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HERMAN LEROY FAIRCHILD, GEOLOGIST

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The name of Herman LeRoy Fairchild is a byword in American geology. To a geologist it means many things. It means Master of Glacial Geology, it means active leader and officer of the Geological Society of America, it means inspiring propagator of geological information, it means Dean of American geologists.

Professor Fairchild's influence on geological thought was considerable. His chief love was the fascinating subject of glacial geology. It is only natural that his thoughts should have been in this direction.

Whether he knew it or not, young Mr. Fairchild entered a glaciologist's paradise when he came to Rochester to be Professor of Geology and Natural History at the University in 1888. One of his first tasks was to unravel the local geology. Thanks to the work of James Hall, State Geologist, and others, some progress had been made on the older bed rock history of Western New York as early as 1844. The more recent events, however, those which dealt with the loose, unconsolidated surface deposits left by the continental ice sheets, were still unexplained.

Fairchild tackled the job energetically and enthusiastically. Any time which was not devoted to his duties at the University and his tasks as officer of the American Association for the Advancement of Science, he spent in the field. He travelled by streetcar, railroad, horse and buggy, on foot, uphill and down valley, until he knew the Genesee country better than the Indians before him. The more he discovered, the more fascinating the search became. He found ancient lake bottoms, shore benches and beaches made by waves in bodies of water which had long since disappeared. He found large boulders miles and miles from their native territories. He found hills made of masses of rocks of all sizes, which he knew could only have been produced by the action of tremendous sheets of ice. He found a buried valley running right past our door. A valley filled with from 400 to 600 feet of sand and gravel, an unseen valley to most people. But Fairchild could see it. He traced it for miles to the south of us and so accurate was his work that years later when surveyors, with all their modern equipment and all their information gathered from drill holes, mapped it, their maps were nearly identical with those of the pioneer.

Then came the task of correlating all the separate pieces of information which he had obtained from his field studies; the task of putting together in their proper chronological order the events which produced the present surface. This he did and the story as he originally told it has in all essentials withstood the test of later investigations.

He was not content to limit his work to this region but extended it over the entire state, down into Pennsylvania, up into Canada, and out to the middle west. Today, when a man works on the glacial geology of this broad area, he begins with Fairchild, and frequently ends with Fairchild.

Fairchild was one who not only collected scientific facts but was able to see the larger significance of these facts. In other words he has influenced geological thought. Let me give you a few examples. Geologists used to have exaggerated ideas of the erosive power of glaciers. They believed that moving ice could gouge out the solid bed rock and create large valleys. Some even went so far as to consider the valleys in which our Finger Lakes are located to have been the result of glacial erosion. Fairchild showed that the cutting power of moving ice was distinctly limited, that the valleys were the result of previous stream cutting and that glaciers did little more than remove the soft weathered deposits from the surface of the bed rock. This was a new conception and one which had a profound effect on the interpretation of geologic events.

The Nebular hypothesis of Laplace for the origin of the earth was the accepted one during the 18th and 19th centuries. At the beginning of the present century Thomas C. Chamberlin, professor of Geology at the University of Chicago, and Forest R. Moulton, professor of Astronomy at the same institution, showed that it failed to meet the requirements of a scientific hypothesis because it did not explain all the facts. In place of it they offered an entirely different conception of earth origin, the Planetesimal hypothesis. This was so different from the Nebular hypothesis that it affected the very foundations of geological thought. Previous conceptions had to be severely modified in the light of the more plausible hypothesis. It was a difficult transition. Many were loath to make it. Fairchild had always been a radical. He never found it difficult to discard old ideas and accept new ones if the new ones were closer to the facts. The result is that he, possibly more than any other geologist, can be credited with the successful readjustment of ideas to meet the requirements of the Planetesimal hypothesis.

In 1891 a geologist reported the finding of a huge hole in the ground near Flagstaff, Arizona. The depression was circular and bowl-shaped, 4000 feet in diameter at the top and 600 feet deep. It was known as Coon Butte and its origin was a mystery. The two most plausible explanations were that, first, it was the crater of an extinct volcano, and second, it was made by the fall of a giant meteorite. The latter seemed rather fantastic and many favored the volcanic hypothesis. Professor Fairchild visited the depression in 1906 and made a careful study of it. His reports proved conclusively that the crater actually had been produced by the impact of a meteorite. Today Coon Butte is known as Meteor Crater and is visited by thousands of tourists each year.

He was always active in the work of scientific organizations. Few men were more influential in organized science than he. He reorganized the nearly defunct New York Academy of Science and was its secretary for several years. He was for many years one of the moving spirits of the American Association for the Advancement of Science. In 1888 he was one of the original thirteen geologists who organized the Geological Society of America. He wrote its constitution and by-laws. He was its Secretary for 16 years and its President in 1912. With his passing goes its last surviving charter member.

His name has been closely linked with the Rochester Academy of Science for over 50 years. In 1888 the Academy was weak, inactive, and faced dissolution. Fairchild had just arrived in Rochester and his advice and aid were solicited. He advised a complete reorganization and was largely instrumental in framing a new set of rules which the Society promptly adopted. He became its president in 1889 and the Academy began a new era of prosperity. He resigned the presidency in 1901 but continued as editor of the Proceedings until 1935. In 1918 he was elected a life member and in 1920 was made a patron. In 1932, while Fairchild was still active and in good health, his portrait bust in bronze was presented by the Academy to the University of Rochester. This now stands in the foyer of Dewey Hall on the River Campus.

I believe the people of this area are unusually geologically minded in spite of the fact that there are relatively few products of economic value found in the local rocks. People here are interested in the origin of the Finger Lakes, the Pinnacle Hills, the rocks exposed along the banks of the Genesee gorge. There is no question about it, this interest can be almost entirely traced to the influence of Professor Fairchild. He was a rare teacher whose enthusiasm was always contagious. He was able to make his rocks live; he gave them a personality. Do you remember when the memorial boulder, opposite the entrance to the main quadrangle of the River Campus, was dedicated to Thomas Thackeray Swinburne, composer of "The Genesee"? Professor Fairchild closed the speaking exercises with an address entitled "Personality of the Boulder." He said among other things:

> "The boulder has appropriateness in bearing the name and perpetuating the memory of Thomas Thackeray Swinburne. We have a geologic name for these alien boulders, transported far from their native sites, and often perched in insecure positions. We call them erratics. Tom Swinburne was an erratic of the human species. He had travelled far from conventional thought and belief. He did not pattern his life and purpose after other people. He was individual.

> His poetic imagination had lifted him from the common plane to the pinnacle of near-genius, always a precarious position. Yet, the world sadly needs more of that type of unconformity to the level of unthinking and superselfish humanity. We honor the memory of Swinburne for his moral individualism and courage as well as for his poetic gifts.
>
> "Rock of Ages Geologic! You are to stand here as a noble memorial of a departed being of poetic genius. And from this commanding position you are assigned to keep watch and ward over the University of Rochester. You are to note the goings-out and the comings-in of the future generations of students; and to them you are to be a reminder of the worth-whileness of 'things of the spirit.' And year by year, you will receive, vicariously, the tribute of successive groups of University graduates."

He gave a personality to his rocks.

In 1920, when he was 70 years of age, Professor Fairchild retired from the University of Rochester as Professor of Geology. When most people reach their 70th year they look forward to a little rest, some leisurely travel, and a chance to do things they have always wanted to do but never had the time to do. But not Fairchild. He remained just about as active as ever. To me one of the most remarkable things about him is what he accomplished between the ages of 70 and 90. He published within these twenty years over 100 scientific papers. And many of these are of considerable size, including a history of the Geological Society of America. A man who could do this must have been made of stern stuff.

May we who are his successors be worthy of the rich heritage which he has left us.

QUANTITATIVE PETROLOGY OF THE GENESEE GORGE SEDIMENTS

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ABSTRACT

The Paleozoic rocks of the Genesee Gorge at Rochester, New York, have been studied by stratigraphers and paleontologists but not by petrographers. A petrographic study now has been done. The quantitative mineral composition of these rocks has been determined by using the Delésse-Rosiwal method of intercepts. Grain size, in terms of nominal sectional diameters, grain roundness, and grain sphericity in two dimensions (circularity) in thin sections have been measured. These data have been arranged into the forms of *complementary microlithologies* and *grain modes* and have been plotted beside the stratigraphic column. Mineral phases, in terms of *microphases,* have been recognized and established. These show the details of the sedimentation, its character, its rhythmic fluctuations, and its relation to shaliness. Studies of fossiliferous rocks reveal that the mineralogical composition governs and controls certain specific megascopic fossils much more than previously realized.

Petrographically the boundaries of the formations are artificial. The base as well as the top of the Clinton group is decidedly arbitrary.

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ILLUSTRATIONS

I. INTRODUCTION

The Genesee Gorge at Rochester, New York, has long been known as a superb section of Paleozoic sedimentary rocks. This geologic mecca has attracted numerous stratigraphers and paleontologists, who have drawn up many correlation charts and listed the fossils. Still there are many unsolved problems, because those who have studied these sediments have been content to accept, in the main, the field descriptions of the rocks as satisfactory analyses of their composition and have not emphasized the rock facies.

This study constitutes a petrographic attack on the problems of these sediments. The rocks studied in thin section range from the top beds of the Queenston up through the Lockport. From the beginning I was expectant of new truths; I have not been disappointed.

The purposes of this paper are first, to determine the mineral composition of these rocks and, second, to study the various rock facies. Some aspects of what Payne (1942, p. 1698) calls "the new stratigraphy" was applied through measurements of grain size and grain roundness in thin sections cut from precisely located specimens. It is believed that only with such information can the paleo-environment be satisfactorily determined.

It was necessary to readapt techniques already developed for studying loose grains and fragments of unconsolidated materials based upon three-dimensional measurements. Thin sections provide only two dimensions (Alling, 1941, 1943). This required the development of new techniques.

These new data made it possible to appreciate for the first time the character of the rock facies, the rhythmic nature of their deposition, and the overlapping of mineral phases that cross formational boundaries. This information furnishes quantitative data for understanding the paleo-environment for specific fossils.

ACKNOWLEDGMENTS

The collecting of measured specimens for thin sections began in April, 1922, with the field assistance of Merle K. Alling. Additional specimens subsequently were provided by Bernard H. Dollen, Dr. William L. Grossman, Dr. Tracy Gillette, Dr. Lois Kremer [Sharpe], and Dr. Virginia Hoyt [Jones], former students of geology at the University of Rochester. To these I am truly thankful. Charles M. Reed and Arthur S. Gale, Jr., furnished the results of a plane table survey of the Rochester and Lockport formations, forming the banks of the New York State Barge Canal to the west of Rochester. The stratigraphic column of the Lockport from the canal was supplied by a chart constructed by Professor George H. Chadwick and students. To them I acknowledge my thanks.

Supplementary slides from the Niagara Gorge were provided by Dr. John T. Sanford, for which I am very grateful.

To Dr. Tracy Gillette, whose death in the fall of 1942 removed a leading authority on the New York Clinton, I am especially indebted for many discussions. The master's thesis of Lois Kremer [Sharpe] (1932) on the Thorold sandstone in New York, has furnished many suggestions. Some of her specimens have been thin sectioned and constitute a portion of the slides used in this investigation. Beginning in 1941, Virginia Hoyt [Jones] (1942) undertook a thorough study of the heavy minerals in the Clinton Group of New York State, from the Niagara Gorge east to Clinton. During this investigation I benefited greatly through many discussions.

Petrographic studies by Marguerite Smith [Robertson] (1938) of the Queenston from Niagara to Rochester has been helpful. The thesis of Charles M. Reed (1936) on the insoluble residues of the Lockport has helped me with the composition and subdivision of that formation.

Professor J. Edward Hoffmeister greatly assisted by reading the manuscript. Appreciation is due to Gordon M. Meade, M.D., and David Jensen for preparing the manuscript for publication.

II. METHODS EMPLOYED

Mineral Composition:—The mineral composition of these rocks was determined by the Delésse-Rosiwal method of intercepts, using a Wentworth stage, and the calculation of the intercepts to a weight percentage. The number of runs per slide depended upon the size of grain; for coarse grained rocks five runs were made; for finer grained rocks the number of runs was three. These seemed to be a sufficient number because a thin section provides only a small sample. A high order of accuracy was therefore not justified and should not be expected. Independent runs give fairly consistent results. One of the poorest checks is shown in Fig. 1A. The choice of the specific gravities for calculating these measurements into weight percentage provided some uncertainty. The clay minerals could not be specifically identified in all cases by the microscope alone, and hence the specific gravities are not very definite. Very few textbooks furnish the value of the specific gravity for collophane, for example. The exact percentage of $MgCO_3$ and $FeCO_3$ in the carbonate minerals could not be determined by optical means. Staining methods help but are not quantitative.

Chemical Analyses:—Commercial analyses provide some assistance even though the exact stratigraphic horizons are not known in most instances. These analyses supply the ratio of the calcium carbonate to the magnesium carbonate.

Grain Size:—In contrast to the three-dimensional measurements of loose grains, thin sections provide areas of random sections of grains. Measurements on identical material in the two forms are not comparable (Krumbein, 1935). As the relationship between two- and three-dimensional measurements is not simple and has not as yet been established, no attempt has been made to modify the thin section measurements to three-dimensional values. *All sizes in this paper are in terms of the nominal sectional diameter (Wadell, 1935) in millimeters measured in thin sections.* Size measurements were accomplished by the diaphragm method previously described (Alling, 1936, pp. 189–204). Measurements of seventy-five to a hundred grains per slide were regarded to be sufficient. The data were plotted as frequency-distribution curves. The mode or peak was chosen for plotting on the charts that follow.

Independent parallel runs of grain size measurements of quartz, for example, are not always strictly reproducible. Nevertheless, such results are comparable. An illustration of an excellent check is the data of two slides cut from the same specimen, as shown in Table 1. The number of grains measured was purposely different. The rock contains only 2.1% of quartz by weight, hence the number of grains in such a rock in thin section is not numerous. The check is very close. The modes are the same.

TABLE 1

Grain Size Analysis of Quartz. Two slides

Nominal sectional diameter, Size, mm.	A* No.	A* %	B* No.	B* %
.000 — .005	0	0	0	0
.005 — .010	5	7.1	3	7.3
.010 — .015	10	14.3	5	12.2
.015 — .020	20	28.3	12	29.3
.020 — .025	15	21.4	9	22.0
.025 — .030	11	15.7	5	12.2
.030 — .035	6	8.6	3	7.3
.035 — .040	2	2.8	2	4.9
.040 — .045	1	1.4	1	2.4
.045 — .050	0	0	1	2.4
	70	99.6	41	100.0

* Rochester formation, 2.16 ft. above base, Densmore Creek.

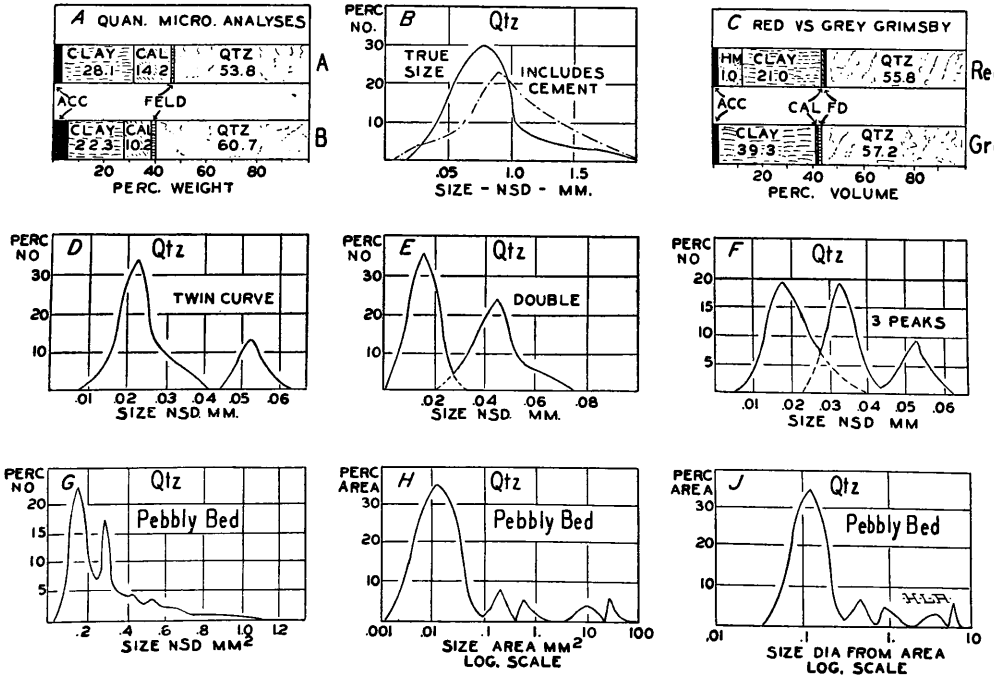
A QUAN. MICRO. ANALYSES
CLAY 28.1
CAL 14.2
QTZ 53.8
A
ACC
FELD
CLAY 22.3
CAL 10.2
QTZ 60.7
B
PERC. WEIGHT
B
PERC NO.
Qtz
TRUE SIZE
INCLUDES CEMENT
SIZE - NSD - MM.
C RED VS GREY GRIMSBY
HM 1.0
CLAY 21.0
QTZ 55.8
Red
ACC
CAL FD
CLAY 39.3
QTZ 57.2
Grey
PERC. VOLUME
D
PERC NO
Qtz
TWIN CURVE
SIZE NSD. MM.
E
Qtz
DOUBLE
SIZE NSD. MM.
F
Qtz
3 PEAKS
SIZE NSD MM
G
Qtz
Pebbly Bed
SIZE NSD MM²
H
PERC AREA
Qtz
Pebbly Bed
SIZE AREA MM²
LOG. SCALE
J
Qtz
Pebbly Bed
SIZE DIA FROM AREA
LOG. SCALE
H.L.A.

FIGURE 1

Multiple Peak Frequency-Distribution Curves:—In 1935, while studying the rocks in the Niagara Gorge (Alling, 1936), the technique of grain size analysis was not completely developed and the cause of multiple peak frequency-distribution curves was not understood. It was not at all clear whether there was any fault of the method, or of the technique, or the method used in plotting the results. Sanford (1939) was doubtful about the value of the curves. It was believed that an increase in the number of grains measured, the use of a mechanical stage to eliminate the personal element in the choice of grains that serve as samples, repeated runs on the same slide, and standardization of the number of class intervals in plotting, would remove these multiple peaks. These improvements have to some extent done so but did not remove all of them. I am now convinced that many peaks exist and represent something real.

In 1936 (Alling, 1936) it was suggested that these peaks pointed to different sources of the sediment or to a lack of complete sorting during transportation. Many slides of rocks which show multiple peaks frequently show two or more types of rocks, sometimes as alternating layers or as heterogeneous aggregates. It is often possible to actually see the several sets of grain sizes. These give added evidence for the reality of multiple complementary microlithologies. Each microlithology may be well sorted, but the microlithologies together produce a multiple peak curve.

There are all gradations in the graphic behavior of these curves. Some have several separated peaks with no grain sizes in between, and constitute distinct curves independent of one another when plotted on the same graph base (see Fig. 1D). Many are joined together (Fig. 1E).

FIGURE 1

All measurements made from thin sections

A. Quantitative microscopic analyses, Delésse-Rosiwal method by Wentworth stage, of one slide. Two independent runs of 3 traverses each, showing poor agreement. Most of the analyses were much better. Thorold, 3.4 feet above base, Genesee Gorge. Percent by weight.

B. Frequency-distribution curve, percent of number of grains of quartz and nominal sectional diameter size in mm. Shows true size, full line, and size including quartz cement, dot-dash line. Top of Thorold, 2.8 feet above base, Glen Edyth.

C. Quantitative microscopic analyses of red and gray portions, top of Grimsby, Densmore Creek, showing great similarity, except for hematite content in the red portion. Percent by volume.

D. Frequency-distribution curve of quartz grains in the Furnaceville at Densmore Creek. The main peak is characteristic of the Reynales, the smaller peak is of Thorold size, showing overlapping of the two sedimentary types.

E. Double-peaked curve, quartz in the Maplewood at Densmore Creek. 10.5 feet above base.

F. Three-peaked curve, quartz, the Rochester, 52.5 feet above base. Barge Canal.

G. Quartz curve, pebbly bed. Grimsby, Genesee Gorge, 10 feet above base. Percent of number and nominal sectional diameter. 112 grains.

H. Quartz curve, pebbly bed. Grimsby, Genesee Gorge, 10 feet above base. Percent of area of grains, size in areas, square millimeters. Log. scale, 1103 grains.

J. Same as H except size is in diameters, calculated from areas, in mm. Log. scale.

Such joined multiples can be treated as separate curves that overlap (Fig. 1F). Most of the curves consist of one main peak with one or more minor peaks; the composite curve is made of a number of curves of unequal size.

The Grimsby contains many layers supplied with pebbles. The usual field term is pebbly bed. The method of plotting percentage frequency of the *number* of grains against the nominal sectional diameter size results in curves with a number of small peaks tagged on to the end (see Fig. 1G). Such curves do not give an adequate picture of the rock. What are seen in the hand specimen are the large grains and pebbles and not necessarily the small grains of the groundmass in which they are set. It is the *areas* of these pebbles, not their relative number, that is impressive. Consequently the percentage by *area* was chosen as the basis for frequency-distribution curves for the pebbly beds.

The method used in measuring these pebbly beds was to place a grid, engraved on a thin sheet of celluloid, directly over the slide. By means of a camera lucida, the pebbles of each grid square were drawn on paper. A polar planimeter was used to measure the areas of not only the pebbles but that of the groundmass as well. The grains constituting the groundmass were sampled by measuring 50 to 100 grains of each grid square. The data of the pebbles and of the groundmass were combined in a single curve (Fig. 1H). In Fig. 1J the basis of the graph was calculated into diameters, for better but not absolute comparison. It is quite possible that areal basis is preferable to frequency by number.

Grain Roundness:—This matter is one of the most illusive concepts in the field of sedimentary statistics. As Wadell (1935, p. 263) has clearly shown, roundness and shape are independent variables. Roundness is the degree to which corners and sharp edges have been ground off. It is not sphericity or circularity. Many methods have been devised (Krumbein, 1935). Some measure something else besides roundness, however. Extensive trial of all these schemes demonstrated their impracticability as applied to thin sections; they prove too time consuming. The only practical method is one of inspection. Krumbein's (1941) chart of roundness for pebbles was adopted and modified for thin sections. Camera lucida drawings were made and sorted as to roundness and a number, 0.1, 0.2, to 0.9, assigned to them and drawn on a long strip of tracing cloth, mounted on rollers, and viewed by a camera lucida. The image of the standard was matched directly with the image of the investigated grain.

III. MINERALOGY

Carbonates in General:—The microscope readily distinguishes several forms of calcitic minerals in these sediments: (A) fragments and sections

PLATE I

Length of scale 0.1 m. All with cross nicols light, except H, K, L, and M. Ordinary light H, reflected light (Leitz Ultrapac) K, L, and M. All from Genesee Gorge, except E.

A. Grimsby, 39 ft. above base, hematitic-coated quartz grains cemented by quartz. Orig. mag. X174.

B. Thorold, 3.5 ft. above base. Lamellae in quartz grain. Orig. mag. X240.

C. Thorold, 3.5 ft. above base. Quartz grains cemented by added quartz. Orig. mag. X240.

D. Thorold, 2.5 ft. above base. Microcline feldspar grain cemented by calcite (rough surfaced, white). Orig. mag. X174.

E. "Grey Furnaceville", .3 ft. above base, Glen Edyth, east side of Irondequoit Bay. Plume chert (lower half), and recrystallized calcite (rough surfaced white grain). No hematite-bearing rock occurs at Glen Edyth. Orig. mag. X174.

F. Upper Reynales, 7.5 ft. above base. Ring of chert in dusty centered recrystallized calcite. Orig. mag. X69.

G. Brewer Dock, 2 ft. above base. "Blade" of quartz derived from recrystallization of chert. Orig. mag. X48.

H. and J. A pair. H, ordinary light, J, cross nicols, Brewer Dock, 2 ft. above base. Collophane with inclusions of quartz and recrystallized calcite. Orig. mag. X48.

K. Thorold, 1.2 ft. above base. Reflected light. Pyrite (white).

L. Furnaceville, .35 ft. above base. Goethite (white) replacing fossil calcite. Reflected light. Orig. mag. X94.

M. Furnaceville, .88 ft. above base. Goethite (white) replacing fossil calcite. Reflected light. Orig. mag. X94.

of fossils, some of which can be specifically identified, (B) large clear homogeneous grains, many of which are twinned and which have experienced recrystallization, and (C) small, dirty, anhedral grains usually in large clusters with irregular surfaces and without optical orientation. These have been considered to be largely clastic in origin. Actually the three types frequently intergrade with one another. The classification of the calcitic substances in some slides is consequently somewhat arbitrary. This was especially true of the carbonates of the Rochester and the Lockport formations.

Fossil Carbonate:—The fossil forms are the easiest to recognize and lend themselves well to Delésse-Rosiwal analyses on the Wentworth stage (see Plates IL, IM, IID, IIJ, IIK, IIL, and IIIM). Cross sections of brachiopods like *Coelospira hemispherica* (see Plate IIJ) and *Pentamerus oblongus* are readily identified. The calcite, apparently very high in calcium carbonate, occurs as clear, clean grains and aggregates which under cross nicols are brilliantly colored. Bryozoa are perfectly obvious. Other fossil fragments, not paleontologically identifiable, show spectacular plumes of bright polarizing calcite. It is clear that much of the calcite of the fossil fragments has been recrystallized. This type has not, however, been cataloged with other recrystallized forms for the purpose of compositional plotting.

Netted Calcite:—Apparently closely genetically related with the fossil fragments is "netted calcite." Moderate to high microscopic objectives reveal the presence of a three-dimensional network especially in the center of grains. The visibility of the network varies greatly depending upon the degree to which it has been replaced by other minerals, especially hematite.

The structure of the net is best acquired from the photographs (Plate II, D through H). It is an interlocking, pale yellow-green tubular network. It is organic in origin and probably zooecial tubes of monticuliporoid bryozoa (Hatch, Rastall, and Black, 1938, p. 158). In composition it seems to be either transparent to translucent chitin or collophane or allied substances. It is opaque under cross nicols and is microscopically amorphous. It is easily replaced by yellow-brown collophane, or is easily changed to that substance. In the Furnaceville, hematite replaces it. Even a single slide may show all gradations from a "net" composed of collophane to one composed entirely of earthy hematite. The hematite attacks and replaces the netted calcite both on the margins and at the center of the grain of netted calcite. The iron solutions probably found their way into the interior through a few tubes of the network that extend to the margin of the grains. First the network is replaced, leaving the calcite in the interstices untouched. Then this calcite is gradually replaced until the whole grain of "netted calcite" is composed of solid, earthy hematite. Pyrite sometimes replaces the netted calcite but never to the extent nor as completely as hematite. In the center of some grains the earthy hematite is recrystallized to brilliant red plates of specularite and sometimes to martite.

Recrystallized Carbonate:—Limestones with a low clay content contain a good deal of recrystallized carbonate. This is recognized by its optical homogeneity and freedom from inclusions of clay and dust particles. The grains range from small (.005 mm.) to several millimeters in diameter, and are frequently striped with twinning bands (see Plates IE, IIM, IIIL, IVB). The clay inclusions formerly present have been cleared by being pushed to the margins where they now constitute part of the cementing materials. A good deal of the recrystallized calcite has been enlarged by the addition of calcite; margins have been added (Plate IIB and C). Much of this kind of carbonate deserves the term authigenous calcite and should be considered in the same class with authigenous feldspar. The added margins are, commonly, on top of clay frames. Examples of multiple margins have been noted.

When carried to an extreme, the large clear grains of recrystallized calcite produce a white rock with sparkling luster. These the field geologist calls "crystalline" limestones. The term is unfortunate because it obscures the gradation from fine-grained, recrystallized carbonate rocks to those coarse-grained. The microscope fails to reveal any appreciable amount of amorphous material. Even the collophane, showing dark under cross nicols, reveals a definite crystal lattice by X-ray analysis. Perhaps the field geologist does not desire to imply that other rocks are amorphous; the term "crystalline" carries this implication, however.

The amount of recrystallization has not been as great nor as extensive in the dolomitic rocks, such as the Rochester and the Lockport formations.

No difficulty is experienced in a qualitative identification of the types of calcite but, in quantitative analyses, where each and every grain in the line of the intercept must be assigned to one of the various types, personal opinion enters into the problem. The processes of recrystallization were evidently spread over a long period of time and are a part of those constituting diagenesis (lithogenesis) and probably continued long afterwards (Thiel, 1942). So sensitive is calcite to this reorganization that it is rather surprising that any unrecrystallized calcite occurs today.

The cause of the recrystallization and its irregular distribution is an intriguing problem. In the same way that water is necessary to affect recrystallization of schists, water in these sediments is regarded as the probable medium. The variable permeability of the sediments may have controlled the volume of this circulating water. The amounts of clay are believed to be a factor in making the sediments watertight, even though the amount of recrystallized calcite does not show any clear relation to the amount of clay. The available data when plotted gives inconclusive scatter-diagrams. However, there is some evidence that a high content of clay *between* the grains (Reynales type), in contrast to the clay included within the calcite (Lockport type), seems to make the rocks less permeable to water circulation. But the clay within the grains restricts the recrystallized calcite to small sized grains.

There is no satisfactory way to express the extent of the recrystallization. Even within a single microscopic field, calcitic grains appear in all stages of reorganization from small grains with optical heterogeneity, with many dust inclusions with subround abraded external surfaces, to large clear grains with twinning bands with euhedral borders (Plate IIM).

Clastic Carbonate:—The term clastic carbonate, as used here, may not be one towards which criticism cannot be directed. It is employed, nevertheless, to designate the type of calcite of limestones which consist of small, irregular, subangular grains of calcite and dolomite that are not fragments of fossils and have not experienced recrystallization (see center of Plate IIK). Many of them in all probability are clastic in a true sense; the debris from wear on previously formed carbonate. Some of this material, especially the excessively small grains, may be derived from chemical precipitation, perhaps aided by organisms. Undoubtedly much of the clastic carbonate has lost its specific identity through recrystallization. A few layers of limestone are chiefly composed of clastic carbonate especially if it is abundantly supplied with clotted clay, and is somewhat magnesian in composition. Clastic carbonate enters into the composition of some fine-grained, argillaceous layers with a prominent shaly structure. The source of the clastic carbonate is not directly indicated. These observations suggest that the limestones from the Genesee Gorge are, in part, if not in large part, of clastic origin.

Clay-clotted Carbonate:—Quantitative microscopic analyses of both the Rochester and of the Lockport formations report less clay than the insoluble residues would suggest. High-power objectives reveal that a good deal of the clay is in exceedingly small units within the grains of the carbonates, quantitatively unmeasurable by the Wentworth stage. Chemical analyses suggest that clay-clotted carbonate is magnesian in composition. Certainly the dolomitization restricts the size of the grains in many cases. Some of the white rocks of these formations, such as the Eramosa beds at Lockport, New York, are essentially calcite.

Clay-clotted carbonate is one of the characteristic mineral microphases recognized, and has been called the Lockport clay microphase.

Quartz:—Detrital quartz occurs in nearly every slide, ranging from minute fragments to large grains, to pebbles. Most of it is clear, homogeneous with sharp and uniform extinction under crossed nicols. Others show wavy extinctions, implying internal strain. Gas bubbles are common. Rutile inclusions are relatively rare (see Plate IVC). Fractured grains are present. A few quartz grains show lamellae due to deformation previous to deposition which are similar to those described by Fairbairn (1941) (see Plate IB). In addition to quartz grains composed of single individuals, there are aggregates and pebbles composed of many separate grains. Many are of quartz; some are composed of detrital chert and chalcedony.

Chert:—Chert and associated minerals, chalcedony and opal, occur in the Furnaceville and in the Upper Reynales. It takes various forms and shapes. Bands of black chert are common in the exposures in the gorge. Slides cut from these layers show that the chert occurs in small units as well. It very definitely replaces calcite, more especially the fossils. Under the microscope the chert can be seen in all stages of crystallization from cryptocrystalline, microcrystalline to secondary quartz (see Plate IE, F, and G). The distinction of the latter from detrital quartz is usually possible. The clastic grains usually show some rounding and dust coating and, less commonly, are optically strained.

So perfect is the replacement of the fossil calcite by chalcedonic quartz that none of the structure of the fossil has been destroyed, and the fossil, in favorable sections, can be specifically identified.

There is abundant evidence that the silica was in solution when it replaced the calcite. Circulation of this solution was probably possible because of the permeability of the sediments. The rocks which contain a low but a definite amount of clay were especially favorable for chert. Layers of the Reynales which carry a large amount of clay do not contain chert. It would seem that large amounts of clay prohibit the formation of chert, or the conditions favorable for clay are unfavorable for chert (see Fig. 6D).

The problem of "primary" and "secondary" chert is a ghost that constantly haunts this investigation. The chert is secondary in the sense that it replaces the calcite; it is primary in the sense that it is in a part of the rock as formed. The development of the chert was one of the many processes collectively called lithogenesis.

Feldspar:—Clastic feldspar is very common: very few slides fail to contain some variety. Some limestones contain very small amounts. The large amounts are not, surprisingly enough, in the rocks with a high quartz content, but rather in those with intermediate amounts. A great flood

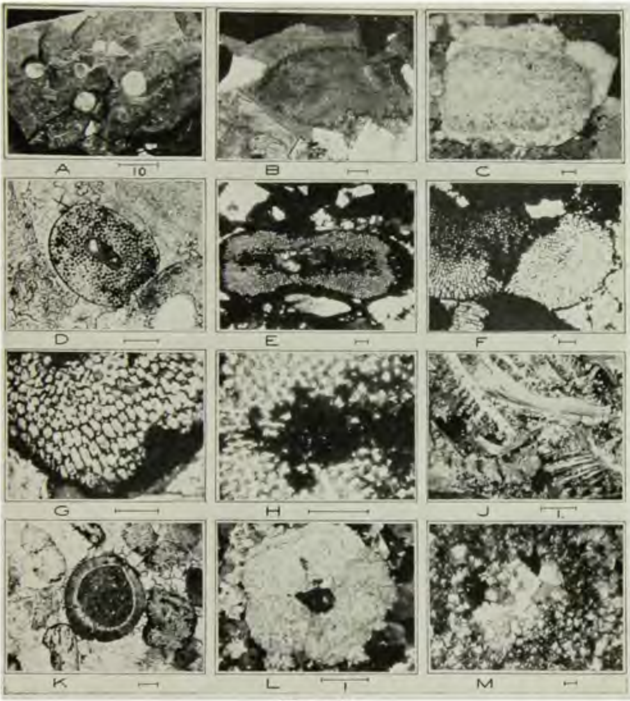

PLATE II

Length of scale 0.1 mm., except A, J. and L.

A. Maplewood, hand specimen, Maplewood Park, Genesee Gorge, showing calcareous discs. Orig. mag. X1.6.

B. Upper Reynales, Genesee Gorge, 5.6 ft. above base. Dusty centered grain of of calcite cemented (enlarged) by calcite. Cross nicols. Orig. mag. X69.

C. Reynales, Niagara Gorge, 12 ft. above base. Dusty centered grain of calcite cemented (enlarged) by calcite. Cross nicols. Orig. mag. X48.

D. Upper Reynales, Genesee Gorge, 11.5 ft. above base. Netted calcite fossil fragment, partially replaced by hematite (black). Ordinary light. Orig. mag. X140.

E. Oölitic ore stringer, 5 ft. below "red flux," Clinton, N. Y. Netted calcite, margined and centered by replacing hematite. Ordinary light. Orig. mag. X48.

F. Furnaceville, Genesee Gorge, .88 ft. above base. Netted calcite partially replaced by hematite. Ordinary light. Orig. mag. X69.

G. Furnaceville, Genesee Gorge, .88 ft. above base. Netted calcite margined and partly replaced by hematite. Ordinary light. Orig. mag. X174.

H. Oölitic ore stringer, 5 ft. below "red flux," Clinton, N. Y. Netted calcite, centered by replacing hematite. Ordinary light. Orig. mag. X240.

J. Lower Sodus, Upper Pearly layer, Genesee Gorge, showing cross sections of *Coelospira hemispherica*. Cross nicols. Orig. mag. X14.

K. Upper Reynales, Genesee Gorge, main *Pentamerus* layer (No. 4). Note clastic calcite within ring of recrystallized calcite, fossil fragments. Cross nicols. Orig. mag. X69.

L. Furnaceville, Genesee Gorge, .8 ft. above base. Calcitic rosette, pentagonal fossil fragment. Cross nicols. Orig. mag. X19.

M. Irondequoit, Densmore Creek, 15.5 ft. above base. Recrystallized magnesian calcite rhombs in limestone. Cross nicols. Orig. mag. X48.

of quartz seems to suppress the amount of feldspar. The amount of feldspar rises with the quartz to a peak and then falls off.

Orthoclase is rare, but microcline is common (see Plate ID). Perthitic feldspars, often in considerable amounts, exhibit all kinds; microclinic microperthite and microclinic antiperthite are dominant over the orthoclasic varieties. Plagioclase is the most abundant of all of the feldspars (see Plate IIID). Many of them are strikingly twinned, some are untwinned. The mode of the frequency-distribution data is oligoclase. Albite, andesine, and labradorite grains are common. Only several grains of bytownite were noted in the Grimsby.

Due to the perfect cleavage in two directions, feldspar grains are usually subangular; sometimes angular and only occasionally subround. The degree of roundness is also dependent upon size. The small grains are less round, the large grains more rounded.

The method of measuring roundness of feldspar was based upon the same principle as that for quartz. Krumbein's (1941) method appears to have two limitations, however. First, it was for relatively large pieces of limestone, not individual grains and, second, roundness characteristics of mineral grains are peculiar to each kind. Instead of using a set of drawings of quartz, a collection of sketches of feldspar grains were drawn and used. The relationship between the roundness of quartz and feldspar has not been investigated; they are not the same. The character of the cleavage of two minerals is part of the difference.

The grain-size range of the feldspar follows closely that of quartz. While the number of grains of feldspar per slide is much less than those of quartz, a sufficient number were found to construct satisfactory frequency-distribution curves that can be set alongside those of quartz. Commonly the mode size of the feldspar is slightly less than that of the quartz and it usually consists of one peak, while the curve of the quartz may show several. Since the grain sizes of quartz and feldspar are so nearly alike, the latter have not been plotted on the charts to avoid confusion.

The feldspar grains appear to be remarkably fresh and unaltered. Only occasionally paragonitization appears on the plagioclase blebs in perthite. Clay derived in situ from the feldspars could not be identified.

The Clay Minerals:—Nearly all of the slides show some form of clay or closely allied minerals. The clay minerals proper are difficult to study and many members of the important clay groups cannot always be identified by optical means in thin section. Nevertheless the kaolinite and montmorillonite types were recognized. The potash-bearing clays, called illite, are very common. The term "illite" is used in the sense of Grim: it "is not the name of a mineral species, but . . . a general term of the clay mineral constituents of argillaceous sediments belonging to the mica group. . . . The dominant . . . species present is [probably] bravaisite . . . " (see Fleischer, 1943). In addition there are pale green, flaky aggregates that are micaceous in habit which are transitional products due to decomposition of primary minerals to which definite names may not be appropriate. These are uralitic hornblende, bleached micas, both muscovite (see Plate IVA) and biotite, as well as a host of chlorites. It is the last that colors the Maplewood bright olive green and gives the gray-green tint to the Thorold and to the green portions of the Lower Sodus, and the Lower Irondequoit.

The red colorization of the Queenston, the Grimsby, and the purple parts of the Lower Sodus are due to hematitic stained clays. The hematite is in submicroscopic units, adsorbed by the clay.

Three clay microphases are recognized: the Queenston type that continues up to 38 feet above the base of the Grimsby, the Maplewood type which extends from this zone of the Grimsby upwards to the base of the Irondequoit, and the Lockport type of clay as clots within the magnesian calcite and dolomite, ranging from the base of the Irondequoit up into the base of the Vernon. These clay microphases are described beyond.

The Queenston especially contains abundant detrital muscovite and bleached biotite. Some flakes show authigeneous additions.

The orientation of the clay minerals is an interesting problem. The flakes are too small for satisfactory Federov Universal stage analysis. The use of the mica plate demonstrates that most of them are optically parallel to the bedding; there are other flakes at right angles to the bedding. Measurements are insufficient to indicate in exactly what planes the latter are chiefly concentrated. Unquestionably their orientation is governed by the presence of quartz grains.

Among the various chlorites, whose iron content is relatively high, is the interesting mineral chamosite which is important in the formation of the oölitic type of Clinton iron ore. In the Rochester region chamosite is rare and is not entirely confined to the Furnaceville. It has been found in the Brewer Dock and above the Furnaceville, as spherulites with polarization crosses. In the Furnaceville a few oölites of chamosite similar to those at Clinton have been found, but they are not as common nor as spectacular.

There are other chlorites involved with the hematites that are not chamosite. These occur as a core or nucleus of oölitic masses of hematite into which blood red specularite has grown. These have royal blue interference colors under crossed nicols.

The shaly character of many of the rocks of the gorge are in part dependent upon the amount of the clay, the kind of clay, the place of it in respect to the calcite and to the fabric or orientation of the flaky substances, and to the looseness of the interlocking of the constituent minerals.

The shaliness of the Genesee Gorge rocks is discussed later under the term, Preferred Compositional Ranges (see Fig. 6F).

Collophane:—Sanford (1936, pp. 799–801) was much interested in the phosphate nodules that occur in these rocks. He hoped that their presence marked definite horizons. Perhaps they do, but this was not substantiated by this study. In the field they are seen as shiny, rounded, dark brown to black pellets, frequently with pitted surfaces, ranging from pea to bean in size. The microscope reveals that collophane, the essential mineral of these nodules, is common, especially in rocks with an appreciable carbonate content. In thin section they are pale brown to straw in color, and opaque under crossed nicols, justifying the expression amorphous; the modern term should be perhaps pseudo-amorphous, as X-ray studies have revealed an apatite crystal lattice (see Plate IH and J). There are usually many inclusions within the masses. Detrital quartz is common but the universal mineral is a black opaque. The surface of this is dull as seen by reflected light and appears to be without any pattern. It is suspected that it is a ferrous sulphide common in sediments, known as hydrotoilite.

The collophane masses occur in two ways: as obvious pebbles, which have experienced considerable rounding and attrition; others are an essential part of the rock and have replaced fossil fragments. Usually the process of replacement is complete and none of the original carbonate remains. A few transitional stages, however, have been found to demonstrate the process. The source of the phosphate is regarded as organic, which is consistent with its occurrence in calcite-rich rocks.

Collophane is also recognized as constituting, at least in part, the network in many fossil fragments.

Collophane seems to be especially susceptible to replacement by compounds of iron, both of yellow-brown goethite and by earthy (cryptocrystalline) hematite.

Hematite:—Naturally hematite plays an important role in the Clinton. It takes many forms and possesses many degrees of crystallization. The two principal forms are the hematite of the Furnaceville and the adsorbed stain of the red Queenston and Grimsby. In the Furnaceville there are several varieties: (A) the powdery or submicrocrystalline, (B) microcrystalline, (C) specularite, and (D) martite.

Goethite:—The use of reflected light, such as obtained by the Leitz Ultrapac, reveals many grains of an opaque, bright yellow mineral in the slides of the Furnaceville. In spite of many attempts to affect a positive identification, there is considerable uncertainty regarding its true nature (see Plate IL and M). It occurs solely in the Furnaceville and at the same time white leucoxene is lacking in this member. These yellow grains could be iron-stained leucoxene. This seems reasonable, but what is the yellow stain? In the Furnaceville, iron compounds are available and hence the stain is probably an oxide or hydroxide of iron. Since the hematite is ferric iron and oxidation may have been part of the ore-forming process, the iron stain is likely to be oxidized as well. Goethite is a good guess. These yellow grains are apparently highly susceptible to further adsorption and replacement by hematite, resulting in flat discs with a hematite color which are insoluble in cold hydrochloric acid. Dr. Hoyt [Jones] (1943) reports these in the heavy mineral suites.

Pyrite-Marcasite:—Pyrite and/or marcasite occur in all of the slides. Most of them are in small units which occur either as round pellets showing a radial structure and a dull luster or as small cubical grains with a bright surface (see Plates IK and IVF). Sometimes the two are part of the same larger unit. Some of the larger grains are long stringers parallel to the bedding. Many of these have a core with a different color. This is a bright, metallic, slightly emerald green in color which contrasts with the brass yellow of pyrite margins. The core is probably marcasite. If so, the pyrite is later than the marcasite.

There are also megascopic discs of radial pyrite lying flat along the bedding planes. These have been found as large as a half dollar. Certainly this is a later development.

Pyrite is not evenly distributed. The Williamson and the Irondequoit are especially rich. In the Rochester and the Lockport the pyrite is in very small sizes as pellets and cubical grains.

Iron Sulphides and Carbonaceous Matter:—Closely associated with the pyrite-marcasite, either as separate masses or as marginal coatings, are dull black opaque substances. Their composition is not definitely known. They are believed to be iron sulphides which are known from many sedimentary rocks. Carbonaceous matter is not ruled out, however. Consequently, these black substances are regarded as possible mixtures of ferrous sulphides and carbonaceous materials. The latter is not the type usually referred to as bituminous. As many know, freshly broken pieces of the Lockport have a bituminous odor. Under the microscope, slides of the Lockport reveal cracks sometimes parallel to the bedding and styolites filled with a dark brown, oily material, unquestionably some form of bitumen. The styolites look as though they are the result of subsequent solution, the resulting cracks filled by the hydrocarbon.

Sulphates:—The Lockport has long been known to furnish mineral collectors with many beautiful specimens (Giles, 1920, Jensen, 1942). Many

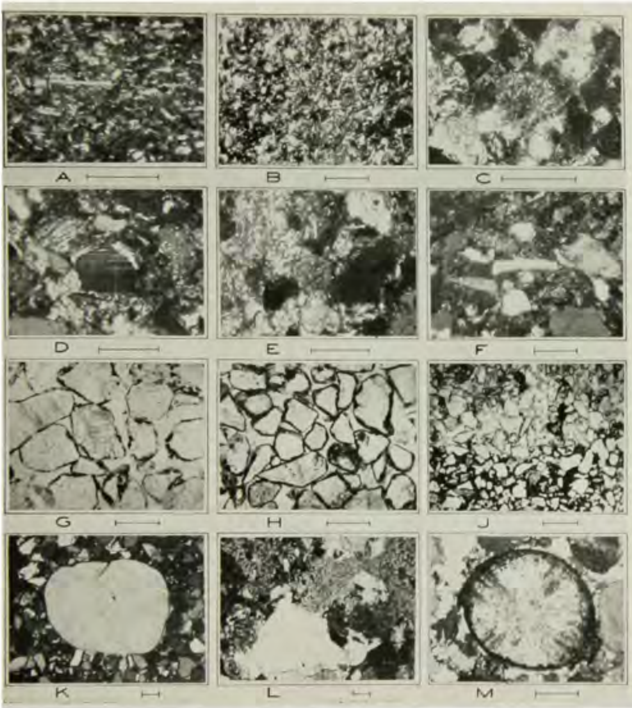

PLATE III

Length of scale, 0.1 mm.

A to E inclusive, Queenston. F to M, Grimsby. All from Genesee Gorge except M.

A. Queenston, .2 ft. below top. Red shaly bed, parallel to bedding, long flake of muscovite. Cross nicols. Orig. mag. X290.

B. Queenston, 6.5 ft. below top. Green shaly bed. Maplewood clay microphase. Cross nicols. Orig. mag. X174.

C. Queenston, 15.2 ft. below top. "Red Greywacke." Grain of glauconite in the center. Cross nicols. Orig. mag. X302.

D. Queenston, 4.3 ft. below top. "Red Greywacke," grain of oligoclase, center Queenston clay microphase. Cross nicols. Orig. mag. X240.

E. Queenston, 4.3 ft. below top. "Red Greywacke." Queenston clay microphase. Cross nicols. Orig. mag. X240.

F. Grimsby, 2.5 ft. above base. Queenston "Red Greywacke" type. Quartz grains. Cross nicols. Orig. mag. X174.

G. Grimsby, 26 ft. above base. Pink Grimsby type. Ordinary light. Note hematite coating quartz grains inside quartz cement. Orig. mag. X174.

H. Grimsby, 50 ft. above base. Red Grimsby type. Ordinary light. Heavier coatings than in G. Orig. mag. X174.

J. Grimsby, 54 ft. above base. Alternating red Grimsby (bottom) and pink layers (center). Ordinary light. Orig. mag. X140.

K. Grimsby, 54 ft. above base. Pebble in siltstone. Cross nicols. Orig. mag. X69.

L. Grimsby, 0 ft. above base. Recrystallized calcite (white) showing cleavage and a twinning striation. Cross nicols. Orig. mag. X69.

M. Grimsby, Densmore Creek, 27 ft. above base. Water-worn fossil fragment coated by hematite. Cross nicols. Orig. mag. X174.

of these minerals have been identified as microscopic grains in thin sections as well. In special slides, prepared without the use of water, little cubes of halite have been identified. All of these clearly indicate the increasing salinity of the Lockport sea.

Both anhydrite and gypsum occur in the Lockport. The microscope shows that the gypsum was derived from the anhydrite by hydration. There is no way of deciding whether the anhydrite was originally formed by dehydration of primary gypsum. In any case the present gypsum occupies more space than the anhydrite and has produced microfaulting and microfolding in similar fashion to that reported in Vernon-Camillus rocks of the Salina. The Lockport contains many geodes and solution cavities which show the corrosive effects of the saline waters.

Leucoxene:—This mineral is very abundant in all the slides. It is sometimes more abundant than quartz. The argillaceous rocks contain many, but small, grains. They can best be studied by reflected and transmitted light, first one, then the other, then both together. The Leitz Ultrapac equipment is very satisfactory for this purpose.

In color the leucoxene varies from porcelain white through straw, buff, yellow, yellow-brown to brown. The margins of many are translucent. The origin of these grains does not appear to be simple. Probably ilmenite is the main source; many of these grains have been sliced in the making of the thin section, and reveal that the transformation from the primary mineral to leucoxene has not always been complete, as many cores of ilmenite still exist. But the cores are not all ilmenite; some are sphene and others are rutile. The white material is largely hydrated titania, as recent analyses show (Coil, 1933, Edwards, 1942). The yellowish leucoxene appears to be stained by ferric iron. Slides of the Furnaceville show yellow opaque masses that are regarded as goethite-stained leucoxene.

Zircon:—One of the most interesting detrital grains of the accessory or "heavy" mineral group is zircon. It was found in almost every slide. "Heavies" are usually studied in loose grains from crushing, with care, a sample from a quarter to a pound of the rock. But it was found that thin sections show many of these minerals and they can be studied and measured in this form. Zircons frequently show crystal outlines, even though the corners have been rounded and a few have been fractured. In color they have a considerable range, from colorless, pale yellows, browns, greens, to opaque. Hyacinth is occasionally found. In shape they are short, stout grains, some with fair terminations to long thin needles. Dr. Hoyt (1943) reports "sawfish" authigenetic additions on some zircons. Only two such grains were found in thin sections of the Thorold. The grains have the appearance of having experienced several erosional cycles.

Tourmaline:—Tourmaline, together with zircon, is the most abundant accessory mineral in these rocks. The ratio of these two varies somewhat, but they are roughly equal in amount.

Perfection of rounding probably is attained by more tourmaline grains than any other mineral; not only are they round but many are circular as well. Certainly the roundness scale or standard for zircon does not apply to tourmaline, and awaits laboratory data for its construction.

For ranges of color and variety of pleochromism, nothing in these rocks equals this mineral. Colorless tourmaline is rare but yellows, browns, greens, and blues are common. Like zircon, tourmaline is one of the most stable minerals and very probably has been through many erosional cycles.

A few grains of tourmaline were found with authigenic additions, which are colorless or pale pink in color, usually in strong contrast with the colors of the core mineral.

Glauconite:—Occasionally small, roundish grains of glauconite are seen in almost every formation, although not in every slide (see Plate IIIC). No relation to known stratigraphic breaks is recognized. They appear to be more abundant, however, at the planes of possible diastems (Goldman, 1921).

Other Accessory Minerals:—Occasionally the following detrital minerals can be identified in the thin sections: hypersthene, diopside, corundum, anatase, rutile, brookite, allanite, garnet, magnetite, ilmenite, andalusite, and spinel.

The Absent Minerals:—These rocks are especially interesting in the minerals that are absent. Garnet is comparatively rare and when found is usually corroded. Hypersthene and diopside were the only pyroxenes found, but no amphibole. The feldspathoids and the olivines are conspicuous by their absence. Many minerals have been removed from these rocks since their deposition; many have been added. Sedimentary rocks are not closed systems. Diagenesis and leachings consist of many processes that seemingly never cease operating. Sedimentary rocks are complex, worthy of careful study.

IV. MICROLITHOLOGIES

Stratigraphers recognize that rocks intergrade horizontally, shales into sandy beds, marine sediments into continental rocks, gray sediments into red beds, etc. These are rock facies. Caster (1934) has crystallized our thinking by proposing two effective terms: magnafacies for rock types spanning more than one formation, and as a subdivision, parvafacies, limited to one formation. The boundaries of facies are not always parallel to the formational limits nor are they necessarily parallel to the planes of contemporaneity. Chadwick, in his studies of the Upper Devonian of New York, has used facies and has made extraordinary progress. He has done the science of stratigraphy a great service in recognizing that the Chemung is Portage, for example. But perhaps he did not always distinguish between formational units and parvafacies.

