from *Asclepias* sp., (Gillette, J.E.E. 3(4):368, 1910), 29 Oct 1946, on *Asclepias* sp., (Chapman coll—Mason det). CROSBY 10 Sept 1934, on milkweed, (Crosby and Leonard coll). ITHACA (1905), on *A. syriaca,* (Hayhurst coll; slide in USNM), 30 Aug 1935, on milkweed, (Crosby coll). HAGUE, LAKE GEORGE Jl 1947, on milkweed, (M. D. and D. D. Leonard coll). PORTLAND 23 Sept 1959, LOCKPORT 3 Sept 1960, on *A. syriaca,* (Pechuman coll). ILION Madison Co. Aug 1960, heavily infesting lamb's quarters scattered throughout a poorly cared for field of cabbage and cauliflower and mixed with *Myzocallis punctata (Monell),* (A. A. Muka coll—MDL det). LI: PECONIC 25 Jl 1948, on *A. syriaca,* GREENPORT 26 Jl, 2 Aug 1959, common on *A. amplexicaule,* ORIENT 3 Aug 1959, on *A. syriaca,* (all Latham coll).

Myzocallis bella (Walsh)

ROCHESTER 29, 30 Ju 1909, on upperside of leaves of *Quercus rubra,* (Gillette, J.E.E. 3(4):368, 1910); this may or may not be *bella.* WHITE PLAINS 27 Sept 1914, on *Q. rubra,* (Olsen coll); this may or may not be *bella.* ITHACA Ju 1912, rather common on *Q. rubra,* (Morrison coll); this may or may not be *bella.* ITHACA 29 Sept 1933, on *Q. borealis,* (Crosby coll—Boudreaux and Tissot det). LYNDONVILLE 2 Sept 1960, on *Quercus* sp., TONAWANDA INDIAN RES. Genesee Co. 3 Sept, MIDDLEPORT 19 Sept 1960, on *Q. borealis maxima* red oak, (Pechuman coll—Ole Heie det). LI: RIVERHEAD 20 Sept 1957, on *Q. coccinea,* (Latham coll—Boudreaux and Tissot det); KISSENA LAKE Flushing 4 Oct 1914, on *Q. rubra* (Olsen coll); may or may not be *bella.*

Myzocallis coryli (Goeze)

ITHACA 26 Sept 1933, on *Corylus* sp., (Wm. E. Blauvelt coll), 24 Jl 1939, on *C. americana,* (Griswold coll and det). GENEVA 20 Sept 1946, on *C. maxima,* (Chapman coll—Mason det; 1 slide in USNM). LYNDONVILLE 15 Jl, 2 Sept 1960, on *C. avellana,* 15 Jl 1960, on *C. avellana* var. *contorta,* (Pechuman coll—CFS det).

Myzocallis discolor (Monell) Eastern Dusky-winged Aphid

ITHACA Presumably this species was very common and indeed a pest on white oaks in the vicinity of Ithaca from June 1912–1914; apparently not reported from the state before, (Morrison coll).

LI: MASPETH 26 Oct 1914, on *Quercus prinus,* (Olsen); BABYLON 29 Jl 1934, on *Q. marylandica,* (Blanton coll—Tissot det); GREENPORT 23 Ju 1947, on *Q. stellata,* SOUND AVE. 25 Jl 1948, on *Q. bicolor,* (Latham coll).

Myzocallis frisoni Boudreaux and Tissot

LI: WESTBURY 6 Oct 1943, on *Quercus palustris,* (Plummer coll—Boudreaux and Tissot det; Sp Port Surv; 1 slide of 3 oviparae in USNM).

Myzocallis granovskyi Boudreaux and Tissot

ITHACA 22 Aug 1958, on *Quercus rubra,* (John Graham coll—Boudreaux and Tissot det), 1 Aug 1959, on *Quercus* sp., (CFS et al coll—Boudreaux and Tissot det).

Myzocallis melanocera Boudreaux and Tissot

ITHACA 27 Jl 1938, 2 Ju 1939, on *Quercus rubra,* (Griswold coll—Boudreaux and Tissot det). GENEVA 20 Sept 1946, on *Q. borealis,* (Chapman coll—Boudreaux and Tissot det). LOCKPORT 4 Ju 1959, on *Q. borealis,* (Pechuman coll—Boudreaux and Tissot det). LI: RIVERHEAD 9 Sept 1934, on oak, (Leonard and Crosby coll—Boudreaux and Tissot det); FLUSHING N. Y. World's Fair Ground 23 Jl 1939, on *Q. coccinea,* (MDL coll—Tissot det).

Myzocallis multisetis Boudreaux and Tissot

ITHACA 2 Ju 1939, on *Quercus rubra,* (Griswold coll—Boudreaux and Tissot det), 1 Aug 1959, on hickory oak, (CFS et al coll—Boudreaux and Tissot det); I cannot substantiate the name of this oak—MDL.

Myzocallis punctata (Monell) Clear-winged Oak Aphid

ITHACA 5 Jl 1938, on *Asclepias syriaca,* (Griswold coll—Essig and Griswold det). OAK ORCHARD SWAMP Genesee Co. 4 Aug 1959, on *A. syriaca,* LYNDONVILLE 19 Ju 1959, on *Quercus* sp. (exotic), (Pechuman coll). ILION Madison Co. Aug 1960, heavily infesting lamb's quarters scattered throughout a poorly cared for field of cabbage and cauliflower mixed with *Myzocallis asclepiadis* (Monell), (A. A. Muka coll—MDL det). LI: Greenport 23 Ju, Northwest 26 Ju 1947, on *Quercus stellata,* (Latham coll).

Myzocallis punctatella (Fitch)

In describing this as a new species Fitch (First & Second Reports, p. 165, 1856) merely states it is a hickory aphid. Ithaca 22, 30 Sept 1933, on leaves of *Quercus alba,* (Leonard and Crosby coll), 16 Aug 1927 (det Mason with query) and 25 Jl 1938, on *Q. alba,* (Griswold coll—Essig and Griswold det). 1 slide in USNM labeled "*Callipterus punctatellus,* Type, Fitch No. 1577."

Myzocallis spinosa Boudreaux and Tissot

LI: Riverhead 9 Sept 1934, on oak, (Leonard and Crosby coll—Boudreaux and Tissot det); Flanders 25 Ju 1946, one cluster on *Quercus illicifolia,* (Latham coll—Boudreaux and Tissot det).

Myzocallis tiliae (L.)

Sheridan 8 Aug 1905, on *Tilia americana,* (Hayhurst coll—Tissot det). Geneva 29, 30 Ju 1910 (as *Eucallipterus*), "from underside of leaves of basswood *T. americana.* Common but nowhere seen abundant." (Gillette in J.E.E. 3(4):367, 1910). Ithaca and vicinity (1913 or 1914), common on *T. americana,* (Morrison coll), 22 Aug (about 1914), on basswood, (O. A. Johannsen coll—Patch det; Me. Agr. Exp. Sta. Lot Book), 13 Aug 1937, on *T. cordata,* 1 Aug 1938 on *Tilia* sp., (Griswold coll and det) and 31 May 1958, on *Tilia* sp., (Graham coll—CFS det). Olcott Keg Creek 5 Oct 1960, on *T. americana,* (Pechuman coll—CFS det). Albany on roof of State Education Bldg. 9, 25 Jl 1927 (Felt and Chamberlain coll). Yonkers 21 Ju 1927, on *T. americana,* (J. L. Horsfall coll and det). Geneva 20 Sept 1940, on *T. glabra,* (P. J. Chapman coll—Mason det). Lyndonville 22 May, 1 Jl and 25 Aug 1959, on *T. cordata,* (Pechuman coll). Port Chester 8 Jl 1935, on *T. europaea,* (S. W. Bromley coll). LI: Riverhead 9 Sept 1934, a "drift" on oak leaves, (Leonard and Crosby coll—Tissot det); Southold 21 Jl 1946, Mattituck 3 Jl 1946, on *T. americana,* (Latham coll), 4 Ju 1953, on linden, (Bartlett Tree Res. Labs.); Brooksville 10 Aug 1934, on linden, (Crosby coll—Tissot det).

Myzocallis ulmifolii (Monell) Elm Leaf Aphid

NYL – Common and frequently destructive to the American elm; Albany, Broome, Chautauqua, Fulton, Monroe, Montgomery, Oneida, Ontario, St. Lawrence and Warren Counties, probably generally distributed throughout the state.

Fredonia Aug 1905, on *Ulmus fulva,* (Hayhurst coll). Rochester 29 Ju, Geneva 29, 30 Ju, New York Central Park 2 Jl and Albany

1 Jl 1909, "on elms", (Gillette in J.E.E. 3(4):369, 1910). ITHACA 12 Aug 1933, 28 Aug 1935 (Crosby coll), (1904 or 1905), on *U. americana,* (Hayhurst coll; 2 slides in USNM) and 29 Jl 1938, on *U. americana,* (Griswold coll and det). YONKERS 8 May 1937, on American elm, 4 Jl 1959, ITHACA CU Campus, on American elm, (John Graham coll). LYNDONVILLE 1, 8 Jl 1959, on American elm, LOCKPORT 4 Jl 1959 5 Sept 1960, on *Ulmus thomasi,* (Pechuman coll). GENEVA 20 Sept 1946, on American elm, (Chapman coll—Mason det). PORT CHESTER Ju 1935, on leaves of American elm, (S. W. Bromley coll).

Myzocallis walshii (Monell)

Dr. Boudreaux of Louisiana State University writes me that he believes this is a complex of *walshii* and several new species.

GENEVA 29, 30 Ju 1909, common on *Quercus rubra,* (Gillette in J.E.E. 3(4):368, 1910); this may or may not be *walshii.* ITHACA 26 Jl, 28 Aug 1937 and 27 Jl 1938, on *Q. rubra,* 3 Aug 1938, on *Q. imbricaria,* (all Griswold coll—Boudreaux and Tissot det), 16, 22 Aug 1958, on *Q. rubra,* (John Graham coll—Boudreaux and Tissot det). TONAWANDA INDIAN RES. Genesee Co. 20 Aug 1958, on *Q. borealis,* (Pechuman coll—Boudreaux and Tissot det). LI: GLEN HEAD 24 Jl 1936, on *Q. velutina,* (Maxwell coll—Boudreaux and Tissot det); RIVERHEAD 2 Sept 1957, on *Q. ilicifolia,* (Latham coll—Boudreaux and Tissot det). LYNDONVILLE 19 Ju 1959, on *Q. borealis maxima,* (Pechuman coll—CFS det), Jl 15, Sept 6, 19 and 24 1960, on *Q. borealis maxima red oak,* (Pechuman coll—Ole Heie det).

Myzus sp.

TONAWANDA INDIAN RES. Erie Co. 3 Sept 1960, immatures only, on *Myosotis laxa,* (Pechuman coll—CFS det).

Myzus sp.

ITHACA 30 Sept 1933, on *Galium* sp., (Crosby coll—Tissot det). This may be *cerasi* Fab. since *Galium* has been found elsewhere to serve as a summer host for this aphid. (See also *Myzus cerasi*).

Myzus cerasi (Fabricius) Black Cherry Aphid

Widely distributed in New York and formerly often reported to be very injurious to cherries, badly curling the leaves. In Canada and Europe a partial migration takes place to *Galium* and *Lepidium* and it has been found in Illinois on the former but this aphid has not been identified from these plants in New York. It is possible, however, that a collection made by Crosby at ITHACA 30 Sept 1933, on *Galium* sp., and det by Tissot as *Myzus* sp. may be *cerasi.*

NYL – Generally distributed throughout the state, definite records extending from SARANAC INN to WADING RIVER LI.

NEW YORK as *Aphis*, "Common on the underside of the garden cherry (*Cerasus vulgaris* Mill.). No. 840, male." (Fitch, Cat. Homop. N.Y., p. 65, 1851.)

ITHACA rather common on some cultivated cherries and on escapes from cultivated plants around town, (Morrison coll). YONKERS 3 Ju 1927, on cherry, (J. L. Horsfall coll and det). POUGHKEEPSIE 14 Jl 1938, on cherry, (J. A. Evans coll). BRONX 19 Oct 1943, on *Cotoneaster rosea*, (Adams and Sanford coll—Mason det; Sp Port Surv). LOCKPORT 6 Ju 1959, 19 May 1960, on *Prunus avium;* BARRE Burma Woods 1 Aug and JOHNSONBURG 5 Ju 1960, on *P. pennsylvanica*, (all Pechuman coll). LI: RIVERHEAD 29 Jl 1933, on cherry, (Leonard coll—Tissot det); GREENPORT 15 Ju 1958, ORIENT 24 May 1959, E. MARION 25 Ju and PECONIC 9 Jl 1959, on *P. avium*, ORIENT 9 Ju 1959, 11 May 1960, on *P. cerasus*, (all Latham coll). ITHACA 27 Ju 1939, on *P. avium*, (Hansberry coll—Griswold det).

The Extension Fruit Entomologist at Cornell, Dr. Paul Wooley, furnished the following statement in May 1961: "Black cherry aphid is found to some extent in sweet cherry plantings in Western New York (Wayne, Monroe, Orleans, Niagara Counties) and Hudson Valley (Rockland, Westchester, Orange, Ulster, Dutchess, Columbia and Schenectady Counties). However, it is normally of minor importance." This is based on his own experience of the past seven years with tree fruit insects in the state.

Myzus circumflexus (Buckton) Crescent-marked Lily Aphid

LI: *"Siphonophora circumflexus*, attacks calla lilies, Cyclamens, "Dusty Miller" *Senecio cineraria* and *Spiraxis*. It caused most noticeable injury to the flower of the calla. . . . As soon as the flowers open the plant lice crowd into them and in a short time make them filthy. A soot-like mould soon begins to grow on the flowers where the pests work. (F. A. Sirrine in 14th Ann. Rept. NY (Geneva) Agr. Exp. Sta. for 1895, p. 603, 1896). This is the first report of this aphid in the United States.

ITHACA Mar 1917, on tulip in greenhouse, (Leonard coll—Patch det); Mar 1927, on *Cyclamen* sp., (Upton coll—Griswold det); May, on *Heliotrope* in greenhouse, on *Calendula* sp., Ju, on *Myosotis* in greenhouse, May, Ju, on rose, *Vinca variegata*, Wandering Jew and *Calendula* sp., all in 1926 (Griswold coll—Patch det); Mar 1939, on *Lilium auratum*, (Griswold coll—LMR det). YONKERS 15 May, on *L. pumilum*, 5 Ju 1938, on *L. phillippinense*, (E. P. Imle coll—Essig and Griswold det). NEW YORK Botanic Gardens Jl, Aug, Sept 1931, on *Dahlia*, (Philip Brierley coll; slides in USNM). LI: BABYLON 13 Mar 1935, on Easter Lily, (F. J. Spruijt coll; slide in USNM).

Myzus ligustri Mosley Privet Aphid

LI: ORIENT 14 Jl 1946 (1 aptera), on *Ligustrum vulgare*, (Latham coll).

Myzus lythri (Schrank) Mahaleb Cherry Aphid

ITHACA 21 Jl 1939, on *Lythrum salicaria*, (T.R. Hansberry coll—Essig det 1 slide, LMR det another slide; in CU). LOCKPORT 4 Ju, 4 Jl 1959, on *Prunus mahaleb*, (Pechuman coll—MDL and CFS det). MT. KISCO Bedford Lake Park 11, 27 Aug 1960, on *Lythrum salicaria*, (John Graham coll—MDL and CFS det). LI: GREENPORT 22 Ju 1958, on *Decodon verticillatus*, (Latham coll—LMR det).

Myzus monardae (Davis) Horsemint Aphid

LOCKPORT 10 Ju 1959, on *Monarda fistulosa* "leaves very tightly rolled but only a few aphids found", 12 Aug 1959 (1 alate and 2 apterae), "the only aphids seen on this plant since June 10." (Pechuman coll—MDL and CFS det); 28 May 1960, on *M. fistulosa*, (Pechuman coll—det CFS with query).

Myzus persicae (Sulzer) Green Peach Aphid

This is our commonest aphid. Its distribution is world-wide and it has been recorded from at least 335 species of plants distributed in about 235 genera in 69 plant families. It is found throughout New York where it has here been recorded from about 100 plants. Of these, however, it has been recorded from 67 plants only once and from 15 others only twice. More plants will undoubtedly be added as more collecting is done.

Outdoors in New York, the green peach aphid spends the winter chiefly on the peach, plum and cherry, as eggs placed in the axils of the buds and crevices of the bark. The eggs hatch about the time the buds burst and winged lice in the third generation start to migrate to their herbaceous summer food plants on which they maintain themselves until fall. In the greenhouse, breeding is continuous on a number of plants throughout the year and here it is known to florists as the common and often destructive "green-fly", frequently requiring control measures.

This aphid had formerly been recorded for many years as being injurious in some seasons in commercial plantings of peaches, plums and prunes in Western New York and in the Hudson River Valley. Specifically as to peaches, however, Dr. A. A. Muka, Extension Entomologist at Cornell University, wrote me in May 1961 that Dr. Paul Wooley, his Fruit Specialist, based on the past seven years experience, makes the following statement: "Green peach aphid can probably be found in most commercial orchards but is regarded as a minor pest on peaches. Rarely do agents report it in their weekly disease and insect reports." Also known as the "spinach aphid", it is seasonally destructive on this crop in the state as it is also, to some extent at least, on cabbage, cauliflower, brussels sprouts, peppers, potatoes, rutabaga, broccoli, kale, eggplant and radish.

In addition to its direct injury by feeding on economic plants, this aphid is capable of transmitting a number of destructive plant viruses. Throughout its world-wide range Eastop, "A study of the Aphididae (Homoptera) of East Africa", p. 55, 1958, states that it has been shown to be a vector of more than 100 plant viruses. Dr. Karl H. Fernow, Department of Plant Pathology, Cornell University, wrote me in October 1961 that field transmission of the leaf roll virus of the potatoes can be attributed almost entirely to *M. persicae* but, although this virus occurs in New York not infrequently, it does not often give much trouble in spite of the abundance of the vector. He says it also transmits virus Y of potatoes in a non-persistent manner but that this virus is not very prevalent in New York.

Because of the large number of plants on which the green peach aphid has been found in New York it is felt that the detailed records of its occurrence on these plants would occupy more space than is warranted in this paper. A number of the plants have only rarely been recorded elsewhere as food plants of this aphid and several listed below are recorded presumably for the first time. One of the more interesting of the latter records is on the African violet *Saintpaulia ionantha,* collected by Paul C. Lippold at Middleport, 14 May 1958, (1 slide in USNM). This is the first definite collection from this plant in the U.S.A. Leon W. Coles sent me a number of specimens taken in December 1960 on the flowers and flower-stems of two of his African violet plants growing indoors in Columbus, New Jersey; all sizes of the apterae were present but only one alate. Dr. Floyd F. Smith tells me he has occasionally seen this aphid near Beltsville, Maryland, on potted African violet plants after they have been placed outdoors. (It may be of interest to note that the only published record I can find of an aphid on African violet is by Hall (1926) in Egypt—*Idiopterus nephrolepidis* Davis).

During the seasons of 1958–60 W. H. Day and W. A. Rawlins of Cornell University made a study (as yet unpublished) of the parasites and predators of the green peach aphid on potatoes in connection with the possible effect of insecticides on its abundance. This was done at Riverhead, Long Island. They have kindly permitted me to include the names of the parasites and predators in this paper. The parasites are as follows:

Braconidae: *Aphidius nigripes* Ashm. and *A. nigriteleus* Smith, *Praon simulans* (Prov.), *P. aguti* Smith, *P. occidentalis* Baker. *Eulophidae*: *Aphelinus semiflavus* How.

For the predators see the section on "Natural Controls and Ants."

There follows in alphabetical order by botanical names the known food plants of *Myzus persicae* in New York:

Althea rosea (hollyhock), *Amaranthus retroflexus* (pigweed), *Antirrhinum* sp. (snapdragon) in the greenhouse, *Apium graveolens dulce* (celery), *A. graveolens rapaceum* (celeriac), *Armoracia lapathifolia* (horse-radish), *Atriplex patula, Bougainvillea* sp., *Brassica* sp. (mustard), *B. kaber* var. *pinnatifida* (crunchweed), *B. napobrassica* (rutabaga), *B. oleracea* var. *capitata* (cabbage), *B. napus* (rape), *B. oleracea* var. *gonglyoides* (kohlrabi), *B. oleracea* var. *acephala* (kale), *B. oleracea* var. *botrytis* (cauliflower), *B. oleracea* var. *gemmifera* (brussels sprouts), *B. rapa* (turnip), *Bryphyllum* in the greenhouse, *Cakile edentula, Calendula* sp. in the greenhouse and outdoors, *Calliandra inaequilateralis*, *Campsis radicans* (trumpetcreeper), *Capsella bursa-pastoris* (shepherd's purse), *Capsicum frutescens* (redpepper), *Chenopodium album* (lamb's quarters) in the greenhouse, *Chrysanthemum frutescens* (marguerite), *Ch. leucanthemum* (ox-eye daisy), *Cineraria* sp., *Crataegus oxycantha* var. *pauli*, *Crocus* sp., *Cucumis sativa* (cucumber), *Dahlia* sp., *D. pinnata*, *Dianthus caryophyllum* (carnation) in the greenhouse, *D. chinensis* (Chinese carnation), *Erythronium dens-canis* (dog's-tooth violet), *Galinsoga parviflora* (quickweed), *Gerbera* sp., *Gladiolus* sp., *Glechoma hederacea* (gill-over-the ground), *Gnaphalium polycephalum* (cudweed), *Hedera helix* (English ivy), *Helichrysum* sp. (everlasting), *Hibiscus esculentis* (okra), *Ipomaea batatas* (sweet potato) in the greenhouse, *I. purpurea* (morning glory) in the greenhouse, *Iris* sp., *Lactuca sativa* (garden lettuce), *Lepidium virginicum* (peppergrass), *Martynia louisiana* (devil's claws), *Mathiola incana* (common stock) in the greenhouse, *Matricaria matricarioides, Myosotis* sp. (forget-me-not), *M. alpestris* (Alpine forget-me-not) in the greenhouse, *Narcissus* sp., *Nemsia strumosa, Nemophila menziesi, Nicotiana longiflora, N. tabacum* (tobacco) in the greenhouse, *Oxalis* sp. in the greenhouse, *Petroselinum crispum* (parsley), *Petunia axilaris, P. hybrida* (common petunia), *Philadelphus purpurascens, Polanisia graveolens* (stinking clammyweed), *Prunus avium* (sweet cherry), *P. domestica* (plum, prune), *P. persica* (peach), *P. seiboldi* (Seibold cherry), *P. serotina* (black cherry), *P. serratula* (oriental cherry), *P. virginiana* (chokecherry), *P. yedoensis* (Yoshino cherry), *Pyrus communis* (pear) in the greenhouse, *Ranunclus* sp. (buttercup), *Raphanus raphanistrum* (wild radish), *R. sativus* (garden radish), *Rheum rhaponticum* (rhubarb), *Ricinus communis* (castor bean), *Rumex crispus* (curled dock), *R. obtusifolia* (broadleaved dock), *Saintpaulia ionantha* (African violet), *Senecio mikanoides* (German ivy) in the greenhouse, *S. vulgaris* (common groundsel), *Sisymbrium officinale* (hedge mustard), *Solanum dulcamara* (bitter night-shade), *S. lycopersicon* (tomato), *S. melogena* (eggplant), *S. pseudocapsicum* (Jerusalem cherry), *Solanum tuberosum* (potato), *Sonchus arvensis* (smooth sowthistle), *Spinaca oleracea* (spinach), *Stellaria* sp. (chickweed), *S. media* (chickweed), *Trifolium pratense* (red clover), *Tropaeolum* sp. (nasturtium), *Tulipa* sp., *Vinca* sp. (periwinkle), *V. major* var. *variegata* (mottled periwinkle) and *Yucca filamentosa* (Adamsneedle yucca).

Myzus physocarpi Pepper

GENEVA 24 Oct 1946, on *Physocarpus opulifolius,* (P.J. Chapman coll: 1 slide in USNM).

Myzus porosus Sanderson Yellow Rose Aphid

ROCHESTER 11 Sept 1923, on rose, (L. W. Pizzini coll—Mason det). ITHACA Mar 1926, on rose in greenhouse, (Griswold coll). SI: WOODBURY 17 Sept 1943, on strawberry leaves, (M.J. Ramsey coll—Mason det; Sp Port Surv). LI: JACKSON HEIGHTS 5 Ju 1939, on *Rosa* cult., (MDL coll); RIVERHEAD 20 Aug 1957, on wild rose, (W. A. Day coll: slide in USNM).

Myzus sensoriatus Mason

LI: GREENPORT 22 Sept 1957 (a few apterae and alates), on *Lycopus americana,* (Latham coll—LMR det). The type slide in USNM bears four alate viviparae taken by Pergande, 14 May 1906, on *Crataegus crusgalli*, at Chain Bridge in the District of Columbia.

Myzus solani (Kaltenbach) Foxglove Aphid

This has previously been determined as *convolvuli* Kalt. and *pseudosolani* Theob..

The earliest available record for New York is from SANBORN 13 Jan 1915, on lettuce in a greenhouse, (Crosby coll—LMR det). This is from 1 slide in the Me. Agr. Exp. Sta. which had been labelled by Miss Patch as *Macrosiphinus kaltenbachii* (Schouteden)?

NYL – as *pseudosolani* Theob. ITHACA Jl, on potato, Nov, on *Verbena hybrida* in greenhouse, (Griswold coll—Patch det). (Note by MDL: the date is 5 Nov 1926).

ITHACA May 1927, on tulip, 28 May 1928, on tomato in greenhouse, 19 Ju 1927, on *Dracocephalum virginianum* (given as *Physostegia virginica*), and 9, 12 May 1938, on lettuce in greenhouse, (all Griswold coll and det); 24 Jan 1940, 26 Ju 1938, on potato in greenhouse, (Rawlins coll); 26 Apr 1937, on *Lilium* sp. in greenhouse, (Wm. E. Blauvelt coll—MDL det; 5 slides in CU); 20 May 1927, on dahlia seedling in greenhouse, (Griswold coll—Patch det; 1 slide in CU); 15 Nov 1958, on *Solanum carolinense*, (Norman Furrer coll—det MDL from only 2 apterae with query). YONKERS Apr 1938, on *Lilium longiflorum*, 17 May 1938 on *L. speciosum*, and 20 May 1938, on *L. philippinense*, (E.P. Imle coll—Griswold det). LI: ORIENT 8 Dec 1960, on *Lamium amplexicaule*, (Latham coll).

Nasonovia ribisnigri (Mosley)

ITHACA Dec 1923, on lettuce, (Crosby coll; slide in USNM). TUPPER LAKE 8 Aug 1959, on *Hieracium aurantiacum*, (CFS coll and det). BERGEN SWAMP Genesee Co. 2 Aug, on *H. aurantiacum*; LYNDONVILLE 28 Sept 1960, on *H. aurantiacum*, *H. florentinum*, (Pechuman coll—CFS det). SENECA FALLS 4 Oct, on *Cichorium intybus*, (Pechuman coll—CFS det). LOCKPORT 18 Oct 1960, on *C. intybus*, 19 May 1960, on *Ribes hirtellum*, (Pechuman coll—CFS det). LI: EAST MARION 22 Jl 1960, on *Cichorium intybus*, (Latham coll—CFS det).

Neoprociphilus aceris (Monell)

UNION 25 Aug 1913 "I have received a number of complaints concerning this pest from the Southern Counties of the state." (Crosby, in letter to Miss Patch, who made the determination.) The injury mentioned is assumed to be to *Acer saccharum*. SALISBURY MILLS Orange Co. Ju 1922, no plant given, (John Findley coll; slide in USNM). ITHACA 12 Aug 1927, on limbs and branches of *A. saccharum*.

Neoprociphilus attenuatus Osborn and Sirrine

KARNER 3 Oct 1912, on *Smilax herbacea,* (Crosby coll—Patch det). LI: SOUTHOLD 25 Ju, CALVERTON 19 Ju 1949, a woolly aphid on *S. herbacea,* ORIENT 12 Aug, MATTITUCK 28 Aug 1958, on *S. herbacea,* (all Latham coll); GREENPORT 5 May 1952, on *S. herbacea,* (Latham coll; 1 slide in USNM).

Neosymydobius sp.

MT. KISCO 1 Aug 1960, on *Quercus prinus,* (Graham coll—Ole Heie det).

Neosymydobius albasiphus Davis

LI: RIVERHEAD 9 Sept 1934, on oak twigs, (Leonard and Crosby coll).

Neosymydobius annulatus (Koch)

NEW YORK 27 Ju 1958, on *Betula pendula (verrucosa)*, (Granovsky coll and det; 1 slide in USNM). ALTAMONT 15 Jl 1939, on *B. pendula* var. *gracilis,* (Griswold coll; 3 slides in CU det Griswold and Essig, one of the slides with males and oviparous females). LI: GREENPORT 15 Ju 1958, common on *B. populifolia,* (Latham coll—MDL det).

Ovatus crataegarius (Walker) Mint Aphid

This aphid has long been known in American literature and collections as *Phorodon menthae* (Buckton). The above name, however, has been established as the correct one to use by J. P. Doncaster in his "Francis Walker's Aphids", p. 50, 1961 and this is concurred in by D. Hille Ris Lambers.

ITHACA 26 Jl 1939, on *Mentha spicata,* (Griswold coll; 2 slides in CU), 27 Ju 1952, an alate collected "near potato field", (S. H. Kerr coll; 1 slide in USNM). LOCKPORT 11 Aug, 22 Nov 1960 (a very few apterae), on *M. spicata,* (Pechuman coll), 4 Jl 1960, on *Crataegus oxycantha* var. *paulii,* (Pechuman coll—CFS det). REMSEN 24 Sept 1960 (a very few apterae and several "pupae" on the leaves and stems), on *Mentha cardiaca,* (Geo. N. Wolcott coll). LI: ORIENT 11 Aug 1959, in heads, 27 Jl 1960, a few young in top leaves of *M. crispa,* also 23 Jl 1960, a few, nearly all immature, on *M. spicata,* (Latham coll); ORIENT 11 Ju 1960, on *Crataegus chrysocarpa,* (Latham coll—CFS det).

The *Crataegus* collections by Pechuman and Latham are the first which have been identified in the United States from this genus. In Europe this aphid is reported to winter on *Crataegus,* as well as on *Malus,* and to spend the summer on *Mentha* spp. and several other genera of Labiatae.

Although difficult to find, since it usually occurs only in small numbers on the underside of the upper leaves and on the upper part of the stems with which it is almost concolorous, this little yellowish-green aphid is probably present wherever *Mentha* spp. grow. It has not yet been found on peppermint in New York.

Pemphigus balsamifera Williams Poplar Sugar-Beet Root Aphid

ALTAMONT 15 Sept 1939, on *Populus eugenei,* (Griswold coll—Essig and Griswold det; 3 slides in CU).

Pemphigus brevicornis Hart (*lactucae* (Fitch))

Rhizobius lactucae, new species Fitch. "On the roots of lettuce, often in great numbers; very small oval, white and pale yellow lice, with dusky legs and antennae, their bodies dusted over with a white powder. Lettuce seems to be little damaged but Mr. Newcomb of Pittstown, N.Y. informed me a few years since that little white lice gathered upon his verbenas, in some instances in such numbers as to completely cover the roots, causing the plants to droop and wither and turn yellowish, and when felt of they seemed loosened and not set firmly in the ground." (Fitch, 14th Rept., p. 360, 1872).

NYL as *lactucae* Fitch – A common lettuce root-louse and probably rather generally distributed (Felt). FREDONIA (Pergande).

FREDONIA 27 Ju 1905, on roots of *Rumex crispus,* (Hayhurst coll—Tissot det; 1 slide in USNM, same data but from SHERIDAN). ITHACA 3 Aug 1922, on roots of lettuce or potato, (Crosby coll—1 slide in USNM).

OSWEGO 12 Sept 1929, on lettuce roots, (A.G. Newhall; data from Me. Agr. Exp. Sta. Lot Book; det by Patch as *lactucae*).

Pemphigus bursarius (Linnaeus)

ITHACA 1 May 1924, on lettuce roots, (A. G. Newhall coll; submitted by C. R. Crosby; 1 slide in USNM). MT. KISCO 11 Jl 1960, on *Populus deltoides,* (Graham coll—det CFS with query). LI: FLUSHING 8 Jl 1919, on *P. trichocarpa,* (C. A. Natham coll; 1 slide in USNM).

Pemphigus junctisensoriatus Maxson

LYNDONVILLE 19 Ju 1959, (det CFS with query), 1 Sept 1960, on *Populus candicans,* (Pechuman coll—CFS det).

Pemphigus nortonii Maxson

ITHACA 13 Jl 1938, on curled leaf of *Populus nigra* var. *italica,* (Griswold coll—Essig det; 4 slides in CU).

Pemphigus popularius (Fitch)

Described as a new species by Fitch in his Fifth Report, p. 849, 1859 from numerous specimens found running about on the limbs and trunk of balsam poplar; Oct, warm sunny day. This species has not since been recognized.

Pemphigus populicaulis Fitch Poplar Leaf-petiole Gall Aphid

Discussed as a new species by Fitch, (Fifth Rept., p. 845–847, 1859).

EAST AURORA 10 Aug 1933 (Leonard and Crosby coll). VARNA 12 Ju 1939, on *Populus nigra* var. *italica,* (P. A. Readio coll—Griswold det). LI: The NYL gives MINEOLA Jl (Morrison coll).

> In his Report Fitch states: "This insect is attracting much notice in the city of Albany at the time these pages are passing through the press. The latter part of June an article appeared in one of the daily papers of the city, directing attention to the remarkable phenomenon presented by the poplars in a particular yard on the opposite side of the river in Greenbush, most of the leaves having at their base a little ball filled with insects. Several of the leaves of those trees were kindly procured and forwarded to me by L. A. Orcutt, Esq. Visiting the city personally a fortnite after, I was informed the same bullet-like excrescences were then growing on the poplars everywhere in and around the city, and were so numerous on particular trees that scarcely a leaf could be found which was destitute of them. The specimens shown me were taken from the river poplar or cotton tree (*Populus laevigata* Aiton).
> "Three years since, on the twenty-seventh of June, a leaf which had fallen from a Lombardy poplar in my yard [Salem, N. Y.] . . . showed on the middle of its stalk a bullet-like gall . . . which describes the Albany leaves perfectly."

Pemphigus populiglobuli Fitch — Poplar Bullet Gall Aphid

Described by Fitch as a n. sp.: "Galls containing the aphids on the leaves of the balsam poplar and also several galls on balsam poplar at Salem at the moment of sending these pages to press." (Fitch, Fifth Rept., p. 850, 1859). One slide in USNM and marked "Type," mounted from Fitch collection by A. C. Baker.

NYL – NEW ROCHELLE Jl, on Lombardy poplar, (T.J. Wade coll). LYNDONVILLE 19 Ju 1959, on *Populus candicans,* (Pechuman coll).

Pemphigus populitransversus Riley — Poplar Petiole Gall Aphid

ROCHESTER 29 Ju 1909, on cottonwood leaves, (very few galls seen; Gillette). NYL adds ALBANY Ju, CAMBRIDGE Jl.

EAST AURORA 10 Aug 1933, galls on *Populus* sp., (containing many winged and wingless aphids; most of the aphids in some of the galls had been killed by dipterous larvae and by nymphs of a small predaceous bug which were also feeding on the aphids; Crosby and Leonard coll). AURORA 18 Ju 1939 (Hansberry coll). ITHACA 10 Oct 1939 (C. L. Place coll). KNOWLESVILLE 31 Jl 1939, petiole galls on *Populus* sp., (L. C. Pettit coll—Griswold det). ALBANY Co. 26 Jl 1950, in petiole gall on *P. deltoides,* (A.G. Whitney coll; MDL det; from New York State Museum). GASPORT 2 Jl 1959, on *P. deltoides,* (Pechuman coll).

Pemphigus populivenae Fitch — Poplar-vein Gall Aphid

"A number of the galls containing numerous aphids may be observed during July on the leaves of particular balsam poplars." This statement is in connection with the description of this aphid as a new species (Fitch, Fifth Rept., p. 851–852, 1859). LYNDONVILLE 7 Jl 1960, on *Populus candicans,* (Pechuman coll—det CFS with query).

Pentatrichopus fragaefolii (Cockerell) Strawberry Aphid

GENEVA 25 Sept 1958, NORTH COLLINS 22 Ju 1959, on cultivated strawberry, (Geo. A. Schaefers coll and det). LI: MASPETH 13 Ju 1914, on *Fragaria virginiana,* (Olsen coll).

Pentatrichopus minor Forbes

GENEVA 25 Sept 1958, NORTH COLLINS 22 Ju 1959, on cultivated strawberry, (Geo. A. Schaefers coll and det).

Pentatrichopus minor forma **dorsalis** Schaefers

GENEVA 17 Oct 1958, NORTH COLLINS 22 Ju 1959, on cultivated strawberry, (Geo. A. Schaefers coll and det).

Pentatrichopus thomasi Hille Ris Lambers

GENEVA 25 Sept 1958, NORTH COLLINS 22 Ju 1959, on cultivated strawberry, (Geo. A. Schaefers coll and det).

Pergandeidia trirhoda (Walker)

YONKERS 28 Ju 1927, on *Aquilegia* sp., (Horsfall coll—MDL det). ITHACA 17 Sept 1934 (Leonard coll), 1 Sept 1937 (Griswold coll), both on *Aquilegia chrysantha,* 5 Oct 1928, on *A. vulgaris,* 23 Jl 1926, 27 Sept 1927 and 22 Sept 1930, on *Aquilegia* sp., (Griswold coll and det); 25 Sept 1930, on *Rosa,* (Griswold coll—det Essig as *Hyalopterus*). LOCKPORT 20 Aug 1960, on *A. vulgaris,* (Pechuman coll—CFS det).

Periphyllus americanus (Baker). American Maple Aphid

ITHACA 28 May 1958, rather abundant on the leaves of sugar maple bordering the north shore of the Six-Mile Creek Reservoir, (John Graham coll and det).

Periphyllus lyropictus (Kessler) Norway-Maple Aphid

NYL – OGDENSBURG (J.J. Davis); ALBANY, GREENE and ONTARIO COUNTIES. Probably this is the species which has been very destructive to Norway maples in many widely separated localities in the state.

"Aphis aceris L. Occurs on the *Acer pennsylvanicum.* No. 849, male." (Fitch, Cat. Homop. NY, p. 66, 1851). GENEVA 29, 30 Ju, ALBANY 1 Jl 1910 as *Chaitophorus aceris* L., presumably on sugar maple, (Gillette, J.E.E. 2(6): 387, 1910).

ITHACA 13 Sept 1933, on *Acer saccharum,* (Crosby coll), 2 Sept 1934 on *A. platanoides,* (Crosby and Leonard coll; males and viviparous females) and 6 Sept 1927, 7 Jl 1938, on *A. platanoides,* (Griswold coll—Patch det). GASPORT 13 Jl 1958, on *A. platanoides,* (Pechuman coll). ROCHESTER 16 Jl 1959 on A. *platanoides* var. *laciniatum,* BUFFALO 10 Jl 1959, on

A. p. var. *palmatifilum,* (Pechuman coll). RYE 21 Ju 1935, on Norway maple, (S.W. Bromley coll). SI: NEW BRIGHTON 31 Aug 1934, on *Acer* sp., (C.S. Tuthill coll—Mason det; Sp Port Surv); CASTLETON CORNERS 31 Oct 1960 (sexuales present), on *A. platanoides,* (Rundlett coll). LI: PECONIC 17 Oct 1957 (males, ovip. and vivip. females), GREENPORT 27 Sept 1957 and MATTITUCK 24 Oct 1958, males and ovip. females, all on *A. platanoides,* (Latham coll); MATTITUCK 9 Jl, 7 Nov 1959, on *A. platanoides,* (Latham coll).

Periphyllus negundinis (Thomas) Boxelder Aphid

NYL – NEWPORT, NASSAU, on boxelder. ALBANY 1 Jl 1909, on *Acer negundo,* (Gillette, J.E.E. 2(6):387, 1910). GASPORT 23 Ju 1959, on *A. negundo,* (Pechuman coll). MEDINA 7 Ju 1960, TONAWANDA INDIAN RES. Genesee Co. 3, 24 Sept 1960, on *A. negundo,* (Pechuman coll—CFS det). LI: BABYLON 3 Jl 1939, on pear, (Ed. Kurtz coll); food plant certainly accidental or in error, although the single slide in the USNM bears 4 apterae only.

Phorodon humuli (Schrank) Hop Aphid

The earliest account of this formerly highly destructive aphid to hops is by Dr. Asa Fitch in his Tenth Report, p. 15, for 1864, published in 1867. Because of its historical interest and relative lack of availability it is here quoted in full:

> "Hop Aphis, *Aphis humuli* Schrank. The insect which the past season attracted the most notice and did the most damage in our state, was the aphid or plantlouse on the hops. Although the hop has been growing both wild and cultivated, in this country, from time immemorial, I am not aware that this enemy has ever attacked or been observed upon it, until two summers ago, when it suddenly made its appearance in excessive numbers; and in consequence of its advent, the two past years have been the most disastrous to the extensive hop growers in the central section of our state, which they have ever experienced.
>
> "This insect is not limited to the extensive hop plantations in the central part of our state, but appears to have everywhere overrun the hop vines, both wild and cultivated. It was abundant last summer in my own neighborhood [Salem, N. Y.] and specimens were also sent me from St. Lawrence County, whereby we know that its range is to the eastern and northern confines of the state, but farther than this we do not at present possess any definite information.
>
> "One of our most intelligent hop growers, F. W. Collins, Otsego County, informs me that in 1863 the aphid appeared in his vicinity in such prodigious numbers that some yards around him were not picked."

C. V. Riley in the Report of the Entomologist in the Report of the U.S. Commissioner of Agriculture for 1886 (published in 1887), p. 462 states:

> "*Phorodon humuli* was so destructive in the great hop regions of New York State as to cause an almost total loss. Plans are made to carry on experiments the coming year; for in September (1886) I thought I had discovered the winter host plant (plum) which has hitherto been a mystery."