The term microlithologies (Alling, 1945) was developed and proposed through the observation that many of the formations in the Gorge are in reality composed of several distinct types of sediment. The term is essentially a microscopic one. An illustration of microlithologies is the Reynales formation. The lower beds are calcareous with a fluctuating argillaceous content. The latter are relatively thin shaly partings. These are not composed solely of argillaceous matters, but of carbonates, chiefly calcite, diluted (the word is used deliberately) with argillaceous substances. The expression "shaly limestone" would be a common one to use but the term is sterile. The formation is composed of at least two rock types: a limestone with the various types of calcite, a narrow range of quartz, feldspars, and accessory minerals, each with a characteristic modal grain size, and a finer-grained argillaceous rock with clay minerals and its own limited range of quartz, calcite, and accessories, each with its own grain size. The siliceous microlithology is a minor constituent. It is chiefly the relative *percentage* of the rock microlithologies that makes the formation. For this it is proposed that it be given formal expression in the *principle* of *complementary microlithologies.*

The microscope clearly shows that the multiple types were often deposited together; not a sudden cessation of one at the expense of the other. It is not the case of either limestone or "shale", but a mixing of the two in different proportions. The igneous petrographer is familiar with hybrid rocks. Much of the Reynales is one. The principle furnishes a clue to the manner in which limestones change into shales; it is the *percentage* of the microlithologies that changes, not necessarily a profound change in the composition of each microlithology.

Delésse-Rosiwal analyses by the Wentworth stage provide the percentage mineralogical composition of the rock as a whole. Each specimen can be further analyzed. The total composition can be subdivided in order to recognize the composite nature of the sediments. The calculation of the complementary microlithologies into the basic rock types, calcareous, argillaceous, and siliceous, was based upon the following procedure.

Calculation of Microlithologies:—The rocks which are largely composed of a single microlithology, argillaceous, for example, were selected as the basis for the computation of this particular microlithology. The composition of other specimens in the same formational unit were subdivided on the basis that the composition of the microlithology was similar even though other microlithologies are present.

1. All the clay minerals were assigned to the argillaceous microlithologies.

2. The frequency-distribution curves of quartz were divided into two parts: the small grains were allocated to the argillaceous, and the large to the siliceous microlithology. The point along the size scale that bisected these curves was based upon the size of the quartz of the standard sample. In the case of many of the formations this was close to .032 mm. The area of the two parts of the frequency-distribution curves was measured by a polar planimeter. The ratio of these two areas was used to divide the percentage of the total quartz. The basis of these frequency-distribution curves was geometric and not logarithmic in character.

3. The feldspar content was allocated by the same method as the quartz.

4. All of the recrystallized and fossil calcite was assigned to the calcareous microlithology.

5. The clastic calcite was divided between argillaceous and calcareous microlithologies on the basis that argillaceous rocks with a high clay content rarely contain more than 10% of clastic calcite. Consequently 10% of the clastic calcite was arbitrarily allocated to the argillaceous and the rest to the calcareous microlithologies.

6. The bulk of the accessory minerals were allocated to the siliceous microlithologies; a little (.1 to .3%) to each of the other two.

7. The clay content of the argillaceous microlithology of some rocks, especially of the Rochester and Lockport formations, was slightly increased over that measured by the Wentworth stage, because chemical analyses and insoluble residues showed a higher amount. The grain size of the clay of the Lockport is too small for Delésse-Rosiwal analyses. The clay content was increased ten per cent by subtracting that amount from that of the clastic carbonate as determined microscopically.

In some thin sections the reality of these multiple complementary microlithologies is amply substantiated by simple inspection alone; in other rocks, however, microlithologies become somewhat theoretical or artificial. These microlithologies are exactly comparable to the "normative minerals" used in calculating norms of igneous rocks from chemical analyses. The theoretical nature of some of these microlithologies in no way invalidates the usefulness of the concept, as the diagrams in this paper will show.

The results of these calculations were plotted alongside the geologic column, in three columns, one for each of the three microlithologies, argillaceous, calcareous, and siliceous. The width of these columns was scaled to permit the plotting of one hundred per cent of any one microlithology.

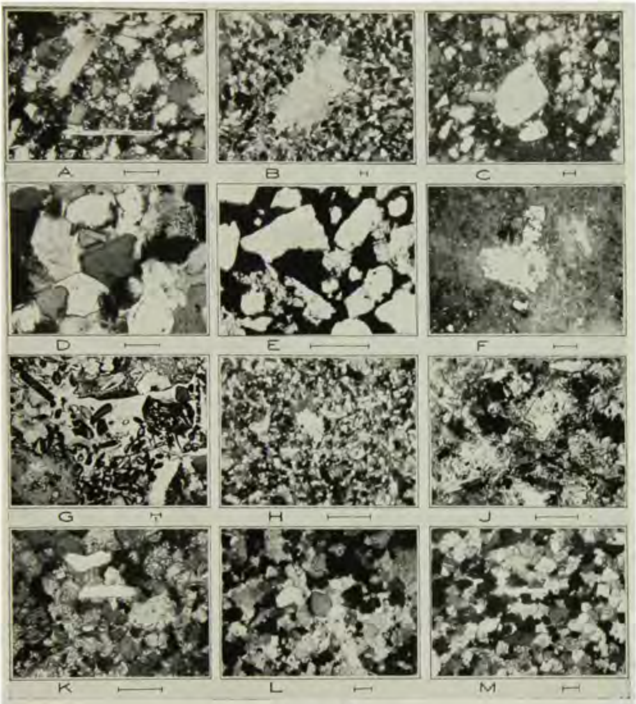

PLATE IV

Length of scale, 0.1 mm., except G, which equals 1. mm. Cross nicols, except E, F, and G.

A. Thorold, Albion, N. Y., 2 ft. above base, showing Maplewood clay microphase "framing" quartz grains. Near bottom, long flake of muscovite. Orig. mag. X140.

B. Thorold, Genesee Gorge, .1 ft. above base, showing crystoblast of recrystallized calcite, exhibiting twinning striations. Orig. mag. X26.

C. Thorold Genesee Gorge, .1 ft. above base, showing rutile needle in sand grain of quartz. Note Maplewood clay microphase framing quartz grains. Orig. mag. X48.

D. Thorold, Genesee Gorge, 2 ft. above base. Quartz grains cemented by added quartz. Orig. mag. X140.

E. Thorold, Genesee Gorge, 1.2 ft. above base. Clinton type of hematite (black) replacing calcite (rough grains) cementing quartz grains (grey). Ordinary light. Orig. mag. X240.

F. Thorold, Genesee Gorge, 1.2 ft. above base. Pyrite (white). Reflected light. Orig. mag. X94.

G. Furnaceville, Densmore Creek, .7 ft. above base. Entire slide, fossil fragments replaced by hematite (black) in calcite (grey) groundmass. Ordinary light. Orig. mag. X4.

H. Lower Sodus, Densmore Creek, 13.5 ft. above base. Just below upper pearly layer, showing very fine-grained limestone. Orig. mag. X174.

J. Rochester, Barge Canal, 5 ft. above base. Fossiliferous zone. Leucoxene and iron sulphide grains, black. Orig. mag. X174.

K. Rochester, Barge Canal, 63 ft. above base. Upper zone, "Gates limestone" quartz, splintery grains in limestone. Orig. mag. X174.

L. Lockport, Barge Canal, 78 ft. above base. Dolomite with quartz grains. Orig. mag. X69.

M. Lockport, Barge Canal, 88 ft. above base. Dolomite with quartz grains. Probably Lower Shelby zone.

In draughting these charts each microlithology was plotted along the central line (50% by weight) so each plot is bilaterally symmetrical.

The varying thicknesses of the formations and the distribution of available thin sections made it desirable to vary the vertical scale from chart to chart.

V. MICROPHASES

The listing of the names of minerals present in these rocks does not express at all what there is to see. There were various fabric, textural, and structural relationships that are characteristic of certain formations. This is not simply composition alone for it involves size, shape, roundness, and orientation, etc. of many minerals. Since minerals by themselves are not rocks they do not constitute rock microlithologies but rather mineral *microphases*. This distinction is patterned after Shand (1942). He applied this principle to a study of the igneous Cortlandt series on the Hudson. He used the term "species" in the same sense as "lithologies" is used here. This change in nomenclature does no violence to Shand's principle, however. The application of this method of attack has resulted in recognizing a number of characteristic microphases.

Maplewood Clay Microphase:—This type consists of clay minerals as fine, feathery shreds with a preferred orientation, some of which, however, lie in planes at right angles to that of the bedding. In oriented thin sections the latter are seen on edge up against the detrital quartz grains, "framing" them (see Plate IVA and C). This gives the illusion that the roundish grains are angular. It gives them the appearance of being rectangular and square cornered.

The Maplewood clay microphase was found in the Neahga of Niagara, in the Thorold of many localities. In the Genesee Gorge it was found at the top of the Grimsby, in the Thorold, in the shaly partings of the Reynales, in the Lower Sodus, and in the Williamson. It is, of course, the dominant microphase of the Maplewood. In the other formations it is significant even though it does not necessarily bulk large. Its presence shows that the conditions and processes that were responsible for it began in the top of the Grimsby and continued with diminishing quantity up to the base of the Irondequoit.

Other microphases were recognized: (A) the Queenston type of clay, (B) the Reynales type of calcite, and (C) the Lockport type of magnesian carbonate. Descriptions of these are given in the appropriate places.

VI. NOMENCLATURE OF SEDIMENTS

The common field terms—sandstone, limestone, and shale—are utterly inadequate for today's needs. This is not a new thought, however, for Grabau in 1917 (p. 743) stated that: "if we stratigraphers insisted on a more refined classification of our sediments, instead of being satisfied with conglomerates, sandstones, shales, limestones, and some minor types, we would make more rapid progress." A satisfactory classification of sediments presupposes a thorough knowledge of them. However, paradoxically, a classification of rocks is not a classification of rocks but a classification of ideas about rocks. Ideas about rocks change. We need ideas before we can have a classification. Instead of reviewing a host of terms and proposing new ones, as Grabau did, a simple way out of the difficulties has been adopted: to refer to the carbonate, the argillaceous, and to the siliceous rocks when composition and composition alone is intended.

Shaly beds, usually referred to as "shales", are abundant throughout the geologic column investigated; some of them, like the Maplewood, are entirely of this character. Many of the others consist in part of thin beds of stratified rocks, usually referred to as "shale partings." The ability of a shale to split parallel to the bedding is not necessarily the direct result of its mineralogical composition. The relationship is not that simple. To be explicit, the word "shale" is not used in this paper but instead the adjective form "shaly", as advocated by Wentworth (1922), is employed. Etymologically "shale" is not a compositional term. The amount of the clay minerals, as well as the kind, is a factor, but these are not the only, or even the essential, characteristics of shaly rocks. The fundamental cause is the orientation or fabric of the minerals which possess basal or flaky cleavages and the lack of effective interlocking of these layers. It takes only a small amount of the oriented flaky substances to produce a shaly rock.

Not all minerals which produce such a structure are clays even in a broad sense. Uralitic hornblende, the chlorites, and even leucoxene are important in producing foliated rocks. The orientation was apparently due to primary deposition and to subsequent compaction.

VII. THE FORMATIONS

The Queenston:—Of the 900 feet or so of the Queenston in the Rochester meridian, only the upper 26 feet have been sampled. The usual field description, "red shale", means very little. Some, however, have recognized the minor beds within the Queenston by referring to cherry red and green shales, and green to gray sandstone (Wilmarth, 1938), or red sandstone and shales, thin gray and green shales. Other expressions are red sandy shales and red arenaceous shales. The Queenston is a composite rock with heavy-bedded argillaceous siltstone layers with thin-bedded to fissile, fine-grained siliceous, argillaceous seams, and "shale partings", purple-red in color. There are also thin, massive to heavy-bedded, gray-green siltstones, not unlike, in a superficial way, the Thorold, and thin, bright green shaly beds.

On the outcrop much of the Queenston appears red in color but in thin section there are narrow streams that are not red at all. I cannot escape the growing impression that some of the red is either due to weathering or to added red stain from wash from indigenously colored members on exposure to the atmosphere. Here field observations have given a false impression which the thin sections clarify. The color is due to hematite and probably not due to ferric hydrate (Raymond, 1942). It is in submicroscopic units and is essentially a red stain on the surface of the micaceous minerals, there by adsorption. As it is very difficult to measure the amount of hematite present by the Wentworth stage, a few chemical analyses were made. The amount of ferric oxide in the red beds ranges from 2.67 to 5.13%. In the green types the ferrous iron is only slightly less. Oxidation of ferrous to ferric iron would account for the change of color from green to red. But there is more to this problem. The hematite is on the margins of the quartz grains, usually *beneath* the quartz content, as well as between the enlarged grains, and especially on the flakes of the clay minerals. In spite of the masking of many details of the characteristics of the clay by the hematite stain, the red Queenston seems to lack in large degree the chlorite possessed by the green and gray members. Was the iron of the hematite derived from the decomposition of ferrous iron-bearing chlorites, such as leptochlorite or penninite, and oxidized to the ferric condition? An affirmative answer seems reasonable on the basis of the present information. But why is the chlorite decomposed in some layers and not in others? Or was the iron introduced from the outside?

In the Niagara Gorge, Grabau (1901, p. 88) reported that "the shale is seamed by whitish or greenish bands, both parallel with or at . . . angles to the stratification plane . . . often extending to an inch on either side . . . due to percolating air or water, the latter probably carrying organic acids in solution . . . along lines of greater permeability."

The implications are that the rock was originally red and the organic acids have reduced the ferric iron to the bivalent condition. This can be carried a step further. This is based upon the observation that the green shaly layers carry the Maplewood clay microphase which is characterized by thin parallel strings of clays, not the bunched illitic types prevalent in the red argillaceous siltstones or greywackes. The microscope suggests that the green types were more permeable between the leaves of clay. Grabau reports slickensided surfaces on joint faces which show discoloration. The movement along these planes provided a channelway for the acid solutions.

In addition to these green bands, there are the perplexing gray-green spots. This phenomenon is not confined to the Queenston. They occur in many red beds. The Grimsby, the Vernon, and the Catskill of New York contain them as well. The position and arrangement of these does not seem to fit any pattern. Perhaps they represent spots due to leachings or, on the other hand, they are spaces not yet stained by hematite.

Quantitative analyses and grain-size measurements, etc., reveal no essential differences between the red and green areas except for the presence of red hematite. The presence or absence of carbonaceous matter, which has been often suggested for non-oxidation and oxidation, respectively, has not been established for these rocks.

Petrographically the Queenston is a red bed (see Plate III, A through E). Slides of some of the Catskill megafacies from New York State are very similar and cannot, except with thorough examination, be distinguished from it. The quartz grains are universally angular and many are splintery. Feldspar grains, while not abundant enough to justify the term arkose, are common.

The clay substances are distinctive. The low birefringence types are in the minority, the bulk being illite, hornblende, uralite, and various chlorites.

Muscovite flakes are very common but many show authigenetic marginal additions of illite and green chlorite materials. The micaceous minerals have not arranged themselves like frames around the quartz grains, as is the case with the Thorold. The clay masses are irregular in shape and occur in patches, not in thin streaks. This is the Queenston clay microphase.

Slides of siliceous flagstones in the upper portion of the Genesee Group of the Upper Devonian of New York, in the Keuka Lake region (Grossman, 1944), are comparable to the Queenston, except for color. Thus there exist two names, "shale" and "flagstone", for much the same kind of rock. Both of these possess many characteristics of relatively fine-grained representatives of the "Flysch" type of sediment, implying sources undergoing gradual uplift. They are continental in character with poor sorting, angular grains, and with interformational shaly beds with a dominant to predominant cementing matrix composed of various chlorites, illitic type of clay, and minor carbonates. In the case of the Devonian sediments, interfingerings of thin calcareous beds with a shaly structure, containing marine fossils, occur. These rocks I call greywackes, departing from the definition given by Twenhofel (1939, p. 289), because it does not fit the rocks described by geologists as greywackes. It is the amount of the cementing matrix that distinguishes them from "shales" on one hand and "sandstones" on the other. The use of the term "greywacke" recognizes the tectonic factor in the sedimentation, which is usually ignored. The work of Krynine (1941) is a notable exception. He called the Queenston a "red greywacke", colloquially. The shale partings of the Queenston alone deserve the name "shale."

Contact of the Queenston with the Grimsby:—The question of the age of the Queenston need not be rediscussed here.* Williams (1919, pp. 47–8) states that at Niagara the Cataract beds rest on the uneven, worn surface of the Queenston. A similar break repeatedly has been looked for in the Genesee Gorge. There are a large number of diastems within the mass of the red Queenston and Grimsby, any one of which, from field scrutiny alone, could be the plane of demarcation. The lack of continuous bedding, with obvious to obscure cross bedding, ripple marks, channel flutings, etc., make it impossible to draw the line. Perhaps no line should be drawn. As a practical measure, the dividing plane has for years been assumed to be at the base of the first heavy bedded siltstone layer; above is the Grimsby, below is the Queenston. It may well be that there is an unconformable contact at Niagara and in Maryland (Ulrich, 1911, pp. 252–257), but it cannot be located at Rochester. If the Whirlpool was recognized at Rochester, the unconformity probably could be found. From what can be seen in the field and under the microscope, the sedimentation was fairly continuous in the ordinary sense. This was the view maintained by Sanford in his classes at the University of Rochester. The gradation from one to the other is well shown in Fig. 2. The demarcation has been drawn at the customary plane assumed at Rochester. There is no assurance, however, that it has been correctly placed.

Paleontologically the distinction between the two formations is unsatisfactory. *Paleophycus tortuosum* occurs in the Queenston and *Arthrophycus alleghaniensis* is found in the Grimsby. It is reasonable to suppose that these worm burrows are in reality facies fossils, dependent upon the type of sediment (see Fig. 6F).

The Grimsby:—The excellent summaries of Schuchert (1914) and of Wilmarth (1938) make it unnecessary to present a lengthy discussion of use of the terms "Medina", "Albion", "Grimsby", "Cataract", etc. I have followed the example of Gillette (1940) in recognizing that the Medina (in its original sense) is divisible into two formations, the Grimsby above and the Cataract below. These are equivalent beds of different facies, that is, they are complementary units. The Grimsby is continental and the Cataract marine in character.

Since the rock at Rochester is chiefly a red siltstone possessing the facies characteristics of the Grimsby at Niagara, it is assumed that the Cataract facies is missing. The term Grimsby is used here.

The lower beds of the Grimsby at Rochester are very similar to the

* The United States Geological Survey accepts the Ordovician age for it.

underlying Queenston (see Plate IIIF). There are some slides that cannot be properly assigned unless recourse to the labels is made. Field and microscopic observations lead to a five-fold list of lithologic types: (A) heavy-bedded red siltstones, (B) heavy-bedded greenish gray siltstones, (C) red greywackes, (D) thin-bedded to fissile red argillaceous shaly partings, and (E) thin fissile green argillaceous rocks. (A) makes up the bulk of the Grimsby.

In terms of total composition, the Grimsby has slightly less clay and more quartz than the Queenston. The carbonate content, however, is about the same.

A study of the microphases shows that the clay in the lower half of the Grimsby (up to 26 feet above the base) is that which prevails in the section of the Queenston sampled. In other words it is the Queenston clay microphase. In the upper zones, however, the Maplewood clay microphase begins to appear. In the zone between 38 and 41 feet above the base there are two green shaly partings, the clay of which is largely that of the Maplewood type. In the red siltstones near the top of the Grimsby both the Queenston and the Maplewood types are present; at first the Queenston phase dominates, and then at the top, especially at Densmore Creek, the Maplewood kind is in the majority. This overlapping of the clay microphases stresses the interlocking and sedimentary intergradation of the two formation units. These microphases could well be studied more as they may prove of assistance in better understanding the sedimentation of these rocks.

The zone 38 to 41 feet from the bottom of the formation represents conditions of abrupt compositional changes. Not only do two green shaly partings occur within it but also six thin red shaly beds as well, separated by red siltstones. There is, in addition, a curious contorted layer with *Daedalus archimedes* and *Arthrophycus alleghaniensis*, pebbly beds approaching conglomerates and some layers with clay balls (Robertson, 1941). This zone is one of several of intraformational shale pebble conglomerates (Schuchert, 1914). All of these changes within 3 feet of sediment occur at the same zone as that of the maximum quartz content. This is graphically shown in terms of microlithologies in Fig. 2. It was necessary to omit some details due to the small scale. The composition of the microlithologies shifts somewhat but the large changes were brought about by the shift in the percentage of the argillaceous and siliceous microlithologies. The pebbly beds contain large grains of quartz, many of which are worn to almost perfect spheres (see Plate IIIK).

This zone has been recognized by Gillette (1940, p. 25) in the Clyde and Sodus Bay quadrangles. Cross bedding and ripple marks are common throughout the mass.

Fairchild (1901) long ago recognized the beach characteristics of the Grimsby in Western New York.

Sarle (1906) stated that the results of burrowing organisms known as *Daedalus archimedes* occur throughout the upper thirty feet of the formation and that *Arthrophycus alleghaniensis* is restricted to the lower 14 feet of this thirty-foot zone. These are plotted on the chart in Fig. 2.

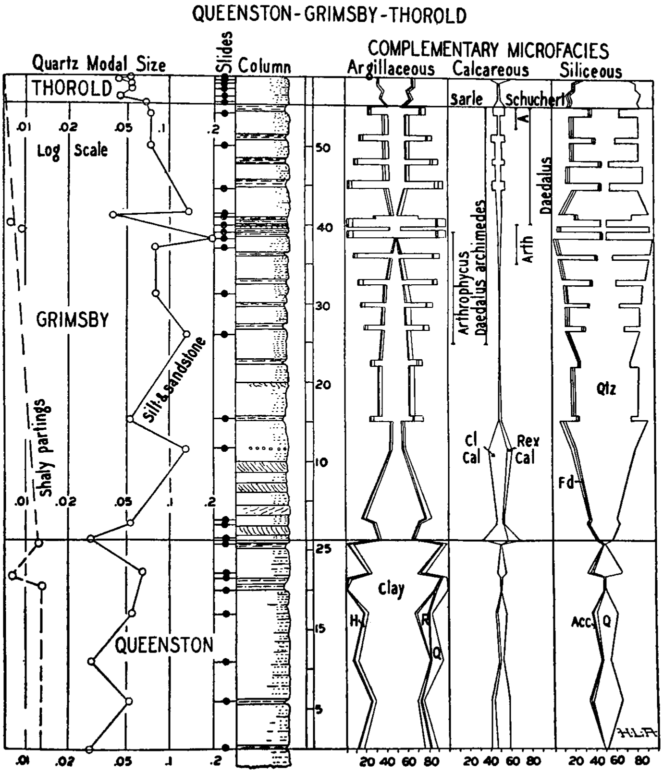

FIGURE 2

Queenston-Grimsby-Thorold Formations

Quartz modal size, measured in thin section, and complementary microlithologies.

Legend: Cl Cal = clastic calcite, Rex Cal & R = recrystallized calcite, H = Hematite, Qtz. & Q. = Quartz, Acc = accessory minerals. Plane at top of Queenston is the customary position assumed at Rochester.

Schuchert (1914) gave slightly different zones for these organisms, as is indicated alongside those of Sarle. The chief divergence is that Schuchert found *Arthrophycus* in the upper six feet as well as 15 to 20 feet farther down.

Field observations would suggest that Sarle's *Arthrophycus* zone contains well-developed specimens, while the upper zone of Schuchert is one with fossils less well developed. This is confirmed by the microscope. Well-developed specimens occur in rocks with a high quartz content; rocks in which those poorly developed occur contain more argillaceous microlithologies. It is significant that the relatively rare *Arthrophycus* in the Thorold in the Genesee Gorge is contained in a rock with a composition very similar to that in the Grimsby with similarly poorly developed forms. This can be appreciated in Figure 6B. The mineral composition of the Thorold at Niagara, which contains *Arthrophycus,* is the same as that of the well-developed zones of the Grimsby. *Arthrophycus* is definitely a facies fossil.

The *Arthrophycus* zones coincide with the maximum amount of quartz and the minimum amount of calcareous minerals.

The *Daedalus archimedes* zones have greater stratigraphic ranges and consist of rocks with a greater mineralogical range, but in all cases the quartz is high and the calcitic minerals may be somewhat higher than is the case of the zones bearing *Arthrophycus.*

The Thorold:—This is the familiar "grayband." It has been regarded by some as the top of the Medina group and the base of the Clinton group by others. These arguments need not concern us here. The microscope easily shows a fundamental Clinton characteristic of the Thorold at Rochester, as will be shown later.

The rock is a gray-green siltstone (Alling, 1943) with both a clay and a calcite cement. All the slides of the Thorold in the Genesee Gorge show some calcite; it is particularly abundant at the base and at the top. In the Niagara Gorge the top of the Thorold is especially rich in calcite, so much so that calcareous brachiopod fossils occur. This layer, a foot thick, Sanford did not regard as Thorold (Sanford, 1935a, p. 173).

The clay consists of two distinct types: (A) a groundmass of a low birefracting clay belonging to the kaolinite and montrillionite groups and (B) micaceous phenocrysts of illite. Both kinds frame individual grains of detrital quartz. These flakes produce the illusion that the quartz grains are angular and often square in cross section (see Plate IVA, B, and C). It takes a little experience to observe that the quartz grains are in reality subangular and have been authigenically enlarged by added quartz and thereby cemented together (see Plate IVD).

Grain size measurements were possible in the majority of the grains only after the most patient and careful study, otherwise the measurements would include quartz cement which would have little significance. Curves of the true grain sizes and those which include the quartz cement are compared in Fig. 1B. The grain size of the quartz of the Thorold is, on the whole, slightly smaller and less rounded compared with the underlying Grimsby. If the Thorold is to be regarded as reworked Grimsby, at least in part, these observations are not incompatible. Gillette (1940, p. 40) says "the sediment itself . . . may have been derived from the underlying Grimsby." The Thorold at Glen Edyth, however, shows the same size of quartz as the underlying Grimsby; the clay content is slightly less than is the case in the Genesee Gorge. Here the reworking of the Grimsby may not have been as extensive as at Rochester. The amount of zircon, tourmaline, leucoxene, and so on, appears to be more abundant than in the Grimsby. However, the hematite-stained clay of the red beds effectively obscures the accessory minerals which reduces the accuracy of the Delésse-Rosiwal analyses.

A red band or lens a tenth of a foot thick occurs slightly over a foot above the base of the Thorold in the Genesee Gorge. In the field it was regarded as a red shaly, recurrent seam of the Grimsby interbedded in the Thorold. Such an interpretation would strengthen the opinion that the gray band is closely tied to the beds underneath. I was fortunate to have a chip of this narrow red streak thin sectioned. It turned out not to be a red argillaceous rock but a Clinton type of "iron ore", more siliceous than the Furnaceville, but essentially a limestone which has experienced considerable replacement by the characteristic earthy type of hematite, not the hematitic stain of the Grimsby adsorbed by the clay substances (see Plate IVE). As there is no characteristic so typical of the Clinton as "iron ores", this slide ties the Thorold, at Rochester, to the Clinton group.

Chadwick (1935) has presented a question that illustrates the problem of correlation by paleontologic means without considering the changing rock facies. The Thorold, both at Thorold, Ontario, and at the Niagara Gorge, contains the work burrow *Arthrophycus alleghaniensis*. Chadwick reported that at Rochester this fossil is lacking and on this basis questioned that the "grayband" is Thorold. At Lockport he reported finding *two* sandstones separated by a few feet of green shale. His conception is that there are two sandstones, each of which deserves a formational name: the lower one the Thorold, and the upper one, which he named the "Kodak." Sanford (1935b, p. 1390) reports the presence of *Arthrophycus* in this rock in the Genesee Gorge, and furthermore questions its value as an index for correlation. Sanford is inclined to believe that what Chadwick attempted to explain is best understood as a change in the rock facies in the absence of critical fossils.

The specimens of the "grayband" from the Genesee Gorge in the Museum of the University of Rochester, several of which were collected by Sanford, contain *Arthrophycus* (see Fig. 6B). They are not as striking as those from Thorold, Ontario, nor are they as well preserved, nor as large. Such specimens evidently are rare; these are the only ones I have seen, so Chadwick's failure to find this worm burrow is not surprising. The rarity of *Arthrophycus* in the Thorold at Rochester may well be because of the difference in the composition of the rock from that at Niagara. Gillette reports that *Arthrophycus* is occasionally found in the Thorold to the east. At Rochester, the Thorold is more argillaceous and constitutes a different environment, evidently unfavorable for the organism that made these burrows. The few feet of green shale at Lockport is evidently a band of the same argillaceous substances that constitute the green shaly partings of the Grimsby. Not only is it unnecessary to use the term "Kodak" but its introduction further adds to an already overburdened nomenclature.

The presence of the Maplewood clay microphase in the Thorold is another reason for assigning it to the Clinton Group.

Chadwick's (1918, p. 334) suggestion that the Thorold at Rochester is not closely related to the underlying Grimsby is not fully understood. He gives no reason for this conclusion. Sanford (1935b, p. 1390) says "this is a matter of opinion."

Farther to the east at North Wolcott, Gillette (1940, p. 43) reports that as the Thorold was being pried from the creek bed it broke up into polygonal pieces. Many of these are separated by thin green shale dividers, apparently composed of the same kind of clay as that parallel to the bedding. This suggests that the Thorold was formed in shallow water in which the sediment was covered from time to time with mud which filtered down the sun-baked cracks.

The Maplewood:—The microscope shows that the Maplewood is very different in many ways from the Lower Sodus with which it was confused by Hall, an error which Chadwick (1918, pp. 331, 334) had the good fortune to discover by plotting the well records of Newland and Hartnagel (1908). Chadwick had an excellent basis for the introduction of the term Maplewood. As fossils are lacking in this rock, his basis was chiefly stratigraphic.

The Maplewood contains a higher percentage of argillaceous substances than any other rock in the gorge. It is bright olive green in color, highly fissile, and very unctuous when wet.

The upper portion contains the interesting calcareous flattened pellets which Sanford (1935a, p. 175) compared with the size and thickness of a dime (see Plate IIA). He was puzzled by them. Under the microscope they are seen to be clay pellets, or balls, with a coating of calcite. The calcite appears to be an encrustation acquired by being rolled around in a lime mud. By compaction the balls became flat pellets.

Calcite occurs in every slide, as small rhombs. In contrast to the low birefracting clays, the calcite under cross nicols is brilliantly lighted and has been recrystallized. The rhombs are usually framed by illite flakes. Some of the calcite acts as cement.

Clastic quartz is always present. The percentage is naturally low with the high clay content. The quartz grains are universally small in size and very angular. With the low amount of quartz, the percentage of feldspar is less than a tenth of one per cent by weight. They, like the calcite, are usually framed by illite flakes.

The clays consist of kaolinite, montmorillonite, illite, and chlorite. It is the latter mineral that gives the rock its green color. There is some secondary muscovite, a few flakes of which have an illite core. A few slides exhibit a curious "basket weave" pattern. The pattern is oriented in respect to the bedding; most of the fibrous flakes are parallel to it; some are normal to it. The character of the clay of the Maplewood is microscopically very distinctive. It appears as a minor constituent in the Thorold, Brewer Dock, Furnaceville, and upper Reynales. It does not appear above the base of the Irondequoit.

Further information on the problem of the Neahga-Maplewood relationship was obtained from Cuylerville, 30 miles south of Rochester. Here 5.2 feet of bright olive green shale occupies this position. From hand specimens alone it could well be either Neahga or Maplewood, but on closer examination a 0.2-foot layer, four feet above the base, contains black-brown nodules of phosphate. The interesting thing is that a thin section of this layer shows, in addition to phosphate nodules, which consist of collophane, considerable recrystallized calcite and grains of detrital quartz of Thorold size, cemented with Maplewood type of clay. It was apparent that this rock was very similar to Sanford's (1935a, p. 173) unnamed bed one foot thick at the top of the Thorold (in his sense) at Niagara, which contained *Coelospira* and underlies Sanford's Neahga. If these microscopic discoveries are taken at their full value, it could be argued that at Cuylerville both the Maplewood, below, and the Neahga, above, occur, while only one rock, the Neahga at Niagara and the Maplewood at Rochester, are present. Perhaps too much has been read into this, probably after all it is the same formation, differing slightly in minor facies changes from locality to locality.

The Brewer Dock Member:—Between the green Maplewood and the red Furnaceville are 3 feet of gray calcareous beds with shaly partings. These have been sometimes confused with the underlying Maplewood but their similarity with the Reynales limestone above the Furnaceville has been well recognized. Chadwick (1918, pp. 342–343) called these three feet "Bear Creek." Sanford (1935a, p. 179) believed these do not correlate into the area of Bear Creek and consequently gave it a local name, "Brewer Dock." It serves well for the present.

The usual field expression, "limestone and shale," fails to indicate the true character of the rock. The composition of the Brewer Dock can be appreciated in terms of the three microlithologies: argillaceous, calcareous, and siliceous. This is shown in Fig. 3. The shaly layers are composite of three microlithologies. The two principal microphases present are the Maplewood clay microphase and the Reynales carbonate microphase. The former has been described; the characteristics of the latter consist of clear grains of calcite, many of which have been recrystallized but not to the extent of developing twinning bands. The presence of the clay substances seems to have prevented the formation of large-sized grains except near the top of the Reynales where the clay content is low. There are clastic grains of calcite as well. The microscopic character of the Reynales carbonate phase is shown in Plate IG.

The recognition of these two microphases illustrates the overlapping character of these rocks; the clay is like that below and the carbonate is like that above. It is the carbonates that obscure the green color of the chlorite and consequently the Brewer Dock is gray when fresh and buff when weathered.

Analysis of each of the shaly layers shows how the clay phase enters into the makeup of the rock. It will be noticed (Fig. 3) that the lowest shaly layer does not contain the maximum amount of clay but is rather low, while in the next higher layer a large amount occurs. From this point upward to the top of the member, the clay content diminishes at a fairly uniform rate and becomes the lowest in the Furnaceville. Of course, in percentage, the amounts of carbonates are complementary, greatest when the clay is lowest in amount.

In the limy layers the same story is repeated in somewhat the same manner; the lowest layer is relatively high in calcite. In the second layer the carbonate is very low only to increase to nearly 100% at the top, which in the next member above became the relatively clay-free lime rock which was the Furnaceville originally, before partly replaced by hematite.

The same pattern prevails in the Upper Reynales as will be shown later.

The thickness of these shaly layers likewise follows much the same pattern: thick at the bottom and thin at the top. The size of the recrystallized calcite in the limy layers, in the form of the mode, is small at the bottom and large just below the Furnaceville. These relations may be determined only through microscopic measurements.

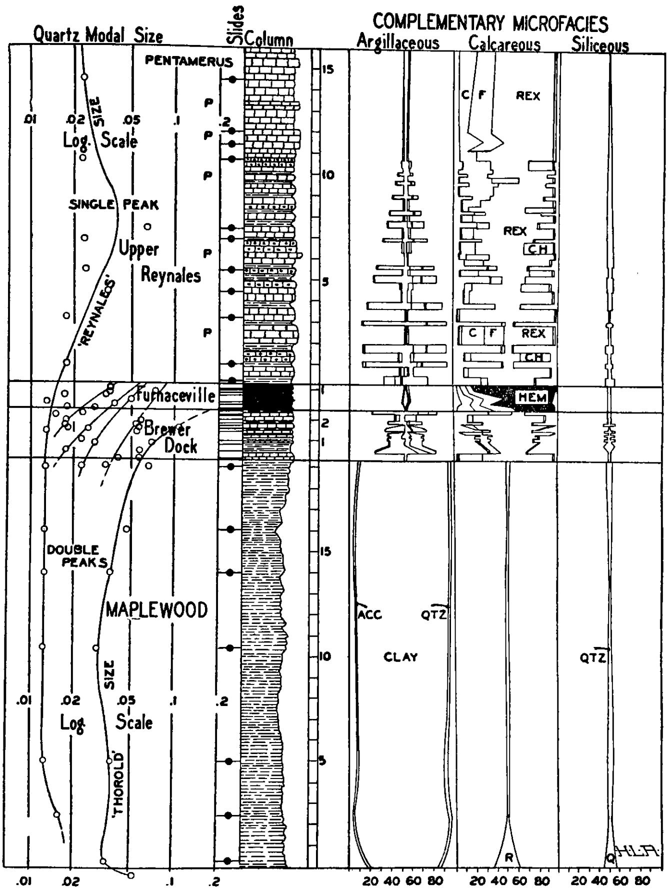

FIGURE 3

Maplewood, Brewer Dock, Furnaceville, Upper Reynales

Quartz modal size, measured in thin section. The frequency distribution curves of quartz grains of the Maplewood are double peaked. The larger size is called "Thorold size", the smaller, "Reynales size." The Brewer Dock and the Furnaceville show multiple peaks, showing mixed conditions. The Upper Reynales shows single-peaked curves.

Legend: C = clastic calcite, F = fossil calcite, Rex, R = recrystallized calcite, Ch = chert, HEM = hematite, Qtz. Q = quartz, P = *Pentamerus* layer.

The Furnaceville:—This hematite-rich rock is one of the red marks of distinction of the Clinton. These ores, while not outstanding in economic value in New York State, and which cannot now compete with the Adirondack magnetites, nevertheless made substantial contributions to the steel backbone of civilization in the early days. Researchers seeking their origin established the common custom of calling these the *Clinton type of ore.*

They are hematite ores. They are sedimentary rocks. Magmatic sources of iron were not available and hence the iron is sedimentary in origin. The chief question is whether the iron was supplied during deposition and diagenesis or was introduced afterward. It is the date when the hematite painted the rocks red that is in dispute. Geologists (Newland and Hartnagel, 1908; Smyth, 1892 and 1894) generally agree that the iron was probably derived from lateritic weathering and polluted the seas and dwarfed the fauna.

The Clinton ores were essentially limestones, with a remarkably low argillaceous and detrital quartz content. The calcite, to varying degrees, has been replaced by hematite, developing oölites, when colloidal chamosite was present, and when absent it formed "fossil" ore. In the Rochester Gorge the Furnaceville varies from .7 foot to 1.4 feet in thickness. It is a fossil "ore". Microscopically the rock is full of interesting and perplexing mineral relationships (see Plate IVG). Chamosite is visible in some slides, particularly from the top and at the bottom of the member. It may be present throughout the Furnaceville in small amounts but if so it is effectively obscured by the hematite so that identification is difficult. The calcite takes two forms: fossil fragments and as minute clastic grains. The fossils are fragments, many of which show considerable wear by water. The rock is essentially a paleocoquina rock. Bryozoans, little corals, and abundant sections of crinoid stems are common. Chadwick (1918, p. 344) has suggested that a wave-worn surface exists beneath the Furnaceville. Such a break may well occur; it, however, may be merely a diastem. It has been suggested that the rock was originally thicker, and what is seen today is a condensed form, implying a sort of downward enrichment by leaching of the upper layers of hematite. This is an interesting theory. The chart in Fig. 3 shows a higher hematite content at the top of the Furnaceville. This would seem to mean, if leaching occurred, that the downward enrichment did not enrich the bottom layers to the same extent as the top. The concentration of fossil fragments in the Furnaceville is not any greater than in other non-hematite zones in the Reynales. The dwarfed forms, however, make more fossils per unit volume.

The two major theories of the origin are: (A) that the ores are primary, deposited essentially in the same condition as they occur today except for compaction and diagenesis, and (B) that they were formed by replacement of original limestones by downward percolating waters which secured the iron in some form from areas of laterization. That is, the ore would be secondary. The implication is that one or the other of these theories, not both, is true. These statements are clear and distinct, but they are too definite to fit the facts.

There are implied concepts in these statements which may not be fully realized but that have an important bearing on the clarity of thinking. To an economic geologist "primary" and "secondary" mean more than first and second, more than a mere order of events. They have come, through usage, to convey something more. They are almost synonyms for syngenetic and epigenetic, respectively. The real obstacle is the word "replacement." It has an important place in the second theory. The word "replacement," apparently conveys the added thought that it can only occur as a secondary process. This is not necessarily so.

This investigation has proved that the earthy or cryptocrystalline hematite in the Furnaceville at Rochester has replaced to a large degree calcite formerly constituting fossil fragments, but it does not follow that the epigenetic hypothesis is thereby substantiated. There is much objection to referring to the second theory as the "replacement theory." The difficulty seems to be that replacement can well have been contemporaneous with and, indeed, may have been an essential part of the diagenesis of the rock. If so, the hematite is syngenetic in the sense of the first theory but it was brought about by replacement as well, an expression which is an important thought in the second theory. Smith * recognizes this syngenetic replacement in a slightly different manner by saying: "The ferruginous waters came in contact with calcareous shell fragments; . . . the iron was precipitated partly by reaction with the lime carbonate, yet mostly by oxidation, while the lime was carried off in solution by the aid of the carbon dioxide set free . . . This method of replacement is widely different from the other process of replacement that has been applied to the ores . . . The iron is a secondary product as regards the individual particles of ore, it is primary in relation to the ore bed itself."

There are therefore four aspects to the problem:

(1) Precipitation of the iron.
(2) Reaction with the calcite.
(3) Replacement of the calcite.
(4) Oxidation of the ore (if it occurred).

There is some danger in this separate listing as it gives the impression that all are independent events. They probably occurred together and are merely aspects of one and the same interlocking process.

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*Smith, C. H., Jr., quoted in translation by Newland (1908, p. 52).

The iron solutions or colloidal suspensions derived from areas supposedly distant, containing both potential hematite and chamosite, stabilized by organic acids would, in contact with the electrolytes of sea water, be precipitated. Reaction with, and replacement of, the calcite liberated lime which neutralized the organic acids, further promoting precipitation. If some of the iron was originally in the ferrous condition, oxidation occurred as well.

Twenhofel (1939, pp. 390–391) says: "Perhaps a combination of the view of original deposition and replacement shortly after deposition best meets the conditions to be explained. The fossil ores are certainly replacements."

From the occurrence of the ostracods, Gillette (1940, p. 49) reaches the conclusion that "the Furnaceville is a lithologic designation and carries no time connotation. It simply represents a condition . . . under which 'iron ore' was forming. It is highly probable that all the ore did not form contemporaneously."

It seems that the essential conditions for the formation of the Clinton iron ores were that they were limestones and at the same time iron-rich solutions were precipitated. The combination seems to have been necessary; neither factor alone was capable of producing them.

The hematitic beds are low in argillaceous substances and usually contain chert. When the clay content approaches ten per cent, or the chert is about twenty per cent, hematite does not occur. Iron, however, is not necessarily absent; it is in the form of pyrite, but not to an equal amount.

At Glen Edyth there is no hematite-bearing rock. There is about 1.4 feet of a cherty bed with pyrite, in the Furnaceville position. Hematite is absent, but is the Furnaceville absent? If it is, then what is called "Furnaceville" is a facies. If the Furnaceville is present then it is what Caster called a "stage" or perhaps, since it is a member of the Reynales formation, it is a "substage." This little problem subtends a major one for stratigraphers to straighten out some time. Gillette (1940, p. 49) comments that the Furnaceville is a "designation" which implies that it is a facies. I have called the rock at Glen Edyth "the gray Furnaceville." But the red ore reoccurs six miles further east at Fruitland. The ore is "pinched out" between Densmore Creek and Fruitland. Is the high clay or chert content sufficient to explain the absence of the hematite? The present investigation would suggest this as the cause.

The Upper Reynales:—Chadwick (1918, pp. 334–5) has shown that the limestone carrying *Pentamerus* in the Rochester Gorge is not the Wolcott as long supposed, but rather the Reynales. The name comes from Reynales Basin, eight miles east of Lockport. Miss Goldring (1931) regarded the Reynales formation as a tripartite limestone. Sanford (1935a,

p. 179) agreed but substituted the term "Brewer Dock member of the Reynales" for Chadwick's "Bear Creek." This is the basis for using the expression "Upper" Reynales.

In the Rochester Gorge it is not all limestone. Approximately the lower two-thirds of the upper Reynales contains shaly partings. These shaly beds are hybrids, best appreciated in terms of microlithologies. Field observations and studies of the thin sections have resulted in recognizing four lithologic types: (A) shaly partings, (B) non-*Pentamerus*-bearing limestones, (C) cherty beds, and (D) *Pentamerus* layers.

Gillette (1940, p. 51) has pointed out that there are six *Pentamerus* layers in the Genesee Gorge. However, they do not correlate from section to section but merely represent similar ecological conditions. Gillette, therefore, did not accept Sanford's (1935a, p. 177) attempts to show by the presence and absence of *Pentamerus* that the Reynales formation varies in age from place to place (Gillette, 1940, p. 53).

The Shaly Partings:—Thirteen shaly partings were recognized and measured in the Genesee Gorge. They do not consist solely of argillaceous matters; they are essentially mixtures of argillaceous and calcareous rocks. The percentage of the argillaceous microlithology in these shaly partings is low at the base, rapidly assumes large proportions, and then tapers gradually to extinction at about 10 feet above the base; theoretically at 12.4 feet (see chart, Fig. 3). The uppermost shale parting (9.7 feet above base) contains only 27%. There are no more such beds above this. The trend of the percentage of the argillaceous microlithology from that point upward is towards zero.

However, not all of the 27% is clay; the latter constitutes only 8%. This shows, unmistakably, that the term "shale" is not solely a compositional one. The amount of the shaly producing factors is the amount of clay, the kind of clay, cleavage, orientation, and grain size, and they are not gradational in their effects but sudden. Unfortunately the relations of these factors are not completely known.

The Non-Pentamerus-bearing Limestones:—These beds consist essentially of one microlithology composed of large amounts of recrystallized calcite, very small amounts of quartz, and accessory minerals. Fossil calcite makes its appearance 10.6 feet above the base. These fossils are not necessarily *Pentamerus*. Fossil calcite continues to the top of the formation. This new element in these limestones coincides with the reduction of the amount of the argillaceous microlithology. Of equal interest is the presence of clastic calcite in fair amounts co-existing with the fossil calcite. This indicates that some clastic calcite was derived from wear on the fossils themselves, probable due to wave abrasion in situ.

The Cherty Beds:—These cherty beds are confined to the lower two-thirds of the Upper Reynales, coinciding with abundant argillaceous microlithologies. The calcareous microlithology, even though the chert has been assigned to it, constitutes only eighty per cent. In other words, the cherty beds, in addition to the chert, contain up to 20% of the argillaceous microlithology. Chert and a definite amount of clay always go together, a relationship not revealed by the usual field observations. Has the clay provided the conditions favorable to the presence of the chert? Is it a case of providing just the right amount of permeability and adsorptiveness? Silica as a gel apparently was able to penetrate the rock in spite of the clay, became adsorbed and partially dehydrated, being trapped by the clay. The exact amount of clay seems critical. Either below or above 20% argillaceous microlithologies, or 4 to 5% clay, there is no chert.

The Pentamerus Layers:—Of course, paleontologically, these are the most interesting. Here the emphasis has been on attempts to decipher the paleoenvironment. Gillette's thesis is that they represent the same ecological conditions. In the first place they are nearly mono-microlithologic, composed of 95 to 100% of the calcareous microlithology. The amount of clay is always less than 3% in these beds.

In thin sections, in contrast to the impressions acquired from hand specimens, fossil fragments, chiefly those of *Pentamerus,* range consistently between 18 to 26% by weight of the rock, for the bulk of the calcite is recrystallized and clastic. Only in two cases is there more fossil calcite than clastic. The calcite inside two valves of a complete *Pentamerus* specimen is clastic. The same conditions obtain in the pearly layers of the Lower Sodus (see Plate IIJ).

There is no chert. The amount of quartz and accessory minerals is always low and fairly consistent in all six of the *Pentamerus* layers.

In the clay we apparently see the major controlling factor. It is less than 3%. Beds above this amount do not contain *Pentamerus*. Consequently, with a slight increase of clay, the correlative value of this brachiopod disappears.

Chadwick (1918, p. 345) says "Westward the Reynales . . . is persistent . . . but eastward it grades into shale, and finally [is] indistinguishable . . . from the Sodus shale above it." This relationship would become very striking in terms of complementary microlithologies, especially in graphic form.

The Lower Sodus:—Hartnagel (1907, p. 13) applied the name Sodus, but Chadwick (1918, p. 341) amended it to fit the proper unit in the Genesee Gorge, as Hartnagel, through Hall's error (1843), applied the name to the Maplewood; a case of mistaken identity. Ulrich and Bassler

(1923) divided the Sodus into two parts, largely on the basis of ostracods. To the upper part they attempted to restrict the name Sodus; the lower part they proposed to call the "Bear Creek." Gillette (1940, p. 54), however, believed that the choice of the latter name was unfortunate for several excellent reasons. Hence, to avoid "adding another name to the already overcrowded terminology," he proposed "Lower and Upper" Sodus. Only the Lower Sodus is present in the Genesee Gorge.

The Lower Sodus, like the Upper Sodus as well, consists of three lithologic types: (A) purple shaly beds, (B) green shaly beds, and (C) thin beds rich in *Coelospira hemispherica,* which are pearly layers. Unfortunately for clear thinking, (A) and (B) have been called "shales" and (C) limestone, giving the impression of great compositional differences between them. In terms of the actual composition, however, as plotted in terms of microlithologies in Fig. 4, the Lower Sodus is essentially a limestone. Thin sections of the Upper Sodus from the Clyde and Sodus Bay Quadrangles, acquired through the kindness of Dr. Gillette, suggest a slightly lower carbonate content. As can be seen, the chart shows quantitative data for understanding the cause of the shale structure; that is, there is sufficient clay to give the limestone a shaly structure.

The Purple and Green Layers:—The cause of the difference in color between the purple and green layers is somewhat obscure. Chlorite is undoubtedly the cause of the green tint, and dusty hematite adsorbed on the surface of the flaky clay minerals is the reason for the purple coloring. How much is original and how much, if any, is due to subsequent weathering is uncertain. This is another illustration of the same problem: red versus green color in sedimentary rocks.

The Pearly Layers:—A common expression found in the descriptions of these layers is that they are "composed entirely of *Coelospira hemisphaerica.*" (Gillette, 1940, p. 57). Certainly hand specimens give this impression. The microscope shows otherwise. Fossil calcite, definitely assignable to this brachiopod, constitutes only from 21 to 32% by weight. Both recrystallized and clastic calcite are present in considerable quantities. Much of the latter occurs inside bivalves and is packed around them (see Plate IIJ). The layers are lenses and do not have any horizontal continuity. Certainly they do not correlate from section to section. They are similar in composition and clay content to the *Pentamerus* layers of the Reynales.

The Pearly Layers contrast with the *Pentamerus* Layers of the Reynales, of course, in the fossil content. Here the question is raised, are there sufficient differences to suggest the ecological reasons for the differences in the organisms? The *Pentamerus* layers are lower in the argillaceous microlithology and in clay. *Coelospira hemispherica* does occur in shaly beds as well as in the Pearly Layers, while *Pentamerus oblongus* does not. The critical argillaceous microlithology content that separates the two is evidently about 12% (see Fig. 6C). The other major difference between the two is that there is more fossil calcite in the Pearly Layers, 21.3 to 31.8%. This is due to the closer packing of the smaller shells of *Coelospira.*

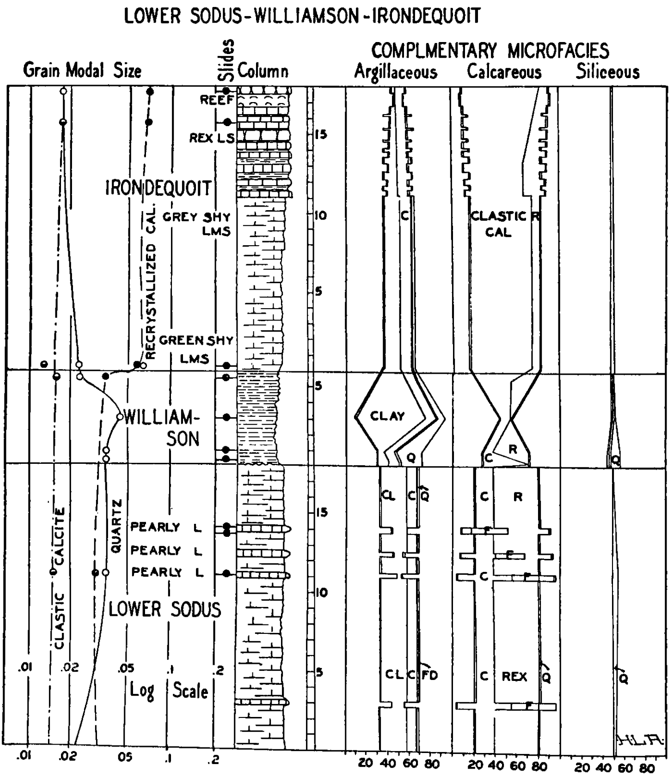


FIGURE 4

Lower Sodus-Williamson-Irondequoit Formations

Grain modal size, measured in thin section. Quartz size is that of the Reynales. Legend: Cl, C = clastic calcite, Rex, R = recrystallized calcite, F = fossil calcite, Q = quartz.

This shows that *Pentamerus* requires a virtually clay-free environment, while *Coelospira* can endure some. It does not explain why *Coelospira* does not occur along with *Pentamerus* in equal amounts. To be sure, *Coelospira* is found in the *Pentamerus* layer but apparently never to the dominating extent of the latter. Both of these fossils are obviously facies fossils. This is apparently the principal reason why ostracods are regarded so highly; they are more independent of the type rock in which they are found.

The Williamson:—The Williamson, named by Hartnagel (1907, pp. 15–16) and restricted by Chadwick (1918, p. 348), with its graptolites is so strikingly different in color from the underlying Lower Sodus and the overlying Irondequoit, that it comes as a surprise to find that most of the Williamson is essentially a limestone, perhaps not to the extent possessed by the Lower Sodus, as it contains considerable quartz. The presence of so much quartz means that a new element has entered into these sediments. This change in composition coincides with the unconformity at the base of the Williamson; the Upper Sodus, the Wolcott, and the Wolcott-Furnace are absent at Rochester. The Williamson is more variable than is generally apparent. The rock ranges from dark olive green to jet black in color, with very thin, gray-blue limestones with *Plectambonites transversalis,* a rock which is similar to that containing the *Pentamerus* and to the Pearly Layers. Some layers, as above noted, are almost quartz siltstones. There are also some pebbly beds which some call conglomerates. The Williamson apparently represents an unstable and a new phase in the sedimentation of the rocks at Rochester, with very rapid oscillations and pulsations.