In the Report of the U.S. Commissioner of Agriculture for 1888 (published in 1889), pp. 93–102 Dr. Riley reviews the literature on the hop aphid in Europe and in this country at considerable length and summarizes the life history of this aphid as determined by himself and his assistants (chiefly Pergande) during 1887 and the spring of 1888. It was established that the aphids spent the winter in the egg stage on plum from which they migrate to the hop. The principal observations were made at Richfield Springs, N. Y. and also checked at Washington, D. C. and there are slides in the USNM by Pergande from plum from these two localities.

A later note is by I. M. Hawley in Cornell Univ. Agr. Exp. Sta. Mem. 15: 202–211 1918 who states concerning the hop aphid:

"Known in New York since 1863 at least and in some years has caused an almost total loss of the crop . . . on May 21, 1913 full-grown lice and recent offspring were found on a plum tree near Springfield." Further notes on the life history in New York include "winged forms have been found on a plum tree under observation through July and August; migration to hops however occurs in June; the height of the return migration occurs during hop picking, about the first of September."

Hops have long since ceased to be grown to any appreciable extent in New York, commercial production having been transferred to the Pacific Northwest, and little attention has been paid to the hop aphid for many years.

A few additional available records of its occurrence are as follows: WAYNE Co., H.H. Fitch reported on 23 Ju 1923 that the hop aphid "has been noticed on plums." NYL – "Probably widely distributed in the state since it has been reported on hop in CATTARAUGUS, DUTCHESS, MADISON, MONTGOMERY, OTSEGO and SCHOHARIE COUNTIES." GENEVA 1 Sept, ITHACA 7 Oct 1939, on hop, (Griswold coll). LI: ORIENT 7 Sept 1957, on hop, (Latham coll); MATTITUCK May 1959, on *Prunus avium*, (Latham coll).

Phorodon menthae (Buckton)

See *Ovatus crataegarius*.

Phyllaphis fagi (Linnaeus)

NYL – "A woolly species which appears to be very common on the leaves of copper beech in various parts of the state; probably widely distributed: ALBANY, TIVOLI, ROCHESTER, BREWSTER and TARRYTOWN."

ALBANY City Park 1 Jl 1909, "infesting the underside of every leaf upon the trees of the European beech *F. sylvatica* of both green and purple varieties, but in no case were the leaves curled at all. I have never seen trees worse infested with plant lice than were these beeches. A few alate lice were taken." (Gillette, J.E.E. 2(6): 385, 1910).

ITHACA about 1914. Appears to be very common on the leaves of the copper beeches on the Cornell campus, (Morrison coll), 27 Oct 1935 (Crosby coll), ARNOT FOREST near ITHACA 12 Aug 1927, on beech, (L.P. Wehrle coll—Patch det), 14 Oct 1938 (males and oviparous females), 2 Aug 1938, 9 Ju 1939, on *Fagus sylvatica*, (Griswold coll). GENEVA 20 Oct 1948, ovipositing on *F. sylvatica*, (Chapman coll—Mason det), 22 Oct 1959, on *F. sylvatica* var. *atropunicea*, (Pechuman coll). LI:

FLUSHING 15 Oct 1940, on *F. sylvatica* var. *cuprea,* (Kisliuk coll—Mason det); ORIENT 25 Ju 1947, 15 Ju 1948, 7 Jl, 1 Nov 1958 and 16 May 1959, on *F. sylvatica,* (Latham coll); GREENPORT 23 Ju 1947, E. MARION 8 Ju 1959, on copper beech, (Latham coll).

Prociphilus sp.

LI: WOODHAVEN 31 Oct 1918, on rhubarb roots, (H. Richter coll—Patch det).

Prociphilus corrugatans (Sirrine) Woolly Hawthorn Aphid

Dr. C. F. Smith wrote me 15 April 1960 that until he has an opportunity to examine Fitch's types and to check into the matter further he believes it would be satisfactory to accept Baker's decision that Fitch's *Eriosoma pyri* is a synonym of *Prociphilus corrugatans.* However, in US Farmer's Bull. 1128, revised April 1926, p. 13, Quaintance and Baker under the heading "Pear Aphids Attacking the Foliage", refer to "Fitch's pear-root aphid, *Prociphilus fitchii* Baker and Davidson, which is very similar to the woolly thorn aphid and occurs in the Eastern States."

Fitch's original statement is as follows: *"Eriosoma pyri* n. sp. The apple root blight. On the roots of a young apple tree brought me from a nursery, excrescences were observed, the crevices in which were found to be covered with small, lice-like larvae, which proved on examination to be this species, from which circumstances its habits are inferred and its name bestowed. No. 862, males." (Fitch, Fourth Rept., p. 68, 1851).

ITHACA 19 May 1911, on *Amelanchier* sp., (immature stem females; Patch; Me. Agr. Exp. Sta. Bull. 233, p. 254, 1914). Wellhouse, Cornell University Agr. Exp. Sta. Mem. 56: 1062, 1922: "A few colonies of the flocculent greenish aphids of the species *Pemphigus corrugatans* were found in early June on *Crataegus punctata.* They live on the underside of the leaves and curl the leaf margins downward."

SI: PORT RICHMOND 1 Sept 1943, on bark of *Crataegus* sp.; (Tuthill coll— Mason det; Sp Port Surv). LI: PECONIC 6 Ju 1958, on *Amelanchier canadensis* underside of leaves, (Latham coll).

Prociphilus erigeronensis (Thomas) White Aster Root Aphid

ITHACA 14 Sept 1928, on roots of *Aster* sp., 22 Oct 1930, on roots of *Primula japonica,* (Griswold coll—Cutright det), 25 Jl 1938, on roots of China Aster *Callistephus chinensis,* (Whetzel coll—Essig and Griswold det). N. COLLINS 3 Aug 1938, on roots of lettuce, (T.W. Kerr Jr. coll—Griswold det). CAMPBELL 28 Aug 1934, on *Oenothera* sp., (May Willard coll). LI: ORIENT 11 Jl 1948, on roots of *Helianthus annuus,* (Latham coll—det MDL with query; 1 slide), 19 Oct 1958, on roots of *Gnaphalium obtusifolium,* (Latham coll—det MDL with query).

Prociphilus imbricator Fitch — Beech Blight Aphid

Fitch's original statement is as follows: "*Erisoma imbricator* n. sp. On the underside of the branches of the beech tree, covered with snow white down. On the slightest jar of the branch, a shower of tiny drops of a water-like fluid falls from these insects. Having met with no description of *E. fagi* (Linn.) or its habits, I am unable to ascertain whether that insect is dissimilar to ours. No. 864, male; 865 female (?); 866 larva." (Fourth Rept., p. 68, 1851).

NYL – Probably widely distributed and somewhat common and abundant. NEWPORT Oct, ITHACA (Morrison), RICHFIELD SPRINGS (Felt), BARNEVELD Aug, INDIAN LADDER Albany Co. and SCARSDALE Aug.

ITHACA, the nymphs and winged pre-sexuals on the underside of beech stems of a number of young trees, the abundant white flocculence making them very conspicuous during the latter half of October (?1913); in the second week in November some of the nymphs and winged still present, but in fewer numbers and at the same time large numbers of the dark, but not black, small eggs, laid promiscuously over the beech limbs, but more thickly on the smaller twigs and buds. (Morrison coll).

SIDNEY 30 Oct 1939, on bark of *Fagus*, (A. B. Hine coll—Essig and Griswold det).

Prociphilus tessellatus (Fitch) — Woolly Alder Aphid

Fitch's original statement is as follows: "*Eriosoma tessellata* n. sp., on the underside of branches of the alder *Alnus rubra* Marsh crowded together and concentrated beneath a dense covering of snow white down. I have searched in vain for winged individuals of this species. No. 863." (Fitch, Cat. Homop. N.Y., p. 68, 1851).

NYL – Somewhat generally distributed but especially abundant in the ADIRONDACKS (Felt). ESSEX, MONROE, TOMPKINS and ORANGE COUNTIES and SUFFOLK Co. L.I.

ITHACA Oct 1906, on *Alnus glutinosa*, (Hayhurst coll—Tissot det). BATAVIA 11 Sept 1934, on *Alnus* sp., (Leonard and Crosby coll). ALTAMONT 17 Sept 1939, on bark of *Acer saccharinum*, (Griswold coll and det). ELLIS HOLLOW 2 Nov 1939, on *Alnus* sp., (Hansberry coll—Griswold det). LI: BABYLON 22 Ju 1934, on *Betula nigra*, (accidental; Blanton coll).

"Biologically this species is of special interest, in addition to its migratory habits, because it is one of the few aphids known to hibernate in the nymphal stage. The sexual forms are produced on maples by migrants leaving the alders in the fall. The over-wintering eggs produce stem mothers in spring which produce generations (*acerifolii* Riley) destined to return in summer to alders. Although the life cycle is interrupted on its probable original host, the maple, the life cycle may continue without interruption on alders. The first person to work out the life history of this species was Patch [1908, 1911], whose findings were confirmed by the extensive studies of Pergande (1912)." (Hottes and Frison in "The Plant Lice, or Aphiidae, of Illinois," p. 373, 1931).

Pterocomma n. sp.

TONAWANDA INDIAN RES. Erie Co. 28 May 1960, on *Salix* sp., BARRE Burma Woods 22 Ju 1960, on *Populus grandidentata,* (Pechuman coll—CFS det).

Pterocomma bicolor (Oestlund) Reddish Brown Willow Bark Aphid

SLATERVILLE 24 May 1939, on *Salix cordata,* (Hansberry coll). LOCKPORT 29 May 1959, on *S. matsudana* var. *tortuosa,* (Pechuman coll—CFS det). LYNDONVILLE 29 Oct 1959, on *S. babylonica,* (Pechuman coll—CFS det).

Pterocomma flocculosa (Weed) American Poplar Bark Aphid

LOCKPORT 29 May 1959, on *Salix matsudana* var. *tortuosa,* (Pechuman coll—CFS det).

Pterocomma populifoliae (Fitch) Reddish Brown Poplar Aphid

"*Aphis populifoliae* n.sp.. On leaves of the *Populus grandidentata.* No. 852, male." (Fitch Cat. Homop. N.Y., p. 66, 1851). ALBANY 9 Ju 1927, on roof of State Ed. Bldg., (1 alate; Felt and Chamberlain).

Pterocomma pseudopopulea Palmer

SI: ROSEBANK 4 Sept 1943, on twig of *Populus* sp., (Lanz coll—Mason det as *P. populea* (Kalt.); Sp Port Surv; 2 slides in USNM). Recorded only from Colorado, Idaho and Utah.

Pterocomma salicis (Linnaeus)

NYL - BUFFALO Sept; KARNER, Ju (NYS).

TOMPKINS Co. 3, 23 May 1939. ITHACA 23 Ju 1939, on bark of *Salix cordata,* (Griswold coll and det as *Clavigerus*). GENEVA 20 Oct 1946, abundant on twigs of *Salix* sp., (Chapman coll—Mason det). BEDFORD Westchester Co. Ju 1935, on twigs of *Salix* sp., (S. W. Bromley coll).

Pterocomma smithiae (Monell)

Willow Grove Aphid or Black Willow Aphid

ITHACA Oct 1906, on *Salix* sp., (Hayhurst coll). ALBANY Ju, Oct 1927, on roof of State Ed. Bldg., in flight, (Felt and Chamberlain). Very common at ITHACA, VARNA, ETNA and FREEVILLE in Tompkins Co.: CROSBY, WILLIAMSVILLE and AMENIA, as well, in Erie Co., on twigs and stems of *S. alba* and other willows, (Leonard and Crosby coll 1933–1935). ITHACA 7 Sept 1939, on *Salix* sp., (Griswold), Sept 1945, on Wisconsin weeping willow *S. blanda,* (H. Aburto coll and det; slide in CU). GENEVA 20 Oct 1946, abundant on twigs of *Salix* sp., (Chapman coll—Mason det). LOCKPORT 6 Ju, on *S. nigra,* TONAWANDA INDIAN RES. Erie Co. 13 Ju, on *Salix* sp., LYNDONVILLE 29 Oct, on *S. babylonica, Populus candicans* and *P. maximowiczii;* all in 1959, (Pechuman coll—CFS det). ROCHESTER 25 Oct 1959, on *Salix* presumably *babylonica;* about this collection Dr. Pechuman writes that the person who sent an infested branch to him reported that "all willow trees, presumably planted for shade, in the area were infested, causing much damage all summer and fall and that frequent spraying with one of the approved aphicides was of little value." LYNDONVILLE 28 Sept 1960, on *Populus nigra* var. *italica,* SENECA FALLS, 4 Oct 1960, on *Salix babylonica,* (Pechuman coll—CFS det). LI: WADING RIVER 30 May 1914, on *S. fragilis* (Olsen coll).

Rhopalosiphoninus staphyleae Koch

NEW YORK Mar, Apr 1937. Quite a number of aphids developed on the leaves of a tulip sprouted in the writer's home from two bulbs purchased locally in a store, (MDL coll—CFS det). This is apparently the first collection in the Eastern States.

There is a slide of this aphid in the USNM from tulip bulbs in Illinois and one of an alate from a trap in Oregon. This aphid is said to be fairly common in Europe where it occurs on bulbs such as tulip, crocus, etc. Cottier (Aphids of New Zealand, p. 255, 1953) records it from three localities in New Zealand on *Aciphylla colensoi, Primula* sp. and potato, and states that it appears to be rare and of no economic importance.

Rhopalosiphum n.sp.

LI: BAY VIEW 12 Jl 1960, on *Rhus toxicodendron,* (Latham coll—CFS det).

Rhopalosiphum angelicae Del Guercio

LI: MASPETH 8 Aug 1913, on *Artemesia absinthimum.* "I found this species on a single wormwood plant in my garden in such great numbers as to do considerable damage both by feeding and by secretion of honeydew, almost destroying the plant before it drew my attention." (Olsen coll).

Rhopalosiphum berberidis (Kaltenbach) Barberry Aphid

In his Cat. Homop. N.Y., p. 65, 1851, Dr. Fitch described *Aphis berberidis* as a new species, in error. He wrote of this aphis as quoted further on.

ITHACA 13 May 1938, on *Berberis thunbergii,* (Griswold coll—Essig det). OSWEGO 8 Aug 1939, on *B. vulgaris,* (Griswold coll and det). BUFFALO 10 Jl 1959, on *Berberis* sp. (not *thunbergii* or *vulgaris*), (Pechuman coll). LOCKPORT, on *B. thunbergii,* 4 Ju, 21 Nov 1959, (sexuals), 5 Dec 1959, many oviparae, 19 Dec 1959, on *B. thunbergii,* (Pechuman); 21 May 1960, on *B. thunbergii,* (Pechuman coll—CFS det). NEW YORK Ft. Tryon Park 26 Sept 1936, abundant on the leaves of a small ornamental planting of *Mahonia* sp., (no alates could be found; MDL and Doris P. Leonard coll—Essig det).

Pechuman wrote of the November collection: "leaves had been dropped for 2 weeks; twigs covered with large numbers of bright green aphids and smaller numbers of larger dark spotted aphids and small numbers of fragile appearing alates. Although there has been considerable snow and ice, aphids are active." And of the December occurrence: "in spite of snow and cold there are still a number of living aphids on my barberries. They immediately become active when brought inside. The twigs are covered with yellow eggs."

The *Mahonia* record is apparently the first of an aphid on this plant in North America. Theobald in "The Plant Lice or Aphididae of Great Britain" 2, p. 43, 1927 merely lists this aphid as occurring on *Mahonia* sp.. The only other reference to an aphid occurring on *Mahonia* that I can find is by Takahashi in 1925 who described *Amphorophora viburni* Takahashi from *M. morrisonensis* in Japan. (Note: Although *Mahonia* is included in *Berberis* by some botanists, Standardized Plant Names states that the name is conserved under International Rules.)

Fitch, Tenth Rept., p. 22, 1867: "*Aphis berberidis* (Kalt.) A bush of barberry planted in my yard [Salem, N. Y.] before the commencement of the present century became infested with an aphis in the year 1846. How this insect came upon this shrub was quite a query in my mind. The nearest bush of this kind within my knowledge was two miles distant, with intervening hills, woods and streams of water. None of the insects appeared to acquire wings whereby it was possible for them to migrate and establish themselves elsewhere, until quite late in the autumn.

"This insect continued to infest the same bush until the year 1855, when it failed to make its appearance, and has not since returned. At no time did it become greatly multiplied, nor was the shrub perceptibly injured by it. So late as the middle of November I have observed the wingless females busily engaged in depositing their eggs . . . in the axils of the buds . . . .

"The first season that these lice appeared, winged individuals were often sought for but none were found, until the month of November, when they became quite numerous . . . . When they were about disappearing eight years afterwards, winged specimens were found in plenty among them in May and June."

Rhopalosiphum conii (Davidson) Honeysuckle and Parsnip Aphid

This is said to be a synonym of *Hydaphis foeniculi* Pass..

ITHACA 21 Oct 1932, on *Symphorocarpus racemosus*, (Leonard coll), 14 Sept 1934, on *Cicuta maculata*, and FOREST HOME (Ithaca) 4 Aug 1933, on wild parsnip, (Leonard and Crosby coll), 22 Oct 1935, on *Lonicera* sp., (G. F. MacLeod coll—MDL det). GENEVA 20 Oct 1946, abundant on *L. tartarica*, (Chapman coll—Mason det), 26 Oct 1938, on *Lonicera* sp., (all males; Griswold coll), 24 Sept 1938, on *Daucus carota* wild, (Hansberry coll—Essig and Griswold det), 17 Oct 1938, on *Symphorocarpus racemosus*, (several males; Griswold coll), 21 Jl 1939, on *Levisticum officinale*, (P. A. Readio coll—LMR det). LOCKPORT 2 Nov 1958, on *Lonicera tartarica*, 26 Oct 1960, on *L. japonica* var. *halliana*, (Pechuman coll). ROCHESTER 3 Ju 1958, on *L. prolifera*, (Pechuman coll). LYNDONVILLE 25 Aug 1959, on *Cicuta maculata*, (Pechuman coll), 28 Sept 1960, on *Lonicera sempervirens*, (Pechuman coll—CFS det). SENECA FALLS 4 Oct 1960 on *L. tartarica*, OLCOTT Keg Creek 5 Oct 1960, on *L. dioica,* (Pechuman coll—CFS det). SI: TOMPKINSVILLE 24 Aug 1943, a heavy infestation on the flowering portions of *Thaspium aureum,* (Tuthill coll—Mason det; Sp Port Surv); CASTLETON CORNERS 20 Nov 1960, 1 alate in Moericke Trap, (Rundlett coll—J. O. Pepper det). LI: MASPETH 1 Nov 1914, on *Lonicera japonica,* (Olsen coll); GREENPORT 15 Sept 1957, on *L. sempervirens,* 25 Sept 1958, on *Daucus carota* wild, (Latham coll); MATTITUCK 22 May, 6 Ju 1958 very common, 17 Oct 1957, on *Lonicera sempervirens,* (Latham coll); ORIENT 17 Aug, on garden carrot, 19 Oct 1958, on *Cicuta maculata,* 9 Jl, on parsley, and 17 Jl 1959, on cult. parsnip, (Latham coll); E. QUOGUE 4 Ju 1959, on *Lonicera sempervirens,* PECONIC 9 Jl 1959, on cult. parsnip, (Latham coll); locality ? 21 Sept 1946, on carrots, SAG HARBOR Sept 1 and GREENPORT 29 Jl 1941, on *Cicuta maculata,* (Latham coll); ORIENT 5 Jl 1959, on *Pastinaca sativa, Heracleum lanatum,* SOUTHOLD 11 Jl 1959, on cult. parsnip, (Latham coll—CFS det).

Rhopalosiphum enigmae Hottes and Frison

LI: RIVERHEAD 22 Jl 1933, on *Typha latifolia,* (Leonard coll); GREENPORT 27 Oct 1946, on *Typha angustifolia,* (Latham coll).

Rhopalosiphum fitchii (Sanderson) Apple Grain Aphid

For sometime past European workers have considered this as a synonym of *Rh. insertum* (Walker). It is possible that some of the records refer to *Rh. padi* (L.), vid.

ITHACA 8 Oct 1933, on *Crataegus* sp., (Crosby coll). SLATERVILLE 16, 24 May 1959, on *Crataegus* sp., (Hansberry coll—MDL det). ITHACA received in USDA 29 Jl 1959 from Dr. Rochow, on barley, (LMR det). NEW YORK Central Park 12 May 1941, on *Crataegus* sp.; ITHACA 19 Oct 1932, on *C. coccinea,* (Leonard and Crosby coll), 17 Ju 1939, on *Triticum aestivum,* (Griswold coll). CAYUTA LAKE 13 Sept 1934, on *Crataegus* sp., (Leonard and Crosby coll). LYNDONVILLE 28 Sept 1960, on *C. (cordata) phaenopyrum,* (Pechuman coll—CFS det). SI: CASTLETON CORNERS 20 Nov 1960, several alates, one a male, in yellow water-pan, (Rundlett coll—det J. O. Pepper as either *fitchii* or *padi*). LI: ORIENT 24 Ju 1946, on *Dactylis glomerata,* 15 Dec 1948, common on rye, (Latham coll).

This aphid is probably present in the state wherever the wild or cultivated apple occurs on which it spends the winter in the egg stage. It also overwinters in the same manner on *Crataegus* spp.. Although it is often abundant on the buds and young foliage in commercial apple orchards it probably causes comparatively little damage since shortly after the blossoms fall it migrates to grains and grasses on which it passes the summer, fall migrants returning to the winter hosts for the purpose of egg-laying. Dr. P. J. Chapman, Entomologist of the N. Y. (Geneva) Agricultural Experiment Station wrote me in July 1961 that this aphid is "generally present, often abundant but not considered an economic pest. Winter eggs normally greatly outnumber those of other apple aphids on twigs and spurs of apple trees."

Dr. W. F. Rochow, Dept. Plant Pathology, Cornell University wrote me in July 1961 that this aphid is the second most important factor in the spread of the barley yellow dwarf disease in New York. Outbreaks on oats in recent years have been more striking than those on barley or wheat.

ITHACA: "The dark green stem mothers of the species *Rhopalosiphum prunifoliae* begin to appear on the buds of native hawthorns as soon as the bud scales have separated enough to show the green leaves within. The colonies increase during April and early May, doing some damage to the leaves and buds, but before June they migrate from the trees to grasses and are not often on the trees between early June and autumn. The winter eggs are laid on hawthorn twigs and buds." (Wellhouse, W. H., Cornell Univ. Agr. Exp. Sta. Mem. 56:1065, 1922).

Rhopalosiphum grabhami Cockerell

ITHACA 29 May 1939, on *Lonicera* sp., (P. A. Readio coll—LMR det).

Rhopalosiphum maidis (Fitch) Corn Leaf Aphid

Dr. Fitch's statement in connection with the original description of this species is as follows:

"The Maize Aphis, *Aphis maidis,* new species. Crowded together and covering the stem which bears the ear; small dull-green and reddish lice, slightly dusted over with a fine white powder." (First and Second Reports, p. 318, 1856).

Insect Pest Survey records in USDA on corn as follows: ADAMS 16 Aug 1919 (Crosby coll); ISCHUA 13 Sept (Crosby); OSWEGO 13 Sept 1933 (Blauvelt coll); HAMMOND, MALONE 13 Sept, 28 Aug 1933, "corn badly infested." (Crosby); ESSEX Co. Sept 1936, abundant in some fields (Crosby); LIVINGSTON Co. several bad infestations; GENESEE Co. Aug 1940, "an 18 acre field heavily infested and injury very evident." (Leiby coll).

Other records are: YONKERS 11 Feb 1927, on *Sorghum* and rye in greenhouse, (J. L. Horsfall coll—LMR det). HAMMOND 11 Sept 1933 (T. E. Petrie coll). ITHACA 15, 18 Apr 1937, on teosinte *Euchlaena perennis,* a plant related to corn, in greenhouse, (Griswold coll—MDL det), 8 Feb 1939, on corn in greenhouse, (Griswold coll—MDL det). MIDDLETOWN 5 Aug 1939, on corn, (R. W. Leiby coll—MDL det). ATHOL Warren Co. Aug 4 1927, an alate on top of fire tower on Crane Mountain, 3289 ft. elevation; NASSAU Co. 3 Oct 1927, 1 alate taken in a kite, (Felt and Chamberlain). ORLEANS Co. Jl 1939, "beginning to show on corn tassells", (O. G. West). GASPORT 19 Sept 1959, on *Echinochloa crusgalli,* (Pechuman coll). A note on insects of sweet corn in the HUDSON RIVER VALLEY in N. Y. Weekly Rept. in CEIR 8(34):750, Aug 22, 1958: "The most abundant insects in corn ears were . . . corn leaf aphid"; N. Y. Weekly Rept. in CEIR 10(34):780, Aug. 19, 1960: "Becoming conspicuous in sweet corn in HUDSON VALLEY and considerable amount present in ERIE COUNTY." TONAWANDA INDIAN RES. Genesee Co. 4 Aug 1959, on *Zea mays,* (Pechuman coll—CFS det).

SI: CASTLETON CORNERS Sept 1954, on *Setaria faberii* Herm., (Rundlett coll—LMR det). LI: MASPETH 24 Aug 1913, on *Digitaria sanguinalis, Setaria glauca* and *Echinochloa crusgalli,* (Olsen coll); SOUTHHOLD 26 Jl 1933, abundant on a large planting of young corn, (MDL coll); ORIENT 22 Jl 1946, on corn, 7 Jl 1946, on *Hordeum vulgare,* (Latham coll); RIVERHEAD 6 Aug 1943, on corn, (Mason det; Sp Port Surv); ORIENT 25 Jl 1955, 22 Jl 1958, on *Echinochloa crusgalli,* 1 Jl 1958, 12 Aug 1959, on *Panicum capillare,* ORIENT 2 Jl, GREENPORT 20, 23 Jl 1959, on sweet corn, (Latham coll).

Common and widespread, often abundant on corn but not often doing much injury. In addition to corn it is found on various grasses. Dr. W. F. Rochow of Cornell University, Dept. Plant Pathology, reports it is often common on oats and barley late in the season, especially in the Ithaca area, and that then it is responsible for the transmission of the barley yellow dwarf virus disease of oats.

Rhopalosiphum nymphaeae (Linnaeus) Waterlily Aphid

ITHACA "Observed on *Typha latifolia* in 1915, 1916 and 1918", (Patch det; P. W. Claassen, Cornell Univ. Agr. Exp. Sta. Mem. 47, p. 500, 1921), 22 Aug 1939, on *Lemna minor,* (M. Scotland coll—Essig and Griswold det); in the Me. Agr. Exp. Sta. Lot Book is the following record: "Aug 7 1933 on *Lemna minor,* Minnie V. Scotland coll., Patch det." ROCHESTER 11 Aug 1933, very abundant and injurious on a large commercial collection of water lilies, (Leonard and Crosby coll). LYNDONVILLE 20 Jl 1959, abundant on *Nelumbium lutea,* (Pechuman coll). LI: CUTCHOGUE 14 Sept 1943, abundant on *Nymphaea odorata,* (C. S. Tuthill coll—Mason det; Sp Port Surv); EAST NORWICH Jl 1936, on waterlily, (K. E. Maxwell coll); CALVERTON 16 Oct 1946, RIVERHEAD 23 Jl 1959, on *Nuphar advena,* (Latham coll); GREENPORT early summer 1957, "Swarms of them on a clump of sweet flag *Acorus calamus* no specimens collected and all gone 2 weeks later" (in lit. from Latham), [I had assumed that this is *R. nymphaeae* but see under *R. rufiabdominalis*]; SHELTER ID., 30 Jl 1960, on *Nuphar advena,* (Graham coll—CFS det).

Rhopalosiphum padi (Linnaeus) Oat Bird-cherry Aphid

W. H. Richards in Can. Ent. Suppl. 13:35, 1960 states: "*R. padi* is very closely related to *R. viridis,* new species, and *R. fitchii.* The winged stages of the three species can be distinguished only with difficulty. . . . The alienicolae can be readily confused with those of *R. fitchii* and records of *R. fitchii* invariably refer to *R. padi.*"

According to this all or most of the records in this List under *R. fitchii* should refer to *R. padi* but it would be difficult, if not impossible, to properly evaluate them. An early New York record, identified as *padi,* is from a slide in the USNM by Pergande, RICHFIELD SPRINGS, N. Y., 31 May 1888.

Rhopalosiphum poae Gillette Gillette's Blue Grass Aphid

OLCOTT 17 Nov 1892 a "drift" on peach (J. O. Lockwood coll—det Tissot 1936 as *Capitophorus*).

NYL – ITHACA Mar, on wheat in greenhouse, (Griswold coll—det Patch as *Aphis pseudoavenae* Patch).

LOCKPORT 25 Ju 1960, on *Bromus commitatus*, (Pechuman coll—det J. O. Pepper according to key by Richards).

Rhopalosiphum pseudobrassicae (Davis) Turnip Aphid

Hille Ris Lambers considers this to be a synonym of *Lipaphis erysini* Kalt.

The turnip aphid had long been confused with the cabbage aphid until its true identity was recognized by J. J. Davis, who described it as a new species in 1914 from specimens taken on cabbage at GENEVA, N. Y., on July 15, 1912, and on mustard and kale at Evansville, Indiana, November 20 of the same year. It is probably generally distributed, since it is so readily confused with the cabbage aphid, and is often very injurious to the cruciferous crops, especially on Long Island. Available individual records are as follows:

ITHACA 14 Sept 1939, on *Brassica arvensis*, (Leonard and Crosby coll); 27 Ju 1939, on turnip, (Hansberry coll—MDL det). TONAWANDA INDIAN RES. Genesee Co. 3 Sept 1960, on *B. nigra*, (Pechuman coll—CFS det). LI: MONTAUK POINT 7 Jl 1933, on *Cakile edentula*, (Leonard coll—Tissot det); BABYLON 7 Jl 1934, on mustard *Brassica* sp., (Blanton coll—Tissot det); 3 Jl 1939, on wild radish, (Ed. Kurtz coll; 1 slide in USNM); NORTHVILLE 13 Sept 1943, on rutabaga, (Tuthill coll—Mason det; Sp Port Surv); ORIENT 16 Jl 1958, on *Raphanus raphanistrum*, (Latham coll: "I found a wide strip of farm land along one edge of string beans that was full of wild radish and that whole strip of radish was alive with aphids, every plant hanging heavy.") ORIENT 11 Jl, on cult. radish, 19 Jl 1959, on leaves and heads of *Cakile edentula*, 26 Jl on *Sisymbrium officinale*, and 1 Dec 1960, on flowers of *Lepidium virginicum*, (Latham coll).

Rhopalosiphum rhois (Monell) Monell's Sumac Aphid

ITHACA 13 Ju 1914, common on the terminal shoots and leaves of sumac, (Morrison coll). ITHACA, EGGLESTON'S GLEN Sept 1933, 1934, on *Rhus glabra*, smokebush *Cotinus cotinus*, (Leonard and Crosby coll), 19 Sept 1935, on sumac, (Crosby coll), 21 Jl 1939, on *Rhus toxicodendron*, (Hansberry coll). FREDONIA 24 Jl 1905, on *Rh. typhina*, (Hayhurst coll). YONKERS 2 Jl 1927, on *Rh. aromatica*, (Horsfall coll and det), 5 Jl 1938, on *Rhus* sp., (E. P. Imle coll—Essig det). BARRE Burma Woods Orleans Co. 9 Jl 1958, on *Rh. typhina*, ("huge colonies but restricted to a few plants"; Pechuman coll). LYNDONVILLE 31 Jl 1959, on *Rh. glabra*, (Pechuman coll). SI: TOTTENVILLE 9 Oct 1960, on *Rh. copellina,* (Rundlett coll). LI: ORIENT Jl 1924, on grass, (Latham coll—Mason det; 1 slide in USNM has both apterae and alates); GREENPORT 26 Jl 1959, on *Rh. glabra,* (Latham coll); BABYLON 12 Jl, 15 Aug 1934, on leaves of sumac, (Blanton coll).

Rhopalosiphum rufiabdominalis (Sasaki)?

LI: ORIENT 2 Aug 1958, "common on blades" of *Acorus calamus,* GREENPORT 1957, (Latham coll—LMR det).

Rhopalosiphum rufomaculatum (Wilson) Pale Chrysanthemum Aphid

ITHACA 11 Nov, 4 Dec 1926, in Floriculture Dept. greenhouse on *Chrysanthemum indicum* hybrid, (Griswold coll—Patch det), 23 Ju 1939, on *Artemisia absinthium,* (Hansberry coll—Essig det).

Rhopalosiphum serotinae (Oestlund)

Hille Ris Lambers places this species in the genus *Cachryphora* which was erected by Oestlund with *serotinae* as the genotype.

LI: NORTHWEST 20 Ju 1948, on *Solidago uliginosa,* ORIENT 29 Sept 1957, in tops of plants of *S. graminifolia,* 29 Sept 1957, on *S. rugosa,* 19 Oct 1958, on *S. serotina,* and 18 Ju 1958, on *S. altissima,* GREENPORT 4 Oct 1957, on *S. altissima,* 26 Jl, on *S. aspera,* and 27 Jl 1958 on *S. rugosa,* BAY VIEW 10 Sept 1960, on *S. rugosa,* (all Latham coll).

Schizolachnus piniradiatae (Davidson)

MEDINA 28 Sept (oviparae), 1 Nov 1960 (oviparae and males), on *Pinus resinosa,* (Pechuman coll—J. O. Pepper det).

Shenahweum minutum (Davis)

ITHACA 31 Jl, 25 Aug 1939, on *Acer saccharum,* (Griswold coll and det; 10 slides in CU).

Sipha (Rungsia) agropyrella Hille Ris Lambers

ITHACA 13 Jl 1952, no plant given, (Pimentel coll—LMR det; 2 slides in USNM). URBANA 2 Jl 1959, on *Agropyron repens,* (Pechuman coll—CFS det). LI: MATTITUCK 3 Ju 1958, on *A. repens,* (Latham coll—LMR det).

Sipha flava (Forbes) Yellow Sugarcane Aphid

FREDONIA Jl 1905, on *Setaria glauca,* (Hayhurst coll). ITHACA 9 Sept 1927, on sugarcane in Plant Pathology greenhouse, (Griswold coll—MDL det).

Sipha glyceriae (Kaltenbach)

ITHACA 10 Ju 1924, in a collection taken from the stomach of a trout by Herbert J. Pack, (Patch det; Me. Agr. Exp. Sta. Lot Book). The only other record for North America is that by Patch; in Me. Agr. Exp. Sta. Bull. 182:241–242, 1910; she records making a single large collection on 22 Ju 1909 from rush, *Juncus* sp. growing in a marsh pool in Orono, Me.. All stages of the aphids were present and: "many of the aphids were completely submerged on dead blades of grass but apparently in no wise disturbed or inconvenienced by this circumstance, but were to all appearances as comfortable as those above the water on live blades."

Stegophylla sp.

ITHACA 31 Jl 1958, on oak, (J. G. Matthysse coll; 1 slide in USNM). SI: CASTLETON CORNERS 6 Oct 1960, on *Quercus palustris*, (Rundlett coll).

Stegophylla quercicola (Baker)

ITHACA 22 Sept 1934, on *Quercus alba*, (Leonard and Crosby coll), 9 Sept 1943, on *Q. rubra*, (L. Cutkomp coll—MDL det), 10 Ju 1939, on *Q. rubra*, (Cutkomp coll—Essig det). LI: RIVERHEAD 9 Sept 1934, on oak leaves, (Leonard and Crosby coll), 10 Oct 1958, on *Q. coccinea*, "under leaves which lay on ground, very common, all apterae, mealy". (Latham coll); LOCUST VALLEY 25 May 1936, on *Q. velutina*, (K. E. Maxwell coll—MDL det).

Tamalia sp.

ITHACA (?) 16 Aug 1927, on red oak, (Griswold coll—Mason det; 10 slides in CU, one with 8 apterae, the other with 10 apterae).

Miss Griswold's note, dated 16 Aug 1927 is as follows: "Brought me by De Mesa. They have long, woolly filaments. Live in curled end of leaf. This curled end turns brown and dies. These aphids were sent to Washington and determined by P. W. Mason as *Tamalia* sp. close to unnamed species in the National Collection."

Tamalia coweni (Cockrell) Manzanita Leaf-gall Aphid

LI: HAMPTON BAYS 6 Ju 1946, galls common on *Arctostaphylos uva-ursi*, MONTAUK 21 Jl 1946, and MANORVILLE 1 Aug 1947, on same plant. (Latham coll).

Thecabius sp.

LI: GREENPORT 25 Ju 1958, on *Lysimachia terrestris*, SOUTHOLD 8 Jl 1960, on same plant, ("white aphids in curled heads of plants"; Latham coll). Hottes and Frison in The Plant Lice, or Aphiidae, of Illinois, p. 374, 1931 under the heading "Thecabius species" say: "What is apparently another species of this genus was collected in leaves of *Lysimachia*

. . . . The apterous forms of all our material produced considerable flocculent secretions." It seems probable that the New York collections may be the same aphid, but without alates specific determination is impossible.

Thecabius populimonilis (Riley) Beadlike Cottonwood Gall Aphid

NYL – ALDER CREEK Aug, gall on Balm-of-Gilead.

Thecabius populiconduplifolius (Cowen)? Folded Leaf Poplar Aphid

SI: NATURE TRAIL 22 Nov 1960, woolly aphids on *Ranunculus repens*, (Rundlett coll—MDL det; only apterae present). Palmer states that apterous viviparae occur on *Ranunculus* in Colorado.

Therioaphis riehmi (Börner) Sweetclover Aphid

TROY AIRPORT 15 Sept 1956, on white sweet clover *Melilotus alba*, (J. W. Gentry coll—LMR det; 1 slide in USNM). TONAWANDA INDIAN RES. Genesee Co. 29 Oct 1960, on *M. alba*, (Pechuman coll—det CFS with query).

Therioaphis trifolii (Monell) Yellow Clover Aphid

Undoubtedly occurs throughout the state on clovers and often fairly common but not a significant pest.

"GENEVA 29–30 June, ALBANY 1 July 1909, in moderate numbers on the underside of leaves of red clover." (Gillette, J.E.E. 3(4):369, 1910). ITHACA Mar 1937, 31 Oct 1939, on *Trifolium* sp. in greenhouse, (Griswold coll). CROWN POINT 25 Aug 1955, on red clover, (LMR coll and det). BINGHAMTON 13 Jl 1956, on red clover, (Geo. Gyrisco coll—LMR det). LOCKPORT 26 Sept 1959 (a few apterae and immatures), on *T. repens* on the lawn, (Pechuman coll). MT. KISCO 1 Aug 1960, on *T. pratense*, (Graham coll—Ole Heie det). LI: SHELTER ID. 28 Aug 1960, on *T. arvense*, 28 Jl 1960, on *T. millefolium*, *T. pratense*, (John Graham coll—MDL det).

Dr. Gyrisco of Cornell University wrote (1961) that this aphid is very abundant on red clover when plants are taken into the greenhouse from the field, and will occur in such numbers as to necessitate control.

Thripsaphis balli (Gillette) Thrips Aphid

RICHFIELD SPRINGS (probably 1888) on *Scirpus sylvaticus*, (Pergande coll; specimens in USNM; No. 4052; A. C. Baker, Can. Ent. 49(1):4, 1917 as *Saltusaphis*).

Toxoptera graminum (Rondani) Green Bug

SODUS 16 Aug 1923, infesting buckwheat, (note by Crosby to Insect Pest Survey, USDA). ITHACA 11 Ju 1952, an alate in flight "near potato fields", (S. H. Kerr coll—LMR det).

Thifidaphis phaseoli (Passerini)

ITHACA 5 Oct 1928, on roots of *Browalia americana*, (Griswold coll—Maxson det; 2 slides in CU).

Trifidaphis radicicola (Essig) Solanum Root Louse

This is quite probably a synonym of *T. phaseoli* (Pass.).

WARSAW 20 Aug 1913, on bean roots, (Crosby coll—Patch det; Me. Agr. Exp. Sta. Lot Book). ITHACA 4 May 1922, on roots of potato (L. P. Wehrle coll; in USNM. LI: MINEOLA 5 May 1926, on roots of sweet pea, (J. P. Chapman coll; in USNM).

J. M. Hawley (Cornell University Agr. Exp. Sta. Mem. 55, pp. 117–118, 1922): "Each year a few bean plants have been found with their roots serving as hosts for the Solanum Root Louse, *Trifidaphis radicicola*. If the aphids are numerous the leaves turn yellow and the plants take on a wilted appearance, due to injury of the lateral roots caused by the feeding of the pest. Infested plants have been found from June 22 to August 22. Only the apterous forms of the insect were seen, and usually there were more immature than fully developed lice present. These aphids are cream-colored but their powdery covering frequently gives them a white, woolly appearance.

"A bean grower near Castile, N. Y., informed the writer that in 1915 his entire field was so badly attacked that the crop was ruined. When beans were planted in the field the next year they were again infested and had to be dragged up. Lice of this species have also been found in small numbers near Batavia, Genesee County . . . . It is probable that the insect may be found on weeds in New York and is injurious to beans only when they are planted after other infested hosts." [Hawley's laboratory was located at Perry from 1917–1921.]

ILLUSTRATIONS

ALL PHOTOMACROGRAPHS BY H. LOU GIBSON 1962

PLATE 1: The Cloudy-winged Cottonwood Leaf Aphid *Chaitophorus populicola* Thomas. From a photomacrograph of a slide mount (CFS) showing wings spread as in flight. The tiny hook, or hamulus, can be seen projecting from the frontal border of each hind wing. This hook engages a looped cell in the basal border of the fore wing in order to couple the wings for action in unison during flight. The tarsi have the hooked claws typical of insects. This species has inconspicuous cornicles; see Plate 2. Actual length of the body is about 2mm (1/12 inch) and the wing spread is about 5mm (1/5 inch).