The graptolites are in thin, black seams interbedded between the argillaceous siliceous limestones. In composition, the graptolites themselves appear to be chitin stained by black iron sulphides and organic matter. So effective is this stain that the general impression is that the Williamson at Rochester is a "black shale." So conclusive are the microscopic findings, however, that the Williamson is essentially an argillaceous siliceous limestone, dark gray to blue gray in color, that discussions regarding the habitat of graptolites, which ignore the limy nature of the rock, may not be highly significant. The slides of graptolite "black shale" show that the organisms are confined to bands averaging less than 0.2 mm. thick. The rock only splits along these bands because they, and they only, have enough clay to be shaly. Associated with the remains of the graptolites, chiefly *Monograptus clintonensis,* are small grains and aggregates of pyrite, or what are now pyrite. This type of pyrite is usually regarded as "primary". Megascopically there are discs with radiating structures up to 25 mm. in diameter along the bedding planes. These are "secondary". Both appear to have been derived from black iron sulphides.

Under reflected light both types are seen to be heterogeneous in color and in structure. These grains and discs are not solely marcasite nor pyrite, but both in varying amounts. In spite of this change the "blackness of color . . . persists after the black sulphides of iron become marcasite or pyrite." (Twenhofel, 1939, p. 304.)

The Irondequoit:—The 18 feet of rock assigned to the Irondequoit provide six lithologic types: (A) at the base green shaly limestone usually called green "shale", (B) the middle portion of gray shaly limestone, commonly referred to as gray "shale", (C) thin to relatively thick limestone layers, (D) gray shaly limestone partings with much the same composition as (B), (E) the coarsely recrystallized limestone with a lower clay content than (C), inappropriately called "crystalline" limestone, and (F) the Bryozoan reef near the top.

It is clear that much the same kind of rhythmic sedimentation that characterizes the Upper Reynales prevailed in the Irondequoit as well. It began with argillaceous material, rich in chlorite. The clay gradually increased in amount and the rock is gray in color with a loss of chlorite or its submergence by the clay. Beginning at 11 feet from the base, thin limestones separated by shaly partings prevail up to 14 feet above the base. Then the lower, coarsely recrystallized limestone bed occurs. Above this the thin shaly partings are thinner and separated from each other by greater distances. Above 16.4 feet no more shaly partings occur. At 17 feet the interesting reef underlies the upper coarsely recrystallized limestone.

These microlithologies point the way to the concept of two parvafacies: the shaly facies and the limestone facies. But the two are separated by a zone of interbedding or interfingering. This can be seen in the field. On correlating the Irondequoit westward it is found that the limestone parvafacies dominates, while to the east it is shaly parvafacies that is most abundant. It would appear that they are complementary to each other. To the east the shaly parvafacies increases in thickness at a faster rate than the thickening of the limestone parvafacies. Each parvafacies appears to contain its own faunal characteristics.

Microscopic examination reveals traces of sulphate minerals, such as anhydrite, gypsum, barite, and celestite. These have been identified with difficulty. Galena was suspected in one slide. All of these minerals are in traces and not as abundant as they are in the overlying Lockport. The small grain size of the clay constituents suggests a slight increase in the saline character of the Irondequoit sea, which shows more abundantly in the Rochester, and even more so in the Lockport. The slightly magnesian content of the Irondequoit is regarded as in conformity with this suggestion.

In the field the contact between the Williamson and the Irondequoit is difficult to draw because of the shaly nature of the base of the latter. Especially to the east, "most of the workers in the past have considered that the Irondequoit included only the limestone," (Gillette, 1940, p. 77) and hence included the gray shaly beds with the Williamson. Gillette, however, assigns the gray shaly beds, which contrast with the dark olive-green beds, to the Irondequoit. These gray shaly beds are "transition" beds. Many stratigraphers at times seem to be reluctant to admit that such beds exist. It is as though the classification must be maintained; the boundaries between formations must be made sharp and clear, in spite of the field facts. The Irondequoit is an illustration. The common practice of a dual nomenclature, "Irondequoit limestone", often leads to the confusion. It will be noticed that this paper does not use dual names.

The Lockport Clay Microphase:—These lower beds contain a new phase, not before encountered. From the top portion of the Grimsby to the top of the Williamson the clay content is the Maplewood microphase. In the basal Irondequoit the clay is in very small units, just visible with an oil immersion objective, and is seen inside rather than outside the calcite grains. This is clay-clotted calcite. This microphase, called the Lockport, is characteristic of the Irondequoit, of the Rochester, and of the Lockport formations.

The Irondequoit is allied to the Rochester petrographically. Gillette (1940, p. 85) has shown that the faunal content of the limestone portions of the Irondequoit are in many instances quite different from those in shaly portions. Many of the latter are identical with those in the Rochester. In fact, he assigns the Rochester to the Clinton, differing from Chadwick (1918, p. 354) who excludes it, partly on this basis.

The Lower Irondequoit:—The Delésse-Rosiwal analysis of slides of the 13.7 feet of green and gray shaly beds of the lower Irondequoit are similar to the shaly partings in the upper part of the Reynales.

The calcareous minerals are finer-grained in the Irondequoit and contain the internal form of clay (Lockport clay microphase). The clay of the shaly Reynales is of the Maplewood type which is dominated by the white mica (illite), while the clay of the Irondequoit is chiefly of the kaolin and chlorite groups.

It will be noted that the amount of the argillaceous microlithology in the shaly Irondequoit, 29.9%, is nearly the same figure as that of the argillaceous microlithology content of the uppermost shaly partings of the Upper Reynales.

In terms of the amount of clay, however, the two are somewhat different; 19.1% for the shaly Irondequoit and 9.0% for the shaly partings

TABLE 2

Microlithologic Analysis of Lower Irondequoit and Shaly Partings in Upper Reynales

	Argillaceous Microlithology						Calcareous Microlithology							Siliceous Microlithology			
	Qtz	Fd	Clast Cal	Clay	Acc	Total	Qtz	Fd	Rex	Clast Cal	FF	Acc	Total	Qtz	Fd	Acc	Total
Shaly Irondequoit . .	.5	1.	10.	19.1*	.2	29.9	.2	–	6.	59.	2.8	.1	68.1	1.4	.1	.5	2.0
Shaly Reynales	8.0	.5	10.	9.0°	.7	28.2	1.0	.2	6.7	62.4	0	1.0	70.4	1.0	.1	.3	1.4

* Lockport clay microphase type
° Maplewood clay microphase type
Fd=Feldspar, FF=Fossil Fragments

Qtz=Quartz
Rex=Recrystallized calcite
Acc=Accessory minerals

of the Reynales. A greater similarity actually exists, however, when it is realized that there is a very different type of clay in the two rocks; the "internal" type in the shaly Irondequoit, and the "external" type in the shaly partings of the Reynales. The 19.1% of the former, because it is inside of the calcite, is not in a position to be as effective in producing the shale structure, hence it takes more of it to accomplish this. Both rocks have about the same degree of shaliness even though the clay content of the two differs. Consequently the physical environment for the organisms may have been essentially the same. Gillette (1940, p. 85) says: "In lithology the highest shale layers [of the Irondequoit] resemble the Rochester."

The Upper Irondequoit:—The upper portion of the formation is not all limestone, as the gray shaly beds continue to near the top as shaly partings. The limestone beds are fine-grained. The mode size of the recrystallized calcite is .07 mm., while that of the clastic calcite is .0175 mm. The small grain size of the former is in great contrast to the very large grains of recrystallized calcite in the non-*Pentamerus*-bearing Reynales, the mode of which is .325 mm. However, there is a light-colored limestone .4 feet thick near the top of the Irondequoit, with abundant recrystallized calcite, which has been referred to as "crystalline", that contains recrystallized calcite with a mode grain size of .225 mm.

The Bryozoan Reef:—Sarle (1901) pointed out that the bryozoan reef near the top of the Irondequoit is composed almost entirely of *Fistulopora tuberculosa* and *F. crustula*. Under the microscope the rock is very fine-grained. The mode of the clastic calcite grain size is less than .005 mm., which serves as a groundmass in which are set occasional phenocrysts of recrystallized calcite and fossil forms. The groundmass is what Grabau called a calcilutite. These reefs arch up the overlying beds of the Irondequoit and of the Rochester as well.

The Rochester:—Petrographically the Rochester and the Lockport are much alike. To obtain quantitative results with the microscope has been difficult because the clay content is not readily discernible. Examination with high magnifications reveals that the clay is in such small units that much is suspected as being submicroscopic in size and not measurable. Hence chemical analyses were resorted to but they were not completely satisfactory because they needed recalculation into probable minerals before comparisons could be made.

A chemical analysis of the Rochester formation from Rochester, presumably from a publication of the United States Geological Survey, was recast years ago as follows:

TABLE 3

Recast of Chemical Analysis of the Rochester *

Quartz	11.6
Microcline	4.0
Plagioclase	2.5
Calcite	36.0
Magnesite	8.5
White Mica	23.2
Kaolinite	10.0
Chlorite	2.7
Accessory	1.5
	100.0

* Lantern Slide, University of Rochester, Department of Geology.

On this basis it will be seen that the quartz, the feldspars, and the clays, together with the accessory minerals, total more than half the rock, a finding not revealed by the microscope.

The other two analyses available are from Hamilton, Ontario, which, because of the distance from Rochester, are of little value to the immediate problem.

TABLE 4

Chemical Analyses of Rochester Formation, Hamilton, Ontario *

	I	II
SiO_2	22.00	22.52
Al_2O_3	12.65	8.12
FeO	1.77	1.13
Fe_2O_3	0.46	1.01
CaO	20.81	21.83
MgO	7.77	10.14
H_2O	7.20	4.00
	72.66	68.75
°CO_2	27.34	31.25

° By difference, added by author
I. 3 feet above base
II. Upper 4 feet.

* Analysis by Mines Branch, Department of Mines, Ottawa. Given by M. Y. Williams (1919).

Attempts to recast these reveal that there are several ways these analyses may be treated. The nondetermination of the alkalies prevents calculation of any feldspars and white micas. Nevertheless the clay content ranges from 35% to nearly 40%. Consequently, insoluble residues were resorted to. Perfectly consistent results were difficult to obtain, probably due to the destruction and partial solubility of minute clay particles and the production of colloid suspensions. This is especially true if there is any beidellite type of clay mineral present and boiling hydrochloric acid is used (Grim, et al., 1937).

The results of measurements of the clay content were consequently increased by deducting 20% from the value of the clastic calcite and adding that amount to that of clay. This was done to the analyses of the fossiliferous and barren zones. In the case of the "Gates" the figure was reduced to 10% as the rock does not possess such a shaly structure.

Under the microscope the Rochester is seen as an aggregate of magnesian calcite, usually small, with modes ranging from .03 to .09 mm., in size, dirty and clotted by kaolinite type of clay, black sulphides of iron and ferric oxides from decomposed pyrite (see Plate IVJ and K). Some grains are slightly recrystallized, but the gradation from clastic to recrystallized is so continuous that any division into the two types would be purely arbitrary.

Pyrite and leucoxene are very abundant but as they are small grains they do not bulk large.

Paleontologically the Rochester can be divided into three parts: a lower, fossiliferous portion, a middle barren section, and the upper part with some fossils. This upper portion has received the local designation of "Gates limestone" by Chadwick (1918, pp. 335–364).

Petrographically the Rochester is a dolomitic limestone with a shaly structure. In detail it consists of thin to heavy-bedded layers of dolomitic limestone separated by numerous shaly partings. These two types are somewhat similar to each other, both in appearance and in composition.

In terms of the three complementary microlithologies, as in the chart, Fig. 5, the similarity of the three paleontological divisions is obvious. The lower fossiliferous portion has a slightly lower argillaceous microlithology content than the barren zone, with 24% recrystallized calcite and about 6% fossil calcite. The barren zone possesses a slightly higher argillaceous content, the fossil content falls off to zero.

In the upper portion the argillaceous microlithology is low, ranging from 10 to 14%. This permits the calcareous microlithology to increase from 75%, average of the barren zone, to about 85%.

So potent is the effect of the argillaceous microlithology in producing a shaly structure that the slight decrease from that in the barren zone to that in the upper zone results in sufficient differences so the rock has been regarded as distinct from the underlying barren zone. Chadwick (1918, p. 360) says it is "separated from . . . [the beds] below by a perfectly clean cut line or clay seam" and gave it the name "Gates limestone." He says it is apparently missing at Niagara. Gillette does not mention it. Chadwick's "clay seam" is one of the many shaly partings that are characteristic of the whole of the Rochester.

The upper zone is somewhat similar to the top limestone zones of the Upper Reynales and the Irondequoit. If the top limestone of the Rochester formation deserves a special name, why not the others as well?

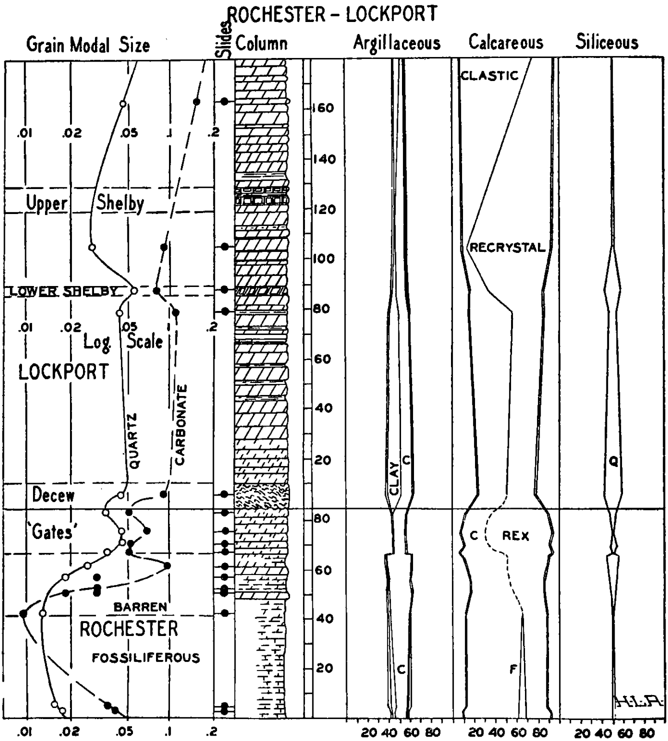


FIGURE 5

Rochester-Lockport Formations

Grain modal size, measured in thin section. Quartz and carbonate. Position of the Shelby zones only approximate.

Legend: C = Clastic carbonate, F = Fossil carbonate,
Rex = Recrystallized carbonate, Q = Quartz.

The term "Gates," in the sense proposed by Chadwick, is a formation, for he says it is "separated from the Rochester shale [restricted] below," that is, he wants to restrict the term Rochester to the fossiliferous and to the barren zones in order to erect a new formational unit. His reason for advocating this is that the rock is really a limestone which has been quarried and sold as such (Schuchert, 1914, p. 304). It has in years past been used for lime. But so is the rest of the Rochester a limestone, with a shaly structure. A more practical method would be to regard the "Gates" as a member of the Rochester.

Actually the "Gates" is a rock facies. The retention of the name "Gates", as a formation or as a member of the Rochester, is deemed inadvisable.

The Lockport:—The Barge Canal, west of Rochester, provides an excellent exposure of the Lockport. The structure of the rocks, which involves two anticlines and a fault, necessitated a plane table survey in order to accurately place the collected specimens in the geologic column. For this I am indebted to C. M. Reed and A. S. Gale, Jr. The base of the Lockport is represented by the Decew member, named by Kindle (1914), which varies from 2 to 10 feet in thickness. It is a dark gray, argillaceous, cross-bedded, dolomitic limestone with a churned or "curly" structure. Williams (1913) reports that it is difficult to separate it from the Rochester. On the other hand, Chadwick has long emphasized the unconformity at the base (Swartz, 1942, p. 535), even granting that some of the material of the Decew may be reworked Rochester. That such a break does occur here, I am convinced, but as to its magnitude, I have no new contribution to make.* Schuchert (1914, p. 304) says "Time break, if any, [was] short." In the winter the ice on the surface of the Barge Canal provides an excellent vantage point to see a wide exposure of the contact. It is unquestionably undulatory. The Decew sags down into slight hollows in the uppermost Rochester ("Gates"). A narrow outcrop does not reveal it. Gillette could not see the unconformity at Lockport, although he made a special trip to that locality. Petrographically the Decew is much like the underlying Rochester and the overlying Lockport. The sedimentation was, essentially, continuous. Slides of the Decew reveal more quartz than most of these rocks; except for this mineral the rock is very similar.

The classification of the 175–180 feet of rock calls for a brief review. As long as the Clinton was recognized as a "formation" then the Lockport is one also. As the Clinton is now recognized as a "group," the question arises, to what group does the Lockport belong? This is an old problem. The term "Lockport group" is rejected by the United States Geological Survey. Gillette (1940, p. 97) says many authors do not consider it necessary to use a group name. This is satisfactory as long as the Guelph is considered to be a part of the Lockport. But some geologists regard the Guelph as a separate formation overlying the Lockport, particularly in Ontario (Shaw, 1937), but in New York State the United States Geological Survey assigns the beds containing the Guelph fossils

* This is an old problem, to which many have contributed. It need not be rediscussed here.

to an indivisible portion of the upper part of the Lockport dolomite. Still this does not answer the fundamental question: Is the Guelph a fauna only? Or is it a member of the Lockport? Or is it a rock facies in which the Guelph fauna exist? Hartnagel (1907) says the Shelby dolomite in the Guelph dolomite "is to be regarded both as a faunistic and a lithologic Guelph element in the succession of the strata." Swartz, et al., (1942) say: "The typical Guelph fauna has not been observed east of Wayne County, New York. Whether this means a hiatus or simply a change in facies cannot here be affirmed." Arey (1892) was the first to recognize the Guelph in the Rochester region. Clarke and Ruedemann (1903) noted that these fossils occur in two beds, called the Lower and Upper Shelby, respectively. They gave the following section from Oak Orchard creek, south of Shelby village, in the southwest township of Orleans County, New York:

(Top)

4. Upper Shelby dolomite	8–10 feet	
3. Lockport dolomite	32 "	
2. Lower Shelby dolomite	3 "	
1. Lockport dolomites	62+ "	(largely covered)

(Base)

This section is some 37 miles west of Rochester. Hartnagel (1907, p 20), however, gave the above section as probably similar to that of the Rochester region, and stated (1907, p. 24) that the total thickness of the Lockport, including the Guelph, "is not far from 130 feet," which is probably too low a figure. Chadwick (1917, p. 172) has furnished additional measurements. From the top down, 90 feet of Guelph, which includes six feet of Eramosa beds; below this are "60 feet plus possibly 15 feet, as yet unexcavated." He gives 10 feet to the Decew beds. These figures total 175 feet, a value very close to that measured by him aided by students along the Barge Canal and given on a chart in the University of Rochester. Reed and Gale, by their plane table survey, measured 180 feet.

I have used the figure of 180 feet and have approximated the positions of the Guelph fauna-bearing beds on the chart, Fig. 5. There is still much uncertainty regarding the exact position of these paleontologically interesting beds in the Rochester region.

Reed's (1936) microscopic studies of the insoluble residues of the Lockport furnished his basis for dividing the Lockport as a whole into four divisions: the lower two corresponding to the "undivided Lockport"; division III is the Eramosa member of Williams (1919) and number IV is the Guelph, which conformably overlies. The Eramosa is Williams' top member of the Lockport in Ontario; the Gasport member of Niagara underlies. Reconciliation of Hartnagel's and Reed's sections can be effected by regarding the 62 feet of Hartnagel as only a portion of the thickness of the Lockport below the lower Shelby. The true value is about 85 feet.

In terms of complementary microlithologies, the Lockport is quite similar to the underlying Rochester. It differs in a slightly lower argillaceous microlithology content, dropping below the critical amount for producing a shaly rock. The rock contains more magnesia and is essentially a dolomite. Van Tuyl (1916) has expressed the view that the dolomite of the Lockport is primary and directly connected with the increased salinity that culminated in the Salina salt deposits.

Slides of the rock in which the lower Guelph fauna occurs show some chert; otherwise the rock is about the same as the upper portions of the Lockport.

VIII. PREFERRED COMPOSITIONAL RANGES

The quantitative microscopic analyses of these rocks provide some information regarding the physical environment prevailing at the time the various organisms, now preserved as fossils, inhabited these seas. The microscope cannot provide all the information desired, however, any more than the fossils themselves furnish all we would like to know. The rocks are not photographs of these vanished conditions for they have been changed by additions and subtractions. Sedimentary rocks are not closed systems.

Thin sections have been cut from rock specimens containing fossils. The composition of these rocks, when analyzed and plotted, clearly shows that there are *preferred* compositions. In Figure 6 the three-fold complementary microlithologies are plotted on equilateral triangular graphs. More could have been accomplished with this method if paleontologists were in the habit of reporting the exact horizons from which fossils were collected. An exception is the data of Sarle (1906) and of Schuchert (1914).

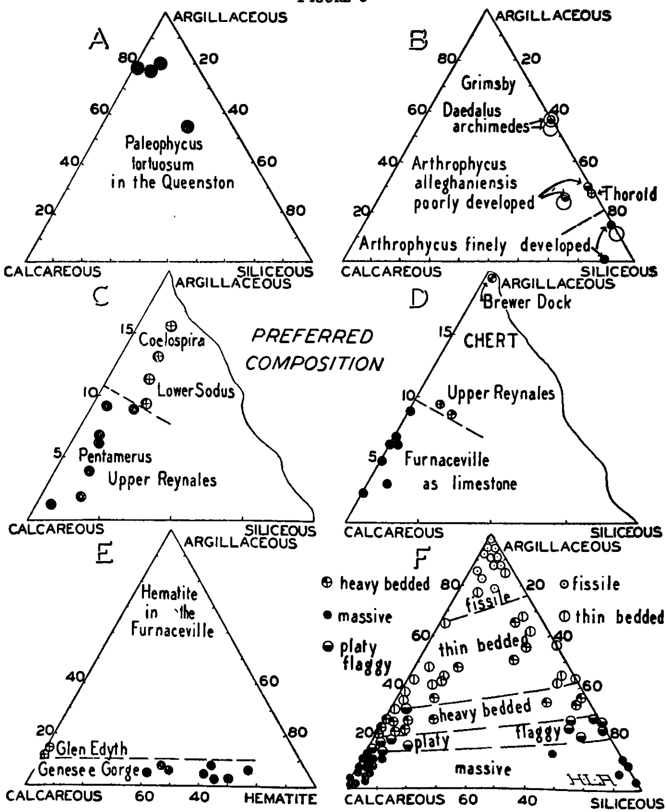
Environment in terms of rock compositions is, of course, only one of the many factors affecting the type and kind of organism. Purely paleontological discussions are left to those better qualified. It was found, however, that a rock type within the same range as the preferred composition frequently occurs without fossils. These specimens have not been plotted as they would not add anything of value.

In addition to the fossil habitates in this sense, there are mineralogical preferences as well; for example, of chert and of hematite. These are plotted in Figs 6D and 6E.

E. W. Berry (1925), writing on correlation, says: "To me the study of paleontology includes the environment, both organic and inorganic, and it is quite futile to consider fauna and flora as apart from the theater of life in which they played their part."

The biologic effect of these preferred ranges upon the organisms themselves is beyond the scope of this paper. However, certain conclusions are possible. The effect of the environment as reflected by the mineral composition of the rocks is much more important than formerly realized. In other words, the rocks, or rather the conditions under which these rocks were made, governed and controlled the kind of megascopic fossils. All the fossils included in this study are facies fauna. They can be used to correlate similar facies. Their value as index fossils for the correlation of contemporaneous formations is consequently not high. Microscopic forms, especially the ostracods, are not affected by their en-

FIGURE 6



vironments anywhere to the same extent as the larger forms, hence they are of much more value.

IX. SUMMARY

The rocks investigated and discussed in this paper range from the summit beds of the Queenston up through and including the Lockport. Sanford (1939) says: "The formations fall into three divisions: the first, in which a terrestrial influence is strongly felt, includes the Queenston, Cataract, and Albion; the second, which is marked by variability, is composed of formations lying between the top of the Thorold and the top of the Williamson; and the third, which is made up of the Irondequoit, the Rochester and Lockport, is dominated by a marine influence." This threefold division is based upon paleogeography in terms of uplift, transgression, and regression.

The microscopic studies emphasize a tripartite division as well. The bases for these three divisions are the complementary microlithologies and the microphases. This is given in Table 5.

A comparison of the two classifications shows them to be the same. This identity is more significant when it is realized that they were constructed entirely independently and on totally different bases.

There are two cases that lack clean separation in Table 5, the Thorold and the Irondequoit. The former belongs to Division I as seen by the x's in column 2. But note the x's in columns 6 and 8 which characterize Division II. The Thorold therefore has some properties of both. The Thorold is placed in the Clinton by some and excluded by others. The finding of the little stringer of "ore" is a petrographic discovery which tips the scales to a Clinton age. The Thorold is, however, transitional.

FIGURE 6

Preferred composition in terms of three complementary microlithologies measured in thin section.

A. *Paleophycus tortuosum* in the Queenston, Genesee Gorge, occurs in highly argillaceous rocks ranging from thin-bedded to fissile in shaliness.

B. *Daedalus archimedes* and *Arthrophycus alleghaniensis* in the Grimsby and Thorold, Genesee Gorge.

C. *Coelospira hemispherica* in the Lower Sodus and *Pentamerus oblongus* in the Upper Reynales, Genesee Gorge. Truncated triangle. The *Pentamerus* layers are lower in the argillaceous microlithology.

D. Chert-bearing beds, Furnaceville, Brewer Dock, and Upper Reynales. Truncated triangle. The Furnaceville calculated as limestone.

E. Hematite in the Furnaceville. Specimens from the Gorge contain hematite, and less than ten percent of argillaceous microlithology. Those from Glen Edyth contain no hematite and more than ten percent of the same microlithology.

F. Plot of 90 specimens of sedimentary rocks from the Rochester region in terms of shaliness as determined by inspection of hand specimens. The dashed lines are "contours of shaliness." 85 percent of the area of the triangle are "shales." Siliceous content reduces shaliness as is shown by the slant of the "contours" towards the calcareous corner.

TABLE 5

Tripartite Division by Petrologic Analysis

	1	2	3	4	5	6	7	8	9
	Tri-partite division	Essentially silic. and argill.	Essentially calcitic and argill.	Essentially dolomitic and argill.	Queenston type of clay	Maplewood type of clay	Lockport type of clay	Reynales type of calcite	Lockport type of dolomite
Lockport				x			x		x
Rochester	III			x			x		x
Irondequoit			x				x	x Minor	x Minor
Williamson		x	x			x		x	
Lower Sodus	II		x			x		x	
Reynales			x			x		x	
Maplewood			x			x		x	
Thorold		x				x		x	
Grimsby	I	x			Lower Portion	Top only			
Queenston		x			x				

The boundary line, whether on top or at the bottom of the Thorold, is arbitrary. An alternative plane of demarcation would be the unstable zone near the top of the Grimsby, 38 to 41 feet above the base. The Queenston clay microphase is limited to beds below this zone. The Maplewood clay microphase occurs only above it. This zone may prove to be more significant than it appears to be at present.

The Irondequoit is likewise transitional. Sanford goes further and names three divisions: I, Medina group, II, Clinton group, and III, Niagara group. But excluding the Irondequoit and the Rochester from the Clinton group satisfied neither Chadwick (1918) nor Gillette (1940), each for different reasons.

All agree that drawing the upper limit of the Clinton group is difficult. It is concluded that it, too, is arbitrary. The limits to the groups are in reality artificial. The rocks are gradational.

The name "Clinton" is satisfactory in a general way, however. To the writer there are many problems of greater importance than discussing the exact arbitrary limits of the group.

An igneous rock petrographer studying thin sections of these sediments is tempted to apply methods and nomenclature with which he is familiar. To him shaly rocks are foliated rocks possessing a depositional fabric but carrying no connotation as to composition.

These rocks possess compositional, structural, textural, and fabric characteristics that, if they were igneous, could be called by such terms as "Queenstonite", "Thoroldite", "Reynalesite", etc. Heaven forbid! But the rocks *themselves* deserve study, and thin sections provide the means.

Discussions regarding the diagenesis of these rocks must be tentative. Much has been removed from these rocks. Among the missing minerals are garnet, the clinopyroxenes, the amphiboles, the olivines, etc. Recrystallization has affected a good deal of the carbonate and the hematite. Silica has been added and now occurs as quartz cement in the siliceous siltstones, as chert in the limestones. Hematite has been added to form the Clinton ores. Many minerals have been autogenously "enlarged." In a narrow sense these rocks have been anamorphosed. They are immeasurably more complex than igneous rocks. Much more remains to be done. The sedimentation of these rocks shows gradational changes that cross the formational boundaries. Sudden changes, such as a shaly parting, occur only after a slow and gradual "build up." In the Grimsby the unstable zone occurs at the point of maximum quartz content.

The limestone units, the Brewer Dock, the Upper Reynales, the Irondequoit, and the Rochester have summits of limestone, bases of argillaceous substances, and middle zones of interfingering of the facies types, each one of which may carry a distinctive fauna.

X. CONCLUSIONS

1. The study of petrographic thin sections of consolidated sediments reveals much that is obtainable in no other way. A satisfactory study of heavy minerals is also possible by this means.

2. Thin sections provide adequate samples for Delésse-Rosiwal analyses, measurements for grain size, grain roundness, and grain circularity in two dimensions.

3. The mineral composition of these rocks is best understood by calculating the three complementary microlithologies: argillaceous, calcareous, and siliceous. These can be plotted on triangular graphs.

4. The plotting of these complementary microlithologies alongside the geologic column reveals the true nature of the rocks.

5. The usual nomenclature of sedimentary rocks is inadequate. The term "shale" does not express the mineral composition, but is a structural characteristic. The composition of these sedimentary rocks is here expressed by referring to them as argillaceous, calcareous, and siliceous rocks. "Sandstone" is a textural term, implying size only. Many of the rocks, including most of the Grimsby and Thorold, are siltstones.

6. The frequency-distribution curves of quartz grains, measured in thin section, commonly are multiple peaked. The peaks are regarded as corresponding to different complementary microlithologies.

7. Certain minerals and their fabric relations and distribution constitute microphases. The following were recognized: (A) the Maplewood clay microphase, (B) the Queenston clay microphase, (C) the Reynales calcite microphase, (D) the Lockport dolomite microphase, and (E) the Lockport clay microphase. These cross formational boundaries.

8. Petrographically, the sedimentary rocks in the Rochester area are gradational. The formational boundaries are to a certain extent artificial. Formations are very convenient but not fundamental.

9. Several of the microscopic fossils have been found to be confined to rocks with a very limited range in mineral composition. These are facies fossils, the correlative value of which is restricted to similar facies. The ostracods are a notable exception as emphasized by Gillette.

10. Shaliness of rocks is expressed by the terms massive, platy, flaggy, heavy-bedded, thin-bedded, and fissile, as related to the composition in terms of three complementary microlithologies, as plotted in Fig. 6F. Eighty-five percent of the area of the triangular plot are shaly.

11. The erection of more "formational" units, such as the "Kodak" and the "Gates", is not encouraged until more is known about the facies. These appear to be parvafacies, not formations.

12. The percentage of feldspar rises with the amount of quartz to a

maximum of 57% of the latter and then falls off. A flood of quartz depresses the feldspar content.

13. The rocks here studied are notable for the minerals that are absent. Garnet is rare, the clinopyroxenes, the amphiboles, and the olivines are missing. These rocks must have been subject to long leaching since the Paleozoic. The permeability varied from layer to layer, consequently this leaching was selective.

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THE VEGETATION OF BERGEN SWAMP

I. The Vascular Plants

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BERGEN SWAMP

A place where one may still see Nature at work and learn some of her lessons and secrets.

A small wilderness of quiet recesses, copses and canopies where one may sojourn in undisturbed solitude for inspiration and stimulus for the future.

An heritage from the past with the possibility of linking the present with the future until both shall have become a part of the dim past.

A small group of pioneers who recognized an obligation of the present generation, a few years ago organized the Bergen Swamp Preservation Society to save Bergen Swamp for future generations.

This brief account of the results of some explorations of its rich vegetation was stimulated by the efforts of these pioneers.

If it interests new recruits to join their ranks, future generations will be grateful.

CONTENTS

INTRODUCTION

Bergen Swamp has been known and tramped through by naturalists for nearly a century. With the early history of its exploration are associated the names of C. M. Booth, G. T. Fish, G. W. Clinton, J. H. Paine, Jr., S. M. Bradley, D. F. Day, C. H. Peck and others.[3, 6] Among the later botanists who explored and collected in the swamp are W. H. Lennon, M. S. Baxter, H. D. House, W. D. Merrill, F. W. Johnson, E. P. Killip, and P. A. Stewart.

In 1864 Paine[1] mentioned 38 species of plants from Bergen Swamp. These were again listed in 1925 by Baxter and House[4] who added 67 less common species from the swamp not included by Paine. Day, 1882,[2] recorded plants from Bergen Swamp in *The Plants of Buffalo and its vicinity* and commented upon some of its rare plants.

Beckwith and Macauley, 1896,[3] listed a number of plants from Bergen Swamp and vicinity in the *Plants of Monroe County and adjacent territory.* They also gave an extensive bibliography of papers mentioning plants of the Genesee Region for the period 1687–1895. Only a few mention Bergen Swamp. Zenkert, 1934,[6] included a description of Bergen Swamp and listed the "more noteworthy" plants of the wooded zone and open marl areas. In his general catalogue he also recorded a number of species based largely upon collections and records from the swamp made by Clinton, Day and Johnson.

Stewart and Merrill, 1937,[7] published the first intensive treatment of Bergen Swamp. Although primarily an ecological study, these authors also included the most complete catalogue of plants of Bergen Swamp published to date. This catalogue was based upon the species recorded by Beckwith and Macauley supplemented by the records published by Baxter and House, 274 species, of which only 106 were seen in the swamp by Stewart and Merrill. These authors added new records of 98 species thus making a total of 372 species in their catalogue.

My own interest in the vegetation of Bergen Swamp began in 1917 when, as a representative of the New York State Food Supply Commission, I was stationed for the summer in Batavia, Genesee County, within about ten miles of the swamp. This opportunity for an intensive introduction to the swamp and many trips in the intervening years have made it possible to visit nearly every part of the swamp, most of them several to many times. Visits have been made throughout the growing season. In one year one or two days were spent in the swamp in every month from April to October. These explorations have added considerably to the knowledge of the flora of the swamp. Although they have not progressed to the point where a complete catalogue of the plants in Bergen Swamp is assured, it seems desirable to bring together the available records of vascular plants in one more steppingstone toward a more nearly complete record. The catalogue here presented includes 780 species, more than double the number of species (372) listed by Stewart and Merrill. Even in its incomplete form may it serve to stimulate further interest in the study and preservation of the vegetation of Bergen Swamp.

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GENERAL FEATURES OF BERGEN SWAMP

Bergen Swamp is usually visualized as a very wild area full of rattlesnakes and a place in which it is easy to get lost. For the preservation of the Swamp this concept may have certain advantages. Ordinarily when several persons enter the swamp together, few larger animals are observed. However, on one trip by myself I noticed two deer, four red foxes, numerous chipmunks, several kinds of snakes including one rattlesnake, several turtles, toads and frogs. Several grouse were flushed, many noisy crows were observed perched in the tops of old white pine trees growing in clumps about the border of the open areas. Various small birds were also observed.

Bergen Swamp is a relatively primitive area in the midst of a highly developed agricultural region. Its close proximity to fields and roads explains the occurrence of many weeds and other exotic plants. Anomalous though it may seem, I have seen wheat, oats, rye, maize and tomatoes growing in openings in the swamp. Trees of exotic species of cherries, pears and apples and seedlings of European mountain ash, Scotch pine and European white birch and bushes of Japanese and European barberry and Tartarian honeysuckle have been found growing in openings in the swamp.

A large number of introduced weeds occur in the swamp. These are included in the catalogue as a record of what grows in the swamp now. Their presence offers witness to the close proximity of the swamp to agricultural areas and transportation lanes and silently attests to the disturbances that man has wrought in the native vegetation. In the future it will be interesting to observe which of these infested scars will be "healed over" by the native vegetation and whether any will become centers of encroachment upon the native plants.

Most of the activities causing disturbances in the swamp center about the cutting of trees around its margin for lumber and making fence posts and poles from the arbor-vitae "cedar" within the swamp. This accounts for numerous openings and cutover areas as well as abandoned logging roads, "trails". Most of this activity takes place in the winter when the swamp is frozen over. At times sphagnum moss has been taken from the hummocks in the marl bogs.

Bergen Swamp is located in the townships of Bergen and Byron in the northeast corner of Genesee County, New York, about 24 miles from the city of Rochester and about three miles west of the village of Bergen. This places it within a few hours ride by car or rail from the principal centers of population, industry and education in western New York. Such a strategic position makes it easily accessible to naturalists interested in the study of its flora and fauna. At the same time it is in grave danger of damage or destruction by others who are interested only in the satisfaction of immediate wants or desires regardless of their effect upon the future of the area.

The particular part of Bergen Swamp that is best known to botanists consists of an open marl bog area surrounded by a forest or swampy thicket. A brief but good general description of Bergen Swamp was published 50 years ago.[3] More recently Stewart and Merrill,[7] in their extensive ecological study discussed in detail many aspects of the swamp and certain of its vegetation types. While the marl bog is an extensive and interesting feature of Bergen Swamp, it represents not a static but a dynamic area the uniqueness and persistence of which is highly dependent upon the physiographic features surrounding the marl areas and the types of vegetation that these support.

Bergen Swamp is situated about 590–600 feet above sea-level. It is about three miles long and one to one and one half miles wide. It occupies an east-west depression on a plain overlying the Salina formation of the Silurian. A few miles to the south is the Onondaga limestone escarpment. The depression itself is rather irregular because of the uneven deposition of large amounts of glacial till. None of the underlying strata are here exposed because of the depth of the till.

A continuous supply of lime-bearing water from the springs flowing northward into the depression from the higher ground on the south is favorable for the formation of marl deposits.

Forming a wide curve near the northwest corner of the swamp, and turning from west to east, flows Black Creek. While it drains Bergen Swamp it is also in part responsible for maintaining it. It has its main source some 20 miles southwest in the hills of the Portage escarpment in Wyoming County. Draining a rather large area, chiefly agricultural land, it picks up a considerable load of silt. From its general northward flow this current is diverted to the east when it strikes the west-east depression with but a slight pitch with the result that much of the silt load is dropped along its banks. The frequent deposition of this silt is responsible for striking differences in the physical and chemical natures of the soils of the north and south sides of the swamp. Whereas, near Black Creek the area of raised alluvial soil which gradually slopes southward toward the lower and northern part of the swamp is subject to periodic flushing or drenching with large volumes of silty surface water, the southern part of the swamp receives smaller but more continuous flows of underground clear water from numerous springs. These differences in the soils are also reflected in the composition of the vegetation of these areas.

It has been stated that the glacial till of the Bergen Swamp region is so heterogeneous and evenly mixed that a uniform soil has resulted which has no effect upon the composition of the vegetational areas.[7] It is also stated that the vegetation of Bergen Swamp is supported entirely upon humus formed by the decay of former vegetation. An examination of the soils around the margin of Bergen Swamp shows that neither the glacial till nor the soils formed by its subsequent erosion and addition of humus from plant remains formerly growing thereon are uniform. The soil map of Genesee County, New York, shows Bergen Swamp (referred to in the accompanying text as "the large muck swamp east of Pumpkin Hill")[5] as an extensive muck area into the south margin of which project at least four distinct soil types within a distance of three miles. Along the north edge of the swamp at least one additional soil type is represented.

These soil types are recorded below. A few of the outstanding properties of each soil, taken from the descriptions by Gustafson,[5] are included.

1. *Granby silty clay loam.*—With poor drainage and a good supply of lime and organic matter. This type is also common in the north and east parts of the swamp.
2. *Mahoning silt loam.*—With good surface drainage and poor internal drainage; low in organic content and rather sour.
3. *Ontario loam.*—With good surface and internal drainage; subsoil well supplied with lime. On the north side this type is represented by Torpy Hill and surrounding base.
4. *Honeoye loam.*—Some gravel on surface; good drainage; well supplied with lime and organic matter. Represented by only a small area on the south border.
5. *Dunkirk fine sandy loam.*—Surface soil fine sandy loam to fine sand, porous; lime content variable. Represented on the north border by a small area, part of which has been cleared.

The existence of these several types of soil indicates at least some basic differences in the glacial till on which they were formed or from which they were derived.

VEGETATION TYPES IN BERGEN SWAMP

Stewart and Merrill [7] have already discussed in some detail the probable origin and early history of the depression in which Bergen Swamp is located, the effect of glacial till on soils in the basin, the formation of marl beds, and the causes and some of the stages of the filling in of the swamp. They have described and discussed the present vegetation of the swamp under five "specific zones and associations" as follows:

1. Open marl association
2. Secondary marl association
3. Sphagnum bog association
4. Pine-hemlock zone
5. Beech-maple zone.

These authors interpret Bergen Swamp as a relatively late stage in succession, attained by the filling in of an open-water area, the earliest stage of which is represented at present by the open marl association, followed in order by the secondary marl association, sphagnum bog association, pine-hemlock zone, and finally the beech-maple zone representing the climax. They state that the region now occupied by the beech-maple zone was undoubtedly at one time open swamp, that if left to its natural development the swamp will in in time become stabilized as a climax forest of the beech-maple type. To them "The presence of the beech-maple climax marks the beginning of the end of Bergen Swamp." A very good reason for preserving Bergen Swamp in as nearly an undisturbed state as possible is to provide opportunity to obtain records and data on the progress of the successions in the future.

My own explorations have resulted in supplementing our knowledge of Bergen Swamp as presented by Stewart and Merrill [7] by:

1. Greatly increasing the inventory of plants known to occur there.
2. Revealing types of vegetation not mentioned by them.
3. Providing a clearer picture of the composition of the vegetation in some of the "associations" previously reported.

As a result some of the assumptions previously made cannot be substantiated and in some instances the observations lead to different interpretations.

The most obvious or striking types of vegetation that can be observed by the visitor to Bergen Swamp today may be indicated as follows:

1. Aquatic plants.
2. Carex riparia swamp.
3. Alluvial soil plants.
4. Open marl bog.
5. Secondary marl bog.
6. Sphagnum bog.
7. Arbor-vitae swamp.
8. Alder swamp.
9. Pine-hemlock forest.
10. Birch-maple-elm forest.

It is apparent that this grouping is not all-inclusive nor are the separate types mutually exclusive. However, each type is dominated by certain species and is limited more or less to a restricted habitat determined on the one hand by the physical factors of the environment and on the other by the stage of succession attained by the vegetation. Since these environmental factors may overlap or are subject to modification it is to be expected that some species may occur in more than one of the types of vegetation here designated. In fact it appears probable that some of the types may represent stages in the succession of another.

A few general remarks are presented about each of the ten types of vegetation here recognized. These are followed by a list of the more striking or dominant species occurring in each.

1. *Aquatic plants.*—These are limited to restricted areas such as small spring-fed pools and the streams having their source in them, Black Creek and its laterals, and several shallow but firm-bottom, mostly intermittent ponds, chiefly along the north side and toward the east and west ends of the swamp. With the exception of *Nasturtium officinale* and *Veronica anagallis—aquatica* in spring brooks—and *Lemna minor, Ranunculus flagellaris* and *Sium suave* in ponds, none of the aquatics is abundant. Most of them are local or known only from a few stations. The submersed species are mostly limited to Black Creek. The water in this stream usually has a low transparency which probably accounts for the paucity of aquatic plants except in shallow water.

2. *Carex riparia swamp.*—This includes a very distinct association of plants. To one who finds himself in its middle, wading in water from one to two feet deep, with *Carex* leaves striking to the height of his ears, eagerly scanning the horizon just at sundown to find its margin anywhere from 200 yards to a half mile distant, its existence is very real. It lies along the north side of the swamp in wet depressions between the alluvial soil area and the alder swamp or arbor-vitae swamp. During flood periods this area may be inundated to a depth of 6 to 8 feet. This occurred on October 2 and 3, 1945, following a very heavy rainfall. On these same days the marl bogs showed no appreciable increase in water depth. The dominant species is *Carex riparia* var. *lacustris*. *Typha latifolia* encroaches the margin of the swamp. In lower areas which form stream courses during high water, *Sparganium eurycarpum, Glyceria grandis* and *Acorus Calamus* are common. The dicotyledonous species listed occur as scattered plants among the Carex.

3. *Alluvial soil plants.*—These occupy a narrow area along the banks of Black Creek which are higher than the more swampy areas farther away. Most of the characteristic species recorded for this habitat do not occur elsewhere in Bergen Swamp. A number of these species are more

common farther to the west, especially in the Ohio Basin. This alluvial soil is very rich and at flood time may be inundated under several feet of water.

4. *Open marl bogs.*—The vegetation of these areas is remarkably uniform and characterized by a restricted number of abundant species, chiefly members of the Cyperaceae, many of which do not appear elsewhere in the swamp except in the secondary marl. The open marl is usually lower and therefore covered by water for a longer part of each year than the somewhat more elevated and drier secondary marl areas. It is not continuous but forms several more or less open marl areas mostly toward the middle of the swamp and in many places the open and secondary marl gradually merge. These open marl areas are sometimes separated by arbor-vitae thickets or again may be bordered by a zone of sphagnum. Frequently they are dotted by raised hummocks covered with little sphagnum bogs.

The open marl area is not static. There are places in which marl is being formed today by *Chara* sp. and blue green algae, *Scytonema* sp., growing in small areas of open water. The boundaries of some of these areas have changed within the last 25 years, due on the one hand to the encroachment of shrubs and even small trees on open areas and on the other hand to changes in the surface contours allowing lime-rich water from spring-fed brooks to extend over areas formerly occupied by shrubs or even arbor-vitae forests.

That such changes have been going on for more than a century appears highly probable from observations. During the last few decades several observers have pointed out that the presence of marl can be demonstrated in the arbor-vitae forest or thickets where trees have been uprooted by the weight of heavy layers of snow or by wind. It is obvious that here the arbor-vitae has invaded marl areas and finally completely covered them. In open marl areas, some of them even with open water with living *Chara contraria* sp. and blue-green algae producing marl, places can be found in which occur remnants of logs, stumps and even erect snags in situ, the remains of *Thuja* trees which formerly grew where today the open marl association predominates.

In other words, it is evident that what is arbor-vitae forest now may have been open marl in the past and may become so again in the future. What is open marl today may have been an arbor-vitae forest or shrub association in the past and may again become so in the future. The changes in succession of these types of vegetation may be initiated by changes in contours which determine the position of the water level, whether above or below the soil contour.

5. *Secondary marl bogs.*—As the marl is built up or as local drainage changes so as to lower the water level, other species, many of them shrubby plants, become common. The most striking of these are *Potentilla fruticosa* and *Juniperus horizontalis*. The shrubby species are usually in scattered clumps with open areas between them which are occupied by small herbaceous species such as *Scleria verticillata, Panicum flexile, Carex* spp. and others also characteristic of the open marl.

6. *Sphagnum bog.*—The areas that are covered with Sphagnum moss are limited to small hummocks raised about one foot above the general level in the open marl bogs and to irregular strips, mostly between the arbor-vitae and secondary marl associations. *Sphagnum* spp.* make a dense carpet over the hummocks with low herbaceous species scattered among the *Sphagnum*. On these little natural "island gardens" small growths of Ericaceous shrubs and *Pyrus melanocarpa* abound. Dwarf, scraggly trees of *Larix laricina* and *Thuja occidentalis,* often only two or three feet in height, complete the setting; occasionally a few dwarf individuals of *Pinus Strobus* also appear. These "islands" appear artistic and colorful. Seldom do more than one or two species blossom at one time but many of the species show bright coloration in the foliage and fruits.

When looking across the open marl area with the hummocks of sphagnum vegetation one may be reminded of a rough sea, the open marl low and the hummocks slightly raised. All the plants, whether trees, shrubs or herbs, are low or dwarfed. The stunted nature of this vegetation has been explained as due to the greater evaporating power of the atmosphere several feet above the soil surface as compared to the more humid atmosphere near the wet soil surface.[7] Granting that the humidity in this area may be higher near the soil than at higher levels above, it does not necessarily follow that this difference is greater where the tamaracks and pines fail to grow tall than in nearby areas where they do grow to a normal height.

The explanation of the stunted growth of the plants in this area may be found in low fertility of the soil involved. Analyses of marl soil and soil from raised sphagnum hummocks from the Junius bog in Seneca County, New York, by Edgar T. Wherry showed that the former was alkaline in reaction and the latter was acid in reaction but that both types were low in nitrates. The acidity of the Sphagnum soils and the poor drainage and aeration of the marl may interfere with the production and accumulation of nitrates sufficient for optimum growth of the woody species here involved.

7. *The arbor-vitae swamp.*—The dominant species in this association is *Thuja occidentalis.* It usually makes a dense growth which in the early

* *Sphagnum capillaceum* (Weiss.) Schrank. is the dominant species on the hummocks. *Sphagnum palustre* L. occurs more commonly in lower places.

stage of development makes an almost impenetrable thicket but ultimately forms a canopied forest with a ground cover of herbaceous species. The association forms an irregular belt between the marl areas and the pine-hemlock and hardwood forests. It is mostly limited to the south side of the swamp although some more or less detached arbor-vitae areas occur on the north side toward the east end or wherever marl springs occur, even on uplands surrounding the bog. In open places in the arbor-vitae swamp the shrubs, *Lonicera oblongifolia, Rhamnus alnifolia* and *Myrica pennsylvanica* thrive. In the partial shade in some of these openings clumps of ladyslippers, *Cypripedium reginae* and *C. Calceolus* var. *pubescens* are frequently found. *Thuja occidentalis,* locally called "cedar", more than any other species is the cause of disturbances in Bergen Swamp. The "white cedar" is highly prized for fence posts and other uses requiring a durable wood. From many tracts in the swamp the "cedar" has been cut for poles and removed. Most of the trails across the bogs represent remnants or sites of former logging roads for hauling "cedar" poles. Some of this activity has been carried on as late as 1945. An examination of the growth rings of cut trees indicates that they required from 50 to 100 years to grow to a diameter of one foot.

8. *Alder swamp.*—This type of vegetation is frequently dominated by *Alnus incana* growing in clumps in soft mucky soil frequently inundated except around the bases of the shrubs. Certain herbaceous species are associated with the higher ground around the shrubs; others grow in the mucky depressions among them. In open places among the alders shrubby willows, Viburnums, *Cornus stolonifera* and *Rubus Idaeus* var. *strigosus* thrive. Around the borders of the alder swamps *Acer rubrum* and *Fraxinus nigra* may intermingle with the shrubby species.

9. *Pine-hemlock forest.*—This association is but poorly represented at the present time. It probably never was well developed in the swamp proper. However, on several so-called "islands" of upland or knolls within the swamp and a few low ridges projecting into the swamp the white pine and hemlock were well established. Unfortunately most of these areas have been cut for timber. Only a few of the more inaccessible knolls still contain relatively large pine or hemlock trees. The hardwood trees associated with the conifers and the shrubs and herbs dominant in the undergrowth and forest carpet are recorded in the list of species.

10. *Birch-maple-elm forest.*—This hardwood forest association covers the greater part of the wooded area of the swamp and the limited woodlands remaining contiguous to it. The dominant trees are yellow birch, *Betula lutea,* red maple, *Acer rubrum,* sugar maple, *Acer saccharum,* and elm, *Ulmus americana.* Beech, *Fagus grandifolia,* is absent or rare and as a component of the swamp forest has been much overrated.[4,7] Sev-

eral smaller, less common trees occur. The forest floor abounds in numerous herbaceous species, the more characteristic of which are listed. This forest type has been designated as the beech-maple zone by Stewart and Merrill,[7] who consider it to be the climax forest developed in Bergen Swamp.

At present there is no evidence that any of the few areas about Bergen Swamp which are now occupied by the beech-maple climax forest were at any time, since the last glacial period, a part of the swamp. Judging by the recent past history of the swamp it does not seem probable that any part of the present swamp will culminate in the beech-maple climax.

The only evidence offered as "proof" by Stewart and Merrill of the invasion of the areas that were at one time open swamp is the occurrence, at "the outermost reaches of the beech-maple zone, of a minor growth of *Thuja occidentalis* and *Typha latifolia*". Their assumption that the original limits of the swamp included these localities now occupied by *Thuja* and *Typha* does not necessarily follow, in fact it appears highly improbable. Several areas along the south margin of the swamp at the present time support *Thuja* and *Typha* about springs some distance above the swamp. The spring-fed brooks often support a marl-bog vegetation much removed from the marl bog proper. The few limited areas of beech-maple in the swamp area are restricted to hard soil or uplands bordering the swamp or a few "islands" or knolls of glacial till. No beeches were found on areas underlain with marl or peat. The few small remaining woodland areas on uplands in the vicinity of Bergen Swamp show well-developed beech-maple climax forests.

1. Aquatic Plants

*Potamogeton amplifolius
*Potamogeton Berchtoldii
Sagittaria latifolia
Alisma Plantago-aquatica
*Anacharis canadensis
f Lemna minor
f Lemna trisulca
f Spirodela polyrhiza
Eleocharis acicularis
Glyceria grandis
*Ranunculus aquatilis
Ranunculus flagellaris
Nuphar advena
Polygonum hydropiperoides
Armoracia aquatica
Nasturtium officinale
*Ceratophyllum demersum
Callitriche palustris
Sium suave
Ludvigia palustris
*Utricularia intermedia
*Utricularia vulgaris var. americana
Veronica americana
Veronica anagallis-aquatica

* = submersed; f = floating; others emersed.

2. Carex Riparia Swamp

Carex riparia var. lacustris
Sparganium eurycarpum
Acorus Calamus
Glyceria grandis
Typha latifolia
Rumex Brittanica
Asclepias incarnata
Cicuta maculata
Cicuta bulbifera
Epilobium densum
Epilobium hirsutum
Lysimachia thyrsiflora
Mentha arvensis var. canadensis

3. Alluvial Soil Plants

Acer saccharinum
Fraxinus pennsylvanica
Ulmus americana
Carya ovata
Quercus macrocarpa
Evonymus atropurpurea
Crataegus macracantha
Ribes americanum
Salix interior
Salix nigra
Pteretis nodulosa
Allium canadense
Arisaema Dracontium
Polygonum virginianum
Laportea canadensis
Ranunculus septentrionalis
Angelica atropurpurea
Heracleum lanatum
Asclepias syriaca
Echinocystis lobata
Ambrosia trifida
Xanthium orientale

4. Open Marl Bog

Triglochin maritima
Triglochin palustris
Phragmites communis
Typha latifolia
Carex bromoides
Carex crawei
Carex flava
Carex gynocrates
Cladium mariscoides
Eleocharis rostellata
Rynchospora alba
Rynchospora capillacea
Scirpus caespitosus
Scirpus acutus
Scirpus americanus
Zygadenus chloranthus
Cypripedium candidum
Juniperus horizontalis
Sarracenia purpurea
Parnassia caroliniana
Lobelia Kalmii
Solidago uniligulata

5. Secondary Marl Bog

Juniperus horizontalis
Thuja occidentalis
Larix laricina
Potentilla fruticosa
Lonicera oblongifolia
Rhamnus alnifolia
Myrica pennsylvanica
Salix candida
Salix serissima
Carex aurea
Carex hystericina
Carex prairea
Cladium mariscoides
Scirpus caespitosus
Scirpus americanus
Scleria verticillata
Panicum flexile
Sorghastrum nutans
Sporobolus vaginiflorus
Zygadenus chloranthus
Cypripedium candidum
Commandra umbellata
Parnassia caroliniana
Aster lateriflorus var. angustifolius
Senecio pauperculus var. Balsamitae
Solidago ohioense
Solidago Houghtoni
Solidago uniligulata

6. Sphagnum Bog

Larix laricina
Gaylussacia baccata
Vaccinium Oxycoccus
Vaccinium corymbosum
Pyrus melanocarpa
Gaultheria procumbens
Ledum groenlandicum
Linnaea borealis var. americana
Chiogenes hispidula
Cornus canadensis
Arethusa bulbosa
Pogonia ophioglossoides
Tofieldia glutinosa
Drosera rotundifolia
Sarracenia purpurea

7. Arbor-Vitae Swamp

Thuja occidentalis
Lonicera oblongifolia
Myrica pennsylvanica
Rhamnus alnifolia
Cypripedium Calceolus var. pubescens
Cypripedium reginae
Rubus triflorus
Mitella nuda
Conioselinum chinense
Viola renifolia var. Brainardi
Viola blanda
Valeriana uliginosa
Trientalis borealis

8. Alder Swamp

Alnus incana
Salix cordata
Salix discolor
Cornus stolonifera
Viburnum Opulus var. americanum
Viburnum dentatum
Clematis virginiana
Rubus Idaeus var. strigosus
Fraxinus nigra
Acer rubrum
Dryopteris cristata
Dryopteris Thelypteris
Habenaria psychodes
Boehmeria cylindrica
Cardamine bulbosa
Caltha palustris
Lobelia siphilitica
Senecio aureus
Solidago patula
Rudbeckia laciniata
Eupatorium maculatum

9. Pine-Hemlock Forest

Pinus Strobus
Tsuga canadensis
Taxus canadensis
Fraxinus americana
Prunus serotina
Viburnum acerifolium
Cornus canadensis
Gaultheria procumbens
Rhododendron nudiflorum
Linnaea borealis var. americana
Chiogenes hispidula
Mitchella repens
Polygala paucifolia
Coptis trifolia var. groenlandica
Clintonia borealis
Maianthemum canadense
Medeola virginica
Aralia nudicaule
Aster macrophyllus

10. Birch—Maple—Elm Forest

Betula lutea
Acer rubrum
Acer spicatum
Acer saccharum
Ulmus americana
Fraxinus americana
Tilia americana
Fagus grandifolia
Carpinus caroliniana
Ostrya virginiana
Cornus rugosa
Adiantum pedatum
Dryopteris marginale
Dryopteris spinulosum var. intermedium
Cystopteris bulbifera
Onoclea sensibilis
Osmunda cinnamomea
Erythronium americanum
Smilacina stellata
Smilacina racemosa
Trillium grandiflorum
Arisaema triphyllum
Mitella diphylla
Tiarella cordata
Viola conspersa
Aralia nudicaulis
Circaea latifolia
Collinsonia canadensis
Eupatorium rugosum
Prenanthes alba
Solidago latifolia
Solidago graminifolia
Solidago rugosa
Solidago serotina

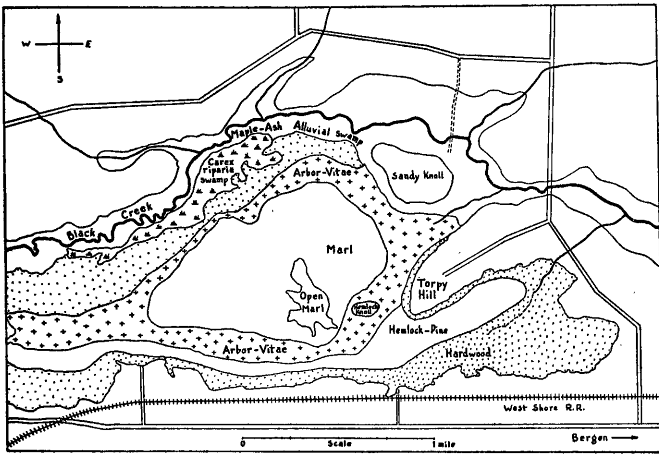

FIGURE 1
Map of Bergen Swamp

The regions indicated as hardwood, hemlock-pine, arbor-vitae and maple-ash are not all continuous but show only the approximate areas in which these types of vegetation are dominant. Some sections in each of these regions have had many of the larger trees removed. The region marked "marl" is not uniform except that it contains low vegetation on marl soil. In some parts sedges and grasses dominate; in others low shrubs are interspersed with sphagnum hummocks on which dwarf tamaracks, arbor-vitae and scattered white pines occur. Some of the arbor-vitae areas also are underlain with marl.

ANNOTATED CATALOGUE OF VASCULAR PLANTS IN BERGEN SWAMP

This catalogue is based primarily on plants observed in the field. Specimens representing more than 650 species are deposited in the herbarium of Cornell University. Among the plants previously reported from Bergen Swamp, Paine,[1] Day,[2] Beckwith and Macauley,[3] Baxter and House,[4] Zenkert,[6] Stewart and Merrill,[7] there were a number which I did not find in the swamp. An attempt was made to locate specimens of these in the principal depositories of the collections upon which the above publications were based. These are the herbaria in the New York State Museum, Albany; the University of Rochester and Rochester Academy of Science; the Buffalo Museum of Science; and Cornell University. Previously reported species which I did not see in the field, if found in any of these herbaria, are included in the catalogue, followed by the names of the collectors and the herbaria in which the specimens are found. If such reported species were not located in any of these herbaria, their names are included but indicated as "not seen" and preceded by a minus sign.

All species without citations to specimens in any of the above herbaria, except those preceded by a minus sign, are represented by herbarium specimens in the herbarium of Cornell University.

An asterisk (*) preceding a name indicates a species not included in the catalogue of Bergen Swamp plants published by Stewart and Merrill.[7]

The herbaria are cited as follows:

Albany ....New York State Herbarium
Buffalo ....Herbarium of Buffalo Museum of Science
Rochester .....Herbarium of University of Rochester
R. Acad. ......Herbarium of the Rochester Academy of Science
Cornell ....Herbarium of the Department of Botany, Cornell University

Introduced species are printed in light type.

Synonyms in italics, without authors, refer to names used in Gray's Manual, ed. 7.

1. POLYPODIACEAE

Adiantum pedatum L. MAIDENHAIR FERN. Moist hardwoods.

Athyrium acrostichoides (Sw.) Diels. SPLEENWORT. In swampy woodlands.

Athyrium felix-femina (L.) Roth., var. **Michauxii** (Spreng.) Underw. LADY FERN. In swampy woods.

Cystopteris bulbifera (L.) Bernh. BLADDER FERN. In wet woods.

Cystopteris fragilis (L.) Bernh. In swampy mixed woodlands.

Dryopteris Boottii (Tuckerm.) Underw. *(Aspidium Boottii.)* In swampy woodland. *(F. W. Johnson (16)* 1924, *Buffalo.)*

Dryopteris cristata (L.) Gray. *(Aspidium cristatum.)* On hummocks in alder swamps.

Dryopteris cristata (L.) Gray, var. **Clintoniana** (D. C. Eaton) Underw. On hummocks in hardwood swamp.

–**Dryopteris Goldiana** (Hook.) Gray. GOLDIE'S FERN. The specimen *(Stewart,* 1933) [7] reported as this species is a small sterile one belonging elsewhere. Also reported by Baxter and House.[4]

Dryopteris Linnaeana C. Chr. *(Phegopteris Dryopteris.)* OAK FERN. On hummocks in hemlock woods; rare.

Dryopteris marginalis (L.) Gray. *(Aspidium marginale.)* MARGINAL SHIELD FERN. Common in mixed woodlands.

Dryopteris noveboracensis (L.) Gray. *(Aspidium noveboracense.)* NEW YORK FERN. In moist open hardwood forest.

Dryopteris spinulosa (O. F. Müller) Ktze. *(Aspidium spinulosum.)* SPINY-TOOTHED SHIELD FERN. In hardwood swamps and forests.

Dryopteris spinulosa, var. **intermedia** (Muhl.) Underw. Mostly in swampy ground under hardwoods.

Dryopteris Thelypteris (L.) Gray. *(Aspidium Thelypteris.)* MARSH SHIELD FERN. In alder swamps and marshes.

Onoclea sensibilis L. SENSITIVE FERN. In marshes and edges of swampy woodlands.

***Pteretis nodulosa** (Michx.) Nieuwl. *(Onoclea Struthiopteris.)* OSTRICH FERN. On moist alluvial soil along streams.

Pteridium aquilinum Kuhn, var. **latiusculum** (Desv.) Underw. *(Pteris aquilina.)* BRACKEN FERN, BRAKE. In open woodland, mostly on knolls.

Polystichum acrostichoides (Michx.) Schott. CHRISTMAS FERN. In moist woodland.

***Polypodium virginianum** L. *(P. vulgare.)* POLYPODY. On hummocks and about the base of hemlock trunks.

–**Woodwardia virginica** (L.) Sm. CHAIN FERN. In sphagnum along edge of arbor-vitae swamp.

2. OSMUNDACEAE

Osmunda cinnamomea L. CINNAMON FERN. Common in swampy areas, mostly under trees.

Osmunda claytoniana L. INTERRUPTED FERN. In wet situations bordering forests.

***Osmunda regalis** L., var. **spectabilis** (Willd.) Gray. ROYAL FERN. In open swampy borders of thickets.

3. OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw. Rattlesnake Fern, Grape Fern. In moist woodlands; frequent.

Botrychium dissectum Spreng., var. **oneidense** (Gilbert) Farw. *(J. B. Fuller,* 1865, under *B. ternatum* Swartz. *R. Acad.)*

–**Botrychium multifidum** (Gmel.) Rupr. subsp. **salaifolium** (Presl.) R. T. Clausen. Reported from woods bordering swamp, by Booth and Fish.[3] under *B. ternatum* Swartz. Not seen.

4. EQUISETACEAE

Equisetum arvense L. Horsetail. Common in wet woodlands and open areas.

Equisetum fluviatile L. Pipes. In mucky soil along streams.

Equisetum hyemale L. Scouring Rush. In springy places along streams.

***Equisetum scirpoides** Michx. Dwarf Scouring Rush. On mossy hummocks in hemlock swamp.

***Equisetum variegatum** Schleich. In wet marly ditch along railroad by Bergen Swamp. *(R. M. Schuster, 20987, Cornell.)*

5. LYCOPODIACEAE

Lycopodium clavatum L. Club-moss. In open woods on knolls.

***Lycopodium annotinum** L. Club-moss. On a hemlock and oak knoll.

***Lycopodium complanatum** L., var. **flabelliforme** Fern. Club-moss. On a sandy knoll.

Lycopodium lucidulum Michx. Club-moss. In wet depressions under hemlocks.

Lycopodium obscurum L. Club-moss. On a hemlock knoll.

6. TAXACEAE

Taxus canadensis Marsh. Yew, Ground Hemlock. A frequent undershrub in swampy woodlands. Usually it does not show thrifty growth because of considerable damage by rabbits and possibly also from browsing of deer.

7. PINACEAE

Larix laricina (Du Roi) Koch. Tamarack, Larch. A common but dwarfed tree on hummocks in the marl bogs; of better size in the bordering spring-fed bogs.

–**Picea mariana** (Mill.) BSP. BLACK SPRUCE. Reported from the swamp.[4,7] I have never seen a tree. No herbarium specimens have been located.

Pinus Strobus L. WHITE PINE. A common tree in the bordering forests and also on hummocks in the open marl bogs.

*PINUS SYLVESTRIS L. SCOTCH PINE. A few small trees, apparently established from seed, were found in an opening in an arbor-vitae swamp.

Tsuga canadensis (L.) Carr. HEMLOCK. A common tree in the swamp and surrounding woods.

8. CUPRESSACEAE

Juniperus horizontalis Moench. TRAILING JUNIPER. Common in the open marl bogs and also on springy slopes bordering the woodland.

***Juniperus virginiana** L. RED CEDAR. Three trees from 8 to 12 feet high, along the south edge of the bog.

***Juniperus horizontalis X J. virginiana.** Two trees, about 6 feet high, with recurved-spreading branches touching the ground, rooting, and creeping horizontally were found growing among *Juniperus horizontalis* in the marl bog. These seem intermediate and may represent hybrids between the two preceding species.

Thuja occidentalis L. ARBOR-VITAE. A common tree in the swamps, forming dense thickets between the open marl bogs and the hardwood forests.

9. TYPHACEAE

***Typha angustifolia** L. NARROW-LEAVED CATTAIL. Local in spring-fed bogs.

Typha latifolia L. COMMON CATTAIL. Common in shallow water, mostly in swales and marshes.

10. SPARGANIACEAE

***Sparganium chlorocarpum** Rydb. BUR-REED. In shallow water along streams.

Sparganium eurycarpum Engelm. GIANT BUR-REED. Along streams and in swales.

11. POTAMOGETONACEAE

***Potamogeton amplifolius** Tuckerm. BROAD-LEAVED PONDWEED. In Black Creek.

*__Potamogeton Berchtoldii__ Fieber. SMALL PONDWEED. In shallow water in Black Creek and its tributaries.

*POTAMOGETON CRISPUS L. In Black Creek, rare.

12. JUNCAGINACEAE

–**Scheuchzeria palustris** L. Report based upon sight record by House, 1925. Not seen.

Triglochin maritima L. ARROW-GRASS. Abundant in wet depressions in the open marl.

Triglochin palustris L. SMALL ARROW-GRASS. In wet depressions, mostly along spring-fed streams in the marl bog.

13. ALISMACEAE

*__Alisma plantago-aquatica__ L. WATER PLANTAIN. In wet swales and along streams.

*__Sagittaria latifolia__ Willd. ARROW-HEAD, WAPATO. In marshy soil and shallow water along streams.

*–**Sagittaria cuneata** Sheldon. ARROW-HEAD. In mucky soil along stream.

14. HYDROCHARITACEAE

*__Anacharis canadensis__ (Michx.) Planchon. *(Elodea canadensis.)* WATER-WEED. Common in Black Creek.

*__Anacharis occidentalis__ (Pursh) Marie-Vict. *(Elodea occidentalis.)* WATER-WEED. Local in Black Creek.

15. GRAMINEAE

*ANTHOXANTHUM ODORATUM L. SWEET VERNAL GRASS. Along edge of swamp.

*__Agrostis stolonifera__ L., var. **compacta** Hartm. REDTOP. Common in wet swales.

*__Agropyron caninum__ (L.) Beauv. In the marl bog.

*__Agropyron repens__ (L.) Beauv. QUACK GRASS. In openings in the marl bog.

–**Alopecurus aequalis** Sobol. FLOATING FOXTAIL. In swales. (Also reported by F. W. Johnson, 1926.)

*__Asprella hystrix__ (L.) Humb. (*Hystrix patula.*) BOTTLE-BRUSH GRASS. In moist woodlands.

*__Bromus ciliatus__ L. BROME-GRASS. In openings in the arbor-vitae swamp.

*BROMUS SECALINUS L. CHESS. Along the border of the swamp.

*__Calamagrostis canadensis__ (Michx.) Beauv. BLUE JOINT. In wet swales.

__Cinna arundinacea__ L. In a wet swale.

*DACTYLIS GLOMERATA L. ORCHARD GRASS. In grassy borders of woods.

__Deschampsia caespitosa__ (L.) Beauv., var. __glauca__ (Hartm.) Lindm. In open marl bog.

–__Deschampsia flexuosa__ (L.) Trin. Not seen.

*__Echinochloa crus-galli__ (L.) Beauv. BARNYARD GRASS. Along paths.

*__Echinochloa pungens__ (Poir.) Rydb. *(E. muricata.)* In swales along streams.

*__Elymus virginicus__ L. WILD RYE. In openings along streams.

*–FESTUCA ELATIOR L. MEADOW FESCUE. Along edges of meadows.

*__Glyceria grandis__ Wats. REED MEADOW GRASS. In mucky soil and in shallow streams.

*__Glyceria striata__ (Lam.) Hitchc. MANNA-GRASS. In openings in the bogs.

__Leersia oryzoides__ (L.) Sw. CUT-GRASS. In swales.

*__Leersia virginica__ Willd. WHITE-GRASS. Along streams in wet woodland.

*__Muhlenbergia foliosa__ Trin. In openings in wet woods.

*__Muhlenbergia mexicana__ (L.) Trin. DROPSEED. In openings in woods.

*__Muhlenbergia racemosa__ (Michx.) BSP. On hummocks in marl bogs.

*__Muhlenbergia tenuiflora__ (Willd.) BSP. In wet woodlands.

*__Oryzopsis asperifolia__ Michx. In swampy hemlock forest.

*__Panicum capillare__ L. WITCH GRASS. Along paths in open bogs.

*__Panicum flexile__ (Gat.) Scribn. In open marl bogs.

*__Panicum lanuginosum__ Ell., var. __Lindheimeri__ (Nash.) Fern. In wet places and along streams in marl.

*PHLEUM PRATENSE L. TIMOTHY. Introduced in openings in the woodlands.

__Phragmites communis__ Trin. REED GRASS. Common in wet borders of marl bogs.

*POA ANNUA L. ANNUAL BLUEGRASS. Along paths in the swamp.

*POA COMPRESSA L. CANADA BLUEGRASS. In openings in the woodlands.

*__Poa palustris__ L. FOUL MEADOW GRASS. On dry hummocks in marl bog.

*POA PRATENSIS L. KENTUCKY BLUEGRASS. In openings bordering the swamps.

*__Schizachne purpurascens__ (Torr.) Swallen. *(Bromelica striata* (Michx.) Farw.) PURPLE OAT. On dry ridges. *(F. P. Metcalf (7557)* 1917. *Cornell.)*

*SETARIA LUTESCENS (Weigel) Hub. *(S. glauca.)* YELLOW FOXTAIL. Along paths.

*SETARIA VIRIDIS (L.) Beauv. GREEN FOXTAIL. In open places.
Sorghastrum nutans (L.) Nash. Forming clumps in open marl bogs.
***Sporobolus vaginiflorus** (Torr.) Wood. In openings in marl bogs.

16. CYPERACEAE

***Carex albursina** Sheldon. On wooded knolls.
***Carex anceps** Muhl. On wooded knolls. Some of the earlier collections have been reported under *C. laxiflora*.
–**Carex angustior** Mack. Reported by Zenkert.[6] Not seen.
***Carex arctata** Boott. In hemlock and beech woods on a knoll.
Carex aurea Nutt. In open marl.
Carex Bebbii Olney. About edges of marshes.
***Carex blanda** Dewey. In open woods and bordering meadows. *(F. W. Johnson,* 1926; *W. A. Mathews, 4308; Albany.)*
Carex bromoides Schk. In open marl.
Carex Buxbaumii Vahl. (*C. polygama.*) In marl areas, mostly about springs.
Carex cephalantha (Bailey) Fern., var. **angustata** Carey. Edge of marl area.
–**Carex communis** Bailey. Open woods.
***Carex convoluta** Mack. In woodlands. (Also *F. W. Johnson,* 1926, *Albany.*)
Carex Crawei Dewey. In open marl.
Carex cristatella Britton. *(C. cristata.)* About marl springs.
***Carex cryptolepis** Mack. Edge of marl bogs.
***Carex diandra** Schrank. Edge of marl bogs.
***Carex disperma** Dewey. *(C. tenella.)* In mucky soil under trees.
Carex eburnea Boott. On grassy hummocks in arbor-vitae swamp.
Carex flava L. Common along streams in open marl bog. Specimens from drier marl areas have been referred to *C. laxior* (Kueken) Mack. These appear to be but forms of *C. flava* with shorter spikes. *(W. A. Mathews, 4317, 3555, Albany.)*
Carex gracillima Schwein. Border of swamp.
***Carex granularis** Muhl., var. **Haleana** (Olney) Porter. About the edges of the swamp.
***Carex grisea** Wahl. Edge of open woods.
Carex gynocrates Wormsk. In marl bogs.
***Carex Howei** Mack. On hummocks, edge of sphagnum bogs. *(M. S. Baxter, 5097, Albany.)*
Carex hystericina Muhl. Along spring-fed brook in marl bog.
***Carex incomperta** Bickn. *(G. W. Clinton,* under *C. sterilis* Willd., det. by K. Mackenzie, *Albany.)*

***Carex interior** Bailey. In wet sphagnum bog near edge of marl. (Also *W. A. Mathews, 4320; M. S. Baxter, 5020; Albany.*)

***Carex lasiocarpa** Ehrh. *(C. filiformis.)* In wet mucky area bordering marl bog. (Also *M. S. Baxter, 219a,* 1913, *Albany.*)

***Carex laxiflora** Lam. Bergen Swamp. *(M. S. Baxter,* 1917, det. by F. J. Hermann. *R. Acad.)* Most specimens from here reported under this species belong to *C. anceps.*

***Carex leptalea** Muhl. *(H. D. House,* 1917, *Albany; M. S. Baxter,* 1917, *Rochester.)*

Carex lupulina Muhl. In shallow water and marshes along streams.

–**Carex lurida** Wahl. In wet swales. (Reported by Day [2] as *C. tentaculata.*) Not seen.

***Carex pallescens** L. In open marsh. *(M. S. Baxter (185),* 1895; *F. W. Johnson,* 1926; *Albany.)*

Carex pauciflora Lightf. On sphagnum hummocks.

***Carex paupercula** Michx. About edge of marl bog.

Carex pedunculata Muhl. On hummocks about arbor-vitae swamp. *(F. P. Metcalf, 7740, Cornell.)*

***Carex plantaginea** Lam. In moist woodlands.

***Carex prairea** Dewey. In marl bog.

Carex pseudo-cyperus L. In shallow water, edge of swamp.

***Carex riparia** Curtis, var. **lacustris** (Willd.) Kueken. Covering extensive areas in swales along the north side of the swamp.

Carex rosea Schk. In wet woodland. (Also *H. D. House,* 1917, *Albany.*)

–**Carex rostrata** Stokes. Reported from Bergen Swamp.[7] Not seen.

–**Carex scabrata** Schwein. Reported.[7] Not seen.

–**Carex siccata** Dewey. Reported by *Clinton* (Day).[3, 6] Not seen. Since this species is usually associated with a dry, sandy habitat, its occurrence here is doubtful.

Carex sterilis Willd. In open marl bog.

***Carex stipata** Muhl. In mucky soil along trails.

***Carex stricta** Lam. In swales along streams.

***Carex tenera** Dewey. In wet fields and along edge of swamp.

Carex trisperma Dewey. Among sphagnum and in arbor-vitae swamp.

Carex vaginata Tausch. In arbor-vitae swamp. *(Booth; M. S. Baxter; F. P. Metcalf, Cornell.)* *C. saltuensis* Bailey, the type of which is stated to be Bergen Swamp, appears to belong here. (N. A. Flora 18:241. 1935.)

Carex viridula Michx. *(C. Oederi,* var. *viridula.)* In openings in the swamp. (Also H. D. *House,* 1917, *Albany.*)

Carex vulpinoidea Michx. In swales and along streams.

Cladium mariscoides (Muhl.) Torr. *(Mariscus mariscoides.)* In wet marl bogs; common.

–**Cyperus diandrus** Torr. In wet places along ponds and streams.

*__Cyperus rivularis__ Kunth. In mud along banks of streams.

*–**Dulichium arundinaceum** (L.) Britt. In wet sphagnum areas.

*__Eleocharis acicularis__ (L.) R. & S. In shallow water and on marshy stream banks.

–**Eleocharis acuminata** (Muhl.) Ness. Reported.[7] Not seen.

*__Eleocharis calva__ Torr. SPIKE RUSH. In shallow water and in marshy places.

*__Eleocharis elliptica__ Kunth. (*E. tenuis.*) In wet marly areas.

*__Eleocharis intermedia__ (Muhl.) Schultes. *(J. B. Fuller* under *Scirpus pauciflorus* Lightf. *(R. Acad.))*

*__Eleocharis obtusa__ (Willd.) Schultes. On muddy areas about margins of shallow pools and streams.

Eleocharis rostellata Torr. In wet open marl bogs; abundant.

–**Eriophorum virginicum** L. Reported.[7] Not seen.

Eriophorum viridi-carinatum (Engelm.) Fern. COTTON GRASS. On sphagnum hummocks in marl bogs; frequent.

Rynchospora alba (L.) Vahl. BEAK RUSH. In sphagnum bogs and also in marl bogs.

Rynchospora capillacea Torr. BEAK RUSH. Common among larger plants in open marl.

Rynchospora capillacea, var. **leviseta** Hill. In open marl.

*__Scirpus acutus__ Muhl. TULE, HARD-STEM BULRUSH. In shallow water and wet marshes.

Scirpus americanus Pers. THREE-SQUARE, SHORE RUSH. In marl bogs and along streams.

Scirpus atrovirens Muhl. In wet open places.

–**Scirpus atrocinctus** Fern. In wet swales; common.

Scirpus caespitosus L. In wet marl bogs; common.

Scirpus cyperinus (L.) Kunth. In wet swales.

*__Scirpus lineatus__ Michx. In wet open places and along trails.

*__Scirpus pedicellatus__ Fern. In swales.

–**Scirpus Torreyi** Olney. Reported by Paine,[2] Day.[3] Apparently not seen since then.

Scirpus validus Vahl. GREAT BULRUSH. Local about springy places, usually in shallow water.

Scleria verticillata Muhl. Among larger plants in open marl; mostly in drier areas.

17. ARACEAE

*__Acorus Calamus__ L. Sweet Flag. In shallow water along streams and in swales.

Arisaema triphyllum (L.) Schott. Jack-in-the-Pulpit. In swamps and moist woods.

*__Arisaema Dracontium__ (L.) Schott. Green Dragon. On alluvial soil along streams, usually among *Pteretis nodulosa*.

Calla palustris L. Wild Calla. In shallow water along streams and in swamps.

Symplocarpus foetidus (L.) Nutt. Skunk Cabbage. In wet woodlands and in swamps.

18. LEMNACEAE

*__Lemna minor__ L. Floating on the surface of sluggish streams and temporary pools and spring-holes.

*__Lemna trisulca__ L. In spring-fed brooks.

*__Spirodela polyrhiza__ (L.) Schleid. In spring-fed pools.

*__Wolffia columbiana__ Karst. With *Lemna minor* L., floating in quiet water in a slough.

*__Wolffia punctata__ Griseb. With the preceding.

19. JUNCACEAE

–**Juncus acuminatus** Michx. Rush. Reported by Paine,[1] and others.[7] Not seen

Juncus alpinus Vill., var. **fuscescens** Fern. In muddy borders of ponds and in swales.

Juncus alpinus Vill., var. **insignis** Fries. In marl openings.

*–**Juncus articulatus** L. In marl bogs.

Juncus balticus Willd., var. **littoralis** Engelm. Rush. In wet depressions in open marl bog.

Juncus brachycephalus (Engelm.) Buch. Along streams and in swales.

Juncus brevicaudatus (Engelm.) Fern. In swales.

Juncus bufonius L. Toad Rush. Along paths and on muddy stream banks.

–**Juncus canadensis** J. Gay. Reported by M. S. Baxter.[3] Not seen.

Juncus Dudleyi. Wieg. In spring-fed bog; rare.

*__Juncus effusus__ L., var. **solutus** Fern. and Wieg. Bulrush. In swales.

*__Juncus macer__ S. F. Gray. Along paths in the bogs.

*__Juncus marginatus__ Rostk. Along streams in marl bog.

*__Juncus nodosus__ L. Rush. In swales and along small streams.

*__Juncus Torreyi__ Coville. In a dried-up pool.

*__Luzula saltuensis__ Fern. Wood Rush. In rich woodlands.

20. LILIACEAE

*__Allium canadense__ L. WILD ONION. In open woods, mostly on alluvial soil.

Allium tricoccum Ait. WILD LEEK. In open woods; rare.

*ALLIUM VINEALE L. WILD GARLIC. Introduced, edge of field.

*__Clintonia borealis__ (Ait.) Raf. WOOD LILY. In swampy woodlands.

*__Erythronium americanum__ Ker. YELLOW ADDER'S TONGUE. In upland hardwoods.

HEMEROCALLIS FULVA L. DAY LILY. Introduced, edge of swamp.

*__Lilium canadense__ L. CANADA LILY. In wet meadows.

*__Lilium philadelphicum__ L. WOOD LILY. In openings in arbor-vitae swamp.

Maianthemum canadense Desf. WILD LILY-OF-THE-VALLEY. On hummocks in swampy forests.

Medeola virginiana L. INDIAN CUCUMBER ROOT. In rich woodlands.

Polygonatum pubescens (Willd.) Pursh. SMALL SOLOMON'S SEAL. In rich woodlands.

Smilacina racemosa (L.) Desf. FALSE SOLOMON'S SEAL. In openings in upland forests.

Smilacina stellata (L.) Desf. In swampy woods and arbor-vitae thickets.

Smilacina trifolia (L.) Desf. On sphagnum hummocks in arbor-vitae thickets.

*__Smilax hispida__ Muhl. GREEN BRIER. In thickets bordering the bogs.

*–__Smilax herbacea__ L. CARRION-FLOWER. Edge of woodland.

*__Streptopus roseus__ Michx. TWISTED-STALK. Among hemlocks in open woods.

Tofieldia glutinosa (Michx.) Pers. Mostly on hummocks in marl bogs.

Trillium erectum L. WAKE ROBIN, RED TRILLIUM. In rich woodlands; rare.

Trillium grandiflorum (Michx.) Salisb. WHITE TRILLIUM. In rich woodlands; common.

Uvularia grandiflora Sm. BELLWORT. In hardwood forests.

–__Uvularia perfoliata__ L. Reported.[7] Not seen.

*__Veratrum viride__ Ait. AMERICAN HELLEBORE. On alluvial soil along Black Creek; infrequent.

Zygadenus chloranthus Richards. In open marl bogs. This is the most extensive of the few stations in New York for this species.

21. IRIDACEAE

*__Iris versicolor__ L. BLUE FLAG, WILD IRIS. In swales and sloughs.

*–__Sisyrinchium angustifolium__ Mill. BLUE-EYED-GRASS. In grassy border along stream.

22. ORCHIDACEAE

Arethusa bulbosa L. On sphagnum hummocks in marl bogs.

Calopogon pulchellus (Sw.) R. Br. GRASS-PINK ORCHID. In wet places in marl bog.

Calypso bulbosa (L.) Oakes. CALYPSO. The habitat of this species is usually in moss in deep coniferous woods. According to C. M. Booth, who discovered Calypso in Bergen Swamp in 1863, about forty plants were growing in hemlock woods bordering the swamp when the station was last visited by Booth and Fuller.[3] Paine[1] reported a single plant noticed by C. M. Booth. It was also reported by G. T. Fish, 1866, and another plant was reported by W. H. Lennon (no date) but probably before 1900.[6] Apparently this species has not been seen in Bergen Swamp since 1900. In the herbarium of the Rochester Academy of Science is the only Bergen material that I have seen, a single sheet containing one plant, labelled "border, Bergen Swamp," 1866, (no collector). It is questionable whether this species still grows in Bergen Swamp.

Corallorhiza maculata Raf. CORAL ROOT. In moist woods. *(Stewart,* 1933, *Rochester.)*

Corallorhiza trifida Chat. CORAL ROOT. The only specimens seen are those collected by *W. H. Lennon,* 1893 *(Albany).*

Cypripedium acaule Ait. STEMLESS LADYSLIPPER, MOCCASIN FLOWER. On hemlock knolls and borders of swamps; infrequent.

Cypripedium Calceolus L., var. **pubescens** (Willd.) Correll. *(C. parviflorum,* var. *pubescens.)* LARGE-FLOWERED YELLOW LADYSLIPPER. Local in openings in the arbor-vitae swamps; infrequent in the open marl.

Cypripedium Calceolus L., var. **parviflorum** (Salisb.) Fern. *(C. parviflorum.)* SMALL-FLOWERED YELLOW LADYSLIPPER. In marl bogs; infrequent. (Cf. Fernald, M. L., Rhodora 48: 4, 1946.)

Cypripedium candidum Muhl. SMALL WHITE LADYSLIPPER. Local in open marl bogs. Most of the specimens occur on the raised drier parts of the marl area. This species is rare in New York State. It is known from only a few other stations in the western part of the state. The New York State Conservation law makes it illegal to disturb the white ladyslipper in Bergen Swamp.

Cypripedium reginae Walt. *(C. spectabile, C. hirsutum.)* SHOWY LADYSLIPPER. Local in wet openings in the arbor-vitae swamp.

*EPIPACTIS LATIFOLIA (L.) All. *(Serapius Helleborine.)* Common in moist woodlands. This orchid is believed to have been introduced from Europe.

–**Goodyera pubescens** (Willd.) R. Br. *(Epipactis pubescens.)* RATTLESNAKE PLANTAIN. Reported.[7] Not seen.

–**Goodyera repens** (L.) R. Br. var. **ophioides** Fern. *(Epipactis repens.)* RATTLESNAKE PLANTAIN. Reported.[7] Not seen.

–**Habenaria blephariglottis** (Willd.) Torr. WHITE FRINGED ORCHIS. Reported by *F. W. Johnson,* Zenkert.[7] I have seen no specimens from Bergen Swamp.

–**Habenaria bracteata** (Willd.) R. Br. Reported.[6, 7] Not seen.

Habenaria dilitata (Pursh) Gray. In open marl bogs.

Habenaria fimbriata (Ait.) R. Br. PURPLE FRINGED ORCHIS. In openings in wet swamps.

Habenaria Hookeri Torr. In rich hardwood forests; rare. (*W. H. Lennon,* 1885, *Albany; E. P. Killip,* 1913, *R. Acad.*)

Habenaria hyperborea (L.) R. Br. In springy marl bogs; infrequent. *H. D. House, 6539,* 1919, *Albany.* Also collected by *Lennon, Peck* and *F. W. Johnson.*

***Habenaria lacera** (Michx.) R. Br. RAGGED ORCHIS. In open grassy places; rare.

–**Habenaria orbiculata** (Pursh) Torr. *W. H. Lennon,* 1892, according to Beckwith and Macauley.[7] Not seen.

Habenaria psychodes (L.) Sw. PURPLE FRINGED ORCHIS. In wet alder swamps; infrequent.

Liparis Loeselii (L.) Rich. In marly areas about springs. First reported by *C. M. Booth.*[8] *(H. D. House, 6522,* 1919, *Albany. F. W. Johnson, 310,* 1923, *Buffalo.* Without name of collector, 1867, *R. Acad.)*

Listera cordata (L.) R. Br. On mossy hummocks in arbor-vitae swamp; infrequent.

Microstylis monophyllos (L.) Lindl. ADDER'S MOUTH. Reported by several authors.[1, 2, 6, 7] Not seen.

Orchis spectabilis L. SHOWY ORCHIS. In moist woodlands; infrequent.

Pogonia ophioglossoides (L.) Ker. On sphagnum hummocks in marl bog; common.

***Spiranthes Romanzoffiana** Cham. In open marl bogs. (Also *W. H. Lennon,* 1891, *R. Acad.; H. D. House,* 1916, *Albany.*)

***Spiranthes cernua** (L.) Rich. AUTUMN LADY'S TRESSES. In grassy openings bordering the swamp.

***Spiranthes lucida** (H. H. Eaton) Ames. LADY'S TRESSES. On hummocks in swales.

23. PIPERACEAE

Saururus cernuus L. LIZARD'S TAIL. In shallow water and in mucky, over-flow soil along streams.

24. SALICACEAE

Populus balsamifera L. *(P. deltoides.)* COTTONWOOD. In wet woodlands and along streams.

*POPULUS CANDICANS Ait. BALM OF GILEAD. Edge of spring-fed bog; rare.

***Populus grandidentata** Michx. LARGE-TOOTHED ASPEN. In open upland woods.

***Populus tacamahacca** Mill. TACAMAHAC. A clump of small trees on the edge of the swamp.

Populus tremuloides Michx. QUAKING ASPEN. In openings about the bogs.

*SALIX ALBA L. var. VITELLINA (L.) Koch. WHITE WILLOW. Along streams.

***Salix amygdaloides** Anders. PEACH-LEAVED WILLOW. Along streams and in swales.

Salix Bebbiana Sarg. BEBB'S WILLOW. In openings in the woodlands and bogs.

Salix candida Flügge. HOARY WILLOW. In openings in the marl.

***Salix cordata** Muhl. Along streams and in marshes.

Salix discolor Muhl. PUSSY WILLOW. Along streams.

–**Salix humilis** Marsh. A fragmentary specimen so determined *(F. W. Johnson,* barren marl, *(336)* 1923, *Buffalo.)* is *Salix petiolaris* Smith.

***Salix interior** Rowlee. *(S. longifolia.)* SAND-BAR WILLOW. Mostly on alluvial soil along Black Creek.

Salix lucida Muhl. SHINING WILLOW. In springy openings.

***Salix nigra** Marsh. BLACK WILLOW. In sloughs and along streams.

***Salix petiolaris** Smith. In openings in the bogs.

***Salix pedicellaris** Pursh. Along small streams in the bog.

*SALIX PURPUREA L. BASKET WILLOW. Established in swales and along streams.

***Salix sericea** Marsh. In openings in the swamp.

***Salix serissima** (Bailey) Fern. AUTUMN WILLOW. In the marl bog, mostly about springs.

25. MYRICACEAE

Myrica pennsylvanica Lois. *(M. carolinensis.)* BAYBERRY. On hummocks in the marl and common in openings in the Thuja swamps.

26. JUGLANDACEAE

***Carya cordiformis** (Wang.) K. Koch. BITTERNUT. A few scattered trees in the hardwood forest.

***Carya glabra** (Mill.) Sweet. PIGNUT. Rare, near west end of swamp.

***Carya ovata** (Mill.) K. Koch. SHAGBARK HICKORY. A number of large trees mostly on alluvial soil near Black Creek.

***Juglans cinerea** L. BUTTERNUT. Scattered along streams in the hardwood forest.

27. BETULACEAE

Alnus incana (L.) Moench. SPECKLED ALDER. Common in wet thickets and alder swamps.

Betula lutea Michx. YELLOW BIRCH. In the bordering swamp forests; common.

***Betula pendula** Roth. EUROPEAN WHITE BIRCH. A few small trees in openings in the arbor-vitae swamp; probably introduced.

***Betula pumila** L. DWARF BIRCH. Rare in the open marl bog, 1944. Otherwise apparently not recorded in western New York outside of Tonawanda Swamp in Erie County, Booth.

Carpinus caroliniana Walt. BLUE BEECH. In woods bordering the swamp.

***Corylus cornuta** Marsh. BEAKED HAZELNUT. In thickets and under hardwoods.

Ostrya virginiana (Mill.) K. Koch. HOP HORNBEAM. In hardwood forests bordering the swamp.

28. FAGACEAE

Fagus grandifolia Ehrh. BEECH. Infrequent in upland forests.

Quercus alba L. WHITE OAK. On ridges; infrequent.

Quercus bicolor Willd. SWAMP WHITE OAK. In swales and swampy woodlands.

Quercus borealis Michx. f., var. **maxima** (Marsh.) Sarg. RED OAK. On ridges with Tsuga; infrequent.

***Quercus macrocarpa** Michx. BUR OAK. In wet depressions and on alluvial soil along Black Creek.

29. URTICACEAE

***Boehmeria cylindrica** (L.) Sw. FALSE NETTLE. In rich mucky soils.

***Humulus lupulus** L. HOP. Established in thickets and along streams; rare.

Laportea canadensis (L.) Gaud. WOOD NETTLE. Common in rich woodlands.

Pilea pumila (L.) Gray. CLEARWEED. In mucky soil under trees.

Urtica procera Muhl. *(U. gracilis.)* STINGING NETTLE. Along streams.

30. MORACEAE

Ulmus americana L. AMERICAN ELM. A common tree in wet woodlands.

***Ulmus rubra** Michx. (*U. fulva* Michx.) SLIPPERY ELM. Infrequent in openings in the forest.

–**Morus rubra** L. A record based upon a seedling with a single lobed leaf (Zenkert,[7] 1932. Among arbor-vitae, *Buffalo*) appears to belong to *Morus alba* L.

31. SANTALACEAE

Comandra umbellata (L.) Nutt. BASTARD TOADFLAX. In openings in the marl bogs.

32. ARISTOLOCHIACEAE

Asarum canadense L. WILD GINGER. In rich humus under hardwoods.

33. POLYGONACEAE

***Polygonum amphibium** L. WATER SMARTWEED. In shallow water.

*POLYGONUM AVICULARE L. KNOTWEED. Along paths and in open areas.

***Polygonum coccineum** Muhl. In larger streams, temporary pools and marshes.

*POLYGONUM CONVOLVULUS L. BLACK BINDWEED. In openings along paths.

***Polygonum Hydropiper** L. SMARTWEED. In mucky openings.

***Polygonum hydropiperoides** Michx. WATER PEPPER. In streams and swales.

***Polygonum lapathifolium** L. Along stream banks.

***Polygonum pennsylvanicum** L. PENNSYLVANIA SMARTWEED. In openings along streams.

POLYGONUM PERSICARIA L. LADY'S THUMB. In paths and open grassy places.

***Polygonum punctatum** Ell. In a swale.

***Polygonum punctatum** Ell., var. **leptostachyum** (Meisn.) Small. On borders of pools and ditches.

Polygonum robustius (Small) Fernald. In mucky soil in swales.

Polygonum sagittatum L. On boggy banks of streams.

***Polygonum scandens** L. On alluvial soil and in marshes.

***Polygonum virginianum** L. In wet open woodlands.

*RUMEX ACETOSELLA L. SHEEP SORREL. Infrequent on grassy hummocks in open areas.

Rumex Brittanica L. GREAT WATER DOCK. In swales and marshes.

*RUMEX CRISPUS L. CURLY DOCK. In openings along trails.

*RUMEX OBTUSIFOLIUS L. BROAD-LEAVED DOCK. In open grassy places.

Rumex verticillatus L. SWAMP DOCK. In swales and temporary pools.

34. CHENOPODIACEAE

*__Atriplex patula__ L., var. __hastata__ (L.) Gray. In openings along paths; probably introduced.

*Chenopodium album L. Lamb's Quarters. Openings along trail.

*Chenopodium glaucum L. Oak-leaved Goosefoot. On muddy banks of Black Creek.

*__Chenopodium hybridum__ L. Maple-leaved Goosefoot. Along woodland road.

*__Chenopodium paganum__ Reich. Pigweed. Along bank of Black Creek.

35. AMARANTHACEAE

*Amaranthus graecizans L. Tumbleweed. On island in Black Creek.

*Amaranthus hybridus L. Green Amaranth. Along Black Creek.

*Amaranthus retroflexus L. Amaranth Pigweed. Along trails.

36. PHYTOLACCACEAE

*__Phytolacca americana__ L. Pokeweed. On rich moist soil in openings in the forests.

37. ILLEBRACACEAE

*Scleranthus annuus L. Knawel. In open sandy places.

38. CARYOPHYLLACEAE

*Agrostemma Githago L. Purple Cockle. Edge of field bordering the swamp.

*Arenaria serpyllifolia L. Sandwort. In open places.

*Cerastium vulgatum L. Mouse-ear Chickweed. In open grassy places.

*Dianthus Armeria L. Deptford Pink. In grassy openings.

*Lychnis alba Mill. White Cockle. Along road; edge of swamp.

*Silene noctiflora L. Night-flowering Catchfly. Along woods road.

Stellaria graminea L. Stitchwort. In grassy openings.

Stellaria longifolia Muhl. Stitchwort. On hummocks in the arbor-vitae swamp; also *J. Laird*, 1898 *(R. Acad.)*

Stellaria media (L.) Cyrill. Chickweed. In open places along paths.

39. PORTULACCACEAE

Claytonia virginica L. Spring Beauty. In moist hardwood forests.

*__Claytonia caroliniana__ Michx. In hardwood forest.

40. CERATOPHYLLACEAE

***Ceratophyllum demersum** L. HORNWORT. Submersed in Black Creek.

41. NYMPHAEACEAE

***Nuphar advena** Ait. SPATTERDOCK, YELLOW POND-LILY. In a small stream entering Black Creek.

42. RANUNCULACEAE

Actaea alba (L.) Mill. WHITE BANEBERRY. In rich woodlands.

***Actaea rubra** (Ait.) Willd. RED BANEBERRY. In rich woodlands.

***Anemone canadensis** L. ANEMONE. In open areas in the swamp.

Anemone virginiana L. In open woodlands and along streams.

***Anemonella thalictrioides** (L.) Spach. Open upland woods; rare.

Aquilegia canadensis L. COLUMBINE. In secondary marl bogs and in openings in woods.

Caltha palustris L. COWSLIP, MARSH MARIGOLD. In marshes along brooks.

Clematis virginiana L. VIRGIN'S BOWER. In thickets in the bogs and on uplands.

Coptis trifolia (L.) Salisb. subsp. **groenlandica** (Oeder) Hulten. GOLD-THREAD. In rich humus in woods bordering the bogs.

Hepatica americana (DC.) Ker. HEPATICA. In rich woodlands.

Hepatica acutiloba DC. HEPATICA. In upland woodlands.

–**Hydrastis canadensis** L. GOLDEN SEAL. Reported from Bergen by *W. H. Lennon.*[3] No specimens have been seen in the field or herbaria.

Ranunculus abortivus L. SMALL-FLOWERED BUTTERCUP. Open woodlands.

RANUNCULUS ACRIS L. TALL FIELD BUTTERCUP. In openings in the swamp.

***Ranunculus aquatilis** L. WHITE WATER-CROWFOOT. In streams and ponds.

Ranunculus flagellaris Raf. YELLOW WATER-BUTTERCUP. Temporary ponds and swales.

***Ranunculus recurvatus** Poir. HOOKED BUTTERCUP. In wet woodlands.

***Ranunculus sceleratus** L. CURSED CROWFOOT. In shallow water and mucky stream banks.

***Ranunculus septentrionalis** Poir. SWAMP BUTTERCUP. Marshy thickets and sloughs.

***Thalictrum dioicum** L. MEADOW RUE. In open woodlands.

***Thalictrum polygamum** Muhl. MEADOW RUE. Swamps and along streams.

43. MAGNOLIACEAE

*__Magnolia acuminata__ L. CUCUMBER TREE. A few small trees near the border.

44. MENISPERMACEAE

*__Menispermum canadense__ L. MOONSEED. Borders of woodlands and thickets.

45. BERBERIDACEAE

*BERBERIS THUNBERGII DC. JAPANESE BARBERRY. Established in the open marl and edge of the swamp.

*BERBERIS VULGARIS L. COMMON BARBERRY. Established in openings in the marl.

*__Caulophyllum thalictroides__ (L.) Michx. BLUE COHOSH. In moist rich woodlands.

Podophyllum peltatum L. MAY APPLE. In openings and borders of woodland.

46. LAURACEAE

Lindera Benzoin (L.) Bl. (*Benzoin aeativale* L.) SPICEBUSH. In wet woodlands.

47. PAPAVERACEAE

Sanguinaria canadensis L. BLOODROOT. In open woods and thickets.

*CHELIDONIUM MAJUS L. CELANDINE. Under trees along the south border of the swamp.

48. FUMARIACEAE

Dicentra canadensis (Goldie) Walp. SQUIRREL CORN. In rich woodlands.

Dicentra Cucullaria (L.) Bernh. DUTCHMAN'S BREECHES. In rich woodlands.

49. CRUCIFERAE

–**Arabis hirsuta** (L.) Scop. The specimen so reported[7] is a depauperate plant of *Cardamine bulbosa (Stewart,* 1933, *Rochester)*.

*__Armoracia aquatica__ (Eaton) Wieg. LAKE CRESS. In streams. Along margin of Black Creek.

*ARMORACIA RUSTICANA Gaertn. HORSE RADISH. In swales and along streams.

*BARBAREA VULGARIS R. Br. WINTER CRESS. In openings in the bogs and elsewhere.

*CAPSELLA BURSA-PASTORIS (L.) Medic. SHEPHERD'S PURSE. Along path. Rare.

*CAMELINA MICROCARPA Andrz. FALSE FLAX. Along paths.
–CAMELINA SATIVA Grantz. Specimens so reported are *C. microcarpa.* (E. P. Killipp, R. Acad.)
Cardamine bulbosa (Schreb.) BSP. SPRING CRESS. In rich mucky soil.
***Cardamine pennsylvanica** Muhl. In mucky swales and in shallow brooks.
***Cardamine pratensis** L., var. **palustris** Wimm. and Grab. CUCKOO FLOWER. In wet alder swamps.
Dentaria diphylla Michx. TOOTHWORT. In hardwood forests.
Dentaria laciniata Muhl. TOOTHWORT. In moist hardwoods; rare.
*ERYSIMUM CHEIRANTHOIDES L. WORMSEED MUSTARD. In openings, mostly on mucky soil.
*HESPERIS MATRONALIS L. ROCKET. In open woods bordering the swamp.
*LEPIDIUM CAMPESTRE (L.) R. Br. DOWNY PEPPERGRASS. In openings and along trails.
*NASTURTIUM OFFICINALE R. Br. WATER CRESS. In small spring-fed pools and their outlets.
***Roripa islandica** (Oeder ex. Murr.) Borbás var. **hispida** Butters and Abbe. *(R. palustris,* var. *hispida.)* MARSH CRESS. In swales and marshes.
***Roripa islandica** (Oeder ex. Murr.) Borbás var. **microcarpa** (Regal.) Fern. *(R. hispida,* var. *glabrata.)* In marshy places.
*SISYMBRIUM ALTISSIMUM L. TUMBLE MUSTARD. In openings along trails.
SISYMBRIUM OFFICINALE (L.) Scop. HEDGE MUSTARD. Along trails and in openings.

50. SARRACENIACEAE

Sarracenia purpurea L. PITCHER PLANT. In sphagnum bogs and on hummocks in the marl bogs; sometimes in wet depressions in the open marl.

51. DROSERACEAE

Drosera rotundifolia L. SUNDEW. On sphagnum hummocks in arborvitae swamps and open marl bogs.

52. CRASSULACEAE

***Penthorum sedoides** L. DITCH STONECROP. In swales and along streams.
SEDUM PURPUREUM Tausch. LIVE-FOR-EVER. Established along edge of swamp.

53. SAXIFRAGACEAE

Chrysosplenium americanum Schw. GOLDEN SAXIFRAGE. In mucky soil along streams.

Mitella diphylla L. MITERWORT. In rich woodlands.
Mitella nuda L. In mucky soil, usually under evergreen trees.
Parnassia caroliniana Michx. GRASS-OF-PARNASSUS. In marl bog, and about marl springs.
***Ribes americanum** Mill. WILD BLACK CURRANT. In swampy places.
Ribes Cynosbati L. PRICKLY GOOSEBERRY. In open woodlands.
***Ribes hirtellum** Michx. SWAMP GOOSEBERRY. In marl bogs and in openings in arbor-vitae swamp.
***Ribes triste** Pall., var. **albinervium** (Michx.) Fern. WILD RED CURRANT. In wet marshy woodlands.
Saxifraga pennsylvanica L. SWAMP SAXIFRAGE. In mucky soil in swamps.
***Saxifraga virginensis** Michx. EARLY SAXIFRAGE. Upland woods; rare.
Tiarella cordifolia L. FALSE MITERWORT. In rich woodlands.

54. HAMAMELIDACEAE

***Hamamelis virginiana** L. WITCH-HAZEL. In open woodlands.

55. PLATANACEAE

***Platanus occidentalis** L. SYCAMORE. Several large trees occur among the hardwoods within the swamp.

56. ROSACEAE

Agrimonia gryposepala Wallr. AGRIMONY. In open grassy places.
Amelanchier arborea (Michx.) Fern. (*A. canadensis.*) SHADBUSH. In open woods, mostly on upland.
***Amelanchier intermedia** Spach. SERVICEBERRY. In openings in the bogs.
***Amelanchier laevis** Wieg. JUNEBERRY. On uplands bordering the bogs.
***Crataegus brainerdi** Sarg. THORNAPPLE. In open places; infrequent.
***Crataegus macracantha** Lodd. LONG-SPURRED THORN. On alluvial soil along streams; frequent.
***Crataegus punctata** Jacq. THORNAPPLE. In thickets, edge of swamp; frequent.
Dalibarda repens L. On rotten logs and stumps; rare. (also *G. T. Fish*, 1865 *(708) R. Acad.*)
Fragaria vesca L. WILD STRAWBERRY. In openings in woods; rare.
Fragaria virginiana Duch. FIELD STRAWBERRY. Common in grassy places and cut-over woodlands.
***Geum canadense** Jacq. WHITE AVENS. In openings in woods.
***Geum rivale** L. PURPLE AVENS. In mucky soil mostly in alder swamps.