PLATE 2: The Brown Ambrosia Aphid *Dactynotus ambrosiae* (Thomas). From a slide (A.T. Olive) comparing winged and wingless forms and mounted to show wing venation and keys to the species. Note that the cornicles, long black rods protruding from the abdomen, are pronounced. The rostrum is folded under the body on this slide. Actual length of the body is about 3mm (1/8 inch).

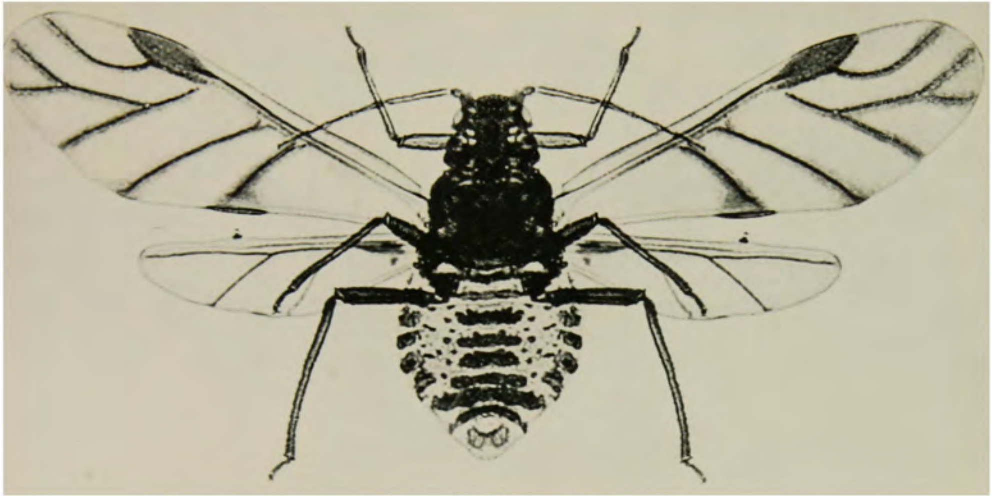

PLATE 1

PLATE 2

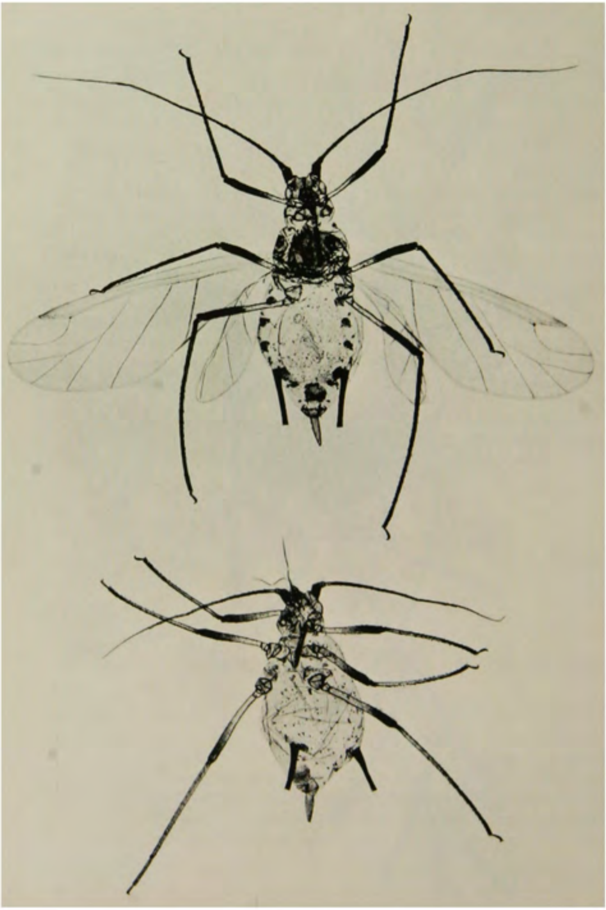

PLATE 3

PLATE 4

PLATE 3: Live Brown Ambrosia Aphids on stems of black-eyed susan *Rudbeckia hirta*. The insects were in their characteristic feeding position—heads downward, abdomens and hind legs elevated, styli inserted into plant. They arrange themselves in orderly rows and when disturbed crouch close to the stems in amazing unison. They also return to the feeding position together as one. The photographic field selected placed an alate prominently in the center. Gibson observes that: "this species (and several others) folds its wings with the frontal edges next to the body. This is about 90° to 180° axial rotation from the usual position adopted by most other 4-winged insects, which rest with the basal edges of the wings horizontally across or vertically touching the body. The aphid probably takes this stance in order to preclude interference of the wing bases with the cornicles, or perhaps to conserve space in crowded colonies".

PLATE 4 (Top): Live mature wingless specimens of the well-known Rose Aphid *Macrosiphum rosae* (Linnaeus). On the left the typical stance of the fore legs and the insertion of the beak can be noted. Cornicles and cauda are presented by the righthand specimen. An immature aptera lurks under the bud. Average length of the mature body is 3mm (1/8 inch).

PLATE 4 (Bottom): Aphids exhibit varied shapes and colors that differ quite a lot from the most commonly seen green species. For example, the live alate and aptera recorded here were powdery white with a jet-black pattern. The cornicles are of intermediate proportion. These specimens have as yet not been determined. They were feeding on May weed *Anthemis cotula* and were about 3mm (1/8 inch) long.

LIST OF FOOD PLANTS

Abies balsamea Balsam Fir
Cinara curvipes
Mindarus abietinus

Abies concolor White Fir
Mindarus abietinus

Acanthopanax sieboldianus Fiveleaf Aralia
Aphis spiraecola

Acer sp. Maple
Longistigma caryae
Neoprociphilus aceris
Periphyllus lyropictus

Acer negundo Boxelder
Aphis sp.
Drepanosiphum platanoides
Periphyllus negundinis

Acer nigrum Black Maple
Drepanaphis acerifoliae
D. carolinensis

Acer pennsylvanicum Striped Maple
Periphyllus lyropictus

Acer platanoides Norway Maple
Drepanosiphum platanoides
Periphyllus lyropictus

Acer platanoides var. **palmatifidum** Cutleaf Norway Maple
Periphyllus lyropictus

Acer platanoides var. **laciniatum** Eagle-claw Maple
Periphyllus lyropictus

Acer pseudo-platanus Sycamore Maple
Drepanosiphum platanoides
Periphyllus lyropictus

Acer rubrum Red Maple
Drepanaphis acerifoliae

Acer saccharinum Silver Maple
Drepanaphis acerifoliae
Neoprociphilus aceris
Prociphilus tesselatus

Acer saccharum Sugar Maple
Drepanaphis acerifoliae
D. carolinensis
D. kansensis

Acer saccharum—Cont'd
D. monelli
D. parvus
Periphyllus americanus
P. lyropictus
Prociphilus tesselatus
Shenahweum minutum

Achillea lanulosa Yarrow
Macrosiphoniella millefolii

Achillea millefolium Common Yarrow
Dactynotus ambrosiae
Macrosiphoniella millefolii
Macrosiphum sp.

Acorus calamus Sweetflag
Rhopalosiphum rufiabdominalis ?

Adiantum sp. Maidenhair Fern
Idiopterus nephrelepidis

African Violet see **Saintpaulia**

Agrimonia gryposepala Agrimony
Macrosiphum agrimonellum
Macrosiphum euphorbiae

Agrimony see **Agrimonia**

Agropyron repens Quackgrass
Sipha agropyrella

Alder see **Alnus**

Alfalfa see **Medicago**

Allium cepa Onion
Micromyzus formosanus

Allspice, Carolina see **Calycanthus**

Alnus sp. Alder
Myzocallis alnifoliae
Prociphilus tessellatus

Alnus glutinosa Black Alder
Myzocallis alnifoliae
Prociphilus tessellatus

Alnus incana White Alder
Myzocallis alnifoliae
Prociphilus tessellatus

Alnus rubra Red Alder
Prociphilus tessellatus

Alnus rugosa Speckled Alder
Calaphis alnosa
Myzocallis alnifoliae

Althaea rosea Hollyhock
Myzus persicae

Amaranthus hybridus Prince's Feather
Aphis helianthi ?
Macrosiphum euphorbiae

Amaranthus retroflexus Pigweed
Macrosiphum euphorbiae
Myzus persicae

Ambrosia sp. Ragweed
Dactynotus ambrosiae

Ambrosia artemisiifolia Common Ragweed
Aphis gossypii
Geoica lucifuga ?

Ambrosia trifida Giant Ragweed
Dactynotus ambrosiae

Amelanchier sp. Shadbush
Prociphilus corrugatans

Amelanchier canadensis
Eriosoma americana
Prociphilus corrugatans

Amelanchier florida
Aphis spiraecola

Amelanchier laevis Allegany Shadbush
Aphis spiraecola

Amelanchier sanguinea Roundleaf Shadbush
Aphis spiraecola

Anaphalis margarita Pearly Everlasting
Dactynotus ambrosiae
D. idahoensis
D. russellae

Angelica sp.
Cavariella aegopodii

Anise Root see **Osmorhiza**

Antennaria neodioica Smaller Pussytoes
Macrosiphum rudbeckiae

Anthemis cotula Dogfennel, Mayweed
Aphis gossypii
Macrosiphum euphorbiae

Anthemis tinctoria Chamomile
Aphis gossypii

Antirrhinum sp. Snapdragon
Macrosiphum euphorbiae
Myzus persicae

Antirrhinum majus Common Snapdragon
Myzus persicae

Apium graveolens var. **dulce** Celery
Aphis gossypii
A. nasturtii
A. sanborni
Cavariella aegopodii
Myzus persicae
M. solani

Apium graveolens var. **rapaceum** Celeriac
Myzus persicae

Apocynum cannabinum Dogbane
Aphis asclepiadis
A. spiraecola
Macrosiphum euphorbiae

Apple see **Malus**

Aquilegia sp. Columbine
Pergandeidia trirhoda

Aquilegia chrysantha
Kakimia essigi
Pergandeidia trirhoda

Aquilegia vulgaris European Columbine
Kakimia essigi
Pergandeidia trirhoda

Aralia see **Acanthopanax**

Arborvitae see **Thuja**

Arctium lappa Great Burdock
Aphis fabae
Macrosiphum gravicornis

Arctium minus Common Burdock
Aphis fabae
Cavariella pastinaceae

Arctostaphylos uva-ursi Bearberry
Tamalia coweni

Arctotis sp.
Dactynotus ambrosiae

Armoracia rusticana (lapathifolia) Horse-radish
Aphis fabae
Myzus persicae

Aronia arbutifolia Red Chokeberry
Aphis pomi

Aronia melanocarpa Black Chokeberry
Aphis pomi

Arrow-wood see **Viburnum**

Artemisia absinthium Wormwood
Macrosiphoniella absinthii
Rhopalosiphum angelicae

Artemisia vulgaris Mugwort
Macrosiphoniella artemisiae

Artemesia schmidtiana var. **nana**
Macrosiphoniella n. sp. ?

Asclepias sp. Milkweed
Aphis asclepiadis
A. nerii
Macrosiphum euphorbiae
Myzocallis asclepiadis
M. punctata

Asclepias amplexicaulis
Myzocallis asclepiadis

Asclepias pulchra Swamp Milkweed
Aphis helianthi

Asclepias syriaca Common Milkweed
Aphis asclepiadis
A. gossypii
A. nerii
A. spiraecola ?
Macrosiphum euphorbiae
Myzocallis asclepiadis
M. punctata

Aster spp. Wild Aster
Anuraphis maidiradicis
Aphis gossypii
Dactynotus ambrosiae
D. gravicornis
D. n.sp. No. 5
Forda sp.

Aster spp.—Cont'd
F. olivacea
Macrosiphum euphorbiae
Prociphilus erigeronensis

Aster spp. Cultivated Aster
Anuraphis maidiradicis
Dactynotus ambrosiae
D. rudbeckiae

Aster ericoides Heath Aster
Dactynotus ambrosiae
D. n.sp. No. 7

Aster lateriflorus
Aphis armoraciae

Aster macrophyllus
Dactynotus ambrosiae

Aster novae-angliae New England Aster
Macrosiphum anomalae ?

Aster novi-belgi New York Aster
Aphis asterensis
Dactynotus ambrosiae

Aster puniceus
Dactynotus ambrosiae
D. tissoti

Aster simplex
Aphis armoraciae

Aster umbellatus Flattop Aster
Dactynotus ambrosiae
D. rudbeckiae
D. sp.

Atriplex patula
Aphis fabae
Macrosiphum euphorbiae
Myzus persicae

Avena sativa Oat
Macrosiphum granarium
Rhopalosiphum fitchii
R. maidis

Avens, White see **Geum canadense**

Azalea see **Rhododendron**

Baccharis halmifolia Sea Myrtle
Aphis coreopsidis
Macrosiphum baccharidis

Balm of Gilead see **Populus gileadensis**

Balsam see **Abies**

Baptisia tinctoria Wild Indigo
Macrosiphum euphorbiae

Barberry see **Berberis**

Barley see **Hordeum**

Barnyard Grass see **Echinochloa**

Basswood or Linden see **Tilia**

Bean see **Phaseolus**

Bearberry see **Arctostaphylos**

Bedstraw see **Galium**

Beet see **Beta**

Beggarticks see **Bidens**

Bergamot, Wild see **Monarda fistulosa**

Begonia semperflorens Perpetual Begonia
Aphis gossypii

Belamcanda chinensis Blackberry Lily
Macrosiphum euphorbiae

Berberis sp. Barberry
Rhopalosiphum berberidis

Berberis thunbergii Japanese Barberry
Rhopalosiphum berberidis

Berberis vulgaris European Barberry
Rhopalosiphum berberidis

Bergenia (Saxifraga) crassifolia
Amphorophora sonchi
Hypermyzus pallidus

Beta vulgaris Beet
Anuraphis maidiradicis
Aphis fabae
Geoica lucifuga ?

Beta vulgaris var. **cicala** Swiss Chard
Aphis fabae

Betula spp. Birch
Calaphis betulae ?
C. betulaecolens
Euceraphis brevis
E. deducta
E. mucida
Hamamelistes spinosus
Longistigma caryae

Betula sp. Willow Birch
Euceraphis betulae
Hamamelistes spinosus

Betula lenta Sweet or Black Birch
Euceraphis betulae
E. mucida
Hamamelistes spinosus

Betula lutea Gray or Yellow Birch
Calaphis betulaecolens
Euceraphis betulae
E. lineata

Betula maximowicziana Monarch Birch
Calaphis betulaecolens
C. granovskyi
Euceraphis gillettei

Betula nigra River or Red Birch
Calaphis betulaecolens
Pemphigus balsamifera ?

Betula papyrifera Paper Birch
Calaphis betulaecolens
C. betulella
Euceraphis betulae
E. gillettei
E. punctipennis

Betula pendula European White Birch
Calaphis granovskyi
Chaitophorus betulae ?
Euceraphis betulae

Betula pendula var. **dalecarlica** Cut-leaved Birch
Calaphis betulaecolens
Neosymydobius annulatus

Betula populifolia Gray Birch
Calaphis betulaecolens
Euceraphis betulae
Hamamelistes spinosus
Neosymydobius annulatus

Bidens sp. Beggarticks
Dactynotus chrysanthemi

Bidens cerna
Dactynotus chrysanthemi

Bidens comosa
Dactynotus chrysanthemi

Bidens frondosa
Aphis coreopsidis
Dactynotus chrysanthemi

Bidens vulgata
Aphis coreopsidis
Dactynotus chrysanthemi

Birch see **Betula**
Birdsfoot Trefoil see **Lotus**
Bittersweet see **Celastrus**
Blackberry see **Rubus**
Blackberry Lily see **Belamcanda**
Black Snakeroot see **Sanicula**
Blackeyed Susan see **Rudbeckia**
Blueberry see **Vaccinium**
Boneset see **Eupatorium**
Boston Fern see **Nephrolepis**

Bougainvillea sp.
Myzus persicae

Bouvardia sp.
Aphis craccivora

Bracken see **Pteris**

Brake Fern see **Pteridium**

Brassica sp. Mustard
Myzus persicae
Rhopalosiphum pseudobrassicae

Brassica kaber (arvensis) Charlock
Myzus persicae

Brassica napobrassicae Rutabaga
Aphis gossypii
Brevicoryne brassicae
Myzus persicae
Rhopalosiphum pseudobrassicae

Brassica napus Rape
Brevicoryne brassicae
Myzus persicae

Brassica nigra Black Mustard
Brevicoryne brassicae
Rhopalosiphum pseudobrassicae

Brassica oleracea var. **botrytis** Broccoli, Cauliflower
Brevicoryne brassicae
Myzus persicae

Brassica oleracea var. **capitata** Cabbage
Brevicoryne brassicae
Myzus persicae
Rhopalosiphum pseudobrassicae

Brassica oleracea var. **gemmifera** Brussels Sprouts
Brevicoryne brassicae
Myzus persicae
Rhopalosiphum pseudobrassicae

Brassica oleracea var. **gonglyodes** Kohlrabi
Aphis gossypii
Brevicoryne brassicae
Myzus persicae

Brassica oleracea (acephala) var. **viridis** Kale or Collards
Brevicoryne brassicae
Myzus persicae

Brassica pekinensis Petsai Cabbage
Myzus persicae

Brassica rapa Turnip
Myzus persicae
Rhopalosiphum pseudobrassicae

Broccoli see **Brassica**

Browalia americana
Trifidaphis phaseoli

Brussels Sprouts see **Brassica**

Bryophyllum sp.
Myzus persicae

Buckthorn see **Rhammus**
Buckwheat see **Fagopyrum**
Buffalo Berry see **Shepherdia**
Bulrush see **Scirpus**
Burdock see **Arctium**
Buttercup see **Ranunculus**
Buttonbush see **Cephalanthus**

Cabbage, Petsai see **Brassica**

Cactus, Orchid see **Epiphyllus**

Cakile edentula Sea Rocket
Myzus persicae
Rhopalosiphum pseudobrassicae

Calamagrostis canadensis Reedgrass
Hyalopterus arundinis

Calendula sp.
Aphis fabae
Dactynotus ambrosiae
Macrosiphum euphorbiae
Myzus circumflexus
M. persicae

Calendula officinalis Pot Marigold
Aphis fabae
Geoica lucifuga ?
Myzus circumflexus
M. persicae

Callalily see **Zantedeschia**

Calliandra inaequilatera
Myzus persicae

Callistephus chinensis China Aster
Macrosiphum euphorbiae
Prociphilus erigeronensis

Calycanthus sp. Carolina Allspice
Aphis fabae

Campsis (Tecoma) radicans Trumpet Creeper
Aphis craccivora
Myzus persicae

Cape Marigold see **Dimorphotheca**

Capsella bursa-pastoris Shepard's Purse
Aphis fabae
Myzus persicae

Capsicum frutescens Redpepper
Macrosiphum euphorbiae
Myzus persicae

Caraway see **Carum**

Cardoon see **Cynara**

Carex annectens Sedge
Aphis sp.

Carnation see **Dianthus**

Carpinus caroliniana American Hornbeam
Macrosiphum carpinicolens

Carrion Flower see **Smilax**

Carrot see **Daucus**

Castorbean see **Ricinus**

Carum carvi Caraway
Aphis sp.

Carya sp. Hickory
Longistigma caryae
Melanocallis caryaefoliae
Monellia caryae
M. caryaella
M. costalis
M. nigropunctata
Myzocallis punctatella

Carya cordiformis Bitternut Hickory
Monellia caryae
M. caryaella
M. costalis
M. nigropunctata

Carya glabra Pignut Hickory
Monellia costalis

Carya ovalis Red Hickory
Melanocallis caryaefoliae

Carya ovata Shagbark Hickory
Melanocallis caryaefoliae
Monellia caryae
M. costalis
M. nigropunctata
M. punctata

Castanea dentata American Chestnut
Calaphis castaneae

Catalpa bignonioides Southern Catalpa
Aphis gossypii

Catnip see **Nepeta**

Cat's-ear see **Hypochaeris**

Cattail see **Typha**

Cauliflower see **Brassica**

Celastrus sp. Bittersweet
Aphis fabae

Celastrus orbiculata Oriental Bittersweet
Aphis fabae

Celastrus scandens American Bittersweet
Aphis fabae
A. craccivora

Celery see **Apium**

Centaurea sp. Star Thistle
Anuraphis cardui

Cephalanthus occidentalis Buttonbush
Aphis cephalanthi

Chaenomeles sp. Flowering Quince
Aphis pomi ?

Chaenomeles (Cydonia) japonica Japanese Flowering Quince
Aphis pomi ?

Charlock see **Brassica**

Chenopodium sp. Pigweed
Aphis craccivora
A. fabae
Hyalopterus atriplicis

Chenopodium album Lamb's-quarters or Pigweed
Aphis fabae
A. gossypii
Hyalopterus atriplicis
Macrosiphum dirhodum ?
M. euphorbiae
Myzus persicae
Rhopalosiphum pseudobrassicae

Cherry see **Prunus**

Chestnut see **Castanea**

Chickweed see **Stellaria**

Chicory see **Cichorium**

China Aster see **Callistephus**

Chokeberry see **Aronia**

Chokecherry see **Prunus**

Chrysanthemum sp.
Aphis gossypii
Dactynotus n.sp. No. 7
Macrosiphoniella sanborni
Rhopalosiphum rufomaculatum

Chrysanthemus balsamita Costmary
Macrosiphum ludovicianae

Chrysanthemum frutescens Marguerite Chrysanthemum
Aphis gossypii
Myzus persicae

Chrysanthemum indica Mother Chrysanthemum
Aphis gossypii
Macrosiphoniella sanborni
Rhopalosiphum rufomaculatum

Chrysanthemum leucanthemum Ox-eye Daisy
Aphis gossypii
Dactynotus n.sp. No. 7
Macrosiphoniella sanborni
Myzus persicae

Chrysanthemum maxima Shasta Daisy
Aphis sp.

Chrysanthemum morifolium Florists' Chrysanthemum
Aphis gossypii
Macrosiphoniella sanborni
Rhopalosiphum rufomaculata

Chrysopsis falcacta Sickleleaf Golden Aster
Dactynotus n.sp. No. 1
Myzus persicae

Chrysopsis mariana
Dactynotus n.sp. No. 1

Cichorium endivia Endive
Macrosiphum euphorbiae

Cichorium intybus Common Chicory
Dactynotus n.sp. No. 7
Macrosiphum euphorbiae
Nasonovia ribisnigri

Cicuta sp. Water Hemlock
Cavariella aegopodii

Cicuta maculata Spotted Water Hemlock
Aphis gossypii
Cavariella aegopodii
C. hendersoni ?
Dactynotus n.sp. No. 7
Rhopalosiphum conii

Cineraria see **Senecio**

Cinquefoil see **Potentilla**

Cirsium sp. Thistle
Aphis fabae
Capitophorus braggii
Dactynotus rudbeckiae

Cirsium arvense Canada Thistle
Capitophorus braggii
C. eleagni
Dactynotus ambrosiae
Rhopalosiphum conii

Cirsium discolor Field Thistle
Anuraphis cardui
Dactynotus ambrosiae
D. n.sp. No. 7

Cirsium vulgare (lanceolatum) Bull Thistle
Anuraphis carduella
A. cardui

Citrullus vulgaris Watermelon
Aphis gossypii

Clethra barbinervis Japanese Clethra
Aphis sp. near *pomi*

Clover see **Trifolium**

Cnicus arvensis
Capitophorus braggii

Cobaea scandens Purplebell Cobaea
Macrosiphum euphorbiae

Cocklebur see **Xanthium**

Collards see **Brassica**

Collinsonia canadensis Richweed
Hyalomyzus eriobotryae ?
H. sp.

Columbine see **Aquilegia**

Comptonia peregrina var. **asplenifolia** Sweetfern
Cepegillettea myricae

Coneflower see **Rudbeckia**

Convolvulus sepium Wild Morning Glory
Macrosiphum euphorbiae

Coreopsis sp.
Macrosiphum euphorbiae

Corn see **Zea**

Cornus sp. Dogwood
Anoecia corni
Aphis cornifoliae
A. helianthi ?

Cornus alternifolia Green Osier
Anoecia corni ?

Cornus amomum Silky Dogwood
Anoecia corni

Cornus asperifolia (candidissima) Roughleaf Dogwood
Anoecia corni
Aphis cornifoliae

Cornus foemina
Anoecia querci

Cornus racemosa (paniculata)
Anoecia corni
Aphis cornifoliae

Cornus rugosa
Anoecia corni ?
Aphis neogillettei

Cornus stolonifera Red Osier
Anoecia corni

Corylus sp. Filbert
Myzocallis coryli

Corylus americana American Filbert
Myzocallis coryli

Corylus avellana var. **contorta** Curly European Filbert
Myzocallis coryli

Corylus cornuta Beaked Filbert
Myzocallis coryli

Corylus maxima Giant Filbert
Myzocallis corlyi

Cosmos sp.
Aphis coreopsidis
A. fabae
Macrosiphum euphorbiae

Cosmos bipinnatus
Anuraphis maidiradicis
Aphis spiraecola
Geoica licifuga ?

Cotinus americanus Smoke Tree
Rhopalosiphum rhois

Cotoneaster rosea
Myzus cerasi

Cottonwood see **Populus**

Cowlily see **Nuphar**

Cowparsnip see **Heracleum**

Crabapple see **Malus**

Crabgrass see **Digitaria**

Cranberrybush see **Viburnum**

Crataegus sp. Hawthorn
Amphorophora crataegi
Anuraphis bakeri
Aphis crataegifoliae
A. pomi
Eriosoma crataegi
Prociphilus corrugatans
Rhopalosiphum fitchii

Crataegus anomala
Amphorophora crataegi

Crataegus chrysocarpa Fireberry Hawthorn
Eriosoma crataegi
Ovatus crataegarius

Crataegus crusgalli Cockspur Hawthorn
Amphorophora crataegi
Eriosoma crataegi

Crataegus intricata (coccinea) Thicket Hawthorn
Aphis crataegifoliae
A. pomi
Rhopalosiphum fitchii

Crataegus macrosperma
Amphorophora crataegi ?
Aphis crataegifolia

Crataegus oxycantha English Hawthorn
Aphis crataegifoliae
A. pomi
Eriosoma crataegi

Crataegus oxycantha var. **pauli** Paul's Scarlet Thorn
Eriosoma crataegi
E. lanigerum
Myzus persicae
Ovatus crataegarius

Crataegus phaenopyrum Washington Hawthorn
Aphis crataegifoliae ?
Rhopalosiphum fitchii

Crataegus pruinosa **Frosted Hawthorn**
Amphorophora crataegi

Crataegus punctata Dotted Hawthorn
Amphorophora crataegi
Aphis crataegifoliae
Prociphilus corrugatans

Crimson Clover see **Trifolium**

Crocus sp.
Myzus persicae

Crunchweed see **Brassica**

Cucumber see **Cucumis**

Cucumber Tree see **Magnolia**

Cucumis melo Muskmelon
Aphis gossypii

Cucumis sativus Cucumber
Aphis gossypii

Cucurbita maxima Squash
Aphis gossypii
Macrosiphum euphorbiae

Cucurbita moschata Cushaw or Crookneck
Aphis gossypii

Cucurbita pepo Pumpkin
Aphis gossypii

Cucurbita pepo var. **ovifera** Gourd
Aphis gossypii
Macrosiphum euphorbiae

Cudweed see **Gnaphalium**

Currant see **Ribes**

Cyclamen sp.
Myzus circumflexus

Cyclamen indicum Ivyleaf Cyclamen
Aphis gossypii
Myzus circumflexus

Cydonia oblonga Quince
Aphis pomi ?

Cynara cardunculus Cardoon
Aphis fabae

Cyrtomium sp. Fern
Idiopterus nephrelepidis

Dactylus glomerata Orchard Grass
Anoecia corni
Hyalopteroides humilis
Rhopalosiphum fitchii

Dahlia sp.
Anuraphis rumexicolens
A. tulipae
Aphis fabae
A. gossypii
A. nasturtii
Macrosiphum euphorbiae
Myzus persicae

Dahlia pinnata Aztec Dahlia
Aphis fabae
Macrosiphum euphorbiae
Myzus persicae

Dandelion see **Taraxacum**

Daucus carota Wild Carrot
Cavariella pastinaceae
Rhopalosiphum conii

Daucus carota Garden Carrot
Anuraphis carotae
A. maidiradicis
Aphis fabae
A. gossypii
Cavariella aegopodii
Rhopalosiphum conii

Decodon verticillatus Swamp Loosestrife
Myzus lythri

Delphinium sp. (Cult.) Larkspur
Aphis rociadae

Desmodium canadense Canadian Tick Trefoil
Hyalopterus arundinis
Microparsus variabilis

Deutzia scabra Fuzzy Deutzia
Aphis craccivora

Devil's Claws see **Martynia**

Devil's Paintbrush see **Hieracium**

Dianthus caryophyllus Carnation
Myzus persicae

Dianthus chinensis
Myzus persicae

Digitaria ischaemum Smooth Crabgrass
Myzus persicae

Digitaria sanguinalis
Aphis sp.
Hysteroneura setariae
Rhopalosiphum maidis

Dimorphotheca sp. Cape Marigold
Dactynotus ambrosiae

Dipsacus sp. Teasel
Macrosiphum rosae

Dipsacus sylvestris Wild Teasel
Macrosiphum rosae

Dock see **Rumex**

Dogbane see **Apocynum**

Dogfennel see **Anthemis**

Dog's-tooth Violet see **Erythronium**

Dogwood see **Cornus**

Dracocephalum (Physostegia) virginianum
Myzus solani

Duckweed see **Lemna**

Echinochloa crusgalli Barnyard Grass
Rhopalosiphum maidis

Eggplant see **Solanum**

Elder see **Sambucus**

Elaeagnus angustifolia Russian Olive
Capitophorus archangelskii
C. braggii
C. elaeagni

Elaeagnus multiflora Cherry Elaeagnus
Capitophorus braggii

Eleusine indica Goose Grass
Anoecia querci

Elm see **Ulmus**

Endive see **Cichorium**

Epilobium coloratum Purpleleaf Willowweed
Aphis nasturtii

Epiphyllum sp. Orchid Cactus
Myzus persicae

Erechtites hieraceifolia Fireweed
Aphis fabae

Erigeron sp. Fleabane
Dactynotus erigeronensis
D. gravicornis

Erigeron annuus Daisy Fleabane
Aphis helichrysi
Dactynotus erigeronensis
D. gravicornis

Erigeron canadensis Horseweed Fleabane
Aphis armoraciae
A. gossypii
Dactynotus erigeronensis
D. gravicornis

Erigeron pulchellus Robin's Plantain
Dactynotus erigeronensis

Erigeron speciosus Showy Fleabane
Dactynotus gravicornis

Erigeron strigosus (ramosus)
Dactynotus gravicornis
D. tissoti

Erythronium dens-canis Dog's-tooth Violet
Myzus persicae

Euchlena mexicana (perennis) Teosinte
Rhopalosiphum maidis

Euonymus sp. Spindletree
Aphis fabae

Euonymus sp. **(? bungeanus)** Winterberry Euonymus
Aphis fabae

Euonymus americanus Strawberry-bush
Aphis fabae

Euonymus atropurpureus Eastern Wahoo
Aphis fabae

Euonymus europaeus European Spindle Tree
Aphis fabae

Euonymus nikoensis Nikko Euonymus
Aphis fabae

Eupatorium sp.
Dactynotus ambrosiae

Eupatorium aromaticum
Aphis gossypii

Eupatorium coelestinum forma **alba**
Aphis sp.
Microsiphum sp.

Eupatorium maculatum Joepyeweed
Aphis gossypii
A. nostras
A. vernoniae ?

Eupatorium perfoliatum Boneset
Aphis sp.
Dactynotus ambrosiae
Macrosiphum pseudorosae

Eupatorium purpureum Bluestem Joepyeweed
Aphis gossypii
Dactynotus ambrosiae
D. gravicornis

Eupatorium rugosum (urticaefolium) White Snakeroot
Dactynotus ambrosiae
D. chrysanthemi

Evening Primrose see **Oenothera**

Everlasting see **Anaphalis**
see **Gnaphalium**
see **Helichrysum**

Fagopyrum saggitatum Buckwheat
Aphis fabae
Toxoptera graminum

Fagus grandifolia American Beech
Longistigma caryae
Phyllaphis fagi ?

Fagus sylvatica var. **atropunicea** Copper or Purple Beech
Phyllaphis fagi
Prociphilus imbricator

False Buckwheat see **Polygonum**
False Dandelion see **Pyrrhopappus**
False Hellebore see **Veratrum**

Fern, Maidenhair see **Adiantum**

Filbert see **Corylus**

Fir see **Abies**

Fleabane see **Erigeron**

Forgetmenot see **Myosotis**

Four-o'clock see **Mirabilis**

Foxglove see **Digitalis**

Foxtail see **Setaria**

Fragaria sp. Strawberry
Myzus porosus
Pentatrichopus minor
P. minor var. *dorsalis*
P. thomasi

Fragaria chiloensis Chiloe Strawberry
Macrosiphum rosae

Fragaria virginiana Virginia Strawberry
Aphis forbesi
Pentatrichopus fragaefolii

Freesia sp.
Myzus persicae

Galinsoga parviflora Quickweed
Geoica lucifuga ?
Myzus persicae

Galium sp. Bedstraw
Myzus sp.

Galium aparine
Aphis gossypii

Galium circaezans
Aphis gossypii

Geranium (Cult.) see **Pelargonium**

Geranium robertianum Herb-Robert
Macrosiphum (Acyrthosiphon) pelargonii

Gerbera sp.
Aphis gossypii
Macrosiphum pseudorosae
Myzus persicae
Rhopalosiphum pseudobrassicae

German Ivy see **Senecio**

Geum canadense White Avens
Amphorophora rossi

Gill-over-the-ground see **Glecoma**

Gladiolus sp.
Anuraphis tulipae
Aphis fabae
Myzus persicae

Gladiolus gandavensis (hybrid)
Anuraphis tulipae

Glecoma hederacea Gill-over-the-ground
Macrosiphum sp.
Myzus persicae

Gleditsia triacanthos Honey Locust
Aphis craccivora

Gnaphalium obtusifolium Fragrant Cudweed
Prociphilus erigeronensis ?

Gnaphalium polycephalum
Dactynotus n.sp. No. 7
Myzus persicae
Prociphilus erigeronensis ?

Goat's Rue see **Tephrosia**

Golden Chain Tree see **Laburnum**

Goldenglow see **Rudbeckia**

Goldenrod see **Solidago**

Gooseberry see **Ribes**

Goose Grass see **Eleusine**

Gourd see **Cucurbita**

Gourd see **Lagenaria**

Grape see **Vitis**

Groundsel see **Senecio**

Hamamelis virginiana Witchhazel
Hamamelistes spinosus
Hormaphis hamamelidis

Hawkweed, Rough see **Hieracium**

Hawthorn see **Crataegus**

Heart's-Ease see **Polygonum**

Hedera helix English Ivy
Aphis pseudohederae
Myzus persicae

Hedge Mustard see **Sisymbrium**

Helenium sp.
Macrosiphum tardae

Helianthus sp. Sunflower
Dactynotus gravicornis
Macrosiphum illini var. *sangamonensis*

Helianthus annuus Common Sunflower
Geoica lucifuga ?
Macrosiphum illini
Prociphilus erigeronensis ?

Helianthus decapetalus Thinleaf Sunflower
Aphis helianthi
Dactynotus ambrosiae

Helianthus giganteus Giant Sunflower
Macrosiphum sp.

Helianthus grosseserratus Sawtooth Sunflower
Geoica lucifuga ?

Helianthus latiflorus var. **rigidus** Stiff Sunflower
Aphis helianthi

Helianthus petiolaris Prairie Sunflower
Macrosiphum sp.

Helianthus tuberosus Jerusalem Artichoke
Dactynotus n.sp. No. 3

Helichrysum sp. Everlasting
Dactynotus ambrosiae
Myzus persicae

Helichrysum bracteatum Strawflower
Myzus persicae

Heliopsis helianthoides Ox-eye
Dactynotus n.sp.

Heliotrope see **Heliotropium**

Heliotropium arborescens Common Heliotrope
Myzus circumflexus

Henbit see **Lamium**

Heracleum sp. Cowparsnip
Cavariella theobaldi

Heracleum lanatum Common Cowparsnip
Aphis helianthi ?
A. heraclella
Cavariella essigi ?
C. theobaldi
Rhopalosiphum conii

Herb-Robert see **Geranium**

Hercules Club see **Zanthoxylum**

Hibiscus esculentus Okra
Aphis gossypii
Macrosiphum euphorbiae
Myzus persicae

Hibiscus moscheutos Rosemallow
Aphis fabae

Hibiscus syriacus Rose-of-Sharon
Aphis gossypii

Hickory see **Carya**

Hieracium aurantiacum Devil's Paint-brush
Dactynotus gravicornis
Nasonovia ribisnigri

Hieracium canadense var. **hirtirameum**
Macrosiphum sp.

Hieracium florentinum
Nasonovia ribisnigri

Hieracium pratense King Devil
Dactynotus ambrosiae
D. sp.

Hieracium scabrum Rough Hawkweed
Dactynotus sp.

Hollyhock see **Althaea**

Honey Locust see **Gleditsia**

Honeysuckle see **Lonicera**

Hop see **Humulus**

Hordeum vulgare Barley
Macrosiphum granarium
Rhopalosiphum fitchii
R. maidis

Hornbeam see **Carpinus**

Horse-nettle see **Solanum**

Horse-radish see **Armoracia**

Humulus lupulus Hop
Phorodon humuli

Hypericum sp. St. Johnswort
Aphis fabae

Hypochoeris radicata Spotted Cat's-ear
Dactynotus n.sp. No. 7

Impatiens sp. Jewelweed
Aphis coreopsidis
A. impatientis
Macrosiphum impatiensicolens
M. pseudorosae

Impatiens biflora (capensis) Spotted Touchmenot
Aphis impatientis
Dactynotus sp.
Macrosiphum impatiensicolens ?

Ipomoea batata Sweet Potato
Myzus persicae

Ipomoea purpurea Morning Glory
Myzus persicae

Iris sp.
Anuraphis tulipae
Macrosiphum euphorbiae
Myzus circumflexus
M. persicae

Iris ensata Russian Iris
Anuraphis tulipae

Iris germanica German Iris
Macrosiphum euphorbiae

Iris susiana Mourning Iris
Anuraphis tulipae

Ironweed see **Vernonia**

Iva oraria (frutescens)
Dactynotus ambrosiae

Iva xanthifolia
Dactynotus ambrosiae

Ivy, English see **Hedera**

Jerusalem Cherry see **Solanium**

Jetbead see **Rhodotypus**

Jewelweed see **Impatiens**

Joepyeweed see **Eupatorium**

Juglans nigra Black Walnut
Monellia caryae
M. costalis
M. nigropunctata

Juglans regia Persian Walnut
Chromaphis juglandicola

Juglans sieboldiana Siebold Walnut
Monellia caryae

Juniperus virginiana Red Cedar
Cinara sabinae

Kale see **Brassica**

King Devil see **Hieracium**

Knotweed see **Polygonum**

Kohlrabi see **Brassica**

Laburnum anagyroides Golden Chain Tree
Aphis craccivora

Lactuca sp. Lettuce
Dactynotus ambrosiae
D. sonchellus
D. n.sp.
Macrosiphum rudbeckiae

Lactuca canadensis Canada Lettuce
Amphorophora sonchi
Dactynotus ambrosiae
D. sonchellus
D. n.sp.

Lactuca saggitifolia
Dactynotus ambrosiae ?

Lactuca sativa Garden Lettuce
Dactynotus n.sp. No. 7
D. ambrosiae
D. rudbeckiae
Macrosiphum euphorbiae
Myzus persicae
M. solani
Nasonovia ribisnigri
Pemphigus bursarius

Lactuca serriola Prickly Lettuce
Dactynotus n.sp. No. 7
D. ambrosiae ?
D. sonchellus

Lactuca serriola var. **integrata**
Macrosiphum sp.

Lactuca spicata Blue Lettuce
Dactynotus ambrosiae
D. sonchellus
D. n.sp. No.7

Lagenaria leucantha (vulgaris) Cultivated Gourd
Macrosiphum euphorbiae

Lambsquarters see **Chenopodium**

Lamium amplexicaule Henbit
Myzus solani

Larch see **Larix**

Larix sp. Larch
Cinara laricis

Larix laricina Tamarack
Cinara laricis

Larkspur see **Delphinium**

Lathyrus odorata Sweet Pea
Geoica radicicola
Macrosiphum pisi

Leersia (Homalocenchrus) oryzoids Rice Cut-grass
Colopha ulmicola

Leersia virginica
Colopha ulmicola

Lemna minor Common Duckweed
Rhopalosiphum nymphaeae

Lepidium virginicum Peppergrass
Aphis fabae
A. craccivora
Myzus persicae
Rhopalosiphum pseudobrassicae

Lettuce see **Lactuca**

Levisticum officinale Garden Lovage
Rhopalosiphum conii

Licorice, Wild see **Galium**

Ligusticum scothicum Scotch Lovage
Aphis fabae

Ligustrum vulgare European Privet
Myzus ligustri

Lilium sp. Lily
Macrosiphum lilii
Myzus solani

Lilium auratum Goldband Lily
Myzus circumflexus

Lilium canadense Canada Lily
Macrosiphum lilii

Lilium candidum Madonna Lily
Aphis gossypii

Lilium formosanus Formosa Lily
Macrosiphum lilii

Lilium longiflorum Easter Lily
Aphis gossypii
Macrosiphum euphorbiae
M. lilii
Myzus circumflexus
M. solani

Lilium philippense Philippine Lily
Macrosiphum lilii
Myzus circumflexus
M. solani

Lilium pumilum
Myzus circumflexus

Lilium regale Regal Lily
Macrosiphum lilii

Lilium speciosum Speciosum Lily
Aphis gossypii
Macrosiphum lilii
Myzus solani

Lilium superbum Turkscap Lily
Macrosiphum lilii

Lilium tigrinum Tiger Lily
Macrosiphum lilii

Lily see **Lilium**

Linden or Basswood see **Tilia**

Lion's Foot see **Prenanthes**

Liriodendron tilipifera Tulip Tree
Macrosiphum liriodendri

Liveforever see **Sedum**

Locust see **Robinia**

Lonicera sp. Honeysuckle
Rhopalosiphum conii
R. grabhami

Lonicera dioica
Rhopalosiphum conii

Lonicera japonica Japanese Honeysuckle
Macrosiphum euphorbiae
Rhopalosiphum conii

Lonicera japonica var. **halliana** Hall's Honeysuckle
Rhopalosiphum conii

Lonicera prolifera Grape Honeysuckle
Rhopalosiphum conii

Lonicera sempervirens Trumpet Honeysuckle
Rhopalosiphum conii
(*Drepanosiphum platanoides*)

Lonicera tartarica Tartarian Honeysuckle
Rhopalosiphum conii

Loosestrife see **Lysimachia**

Loosestrife, Fringed see **Steironema**

Loosestrife, Swamp see **Decodon**

Lotus see **Nelumbium**

Lotus sp. Birdsfoot Trefoil
Aphis craccivora

Lotus corniculatus Birdsfoot Trefoil
Macrosiphum pisi

Lovage, Garden see **Levisticum**

Lovage, Scotch see **Ligusticum**

Lupine see **Lupinus**

Lupinus sp. Lupine
Macrosiphum albifrons

Lupinus polyphyllus Washington Lupine
Macrosiphum albifrons

Lychnis alba White Campion
Aphis sp.
Macrosiphum euphorbiae

Lycopersicon esculentum Tomato
Aphis gossypii
Macrosiphum euphorbiae
Myzus persiae
M. solani

Lycopus americanus Water Horehound
Myzus sensoriatus

Lysimachia (Steironema) ciliata Loosestrife
Aphis sp.