Geum aleppicum Jacq., var. **strictum** (Ait.) Fern. (*G. strictum.*) YELLOW AVENS. In grassy openings.

–MALUS GLAUCESCENS Rehder. Report based upon a specimen collected by *C. H. Peck* in 1904, *(Albany)* is labelled Bergen. This undoubtedly refers to the village and not the swamp.

***Potentilla argentea** L. SILVERY CINQUEFOIL. Along trails and in cut-over areas.

*POTENTILLA ARGUTA Pursh. In grassy opening bordering the swamp.

Potentilla fruticosa L. SHRUBBY CINQUEFOIL. In marl bogs; abundant.

***Potentilla norvegica** L., var. **hirsuta** (Michx.) Lehm. ROUGH CINQUEFOIL. In openings in and about the swamp.

–**Potentilla palustris** (L.) Scop. MARSH CINQUEFOIL. Reported by Day.[2] Not seen.

*POTENTILLA RECTA L. SULFUR CINQUEFOIL. In cut-over woodland areas and along trails; infrequent.

*PRUNUS AVIUM L. SWEET CHERRY. Scattered trees established in thickets.

*PRUNUS MAHALEB L. MAHALEB CHERRY. A clump of shrubby specimens established along a fence row.

***Prunus pennsylvanica** L. f. PIN- or FIRE-CHERRY. A common tree in new growth on cut-over areas.

***Prunus serotina** Ehrh. WILD BLACK CHERRY. In openings in the bog and in the surrounding forest.

Prunus virginiana L. CHOKE CHERRY. In thickets in and about the swamp.

*PYRUS AUCUPARIA L. (*Sorbus aucuparis* L.) EUROPEAN MOUNTAIN ASH. A few small specimens established in openings in arbor-vitae swamp.

Pyrus arbutifolia (L.) lf., var. **atropurpurea** (Britt.) Robins. (*Aronia arbutifolia*, var. *atropurpurea* [Britt.] Schneid.) RED CHOKEBERRY. On hummocks in marl bogs; infrequent.

*PYRUS COMMUNIS L. PEAR. A few trees are established, one even in the marl bog.

*PYRUS MALUS L. (*Malus pumila* Mill.) APPLE. Scattered trees occur in thickets about the swamp.

***Pyrus melanocarpa** (Michx.) Willd. (*Aronia melanocarpa* [Michx.] Britt.) In marl bogs and swamp; common.

***Rosa acicularis** Lindl., var. **sayana** Erlanson. *(F. W. Johnson,* 1923, *Albany.)*

–**Rosa carolina** L. DWARF ROSE. Reported,[7] but not seen.

***Rosa palustris** Marsh. SWAMP ROSE. In marshes, frequent.

***Rosa Housei** Erlandon. *(F. W. Dorst,* 1931, (Det. E. W. Erlanson.) *30785.* Marl bog. *Buffalo.)*

*__Rosa setigera__ Michx. PRAIRIE ROSE. Forming a thicket along a spring-fed brook.

__Rubus allegheniensis__ Porter. BLACKBERRY. In cut-over woods.

*__Rubus flagellaris__ Willd. DEWBERRY. In openings in the woodlands and borders of bog.

–__Rubus hispidus__ L. BLACKBERRY. In open woods.

*–RUBUS IDAEUS L. RED RASPBERRY. In cut-over swampland.

*__Rubus idaeus__ L., var. __strigosus__ (Michx.) Maxim. RED RASPBERRY. In openings and along stream banks.

*__Rubus occidentalis__ L. BLACK RASPBERRY. In thickets bordering the swamp.

__Rubus odoratus__ L. FLOWERING RASPBERRY. In rich soil bordering woodlands.

__Rubus pubescens__ Raf. *(R. triflorus.)* DWARF DEWBERRY. In wet mossy woodlands.

*__Waldsteinia fragarioides__ (Michx.) Tratt. BARREN STRAWBERRY. In open woods on uplands.

57. LEGUMINOSAE

*__Amphicarpa bracteata__ (L.) Fern. *(A. monoica.)* HOG PEANUT. In rich moist woods.

__Apios americana__ Medic. *(A. tuberosa.)* GROUNDNUT. On alluvial soil along streams.

–__Desmodium bracteosum__ (Michx.) DC. Reported.[7] Not seen.

–__Desmodium canescens__ (L.) DC. Reported.[7] Not seen.

__Desmodium glutinosum__ (Muhl. ex. Willd.) Wood. *(D. grandiflorum.)* TICK TREFOIL. In openings in upland woods.

*GLEDITSIA TRIACANTHOS L. HONEY LOCUST. Several trees along a fence row of an abandoned roadway; introduced.

*MEDICAGO LUPULINA L. BLACK MEDIC. In open places and along trails.

*MELILOTUS ALBA Desv. WHITE SWEET CLOVER. Established in cut-over areas.

*MELILOTUS ALTISSIMA Thuill. YELLOW SWEET CLOVER. Established along trails.

*MELILOTUS OFFICINALIS (L.) Lam. YELLOW SWEET CLOVER. In open grassy places along bank of Black Creek.

*TRIFOLIUM AGRARIUM L. YELLOW CLOVER. In cut-over areas.

–TRIFOLIUM ARVENSE L. RABBIT CLOVER. Reported growing along a logging road. *(F. W. Johnson.)* Not seen.

*TRIFOLIUM HYBRIDUM L. ALSIKE CLOVER. Established in openings along trails.

*–TRIFOLIUM REPENS L. WHITE CLOVER. Established in openings.

*TRIFOLIUM PRATENSE L. RED CLOVER. Established along trails and in openings.

58. OXALIDACEAE

***Oxalis europaea** Jord. *(O. corniculata.)* YELLOW WOOD SORREL. In openings along trails.

***Oxalis stricta** L. YELLOW WOOD SORREL. In grassy openings.

59. GERANIACEAE

Geranium maculatum L. CRANESBILL. In open woodlands.

Geranium Robertianum L. HERB ROBERT. In cut-over woodlands and in thickets.

60. RUTACEAE

***Zanthoxylum americanum** Mill. PRICKLY ASH. Forming thickets, mostly where the swamp joins the upland.

61. POLYGALACEAE

Polygala paucifolia Willd. FRINGED POLYGALA. In open woodlands on ridges and in the arbor-vitae swamps; common. An extensive colony with pure white corollas was found in an opening in a wet arbor-vitae swamp.

62. EUPHORBIACEAE

***Acalypha rhomboidea** Raf. *(A. virginica.)* THREE-SEEDED MERCURY. In grassy openings.

*EUPHORBIA ESULA L. LEAFY SPURGE. Along an old roadway leading into the swamp. A common introduced weed along roadsides and in grasslands between the village of Bergen and the swamp.

***Euphorbia nutans** Lag. SPURGE. In open places along trails.

63. CALLITRICHACEAE

***Callitriche palustris** L. WATER STARWORT. In shallow pools and streams with mucky bottom; local among *Cephalanthus* in swamps.

64. LIMNANTHACEAE

Floerkea proserpinacoides Willd. FALSE MERMAID. In moist woods bordering a stream, rare.

65. ANACARDIACEAE

Rhus Toxicodendron L. POISON IVY. In thickets and in cut-over arbor-vitae swamps where it may form a luxurious growth.

Rhus typhina L. STAGHORN SUMACH. In openings in the bogs and surrounding forests.

Rhus vernix L. POISON SUMACH. In a cut-over arbor-vitae swamp; rare elsewhere.

66. AQUIFOLIACEAE

Ilex verticillata (L.) Gray. WINTERBERRY, BLACK ALDER. In openings in and about the marl bogs; infrequent.

***Nemopanthus mucronata** (L.) Trel. MOUNTAIN HOLLY. In thickets, mostly between the open marl and arbor-vitae swamps.

67. CELASTRACEAE

***Celastrus scandens** L. BITTERSWEET. In upland thickets.

***Euonymus atropurpureus** Jacq. BURNING BUSH, WAHOO. Several extensive areas on alluvial soil near Black Creek.

68. ACERACEAE

***Acer nigrum** Michx. f. BLACK MAPLE. In moist hardwood forest; infrequent.

Acer pennsylvanicum L. STRIPED MAPLE. In rich woods on ridge; rare.

Acer rubrum L. RED MAPLE. In the swamp and also in marl bogs; common.

Acer saccharinum L. SILVER MAPLE. In wet woodlands; common; mostly along the north side of swamp.

Acer saccharum Marsh. SUGAR MAPLE. A common tree in the hardwood forest.

Acer spicatum Lam. MOUNTAIN MAPLE. In openings between arbor-vitae and in upland forests.

69. BALSAMINACEAE

Impatiens biflora Walt. TOUCH-ME-NOT. In moist woodlands and along streams.

***Impatiens pallida** Nutt. PALE TOUCH-ME-NOT. In moist woodlands.

70. RHAMNACEAE

Rhamnus alnifolia L'Her. SWAMP BUCKTHORN. In openings in marl bogs and along streams in arbor-vitae swamps; common.

*RHAMNUS CATHARTICA L. COMMON BUCKTHORN. A few clumps established in the drier marl openings.

71. VITACEAE

***Vitis vulpina** L. FROST GRAPE. In thickets and woodlands; common.

Parthenocissus quinquefolia (L.) Planch. VIRGINIA CREEPER. In open woodlands; common.

***Parthenocissus vitaceae** (Knerr.) Hitchc. In thickets and woodlands, infrequent.

72. TILIACEAE

Tilia americana L. BASSWOOD. Common in hardwood forest.

73. MALVACEAE

–**Hibiscus moscheutos** L. SWAMP MALLOW. Reported.[7] Not seen.
*MALVA MOSCHATA L. MUSK MALLOW. In grassy cut-over area; rare.
*MALVA NEGLECTA Wallr. (*M. rotundifolia.*) ROUND-LEAVED MALLOW. Established along a trail; rare.

74. HYPERICACEAE

–**Hypericum boreale** (Britt.) Bickn. In wet openings bordering arbor-vitae swamp.
*HYPERICUM PERFORATUM L. ST. JOHN'S-WORT. Established in numerous places in openings in the woods and dry border of marl bog.
Hypericum punctatum Lam. In spring-fed boggy areas.
Hypericum virginicum L. In sphagnum hummocks along edge of arbor-vitae swamp.

75. VIOLACEAE

***Viola affinis** LeConte. In wet woods, chiefly on alluvial soil; infrequent. (Also *E. P. Killipp,* 1916, *R. Acad.*)
Viola blanda Willd. STEMLESS WHITE VIOLET. In wet arbor-vitae swamp.
*VIOLA ARVENSIS Murr. FIELD PANSY. In field bordering Bergen swamp. *(F. W. Johnson,* 1924, *Rochester.)*
Viola canadensis L. CANADA VIOLET. In open upland woods; infrequent.
Viola conspersa Reichenb. DOG VIOLET. In open woodlands; frequent.
***Viola cucullata** Ait. MARSH BLUE VIOLET. In marshy woodlands; infrequent.
Viola eriocarpa Schwein., var. **leiocarpa** Fern. & Wieg. *(V. scabriuscula.)* STEMMED YELLOW VIOLET. In moist woods.
***Viola incognita** Brainerd. STEMLESS WHITE VIOLET. In wet woods and boggy areas. *(K. M. Wiegand,* 1918, *Cornell.)*
Viola nephrophylla Greene. NORTHERN BOG VIOLET. In marl bogs.
Viola pallens (Banks) Brainerd. STEMLESS WHITE VIOLET. In bogs and wet woodlands.
***Viola pubescens** Ait. STEMMED YELLOW VIOLET. In rich woodlands.
Viola renifolia Gray, var. **Brainerdii** Fern. STEMLESS WHITE VIOLET. In mossy carpets in arbor-vitae swamp; common.
Viola rostrata Pursh. LONG-SPURRED VIOLET. In open woods; common.
–**Viola rotundifolia** Michx. STEMLESS YELLOW VIOLET. In rich moist woods; rare.

-**Viola septentrionalis** Greene. NORTHERN BLUE VIOLET. In open woodlands; infrequent.

Viola sororia Willd. (*V. cucullata* in part.) MEADOW BLUE VIOLET. On alluvial soils, chiefly in moist open woodlands.

76. ONAGRACEAE

Circaea alpina L. ENCHANTER'S NIGHTSHADE. In arbor-vitae swamp; frequent.

Circaea latifolia L. ENCHANTER'S NIGHTSHADE. In moist open woodlands.

Epilobium angustifolium L. FIREWEED. In openings in the bogs and woodlands.

***Epilobium densum** Raf. MARSH WILLOW HERB. Among sedges in open marshes.

***Epilobium coloratum** Muhl. WILLOW HERB. In cut-over arbor-vitae swamps and along streams.

***Epilobium glandulosum** Lehm., var. **perplexans** (Trel.) Fern. Along small streams and about springy places.

*EPILOBIUM HIRSUTUM L. WILLOW HERB. In mucky soil along spring-fed streams and ditches.

***Ludvigia palustris** (L.) Ell. WATER PURSLANE. In small streams and shallow ponds.

OENOTHERA BIENNIS L., var. NUTANS (Atkins. and Bart.) Wieg. EVENING PRIMROSE. In openings in arbor-vitae swamp.

OENOTHERA BIENNIS L., var. PYCNOCARPA (Atkins. and Bart.) Wieg. Along trails and in openings and swampy areas.

***Oenothera perennis** L. SUNDROPS. In grassy areas bordering the swamp.

77. ARALIACEAE

Aralia hispida Vent. BRISTLY SARSAPARILLA. On a gravelly ridge; infrequent.

Aralia nudicaulis L. WILD SARSAPARILLA. Common in swampy woodlands.

***Aralia racemosa** L. SPIKENARD. In moist rich woodlands bordering the swamp; infrequent.

78. UMBELLIFERAE

***Angelica atropurpurea** L. ANGELICA. On alluvial and swampy areas; infrequent.

*CARUM CARVI L. CARAWAY. Established along a trail; frequent in grasslands about the swamp.

***Cicuta bulbifera** L. In shallow temporary pools in the swamp; sometimes growing on floating mats.

Cicuta maculata L. WATER HEMLOCK. Along streams and in open swampy areas.

*CONIUM MACULATUM L. POISON HEMLOCK. Along Black Creek; rare.

Conioselinum chinense (L.) BSP. In rich mucky soil in arbor-vitae swamp.

Cryptotaenia canadensis (L.) DC. In open upland woods.

DAUCUS CAROTA L. WILD CARROT. Established in numerous openings and cut-over areas.

***Heracleum lanatum** Michx. COW PARSNIP. On alluvial soil along streams; rare.

*–**Hydrocotyle americana** L. In mucky soil along small streams.

Osmorhiza Claytoni (Michx.) Clarke. SWEET CICELY. In open upland woods; infrequent.

*PASTINACA SATIVA L. PARSNIP. Established in openings.

Sanicula marilandica L. SANICLE. In open upland woods.

***Sium suave** Walt. WATER PARSNIP. In temporary pools and along streams; frequent.

79. CORNACEAE

***Cornus alternifolia** L. f. In open woods and openings in the arbor-vitae swamps.

***Cornus amomum** Mill. In thickets about streams and edges of swamps.

Cornus canadensis L. BUNCHBERRY, DWARF CORNEL. In rich humus in the arbor-vitae swamp; also on sphagnum hummocks in the marl bogs.

***Cornus racemosa** Lam. *(C. paniculata.)* GRAY DOGWOOD. Forming thickets about borders of swamp and forests.

Cornus rugosa Lam. (*C. circinata.*) ROUND-LEAVED DOGWOOD. In openings in the hardwood forests and arbor-vitae swamps.

Cornus stolonifera Michx. RED OSIER DOGWOOD. In wet places about springy areas and in marshes.

80. ERICACEAE

–**Chamaedaphne calyculata** (L.) Moench. LEATHER-LEAF. Recorded as one of the "sub-dominant species in the secondary marl association".[7] Although diligently searched for, no specimens were seen in the swamp. No specimens could be found in herbaria.

Chiogenes hispidula (L.) T. and G. CREEPING SNOWBERRY, SQUAWBERRY. On mossy forest floor, especially on decayed logs and stumps; frequent.

Gaultheria procumbens L. WINTERGREEN. On sphagnum hummocks in the marl bogs; also on upland ridges and in openings in the arbor-vitae swamps.

Gaylussacia baccata (Wang.) K. Koch. BLACK HUCKLEBERRY. Common on hummocks in marl bogs; in openings in the arbor-vitae swamps.

***Chimaphila umbellata** (L.) Bart. PIPSISSEWA. On pine-hemlock ridge. *(J. Laird,* 1894, *R. Acad.)*

Ledum groenlandicum Oeder. LABRADOR TEA. Between marl bogs and arbor-vitae swamps.

–**Moneses uniflora** (L.) Gray. Reported by *M. E. Macauley,*[3] and others.[7] No specimens from Bergen Swamp were seen.

Monotropa uniflora L. INDIAN PIPE. In rich moist woodlands; infrequent.

Pyrola americana Sweet. SHINLEAF. In woodlands; infrequent.

Pyrola asarifolia Michx., var. **incarnata** (Fisch.) Fern. About borders of arbor-vitae swamps.

Pyrola chlorantha Sw. SHINLEAF. On hummocks in wooded swamp.

Pyrola elliptica Nutt. SHINLEAF. *(W. H. Lennon,* 1893, *Albany.)*

Pyrola secunda L. SHINLEAF. In upland woods; rare. *(E. P. Killipp,* 1913, *R. Acad.)*

Rhododendron nudiflorum (L.) Torr., var. **roseum** (Lois.) Wieg. PINK AZALEA. On hummocks about margin of marl bogs and in openings in the forests.

***Vaccinium canadense** Kalm. CANADA BLUEBERRY. In openings in marl bogs and arbor-vitae swamps; infrequent.

Vaccinium corymbosum L. HIGHBUSH BLUEBERRY. In swamps; frequent.

–**Vaccinium macrocarpon** Ait. LARGE CRANBERRY. Recorded from Bergen Swamp.[3,7] A careful search in many sphagnum areas failed to locate it. No herbarium specimens could be found.

Vaccinium Oxycoccus L. SMALL CRANBERRY. On sphagnum hummocks, mostly in marl bogs.

Vaccinium angustifolium Ait. *(V. pennsylvanicum.)* EARLY UPLAND BLUEBERRY. On upland ridges and knolls; infrequent.

–**Vaccinium stamineum** L. DEERBERRY. On gravelly ridge, rare.

81. PRIMULACEAE

LYSIMACHIA NUMMULARIA L. MONEYWORT. In swales or along streams; common.

Lysimachia terrestris (L.) BSP. YELLOW LOOSESTRIFE. In open places bordering swamp; infrequent.

***Lysimachia thyrsiflora** L. TUFTED LOOSESTRIFE. In swales and temporary pools; frequent.

Samolus floribundus HBK. WATER PIMPERNEL. In mucky soil along trails and streams.

Steironema ciliatum (L.) Raf. FRINGED LOOSESTRIFE. In swampy thickets and along streams.

Trientalis borealis Raf. STARFLOWER. In rich humus mostly in the arbor-vitae swamp; common.

82. OLEACEAE

Fraxinus americana L. WHITE ASH. A common tree in the hardwood forest.

Fraxinus nigra Marsh. BLACK ASH. In bogs and marshes; common.

***Fraxinus pennsylvanica** Marsh. RED ASH. In swamps and alluvial soil; common.

83. GENTIANACEAE

***Gentiana crinita** Froel. FRINGED GENTIAN. No date, Bergen. W. H. Lennon. (Under *G. Andrewsii, Albany.*)

84. MENYANTHACEAE

–**Menyanthes trifoliata** L. BUCKBEAN. Reported from swamp by Day,[8] and Baxter and House.[5] Not seen.

85. APOCYNACEAE

***Apocynum androsaemifolium** L. SPREADING DOGBANE. In openings along trails and in openings on ridge.

Apocynum cannabinum L. INDIAN HEMP. In openings and along border of swamp.

***Apocynum cannabinum** L. var. **pubescens** (R. Br.) DC. In dry open areas in marl bogs.

86. ASCLEPIADACEAE

***Asclepias incarnata** L. SWAMP MILKWEED. In swales and openings in swamps; common.

Asclepias quadrifolia Jacq. On low sandy ridge; rare.

***Asclepias syriaca** L. MILKWEED. In openings, especially on alluvial soil; common.

87. CONVOLVULACEAE

***Convolvulus sepium** L. HEDGE BINDWEED. In openings in the swamp and along streams.

***Cuscuta Gronovii** Willd. DODDER. On numerous hosts in several areas in the swamp.

88. POLEMONIACEAE

Phlox divaricata L. BLUE PHLOX. In open upland forest. Several clumps were found in which the corollas were pure white.

89. HYDROPHYLLACEAE

***Hydrophyllum virginianum** L. WATERLEAF. Among trees and in thickets bordering the swamp.

90. BORAGINACEAE

*CYNOGLOSSUM OFFICINALE L. HOUND'S-TONGUE. In open grassy places; infrequent.

***Hackelia virginiana** (L.) Johnston. BEGGAR'S LICE. In rich open woodlands.

–**Myosotis laxa** Lehm. FORGET-ME-NOT. In spring-fed brook; rare.

91. VERBENACEAE

***Verbena hastata** L. BLUE VERVAIN. In open swampy areas.

***Verbena urticaefolia** L. WHITE VERVAIN. Along streams, mostly on alluvial soil.

92. LABIATAE

***Collinsonia canadensis** L. HORSE BALM. In wet woodlands; common.

***Hedeoma pulegioides** (L.) Pers. AMERICAN PENNYROYAL. In grassy places along trail.

*LEONURUS CARDIACA L. MOTHERWORT. Established in open places; common.

Lycopus americanus Muhl. WATER HOREHOUND. In swales and along streams.

***Lycopus uniflorus** Michx. BUGLE WEED. In bogs and marshes, especially near streams.

***Lycopus lucidus** Turcz., var. **americanus** Gray. *(H. D. House,* 1916. *Albany.)* In marl bogs, apparently rare.

***Mentha arvensis** L., var. **canadensis** (L.) Briq. WILD MINT. In openings in swampy places and along streams.

*MENTHA PIPERITA L. PEPPERMINT. Established along spring-fed brooks; frequent.

*MENTHA SPICATA L. SPEARMINT. Established in open places along streams; frequent.

*NEPETA CATARIA L. CATNIP. Common along edge of woods.

*NEPETA HEDERACEA (L.) Trev. GROUND IVY. In open woods bordering the swamp.

PRUNELLA VULGARIS L. HEAL-ALL. In open grassy places.

***Satureja vulgaris** (L.) Fritsch. WILD BASIL. In open grassy places on uplands.

Scutellaria lateriflora L. SKULLCAP. In bogs and along streams.

***Scutellaria epilobiifolia** Hamil. SKULLCAP. Along streams and in sloughs.

***Stachys tenuifolia** Willd., var. **aspera** (Michx.) Fern. HEDGE NETTLE. In swales.

Teucrium canadense L. GERMANDER. In grassy places along streams.

***Teucrium occidentale** Gray, var. **boreale** (Bickn.) Fern. In marshy openings.

93. SOLANACEAE

***Physalis heterophylla** Nees., var. **ambigua** (Gray) Rydb. GROUND CHERRY. In sandy soil, near base of ridge.

***Physalis subglabrata** Mack. and Bush. GROUND CHERRY. In openings bordering the swamp.

SOLANUM DULCAMARA L. EUROPEAN BITTERSWEET. In thickets along streams and in swamps. A clump with pure white corollas was found near the margin of the swamp.

***Solanum nigrum** L. NIGHTSHADE. Along edge of woods; rare.

94. SCROPHULARIACEAE

Chelone glabra L. TURTLEHEAD. In mucky soil along streams.

***Gerardia paupercula** (Gray) Britt. In open marl bogs; rare. Determined as subsp. *borealis* (Penn.) Penn. by Pennell.

–**Gerardia purpurea** L. Specimens reported as this species upon examination proved to belong to the preceding species.

***Gratiola neglecta** Torr. In swales.

*LINARIA VULGARIS L. BUTTER-AND-EGGS. In open grassy places.

Mimulus ringens L. MONKEY FLOWER. In marshes and along streams.

***Pedicularis canadensis** L. LOUSEWORT. In open woodlands.

*PENTSTEMON LAEVIGATUS Ait. var. DIGITALIS (Sweet) Gray. BEARD-TONGUE. In grassy openings in the swamp.

***Scrophularia lanceolata** Pursh. FIGWORT. Along the forest margin.

*VERBASCUM BLATTARIA L. MOTH MULLEIN. Along trails and in openings.

*VERBASCUM THAPSUS L. MULLEIN. On a cut-over ridge.

Veronica americana Schwein. AMERICAN BROOKLIME. In spring-fed brooks.

***Veronica anagallis-aquatica** L. BROOKLIME. In spring-fed brooks and swales.

*VERONICA ARVENSIS L. CORN SPEEDWELL. In grassy openings along trails.

*VERONICA PEREGRINA L. PURSLANE SPEEDWELL. In open places along trails.

***Veronica catenata** Penn., var. **glandulosa** (Farw.) Penn. SPEEDWELL. In spring-fed streams and along Black Creek.

***Veronica officinalis** L. COMMON SPEEDWELL. In open woodlands.

Veronica scutellata L. MARSH SPEEDWELL. In streams and temporary pools.

***Veronica serpyllifolia** L. THYME-LEAVED SPEEDWELL. In grassy openings along trails.

*VERONICA SPICATA L. SPEEDWELL. Established on a grassy knoll.

95. OROBANCHACEAE

***Epifagus virginiana** (L.) Bart. BEECHDROPS. In rich hardwood forests.

–**Orobanche uniflora** L. CANCER-ROOT. Not seen.

96. LENTIBULARIACEAE

***Utricularia intermedia** Hayne. BLADDERWORT. In shallow water in open marl bogs.

***Utricularia vulgaris** L., var. **americana** Gray. GREAT BLADDERWORT. In Black Creek.

97. PHRYMACEAE

Phryma leptostachya L. LOPSEED. In rich woodlands.

98. PLANTAGINACEAE

*PLANTAGO LANCEOLATA L. NARROW-LEAVED PLANTAIN, BUCKHORN. In grassy places.

*PLANTAGO MAJOR L. BROAD-LEAVED PLANTAIN. Along trails.

*PLANTAGO RUGELII Dcne. RUGEL'S PLANTAIN. Along trails.

99. RUBIACEAE

***Cephalanthus occidentalis** L. BUTTONBUSH. Along streams and in wet swales.

***Galium Aparine** L. CLEAVERS. In open woods.

***Galium asprellum** Michx. ROUGH BEDSTRAW. In marshes and thickets.

Galium boreale L. NORTHERN BEDSTRAW. On hummocks in marl bogs and about springs.

***Galium circaezans** Michx. WILD LICORICE. In rich woodlands.

***Galium lanceolatum** Torr. WILD LICORICE. In upland woods.

Galium triflorum Michx. BEDSTRAW. In marshes.

***Galium trifidum** L. In marshes.

Mitchella repens L. PARTRIDGE BERRY. On ridges, under coniferous trees.

100. CAPRIFOLIACEAE

***Diervilla Lonicera** Mill. BUSH HONEYSUCKLE. In openings on the knolls.

Linnaea borealis L., var. **americana** (Forbes) Rehder. TWIN-FLOWER. Forming mats over humus floor of rich woodlands.

***Lonicera canadensis** Marsh. FLY HONEYSUCKLE. In openings about the arbor-vitae swamp.

***Lonicera dioica** L. HONEYSUCKLE. In open woodlands.

Lonicera oblongifolia (Goldie) Hook. SWAMP FLY HONEYSUCKLE. In open marl bogs and about marl springs.

LONICERA TATARICA L. TARTARIAN HONEYSUCKLE. A few bushes scattered in open woods.

Sambucus pubens Michx. (S. racemosa) RED-BERRIED ELDER. In rich woodlands.

***Sambucus canadensis** L. COMMON ELDER. In the swamp border and along small streams.

Triosteum perfoliatum L., var. **aurantiacum** (Bickn.) Wieg. HORSE GENTIAN. Along bank of Black Creek; rare.

Viburnum acerifolium L. MAPLE-LEAVED ARROW-WOOD. On the knolls and ridges.

–**Viburnum cassinoides** L. WITHE-ROD. Reported.[7] Not seen.

***Viburnum recognitum** Fern. *(V. dentatum.)* ARROW-WOOD. In open marshy places.

***Viburnum lentago** L. NANNYBERRY. In woodlands and about swamp border.

***Viburnum Opulus** L., var. **americanum** Ait. *(V. trilobum.)* HIGHBUSH CRANBERRY. In open places in marshes, forming clumps.

101. VALERIANACEAE

Valeriana uliginosa (T. and G.) Rydb. SWAMP VALERIAN. In marl bogs, especially about springs and streams.

102. DIPSACACEAE

*DIPSACUS SYLVESTRIS Huds. TEASEL. Established in open places.

103. CUCURBITACEAE

*__Echinocystis lobata__ (Michx.) T. and G. WILD CUCUMBER. In thickets on alluvial soil.

104. CAMPANULACEAE

*–__Campanula uliginosa__ Rydb. MARSH BELLFLOWER. Edge of marl bogs.

*SPECULARIA PERFOLIATA (L.) A. DC. VENUS' LOOKING-GLASS. In grassy openings.

105. LOBELIACEAE

*__Lobelia cardinalis__ L. CARDINAL-FLOWER. In mucky soil along streams; rare.

*__Lobelia inflata__ L. INDIAN TOBACCO. In openings in the swamp.

__Lobelia Kalmii__ L. KALM'S LOBELIA. In marl bogs; common.

__Lobelia siphilitica__ L. GREAT LOBELIA. Along streams and in swales.

106. COMPOSITAE

ACHILLEA MILLEFOLIUM L. YARROW, MILFOIL. In openings along trails.

*__Ambrosia artemisiifolia__ L. RAGWEED. In openings in woods and swamps.

*__Ambrosia trifida__ L. GIANT RAGWEED. Along Black Creek.

__Anaphalis margaritacea__ (L.) B. and H. PEARLY EVERLASTING. In cut-over areas and borders of woodlands.

*__Antennaria canadensis__ Greene. LADY'S TOBACCO, PUSSY'S TOES. On grassy knolls.

*__Antennaria fallax__ Greene. In dry grassy places.

*__Antennaria neglecta__ Greene. In open places bordering the swamp.

*__Antennaria neodioica__ Greene. PUSSY'S TOES. In open grassy places.

*__Antennaria petaloidea__ Fernald. On knolls in grassy places; infrequent.

*__Antennaria plantaginifolia__ (L.) Richards. Borders of thickets; rare.

*ANTHEMIS ARVENSIS L., var. AGRESTIS (Wallr.) DC. MAYWEED. Established along trails.

*ANTHEMIS COTULA L. DOG FENNEL. Established along a wood road; rare.

*APARGIA AUTUMNALE (L.) Hoffm. FALL DANDELION. On grassy banks along trail.

*ARCTIUM MINUS (Hill) Bernh. BURDOCK. In cut-over places; infrequent.

*__Aster acuminatus__ Michx. WILD ASTER. In open woodlands.

*__Aster ericoides__ L. In a wet swale; rare.

***Aster cordifolius** L. In upland woods.

***Aster divaricatus** L. In moist woodlands.

***Aster lateriflorus** (L.) Britt. In openings in the woodland.

***Aster lateriflorus** (L.) Britt., var. **angustifolius** Wieg. Common in open marl bogs and along small spring-fed streams. Earlier collections of this species were recorded as *A. Junceus* Ait.

***Aster lucidulus** (Gray) Wieg. In swales and about spring holes.

Aster macrophyllus L. In open woodlands.

Aster novae-angliae L. NEW ENGLAND ASTER. In open areas and along streams.

Aster paniculatus Lam. Edge of swamp.

***Aster paniculatus** Lam., var. **simplex** (Willd.) Burg. Along small streams.

***Aster pilosus** Willd. Edge of woods; rare.

***Aster prenanthoides** Muhl. In swales and open marshy woods.

Aster puniceus L. In swampy places along streams and spring holes.

Aster umbellatus Mill. In open places in marshes and moist woods.

Bidens cernua L. In mucky soil along streams.

***Bidens comosa** (Gray) Wieg. In mucky soil.

***Bidens connata** Muhl. In wet boggy places along trails and streams.

Bidens frondosa L. BEGGAR'S TICKS. Along wet trails.

***Bidens vulgata** Greene. BEGGAR'S TICKS. Along streams and trails.

CHRYSANTHEMUM LEUCANTHEMUM L., var. PINNATIFIDUM Lecoq. and Lam. OX-EYE DAISY. On grassy knolls; infrequent.

*CICHORIUM INTYBUS L. CHICORY. Along the edge of the swamp.

*CENTAUREA JACEA L. KNAPWEED. On the margin of a field bordering the swamp.

***Centaurea vochinensis** Bernh. STAR THISTLE. In a cut-over area in the hardwood forest.

*CIRSIUM ARVENSE (L.) Scop. CANADA THISTLE. Occasional in openings in the swamp and cut-over areas.

*CIRSIUM LANCEOLATUM (L.) Hill. BULL THISTLE. On alluvial soil along Black Creek.

***Cirsium muticum** Michx. SWAMP THISTLE. Mostly in wet alder thickets.

ERECHTITES HIERACIFOLIA (L.) Raf. FIREWEED. Common in cut-over arbor-vitae swamps.

***Erigeron annuus** (L.) Pers. DAISY FLEABANE. Along trails.

***Erigeron canadensis** L. HORSEWEED. In cut-over areas.

Erigeron philadelphicus L. FLEABANE. In moist open woodlands.

*–**Erigeron pulchellus** Michx. ROBIN'S PLANTAIN. Along trails and borders of open woods.

*Erigeron strigosus Muhl. *(E. ramosus.)* DAISY FLEABANE. Along trails on uplands.

Eupatorium perfoliatum L. BONESET. Along streams and in swales.

–Eupatorium falcatum Michx. JOE-PYE WEED. In swales, usually in partial shade.

*Eupatorium maculatum L. JOE-PYE WEED. In marshy places.

Eupatorium rugosum Houtt. *(E. urticaefolium.)* WHITE SNAKEROOT. Common in moist, rich, hardwood forests.

*Gnaphalium obtusifolium L. In cut-over upland.

*Gnaphalium Macounii Greene. *(G. decurrens.)* On a sandy knoll; rare.

*Gnaphalium uliginosum L. CUDWEED. In dried-up swales and along stream banks.

Helenium autumnale L. SNEEZEWEED. In marshes, swales and along streams.

*Helianthus strumosus L. WILD SUNFLOWER. In moist places.

*Helianthus divaricatus L. WILD SUNFLOWER. In open upland woods.

*Heliopsis helianthoides (L.) Sweet. On alluvial soil along stream bank.

HIERACIUM AURANTIACUM L. ORANGE HAWKWEED. On knolls in open grassy places.

HIERACIUM PRATENSE Tausch. YELLOW PAINTBRUSH. In meadows bordering the bogs.

*INULA HELENIUM L. ELECAMPANE. On alluvial soils.

*LACTUCA SCARIOLA L. PRICKLY LETTUCE. Along a trail; infrequent.

*Lactuca spicata (Lam.) Hitchc. BLUE LETTUCE. In moist open woodlands.

-ONOPORDUM ACANTHIUM L. SCOTCH THISTLE. Reported from Bergen.[2, 3, 6, 7] This record is probably based upon specimens observed in the village of Bergen. Not seen.

–Petasites palmatus (Ait.) Gray. SWEET COLTSFOOT. Reported from marly soil by *F. W. Johnson.*[6] Some specimens so labelled appeared to be basal leaves of *Prenanthes sp.*

Polymnia canadensis L. LEAFCUP. Moist overflow land in hardwoods.

–Polymnia uvedalia L. LEAFCUP. Reported.[7] Not seen.

Prenanthes alba L. RATTLESNAKE ROOT. In rich mucky soil in woods.

RUDBECKIA HIRTA L. BLACK-EYED SUSAN. In grass, edge of swamp.

Rudbeckia laciniata L. CONE-FLOWER. In wet mucky swamps.

Senecio aureus L. RAGWORT. In mucky soil along spring-fed brooks.

Senecio pauperculus Michx., var. balsamitae (Muhl.) Fern. In open marl.

*Solidago altissima L. GOLDENROD. Edge of swamp.

Solidago arguta Ait. In arbor-vitae swamp. (Also *M. S. Baxter,* 1913, *R. Acad.*)

Solidago bicolor L. SILVERROD. On a sandy knoll.

Solidago canadensis L. In open places, chiefly on alluvial soil.

Solidago graminifolia (L.) Salisb. FLAT-TOPPED GOLDENROD. In openings and along stream banks.

Solidago Houghtonii T. and G. HOUGHTON'S GOLDENROD. Local in open marl bogs. This is the only known station for this species in New York State.

***Solidago juncea** Ait. EARLY GOLDENROD. In open places on uplands.

Solidago latifolia L. In rich woodlands; common.

***Solidago nemoralis** Ait. On a dry grassy knoll.

Solidago ohioensis Riddell. Common in open marl bogs; also abundant in abandoned fields and about springs.

Solidago patula Muhl. In swampy places and openings in woodlands.

Solidago rugosa Mill. In rich woodlands, along streams and in disturbed areas.

***Solidago serotina** Ait. In open woods and by borders of swamp.

***Solidago serotina** Ait., var. **gigantea** (Ait.) Gray. In borders of woods and open places along trails.

Solidago ulmifolia Muhl. In open woods.

Solidago uniligulata (DC.) Porter. *(S. neglecta,* var. *linoides.)* This is the common, rather small, narrow-leaved goldenrod in the open marl. About the edge of the open marl bogs and in cut-over arbor-vitae swamps it becomes larger and develops wider leaves and larger and often less secund panicles approaching the following variety.

Solidago uniligulata (DC.) Porter, var. **neglecta** (T. and G.) Fern. *(S. neglecta.)* In wet springy places and in cut-over arbor-vitae swamps. In Bergen swamp specimens intermediate between this variety and the preceding species are not uncommon. The species seems smaller and narrow-leaved when growing in the open marl but in other places it appears to gradually merge with the larger broader-leaved variety. Some specimens have a narrow thyrsoid inflorescence approaching *S. humilis* in general appearance except for the larger heads.

*SONCHUS ARVENSIS L. PERENNIAL SOW THISTLE. In cut-over areas and openings in the bogs.

*SONCHUS ASPER (L.) Hill. SPINY SOW THISTLE. Along paths.

*SONCHUS OLERACEUS L. ANNUAL SOW THISTLE. In disturbed areas.

*TANACETUM VULGARE L. TANSY. Several clumps along the border of the swamp.

*TARAXACUM OFFICINALE Weber. DANDELION. In open grassy places.

*TRAGOPOGON PRATENSIS L. GOAT'S BEARD. In cut-over areas.

*–TRAGOPOGON PORRIFOLIUS L. SALSIFY. Along trails.

TUSSILAGO FARFARA L. COLTSFOOT. In wet open areas.

***Xanthium orientale** L. COCKLEBUR. On alluvial soil along Black Creek.

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APPENDIX

Among the plants that one would expect to see growing in Bergen Swamp several notable absences may be mentioned. *Trollius laxus, Spiraea alba, Anemone quinquefolia, Panax trifolia, Andromeda glaucophylla, Monarda didyma, Staphylea trifolia, Hippuris vulgaris* and *Peltandra virginica,* species found in similar habitats nearby, as far as I know, have not been found in Bergen Swamp. Perhaps future explorations may yet reveal at least some of these. *Scirpus Torreyi, Picea rubra, Chamaedaphne calyculata, Vaccinium macrocarpon, Gentiana crinita* and *Calypso borealis,* all strikingly distinct species, were reported by early botanists but have not been observed by me. Herbarium specimens of the latter two have been seen but of the other species none could be located.

ADDENDA

After the type for the foregoing paper had been set I discovered several additional species in Bergen Swamp. Since it is too late to insert them in their proper sequence in the catalogue they are appended here. This expands the list of species to 800.

Potamogeton pectinatus L. SAGO PONDWEED. In Black Creek.

Potamogeton zosteriformis Fernald. PONDWEED. In Black Creek.

ARRHENATHERUM ELATIUS (L.) Mert. and Koch. OAT GRASS. On raised places along border of swamp.

Milium effusum L. In wet woodland.

Phalaris arundinacea L. REED CANARY GRASS. In sloughs bordering streams.

Poa alsodes Gray. In wet woodlands.

ASPARAGUS OFFICINALIS L. ASPARAGUS. Escaped in an open place in the swamp.

BRASSICA KABER Wheeler. (*B. arvensis* Ktze.) FIELD MUSTARD. In open overflow areas along streams.

RIBES SATIVUM Syme. RED CURRANT. In mucky woodland near the border of the swamp.

VIOLA ARVENSIS Murr. WILD PANSY. In open grassy area.

LAMIUM AMPLEXICAULE L. DEAD NETTLE. Along path through cut-over area.

Utricularia minor L. BLADDERWORT. In shallow water in open marl areas.

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THE VEGETATION OF BERGEN SWAMP *

II The Epiphytic Plants

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The flora of Bergen Swamp includes several species of flowering plants that occur but rarely or not at all elsewhere in New York state. This swamp, about three miles long in a general east-west direction and varying from one to one and a half miles in width, is situated some 600 feet above sea-level in Genesee County in western New York. The restricted distribution of certain vascular plants of Bergen Swamp is largely accounted for by the peculiar soil conditions in and about the marl areas of the swamp rather than by climatic factors.

Epiphytes are plants which grow attached to other living plants. As used here the term, epiphyte, signifies plants of corticolous habit, without soil connections, which complete their life cycle supported on woody "hosts" from which they are nutritionally independent except for the moisture or inorganic matter obtained through superficial absorption from the surface of their bark substratum. In temperate zones lichens, liverworts and mosses occur rather commonly and conspicuously as epiphytes. Somewhat less conspicuous are epiphytic algae. Ferns may be seen infrequently as epiphytes, while truly epiphytic phanerogams rarely occur outside tropical and sub-tropical regions.

During the spring and summer from 1944 to 1946 I had opportunities to study the distribution of the epiphytic plants in Bergen Swamp in connection with a study of the distribution of epiphytic plants in New York State. (Brown, 1948.) Collections of epiphytic plants were made every month from April to November, in all of the main areas of the swamp from the few to several woody species characteristic of each. These included the hardwood, the hemlock-pine, the arbor-vitae, the open marl and the alluvial swamp areas. The 30 woody species examined embraced 26 common hardwoods and 4 conifers.

In making a collection samples of all visible lichens, algae, liverworts and mosses were removed from or with a small piece of the bark from the stump or trunk of the "host" within the reach of the arm. All samples for a given species of woody plant were placed in a bag and taken to the laboratory for study and determination. Samples from several individuals of a given woody species in an area were taken wherever possible. The

* Part I under this title, The Vascular Plants, by Walter C. Muenscher (Proc. Roch. Acad. Sci., 9:64–117, 1946) includes a general discussion of Bergen Swamp.

crown bases and crowns of taller trees in most areas could not be conveniently examined except where a tree had recently fallen or stood in a much inclined position. In the open marl, however, stunted specimens of *Pinus strobus, Larix laricina, Thuja occidentalis* and *Acer rubrum* could readily be examined from stump to crown.

The distributions of epiphytic plants in Bergen Swamp are recorded by hosts in Tables I to III. (30 species are listed in the tables; 3 other species were observed that are not listed) The only alga observed, *Protococcus viridis* Ag., is not included in the Tables since it was found on every host examined.

I wish to thank Professor Walter C. Muenscher of Cornell University whose generosity and interest in Bergen Swamp made many of the collecting trips possible. I should like also to acknowledge the assistance of Professor LeRoy Andrews of Cornell University in the determination of various key specimens of mosses. I am grateful, too, to Mrs. Volney H. Jones, Curator of the Lichen Herbarium of the University of Michigan, for the identification of several critical specimens of lichens.

Specimens of many of the epiphytes have been deposited in herbaria at Cornell University.

SUMMARY

An examination of living specimens of 33 kinds of trees and *Cephalanthus occidentalis* growing in Bergen Swamp, New York, yielded a total of 59 species of epiphytes on their trunks or branches.

The list of epiphytes includes 18 lichens, 1 alga, 15 liverworts and 25 mosses.

The hosts with the richest flora and the number of epiphytes found on each follow: *Tilia americana,* 30 species; *Fraxinus nigra,* 28; *Fraxinus americana,* 27; *Thuja occidentalis,* 26; *Acer saccharinum,* 25; *Ulmus americana,* 24. All these trees have a rather rough, spongy, persistent bark which readily absorbs and retains moisture.

Other species with more than 10 kinds of epiphytes observed on each are:

Quercus borealis var. *maxima,* 21; *Acer rubrum,* 20; *Acer saccharum,* 19; *Fraxinus pennsylvanica,* 18; *Juglans cinerea,* 18; *Carya ovata,* 15; *Platanus occidentalis,* 15; *Larix laricina,* 14; *Betula lutea,* 14; *Populus tremuloides,* 14; *Salix nigra,* 14; *Quercus bicolor,* 13; *Liriodendron tulipifera,* 11. These species except *Larix* have harder bark which remains smooth longer and does not absorb water as readily as that of the above species. The bark of *Larix* early becomes granular and rough and absorbs moisture readily. The bark of *Platanus* and *Betula* peels off in large sheets except about the basal part of the trunk with the result that few epiphytes colonize the trunk except on the rough fissured basal parts of old trees.

The other 11 species of hosts listed in the tables supported only a few kinds of epiphytes, mostly fewer than 10 species.

An examination of the epiphytes found in Bergen Swamp shows that most of them are species with a widespread or general distribution in New York State, occurring also in such widely diverse regions as Montauk Point on Long Island, the Finger Lakes region and the Adirondack Mountains.

Unlike that of the flowering plants in Bergen Swamp, the study of the epiphytes so far has revealed but few species with a restricted distribution in New York State.

TABLE I
EPIPHYTIC LICHENS OF BERGEN SWAMP

HOST \ EPIPHYTE	Alectoria chalybeiformis	Cetraria ciliaris	Cladonia pyxidata	Evernia prunastri	Graphis scripta	Leptogium tremelloides	Mycoblastus sanguinarius	Parmelia caperata	Parmelia olivacea	Parmelia pertusa	Parmelia physodes	Parmelia rudecta	Peltigera canina	Physcia astroidea	Physcia endochrysea	Pyrenula nitida	Ramalina calicaris	Total
Larix laricina	x	x	x	x						x	x	x						7
Pinus Strobus			x								x	x		x				4
Tsuga canadensis			x					x										2
Thuja occidentalis			x	x				x		x	x	x						6
Populus grandidentata			x															1
Populus tremuloides			x						x		x							3
Salix nigra								x	x			x		x				4
Juglans cinerea			x		x				x						x			4
Carya cordiformis								x							x			2
Carya ovata			x					x	x		x	x		x				6
Ostrya virginiana																		0
Carpinus caroliniana			x						x			x						3
Betula lutea			x													x		2
Fagus grandifolia			x		x													2
Quercus bicolor			x					x				x		x	x			5
Quercus borealis			x		x			x	x			x			x			6
Quercus macrocarpa			x												x	x		3
Ulmus americana			x					x	x			x	x	x	x	x	x	9
Liriodendron tulipifera			x		x													2
Platanus occidentalis			x					x	x			x		x		x		6
Amelanchier arborea															x			1
Pyrus Malus			x															1
Prunus serotina			x					x										2
Acer rubrum			x		x			x	x		x				x			6
Acer saccharum			x		x			x	x			x		x	x			7
Acer saccharinum			x		x	x		x	x			x		x	x	x		9
Tilia americana			x		x	x	x	x	x		x	x		x	x			10
Fraxinus americana			x					x	x		x				x		x	6
Fraxinus nigra			x		x	x		x	x		x	x		x		x		9
Fraxinus pennsylvanica			x		x			x	x		x	x		x				7

TABLE II
EPIPHYTIC LIVERWORTS OF BERGEN SWAMP

HOST \ EPIPHYTE	Bazzania trilobata	Calypogeia Trichomanis	Cololejeunea Biddlecomiae	Frullania eboracensis	Lepidozia reptans	Lophocolea heterophylla	Porella platyphylloidea	Porella pinnata	Ptilidium pulcherrimum	Radula complanata	Riccardia latifrons	Riccardia pinguis	Trichocolea tomentella	Total
Larix laricina						x			x					2
Pinus Strobus						x								1
Tsuga canadensis	x					x			x					3
Thuja occidentalis		x	x	x	x	x			x	x	x	x		9
Populus grandidentata				x		x			x					3
Populus tremuloides				x		x			x	x				4
Salix nigra						x				x				2
Juglans cinerea			x	x			x			x				4
Carya cordiformis			x	x						x				3
Carya ovata				x		x				x				3
Ostrya virginiana			x	x		x				x				4
Carpinus caroliniana						x								1
Betula lutea			x			x			x	x				4
Fagus grandifolia						x			x	x				3
Quercus bicolor				x						x				2
Quercus borealis			x	x		x	x		x	x				6
Quercus macrocarpa			x			x	x			x				4
Ulmus americana			x	x		x				x			x	5
Liriodendron tulipifera			x			x				x				3
Platanus occidentalis				x		x				x				3
Amelanchier arborea			x			x			x	x				4
Pyrus Malus				x		x								2
Prunus serotina				x					x	x				3
Acer rubrum	x			x		x	x	x	x	x				7
Acer saccharum			x	x		x	x		x	x				6
Acer saccharinum				x		x	x		x	x				5
Tilia americana			x	x		x	x		x	x				6
Fraxinus americana		x	x	x		x			x	x				6
Fraxinus nigra			x	x		x	x		x	x				6
Fraxinus pennsylvanica	x			x		x				x				4

TABLE III
EPIPHYTIC MOSSES OF BERGEN SWAMP

HOST \ EPIPHYTE	Amblystegium serpens	Amblystegium varium	Anomodon attenuatus	Anomodon rostratus	Brachythecium oxycladon	Brotherella recurvans	Campylium chrysophyllum	Dicranum flagellare	Dicranum fulvum	Dicranum montanum	Fissidens adiantoides	Hypnum imponens	Hypnum reptile	Leucodon sciuroides	Orthotrichum strangulatum	Plagiothecium denticulatum	Platygyrium repens	Thuidium delicatulum	Ulota crispa	Total
Larix laricina				x		x				x						x				4
Pinus Strobus										x						x				2
Tsuga canadensis								x		x						x				3
Thuja occidentalis		x	x		x		x	x	x							x	x	x	x	10
Populus grandidentata					x		x	x								x	x			5
Populus tremuloides					x		x					x	x			x	x			6
Salix nigra		x	x		x		x					x				x	x			7
Juglans cinerea			x	x	x		x							x		x	x	x	x	9
Carya cordiformis			x													x	x			3
Carya ovata			x	x	x												x	x		5
Ostrya virginiana			x													x	x			3
Carpinus caroliniana							x									x				2
Betula lutea	x				x		x	x		x						x			x	7
Fagus grandifolia										x						x	x			3
Quercus bicolor			x		x		x									x	x			5
Quercus borealis			x		x		x	x		x						x	x	x		8
Quercus macrocarpa			x													x				2
Ulmus americana			x	x	x								x		x	x	x	x	x	9
Liriodendron tulipifera	x						x	x									x	x		5
Platanus occidentalis		x	x		x		x										x			5
Amelanchier arborea			x		x	x											x			4
Pyrus Malus					x		x										x			3
Prunus serotina								x								x	x			3
Acer rubrum						x	x	x		x						x	x			6
Acer saccharum			x	x				x								x	x			5
Acer saccharinum			x	x	x	x					x			x	x	x	x		x	10
Tilia americana	x		x		x	x	x	x	x			x		x		x	x	x	x	13
Fraxinus americana	x		x	x	x	x	x	x				x	x	x	x	x	x		x	14
Fraxinus nigra		x	x	x	x		x	x			x	x				x	x	x	x	12
Fraxinus pennsylvanica		x	x		x		x									x	x			6

ANNOTATED LIST OF EPIPHYTES OBSERVED IN BERGEN SWAMP

Lichens

PYRENULACEAE

Pyrenula nitida (Weig.) Ach. On lower trunk of several hardwoods.

GRAPHIDACEAE

Graphis scripta (L.) Ach. Locally common on smooth bark on trunk of hardwoods.

COLLEMACEAE

Leptogium tremelloides (L.) S. F. Gray. Local in fissures of moist, shaded bark on lower trunk of *Acer saccharinum, Tilia americana* and *Fraxinus nigra.*

PELTIGERACEAE

Peltigera canina (L.) Willd. Rare, on the lower trunk of *Ulmus americana.*

LECIDEACEAE

Bacidia Schweinitzii (Tuck.) Schneid. On trunk *Fraxinus americana.*

Mycoblastus sanguinaris var. **alpinus** (E. Fries) Stein. On rough bark on lower trunk of *Tilia americana.*

CLADONIACEAE

Cladonia pyxidata (L.) Hoffm. On the lower trunk and stumps of the conifers and most of the hardwoods.

PARMELIACEAE

Cetraria ciliaris Ach. On crown and smaller branches of *Larix laricina.*

Parmelia caperata (L.) Ach. Common on the upper trunk and larger branches in the crown of hardwoods and *Tsuga canadensis* and *Thuja occidentalis;* chiefly on isolated or exposed trees.

Parmelia olivacea (L.) Ach. Common in small close patches on the trunk of hardwoods.

Parmelia pertusa (Schrank) Schaer. On trunks and larger branches of *Larix laricina* and *Thuja occidentalis.*

Parmelia physodes (L.) Ach. Common, mostly on branches and upper trunk, *Pinus Strobus, Larix laricina, Thuja occidentalis,* hardwoods.

Parmelia rudecta Ach. Common on trunk of conifers and many hardwoods.

USNEACEAE

Alectoria chalybeiformis (L.) Rohling. On trunk and branches of *Larix laricina.*

Evernia prunastri (L.) Ach. Infrequent on the upper trunk and crown of *Larix laricina* and *Thuja occidentalis.*

Ramalina calicaris (L.) Nyl. Local on trunk and branches of *Ulmus americana* and *Fraxinus americana,* chiefly on isolated trees in open swamp.

PHYSCIACEAE

Physcia astroidea (Clem.) Nyl. Local on trunk and larger branches of *Pinus Strobus* and hardwoods.

Physcia endochrysea (Hampe.) Nyl. Common on the trunk of hardwoods.

Algae

Protococcus viridis Ag. Common on the trunk and lower branches of all species, included in the tables; also on *Cephalanthus occidentalis* and *Juniperus virginiana.*

Hepaticae — Liverworts

PTILIDIACEAE

Ptilidium pulcherrimum (Web.) Hampe. Common on trunk of *Larix laricina, Thuja occidentalis* and many hardwoods.

Trichocolea tomentella (Ehrh.) Dum. Rare on lower trunk of *Ulmus americana.*

LEPIDOZIACEAE

Bazzania trilobata (L.) S. F. Gray. Infrequent on lower trunk and roots of *Tsuga canadensis, Acer rubrum* and *Fraxinus pennsylvanica;* more common in moist shaded places on rotting logs, stumps and humus.

Lepidozia reptans (L.) Dum. Rare on the lower trunk of *Thuja occidentalis.*

CALYPOGEIACEAE

Calypogeia Trichomanis (L.) Corda. Infrequent on stumps of *Thuja occidentalis* and *Fraxinus americana.*

HARPANTHACEAE

Lophocolea heterophylla (Schrad.) Dum. Common on the trunk and stump of conifers and many hardwoods.

PLAGIOCHILACEAE

Plagiochila asplenoides (L.) Dum. On lower trunk, *Ulmus americana.*

PORELLACEAE

Porella pinnata L. Infrequent on the lower trunk and stump of *Acer rubrum.*

Porella platyphylla (L.) Lindb. Infrequent on the lower trunk of *Salix amygdaloides.*

Porella platyphylloidea (Schwein.) Lindb. Common on the trunk and larger branches of several hardwoods.

RADULACEAE

Radula complanata (L.) Dum. Common on trunk and stump of most hardwoods and infrequent on *Thuja occidentalis.*

FRULLANIACEAE

Frullania eboracensis Gottsche. Common on smooth bark of trunk of most hardwoods and *Thuja occidentalis.*

LEJEUNEACEAE

Cololejeunea Biddlecomiae (Aust.) Evans. Locally common among larger liverworts and mosses growing on the trunk of *Thuja occidentalis* and many hardwoods.

RICCARDIACEAE

Riccardia latifrons Lindb. Rare on base of trunk of *Thuja occidentalis.*

Riccardia pinguis (L.) S. F. Gray. Rare on base of trunk of *Thuja occidentalis.*

Musci — Mosses

FISSIDENTACEAE

Fissidens adiantoides (L.) Hedw. Local on lower trunk of *Populus balsamifera, Fraxinus nigra* and *Acer saccharinum,* with base subject to inundation.

Fissidens Julianus (Sani.) Schimp. On stump and lower trunk of *Acer saccharinum;* submersed during high water.

DICRANACEAE

Dicranum flagellare Hedw. Local on the trunk of *Thuja occidentalis* and many hardwoods.

Dicranum fulvum Hook. Local on the lower trunk of *Thuja occidentalis* and *Tilia americana.*

Dicranum montanum Hedw. Frequent on trunk of *Tsuga canadensis, Pinus Strobus, Larix laricina,* and several hardwoods.

ORTHOTRICHACEAE

Orthotrichum strangulatum Sulliv. On upper trunk of *Acer saccharinum, Fraxinus americana* and *Ulmus americana.*

Ulota crispa (Hedw.) Brid. On trunk and lower branches of hardwoods and *Thuja occidentalis.*

HYPNACEAE

Amblystegium serpens Hedw. On lower trunk of several hardwoods.

Amblystegium varium (Hedw.) Lindb. On trunk and stump of *Thuja occidentalis* and hardwoods.

Brachythecium oxycladon (Brad.) J. and S. Local on the lower trunk of many hardwoods and *Thuja occidentalis.*

Brotherella recurvans (Michx.) Fleisch. Local on the lower trunk of *Larix laricina* and several hardwoods.

Calliergonella Schreberi (Bry. Eur.) Grout. (*Hypnum Schreberi* Willd.) Local on stump of *Thuja occidentalis;* in wet bog.

Campylium chrysophyllum (Brid.) Bryhn. Common on the lower trunk of hardwoods and on *Thuja occidentalis.*

Heterophyllium Haldanianum (Grev.) Kindb. (*Hypnum Haldanianum* Grev.) Local on lower trunk of *Populus balsamifera; Populus grandidentata* and *Thuja occidentalis.*

Hypnum imponens Hedw. On lower trunk of hardwoods.

Hypnum reptile Michx. On lower trunk of *Ulmus americana, Fraxinus americana* and *Populus tremuloides.*

Leptodictyum riparium (Hedw.) Warnst. On basal parts of stems of shrubs of *Cephalanthus occidentalis* where subject to inundation.

Plagiothecium denticulatum (L.) Br. and Sch. Common on the lower trunk of most of the hardwood trees examined; *Thuja occidentalis.*

Platygyrium repens (Brid.) Br. and Sch. Common on the trunk of most of the hardwood trees examined.

Pylaisia intricata (Hedw.) Bry. Eur. On lower trunk of *Thuja occidentalis.*

LESKEACEAE

Anomodon attenuatus (Schreb.) Hueb. Common on trunk of hardwoods; infrequent on *Thuja occidentalis.*

Anomodon rostratus (Hedw.) Schimp. Frequent on trunk of *Larix laricina,* and hardwoods. *Acer saccharum, Fraxinus americana* and *F. nigra.* Frequently intermixed with *Anomodon attenuatus.*

Haplohymenium triste (Cesati) Kindb. [*Anomodon tristis* (Cesat.) Sulliv.] Rare, on lower trunk of *Tilia americana.*

Thuidium delicatulum (L.) Mitt. Local near the base of trunk of *Thuja occidentalis* and several hardwoods; chiefly in wet bogs.

LEUCODONTACEAE

Leucodon sciuroides (L.) Schwaeger. On exposed trunk of *Juglans cinerea, Tilia americana, Fraxinus americana* and *Ulmus americana.*

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THE VEGETATION OF BERGEN SWAMP *

III. The Myxomycetes

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The Myxomycetes or Slime-molds, also called Mycetozoa, are organisms that develop through two very different phases. Their spores, upon germination, produce small, flagellated, motile, amoeboid bodies which fuse and grow into the extensive, often highly colored, naked mass of motile protoplasm, the plasmodium or vegetative phase. The plasmodium, after a period of animal-like existence, becomes transformed into fruiting structures or spore-producing bodies resembling sporangia of fungi. While the plasmodia of some species of slime-molds have distinctive characteristics such as color, size and habitat preferences, it is the "fruiting" or spore-producing stages that provide the morphological characteristics used in their recognition and taxonomic treatment. The Myxomycetes by some have been considered as animals even though they possess some plant-like stages.

The Myxomycetes thrive best in a warm, moist habitat rich in decomposing vegetable matter. Decaying logs, piles of sticks, leaves, herbaceous stems and trash are suitable places for their development. In favorable localities a few kinds of slime-molds may be picked up almost any time during the growing season, but the best time to find good fruiting stages is during warm weather about four to six days after a rainy period. Any time when mosquitoes are out in "full force" is a good time for finding "fruiting" slime-molds. During dry seasons or extreme cold, slime-molds persist as spores or the plasmodia pass into a sclerotium or resting stage.

The spores of slime-molds are minute, mostly between 4 to 12 microns in diameter. Since these are widely disseminated by air currents, many species are widespread over the land areas of the world wherever congenial habitats occur.

Lister (1925) records about 300 species of Myxomycetes known from the whole world. Hagelstein (1944) records 285 species from North America and recognizes 33 additional species from other parts of the world. Hagelstein (1936) lists 162 species found on Long Island, New York. Wann and Muenscher (1922) report 92 species from the Cayuga Lake Basin, New York. The above figures serve to emphasize the cosmopolitan nature of the distribution of many Myxomycetes. Most species are common in temperate regions; however, some are limited chiefly to the tropics and others to alpine regions.

* Part I, under this title, The Vascular Plants, (Proc. Roch. Acad. Sci. 9:64–117, 1946) includes a general discussion of Bergen Swamp.

The present list of Myxomycetes of Bergen Swamp in Genesee County, New York, includes 73 species in 25 genera and 11 families. The gatherings of materials upon which this report is based were begun by me in 1917. Many additional species were collected during recent summers. Most of the species were obtained in the moist wooded areas of the swamp; only a few kinds were common in the open areas.

My thanks are due to Miss G. Lister and the late Professor T. H. Macbride for aid in the determination of certain obscure specimens from the earlier collections. Dr. Babette I. Brown assisted with the field collections during the summers of 1945 and 1946.

Specimens of most of the species have been deposited in the mycological herbarium of the Department of Plant Pathology at Cornell University, Ithaca, New York.

ANNOTATED CATALOGUE OF MYXOMYCETES * IN BERGEN SWAMP

Subclass I. — Exosporeae

FAMILY 1. CERATIOMYXACEAE

Ceratiomyxa fruticulosa (Muell.) Macbr. Common chiefly in early summer when extensive areas are white or pinkish with large patches of sporophores; mostly on the under side of decaying logs. This is our only representative with spores produced externally on the sporophore.

Subclass II. — Endosporeae

FAMILY 2. PHYSARACEAE

Badhamia decipiens (Curt.) Berk. On sticks and leaves on wet ground; rare.

Badhamia lilacina (Fries) Rost. On dead leaves and stems in wet sphagnum bog.

Badhamia macrocarpa (Ces.) Rost. On dead wood; infrequent.

Badhamia rubiginosa (Chev.) Rost. On moist mosses; rare.

Craterium leucocephalum (Pers.) Ditm. On dead leaves and sticks, under herbs.

Diachea bulbillosa (Berk. and Br.) Lister. Rare on leaves, twigs and other herbaceous material.

Diachea leucopodia (Bull.) Rost. Local on dead leaves and twigs.

Diderma crustaceum Peck. On herbaceous stems.

Diderma effusum (Schw.) Morgan. On dead leaves, stems and rarely on wood.

Diderma globosum Pers. On dead leaves; rare.

Diderma spumarioides Fries. Forming extensive grayish white crusts on leaves and stalks.

Diderma testaceum (Schrad.) Pers. Local on leaves and mosses in moist shaded thickets.

Fuligo septica (L.) Weber. Forming large gray, yellow or brownish aethalia from 2 to 20 cm. in diameter; common on wood, bark, leaf mold and organic soil.

* The arrangement here follows that used by Lister (1925). For detailed descriptions of species this or the monograph by Hagelstein (1944) or Macbride and Martin (1934) may be consulted.

Leocarpus fragilis (Dickson) Rost. Occasional on dead leaves and stems; rarely on living leaves of *Lycopodium lucidulum*.

Physarella oblonga (Berk. and Curt.) Morgan. On the lower surface of a decaying elm log.

Physarum cinereum (Batsch.) Pers. On dead herbs, groups of sporangia may cover the vegetation over an area 10 to 20 cm. in diameter.

Physarum connatum Lister. On dead stems of aspens.

Physarum contextum Pers. Infrequent on dead leaves.

Physarum flavicomum Berk. On leaves and sticks in wet swampy thickets.

Physarum leucopus Link. On dead leaves in rich woodland.

Physarum nutans Pers. On dry sticks and dead leaves.

Physarum pulcherripes Peck. On decaying moss-covered log.

Physarum rubiginosum Fries. On mosses and bark of logs.

Physarum sinuosum (Bull.) Weinm. On dead leaves and stems.

Physarum virescens Ditm. On dead leaves and twigs.

Physarum viride (Bull.) Pers. Common on decaying logs.

FAMILY 3. DIDYMIACEAE

Didymium Clavus (Alb. and Schw.) Rabenh. On leaves and twigs, chiefly of herbaceous plants.

Didymium difforme (Pers.) Duby. On dead leaves and sticks under herbaceous thickets.

Didymium melanospermum (Pers.) Macbr. On decomposing plant material.

Didymium squamulosum (Alb. and Schw.) Fries. On leaves and stems, mostly of herbs.

Mucilago spongiosa (Leyss.) Morgan. On stems of living and dead herbs; rare.

FAMILY 4. STEMONITACEAE

Comatricha irregularis Rex. On decaying wood.

Comatricha longa Peck. On decaying logs and stumps.

Comatricha nigra (Pers.) Schroet. On dead logs.

Comatricha pulchella (Bab.) Rost. On dead leaves and stems, mostly of herbaceous plants.

Comatricha typhoides (Bull.) Rost. On decaying wood.

Lamproderma arcyrionema Rost. On dead wood; infrequent.

Lamproderma columbinum (Pers.) Rost. Among mosses on logs and stumps; infrequent.

Lamproderma scintillans (Berk. and Br.) Morgan. On dried leaves and sticks.

Lamproderma violaceum (Fries) Rost. On dead leaves and wood.

Stemonitis axifera (Bull.) Macbr. (*S. ferruginea* Ehrenb.) On stumps and logs; sometimes forming extensive clusters of rusty brown sporangia.

Stemonitis fusca Roth. On decaying wood; frequently covering large areas with purplish brown or almost black sporangia.

Stemonitis hyperopta Meylan. On decaying wood; sporangia small, mostly scattered.

Stemonitis pallida Wing. On decaying sticks and logs; usually the small sporangia are scattered.

Stemonitis splendens Rost. On decaying wood; commonly in large colonies.

FAMILY 5. AMAUROCHAETACEAE

Amaurochaete fuliginosa (Sow.) Macbr. A single large aethalium observed in autumn on a white pine stump.

FAMILY 6. CRIBRARIACEAE

Cribraria argillaceae Pers. On decaying sticks.

Cribraria aurantiaca Schrad. On decaying coniferous logs.

Cribraria intricata Schrad. On decayed wood in hemlock woods.

Cribraria macrocarpa Schrad. On decaying logs and stumps.

Cribraria purpurea Schrad. On dead wood.

Dictydium cancellatum (Batsch.) Macbr. Common on decaying mostly decorticated wood.

FAMILY 7. TUBULINACEAE

Tubifera ferruginosa (Batsch.) Gmel. On dry dead logs and sticks.

FAMILY 8. RETICULARIACEAE

Dictydiaethalium plumbeum (Schum.) Rost. Forming flat, olive brown or grayish brown aethalia on dry wood; observed but once.

Enteridium Rozeanum (Rost.) Wing. On dead wood; frequent.

Reticularia Lycoperdon Bull. On decaying logs; infrequent.

FAMILY 9. LYCOGALACEAE

Lycogala epidendrum (L.) Fries. Common on dead and decaying wood throughout the growing season. The immature aethalia are pink or pinkish gray; with maturity they become yellowish brown, dark brown or almost black, variable in size but seldom exceeding 12 mm. in diameter.

Lycogala flavo-fuscum (Ehrenb.) Rost. Local on dead knots on a living sugar maple tree; also found on a beech log. Observed only in late summer and early autumn. Aethalia silvery gray, up to 6 cm. in diameter.

FAMILY 10. TRICHIACEAE

Hemitrichia clavata (Pers.) Rost. On decaying logs and stumps; from early spring to late autumn. This is perhaps the most common species in the area.

Hemitrichia Serpula (Scop.) Rost. On dead wood; only two collections have been made. The winding golden yellow to light brown sporangia form a net-like plasmodiocarp.

Hemitrichia Vesparium (Batsch.) Macbr. On decaying wood; frequently the clusters of reddish brown sporangia cover considerable areas of the lower surface of decaying logs. Frequently found in association with *Hemitrichia clavata.*

Trichia contorta (Ditm.) Rost. Abundant on moist decaying logs and stumps.

Trichia decipiens (Pers.) Macbr. On decaying logs.

Trichia favoginea (Batsch.) Pers. On inner bark of logs and trunks, especially on hemlock.

Trichia persimilis Karst. On inner bark of logs and stumps. This species and the preceding may persist even through late winter or to the following spring.

Trichia scabra Rost. On decaying logs.

Trichia varia Pers. On decaying logs and stumps.

FAMILY 11. ARCYRIACEAE

Arcyria cinerea (Bull.) Pers. Common on moist decaying logs and stumps of hardwoods; sporangia light gray, scattered.

Arcyria denudata (L.) Wettst. On decaying hardwoods.

Arcyria incarnata Pers. On dead wood and bark of hardwoods.

Arcyria nutans (Bull.) Grev. On decaying decorticated log.

Arcyria Oerstedtii Rost. Locally abundant on a decaying beech log.

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NOTES ON THE EQUILIBRIUM OF TROPICAL AQUARIUM FISHES AND THEIR PERCEPTION OF COLORS *

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While determining lighting angles suitable for photographing various common tropical aquarium fishes, it was noticed that the fishes would orient themselves in such a manner as to make the normally horizontal plane through their eyes become perpendicular to the light beam. Subsequent investigation with a focusing flashlight showed that it was possible to cause the fishes to swim with varying degrees of "roll" or "pitch" in accordance with this tendency, depending on the direction of the ray (Figure 1). In the case of one specimen, a red swordtail, it was possible to make the fish swim upside down.

This suggested a means for testing color perception. Wratten filters, Nos. 25 (red), 58 (green), 47 (blue) and 87 (infrared), were placed in turn over the flashlight. The fishes evidenced, by their tilting, the perception of red, green, and blue, but not infrared. Ultraviolet tests were not made.

The experiments were done under dim room lighting (except for the infrared trials as noted below) and the lighting unit over the tank was turned off. The flashlight was focused on a fish from above and then slowly swung around to various angles to induce the reaction. The infrared investigations were carried out in total darkness. The flashlight was aimed into the tank at an angle. After about a minute a light was turned on and the fishes observed immediately. Any fish in line with the flashlight beam was seen to be still swimming upright, indicating lack of effect from infrared radiation.

Apparently the equilibrium mechanisms of the fishes are associated with the optic centers of the brain. A governing factor is probably the equal intensity received in both eyes from natural overhead lighting when the fishes are swimming normally. This cannot be the only factor, however, because fishes swim upright in the dark and a fish that has lost one eye can also maintain normal equilibrium. The author has also noted the tilting response in a red swordtail that had lost an eye in a battle; this suggests that directional imagery in a single eye causes the effect as much as unequal intensities in both eyes. It might be revealing to compare the optic and other equilibrium centers in the brains of blind cave fishes with those of their normal counterparts.

Another fact that was noted is this: the fishes would respond to the

* Read before the Rochester Academy of Science, February 20, 1947. Contribution No. 1 of the Photography Section.

directional flashlight beam even with the lighting unit over the tank turned on. But the flashlight had to be brought very close to the tank so as to make its illumination stronger on a fish than the overhead light. The experimental method was not sufficiently refined to determine whether the fishes aligned themselves to the flashlight ray or to the resultant of the two illuminations. However, the phenomenon suggests a way to plot the quantitative color response of fishes—that of measuring the intensity of monochromatic sources required to offset a constant white illumination.

FIGURE 1—Photoflash record of angel fish tilting into beam of light from flashlight. Dotted line shows direction of ray. Note that goldfish at bottom was not in beam and, therefore not influenced by it. (Courtesy of the Journal of the Biological Photographic Association.)

NEWS AND NOTES

The last NEWS AND NOTES were published in the PROCEEDINGS in Volume 8, No. 4, September 10, 1942. To bring the record up to date, the program and activities of the Academy and its Sections since then are reviewed in this issue.

The growth of the Academy's membership during recent years has been substantial. This growth, together with expansion of its activities through the increased number and variety of its working sections, provides ample evidence that the Academy is now playing a role of increasing importance in the scientific life of the community.

Tabulated data of the Academy's enrollment at intervals through the years bring out two interesting points—the low ebb in the mid-thirties, and the present highest peak in membership in the nearly 70 years of the Academy's existence.

January 1,	1890	172
"	1907	53
"	1910	63
"	1915	79
"	1920	179
"	1925	143
"	1930	89
"	1935	48
"	1940	107
"	1945	181
"	1946	365
"	1947	383
April 1,	1948	460

Active drives for membership under the Chairmanship of Mr. David E. Jensen (Chairman of the Committee on Sections and Membership), and for contributions to the Fairchild Memorial Fund, under the direction of Mrs. Harold L. Alling, were initiated on October 16, 1947. It soon became apparent, however, that any effort to augment the Academy's membership should be a perpetual rather than an annual enterprise. Therefore, the membership drive, originally scheduled to end on October 31, 1947, has been extended indefinitely to serve as a continuing stimulus for promoting the activities of the Academy. The drive so far has resulted in the addition of more than 100 new members, including 5 Life Members, though the net gain in membership to April 1, 1948 was 77 members as a result of normal annual loss through death and resignations, and the elimination of the names of individuals who had not paid dues during the past 3 years. Most of the loss in the latter category was due to the moving of former members to other communities. However, more than 50 members do, in fact, live outside Rochester, mostly in nearby communities, with 7 members outside of New York State.

The formation of new working sections within the past 4 years has been a most effective factor in the growth of the Academy. In 1942, there were but 3 active sections: Botany, Minerology, and Research. The latter became inactive in 1943. Since 1942, the Rochester Astronomy Club and the Genesee Ornithological Society became affiliated as Sections of the Academy, and Sections for Photography, Weather Science (Meteorology), Entomology, Physical Anthropology, and a second Section for Botany have been established—a total of 9 Sections in all. A summary of their activities is presented on pages 147 to 153.

The officers of the Academy from 1943 to 1947 inclusive were as follows: President, Prof. Floyd C. Fairbanks (1943–1945); Prof. Sherman C. Bishop (1946–1947); Vice-President, Dr. Dean L. Gamble (1943–1945); Dr. Gordon M. Mead (1945–1946);

Dr. Robert L. Roudabush (1947); Secretary, Milroy N. Stewart; Treasurer, George Wendt (1943–1944); William S. Cornwell (1945–1947); Assistant Treasurer, William S. Cornwell (1943–1944); Corresponding Secretary, Mrs. David E. Jensen (1945–1947).

Elected Councillors were as follows: William S. Cornwell (1943); W. L. G. Edson (1943–1944); Prof. Sherman C. Bishop (1943–1944); Dr. Gordon M. Meade (1943–1944); Melissa E. Bingeman (1943–1945); Dr. F. W. C. Meyer (1943–1945); Dr. Arthur C. Parker (1943–1945); E. G. Foster (1943–1947); Dr. Dean L. Gamble (1945–1947); Dr. Robert L. Roudabush (1945–1947); Paul Davis (1946–1947); Mrs. Harold L. Alling (1946–1947); and Clarence W. Carroll (1946–1947).

THE FAIRCHILD MEMORIAL FUND

On June 25, 1946, the capital funds of the Academy were given the name, Fairchild Memorial Fund, in honor of the late Professor Herman Le Roy Fairchild, President of the Academy for 12 years (1889–1901) and for many years, until his death in 1942, Patron of the Academy. The earnings of this Fund may be used at the discretion of the Council to defray publication expenses, or any other suitable academic purpose. The Publication Account of the Academy is part of this Fund and into it are paid $1.00 of the annual dues of each active member, not less than half of payments for Life Membership, all voluntary contributions, the earnings from investments, and the receipts from the sale of publications. From time to time surpluses over and above current publication needs are permanently invested in bonds considered suitable as security for trust funds. These investments are recommended to the Council by the Finance Committee of which Mr. George Wendt is Chairman. On January 16, 1948, the invested portion of this Fund totaled $5,853.00. It is hoped that the Fund may be rapidly augmented by contributions from individuals and from industrial and other organizations so that the income from the Fund will eventually be sufficient for basic publication needs and permit the granting of scholarships or prizes to stimulate and reward individual research and other contributions to science.

REVISION OF CONSTITUTION AND BY-LAWS

After more than a year's thoughtful consideration, with hard work by the Council and a special committee headed by Milroy N. Stewart, a revised Constitution and a new set of By-Laws were presented for the approval of the Academy's membership in 1946. By February 1, 1947 all amendments were in effect.

The principal change in the Constitution was the reduction in size of the unwieldy Council so that it now consists of the five constitutional officers, six elected councillors, and the chairman of each section. Previously, the recorder of each section was also a member.

In the By-Laws, the status of the various classes of membership has been clarified, and the duties of the various officers redefined. A radical change was made in the election procedure. The By-Laws now provide for balloting by mail on a number of candidates to be nominated several months before election. The officers chosen in January will take office in June.

The agreements with the University of Rochester pertaining to its use and care of the Academy's library and herbarium have been published as appendices to the By-Laws.

THE GENERAL LECTURE PROGRAM

The Academy holds regular meetings on the third Thursday of each month from October through May. The following is a summary of the meetings from October, 1942 through December, 1947. For economy of space, the speaker and the title of his address are given. Only the Fairchild Memorial Lectures, presented every other year, will be described in detail. Unless otherwise stated the speaker was affiliated with some Rochester institution and the meetings were held in the Rochester Museum of Arts and Sciences.

October 15, 1942. J. Franklin Bonner: Natural Vegetation Studies in Monroe County.

November 19, 1942. Dr. Gordon M. Meade: Diseases of Wild Birds.

December 7, 1942. Dr. Clyde Fisher, Director of the Hayden Planetarium: Meteors.

January 21, 1943. T. Lyle Keith: Kodachrome Photographs of New York State Wild Flowers.

February 11, 1943. Prof. Sherman C. Bishop: Spiders and Spiderwebs.

March 18, 1943. Dr. Don R. Charles: Inheritance of Size.

May 1, 1943. Dr. Ralph Linton, Department of Anthropology, Columbia University, in a joint meeting with Morgan Chapter, New York State Archeological Society: How Civilizations Grow.

October 21, 1943. Dr. Ralph Evans: Visual Processes and Color Photography. (Sponsored by the Photography Section.)

November 18, 1943. Herbert Mermagen: Demonstration of 1,000,000-volt X-ray apparatus at the Industrial X-ray Laboratory of the University of Rochester.

December 3, 1943. Prof. Bart Bok, Harvard University: The Milky Way. (Sponsored by the Astronomy Section).

January 20, 1944. Dr. Elliot E. Stauffer: Orchids and Associated Bog Flora of the Northeastern States. (Sponsored by the Botany Section).

February 17, 1944. First Fairchild Memorial Lecture. Prof. J. Edward Hoffmeister: The Nature of the Ocean Bottom. (Sponsored by the Mineralogy Section).

Around each continent is a terrace, extending out some 200 miles. This usually consists of a gently sloping shelf with a more abrupt slope at its outer edge. Many canyons of great depth—perhaps 5,000 feet—are cut in this slope. They often do not line up with existing river mouths and their cause is the subject of much discussion. Many believe that they were cut when the sea level was several thousand feet lower than at present.

In the center of the Atlantic Ocean there is a great ridge running North and South nearly its entire length. It is called the "Dolphin" ridge. The deepest parts of the seas on the other hand are in the Pacific Ocean—35,000 feet near the Philippine Islands.

The material found on the continental shelves is erosional sediment, with blue mud on the slopes farthest from dry land. Beyond these slopes are oozes derived from diatoms, radiolarians, and similar marine organisms. In the deeps of the seas there is a red clay containing volcanic ash.

It is deduced from cores of material obtained from the ocean bottom that there have been alternating eras of warmth with an abundance of life in the sea, and eras when glaciers pushed down from the North and halted the deposition of debris from animal life. In comparatively recent times there have been active volcanoes in the Atlantic area.

March 16, 1944. Dr. Robert Galambos: How Bats Fly by Night.

April 20, 1944. Donald Hines and Lt. Fred Bryan: Demonstration of Methods of Blood Collection and Transfusion.

May 18, 1944. A demonstration of the animals at the Rochester Seneca Park Zoo. Fred Strassle, Curator, described the larger animals. Prof. Sherman C. Bishop displayed and discussed the turtles. Dr. Hobart Smith exhibited a coati-mundi. William S. Cornwell discussed the various primates.

October 10, 1944. Dr. Charles C. Abbott, retired Secretary of the Smithsonian Institution: Solar Radiation and the Weather. Joint Meeting with the American Optical Society.

November 14, 1944. Dr. E. F. Phillips, Department of Entomology, Cornell University: The Life of the Honeybee.

November 28, 1944. Lt. E. F. Carpenter, Director of Steward Observatory, Tucson, Arizona: Properties of Double and Multiple Galaxies. (Sponsored by the Astronomy Section).

January 25, 1945. Walter Schoonmaker, New York State Museum: Wild Life Photography. (Sponsored by the Photography Section).

February 15, 1945. Dr. George B. Cressey, Syracuse University: Report from Asia.

March 15, 1945. Dr. Arthur C. Parker: The Story of the Genesee.

April 14, 1945. Dr. Wilton Krogman, Department of Anatomy, University of Chicago: The Physical Anthropologist as a Crime Detective. Joint meeting with the Morgan Chapter, New York State Archeological Association.

May 17, 1945. Prof. J. Edward Hoffmeister: Landing Problems in the Pacific. A reception in honor of Professor Floyd C. Fairbanks, President of the Academy, followed the lecture.

October 18, 1945. Hal Harrison, Tarentum, Pa.: Kodachrome Photographs of Wild Birds and Flowers, Joint Meeting with the Burroughs Audubon Society and the Hawkeye Camera Club. (Sponsored by the Photography Section.)

November 15, 1945. Dr. Kenneth Hickman: The Romance of Vitamin E.

December 4, 1945. Dr. Gerhard Dessauer: Nuclear Physics. Strong Auditorium, River Campus, University of Rochester.

January 17, 1946. Dr. Paul B. Sears, Department of Botany, Oberlin College: Fossil Pollen and the Climatic Record. (Sponsored by the Botany Section).

February 1, 1946. Prof. Arthur Allen: Nesting Birds. Joint meeting with the Rochester Garden Center. Strong Auditorium, River Campus, University of Rochester.

February 21, 1946. Prof. George P. Berry: Viruses.

March 21, 1946. Emil Raab: Rochester's Climate. (Sponsored by the Weather Science Section).

April 18, 1946. Dr. John Q. Stewart, Princeton University: Solar Eclipses. (Sponsored by the Astonomy Section).

May 16, 1946. The Second Fairchild Memorial Lecture. Professor O. D. Von Engelen, Department of Geology, Cornell University: The Finger Lakes, East; the Finger Lakes, West. (Sponsored by the Mineralogy Section).

There have been two theories about the origin of these lakes. The one to which Prof. Fairchild adhered was proposed by Prof. Playfair; it maintains the supremacy of rivers as valley-makers. The second, proposed by Prof. Davis and followed by Gilbert, Tarr and the speaker, emphasizes the erosional power of glaciers and maintains that they were competent to have produced the Finger Lake valleys. Prof. Von Engeln proposed to reconcile these views.

Whereas it was Prof. Fairchild's opinion that the deep channels which now contain the Finger Lakes were once the valleys of north-flowing rivers, tributary to the Ontarian River, which was the predecessor of Lake Ontario and that they were merely scoured out by the glacier, it is Prof. Von Engeln's belief that these were only small streams before the coming of the ice and that deepening to their present level was accomplished by the glacier.

In support of his opinion, Prof. Von Engeln presented the following considerations: (1) The runoff would not have supported so many large parallel rivers as close together as is called for by Prof. Fairchild's theory of North-Flowing rivers throughout New York State, especially those flowing through the Cayuga and Seneca Valleys. (2) The dendritic pattern of drainage of the upper Delaware and Susquehanna is that which is characteristic of the southern side of the original divide and not greatly affected by the ice. (3) Rivers flowing north from this divide cut deeper and faster than those flowing south because they could cut across the ends of up-tilted strata and did not have many folds of contorted strata to contend with. (4) The ice, pushing into funnel-shaped valleys opening to the north, was accelerated as it progressed and its abrasive power was increased; this sufficed to make the valleys deeper at their southern ends. (5) "Hanging Valleys", which are a problem to a river-origin theory, are a natural corollary to the glacier-origin theory, for they denote the presence of secondary glaciers at the side of the main ice sheet. (6) "Through" valleys can be accounted for by overflow of water impounded ahead of the advancing ice and by the action of the glacier in deepening such valleys.

Prof. Von Engeln believes that the western lakes—Conesus, Hemlock, Canadice, Honeoye, Keuka and Canandaigua were not deeply excavated by the ice because the original divide here swung to the north, whereas to the east the glacier worked under more favorable conditions with the result that much wider and deeper valleys were there created. He estimates that the maximum ice thickness was about 3,000 feet.

There was a dramatic conclusion to the lecture when, during the subsequent question period, an individual in the employ of one of the public utility companies reported data obtained by drilling for natural gas at various points in the area under consideration. He stated that drillings just north of Geneva showed that the rock level at the bottom of the valley filling there was by no means low enough to check with the demands of Prof. Fairchild's theory of north-flowing rivers, it being only about 250 feet.

October 11 1946. Charles E. Mohr, Philadelphia Academy of Natural Sciences: Photographing Nature. Joint meeting with Burroughs Audubon Nature Club and the Hawkeye Camera Club. (Sponsored by the Photography Section.)

November 21, 1946. Dr. Ben V. Meed, Associate Director of the Royal Ontario Museum of Toronto, Canada: Mineral Collecting in the Maritime Provinces. (Sponsored by Mineralogy Section).

December 19, 1946. Dr. Walter Roberts: The Solar Corona. (Sponsored by the Astronomy Section).

January 16, 1947. Dr. George M. Sutton, Department of Zoology, University of Michigan, Ann Arbor: Birds of Northeastern Mexico. (Sponsored by the Ornithology Section).

February 20, 1947. Original Papers and Demonstrations. (1) Dr. Gordon Meade and Fred Hall: The 1945–46 Snowy Owl Invasion of New York State; (2) Dr. Robert Bugbee: Parasitic Insects of Rose Galls; (3) Clarence Carroll: Beekeeping; (4) H. L. Gibson: Behavior Response of Tropical Fish to Directional Lighting; Color Changes in Goldbug; (5) William S. Cornwell: Hybrid Primates.

March 20, 1947. Dr. F. C. Steward: Hunting Valonia in the Dry Tortugas (Sponsored by the Botany Section).

April 17, 1947. Original Papers and Demonstrations. (1) Dr. W. F. Jenks: Ore Deposition in Southern Peru; (2) Paul W. Stevens: Giacobini-Zinner Comet seen October 9, 1946; (3) Dr. Robert L. Roudabush: Making Bio-plastics.

May 15, 1947. Dr. Elliott Maynard: Entomology—Hobby, Profession and Science. (Sponsored by the Entomology Section).

October 16, 1947. Dr. Edward T. Boardman: Photographic Records of a Naturalist (Sponsored by the Photography Section).

November 20, 1947. Prof. Sherman C. Bishop: The Lives of the Salamanders.

December 18, 1947. Dr. Carl C. Gartlein, Cornell University: The Aurora Borealis (Sponsored by the Astronomy Section).

"EXCURSIONS IN SCIENCE"

Junior Science

Early in 1946 the Academy was instrumental in organizing the scientific groups of Rochester to aid young people in their understanding of science, its recent advances, and the opportunities which scientific work offers as a vocation. The outcome of the planning was a program called "Excursions in Science." Students and teachers of Monroe County High Schools were all invited to attend the monthly meetings which were held at various places.

The first meeting included a program on optics, in which the Bausch and Lomb Optical Company, the Optical Society of America, and the Rochester Museum of Arts and Sciences cooperated.

Mr. Arthur Schoen, at the second meeting, discussed the electronic microscope and its application to science and industry.

The third program, conducted by Mr. Robert Titus, included the history of the microscope and some modern industrial applications of microscopic methods to trace production difficulties, especially in the manufacture of photographic film.

The Rochester Technical Section of the Photograhic Society of America furnished as a speaker for the fourth meeting Mr. Adrian Terlouw who discussed the vocational opportunities in the field of photography.

Plastics, at present a popular subject, were discussed and demonstrated by Mr. Gordon Hiatt in a program sponsored by the Rochester Section of the American Chemical Society.

"Excursions in Science" is still in a period of development, but in its first year the programs have been well attended and have met with the approval of those participating.

The following groups have representatives on the central committee which is sponsoring "Excursions in Science:" American Chemical Society, Burrough's Audubon Society, Optical Society of America, Photographic Society of America, Rochester Academy of Science, Rochester Chamber of Commerce, Rochester Engineering Society, Rochester High Schools, Rochester Institute of Technology, Rochester Junior Chamber of Commerce, Rochester Museum of Arts and Sciences, Rochester Park Bureau and the University of Rochester.

THE SECTIONS *

Botany A

During the 4 year period—1943–1947—the Section's officers were Dr. Grace A. B. Carter, *Chairman,* and Mrs. Josephine Z. Edson, *Recorder.* The regular meeting place was the Academy's room, Eastman Building, Prince Street Campus, University of Rochester, first and third Monday of each month.

1943—The emphasis was study of herbarium specimens from the Academy Herbarium and from the herbariums of various members. Orchids, trilliums and ferns from the Milton S. Baxter collection were examined as were also sheets from the herbarium of the Burroughs-Audubon Nature Club. Material was presented on the use of goldenrod in the manufacture of rubber, and studies were conducted on local wild grasses.

1944—The Section held a few short-distance field trips and continued its study of the Baxter collection of orchids and ferns. Several interesting specimens were brought in by members for special study including an unusual grass, *Elymus virginicus,* var. *hirsutiglumis* from North Bloomfield, N. Y. by Mr. Warren A. Matthews, and a herbarium specimen of the Heart-leaved Golden Alexander, *Zizie cordata* by Mrs. Edson. This specimen was collected at Honeoye Lake, Ontario County, the only known station for the plant in this locality.

1945—Several plants new to Monroe County were listed by the Section: *Salix candida* var. *denudata; Cyperus erythrorhizos; Carex molesta; Carex Billingsii; Polygala verticillata* var. *isocycla; Panicum lanuginosum* var. *Lindheimeri; Panicum sphaerocarpon; Aspidium Thelypteris* var. *pubescens; Ambrosia trifida; Sporobolus vaginiflorus; Aster puniceus* var. *lucidulus.* Many introduced plants found included: *Linaria Dalmatica; Linaria Macedonica; Symphoricarpos racemosus* var. *laevigatus; Oxybanthus floribundus; Centaurea Jacea; Carduus acenthoides; Alliaria officinalis; Digitalis lutea; Sanguisorba minor.* Several stations were also reported for plants not seen for several years. As a result of careful study by Miss Lillian Chadsey the goldenrod, always accepted here as *Solidago caesia,* seems now to be *S. c.* var. *axillaris.*

The Section lost by death, October 12, 1945, Mr. Fred S. Boughton, throughout all the latter years of his life a faithful and enthusiastic member.

1946—A study was made of hickories (*Carya*), Blackberries (*Burus*) and Currants (*Ribes*) and a portion of one meeting was devoted to a discussion of poison ivy

* EDITOR'S NOTE: To conserve space, only the general subject matter in the programs of the Sections are listed, except where the presentation was by an invited guest outside the Section. With some Sections this procedure also avoids the frequent repetition of the name of members.

(*Rhus toxicodendron*), its characteristics, and the prevention and cure of its effects. Several new or interesting plants were reported: *Euphorbia Esula; Sedum Telephium; Solidago graminifolia* var. *Nuttallii; Ilex verticillata.* During the growing season fresh plants were collected and studied while during the fall and winter twigs and shrubs were brought in and identified by means of twig keys. A plant survey of Monroe County was planned.

1947—At the invitation of Dr. F. C. Stewart, The Section held the first meeting of each month at the Herbarium Room, River Campus. Particular study was made of *Epiloliums, Oenotheras, Pinaceae,* and *Polypodiaceae.* Mr. Matthews reported the following plants: *Carya varia; Scirpus planifolius; Antennaria fallax; Samolus floribundus; Aster Acuminatus.* Mrs. George Reed reported Strawberry raspberry (*Rubus illecebrosus*) and Red Dead Nettle (*Lamium purpureum*) from Honeoye. Mr. and Mrs. Edson reported new stations for Cardinal Flower (*Lobelia cardinalis*) and Bottle Gentian (*Gentiana andrewsii*) in the elm swamp on Brook Road.

Mineralogy

Between 1943 and 1947 the Section had the following officers: Chairman—Robert C. Vance (1943–1946), Charles W. Foster (1947); Recorder—David E. Jensen (1943–1946), Walter H. Wright (1947); Treasurer—George R. Costich (1943, 1946, 1947), Albert Marble (1944, 1945); Chairman of Committee on Mineral Locations in Monroe County—Edwin G. Foster (1943–1945), David E. Jensen (1946–1947); Chairman of Program Committee—Charles W. Foster (1943–1946), John McMasters (1947). The regular meetings are held the second Thursday of each month (October–May) at the Rochester Museum of Arts and Sciences.

1943—The 9 meetings featured programs devoted to quartz; calcite; minerals and money; micromounts; the geology of Irondequoit Bay; and the minerals of Italy, Brazil and Mexico. The collection of Monroe County minerals and the Geologic map of Monroe County assembled by the Committee on Mineral Locations was housed in the Museum and were placed on display in the Geology alcove. The Section became affiliated with Rocks and Minerals Association.

1944—There were 8 meetings with programs devoted to nickel mining; the mineral resources of Arizona; fluorescence; new developments in strategic war materials; mica and its applications; lead mining in Missouri; the origin of the Earth and its age; the new Dana system of Mineralogy; diamonds and volcanic activity. The collection of local minerals housed in the Museum were catalogued and indexed.

1945—The principle activity was the 8 regular meetings the programs of which included discussions on quartz geodes; geologic faulting; water, minerals formed by water; factors in determining the values of fine mineral specimens; an introduction to mineralogic literature; the hardness and tenacity of minerals; the cleavage parting and fracture of minerals; some famous mineral localities; and a symposium on opals.

1946—The programs of the 8 meetings considered the specific gravity of minerals; uranium minerals and the atomic bomb; luster, color, and color streak; physical properties of minerals depending upon light; Devonian fossils and fossil-collecting in Livingston County; fluorescence; the geology of the Gouverneur Region, a visit to the mineral collection of Mr. and Mrs. H. B. Hanley; garnets and their varieties; mineral nomenclature; pseudomorphs or the masquerading of minerals. On May 18 members collected fossils in the vicinity of York under the leadership of Milroy N. Stewart and visited the talc, zinc and iron mines of St. Lawrence County on June 15 and 16 and the mineral collection of Ward's Natural Science Establishment on September 29.

1947—The Section held 8 meetings and 4 field trips. The former featured talks and demonstrations on the enhancement of mineral specimens; gold prospecting in northwest Ontario; crystallography and the making of X1 models; tourmaline; fluorescence and phosphorescence; lapidary activities. June 14 the Section visited Ward's Natural Science Establishment to study type minerals of Ontario. On July 4–6 the Section held a joint expedition with the Walker Mineralogy Club of Toronto and did extensive collecting at various mine dumps and locations around Bancroft and Madoc, Ontario, Canada. Several members spent the day on August 9 with Mr. Charles Foster hunting septaria on his property at Canandaigua Lake. The Genesee Feldspar Plant on Boxart Street, Rochester was visited by the Section on September 13.

Photography

The section was first organized on February 24, 1943. The officers from 1943 to 1947 have been as follows: Chairman—H. Lou Gibson (1943–1945), Charles S. Foster (1946); John J. Beiter (1947); Recorder—Mrs. David E. Jensen (1943–1945); Treasurer—Ann Slater (1944–1945); Recorder and Treasurer—John J. Beiter (1946), Barbara Ann White (1947), Chairman, Program Committee—C. S. Foster (1943–1946), H. Lou Gibson (1947). Meetings are held the fourth Thursday each month, except in the Summer, at the Rochester Museum of Arts and Sciences.

1943—There were 8 meetings of the Section with the program featuring discussions and demonstrations on the technic of close-up photography; penetrating natural camouflage with photographic contrasts; artistic requirements of scientific photography (Mr. Walter Meyers, noted pictorialist as guest critic); a report on the Fifth International Salon of Nature Photography at Buffalo; a demonstration of lighting; a field trip to Irondequoit Bay; an exhibit at the Gas and Electric Company; and other subjects.

1944—The first meeting was held jointly with the Rochester Aquarium Society and featured a demonstration on photographing live tropical fish in color. This was followed by meetings devoted to subjects that included the use of colored backgrounds for medical photography; photographing hummingbirds; a motion picture on beekeeping; the use of photography in the Psychology Department; and photographing wild flowers in color.

1945—The meetings during this year featured the following: demonstration of depth of field; superior commercial photographs; medical photography; the color photography of Rochester's Parks; composition in nature photography; the use of Kodachrome nature slides in religious presentation. A picnic supper was held July 1 at the home of Mr. and Mrs. Jensen to honor Miss Ann Slater then leaving for Turkey to teach general science.

1946—The lecture programs and work sessions included presentations and discussions of color photography of flowers and other nature subjects; illustrated nature lectures available to camera clubs and similar groups; problems in color photography; depth of field; photographing insects; and beekeeping

1947—This year's meetings saw the return of some previously discussed subjects as well as new ones and included color photography of flowers and shrubs in the Rochester Parks; photography of wild flowers; methods for lighting specimens; beekeeping; focal length of lenses; time lapse cinematography; movies of the 1945 solar eclipse; and a motion picture on the West.

Astronomy

This Section was organized with 22 members on May 31, 1945. Mr. Paul Stevens was elected Chairman and Mr. Merlin L. Groff, recorder, respectively. It was decided to hold regular meetings the first Friday of the month from October through May.

1945—There were 3 lectures on the subjects of optical lenses and prisms, photography of the sun and moon, and eclipses of the sun and moon. Two observation sessions were also held to observe the 3-cornered conjunction of the moon, Mars and Saturn on Oct. 26 and Nov. 23 and one session to observe the total eclipse of the moon on Dec. 18.

1946—Messrs. Stevens and Groff continued as officers. There were 6 regular meetings with discussions of the Giacobini-Zinner meteorite shower, the portrait eclipse of the sun (Nov. 23), clouds in motion; photography of the sun and radio (a review of lecture before Rochester Technical Section of the Photographic Society of America by Dr. Donald Menzee), and variable stars. Observational meetings were held to note the seasonal status of the heavens and the portrait eclipse of the sun. Prof. John Evans of the University of Rochester discussed the atmosphere of the sun at the Jan. 4 meeting.

1947—Mr. Mark C. Caulkins became Chairman and Mr. E. M. Root was elected recorder at the May meeting. Presentations by members at regular meetings included discussion of the satellites of Jupiter, the apparent coincidence of the conjunction of Jupiter and the sun at the times of the sun's eclipse cycles, celestial navigation, and the astronomical experiences of an instructor in the army's training program in England. Invited lecturers spoke at 3 regular meetings: Feb. 8—Mr. W. F. Swann, Eastman Kodak Co., sun spots and the aurora borealis; Mar. 7—Mr. H. W. Southgate, Rochester Democrat and Chronicle, random thoughts on stars; May 2—Dr. Henry E. Paul, Norwich, N. Y., development of the Schmidt camera. There were 4 observational meetings.

Weather Science

The organization meeting of this Section was held September 20, 1945 in the Rochester Museum of Arts and Sciences. Mr. Emil A. P. Raab was elected chairman and Mr. Oscar Westgate as recorder. During 1945 and 1946 meetings were held the first and third Thursdays at Anderson Hall, Prince Street Campus. Subsequently, during 1947, the Section met on the first Thursday of each month from October through May.

1945—The lecture series included discussions of the circulation of the air, clouds, radiosonics, weather maps, secondary circulation of air, and reviews of the books, "Snow Crystals" by Bentley and "Storm" by Stewart.

1946—Continuing the lecture series, the topics presented were as follows: solar radiation, insulation and its effects, fog, specialized forecasts, radar and weather, weather proverbs. Mr. H. R. Condit showed color movies of clouds in motion. An exhibit of meterological instruments was prepared by and a discussion of the manufacture, testing and calibrating of thermometers, barometers and similar apparatus was presented by Milroy N. Stewart. The Section visited the Rochester Weather Bureau on two occasions. Mrs. Dorothy Warren was recorder.

1947—The Section's activities featured a joint meeting with the Astronomy Section; the topics discussed were the aurora and sun spots. Other lecture topics during the year included weather and industry and weather observations in the Army and Navy weather services. Mr. Raab asked that he be relieved as chairman. This request was accepted reluctantly and John Williams was elected in his place, with Mrs. Warren as recorder. Mr. Raab was elected as permanent honorary chairman.

Ornithology

The Genesee Ornithological Section became the Ornithology Section on March 21, 1946. Officers through 1947 were: Dr. Gordon M. Meade, president; Fred Raetz, vice-president; Albert Bussewitz, secretary; and Leo Tanghe, treasurer, the president and secretary functioning as chairman and recorder, respectively, of the Section.

Since its affiliation with the Academy, the Genesee Ornithological Society has continued to promote its original purpose as expressed in its constitution: "to further the scientific study of birds, to promote conservation of wild life, and to give encouragement and assistance to persons who desire to extend their knowledge of birds."

Meetings are held on the second Wednesday of each month, except July and August, in the Rochester Museum of Arts and Sciences. Programs are varied to suit the seasons. They provide for reports of observations by members and general informal exchange of experiences and information, and include talks and papers on ornithological subjects by members as well as by authorities from outside the membership. Outstanding speakers heard by the Society since its affiliation with the Academy of Science have been W. Stephen Thomas on "The Birds of Northern Chili;" William Dilger on "Birds of India and Burma;" Fred T. Hall on "Birding in Bermuda;" Dirck Benson of the New York State Conservation Commission on "Ducks of Western New York;" Dr. Robert Bugbee on "Bird-Insect Relationships;" Dr. Edward T. Boardman on "Birds of the Marsh." Dick Bird of Regina, Saskatchewan, showed his outstanding color motion picture, "Birds of the Canadian Prairie," at the February, 1947 meeting, and in the fall of 1947 Mr. Bird's second appearance in Rochester was at an open meeting in the Rochester Museum, sponsored by the Society.

Aside from its regular meetings, the Society's activities include at least one field trip each month, an Annual Spring Bird Census in May, the annual Christmas Census in December, in cooperation with the National Association of Audubon Societies, and a Breeding Bird Census which records all breeding and nesting data observed by members in the area during the season.

The 1946 Spring Census, held on May 17, recorded a total of 165 species seen in the one day, and for the 1947 Census, held on May 16, observers turned in a total of 168 species. The 1946 Christmas Census, made on December 22, yielded a total of 63 species, including a number whose winter presence in this area is exceptionally unusual, such as the Northern Yellowthroat, Blackburnian Warbler, Myrtle Warbler, Greater and Hoary Redpolls. The 1947 Christmas Census, taken on December 21, yielded 68 species and revealed an interesting comparative scarcity both of the northern finches and wintering warblers which also was characteristic of the 1946 count.

The Breeding Bird Census, which endeavors to establish positive records of all birds nesting in Monroe County, was initiated in 1946 and during that season 73 species were observed actually nesting. Thirty-three additional species were assumed to have bred in the area on such circumstantial evidence as the presence of singing males throughout the breeding season, and observation of fully fledged young of the year.

The 1947 count yielded a total of 73 species nesting, of which 67 species were observed actually at the nest or feeding the young. These observations raised the total of species actually seen nesting in the area to 84 during the two-year period.

Careful records are kept of all observations. This work is in charge of a statistical committee, Allan Klonick, chairman, and is entrusted with the careful compilation and correlation of these records in such manner as to be of greatest value in the extension of our knowledge of the avifauna of the area.

A complete checklist of the birds of Monroe County has been compiled by Ambrose Secker and it is expected that this will be published within a short time. In January, 1948 the Society began publication of a bi-monthly official organ called The Goshawk, under the editorship of Albert Bussewitz; the first two issues are now in circulation. Furnished free to members of the Society, it endeavors to cover all happenings of interest to local bird students. It is available to non-members at $1.00 a year.

Entomology

After an interim of more than 6 years, a group of Academy members interested in entomology met in the Academy's room, Eastman Building, Prince Street Campus, University of Rochester on April 8, 1946 and voted to re-organize an Entomology Section. Dr. R. E. Bugbee was elected Chairman, and Frank C. Fletcher, Recorder. On April 23, Mrs. John Spence was elected Treasurer, and William L. Downs, Curator. An assessment of 50 cents per quarter year for purchase of equipment was agreed upon. It was decided to hold meetings twice monthly and to conduct field trips. In November, 1947 Dr. Edward T. Boardman was elected Chairman and Elisabeth Keiper, Recorder.

During 1946 and 1947, the program sessions were interspersed with work sessions at which insects were identified and mounted. The programs included discussions by members on the making of insect collections, the orders of insects, garden insects and their control, dragonflies, galls and gall-making insects, wasps, primitive insects, and mosquitoes and disease. Guest speakers and their topics were Dr. Curt Stern on "The Role of Insects, especially Drosophila, in Genetic Research," and A. Gordon Dye on "The Life of the Hive." The discussion of primitive insects by Mr. Downs especially emphasized the collembola to which he has devoted eight years study. The presentation of wasps and their habits by Mr. Ross Phillips features his very noteworthy collection of pastel drawings of various species. These were later exhibited at the Rochester Museum of Arts and Sciences.

The Section also sponsored on November 25, 1947, a public showing of the 16 mm. colored motion picture on the life cycle of the Japanese beetle and methods of control produced by New York State. Field trips were conducted to Ward's Natural Science Establishment, Mendon Ponds Park and Bergen Swamp.

Botany B

The section was formally organized on January 15, 1947 at a meeting held in the Eastman Building, Prince Street Campus, University of Rochester. The organization was the culmination of a series of informal meetings during the war years largely under the leadership of Dr. Richard Goodwin. Particularly notable among these meetings was a field trip to the oak openings near Rush, N. Y. The officers elected were Dr. Robert Erickson, *Chairman*, and Dr. Robert E. Stauffer, *Recorder*. Regular section meetings are held the third Wednesday of each month, except during the summer months, at the Eastman Building.