Lysimachia terrestris Swamp Loosestrife
Thecabius sp.

Lythrum salicaria Purple Loosestrife
Myzus lythri

Lythrus odoratus Sweet Pea
Macrosiphum pisi
Trifidaphis radicicola

Magnolia acuminata Cucumber Tree
Macrosiphum liriodendri

Magnolia slavani Slavan Magnolia
Macrosiphum liriodendri

Magnolia soulangiana Saucer Magnolia
Macrosiphum liriodendri

Mahonia sp.
Rhopalosiphum berberidis

Malus sp. Crabapple
Aphis pomi

Malus sp. Van Eseltine Crab
Aphis pomi

Malus baccata Siberian Crabapple
Aphis pomi

Malus coronaria Wild Sweet Crabapple
Aphis pomi
Eriosoma lanigerum

Malus floribunda Purple Chokeberry
Eriosoma lanigera

Malus ioensis var. **plena** Bechtel's Crab
Aphis pomi

Malus pumila Common Apple
Anuraphis bakeri
A. rosea
Aphis pomi
Eriosoma lanigerum
Rhopalosiphum fitchii

Malus sylvestris Apple
Aphis fabae

Malva rotundifolia
Chaitophorus sp.

Maple see **Acer**

Marigold, African see **Tagetes**

Marsh-Grass see **Spartina**

Martynia louisiana Devil's Claws
Aphis gossypii
Myzus persicae

Matthiola incana Common Stock
Brevicoryne brassicae
Myzus persicae

Matricaria chamomilla German Camomile
Macrosiphum sp.

Matricaria matricarioides (suaveolens)
Aphis fabae
Myzus persicae ?
M. solani ?

May Weed see **Anthemis**

Meadow Parsnip see **Thaspium**

Meadowrue see **Thalictrum**

Medic see **Medicago**

Medicago lupulina Black Medic
Macrosiphum pisi

Medicago sativa Alfalfa
Macrosiphum pisi

Medlar see **Mespilus**

Melilotus alba White Sweet Clover
Therioaphis riehmi

Mentha cardiaca
Ovatus crataegarius

Mentha crispa Curled Mint
Ovatus crataegarius

Mentha spicata Spearmint
Ovatus crataegarius

Mespilus germanica Medlar
Aphis pomi

Milkweed see **Asclepias**

Mint see **Mentha**

Mirabilis jalapa Common Four-o'clock
Aphis craccivora

Mockorange see **Philadelphus**

Monarda sp.
Capitophorus sp.

Monarda didyma Oswego Beebalm
Aphis monardae

Monarda fistulosa Wild Bergamot
Aphis monardae
Myzus monardae

Morning Glory see **Ipomoea**

Morning Glory, wild see **Convolvulus**

Mountain Ash see **Sorbus**

Muskmelon see **Cucumis**

Mustard see **Brassica**

Myosotis sp. Forgetmenot
Myzus circumflexus
M. persicae

Myosotis alpestris Alpine Forgetmenot
Myzus persicae

Myosotis laxa
Myzus sp.

Myrica cerifera Wax Myrtle
Cepegillettea myricae ?

Myrica gale Sweet Gale
Cepegillettea sp.

Nannyberry see **Viburnum**

Narcissus sp.
Macrosiphum euphorbiae
Myzus persicae

Nasturtium see **Tropaeolum**

Nasturtium officinale Watercress
Aphis sp.

Nelumbium (Nelumbo) lutea American Lotus
Rhopalosiphum nymphaeae

Nemesia strumosa
Aphis gossypii
Myzus persicae

Nemophila menziesi
Myzus persicae

Nepeta cataria Catnip
Aphis nasturtii

Nephrolepsis exaltata var. **bostonensis** Boston Fern
Idiopterus nephrelepidis

Nettle see **Urtica**

Nicotiana longiflora
Myzus persicae

Nicotiana tabacum Common Tobacco
Myzus persicae

Nightshade see **Solanum**

Ninebark see **Physocarpus**

Nuphar advena Cowlily
Rhopalosiphum nymphaeae

Nymphaea sp. Waterlily
Rhopalosiphum nymphaeae

Nymphaea odorata Pondlily
Rhopalosiphum nymphaeae

Nyssa sylvatica Tupelo
Aphis coreopsidis

Oak see **Quercus**

Oat see **Avena**

Oenothera sp. Evening Primrose
Aphis oenotherae
A. oestlundi
Prociphilus erigeronensis

Oenothera biennis Common Evening Primrose
Aphis euonymi

Oenothera biennis—Cont'd
A. nasturtii
A. oenotherae
A. oestlundi
Macrosiphum euphorbiae
M. pseudorosae

Oenothera pariflora var. **oakesiana**
Aphis oenotherae

Okra see **Hibiscus**

Onion see **Allium**

Onoclea sensibilis Sensitive Fern
Amphorophora laingi

Onopordum acanthium Scotch Thistle
Anuraphis cardui
Aphis fabae

Orchard Grass see **Dactylis**

Orchid sp.
Dactynotus luteus

Osier, Green see **Cornus**

Osmorhiza claytoni Sweet Jarvil
Aphis sp.
Cavariella aegopodii

Osmorhiza longistilis Anise Root
Cavariella aegopodii

Ostrich Fern see **Pteretis**

Oswego Beebalm see **Monarda**

Oxalis sp.
Myzus persicae

Oxalis cernua Buttercup Oxalis
Myzus persicae

Ox-eye see **Heliopsis**

Ox-eye Daisy see **Chrysanthemum**

Panicum sp. Witch Grass
Hyalopteroides humilis

Panicum cappilare Old Witch Grass
Rhopalosiphum maidis

Papaver orientalis Oriental Poppy
Aphis fabae

Papaver rhoeas Corn Poppy
Aphis fabae
A. gossypii

Parsley see **Petroselinum**

Parsnip see **Pastinaca**

Parthenocissus tricuspidata Virginia Creeper
Aphis folsomii

Pastinaca sativa Garden Parsnip
Cavariella capreae
C. theoboldi
Rhopalosiphum conii

Pastinaca sativa var. **sylvestris** Wild Parsnip
Aphis fabae
Cavariella pastinaceae
Rhopalosiphum conii

Pea see **Pisum**

Peach see **Prunus**

Pear see **Pyrus**

Pelargonium domesticum
Macrosiphum pelargonii

Pelargonium graveolens
Macrosiphum pelargonii

Pelargonium odoratissimum
Macrosiphum pelargonii

Pelargonium peltatum
Macrosiphum pelargonii

Pelargonium quercifolium
Macrosiphum pelargonii

Pelargonium radula
Macrosiphum pelargonii

Pennycress see **Thlaspi**

Pepper see **Capsicum**

Peppergrass see **Lepidium**

Periwinkle see **Vinca**

Petroselinum crispum Common Parsley
Cavariella theobaldi
Rhopalosiphum conii

Petunia sp.
Macrosiphum euphorbiae

Petunia axillaris
Macrosiphum euphorbiae
Myzus persicae

Petunia hybrida Common Petunia
Myzus persicae

Phaseolus sp. Bean
Aphis craccivora
Geoica radicola
Macrosiphum pisi
Trifidaphis radicicola

Phaseolus lunatus Lima Bean
Aphis fabae
A. craccivora

Phaseolus vulgaris Kidney Bean
Aphis fabae

Philadelphus sp. Mockorange
Aphis fabae

Philadelphus hirsutus var. **intermedius**
Aphis fabae

Philadelphus pubescens
Myzus persicae

Philadelphus pururescens
Myzus persicae

Phlox sp.
Aphis middletoni ?

Phragmites sp. Reed
Hyalopterus arundinis

Phragmites communis Common Reed
Hyalopterus arundinis

Physocarpus opulifolius Common Ninebark
Myzus physocarpi

Phytolacca americana Pokeweed
Aphis spiraecola

Picea abies (excelsa) Norway Spruce
Cinara costata
C. hyalina
C. palmerae
C. piceicola

Picea glauca White Spruce
Cinara pilicornis
Cinara pinicola

Picea pungens Colorado Spruce
Cinara palmerae ?

Pignut see **Carya**

Pigweed see **Amaranthus**
see **Chenopodium**

Pine see **Pinus**

Pin Cherry see **Prunus**

Pineappleweed see **Matricaria**

Pinus sp. Pine
Cinara carolina
C. pinivora
C. strobi
Eulachnus agilis

Pinus banksiana Jack or Scrub Pine
Cinara banksiana

Pinus nigra Austrian Pine
Cinara carolina
C. pini
Eulachnus rileyi

Pinus resinosa Red or Norway Pine
Cinara pini
Eulachnus rileyi
Schizolachnus pini-radiatae ?

Pinus rigida Pitch Pine
Cinara carolina
Essigella pini
Eulachnus rileyi

Pinus strobus White Pine
Cinara strobi

Pinus sylvestris Scotch Pine
Cinara sp.
C. pinea
C. watsoni
Eulachnus agilis
Mindarus abietinus

Pinus thunbergi Japanese Black Pine
Cinara pini

Pisum sativum Garden Pea
Macrosiphum pisi

Planetree see **Platanus**

Plantago lanceolata Ribgrass or Narrow-leaved Plantain
Anuraphis rosea

Plantago major Common or Broad-leaved Plantain
Anuraphis rosea

Plantain see **Plantago**

Platanus occidentalis American Plane-tree or Sycamore
Longistigma caryae

Platanus orientalis Oriental Planetree
Longistigma caryae

Plum see **Prunus**

Poison Ivy see **Rhus**

Pokeweed see **Phytolacca**

Polanisia graveolens Stinking Clammyweed
Myzus persicae

Polianthes tuberosa Tuberose
Aphis fabae

Polygonum sp. Knotweed or Smartweed
Capitophorus hippophaes
C. hippophaes subsp. *javanicus*
Forda occidentalis

Polygonum aviculare Knotweed
Aphis fabae

Polygonum convolvulus Black Bindweed
Macrosiphoniella sp.

Polygonum cuspidatum Japanese Knotweed
Aphis fabae

Polygonum pennsylvanicum Pinkweed
Capitophorus hippophaes

Polygonum persicaria Heart's-ease
Capitophorus braggii
C. hippophaes
C. hippophaes subsp. *javanicus*

Polygonum scandens
Macrosiphum euphorbiae

Pondlily see **Nymphaea**

Poplar see **Populus**

Poppy see **Papaver**

Populus sp. Poplar
Aphis maculatae
Chaitophorus stevensis
C. populicola
Mordwilkoja vagabunda
Pemphigus populicaulis
P. populitransversus
Pterocomma pseudopopulea

Populus canadensis var. **eugenii** Carolina Poplar
Chaitophorus populicola
Ch. stevensis
Mordwilkoja vagabunda
Pemphigus balsamiferae

Populus candicans Balm-of-Gilead Poplar
Chaitophorus populicola
Ch. stevensis
Pemphigus junctisensoriatus
P. populiglobuli
Thecabius populimonilis

Populus deltoides Carolina Poplar, Cottonwood
Chaitophorus populicola
Ch. stevensis
Pemphigus bursarius ?
P. populitransversus

Populus (balsamifera) deltoides var. **missouriensis** Balsam Poplar
Chaitophorus populicola
Pemphigus populimonilis
P. populivenae

Populus grandidentata Big-toothed Poplar
Chaitophorus populicola
Ch. stevensis
Ch. populifolii var. *simpsoni*
Pterocomma n.sp.
Pt. populifoliae

Populus heterophylla Swamp Poplar
Chaitophorus populellus ?

Populus nigra var. **italica** Lombardy Poplar
Pemphigus nortonii
P. populicaulis
P. populiglobuli
Pterocomma smithii

Populus tremuloides Aspen
Chaitophorus populicola
Ch. stevensis
Ch. populifolii var. *simpsoni*

Populus trichocarpa California Poplar
Pemphigus bursarius

Potato see **Solanum**

Potentilla norvegica var. **hirsuta**
Capitophorus thomasi

Potentilla recta Sulfur Cinquefoil
Macrosiphum euphorbiae
Myzus persicae

Pot Marigold see **Calendula**

Prenanthes (Nabalus) alba Rattlesnake Root
Dactynotus n.sp. No. 7

Prenanthes (Nabalus) trifoliata Lion's Foot
Amphorophora nabali
Dactynotus sp.

Primrose see **Primula**

Primula japonica Japanese Primrose
Prociphilus erigeronensis

Prince's Feather see **Amaranthus**

Privet see **Ligustrum**

Proboscidea jussievi see **Martynia**

Prune see **Prunus**

Prunus sp. Cherry
Aphis fabae
Myzus cerasi

Prunus avium Sweet Cherry
Aphis sp.
Hyalopterus arundinis
Myzus cerasi
M. lythri ?
M. persicae
Phorodon humuli

Prunus cerasus Sour Cherry
Myzus cerasi
M. persicae

Prunus domestica Plum, Prune
Anuraphis cardui
Aphis gossypii ?
Hyalopterus arundinis
Myzus persicae
Rhopalosiphum padi

Prunus hortulana Hortulana Plum
Hyalopterus arundinis

Prunus mahaleb Mahaleb Cherry
Myzus lythri

Prunus pennsylvanica Pin Cherry
Myzus cerasi

Prunus persica Peach
Anuraphis persicaeniger
Myzus persicae

Prunus sieboldii Siebold Cherry
Hyalopterus arundinis
Myzus persicae

Prunus serotina Black Cherry
Aphis feminea
Myzus persicae

Prunus virginiana Common Chokecherry
Aphis cerasifoliae
Asaphonaphis pruni
Myzus persicae

Prunus yedoensis Yoshina Cherry
Hysteroneura setariae
Myzus persicae

Ptelea trifoliata Common Hoptree
Aphis sp.

Pteretis nodulosa Ostrich Fern
Amphorophora laingi

Pteridium latiusculum Eastern Brake Fern
Macrosiphum ptericolens

Pteris sp. Bracken
Idiopterus nephrelepidis

Pumpkin see **Cucurbita**

Pussytoes see **Antennaria**

Pyrrhopappus carolinianus False Dandelion
Dactynotus rudbeckiae ?

Pyrus communis Pear
Aphis gossypii
A. pomi
Dactynotus ambrosiae
Myzus persicae

Quackgrass see **Agropyron**

Quercus sp. Oak
Lachnus sp.
Myzocallis (*Tuberculoides*) sp.
M. alhambra
M. bella
M. granovskyi
M. melanocera
M. punctata
M. spinosa
Neosymydobius albasiphus
Stegophylla sp.
S. quercicola

Quercus alba White Oak
Hoplochaitophorus quercicola
Myzocallis alhambra
M. discolor
M. punctatellus
Stegophylla quercicola

Quercus bicolor Swamp White Oak
Hyplochaitophorus quercicola
Myzocallis (*Tuberculoides*) sp.
M. alhambra

Quercus borealis Northern Red Oak
Myzocallis bella
M. melanocera
M. walshii

Quercus coccinea Scarlet Oak
Myzocallis alhambra
M. bella
M. melanocera
M. walshii
Stegophylla quercicola

Quercus falcata Southern Red Oak
Anaccia querci
Myzocallis bella ?
M. walshii ?
Stegophylla quercicola
Tamalia sp.

Quercus ilicifolia Scrub Oak
Myzocallis spinosa
M. walshii

Quercus macrocarpa Bur Oak
Myzocallis alhambra

Quercus marilandica Blackjack Oak
Myzocallis discolor

Quercus palustris Pin Oak
Longistigma caryae

Quercus palustris—Cont'd
Myzocallis frisoni
M. walshii ?
Stegophylla sp.

Quercus prinus Swamp Chestnut Oak
Monellia discolor
Neosymydobius sp.

Quercus robur English Oak
Myzocallis annulata

Quercus rubra see **Q. falcata**
Q. borealis

Quercus stellata Post Oak
Myzocallis discolor
M. punctata

Quercus velutina Black Oak
Myzocallis alhambra
M. punctata
M. walshii
Stegophylla quercicola

Quickweed see **Galinsoga**

Quince see **Cydonia**

Quince, Japanese Flowering
see **Chaenomeles**

Radish see **Raphanus**

Ragweed see **Ambrosia**

Ranunculus sp. Buttercup
Myzus persicae

Ranunculus asiaticus
Persian Buttercup
Myzus persicae

Ranunculus repens
Macrosiphum sp.
Thecabius populiconduplifolius ?

Rape see **Brassica**

Raphanus raphanistrum Wild Radish
Brevicoryne brassicae
Myzus persicae
Rhopalosiphum pseudobrassicae

Raphanus sativus Garden Radish
Aphis gossypii
Brevicoryne brassicae
Myzus persicae
Rhopalosiphum pseudobrassicae

Raspberry see **Rubus**

Rattlesnake Root see **Prenanthes**

Redpepper or Bellpepper
see **Capsicum**

Reed see **Phragmites**

Reedgrass see **Calamagrostis**

Rhamnus cathartica Buckthorn
Aphis nasturtii

Rheum rhaponticum Garden Rhubarb
Aphis fabae
Macrosiphum euphorbiae
Myzus persicae
Prociphilus sp.

Rhododendron micranthum
Amphorophora sp.

Rhododendron nudiflorum var. **roseum**
Masonaphis rhokalaza

Rhubarb see **Rheum**

Rhus sp. Sumac
Melaphis rhois
Rhopalosiphum rhois

Rhus aromatica Fragrant Sumac
Rhopalosiphum rhois

Rhus copallina Dwarf Sumac
Rhopalosiphum rhois

Rhus glabra Smooth Sumac
Melaphis rhois
Rhopalosiphum rhois

Rhus toxicodendron Poison Ivy
Rhopalosiphum rhois ?
Rh. n.sp.

Rhus typhina Staghorn Sumac
Melaphis rhois
Rhopalosiphum rhois

Ribes sp. Currant
Amphorophora sonchi
Capitophorus ribis
Kakimia sp.

Ribes dowingianum
(hirtellum × reclinatum)
Poorman Gooseberry
Amphorophora sonchi

Ribes hirtellum Hairystem Gooseberry
Amphorophora sonchi
Kakimia cynosbati
Nasonovia ribisnigri

Ribes nibrum Black Currant, Cult.
Amphorophora ribiella
Aphis varians

Ribes rotundifolium Roundleaf Gooseberry
Kakimia houghtonensis

Ribes sativum Common Red Currant
Amphorophora sonchi
Capitophorus ribis

Rib Grass see **Plantago**

Richweed see **Collinsonia**

Ricinus communis Castorbean
Myzus persicae

Robinia pseudaccacia Black Locust
Aphis craccivora

Robinia viscosa Clammy Locust
Aphis craccivora

Rosa sp. Rose
Macrosiphum dirhodum
M. pseudodirhodum
M. rosae
Myzus circumflexus
M. persicae
M. porosus
Pentatrichopus fragaefolii
Pergandeidia trirhoda

Rosa sp. Hybrid Tea
Macrosiphum rosae

Rosa sp. Moss Rose
Macrosiphum rosae

Rosa hugonis Father Hugo Rose
Macrosiphum rosae

Rosemallow see **Hibiscus**

Rosemary see **Rosemarinus**

Rose-of-Sharon see **Hibiscus**

Rosmarinus officinalis Rosemary
Macrosiphum sp.

Rubus spp. Cultivated Blackberry
Aphis rubifolii
Cerosipha rubifolii

Rubus sp. Wild Blackberry
Macrosiphum sp.