The lecture program of the section included discussions of the floral elements of the Ozark Mountains; an ecologic study of South Haven Peninsula near Bournemouth, England; epiphytic flora of New York State; broadleaf deciduous forests of the Pacific Northwest; mint plants and their use in flavoring oils; plants and plant associations of Pemaquid Point nad Mount Desert Island, Maine. Members undertook to keep phenological records for Monroe County. Two field trips were held (1) to Sullivan's Woods on May 17, and (2) to Limerock on June 7.

Physical Anthropology

This latest Section held its organization meeting December 19, 1947 at the Rochester Museum of Arts and Sciences. However, it did not become formally associated with the Academy until February 10, 1948, hence its activities will not be reported until the next issue of News and Notes. Its meetings are held the fourth Friday of each month (September–May) at the University of Rochester School of Medicine and Dentistry.

ROCHESTER ACADEMY OF SCIENCE

Membership List

(corrected to June 1, 1948)

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Dr. Eric L. Alling
Prof. Harold L. Alling*†
Mrs. Harold L. Alling*
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Kate R. Andrews
Melvin D. Andrews
Esther L. Averill

Bertrand C. Backus
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James H. Barlow
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Earl C. Bartlett
Otto J. Bauerle
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Dirck Benson
Cogswell Bentley
Mary C. Bentley
Harold F. Bermett
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Prof. Sherman C. Bishop
R. Kingsley Blake
Arthur Blensinger
Prof. Walter R. Bloor
Dr. Edward T. Boardman
E. Flossie Booth
William Bornemann
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William L. G. Edson*
Mrs. Josephine Edson
M. Herbert Eisenhart*
Grover A. Erickson
Robert J. Erwin
Clarence B. Evaul
Pattee Evenson

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* Life Member.
† Fellow.

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Richard N. Fennessy
Clifton O. Field
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Dr. William F. Jenks
Alfred J. Jerome
Dr. Leonard W. Jones

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Timothy Keady
Elisabeth Keiper
T. Lyle Keith
John J. Keller
Jessy B. Kendall
Oscar C. Kirchhoff
Floyd G. Kirkham
Allan S. Klonick
Harvey J. Klumb
Chester L. Knight
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Cyril Ledoux
Herman R. Leitenberger
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Mortimer E. Milburn
Gordon G. Milne

* Life Member.
† Fellow.

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THE PHALANGIDA (OPILIONES) OF NEW YORK

With special reference to the species of The Edmund Niles Huyck Preserve, Rensselaerville, New York

by

SHERMAN C. BISHOP *

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PART I

Introduction

In 1928 we included the Phalangida in "A List of the Insects of New York" edited by Dr. M. D. Leonard (Mem. 101, Cornell Univ. Agr. Exp. Sta. pp. 1074–1076). Since that time new material has accumulated in various institutions, much of which has been studied. The original list of nineteen species has been extended to twenty-four, a number which probably represents the majority of species to be found in the state. In addition to my own collections, critical materials have been examined from Cornell University, the Museum of Comparative Zoology, Cambridge, Mass., the American Museum, New York, the New York State Museum, Albany and the extensive private collection of Mr. Roy Latham of Orient, Long Island, New York. For the use of these collections I am greatly indebted to the several museum authorities and to Mr. Latham.

For convenience, I have listed the distribution records of the various species under New York counties arranged alphabetically, except those from Long Island which are considered separately. As a small tribute to those naturalists who have spent time and effort in making collections, I have indicated their contributions by enclosing their initials in parentheses and by including a list of names to identify them.

The drawings accompanying the report were made by Mr. Hugh P. Chrisp of Albany, New York and Miss Carolyn Fallon, staff artist, Department of Zoology, University of Rochester, their contributions being indicated by their monograms.

It is a pleasure to acknowledge my indebtedness to the directors of the Edmund Niles Huyck Preserve, at Rensselaerville, New York, for a fellowship which made it possible for me to study phalangids during the summer of 1948. Conditions at the preserve were found to be ideal for field study of phalangids and most of the observations on life histories, habits and ecology were made during the two months' tenure of the fellowship.

Finally, I would express my appreciation to Dr. Donald R. Charles, Chairman, Department of Biology, University of Rochester, whose interest and support has made it possible for me to complete this study.

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Relationships and General Structure

The Phalangida constitute one of the orders of the class Arachnida which includes, among others, the spiders, mites, ticks and scorpions. Like the spiders, the body of phalangids consists of a cephalothorax (fused head and thorax) and abdomen. They differ from the spiders in that the cephalothorax is broadly attached to the segmented abdomen while in the spiders these structures are joined by a slender pedicel and, in all but one small group, the abdomen is unsegmented. Both spiders and phalangids possess four pairs of legs and a pair of leg-like palpi, one on either side of the head.

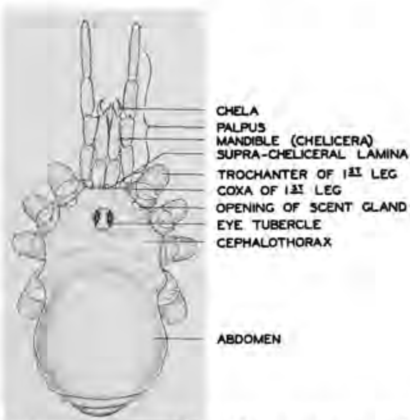

Fig. 1. Dorsal aspect of *Leiobunum flavum*, male, to show structures used in classification. In many species the segmentation of the abdomen is much more evident.

The drawings of dorsal and ventral aspects of *Leiobunum flavum* (Figs. 1 and 2) show the external structures commonly used in the identification of phalangids. Because of their extreme length, the terminal segments of the legs have not been shown. The legs in their entirety consist of seven segments i. e. coxa, trochanter, femur, patella, tibia, metatarsus and tarsus, named in order from the point of attachment to the body. The segments of the palpus are like those of the legs except that the metatarsus is lacking. A pair of three-jointed chelicerae, or mandibles, is attached to the ventral side of the head in front and serve as grasping organs, being provided with apposable claws at the tip. The number and character of the claws which, in some species, terminate the tips of the tarsi of both legs and palpi, are of significance in classification.

In many species of phalangids, the sexes may be recognized by differences in size, proportions and color of the body and appendages. In some, however, these differences are not pronounced and recourse must be had to dissection. To determine the sex in doubtful cases, it is necessary to expose the genital organs by cutting along each side of the flap-like genital operculum and turning this structure backward toward the tip of the abdomen. The penis or ovipositor will then be exposed and may be withdrawn from the membranous or chitinized sheath which encloses it. If, when adult specimens are collected, the abdomen of the phalangid is squeezed between the tips of the thumb and forefinger, the genital organs will be extruded and may be kept exposed by plunging the specimen in 75% alcohol.

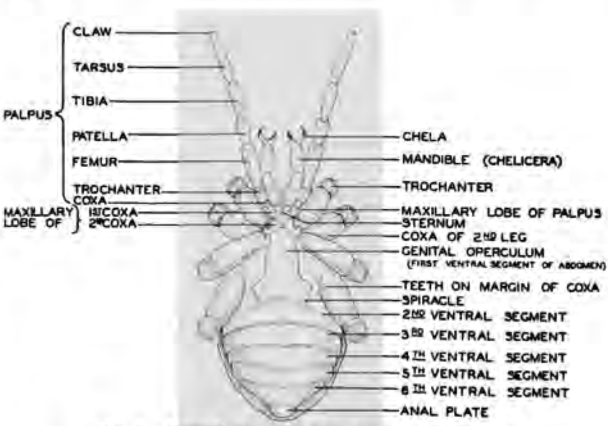

Fig. 2. Ventral aspect of *Leiobunum flavum*, male.

Where to Look for Phalangids and How to Collect Them

Phalangids live in many different kinds of places. The larger diurnal species may be found crawling on the ground or on trees, buildings, fences, walls and other structures. They are most abundant where there is evidence of moisture and should be looked for following warm rains when many may be observed foraging in the open. Some species are partial to caves and other dark places, *Leiobunum bicolor*, for example. Others, particularly the smaller species, live among the debris to be found on shaded banks, or in bogs, the moss that covers rotting logs, or in the leaf mold that accumulates on the ground beneath forest trees, both evergreen and broad-leaved types. The species of the genus *Caddo* are often taken by sifting sphagnum moss, or the rubbish beneath stands of tall ferns in boggy places.

One of the most effective pieces of apparatus for collecting small phalangids can be made by removing the bottom from a canvas wash-basin and replacing it with wire screen having a mesh of about three-eighths of an inch. Leaves, moss and other surface debris may then be sifted over a piece of light-colored cloth, and the specimens collected as they reveal themselves by movement.

Some nocturnal species are attracted to the substances used by entomologists when collecting moths by the process called "sugaring." Molasses, sugar syrup, stale beer, or mixtures of these substances, are sometimes employed effectively when smeared on the surface of trees or buildings.

Preservation of Phalangids

Phalangids may be preserved in a more or less flexible condition in 75% grain alcohol. Formalin solution or alcohol of greater strengths tend to make the specimens very brittle.

When collecting I have found it convenient to use small, wide-mouthed jars so that the specimens could be poked beneath the surface of the alcohol with the tip of the finger. The specimens will cease to struggle very quickly and will remain in a relaxed condition. Before permanent storage, the legs of the larger specimens should be straightened and brought together, much as one would gather the stems of small flowers in making a bouquet. This treatment will facilitate subsequent handling and storage and help in keeping the legs attached to the body.

PART II

The Biology of the Phalangida

Many writers have commented on the scarcity of information dealing with the biology of the group but few have contributed anything to correct the situation. Such minor contributions as have appeared abound in errors. For example, the statement is made repeatedly that phalangids are nocturnal and hence difficult to study. As a matter of fact, some species are strictly diurnal. Commentating on the food of phalangids, some writers repeat the old contention that they feed mainly on aphids or other small, soft-bodied insects when, in truth, aphids are avoided by species that will eat almost every other kind of food that may be found or captured, including animal and vegetable scraps from the table. It has been maintained that phalangids feed only on dead insects but a few hours' observation of caged specimens will demonstrate their ability to capture and kill dozens of kinds of insects, spiders and other small animals. It is probably true that, in the north, most species die in the fall of the year in which they are hatched; but more species winter over, either as adults or as partly grown young, than is indicated in the literature. Species known to winter as adults include *Leiobunum formosum* and *L. bicolor,* the latter often in caves or dark crevices. Those wintering as partly grown individuals are *Leiobunum ventricosum* and *Hadrobunus maculosus.* Occasionally, adults of *Phalangium opilio* and *Opilio parietinus* will survive a mild winter. Some individuals of *Sabacon crassipalpe,* which are only half grown in September, very likely require another season to reach maturity.

Two European writers, T. H. Savory and Mitja Roters (see bibliography) have given interesting accounts of the behavior of phalangids and the notes which follow will serve to supplement their accounts.

Light. While it is true that nocturnal species of phalangids usually avoid strong light and may be found during daylight hours hiding beneath bark, logs or other debris, they soon become adapted to direct light and may be studied in glass cages. Diurnal species, like *Leiobunum longipes,* will continue all normal activities, feeding, mating, drinking, etc., while directly in the beam of a strong light.

Water. Water is of primary importance in the economy of phalangids and they do not long survive without it. They may fast for a week or ten days without serious difficulty but many will die in a couple of days if deprived of water. After a warm rain many species, both diurnal and nocturnal, may be found abroad but during a period of drouth almost all kinds will avoid direct light and forage only at twilight or early in the morning.

Food. Observations made in the field and supplemented by the study of caged specimens, indicate that the diet of phalangids is an extremely varied one. I have found *L. longipes* feeding on various insects, spiders, bits of earthworm and slugs. In captivity I have fed them with dozens of kinds of insects and spiders and with bits of meat, fruit, and vegetables. Hard-shelled insects, such as ants and beetles, and large spiders, grasshoppers, dragon-flies, plant bugs, moths and butterflies have to be crushed before they can be eaten; but a surprising number of the smaller forms are captured and eaten avidly. A few species of phalangids are reported to be cannibalistic. The sensitive second legs are perhaps of prime importance in the recognition of prey.

When eating, the chelicerae, the palpi and the legs may all be brought into use. Legs and palpi help in subduing living prey and the pinchers of the chelicerae serve to tear it into bits. On several occasions I have observed two or more phalangids pulling and tugging at the same bit of food.

Mating. Mating among the phalangids is as casual an affair as eating or drinking. Mature males and females that encounter one another in the field ordinarily mate briefly, separate and continue their wanderings. A short time later they may again mate with one another or with different individuals. The necessity for frequent matings may perhaps be found in the fact that the eggs mature a few at a time and are deposited at intervals throughout the summer.

So far as I have observed there is no courtship preceding mating nor is any attention given the eggs after they have been deposited. As noted elsewhere, the eggs of the majority of our species pass the winter in the soil or rotted wood and hatch in the spring. The young, so far as they have been studied, are entirely lacking in pigment at hatching.

Oviposition. The female phalangid may start to deposit her eggs immediately after mating if she happens to be in a situation where there are suitable conditions of soil or well rotted wood. The long flexible ovipositor is out-thrust beneath her body, the tip exploring the surface until proper conditions are encountered. The soil or wood must be soft and moist to permit penetration of the ovipositor; or a crevice must be found. If mating has taken place where conditions for egg-laying are not suitable, the female will often seek a particular spot the location of which she seems to have prior knowledge. Observing many matings in the field, I have followed individual females to watch egg-laying in a well-rotted hemlock root where it broke the surface of the ground some distance from the place of mating.

Egg-laying may be limited to a few seconds or continued for a minute or more depending, apparently, upon the number of eggs ready to be laid. Often the female is accompanied by a male who takes up a protective position above her and spreads his long legs over her body, like the ribs of an umbrella. In this position he attempts to drive off rival males who seek to usurp his position and prerogatives.

The eggs are tiny, .3 to .5 mm. in diameter, pale yellow or pale green spheres, and an individual female, depending on the species, may deposit a hundred or more.

External parasites. Small red mites are often found attached to the legs of phalangids but, so far as I am aware, the American species has not been identified. Savory (1938, p. 4) reports the presence of pseudoscorpions on specimens of *Opilio parietinus* in England but regards them as merely travellers.

Tonic Immobility. Savory (1938, p. 6) noticed that when a number of phalangids were confined in limited quarters they seemed to be anaesthetized, intoxicated or narcotized by each other and remained for long periods in the state of insensibility. When thrown out upon the floor of a cage they promptly recovered and ran about normally. While studying phalangids in small glass boxes, I have several times observed the same phenomenon. The specimens lay in a tangled mass of legs and bodies, apparently without life, but when disturbed, by shaking the box, they recovered and assumed normal activities.

Loss of legs. Unlike most arachnids, the phalangids fail to regenerate lost appendages. Specimens are often found which have fewer than the normal number of legs and when the loss involves the second pair they are indeed handicapped. In species that reach maturity and die in a single season, most specimens that survive until late summer or fall will have lost one or more of the legs. They apparently lack the ability to rid themselves of damaged members and will continue to drag a crippled leg until it severs itself.

"Silk." The shed skins of Harvestmen are often found hanging from a thread which many have assumed to have been made by spiders and adapted to the use of the phalangid. Th. Savory, however, (1938, p. 1) believes that at least some Harvestmen produce a kind of "silk" the origin of which remains a mystery. Specimens confined in boxes produced very fine lines on the floor and sides of the container and in one instance used these lines to suspend the remains of an insect.

I have tried many times to find evidence of this "silk" in glass boxes used to confine a number of different American species of Harvestmen but so far without success.

Moulting. Harvestmen shed their skins from time to time to accommodate their changing dimensions. Hanging themselves by the hind legs they twist and jerk until a split occurs in the skin and from this opening the chelicerae and basal segments of the legs are withdrawn. The body proper than appears followed by the terminal segments of the legs.

PART III

Synopsis of genera and species of New York Phalangida

Order Phalangida

SUBORDER LANIATORES

FAMILY PHALANGODIDAE SIMON

Genus Erebomaster Cope

E. flavescens Cope

SUBORDER PALPATORES

FAMILY NEMASTOMATIDAE SIMON

Genus Crosbycus Roewer

C. dasycnemus (Crosby)

FAMILY ISCHYROPSALIDAE SIMON

Genus Sabacon Simon

S. crassipalpe (L. Koch)

FAMILY PHALANGIIDAE SIMON

Genus Caddo Banks

C. agilis Banks

C. boöpis Crosby

Genus Mitopus Thorell

M. morio (Fabricius)

Genus Odiellus Roewer

O. pictus (Wood)

Genus Phalangium Linnaeus

P. opilio Linnaeus

Genus Opilio Herbst

O. parietinus De Geer

Genus Leiobunum C. L. Koch

L. bicolor (Wood)

L. calcar (Wood)

L. flavum Banks

L. formosum (Wood)

L. longipes longipes Weed

L. nigripes Weed

L. nigropalpi (Wood)

L. politum Weed

L. serratipalpi Roewer

L. speciosum Banks

L. uxorium Crosby and Bishop

L. ventricosum (Wood)

L. verrucosum (Wood)

L. vittatum (Say)

Genus Hadrobunus Banks

H. maculosus (Wood)

KEY TO THE PHALANGIDA (OPILIONES) OF NEW YORK

1. Coxae of 4th legs free at tips; palpi armed on all segments beyond coxae with very long, strong, spine-tipped tubercles (Phalangodidae) .... *Erebomaster flavescens* p. 170
   Coxae of 4th legs fused to venter; palpi variable but never armed on all segments beyond coxae with very long, strong, spine-tipped tubercles .. 2

2. Tarsus of palpus with a claw at tip (Phalangidae) 4
   Tarsus of palpus without a claw at tip 3

3. Palpi large and stout; tibia and tarsus swollen and armed with bristles, like a teasel-burr; species of moderate size, to 5 mm. (Ischyropsalidae) .... *Sabacon crassipalpe* p. 173
   Palpi very long and slender; tibia and tarsus not swollen and covered only with fine hair; species very small, to 1 mm. (Nemastomatidae) .... *Crosbycus dasycnemus* p. 172

4. Eye-tubercle relatively very large, extending the entire width of the thorax; eyes very large (Caddini) 5
   Eye-tubercle normal, not extending width of thorax; eyes of normal size 6

5. Trochanter of palpus with one or two large spines below; femur of palpus with three large spines below, two close together at base, one near middle of length; tibia of palpus with two large spines below .... *Caddo boöpis* p. 176
   Trochanter of palpus without large spines below; femur of palpus with three large spines on basal half; no spines below on tibia .. *Caddo agilis* p. 175

6. Claw of palpus denticulate at base below; a row of small denticles on sides of coxae, at least on coxa I; legs long except in *Hadrobunus* (Leiobuninae) 10
   Claw of palpus smooth; no rows of denticles on coxae; legs usually short 7

7. Proximal segment of chelicera with a basally stout, apically slender and pointed spine at base below (Oligolophinae) 8
   Proximal segment of chelicera without such a spine below; legs with series of spines arranged in regular rows (Phalanginae) 9

8. Femur of palpus with a ventro-lateral series of long, strong spines; three large spines at margin of carapace in front at mid line .... *Odiellus pictus* p. 180
   Femur of palpus without a ventro-lateral series of long, strong spines; a group of small tubercles just behind margin of carapace at mid line .. .. *Mitopus morio* p. 178

9. Supra-cheliceral laminae prominent, each with a large spine on mesal side; 2nd segment of chelicera of male with a prominent spur above ... . *Phalangium opilio* p. 183
   Supra-cheliceral laminae inconspicuous and without a spine on the mesal side; no spur on the 2nd segment of chelicera of male .. *Opilio parietinus* p. 185

10. Femur of 1st leg shorter than width of body; tibia II of adults, without false articulations; tarsus of palpus not armed with a meso-ventral series of small dark denticles .... *Habrobunus maculosus* p. 215
Femur of 1st leg longer than width of body; usually longer than length of body; tibia II with false articulations; tarsus of palpus of male armed with a meso-ventral series of small, dark denticles (*Leiobunum*) 11

11. Base of tibia of palpus of male swollen and protuberant below and armed with a cluster of black denticles; trochanters either concolorous or contrasting in color; female, when known, with femur of palpus armed ventrally with a series of short, sharp denticles, tibia with a ventro-lateral series of denticles 12
Base of tibia of palpus of male not at all or (*nigropalpi*) slightly swollen below and sometimes armed with small denticles; femur of palpus of female without a ventro-lateral series of denticles, tibia with or without a ventro-lateral series of denticles 13

12. Femur of palpus of male with a large, ventro-lateral spur which may be apposed to swollen base of tibia; male generally light tan or light brown above with central figure lightly developed; female with central figure developed on anterior two-thirds of abdomen .. *Leiobunum calcar* p. 189
Femur of palpus of male without a large ventro-lateral spur but armed with a ventro-lateral group of short black denticles on distal third; general color above yellow; female unknown ... *Leiobunum serratipalpi* p. 203

13. Coxae and trochanters of legs concolorous; or trochanters no darker than dorsum 14
Coxae and trochanters of legs contrasting in color, the trochanters brown or black 17

14. Legs with white bands more or less well developed at the articulations .... *Leiobunum bicolor* p. 187
Legs not so marked 15

15. Legs light to dark brown, sometimes darker distally, male; femora and tibiae usually shaded distally in legs I, III, IV in female; tip of tibia of 2nd legs with a white band sometimes faint in females; denticles on anterior surface of coxae poorly developed or absent, except on coxa I; penis not alate, compressed near tip; size small, male to 4 mm., female to 5 mm. .... *Leiobunum politum* p. 201
Patellae of legs usually darker than other segments; denticles well developed on anterior surface of coxae I to IV; penis alate; size large, male to 8 mm., female to 10 mm. 16

16. Eye-tubercle smooth or at most with a few low rounded tubercles; legs slender; abdomen long, pointed behind, especially in the male .... *Leiobunum ventricosum* p. 207
Eye-tubercle armed with well developed denticles on carinae; abdomen rounded behind in female, bluntly pointed in male .. *Leiobunum flavum* p. 192

17. Legs very long and slender; tip of tibia of 2nd legs, in both sexes, banded with white; male small, orange .... *Leiobunum longipes* p. 195
Tip of 2nd tibiae ***not*** banded with white 18

18. Legs banded in female; in male sometimes faintly banded; usually tips of femora, tibiae and patellae dark brown or black 19
Legs uniformly colored or, rarely, (*verrucosum*) yellow, with patellae light brown and femora and tibiae shaded distally 21

19. Central figure of dorsum very strongly developed in both sexes; femur of palpus of male long, slender and curved, extending above surface of carapace a distance equal to six or eight times the height of eye-tubercle .... *Leiobunum vittatum* p. 211
Central figure of dorsum poorly developed or at most limited to the anterior half of abdomen; femur of palpus of male long or short; penis not alate near tip 20

20. Eye-tubercle nearly smooth, at most with only one or two tubercles on carinae; dorsal side of trochanters blotched with yellow, at least faintly in females; femur of palpus of male short; legs moderately stout in female; tip of femur and the patella of palpus dark or at least shaded faintly .... *Leiobunum formosum* p. 193

Eye-tubercle armed with numerous tubercles on carinae; femur of palpus of male long; palpus yellow .... *Leiobunum speciosum* p. 204

21. Palpus with some segments brown or black, at least above; dorsum of male yellow, of female tan or light to dark brown 22
Palpus yellow or tan 23

22. Femur, patella and tibia of palpus dark brown or black, at least above; tibia of palpus of male slightly swollen at base below and armed with tubercles; penis not alate; female with central figure developed on anterior half of abdomen .... *Leiobunum nigropalpi* p. 199
Femur and patella of palpus of male and femur, patella and tibia of palpus of female light brown or mottled above; base of tibia not swollen below and armed with stout denticles; dorsal figure of female limited to basal half; penis alate .... *Leiobunum nigripes* p. 198

23. Penis not alate; size, male to 4 mm., female to 6 mm.; legs nearly uniformly brown; male yellow; female with central figure moderately well developed on anterior half .... *Leiobunum uxorium* p. 206
Penis alate; size, male to 6 or 7 mm., female to 6 or 8 mm.; male pale yellow to brown above, whitish below; female with central figure faintly developed; legs, northern specimens, faintly banded, southern specimens nearly uniformly colored .... *Leiobunum verrucosum* p. 209

Accounts of Genera and Species

EREBOMASTER COPE

This genus was established by Cope for *E. flavescens* Cope from Wyandotte Cave, Indiana. Related forms have been recorded from caves in Virginia and Kentucky and given subspecies status by Roewer (1923, p. 107). I have not had specimens of these forms for comparison and for the present regard *E. flavescens* as a distinct species.

Erebomaster flavescens Cope

Pl. 1, figs. 1–5.

Erebomaster flavescens Cope, Amer. Nat. 6(7):420, figs. 114–115. 1872.*
Phalangodes flavescens, Simon, Arach. France, 7:156. 1879.
Phalangodes flavescens, Packard, Mem. Nat. Acad. Sci. 4(1):49–50, pl. 12, figs. 1–3; pl. 14, fig. 1. 1888.
Scotolemon flavescens, Banks, Amer. Nat. 35(416):672. 1901.
Scotolemon flavescens, Comstock, The Spider Book, pp. 62–63. 1912.
Erebomaster flavescens flavescens, Roewer, Weberknechte der Erde, p. 107. 1923.
Erebomaster flavescens, Comstock, The Spider Book, rev. ed. p. 63. 1940.

Female, length 2 mm.; width 1.25 mm.

Legs, I, 4.25 mm.; II, 5.5 mm.; III, 4 mm.; IV, 6 mm.

Dorsal integument finely granular; eye tubercle conical, broad at base, pointed at tip; eyes small, black, widely separated at base of tubercle; abdomen broadly rounded at the sides, bluntly pointed at tip, from above with four segments evident.

* No attempt has been made to give a complete synonymy of any species. References cited are those most useful and generally available or of importance in determining distribution.

Venter with coxae and genital operculum slightly granular; coxae armed at distal ends behind with a few low, rounded tubercles; coxa II longest, its tip extending well beyond edge of carapace; coxa IV widest, free at tip. Legs, 3–1–2–4 in order of length from the shortest; trochanters short, more or less globular; femora slender; patellae short, somewhat thicker than femora; tibia plus patella about as long as femur; metatarsi slender, longer than tibiae; tarsi slender. Abdomen from below with six or seven segments evident.

Palpus very large and stout, longer than body and armed with very long tubercles bearing long, strong spines; femur of palpus strongly arched above and armed with a series of four stout tubercles each directed forward and bearing a short, sharp spine, below armed with three very large and several smaller tubercles bearing at their tips long, slender spines; armed mesally, near the tip, with a single long tubercle and spine; patella short, arched above and armed with two or three low tubercles, mesally with one or two very long, strong, spine-tipped tubercles and ventro-laterally at tip with a single long, spine-tipped tubercle; tibia about as long as femur, rounded above, from side to side, flattened below, armed ventro-laterally with three and mesally with four large, spine-tipped tubercles; tarsus depressed, bluntly pointed or truncate at tip, armed mesally and laterally with three large and several small, spine-tipped tubercles; claw very large, curved downward. Chelicera with basal segment cylindrical, slightly widened distally; second segment thicker, armed in front with low, rounded tubercles, claws directed mesally.

Color, uniformly yellow above and below except integument between abdominal segments, which is white.

The sexes are essentially similar.

Type locality, Wyandotte Cave, Indiana.

Distribution.—New York. ULSTER: Sam's Point, May 24, 1920. A single specimen was collected in a deep rock crevice at the summit of the ridge. The species has also been recorded from caves and dark situations in Kentucky and Virginia.

For specimens from the type locality I am indebted to Dr. Clarence J. Goodnight.

CROSBYCUS ROEWER

This genus was erected by Roewer (1914, p. 168) to include the species described by Crosby (1911, p. 20) as *Nemastoma dasycnemum*. So far as I am aware, no other species have been described.

Crosbycus dasycnemus (Crosby)

Pl. 1, fig. 6.

Nemastoma dasycnemum Crosby, Can. Ent. 43:20, fig. 1. 1911.
Nemastoma dasycnemum, Comstock, Spider Book, pp. 78–79. 1912.
Crosbycus dasycnemum, Roewer, Arch. Naturg. 80(3):168. 1914.
Crosbycus dasycnemum, Roewer, Arch. Naturg. 83(2):160. 1917.
Crosbycus dasycnemus, Roewer, Weberknechte der Erde, p. 678. 1923.
Crosbycus dasycnemus, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1074. 1928.
Crosbycus dasycnemon, Comstock, Spider Book, rev. ed., pp. 78–79. 1940.

Male, length 1 mm.

Male, dorsal integument studded with small, dark brown denticles forming indistinct patches on either side of the thorax; a conspicuous narrow band, convex anteriorly, on the first abdominal segment, a broad patch covering the anterior second and third abdominal segments and narrower bands which do not reach the lateral margins on the succeeding posterior segments; anterior margin of carapace with a group of small, black, sharp-pointed spines at center just in front of eye-tubercle; eyes small, black, on a broad, low tubercle, separated by about the diameter of one of them. Coxae armed below with two or three longitudinal bands of small brown tubercles; trochanters covered generally with similar tubercles, sternites, but not the genital operculum, with similar brown denticles forming transverse bands.

Palpus extremely long and slender, nearly as long as first pair of legs, the segments nearly straight, cylindrical and of uniform diameter; coxae, trochanters, femora and tibiae light brown, distal segments yellowish; femora, patellae and tibiae of legs somewhat thickened and armed with pale hairs and short, black, sharp-tipped spines; femora in particular with long, fine hairs.

Color. Above light to dark brown, appearing darker where covered with denticles; posterior lateral angles of abdomen with flange-like projections pale, yellowish white, in some nearly transparent; legs pale yellow to brownish; venter light brown, yellowish in transverse bands between abdominal segments in a fully adult specimen; some individuals much paler, juveniles very pale.

Female similar to male in form in the single specimen I have seen; colors much paler, the tubercles less well developed, particularly on the venter of the abdomen.

Type locality, Columbia, Mo.

Distribution.—New York. ONTARIO: Hemlock lake, Apr. (A. J.). TOMPKINS: Freeville, Oct. (C. R. C.); Ithaca, Apr. (A. J.). YATES: Keuka lake, Sept. (C. R. C.); Egleston Glen, Apr., Jly., Oct. (C. R. C.). Long Island, SUFFOLK: Montauk Point, Je. (C. R. C.)

Specimens also seen from Ill., Urbana, Oct. (V. G. S.); Minn., Lake Minnetonka, Aug. (F. C. P.)

SABACON SIMON

The genus *Sabacon* was established by Simon (1879, p. 266, pl. 24, figs. 5, 5a) with *S. paradoxus* as the type. In this genus the tibia of the palpus is greatly enlarged, the tarsus is short and turned back upon the tibia and both tibia and tarsus are provided with stout bristles so that they resemble a teasel-burr or bottle-brush.

Sabacon crassipalpe (L. Koch)

Pl. 1, figs. 7–8.

Nemastoma crassipalpis L. Koch, Svenska-Akad. Handl. 16(5):111–112, pl. 3, fig. 19. 1879.

Phlegmacera cavicolens Packard, Amer. Nat. 18(2):203. 1884.

Phlegmacera cavicolens Packard, Mem. Nat. Acad. Sci. 4(1):54, pl. 14, figs. 5, 5a–5g. 1888.

Sabacon spinosus Weed, Amer. Nat. 27(318):575, fig. 1. 1893.

Phlegmacera cavicoleus (sic), Banks, Psyche 7:52. 1894.

Phlegmacera occidentalis Banks, ibid., p. 51.

Phlegmacera cavicoleus (sic), Banks, Jour. N. Y. Ent. Soc. 2:40. 1894.

Phlegmacera cavicoleus (sic), Banks, Amer. Nat. 35(416):677. 1901.

Phlegmacera cavicoleus (sic), Banks, Ent. News. 13:308. 1902.

Phlegmacera cavicolens, Comstock, Spider Book, p. 78. 1912.

Sabacon crassipalpis, Roewer, Arch. Naturg. 80(3):125, fig. 16a–c. 1914.

Sabacon crassipalpe, Roewer, Weberknechte der Erde, pp. 694–695, fig. 869. 1923.

Sabacon cavicolens, Crosby and Bishop, Jour. Elisha Mitchell Sci. Soc. 40:23, fig. 16. 1924.

Sabacon cavicolens, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1074. 1928.

Sabacon crassipalpe, Comstock, Spider Book, rev. ed. p. 77. 1940.

Male, length 3 mm.; width 1.5 mm.

Legs, I, 10 mm.; II, 16.75 mm.; III, 10 mm.; IV, 15 mm.

Dorsal integument moderately soft, shining; anterior margin of carapace nearly straight and armed with a few short, dark hairs; eye tubercle low, broader than long, shallowly canaliculate, the carinae unarmed, the eyes directed dorso-laterally; openings of scent glands small, placed opposite space between base of palpus and first pair of legs; transverse ridge behind eye tubercle with a row of short dark hairs; abdominal segments above each with a slightly chitinized, broadly oval patch bearing a transverse row of short dark hairs; coxae and genital operculum with numerous, moderately long, dark, brown bristles; sternites each armed, along the anterior margin, with a row of short dark hairs.

Palpus stout, the trochanter short, cylindrical, armed with a few very short hairs distally above; femur about one and one half as long as trochanter, slender at base, widened distally, armed above with short dark hairs and ventrally and mesally with longer dark bristles; patella a little shorter than femur but wider, armed with dark bristles except ventro-mesally where there is a sharp-pointed, black-tipped tooth at the distal end; tibia large, gourd-shaped, swollen on basal half, curved mesally at tip where it is slightly excavated to receive the folded back tarsus, armed densely with bristles to resemble a teasel burr except on the excavation; tarsus short, covered densely with bristles and turned back to lie along the excavated part of tibia.

Chelicerae stout, armed above with dark bristles, the claws bent mesally. Femora, patellae and tibiae of legs armed with scattered, short, dark bristles; the patellae, tibiae, metatarsi and tarsi in addition clothed with very short brown hairs.

Color. Carapace dull yellowish-white margined with pale, purplish brown; eye-tubercle black, notched in front with yellow; transverse ridge back of eye-tubercle and the abdominal segments above with transverse tapering blotches of purplish brown, the interspaces on the sides dull yellowish-white; appendages all dull yellowish-white; abdominal sternites with tinges of purplish brown laterally.

Female, length 4 mm.; width 2.5 mm.

Legs, I, 9.5 mm.; II, 13 mm.; III, 8 mm.; IV, 12 mm.

The female resembles the male closely in general appearance but the patella of the palpus lacks the black tooth distally below and the tibia is larger and more strongly swollen on the basal half; abdominal sternites usually darker than in the male.

Type locality, Siberia.

Distribution.—New York. MONROE: Forest Lawn, Feb. STEUBEN: Prattsburg, Jly., juv. (C. R. C.). TOMPKINS: Enfield Glen, May, juv. (C. R. C.); Ithaca (N. B.) Jly., Aug., ad. male (C. R. C.). YATES: Potter Swamp, Jly., juv. (C. R. C.) Long Island. SUFFOLK: Montauk Point, Je., juv.

I have also examined specimens from N. C., Grandfather Mt., Oct. (C. and B.); Mt. Mitchell, Sept. (N. B.); Blowing Rock, Oct., juv. (C. and B.); Oregon, Winchester Beach, Je. (C. R. C.); Canada. B. C., Prince Rupert, Je. (C. R. C.); Alert Bay, Je. (C. R. C.) The species has been recorded from Alaska, California, Kentucky, Maine, New Hampshire, and Washington.

Most specimens of this species have been taken by sifting leaf mold and the rubbish beneath ferns. Since both adults and half-grown young have been taken at the same time in September, the species may require more than one season to reach maturity.

CADDO BANKS

The genus *Caddo* was established by Banks (1892, p. 250) for *Caddo agilis,* described from Long Island, New York. In 1904 (pp. 253–255) Crosby described *C. glaucopis* and *C. boöpis*. *Caddo agilis* had been described from immature specimens so Crosby did not realize his adult *glaucopis* was the same species. The error was corrected by Crosby (1907,

p. 161) but the note was overlooked by Roewer who continued to recognize *glaucopis* as a distinct species in his 1912 and 1923 reports. (See synonymy under *C. agilis.*) In 1924, Bishop and Crosby recognized *Platybunus dentipalpus* Koch and Berendt (1854, p. 101, pl. 15, fig. 125) as an undoubted representative of the genus *Caddo,* closely related to *C. agilis,* from early Tertiary Baltic amber. Goodnight and Goodnight (1948, p. 201) have described another species, *C. chomulae,* from San Cristobal de las Casas, Chiapas.

Caddo agilis Banks

Pl. 1, figs. 9–14.

Caddo agilis Banks, Proc. Ent. Soc. Wash. 2:249. 1892.
Caddo agilis Banks, Can. Ent. 25 (8):207. 1893.
Caddo agilis Banks, Jour. N. Y. Ent. Soc. 2:40. 1894.
Caddo agilis Banks, Amer. Nat. 35 (416):674. 1901.
Caddo agilis Banks, Ent. News 13:308. 1902.
Caddo agilis Banks, Jour. N. Y. Ent. Soc. 12:256. 1904.
Caddo glaucopis Crosby, Jour. N. Y. Ent. Soc. 12(4):253–255. 1904. (fig. 4 applies to Caddo *boöpis*)
Caddo glaucopis Crosby, Ent. News 18(4):161. 1907.
Caddo agilis, Comstock, The Spider Book, 1st ed. p. 68, figs. 50, 56. 1912.
Caddo agilis, Roewer, Abhandl. a Gebiete Naturw. Hamburg 20(1):34 pl. 1, fig. 9; pl. 2, figs. 3, 10, 12. 1912.
Caddo glaucopis, Roewer, Abhandl. a Gebiete Naturw. Hamburg 20(1):34–35. 1912. (pl. 1, fig. 3 applies to *Caddo boöpis*)
Caddo agilis, Roewer, Die Weberknechte der Erde, p. 713, fig. 889 a–b. 1923.
Caddo glaucopis, Roewer, Die Weberknechte der Erde, p. 713–714. 1923.
Caddo agilis, Bishop and Crosby, N. Y. State Mus. Bull. No. 253, pp. 83–84, fig. 3. 1924.
Caddo agilis, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1074. 1928.
Caddo agilis, Comstock, The Spider Book, rev. ed. p. 68, figs. 50, 56. 1940.

Male, length 1.4 mm.

Legs, I, 10.5 mm.; II, 13 mm.; III, 11.5 mm.; IV, 13 mm.

Integument of male above soft, that of the thoracic part smooth and shining, abdomen dull; no spines, tubercles or denticles on any part of the body proper above or below; eye tubercle large, occupying nearly the whole width of thorax; ratio of length of eye tubercle to length of body as 1 to 3; the eyes essentially the size of those of some species of phalangids having a body length of 10 to 12 mm.; eye-tubercle with a broad longitudinal canal, the carinae unarmed; coxae and genital operculum smooth, armed with a few short, scattered brown hairs; sternites smooth. Palpus stout, trochanter short, thick and unarmed except for a few short hairs; femur a little longer than trochanter, slightly curved above and armed below on the basal half with three large, sharp-pointed, brown-tipped spines; patella short and thick, nearly as long as femur, armed disto-mesally with a patch of stout spines; tibia about as long as patella and with spines on the mesal surface; tarsus nearly twice as long as tibia, armed mesally with a band of stout spines and laterally with a few scattered spines. Chelicera with basal segment short and cylindrical, the distal segment large, swollen at base.

Color. Thoracic part bright silvery tinged with dusky laterally; eye tubercle silvery at center of groove, dusky yellowish to the broad, black rim around each eye; palpus and chelicera, except claws of latter, silvery white; abdomen above purplish brown with a median series of connected silvery spots having narrow lateral extensions to a sublateral series of silvery spots on each side; below silvery white.

Female, length 2.6 mm. A fully adult female from Boonville differs from the male in its much larger size and longer abdomen, the ratio of length of eye tubercle to that of body as 1 to 3.7. The colors are strikingly developed. The thoracic part is pale yellowish with bright, silvery reflections, the eyes only being surrounded by a broad black band; palpi and chelicerae pale yellowish, the claws of both dark tipped. Abdomen above purplish-grey with a broad median band and narrow cross bands, widened laterally, bright silver. In some individuals, the widened ends of silvery cross bands fuse to form definite lateral bands.

In juveniles, the femur of the palpus bears a large, blunt protuberance on the distal mesal angle.

Type locality, Long Island, New York.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly. DELAWARE: Delhi, May (C. R. C.). HERKIMER: Big Moose lake, Je. NIAGARA: Olcott, Sept. (H. D.). ONEIDA: Boonville, Jly. (L. C. K.). SENECA: Covert, Jly. (J. C. B.). TOMPKINS: Ithaca, Aug. (C. R. C.); Woodwardia swamp, Freeville, Aug. Long Island, Jly. (N. B.). QUEENS: Jamaica, Je. (A. W.). SUFFOLK: Cold Spring Harbor, Je. (J. W. G.). Great Pond, Riverhead, May; Montauk Point, May.

Specimens also examined from D. C., Washington (N. B.); Maine, Mt. Katahdin (H. W. B.); N. J., Princeton, Jly. Aug. (K. W. C.); N. C. Swannanoa Valley. Canada. Ontario: Sanford, Je. (C. R. C.); Quebec: Bagotville, Jly. (C. R. C. & H. Z.); St. Joseph d'Alma, Jly. (C. R. C. & H. Z.).

Caddo agilis has been taken in a great variety of situations, on and under logs in woods, under leaves, in sphagnum moss, crawling on trees and on a house, and under logs in woods near the sea shore. It is most easily found by sifting sphagnum moss and leaves in boggy situations.

Caddo boöpis Crosby

Pl. 1, figs. 15–18.

Caddo boöpis Crosby, Jour. N. Y. Ent. Soc. 12(4):255, fig. 4. 1904.
Caddo boöpis Crosby, Ent. News, 18(4):161. 1907.
Caddo boöpis, Comstock, The Spider Book, 1st ed. p. 68. 1912.
Caddo boöpis, Roewer, Abhandl. a Gebiete Naturw. Hamburg 20(1):35–36, pl. 1, fig. 3. 1912.
Caddo boöpis, Roewer, Weberknechte der Erde, p. 714, fig. 890. 1923.

Caddo boöpis, Bishop and Crosby, N. Y. State Mus. Bull. No. 253, pp 83–84, fig. 2. 1924.

Caddo boöpis, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1074. 1928.

Caddo boöpis, Comstock, The Spider Book, rev. ed. p. 68. 1940.

Male, length 1 mm.

Legs, I, 2.2 mm.; II, 3 mm.; III, 2.5 mm.; IV, 3.7 mm.

Integument of male above soft, that of thoracic part smooth and shining, abdomen dull; no spines or tubercles present on body proper above or below; eye tubercle, relative to body size enormous, as wide as thorax; ratio of length of tubercle to that of body as 5 to 13; eye tubercle with a broad, shallow, longitudinal canal, widest behind, the eyes diverging posteriorly. Venter. Coxae and genital operculum smooth, unarmed except for a few short hairs; sternites smooth. Palpus not as stout as in *C agilis* but relatively longer; trochanter short, about one third as long as femur, armed below distally with one large and one small spine which arise from a common base; femur slender, evenly rounded above, armed disto-mesally with a large, ventro-mesally directed spine and below with two (rarely three) large spines at base of segment and a single large spine at the middle; patella a little more than half as long as femur, armed ventro-laterally with one or two small spines and mesally with short hairs; tibia a little shorter than patella, armed ventro-laterally with two large and one small spine, mesally with a band of hairs; tarsus a little shorter than tibia, armed with short hairs. Chelicera with basal segment short, the distal segment swollen proximally.

Color. Thoracic part, palpi and chelicerae yellow; claws of chelicerae black-tipped; a broad, oval black rim around each eye; coxae and genital operculum yellow, tinged with dusky; abdomen above light purplish grey crossed by narrow light lines between the segments, below lighter; legs yellowish tinged with dusky.

Female. Essentially similar to male but slightly larger.

Type locality, Ithaca, New York.

Distribution.—New York. ALBANY: Voorheesville, Aug. (Mrs. M. D. L.). FULTON: East Caroga lake, Jly. ORLEANS: West Barre, Sept. SARATOGA: Ballston lake, Aug. (A. W.). TOMPKINS: Ithaca, Aug. type (C. R. C.). Long Island. QUEENS: Flushing, spring 1938 (K. W. C.).

Most specimens of this species have been taken by sifting white pine needles, the type by sifting leaves on a wooded bank.

MITOPUS THORELL

The genus *Mitopus* includes relatively few species but the type, *M. morio*, is very widely distributed in Europe, Asia, North Africa and North America, and has appeared in the literature under a great variety of names. In this genus the femur of the first legs is shorter than the width of the body.

Mitopus morio (Fabricius)

Pl. 2, figs. 19–22.

Phalangium morio Fabricius, Reise nach Norwegen, p. 340. 1779.
Oligolophus montanus Banks, Can. Ent. 25:252–253. 1893.
Mitopus montanus Banks, Amer. Nat. 35(416):674. 1901.
N (*sic*) *itopus montanus* Banks, Ent. News 13:308. 1902.
Mitopus montanus, Comstock, Spider Book, p. 70. 1912.
Mitopus morio, Roewer, Abhandl. a Gebiete Naturw. 20(1):45–48. 1912.
Mitopus morio, Roewer, Weberknechte der Erde, pp. 718–719, fig. 892. 1923.
Mitopus morio, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1074. 1928.
Mitopus montanus, Comstock, Spider Book, rev. ed. p. 70. 1940.

Male, length 4 mm.; width 3 mm.

Legs, I, 21 mm.; II, 35 mm.; III, 23 mm.; IV, 35 mm.

Carapace with a cluster of four or five small tubercles at center just back of anterior margin and a row along margin of pigmented area back of anterior margin; lateral margins of carapace with one or two small tubercles between coxae I–II and II–III; dorsum of abdomen smooth except for small widely spaced tubercles in a transverse series on each segment; openings of scent glands at the edge of the carapace, opposite trochanters of first legs; eye-tubercle with a shallow canal, the carinae with a few small, low, rounded tubercles; nine or ten small tubercles in a transverse row behind eye-tubercle, this row followed by a transverse groove and fold, nearly straight at the center but with the ends turned backward. Abdomen widest at about the middle of the length, bluntly rounded behind and turned downward at tip.

Venter. Coxae smooth with sparse, short, brown hairs; genital operculum similarly clothed; posterior distal angle of coxa II with a tubercle bearing one black-tipped spine; coxa IV with a broad, flat, pointed tubercle on the anterior, distal angle; trochanters short, globose, armed laterally and ventrally at distal margin with short dark hairs; femora III and IV nearly rectangular in cross section, the ridges on III and IV armed with short, black, curved spines, forming regular series; femora I and II more nearly cylindrical, armed with short hairs only; patellae short, curved above and armed sparsely with short hairs and with a few short, black sharp-pointed spines on the distal margin above; all tibiae more or less rectangular in cross-section and armed with short hairs on the angles; metatarsi slender, cylindrical, armed with fine, short hairs and with short black spines forming a single series below at the false articulations; tarsi slender, the single claw simple, sickle-shape.

Femur of palpus from above slender, slightly widened distally and with blunt apophyses on the disto-mesal angle, from the side slightly curved above and below; patella short and thick, widened distally, armed dorso-mesally with a dense patch of short hairs; tibia short, slightly longer than patella, armed dorso-mesally with short dense hairs; tarsus slender, about twice as long as tibia, armed beneath on basal two-thirds, with a narrow band of very small black denticles and distally with a single curved claw. Proximal segment of chelicera below at base with a distinct spur.

Color. Ground color above chalky white to dull yellow, marked laterally with transverse rows of small, dark brown to black spots and larger irregular blotches of brown; a broad central marking in strong contrast to adjacent light parts; the central figure light tan to brown, spotted and mottled with darker on the thoracic part, dark brown to black on the abdomen, somewhat lighter in the center; the dark figure widest at the suture between third and fourth abdominal segments, narrowing on the two following segments, slightly widened on the next behind, then narrowing to the tip of the abdomen; eye-tubercle light tan; chelicerae mottled brown and yellow on the basal segment above; claws yellow at base, black-tipped.

Femur of palpus brown, lighter distally; patella mottled brown, light on the sides and with a wedge-shape light mark above the apex directed backward; tibia variable, in some marked with alternating light and dark, longitudinal lines; tarsus generally light. Legs short, light in color with coxae lightly clouded with brown; trochanters light, mottled with pale brown; femora shaded distally; patellae brown; tibiae brown with a lighter band at center, metatarsi and tarsi light.

Female, length 4.5 to 6.25 mm.; width, 3.25 to 3.5 mm.

Legs, I, 20 mm.; II, 35 mm.; III, 21 mm.; IV, 34 mm.

Similar to male but larger and stouter; in general, the pattern above is the same in both sexes but the female is usually duller and with markings in less contrast than in male; tip of abdomen not turned downward as in male; venter irregularly and lightly mottled with brown and white on coxae and abdomen.

Type locality, Sweden.

Distribution.—New York. Adirondack Mountains. ESSEX: Artist Brook, Je. juv.; Avalanche lake, Jly. juv.; Lake Tear, Jly. juv. (W. T. M. F.); Mt. Marcy, summit, Jly. juv., Aug. Sept. ad.; Mt. MacIntyre, summit, Jly. juv.; Mt. Whiteface, 4000 ft., Aug. (C. R. C.); Uphill brook and Opalescent river, Jly. (C. R. C.).

Specimens also examined from Nova Scotia, Truro, Oct.; P. Q., Natashquan, Aug. (H. H. C.).

Mitopus morio is a mountain form, all New York specimens having been recorded from the Adirondacks, usually at elevations in excess of 4000 feet. The species should be looked for on the higher peaks of the Catskills.

ODIELLUS ROEWER

The genus *Odiellus* was proposed by Roewer (1923, p. 724) to include a considerable number of species formerly placed in *Oliogolphus, Phalangium, Odius,* and several other genera. It is characterized by the presence of three prominent spines on the anterior margin of the carapace in front of the eye-tubercle and the carinae of the eye-tubercle are armed with pointed tubercles; the femur of the palpus has a ventral row of prominent spines. I have included in this genus the phalangids from the north which have been recognized in the literature as *Lacinius ohioensis*. All the specimens of this supposed species I have seen are immature or mature individuals of *Odiellus pictus*. Whether or not the genus *Lacinius* is a valid one will have to be determined by a study of more adequate material than I possess. *Lacinius* is supposed to be distinguished by the lack of false articulations in the metatarsus of the first legs but many immature specimens of *Odiellus pictus* also lack these structures.

Odiellus pictus (Wood)

Pl. 2, figs. 23–28.

Phalangium pictum Wood, Commun. Essex Inst. 6(1):30–31, 1 fig. 1870.
Oligolophus pictus, Weed, Bull. Ill. St. Lab. Nat. Hist. 3:95–97, 1 fig. 1889; ibid. p. 106.
Oligolphus pictus, Weed, Amer. Nat. 24(286):917. 1890.
Oligolphus ohioensis Weed, Amer. Nat. 23(276):1102–1104, pl. 42, figs. 1–2. 1889.
Mitopus pictus, Weed, Proc. U. S. Nat. Mus. 16:557–558, pl. 62, fig. 2. 1893.
Mitopus ohioensis Weed, ibid., pp. 558–559, pl. 68, figs. 1–2. 1893.
Lacinius ohioensis, Banks, Can. Ent. 25:207. 1893.
Lacinius ohioensis, Banks, Jour. N. Y. Ent. Soc. 2:40. 1894.
Lacinius ohioensis, Banks, Amer. Nat. 35(416):674. 1901.
Oligolophus pictus, Banks, ibid.
Oligolophus pictus, Banks, Ent. News. 13:308. 1902.
Odius pictus, Roewer, Abhandl. a Gebiete Naturw. 20(1):70–71. 1912.
Lacinius ohioensis, Roewer, ibid., pp. 80–81.
Oligolophus pictus, Comstock, Spider Book, pp. 70–71. 1912.
Lacinius ohioensis, ibid., p. 70.
Odiellus pictus, Roewer, Weberknechte der Erde, pp. 734–735. 1923.
Lacinius ohioensis, Roewer, ibid., p. 743.
Odiellus pictus, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1074. 1928.
Odiellus pictus, Comstock, Spider Book, rev. ed. pp. 70–71. 1940.
Lacinius ohioensis, ibid., p. 70.

Male, length 5 mm., width 3.5 mm.

Legs, I, 11 mm.; II, 23 mm.; III, 13 mm.; IV, 16 mm.

Dorsum of thorax finely granular, that of abdomen relatively smooth between transverse rows of tubercles; anterior margin of carapace armed at the lateral angles with one or two small pointed tubercles and at the center with a series of three larger and longer spine-like tubercles; the center one largest; lateral margins of carapace with one or two small pointed tubercles between the coxae I–II and II–III; eye-tubercle shallowly canaliculate and armed with a row of tubercles on each carina; a single transverse row of small tubercles behind the eye-tubercle and this followed by a broadly marginate, transverse, impressed line; abdomen widest at about the middle of its length, pointed behind; a transverse row of small white tubercles across each abdominal segment above; coxae smooth or nearly so, armed anteriorly and ventrally with short dark hairs, the 2nd, 3rd and 4th progressively with finer hairs; sternites smooth; genital operculum smooth, armed with scattered short dark hairs; posterior lateral angle of coxa II armed with a single stout spine and anterior lateral angle of coxa IV with a broad tubercle tipped with two or three short spines.

Femur of palpus slender, gently curved, slightly thickened distally and armed on the disto-mesal side with a rounded hump, armed ventro-laterally with a single irregular row of eight to ten slender tubercles, each tipped with a sharp black hair; patella short, widened distally, strongly arched above, nearly straight below, the disto-mesal angle produced into a blunt lobe; tibia slightly longer than patella, the disto-mesal angle somewhat swollen, hairy above and armed ventrally, in some, with a few elongate, hair-tipped tubercles; tarsus slender, slightly curved ventrally, armed ventro-mesally with a narrow band of small, black denticles and ventro-laterally with an irregular series of stout black hairs; claw of tarsus simple, curved.