Rubus spp. Cultivated Raspberry
Aphis rubicola
A. rubifolii

Rubus argutus A Blackberry
Aphis rubifolii

Rubus frondosus Yankee Blackberry
Aphis rubifolii

Rubus idaeus Red Raspberry
Aphis rubicola

Rubus idaeus var. **strigosus** American Red Raspberry
Amphorophora rubi
A. sensoriata
Aphis rubicola
Masonaphis rubicola

Rubus laciniatus Cut-leaved Blackberry
Aphis rubifolii

Rubus occidentalis Blackcap Raspberry
Amphorophora rubi
Aphis rubicola
A. rubifolii
Masonaphis rubicola

Rubus phoenicolasius Wineberry
Amphorophora rubi ?

Rudbeckia (serotina) hirta Blackeyed Susan
Dactynotus ambrosiae
D. rudbeckiae ?

Rudbeckia laciniata Goldenglow
Dactynotus ambrosiae
D. rudbeckiae

Rumex sp. Dock
Aphis rumexicolens
A. rumicis

Rumex acetosella Sheep-sorrel
Aphis rumicis

Rumex crispus Curled Dock
Aphis rumicis
Myzus persicae
Pemphigus brevicornis

Rumex obtusifolius Broad-leaved Dock
Aphis armoraciae
A. fabae
A. rumicis
Myzus persicae

Rumex verticillatus Swamp Dock
Aphis sp.
A. fabae

Russian Olive see **Elaeagnus**

Rutabaga see **Brassica**

Rye see **Secale**

Saccharum officinarum Sugarcane
Sipha flava

Saintpaulia ionantha African Violet
Myzus persicae

Salix sp. Willow
Aphis saliceti
Cavariella aegopodii
Chaitophorus viminalis
Lachnus salignus
Macrosiphum californicum
Pterocomma n.sp.
Pt. salicis
Pt. saliceti

Salix alba White Willow
Chaitophorus viminalis
Pterocomma smithiae

Salix babylonica Weeping Willow
Chaitophorus viminalis
Lachnus salignus
Pterocomma bicolor
Pt. smithiae

Salix blanda Wisconsin Weeping Willow
Pterocomma smithiae

Salix caprea Goat Willow
Macrosiphum californicum

Salix cordata Hartleaf Willow
Chaitophorus saliciniger ?
Ch. viminalis
Pterocomma bicolor
Pt. salicis

Salix discolor Pussy Willow
Chaitophorus viminalis

Salix (incana) elaeagnus Elaeagnus Willow
Lachnus salignus

Salix fragilis Brittle Willow
Clavigerus smithii

Salix humilis Prairie Willow
Aphis saliceti

Salix incana
Lachnus salignus

Salix matsudana var. **tortuosa** Dragonclaw Willow
Lachnus saligna

Salix nigra Black Willow
Chaitophorus viminalis

Salix purpurea Basket Willow
Chaitophorus viminalis

Salix viminalis Osier
Chaitophorus viminalis

Sambucus canadensis American Elder
Aphis fabae
A. sambucifoliae
A. sanborni

Sambucus racemosa European Red Elder
Aphis sambucifoliae

Sanicula canadensis Black Snake-Root
Aphis sp.

Scirpus sylvaticus Woodland Bulrush
Thripsaphis balli

Scotch Thistle see **Onopordum**

Sea Myrtle see **Baccharis**

Secale cereale Rye
Macrosiphum granarium
Rhopalosiphum fitchii
R. maidis

Sedum hispaninicum Spanish Stonecrop
Aphis sedi

Sedum (triphyllum) telephium purpureum Liveforever
Aphis sedi

Senecio cineraria Silver Groundsel
Myzus circumflexus

Senecio cruentus Common Cineraria
Aphis gossypii
Dactynotus ambrosiae ?
Macrosiphum euphorbiae
Myzus persicae

Senecio mikanioides German Ivy
Aphis gossypii
Myzus persicae

Senecio pauperculus
Dactynotus ambrosiae

Senecio vulgaris Common Groundsel
Aphis sp.

Sensitive Fern see **Onoclea**

Setaria faberii Foxtail
Rhopalosiphum maidis

Setaria glauca Bristly Foxtail
Sipha flava
Rhopalosiphum maidis

Shadbush see **Amelanchier**

Shasta Daisy see **Chrysanthemum**

Sheep-sorrell see **Rumex**

Shepard's Purse see **Capsella**

Shepherdia argentea Buffalo Berry
Capitophorus sp.

Silene noctiflora Night-flowering Silene
Dactynotus rudbeckiae

Sisymbrium officinale Hedge Mustard
Aphis sp.
Myzus persicae
Rhopalosiphum pseudobrassicae

Sium (cicutifolium) suave Water Parsnip
Aphis fabae
Cavariella sp.

Smartweed see **Polygonum**

Smilax herbacea Carrion Flower
Neoprociphilus attenuatus

Smoke Tree see **Cotinus**

Snakeroot, White see **Eupatorium**

Snapdragon see **Antirrhinum**

Snowball Tree see **Viburnum**

Sobralia macrantha
Cerataphis lataniae

Solanum carolinense Horse-nettle
Myzus solani ?

Solanum dulcamara Bitter Nightshade
Myzus persicae

Solanum melongena Eggplant
Macrosiphum euphorbiae
Myzus persicae

Solanum pseudocapsicum Jerusalem Cherry
Macrosiphum euphorbiae
Myzus persicae

Solanum tuberosum Potato
Aphis gossypii ?
Geoica radicicola
Macrosiphum euphorbiae
Myzus persicae
M. solani
Trifidaphis radicicola

Solidago sp. Goldenrod
Aphis gossypii
A. solidaginifoliae
Dactynotus n.sp. No. 5
D. ambrosiae
D. chrysanthemi
D. erigeronensis
D. gravicornis
D. luteola
D. rudbeckiae
D. tissoti

Solidago altissima Tall Goldenrod
Dactynotus n.sp. No. 5
D. ambrosiae ?
D. tissoti
Rhopalosiphum serotinae

Solidago arguta
Dactynotus n.sp. No. 5

Solidago aspera
Dactynotus n.sp. No. 5

Solidago canadensis
Dactynotus ambrosiae ?
D. n.sp. No. 5
D. n.sp. No.7

Solidago canadensis var. **hargeri**
Dactynotus ambrosiae ?

Solidago (serotina) gigantea leiophylla
Dactynotus ambrosiae ?
D. rudbeckiae ?

Solidago graminifolia
Rhopalosiphum asterensis

Solidago juncea
Dactynotus gravicornis
D. tissoti

Solidago memoralis
Dactynotus ambrosiae

Solidago odora
Dactynotus sp.
D. rudbeckiae ?

Solidago puberula
Dactynotus sp. ?

Solidago rugosa
Dactynotus n.sp. No. 5
D. tissoti
Rhopalosiphum serotinae

Solidago rugosa var. **aspera**
Rhopalosiphum serotinae

Solidago sempervirens Seaside Goldenrod
Dactynota ambrosiae

Solidago uliginosa Bog Goldenrod
Rhopalosiphum serotinae

Sonchus arvensis Sowthistle
Amphorophora sonchi
Dactynotus ambrosiae ?
Myzus persicae

Sonchus asper Spiny Sowthistle
Amphorophora sonchi

Sonchus oleraceus Common Sowthistle
Amphorophora sonchi
Dactynotus n.sp. No. 7

Sorbus americana American Mountain Ash
Aphis pomi

Sorbus aucuparia European Mountain Ash
Aphis pomi

Sorghum a cult. var.
Amphorophora sp.

Sorghum vulgare
Rhopalosiphum maidis

Sorrel see **Rumex**

Sourgum see **Nyssa**

Sowthistle see **Sonchus**

Sparaxis grandiflora Wandflower
Myzus circumflexus

Spartina sp. Marsh-grass
Hyalopterus arundinis

Spearmint see **Mentha**

Speedwell see **Veronica**

Spinach see **Spinacia**

Spinacia oleracea Spinach
Macrosiphum euphorbiae
Myzus persicae

Spindle Tree see **Euonymus**

Spiraea bumalda var. **Anthony Waterer**
Aphis spiraecola

Spiraea japonica Japanese Spiraea
Aphis spiraecola

Spiraea latifolia
Macrosiphum sp. (near *M. pseudodirhodum*)

Spiraea prunifolia Bridalwreath Spiraea
Aphis spiraecola

Spiraea vanhouttei Vanhoutte Spiraea
Aphis spiraecola

Spruce see **Picea**

Squash see **Curcubita**

St. Johnswort see **Hypericum**

Star Thistle see **Centaurea**

Steironema ciliatum Fringed Loosestrife
Aphis sp.

Stellaria sp. Chickweed
Myzus persicae

Stellaria media Common Chickweed
Myzus persicae

Stinking Clammyweed see **Polanisia**

Stock see **Matthiola**

Stonecrop see **Sedum**

Strawberry see **Fragaria**

Strawberry-bush see **Euonymus**

Strawflower see **Helichrysum**

Sugarcane see **Saccharum**

Sumac see **Rhus**

Sunflower see **Helianthus**

Sweetfern see **Comptonia**

Sweetflag see **Acorus**

Sweet Jarvil see **Osmorhiza**

Sweet Pea see **Lathyrus**

Sweet Potato see **Ipomoea**

Swiss Chard see **Beta**

Sycamore see **Platanus**

Symphoricarpos (racemosus) albus Common Snowberry
Rhopalosiphum conii

Tagetes erecta African Marigold
Geoica lucifuga ?
Dactynotus ambrosiae

Tanacetum vulgare Tansy
Macrosiphoniella tanecetaria
M. ludovicianae

Tansy see **Tanacetum**

Taraxacum sp. Dandelion
Macrosiphum taraxaci

Taraxacum officinale Common Dandelion
Macrosiphum taraxici

Teasel see **Dipsacus**

Teosinte see **Euchlena**

Thalictrum polyganum Tall Meadowrue
Kakimia purpurascens

Thalictrum revolutum Purple Meadowrue
Aphis craccivora
Kakimia purpurascens

Thaspium (aureum) trifoliatum Meadow Parsnip
Rhopalosiphum conii

Thistle see **Cirsium**

Thlaspi arvense Pennycress
Brevicoryne brassicae

Thoroughwort see **Eupatorium**

Thuja orientalis Oriental Arborvitae
Cinara sp.

Tick Trefoil see **Desmodium**

Tilia sp. Linden, Basswood
Myzocallis tiliae

Tilia americana American Linden
Macrosiphum tiliae
Myzocallis tiliae

Tilia cordata Littleleaf Linden
Myzocallis tiliae

Tilia europea European Linden
Longistigma caryae
Myzocallis tiliae

Tithonia sp.
Geoica lucifuga ?

Tithonia (tagetiflora) rotundifolia Scarlet Tithonia
Aphis fabae ?

Tobacco see **Nicotiana**

Tomato see **Lycopersicon**

Tradescantia fluminensis Wandering Jew
Myzus circumflexus

Tragopogon porrifolius Vegetable-oyster
Geoica lucifuga ?

Trifolium sp. Clover
Therioaphis trifolii

Trifolium arvense Rabbit's-foot Clover
Therioaphis trifolii

Trifolium hybrida Alsike Clover
Anuraphis bakeri
Macrosiphum pisi

Trifolium incarnatum var. **elatius** Crimson Clover
Macrosiphum pisi

Trifolium medium Zigzag Clover
Macrosiphum pisi

Trifolium officinale Yellow Sweet Clover
Anuraphis maidiradicis

Trifolium pratense Red Clover
Anuraphis bakeri
Aphis craccivora
Macrosiphum euphorbiae
M. pisi
Myzus persicae
Therioaphis trifolii

Trifolium repens White Clover
Macrosiphum pisi
Therioaphis trifolii

Triticum aestivum Wheat
Geoica squamosa
Macrosiphum granarium
Rhopalosiphum fitchii
R. padi

Tropaeolum majus Nasturtium
Aphis fabae
Myzus persicae

Trumpetcreeper see **Campsis**

Tuberose see **Polianthes**

Tulipa sp. Tulip
Aphis fabae
A. spiraecola
Macrosiphum euphorbiae
M. rosae
Myzus circumflexus
M. persicae
Rhopalosiphoninus staphyleae

Tulip Tree see **Liriodendron**

Tupelo see **Nyssa**

Turnip see **Brassica**

Typha angustifolia Narrowleaf Cattail
Rhopalosiphum enigmae

Typha latifolia Common Cattail
Rhopalosiphum enigmae
R. nymphaeae

Ulmus sp. Elm
Colopha ulmicola
Eriosoma lanigerum
E. lanuginosa
E. rileyi
Myzocallis ulmifolii

Ulmus sp. certain English Elms
Eriosoma lanigerum
E. ulmi

Ulmus americana American Elm
Colopha ulmicola
Eriosoma americana
E. lanigerum
E. ulmi
Myzocallis ulmifolii

Ulmus fulva Slippery Elm
Georgiaphis ulmi
Gobaishia ulmifusa

Ulmus (montana) glabra Scotch Elm
Colopha ulmisacculi

Ulmus thomasi Rock Elm
Georgiaphis ulmi
Myzocallis ulmifolii

Urtica gracilis Stinging Nettle
Macrosiphum sibiricum

Vaccinium sp. Blueberry
Masonaphis (Ericobium) pepperi

Vaccinium atrococcum Downy Blueberry
Masonaphis (Ericobium) azaleae

Valeriana sp. Valerian
Aphis fabae

Valeriana officinalis
Aphis gossypii ?

Vegetable-oyster see **Tragopogon**

Veratrum viride American False Hellebore
Aphis sp. (near *coweni*)

Verbena sp.
Aphis gossypii
Pemphigus brevicornis

Verbena hybrida Garden Verbena
Aphis gossypii
Myzus solani

Vernonia sp. Ironweed
Dactynotus ambrosiae

Vernonia noveboracensis New York Ironweed
Dactynotus rudbeckiae ?

Veronica sp. Speedwell
Dactynotus ambrosiae ?

Veronica longifolia Speedwell
Aphis sp.

Vetch see **Vicia**

Viburnum sp.
Anuraphis viburnicola

Viburnum acerifolium Mapleleaf Viburnum
Anuraphis viburnicola
A. viburniphila

Viburnum dentatum Arrowwood Viburnum
Anuraphis viburnicola
A. viburniphila

Viburnum lentago Nannyberry
Anuraphis viburnicola
Aphis fabae

Viburnum opulus European Cranberrybush or Snowball Tree
Anuraphis viburnicola
A. viburniphila
Aphis fabae

Viburnum opulus var. **americanum** American Cranberrybush
Anuraphis viburnicola
Aphis fabae

Viburnum (tomentosum) plicatum
Anuraphis viburnicola
Aphis fabae

Viburnum recognitum Arrow-wood
Anuraphis viburnicola

Vicia sp. Vetch
Macrosiphum pisi

Vinca sp. Periwinkle
Myzus persicae

Vinca major var. **variegata** Mottled Periwinkle
Myzus circumflexus
M. persicae

Viola odorata Violet
Micromyzus violae

Violet see **Viola**

Virginia Creeper see **Parthenocissus**

Vitis sp. Grape
Aphis illinoisensis

Vitis aestivalis Summer Grape
Aphis illinoisensis

Vitis labrusca Fox Grape
Aphis illinoisensis

Wahoo, Eastern see **Euonymus**

Walnut see **Juglans**

Wandering Jew see **Tradescantia**

Wandflower see **Sparaxis**

Washingtonia see **Osmorhiza**

Watercress see **Nasturtium**

Water Hemlock see **Cicuta**

Water Hemlock or Parsnip see **Sium**

Water Horehound see **Lycopus**

Waterlily see **Nymphaea**

Watermelon see **Citrullus**

Waterwillow see **Decodon**

Wax Myrtle see **Myrica**

Wheat see **Triticum**

White Sweet Clover see **Melilotus**

Wild Indigo see **Baptisia**

Willow see **Salix**

Willowweed see **Epilobium**

Wineberry see **Rubus**

Witch Grass see **Panicum**

Witchhazel see **Hamamelis**

Wormwood **Artemesia**

Xanthium (canadense) orientalis Oriental Cocklebur
Dactynotus rudbeckiae ?

Yarrow see **Achillea**

Yellow Chamomile see **Anthemis**

Yucca filamentosa Adamsneedle Yucca
Aphis fabae
Macrosiphum euphorbiae
Myzus persicae

Zantedeschia aethiopica Callalily
Myzus circumflexus

Zanthoxylum (clavi-herculis) americanum Hercules Club
Aphis spiraecola

Zea mays Corn
Macrosiphum granarium
Rhopalosiphum maidis

Zigzag Clover see **Trifolium**

Zinnia elegans Common Zinnia
Macrosiphum euphorbiae

Fred Raetz

F.R.A.S.

Many will mourn the departure from this life of Fred Raetz on Wednesday morning, August 22, 1962. Quietly he lived and as quietly passed away, leaving an emptiness which cannot be filled by another.

Master mechanic, machinist par excellence and automobile repair-man of whom it could be said: "When you leave your car with him, you know it will be taken care of." Fred operated his garage and machine shop for more years than most of us can remember. A host of drivers would take their cars to no one else, if Fred were available for consultation and work. For him, putting a car into good running order was an art and one to which he was truly dedicated.

Dedicated he was, too, to the youth of our community, for he served as scoutmaster of Troop 60 of Salem Church for 40 years. Fred was a woodsman and his knowledge of woodcraft has been passed along to more boys than most of us have ever known.

The out-of-doors was Fred's temple. He knew it, he loved it, he pined when illness or foul weather kept him indoors too long. Dean of natural historians of the Rochester area, he possessed great knowledge and love of both birds and plants, and, to be sure, of all living creatures. His study of birds and their habits was deep.

No detail of tree or wildflower structure was too small to escape Fred's keen observation and to give him pleasure and delight in the complexity, orderliness and beauty of the plants he so deeply revered. There was always a pot of something he was saving from destruction and wanted to watch, set on the garage floor under the skylight or at the edge of his work bench nearest the solitary window.

One of his most appealing hobbies was the carving, from special bits of wood which he collected, of replicas of birds, with which he was so well acquainted. He painted the model, once completed to his satisfaction, and mounted it, usually on a dead branch of the kind of tree or shrub where it would be found in the field.

To visit with Fred was to experience refreshment of mind and spirit. He never hurried, he maintained a most enviable and admirable calm in his speech, his movements and his life. Of late he had been making a garden of our native ferns at the Burroughs-Audubon Nature Sanctuary—this will be among his countless memorials.

B. B. C.

CITATIONS IN THE ROCHESTER ACADEMY OF SCIENCE

1961

Helen Dakin

Fellow

The Rochester Academy of Science not only encourages and publishes the work of scientists, but also gives the layman a chance to maintain an interest in science. The activities of this candidate illustrate how the Academy guides such interest. Nature's cycles are stimulating to one who notices them. Yet the slow precision of the stars or the fluttering excitement of the warbler migration are much more meaningful when knowledge supports observation, and more satisfying when enjoyed with a group. Our candidate both participates in such activities and helps others to do the same.

She is active in the Ornithology, Astronomy and Mineral Sections and has been secretary for the first two. For the past three years she has been the Editor of the Monthly Bulletin of the Academy. Many hours of work are required to keep our Members informed of activities and highlights in the yearly program. Somehow she finds time to build up a collection of nature photographs, with birds and insects her forte.

For her exemplary enthusiasm and ready service we are happy to confer the honor of Fellow upon Helen Dakin.

Joel T. Johnson

Fellow

It is fitting that an engineer should be interested in mechanics, geometry and hydraulics. But one might wonder why an electrical engineer should be concerned with these branches of applied science. It becomes clear when it is noted that our candidate applies his knowledge of electrical phenomena in his profession and of the others in his recreation. The elegant convolutions of the stars present a year-round mechanical spectacle. The precise arrangement of crystals hold a fascination that has beauty and geometry. The surge of sap each Spring unfolds intricate forms from the lifeless earth. Thus it is understandable why the activities of the Astronomy, Mineral and Botany Sections should attract him.

Testifying to his conviction that worthwhile recreation in science ought to be encouraged was his leadership as President of the Academy during the 1959 and 1960 seasons. He has been particularly vigorous in connection with our relationship with science students. He is past Chairman of the Astronomy Section. He initiated, through his editorship, the Monthly Bulletin in its present informative style.

For his long and active service and his discerning leadership we are proud to welcome as a Fellow, Joel Johnson.

Stephen C. Weber

Fellow

The Rochester Academy of Science serves a double function. It provides activities for its Members and service to the community. This latter phase is seldom so evident as it is in the work of our candidate. His Academy interests are indicated by past Chairmanship of the Astronomy Section and his current leadership of the Botany Section. His interest in our community becomes apparent from a summary of his contacts with it.

He has presented many public slide lectures, especially to young people in YMCA, church and Scout groups. He is an instructor in astronomy for the first organization. He has been a leader in the science seminars of Mercy High School—girls as well as boys have a keen interest in science. He has helped to judge the numerous entries in student science fairs. Because of the varied nature of these amazingly mature exhibits, a wide knowledge is a necessary safeguard against being unfavorably judged *by* the students.

He is a keen nature photographer, being particularly adept at photographing flowers. This activity provides him with many illustrations so that his lectures instill a love for sciences as well as skill.

For his services to the Academy and to our future scientists we are honored to extend our Fellowship to Stephen Weber.

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