Color. Dorsum with light areas silvery, mottled and spotted with brown and with transverse series of small light spots marking the position of tubercles on abdominal segments; a broad central figure, light to very dark brown, widest on the 3rd segment and narrowing on alternate segments to tip of abdomen; eye-tubercle light above; chelicerae yellow with a few dark tubercles on base above; claws with black edges. Palpus yellow, clouded above; patella and tibia with a dusky band above; venter silvery with sides of abdominal segments mottled with dark brown and a narrow dark midline; legs with distal and hind margin of coxae with small rounded brown spots; trochanters yellow; femora with a broad dark band near base and distally; patellae dark; tibiae mottled with dusky or dark at both ends and light between; metatarsus I mostly light in color with at least one false articulation; tarsi light.

Female, length 6 to 6.5 mm.; width 3.5 mm.

Legs I, 9 mm.; II, 22 mm.; III, 11 mm.; IV, 16 mm.

Similar to male but generally larger and stouter and with the abdomen more bluntly rounded behind; tibia of palpus strongly swollen disto-mesally; tarsus slender, not armed ventro-mesally with a narrow band of small, black denticles.

Large females with eggs were taken at Allegany State Park, Aug. 10 and 19, one 6.5 mm. carrying 58 large eggs and many small ones.

Type locality, near Salem, Mass.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly., Aug., Sept.; Kenwood, Oct. (F. C. P.); Thompson lake, Je. (F. H. W.); Voorheesville, Je., Jly. (A. W.). ALLEGANY: Richburg, Sept.; Wellsville, Sept. CATTARAUGUS: Allegany State Park, Aug.; Barcelona, Sept.; Silver creek, Sept.; Stow, Sept.; Rock City, Olean, Aug., Sept. CLINTON: Plattsburg, Sept. (F. C. P.); Valcour Island, Aug. ERIE: Spring Brook, Sept. ESSEX: Chapel pond, Je., Jly.; Elizabethtown, Aug. (C. R. C.); Lake Placid, Sept. (F. C. P.); Mt. MacIntyre, Je., Jly.; Marble Mt., Aug. (C. R. C.); Mt. Marcy, Sept., 3500 feet; Mt. Whiteface, Aug.; Newcomb, Sept. (H. D. H.); Upper Jay, Sept. (F. C. P.); Wilmington Notch, Aug. (C. R. C.). FRANKLIN: Saranac lake, Sept. (F. C. P.). FULTON: Pinnacle Mt. (C. R. C.); Gloversville, Sept. (F. C. P.); Woodworth's lake, Aug. (C. P. A.). HAMILTON: Raquette lake, Sept. (F. C. P.). HERKIMER: Big Moose, Aug. (F. C. P.); Little Falls, Jly.; Wilmurt, Aug. (F. C. P.). JEFFERSON: Brownsville, Sept. (F. C. P.); Watertown, Sept. (F. C. P.). LIVINGSTON: Hemlock lake, Aug. MONROE: Charlotte, Sept. (F. C. P.); Glen Haven, Sept. (F. C. P.); Mendon Ponds Park, Nov. NIAGARA: Lewiston, Sept. (F. C. P.); Olcott, Sept. RENSSELAER: Nassau lake, Sept. (A. W.); Rensselaer, Aug. (F. C. P.). SCHUYLER: Montour Falls, Sept.; Watkins, Oct. SENECA: Interlaken, Nov.; Covert, Aug. (C. R. C.). STEUBEN: Hornell, Sept.; Painted Post, Sept. TOMPKINS: Connecticut Hill, Aug. (C. R. C.); Enfield, Aug.; Ithaca, May to Sept., Nov. (C. R. C.); McLean, Jly.; Taughannock Falls, Aug., Oct. WASHINGTON: Pearl Point, Jly. WAYNE: Lake Bluff, Sept. YATES: Crosby, Sept., Oct. (C. R. C.); Keuka lake, Oct. (C. R. C.). Long Island. SUFFOLK: Mattituck, Aug. (R. L.); Napeague, Sept. (R. L.); Quogue, Sept. (R. L.); Sag Harbor, Sept. (R. L.); Shelter Island, Sept., Oct. (R. L.); Southold, Oct. (R. L.).

Specimens have also been examined from Ga., Summerville, Aug.; Maine, Isle-au-Haut, Sept.; N. C., Blowing Rock, Oct.; Grandfather Mt., Oct.; Pa., Shawanese lake, Sept. (F. C. P.); Tenn., Mt. Le Conte, Oct.; Va., Covington, Sept. Canada, P. Q., Bagotville, Jly. (C. R. C.); St. Joseph d'Alma, Jly. (C. R. C.); Ontario, Bay of Quinte, Aug. (A. W.).

PHALANGIUM LINNAEUS

Phalangium is the only phalangid genus recognized by Linnaeus in the 10th edition of the Systema Naturae (1758, p. 618). Under that generic name the species *opilio* is listed and a number of references to the literature cited. In spite of this, many references in the literature give Linnaeus, Fauna Suec. ed. 2 (1761, p. 485), as the type description of *P. opilio*.

In *Phalangium* the distal segment of the palpus is longer than the one immediately before it and the femur of the palpus lacks prominent spines. There are spines on the anterior margin of the carapace, at the angles, and others form a small group in front of the eye-tubercle. In our only New York species, the males are easily recognized by the development, on the second segment of the chelicera, of a prominent, dorsally produced spur.

Phalangium opilio Linnaeus

Pl. 2, figs. 29–33.

Phalangium opilio Linnaeus, Systema Naturae, 10th ed. 1:618. 1758.
Phalangium opilio Linnaeus, Fauna Suec. ed. 2, p. 485. 1761.
Phalangium longipalpis Weed, Amer. Nat. 24(284):783–785, pl. 27, figs. 1–3. 1890.
Phalangium longipalpis Weed, Amer. Nat. 24(286):918. 1890.
Phalangium longipalpis, Banks, Can. Ent. 25:207. 1893.
Phalangium longipalpis, Banks, Amer. Nat. 35(416):674. 1901.
Phalangium longipalpis, Crosby, Ent. News, 18(4):161. 1907.
Phalangium longipalpis, Crosby, Ent. News, 21(9):420. 1910.
Phalangium cornutum, Roewer, Abhandl. a Gebiete Naturw. 20(1):91–94, pl. 2, fig. 28. 1912.
Phalangium longipalpis, Comstock, Spider Book, p. 69. 1912.
Phalangium opilio, Roewer, Weberknechte der Erde, pp. 751–752, fig. 927. 1923.
Phalangium opilio, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Phalangium opilio, Comstock, Spider Book, rev. ed. p. 69. 1940.

Male, length 6 mm.; width 3.5 mm.

Legs, I, 24 mm.; II, 40 mm.; III, 27 mm.; IV, 34 mm.

Dorsum of carapace armed with numerous black-tipped tubercles disposed as follows: a cluster closely aggregated at each anterior lateral angle, a group behind the anterior margin in front of the eye-tubercle, a few at the anterior edge of the openings of the scent glands and one or two at the posterior edge, a few widely separated at the lateral margins and a straight row on the ridge back of the eye-tubercle. Abdomen widest at about the distal third, bluntly rounded at tip; the dorsal surface smooth except for definite transverse rows of slender, black-tipped tubercles across the segments; eye-tubercle with a broad shallow canal, the carinae each with a row of prominent tubercles; openings of scent glands oval, directed laterally and placed opposite the trochanters of the first legs.

Venter relatively smooth, clothed sparsely with black hairs; no tubercles along the margins of the coxae or on genital operculum. Palpus leg-like, long and slender; femur cylindrical, widest at distal end, armed with scattered black hairs; patella half as long as femur and similarly armed and swollen distally; tibia two thirds as long as femur but with fewer hairs; tarsus about as long as femur, the claw simple. Chelicera with the second segment produced dorsally into a large, strong, pointed horn which varies in size considerably becoming very prominent with age; claw of chelicera black. Trochanters of legs armed distally and on anterior and posterior margins with short spines and hairs; femora armed with five longitudinal rows of prominent, black-tipped tubercles; patellae short, widened distally and armed below with a row of spines and hairs; tibiae with longitudinal bands of very short, dark hairs; metatarsi and tarsi clothed generally with very short, dark hairs and pairs of spines ventrally at the articulations.

Ground color above yellowish, tan or grayish, the central figure usually faintly developed in the male, narrow on the second abdominal segment, somewhat widened on the third segment and again narrowed on the fourth and fifth segments; sutures between segments of abdomen marked laterally by series of three to five small, round dark spots continued across the full width of the abdomen only at the posterior end; eye-tubercle light, slightly darkened around the eyes; chelicerae yellow, the claws black-tipped and margined; femur of palpus light at the extremities, dark brown to black between, remaining segments light; legs I, III, IV tan to brown, darker distally, legs II, lighter.

Female, length 7.5 mm.; width, 3.75 mm.

Legs, I, 21 mm.; II, 38 mm.; III, 22 mm.; IV, 31 mm.

The female is larger than the male but with shorter and more slender legs. The colors, however, are often brighter and the pattern much more distinct. Second segment of chelicera normal, not produced above to form a spur; palpus a little heavier than in male and with shorter segments; disto-mesal angle of the patella produced into a blunt lobe armed with short black hairs.

Type locality, Europe, America.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Myosotis lake, Rensselaerville, Jly. Albany, Aug.; Dormansville, Jly.; Normanskill, Jly.; Normansville, Jly.; Watervleit, Aug. CAYUGA: Fairhaven, Aug. (H. Z.). CHAUTAUQUA: Silver Creek, Sept. (M. D. L.). CLINTON: Plattsburg, Sept. (C. R. C.). COLUMBIA: Kinderhook, Sept. ERIE: Hamburg, Sept. (C. R. C.); Newfane, Oct. (C. R. C.); Spring Brook, Sept. FRANKLIN: Malone, Oct. GENESEE: Bergen swamp, Sept. JEFFERSON: Evans Mills, Oct. Watertown, Sept. (F. C. P.). MADISON: Canastota. MONROE: Charlotte, Sept. (F. C. P.); Honeoye Falls, Jly., Sept., Nov. (C. R. C.); Mendon Ponds Park, Nov.; Rochester, Sept., Oct. (C. R. C.); Oct., Nov. (K. W. C.). NEW YORK: Central Park, Je., Jly. NIAGARA: Lewiston, Sept. (F. C. P.); Lockport, Aug. ONEIDA: Boonville, Jly.; Trenton Falls, Je. ONONDAGA: Syracuse, Sept. (C. R. C.). ONTARIO: Geneva, Nov.; Stanley, Sept. (C. R. C.); Woodville, Je., Jly., Sept. ORLEANS: Carleton Station, Jly., Sept. (C. R. C.); Holley, Oct. (C. R. C.); West Barre, Sept. RENSSELAER: Rensselaer, Jly., Nov. (W. J. S.); South Rensselaer, Jly. SCHUYLER: Cinnamon lake, Jly. STEUBEN: Hornell, Sept. ST. LAWRENCE: Norwood, Oct. TOMPKINS: Ithaca, Jly., Sept., Oct., Nov. (C. R. C.); McLean, Sept. (C. R. C.). WASHINGTON: Elizabeth Island, Lake George, Jly. WAYNE: East Bay, Sept. (F. C. P.); Lake Bluff, Sept. YATES: Lake Keuka, Nov. (C. R. C.). Long Island. KINGS: Brooklyn, Sept., Oct. NASSAU: Manhasset, Je. QUEENS: Jamaica, Sept. SUFFOLK: Calverton, Aug. (R. L.); Cold Spring Harbor, Je. (W. J. G.); East Marion, Oct. (R. L.); Eastport, May (R. L.); East Quogue, Sept. Oct. (R. L.); Flanders, Aug., Sept., Oct. (R. L.); Greenport, Aug. (R. L.); Hampton Bays, Sept. (R. L.); Jamesport, Oct. (R. L.); Manorville, Sept. (R. L.); Mattituck, Aug. (R. L.); Moriches, Nov. (R. L.); Napeague, Sept., Oct. (R. L.);

Northsea, Sept. (R. L.); Northwest, Je., Sept. (R. L.); Orient, Oct. (R. L.); Peconic, Je. (R. L.); Pine Neck, May (R. L.); Riverhead, Sept. (R. L.); Sag Harbor, Sept., Oct. (R. L.); Shelter Island, Sept., Oct. (R. L.); Shinnecock Hills, Sept. (R. L.); Southampton, Sept. (R. L.); Southold, Oct (R. L.); Speonk, May (R. L.).

Specimens also examined from Mass., Marblehead, Je.; Mich., Washtenaw, Nov.

OPILIO HERBST

The species of *Opilio* resemble those of *Phalangium* in the possession of regular rows of sharp-tipped tubercles on the femora of the legs, and in having the last segment of the palpus longer than the penultimate but differ in that the supra-cheliceral laminae are inconspicuous and do not have a spine-tipped tubercle on the disto-mesal angles. Males of *Opilio parietinus* lack the large spur on the second segment of the chelicera which is so prominent in *Phalangium opilio*.

The members of the genus are widely distributed in Europe and are found in North and East Africa, Asia and North America.

Opilio parietinus (De Geer)

Pl. 3, figs. 34–37.

Phalangium parietinum De Geer, Mem. Hist. Ins. 7:166–172, pl. 10, figs. 1–11. 1778.
Phalangium cinereum Wood, Commun. Essex Inst. 6(1):25–26, fig. 5 a–c. 1870.
Phalangium cinereum, Weed, Bull. Ill. State Lab. Nat. Hist. 3:93–94. 1889.
Phalangium cinereum, Weed, ibid., p. 104.
Phalangium cinereum, Weed, Amer. Nat. 24(286):916–917. 1890.
Phalangium cinereum, Weed, Amer. Nat. 26(301):32–36, pl. 1, figs. 1–2. 1892.
Phalangium cinereum, Weed, Trans. Amer. Ent. Soc. 20:292, pl. 5, figs. 1–2. 1893.
Phalangium cinereum, Weed, Proc. U. S. Nat. Mus. 16:560–561, pl. 69, figs. 1–2. 1893.
Phalangium cinereum, Banks, Can. Ent. 25:207. 1893.
Phalangium cinereum, Banks, Jour. N. Y. Ent. Soc. 2:40. 1894.
Phalangium cinereum, Banks, Amer. Nat. 35(416):674. 1901.
Phalangium cinereum, Comstock, Spider Book, p. 69. 1912.
Opilio parietinus, Roewer, Abhandl. a Gebiete Naturw. 20(1):124–127. 1912.
Opilio parietinus, Roewer, Weberknechte der Erde, pp. 770–771, fig. 944. 1923.
Opilio parietinus, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Phalangium parietinus, Comstock, Spider Book, rev. ed., p. 69. 1940.

Male, length 5 mm.; width 3 mm.

Legs, I, 22 mm.; II, 38 mm.; III, 23 mm.; IV, 30 mm.

Carapace above strongly sculptured, broadly emarginate anteriorly, armed with sharp tubercles in two short series in front of eye-tubercle, on ridge behind opening of scent gland, and on an oblique ridge which is parallel to lateral margin of thorax half the distance to the eye-tubercle and on the straight, transverse ridge behind the eye-tubercle; a large sharp-pointed tubercle on either side of eye-tubercle; eye-tubercle broader than long, narrowly canaliculate, the carinae armed with prominent tubercles, the eyes directed dorso-laterally and separated by less than the diameter of one of them; openings of scent glands small, oval, opposite trochanters of first legs. Abdomen broadly oval, widest near the middle of its length and tapering to a point behind; abdominal segments each armed with an irregular, transverse row of small sharp-pointed tubercles.

Venter. Coxae smooth, unarmed except for a very few, short, dark hairs on coxa I; genital operculum smooth and with a few, short, dark hairs anteriorly; sternites smooth, generally unarmed except for sparse, short, dark hairs.

Femur of palpus from above widened distally, armed dorso-laterally on distal half with a group of dark tubercles, dorso-mesally with two rows of smaller tubercles and short dark hairs; patella about half as long as femur, armed dorsally with a single row and dorso-mesally with two rows of short tubercles; tibia short, a little longer than patella, armed dorsally with a row of small tubercles and with a few hairs and tubercles dorso-mesally; tarsus slender, cylindrical, armed with a few small hairs above and a ventral band of very fine dark denticles; claw simple. Legs. Femora of all legs armed with sharp, black-tipped tubercles forming regular rows; patellae short, widened distally, armed with less regularly disposed tubercles; tibiae cylindrical, those of legs I and II shorter and stouter and armed with more tubercles than those of legs III and IV; tibia plus patella about as long as femur; metatarsi and tarsi, slender and tapering, claws simple.

Ground color above light tan, grayish, or yellowish mottled with whitish and light brown blotches on the cephalothorax; abdomen with a wide but faintly developed central figure crossed by transverse lines of light spots marking the position of rows of tubercles and, in some, with an irregular median dorsal light band; sides of abdomen mottled; palpi and chelicerae yellow, brown mottled, claws of the latter black tipped; legs yellow to tan or pale brown without conspicuous bands or shading. Venter generally light, the coxae with round or oval brown spots, forming a median line on many, the abdomen with faint brown spots and transverse series of pale whitish or yellowish spots mainly along the anterior margins of the segments.

Female, length to 8.5 mm.; width 4.5 mm.

Legs, I, 25 mm.; II, 46 mm.; III, 26 mm.; IV, 30 mm.

Similar to male but larger and with the abdomen broadly oval and bluntly pointed behind.

Type locality, Sweden.

Distribution.—New York. CATTARAUGUS: Otto, Sept. (G. H. C.). CLINTON: Plattsburg, Sept. (F. C. P.). HAMILTON: Indian lake, Aug. (W. J. S.). HERKIMER: Wilmurt, Aug. (F. C. P.). MONROE: Mendon Ponds Park, Oct., Nov.; North Greece (R. L. P.); Rochester, Oct. TOMPKINS: Ithaca, Aug., Oct., Nov. (C. R. C.). Long Island. SUFFOLK: Quogue, Sept. (R. L.).

Specimens also examined from Idaho, Pocatello; Mich., Ann Arbor, Oct.; Montana, Missoula, Jly. (C. R. C.); Canada. Quebec: Montreal, Aug. (F. C. P.).

LEIOBUNUM C. L. KOCH

Leiobunum includes the majority of the species of phalangids found in the State. The body is generally soft but in some species it is dorsally somewhat roughened and hardened. Anterior and lateral margins of the carapace smooth; eye-tubercle usually armed with small tubercles on the carinae; coxae usually with marginal rows of denticles or, denticles restricted to anterior row on coxa I and posterior row on coxa IV; terminal claw of palpus with teeth at base below; tarsus of palpus of male with a longitudinal band of small denticles meso-ventrally; legs usually long and slender, the second pair always longest; femora of legs I usually longer than body.

Leiobunum bicolor (Wood)

Pl. 3, figs. 38–42.

Phalangium bicolor Wood, Commun. Essex Inst. 6(1):28, 39, 1 fig. 1870.
Phalangium bicolor, Underwood, Can. Ent. 17(9):168. 1885.
Liobunum bicolor, Weed, Amer. Nat. 21(10):935. 1887.
Liobunum elegans Weed, Bull. Ill. State Lab. Nat. Hist. 3:102. 1889.
Liobunum bicolor, Weed, Bull. Ill. State Lab. Nat. Hist. 3:103. 1889.
Liobunum elegans Weed, Amer. Nat. 24(286):918. 1890.
Astrobunus bicolor, Weed, Amer. Nat. 24(286):917. 1890.
Liobunum bicolor, Weed, Proc. U. S. Nat. Mus. 16:552–553, pl. 64, figs. 1–2; pl. 65, figs. 1–2. 1893.
Liobunum bicolor, Weed, Trans. Amer. Ent. Soc. 20:290. 1893.
Liobunum bicolor, Banks, Can. Ent. 25:211. 1893.
Liobunum bicolor, Banks, Jour. N. Y. Ent. Soc. 2(4):145. 1894.
Liobunum bicolor, Banks, Amer. Nat. 35(416):676. 1901.
Liobunum bicolor, Roewer, Abhandl. a Gebiete Naturw. 19(4):223–224, pl. 5, fig. 23. 1910.
Leiobunum bicolor, Comstock, Spider Book, p. 75. 1912.
Liobunum bicolor, Roewer, Weberknechte der Erde, pp. 901–902. 1923.
Liobunum annulatum Walker, Ohio Biol. Surv. Bull. 19, 4(4):167, pl. 2, fig. 15. 1928.
Leiobunum bicolor, Davis, Amer. Midland Nat. 15(6):667–668, pl. 32, fig. 18. 1934.
Leiobunum bicolor, Comstock, Spider Book, rev. ed. p. 75. 1940.

Male, length 5.5 mm.; width 4 mm.

Legs, I, 42 mm.; II, 68 mm.; III, 44 mm.; IV, 57 mm.

Dorsal integument very finely granular, no tubercles except two or three very small ones near scent glands; eye-tubercle slightly broader than long, shallowly canaliculate, the carinae armed with a few low tubercles; openings of scent glands small, oval, directed upward opposite trochanters of first legs; abdomen with sides nearly parallel then abruptly tapering to the blunt tip which is turned under; paired muscle impressions of abdomen conspicuous.

Venter. Coxae rugose, anterior margins of coxae I and II each with a row of small, square-tipped denticles; other coxae without definite rows either in front or behind; genital operculum slightly roughened at center; sternites smooth; penis, simple, not alate near tip.

Femur of palpus from above slightly widened distally, the dorsal surface smooth on basal two-thirds, lateral, ventral and mesal sides armed with sharp, pointed tubercles, from the side evenly curved; patella short, widened distally, one half as long as femur, armed, except for a smooth dorsal band, with short dark denticles; tibia slightly longer than patella, sides parallel, armed with short brown hairs above, except for a longitudinal band on basal two-thirds, tubercles on sides; tarsus long, slender, armed with hairs above and ventro-mesally with a row of very small, black denticles; claw with a few teeth at base below.

Color. Ground color light yellow, tan or light brown with irregular silvery white blotches on the thorax disposed as follows: a pair in front of eye-tubercle, on each side a diagonal series of three spots decreasing in size posteriorly and lying midway between side of thorax and eye-tubercle; on the abdomen above, transverse rows of light spots which are largest at the sides both anteriorly and posteriorly, all light spots often fading out entirely in preservatives; sides of thorax dark margined; a broadly triangular dark blotch which encloses the eye-tubercle at its apex, dark blotches surrounding light spots at the sides of the abdomen above and narrow transverse bands along anterior margins of abdominal segments; tip of abdomen, dark brown; eye-tubercle dark brown to black, notched with yellow before and behind; palpus brown on the sides, light above in a longitudinal band except tarsus which is yellow; chelicerae yellow, claws black-tipped; legs light brown with light bands at the extremities of femora, tibia, base of metatarsi and at the false articulations of metatarsi and tarsi; patellae usually dark; trochanters light, concolorous with coxae. Venter lighter than dorsum, coxae and genital operculum yellowish, sternites pale or some with a few pale, brown spots in transverse series.

Female, length 6 mm.; width 3.25 mm.

Legs, I, 35 mm.; II, 62 mm.; III, 37 mm.; IV, 52 mm.

Similar to male but larger and with the tip of the abdomen bluntly pointed and not turned under.

Type locality, Haverford College, Delaware County, Pa.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly., Aug.; Indian Ladder, Thacher Park, May; Meadowdale, May; Thompson's lake, Sept.; Voorheesville, Je. ALLEGANY: Richburg, Sept. CATTARAUGUS: Allegany State Park, Oct.; Rock City, Olean, Sept. CHEMUNG: Elmira, Jly. COLUMBIA: Craryville, Aug. (A. W.). ESSEX: Je. (C. R. C.); Artist Brook, Je.; Chapel pond, Jly.; Lake Placid, Sept. (F. C. P.); Newcomb, Sept.; Wilmington, Aug. FRANKLIN: Saranac lake, Sept. GREENE: Haines Falls, Je. LEWIS: Michigan Mills, Sept. (C. R. C.); Whetstone Gulf, Sept. (C. R. C.). ONTARIO: Coy Point, Canandaigua lake, Sept., Nov. SCHUYLER: Montour Falls, Sept. STEU-

BEN: Hornell, Sept. TOMPKINS: Caroline, May (C. R. C.); Enfield Center, May (Rea); Enfield Glen, May, Aug., Sept. (N. W. D.); Ithaca, Jan., Aug., Dec. (C. R. C.); McLean, Apr., May. (C. R. C.). YATES: Crosby, Aug. (C. R. C.); Italy Hill, Sept.

Specimens also examined from Ky., Quicksand, Je. La., Chastine, May (K. P. S.). N. C., Blowing Rock, Oct. (C. R. C.); Grandfather Mt., Oct.; Linville Cave, Apr. Ohio, Cantwell Cliffs, May (C. R. C. and N. W. D.). Pa., Orangeville, Aug. (N. W. D.); Shelter cave, Nov., Dec. (K. D.); Veiled Lady cave, Nov. (K. D.). W. Va., Preston Co., May.

This species is often found in caves where it may hibernate during the colder months. It also frequents dark crevices, the shelter of deep woods and the little excavations beneath pond and stream banks. During the warmer months, it forages at night and may be found on the trunks of trees and crawling on the ground.

Leiobunum calcar (Wood)

Pl. 3, figs. 43–50

Phalangium calcar Wood, Commun. Essex Inst. 6(1):26–27, fig. 6a–b. 1870.
Liobunum (?) *calcar*, Weed, Amer. Nat. 21(10):935. 1887.
Liobunum (?) *calcar*, Weed, Bull. Ill. State Lab. Nat. Hist. 3:90–91. 1889.
Liobunum (?) *calcar*, Weed, Bull. Ill. State Lab. Nat. Hist. 3:102–103. 1889.
Liobunum (?) *calcar*, Weed, Amer. Nat. 24(286):918. 1890.
Liobunum calcar, Weed, Proc. U. S. Nat. Mus. 16:553–554. 1893.
Liobunum (?) *calcar*, Weed, Trans. Amer. Ent. Soc. 20:290–291. 1893.
Liobunum calcar, Banks, Can. Ent. 25:211. 1893.
Liobunum calcar, Banks, Jour. N. Y. Ent. Soc. 2:41. 1894.
Liobunum calcar, Banks, Amer. Nat. 35(416):675. 1901.
Leiobunum calcar, Crosby, Jour. N. Y. Ent. Soc. 12(4):256. 1904.
Liobunum calcar, Roewer, Abhandl. a Gebiete Naturw. 19(4):219. 1910.
Leiobunum calcar, Comstock, Spider Book, p. 73. 1912.
Liobunum calcar, Roewer, Weberknechte der Erde, p. 899, fig. 1054. 1923.
Leiobunum calcar, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Liobunum calcar, Walker, Ohio Biol. Surv. Bull. 19, 4(4):163, pl. 1, fig. 9. 1928.
Liobunum brunnea Walker, Ohio Biol. Surv. Bull. 19, 4(4):167, pl. 2, fig. 12. 1928.
Leiobunum calcar, Davis, Amer. Midland Nat. 15(6):670–672, pl. 32, figs. 16–17, pl. 33, fig. 31. 1934.
Leiobunum calcar, Comstock, Spider Book, rev. ed., p. 73. 1940.
Leiobunum calcar, Bishop, Ent. News, 60(1):10–11, fig. 1. 1949.

Male, length 6 mm.; width 3 mm.

Legs, I, 26 mm.; II, 52 mm.; III, 28 mm.; IV, 40 mm.

Carapace lightly sculptured, the surface otherwise fairly smooth except for a few small tubercles along anterior margin, a line of tubercles in front of eye-tubercle, and a few along inner margins of openings of scent glands. Abdomen pointed behind, dorsum finely granular; eye-tubercle a little longer than broad, shallowly canaliculate, the carinae with a few low tubercles; openings of scent glands oval, opposite trochanters of the first legs. Venter of coxae and genital operculum nearly smooth, the anterior margin of coxa I only with a row of square-tipped denticles; all coxae with a few, short, dark hairs; sternites smooth and shining.

Femur of palpus from above very stout, armed ventro-laterally with a very large, strong spur and disto-laterally with small black denticles, from the side, evenly and broadly arched; patella very short, stout, armed above with small black denticles and distally, at the upper margin, with a few longer denticles, from the side, sharply curved; tibia from above slightly swollen basally, armed with short, dark hairs, from the side evenly rounded above, below with a broad hump at base, the distal part strongly curved, armed on the hump with many dark denticles and a ventro-mesal row extending to the tip of the segment; tarsus slender, curved, and armed with dark hairs and a band of small black denticles ventro-mesally; claw with small teeth at base below; legs armed with numerous, small black-tipped spines.

Ground color above light brown, tan or yellowish marked with slightly darker blotches and reticulations and small light spots; darker markings form transverse bands on the abdomen and a faint central, vase-shaped figure which is bordered laterally with whitish blotches; the light spots form a diagonal line or bar on either side of the eye-tubercle, a regular transverse line on the ridge back of the eye-tubercle and irregular rows across the dark portions of the abdominal segments; eye-tubercle black, slightly lighter in front.

Venter lighter than dorsum, yellowish or pinkish-yellow in life; coxae and genital operculum same as venter of abdomen; trochanters dark brown to black in striking contrast to coxae or, in some individuals, concolorous with coxae; bases of femora black, rest of leg segments brown or, in specimens with yellow trochanters, then base of femora yellow. Femur and patella of palpus dark brown to black, tibia lighter brown; tarsus yellow; Chelicera yellow, the basal segment sometimes with a dark blotch above, the chelae black-tipped. Penis simple, not alate, from the side strongly curved.

Female, length 7 mm.; width 3.5 mm.

Legs, I, 26 mm.; II, 53 mm.; III, 27 mm.; IV, 40 mm.

The female attains a larger size than the male and the abdomen is bluntly rounded behind; the femur of the palpus lacks the ventro-lateral spur and is more slender than in the male, armed ventrally at base with small, sharp-pointed denticles and distally on the ventro-lateral side with a more prominent cluster of large denticles; legs slenderer than in the male.

General color above, chocolate brown to reddish brown, the central figure usually highly developed but limited laterally with silvery-white blotches as in the male. Femur and patella of palpus blotched with brown; legs as in the male but shorter.

Type locality, Mountains of southwestern Virginia.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly., Aug.; Lawson's lake, Je. CATTARAUGUS: Allegany State Park, Aug. CHAUTAUQUA: Chautauqua, Jly., Aug. (C. W.). CLINTON: Valcour Island, Lake Champlain, Aug. ESSEX: Chapel pond, Jly.; Wilmington Notch, Aug. (C. R. C.). FULTON: Gloversville, Jly. (C. P. A.); Woodworth's lake, Je. GREENE: Purling, Jly., Sept. HAMILTON: Long lake, Aug. (C. R. C.). HERKIMER: Big Moose lake, Aug. (F. C. P.); Little Falls, Jly.; Wilmurt, Aug. (F. C. P.). LEWIS: Highmarket, Aug. (Needham). LIVINGSTON: Letchworth State Park, Jly. MADISON: DeRuyter, Jly. (C. R. C.). ONEIDA: Trenton Falls, Jly. (F. C. P.). ONTARIO: Factory Hollow, Aug. (C. R. C.); Coy Point, Canandaigua lake, Je., Jly. ORLEANS: Medina, Jly. SARATOGA: Ballston lake, Aug. (A. W.). SCHENECTADY: High Mills Gorge, Aug. (A. W.). SCHUYLER: Cinnamon lake, Jly. SULLIVAN: Callicoon, Jly. TIOGA: Spencer, Aug. TOMPKINS: Enfield, Jly.; Ithaca, Je., Lly., Aug. (C. R. C.); McLean, Jly.; Ringwood, Jly.; Slaterville, Aug.; Taughannock Falls, Jly.; Woodwardia, Aug. WASHINGTON: Black Mt., Aug. (C. R. C.).

Specimens also examined from Conn., Storrs, Jly.; N. C., Blowing Rock, Oct. (C. R. C.). Canada: Perth Road, Buck lake, Ontario.

This was one of the most abundant species at the E. N. Huyck Preserve, during the summer of 1948, and could be collected in large numbers from the trunks of trees and from the ground in a beech-hemlock forest bordering Lincoln pond.

It is a voracious form, definitely diurnal, and when found at night is usually in the resting position. During the daylight hours, when temperature and humidity permit, it forages openly and will attack and eat anything it can overcome. In the field it was found with bits of earthworm and well chewed ants and other insects in its jaws. In captivity it fed readily and accepted house flies, deer flies, syrphids, dragon flies, crane flies, damsel flies, lace-wing flies, young grasshoppers, spiders, moths, jassids, plant bugs and bits of fresh meat. It usually rejected smooth green caterpillars, beetles, membracids and plant lice.

Many pairs were found mating in the field and the operation could be observed in cages. The male grasps the female so that the spur on the femur of the palpus of the male is apposed to the swollen base of the tibia and forms a grasping organ to hold the trochanter of the first leg of the female. The curved disto-ventral side of the tibia of the male fits the mesal side of the trochanter of the second leg of the female while the tarsus of the male is pressed against the posterior side of the coxa of the second leg of the female. (Bishop, pp. 10–11, 1949)

Occasionally when males encounter one another in the field, they rush together, assume the mating position and, after struggling violently for a short time, come to rest and remain attached for several minutes.

Leiobunum flavum Banks

Pl. 4, figs. 51–54.

Liobunum flavum Banks, Can Ent. 26(6) :164. 1894.
Liobunum flavum Banks, Proc. Acad. Nat. Sci. Phila. 52:541. 1900.
Liobunum flavum Banks, Amer. Nat. 35(416) :676. 1901.
Liobunum flavum, Roewer, Abhandl. a Gebiete Naturw. 19(4) :227–228, pl. 5, fig. 15. 1910.
Liobunum flavum Banks, Proc. Acad. Nat. Sci. Phila. 63:456. 1911.
Leiobunum flavum, Comstock, Spider Book, p. 75. 1912.
Liobunum flavum, Roewer, Weberknechte der Erde, p. 904. 1923.
Leiobunum flavum, Crosby and Bishop, Jour. Elisha Mitchell Sci. Soc. 40:20–21. 1924.
Liobunum flavum, Walker, Ohio Biol. Surv. Bull. 19, 4(4) :166–167, pl. 3, fig. 22. 1928.
Leiobunum flavum, Davis, Amer. Midland Nat. 15(6) :676–678, pl. 32, fig. 20. 1934.
Leiobunum flavum, Comstock, Spider Book, rev. ed. p. 75. 1940.

Male, length 5 to 6 mm., average, 5.2 mm., width 3.75 mm.

Legs, I, 29 mm.; II, 50 mm.; III, 28 mm.; IV, 41 mm.

Dorsal integument of male very finely granular and moderately hardened, anterior margin of carapace with a few minute tubercles at the midline and opposite the insertion of the first legs; eye-tubercle scarcely canaliculate and armed with a few small, low tubercles on each low carina; opening of scent glands directed upwards; no tubercles on thoracic parts behind eye-tubercle or on dorsum of abdomen. Coxae and genital operculum with very small tubercles, the former each armed anteriorly and posteriorly with a definite row of square-tipped tubercles; a submarginal row of similar tubercles on either side of the genital operculum. Femur of palpus from above slightly widened distally; a few scattered tubercles dorso-mesally and laterally; patella short, widened distally, the anterior median angle produced into a short, blunt lobe, armed laterally with a few tubercles; tibia very slightly longer than patella, somewhat thickened, widest at the basal third, the tip squarely truncate; tarsus slender, cylindrical, ratio of length of tibia to tarsus as 13 to 21. Viewed from the side, femur of palpus slightly arched above, nearly straight below and armed ventrally with two rows of small tubercles which converge at the basal third, armed ventro-mesally, on basal half, with a row of about eight small tubercles; patella from the side, strongly arched above and below, armed basally, dorsally and laterally with small tubercles; tibia swollen at base below, nearly straight above and with scattered, short black hairs; tarsus very slightly curved ventrally, armed dorsally and laterally with numerous short black hairs, the mid-ventral line without hairs and margined mesally by a row of very small, black, sharp-pointed denticles. Claw of palpus, dentate, light at base, remainder black.

Color. Above bright golden yellow with slightly darker mottlings on the thoracic part. Abdominal segments indicated by light transverse lines between which the integument is marked with faint light spots on a very slightly darker ground. A central figure is very slightly indicated on some specimens, particularly behind the eye-tubercle and on first and second abdominal segments; eye-tubercle light yellow with black encircling the eyes; chelicera yellow, the claw with tip and margins black; palpus yellow, slightly darker basally. Sternites and genital operculum yellow, slightly paler than coxae. Legs yellow-orange, the patellae and distal part of femora slightly darker; femora, patellae and tibiae armed with short, black-tipped spines. Penis alate near tip. fig. 53.

Female, length 8.5 to 10 mm.; width 5 mm.

Legs, I, 28 mm.; II, 52 mm.; III, 34 mm.; IV, 41 mm.

Similar to male but larger and with the abdomen more bluntly rounded behind. Markings on dorsum essentially similar, ground color sometimes in greater contrast with venter than in the male.

In 1934, Davis (p. 677) described *leiopenis* as a subspecies of *Leiobunum flavum* mainly on the basis of similarity in general appearance, and differences in the form of the penis and character of the armature of the femur of the palpus. In *leiopenis* the tibia of the palpus is long and slender, in *flavum,* thickened. His distribution records, given under the account of *L. flavum leiopenis,* include both *flavum* and *leiopenis*. The type locality of *leiopenis* is given as Shreveport, Louisiana which is the same as for *flavum,* as indicated by Banks and restricted by Crosby and Bishop.

The concept that two or more subspecies of the same species are to be found occupying the same areas is scarcely a tenable one unless evidence is forthcoming that they are segregated in some way, perhaps ecologically. No such evidence has been presented. In this report *L. flavum* is regarded as a distinct species.

Type locality, Shreveport, La., as restricted by Crosby and Bishop, Jour. Elisha Mitchell Sci. Soc. 40:20. 1924.

Distribution.—New York. SUFFOLK: Greenport, Aug. (R. L.); Montauk, Je. (R. L.); Riverhead, Long pond, Je. (C. R. C.).

This species has also been reported from Cayuga, Cayuga Co., Ithaca, Tompkins Co.; and from Axton, Franklin Co., in the Adirondacks. But this is decidedly a southern species which reaches the northern limits of its distribution at Woods Hole, Mass., and the Coastal Plain of Long Island.

Specimens also examined from Ala., Talladega, Aug. (T. H. H.); La., Chastine, May (K. P. S.); Miss., Aug. (T. H. H.), Lucedale, Sept. (H. D.); Mo., Columbia, Je. (C. R. C.), Waynesville, Aug. (E. B. W.), Hollister, Aug.; Okla., Wichita Nat. Forest (T. H. H.); Tenn., Fulton, Aug. (T. H. H.), Obion, Aug. (T. H. H.)

Leiobunum formosum (Wood)

Pl. 4, figs. 55–58.

Phalangium formosum Wood, Commun. Essex Inst. 6(1):30, 40, 1 fig. 1870.
Phalangium formosum, Underwood, Can. Ent. 17(9):168. 1885.
Liobunum formosum, Weed, Amer. Nat. 21(10):935. 1887.
Liobunum (?) *formosum,* Weed, Bull. Ill. State Lab. Nat. Hist. 3:91–92, 1 fig. 1889.

Liobunum (?) *formosum,* Weed, Bull. Ill. State Lab. Nat. Hist. 3:103. 1889.
Forbesium formosum, Weed, Amer. Nat. 24(286):916, 918, pl. 30, fig. 103. 1890.
Liobunum ventricosum, Weed, Proc. U. S. Nat. Mus. 16:551–552, pl. 63. 1893. (*juv. formosum*)
Liobunum formosum, Banks, Jour. N. Y. Ent. Soc. 2(4):145–146. 1894.
Liobunum formosum, Banks, Amer. Nat. 35(416):676. 1901.
Liobunum formosum, Roewer, Abhandl. a Gebiete Naturw. 19(4):214–215. 1910.
Leiobunum formosum, Comstock, Spider Book, p. 74. 1912.
Liobunum formosum, Roewer, Die Weberknechte der Erde, p. 897. 1923.
Liobunum formosum, Walker, Ohio Biol. Surv. Bull. 19, 4(4):164–165, pl. 1, fig. 7. 1928.
Leiobunum formosum, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Leiobunum formosum, Davis, Amer. Midland Nat. 15(6):678–679, pl. 32, fig. 28. 1934.
Leiobunum formosum, Comstock, Spider Book, rev. ed. p. 74. 1940.

Male, length 7 mm.; width 4 mm.

Legs, I, 43 mm.; II, 61 mm.; III, 43 mm.; IV, 60 mm.

Dorsum smooth or at most very finely granular; a group of small tubercles at center of margin of carapace and very small scattered tubercles along lateral margins; openings of scent glands small, oval, at margin of carapace opposite trochanters of first legs; eye-tubercle as broad as long, very shallowly canaliculate and usually armed with a few low, blunt tubercles along the carinae; abdomen widest at about the sixth segment, bluntly pointed behind. Venter. Surface of coxae and genital operculum with small tubercles, coxae I–IV armed with square-tipped tubercles along anterior margins, coxae I, II, and IV similarly armed along posterior margins; genital operculum armed laterally with a definite row of tubercles; sternites smooth or with a few small tubercles; legs with sharp-pointed denticles on femora, patellae and tibiae.

Femur of palpus from above long, slender, slightly widened distally, from the side gently curved, armed dorsally with a few hairs and small tubercles, ventrally, on the mesal side, with larger black-tipped denticles; patella one half as long as femur, widened distally, the disto-mesal angle slightly produced, armed with a few hairs and denticles, especially around the distal margin; from the side, strongly curved, armed disto-ventrally with a few denticles; tibia a little longer than patella, cylindrical, armed with a few small denticles at base and tip below; tarsus slender, armed with brown hairs and with a meso-ventral band of small, black denticles; claw with very small teeth on basal half below.

Ground color above golden yellow; eye-tubercle dark brown; carapace lightly blotched with brown, the margins darker; dorsum of abdomen with central figure obsolete or very faintly developed; segments of abdomen indicated by faint crossbands slightly darker than intervening spaces; venter of abdomen very slightly lighter than dorsum and genital operculum slightly darker; trochanters deep brown to black; femora black at base and tip; patellae black; tibiae black at base and narrowly at tip; metatarsi and tarsi yellow; chelicerae yellow, the claws black-tipped. Femur of palpus yellow, marked distally with brown; patella brown, other segments yellow. Penis simple, not alate at tip.

Female (Long Island, N. Y.), length 7 mm.; width 4 mm.

Legs, I, 24 mm.; II, 41 mm.; III, 23 mm.; IV, 32 mm.

Female duller and darker than male and with the central figure of abdomen usually more evident; abdomen broadly rounded on the sides, bluntly pointed behind; legs usually banded with black as in male but trochanters sometimes blotched with yellow above; eye-tubercle with yellow above in some individuals.

Type localities, District of Columbia, Philadelphia, Pa.

Distribution.—New York. WESTCHESTER: Peekskill, Je. (F. C. P.) Long Island. NASSAU: Sea Cliff (N. B.). SUFFOLK: Greenport, Je., Oct. (R. L.); Manorville, Sept. (R. L.); Riverhead, Sept. (R. L.); Sag Harbor, Aug., Sept. (R. L.)

It has also been recorded from Ithaca, Tompkins County, N. Y., by N. Banks.

Specimens also examined from Ga., Tallulah Falls; Fla., Camp Torreya, May (N. W. D.), Chattahoochee, Je., Marianna, Apr., Jly. (N. W. D.); Ky.; Quicksand, Aug.; N. J., Bargaintown, Aug., Sept. (N. W. D.); Ohio Clear Creek, Hocking Co., Sept. (T. H. H.); S. C., Greenwood, Oct. (T. H. H.)

This is another southern species that reaches the northern limits of its distribution on Long Island, N. Y. Records of specimens taken in other parts of the State are probably in error.

Leiobunum longipes longipes Weed

Pl. 4, figs. 59–64.

Liobunum nigropalpi, Weed, Amer. Nat. 21(10):935. 1887.
Liobunum nigropalpi, Weed, Bull. Ill. State Lab. Nat. Hist. 3:87–88. 1889.
Liobunum longipes Weed, Amer. Nat. 24(285):866–867, pl. 29, figs. 1–2. 1890.
Liobunum longipes Weed, Amer. Nat. 24(286):918. 1890.
Liobunum longipes Weed, Trans. Amer. Ent. Soc. 19:265, pl. 14, fig. 1. 1892.
Liobunum longipes Weed, Proc. U. S. Nat. Mus. 16:550, pl. 62, fig. 1. 1893.
Phalangium longipes, Banks, Can. Ent. 25(8):207. 1893.
Liobunum longipes, Banks, Jour. N. Y. Ent. Soc. 2(4):145. 1894.
Liobunum longipes, Banks, Amer. Nat. 35(416):676. 1901.
Liobunum longipes, Banks, Ent. News, 13:308. 1902.
Liobunum longipes, Roewer, Abhandl. a Gebiete Naturw. 19(4):224, pl. 6, fig. 11. 1910.
Leiobunum longipes, Comstock, Spider Book, p. 74. 1912.
Liobunum longipes longipes, Roewer, Weberknechte der Erde, p. 902. 1923.
Leiobunum longipes, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Liobunum longipes, Walker, Ohio Biol. Surv. Bull. 19, 4(4):164, pl. 1, fig. 3. 1928.
Leiobunum longipes, Davis, Amer. Midland Nat. 15(6):679–681, pl. 31, fig. 10. 1934.
Leiobunum longipes, Comstock, Spider Book, rev. ed. p. 74. 1940.

Male, length 4 mm.; width 2.5 mm.

Legs, I, 39 mm.; II, 73 mm.; III, 40 mm.; IV, 54 mm.

Dorsum very finely granular, no tubercles; openings of scent glands small, oval, at margin of carapace opposite trochanters of first legs; eye-tubercle slightly broader than long, with a shallow canal, the carinae armed with a few small, sharp-pointed tubercles; abdomen short, widest at about the middle of the length, tapering to a blunt point behind and usually turned under.

Coxae and genital operculum generally smooth, sometimes with a few fine granulations; anterior distal margins of coxae I, II, and IV with a row of small pale tubercles, coxa IV armed similarly posteriorly; sternites smooth; legs very long, slender, with short, sparse, dark denticles on femora and tibiae, a very few on patellae.

Femur of palpus slender, cylindrical, nearly straight, with a very few hairs and fine denticles; patella one half as long as femur, slightly widened distally, curved ventrally and armed ventro-laterally with a few small denticles; tibia slender, a little longer than patella; tarsus slender, nearly straight, armed ventro-mesally with a row of fine denticles; claw with one or two slender teeth at base below; penis alate.

Ground color above in life varies from pale, pinkish-yellow through yellowish grey to bright orange with markings forming transverse lines of silver; central figure of abdomen poorly developed; eye-tubercle brown to black; venter lighter than dorsum, nearly white in some individuals; coxae and genital operculum light; trochanters brown to black, contrasting with the coxae; legs brown, base of femora, patellae and distal ends of tibiae, I, III and IV often darker; a broad white band at distal ends of tibiae II and, rarely, a whitish tip on femora II; chelicerae yellow; palpus yellow; penis alate.

Female, length 4.5 mm.; width 2.5 mm.

Legs, I, 33 mm.; II, 64 mm.; III, 32 mm.; IV, 49 mm.

The female is a little larger than the male but with shorter legs; the abdomen is longer and more pointed behind; the central figure is well developed, brown to black, bordered with silvery-white and crossed by incomplete rows of small, silvery-white spots; venter whitish.

Type locality, southern Illinois.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly., Aug.; Albany, Aug. (M. D. L.); Delmar, Aug.; Kenwood, Jly., Aug. (F. C. P.); Normanskill, Jly. (C. R. C.); Normansville, Jly.; Thacher Park, May; Thompson's lake, Sept.; Voorheesville, Je., Jly.; Watervleit Res., Aug. (M. D. L.) ALLEGANY: Richburg, Sept.; Wellsville, Sept. CATTARAUGUS: Allegany State Park, Aug., Oct.; Red House, Aug.; Rock City, Olean, Sept. CAYUGA: Cayuga, Aug. (C. R. C.); Fairhaven, Jly. CHAUTAUQUA: Barcelona, Sept.; Chautauqua, Jly., Aug. (C. W.); Silver Creek, Sept.; Stow, Sept. CHEMUNG: Elmira, Aug. CLINTON: Plattsburg, Sept. (C. R. C.); Valcour Island, Lake Champlain, Aug. COLUMBIA: Mt. Merino, Aug. (M. D. L.). ESSEX: Ausable Chasm, Sept. (M. D. L.); Chapel Pond, Jly.; Lake Placid, Sept. (F. C. P.); Upper Jay, Sept. (F. C. P.); Wilmington, Aug. FRANKLIN: Saranac lake, Sept. (F. C. P.) FULTON: Woodworth's lake, Aug. (C. R. C.) GENESEE: Bergen swamp, Jly. GREEN: Catskill, Jly. (F. C. P.) ONONDAGA: East Onondaga, Sept. (F. C. P.). SARATOGA: Ballston lake, Aug. SCHENECTADY: High Mills Gorge, Aug. (A. W.). SCHUYLER: Montour Falls, Sept. STEUBEN: Hornell, Sept. TOMPKINS: Caroline, May (C. R. C.); Enfield Center, May; Ithaca, Jan., Aug., Dec. (C. R. C.); McLean, Apr., May. ULSTER: Highlands, Aug. (A. W.); West Park, Aug. WARREN: Hague, Sept. (M. D. L.). WASHINGTON: Black Mt., Lake George, Aug. (C. R. C.); Pearl Point, Lake George, Jly. (C. R. C.). YATES: Penn Yan, Aug. (C. R. C.)

Specimens have also been examined from La., Chastine, Apr. (C. R. C.); Mass., Sheffield, Jly. (F. C. P.); Mo., Columbia, Je. (C. R. C.), Rockport Cave, Nov. (C. R. C.) Canada, British Columbia, Selkirk Mts. (J. C. B.)

The species has also been recorded from Arkansas; Ga., Tallulah Falls, Je.; Ill., Chicago; Ind., Madison, Sept., Salt Petre Cave; Ky., Bee Springs, Je., Brooklyn Bridge, Je., Mammoth Cave, Jly., Quicksand, Je., Aug.; Me., Warwick; Mich., Douglas Lake, Jly., Huron Co., Jly., Milford, Sept.; N. C., Owens Gap, Aug., Winston-Salem, Oct.; Ohio, Buckeye lake, Starke Co., Jly.; Pa., Hazelton, Lehighton, Orangeville, Aug.; Tenn., Laurel creek, Oct., Lookout Mt.; Va., Falls Church, Sept., Great Falls, Sept., Pennington Gap; W. Va., Harpers Ferry, Williamsport; and Washington, D. C.

This species was particularly abundant on the east side of Lincoln Pond, Huyck Preserve, where, after rains, it could be collected literally by the hundreds. It is a very active form with excellent vision for detecting movement at distances up to three or four feet. On trees, chiefly hemlocks, they would run around the trunk like squirrels, the males in particular exhibiting great speed. Mated pairs were observed frequently and, on occasion, a second male would be standing nearby and bouncing up and down vigorously. To escape capture they will drop from considerable heights or take to the water and run across the surface.

L. longipes feeds avidly on almost any kind of small animal life it can find or capture.

The subspecies, *L. l. aldrichi,* described by Weed from South Dakota, is said to be distinguished from the typical form by having shorter legs and a strong tendency toward melanism, the palpus, the margin of the cephalothorax and the eye-tubercle being black.

Leiobunum nigripes Weed

Pl. 5, figs. 65–68.

Liobunum verrucosum, Weed, Amer. Nat. 21(10):935. 1887.
Liobunum verrucosum, Weed, Bull. Ill. State Lab. Nat. Hist. 3:88–89, 102. 1889.
Liobunum verrucosum, Weed, Amer. Nat. 24(286):918. 1890.
Liobunum nigripes Weed, Trans. Amer. Ent. Soc. 19:190–191, pl. 7, figs. 1–2. 1892.
Liobunum nigripes Weed, Proc. U. S. Nat. Mus. 16:547, pl. 60, figs. 1–2. 1893.
Liobunum nigripes, Banks, Can. Ent. 25(8):211. 1893.
Liobunum nigripes, Banks, Amer. Nat. 35(416):676. 1901.
Liobunum nigripes, Banks, Ent. News, 13:308. 1902.
Liobunum nigripes, Roewer, Abhandl. a Gebiete Naturw. 19(4):220–221. 1910.
Leiobunum negripes, Comstock, Spider Book, p. 74. 1912.
Liobunum nigripes, Roewer, Weberknechte der Erde, p. 900. 1923.
Liobunum nigripes, Walker, Ohio Biol. Surv. Bull. 19, 4(4):164, pl. 2, fig. 13. 1928.
Leiobunum nigripes, Davis, Amer. Midland Nat. 15(6):681–682, pl. 32, fig. 26. 1934.
Leiobunum nigripes, Comstock, Spider Book, rev. ed. p. 74. 1940.

Male, length 6 mm.; width 4 mm.

Legs, I, 27 mm.; II, 47 mm.; III, 27 mm.; IV, 37 mm.

Dorsal integument of male finely granular and moderately hardened; anterior margin of carapace without a patch of tubercles but with three very small teeth; eye-tubercle shallowly canaliculate and with only a few poorly developed tubercles on the carinae; scent glands, broadly oval in outline, opening upwards; no transverse series of tubercles on thorax back of eye-tubercle or on abdomen.

Coxae and genital operculum finely granular, sternites smooth; coxae I and IV armed both anteriorly and posteriorly with a definite row of square tubercles; coxae II and III armed only anteriorly. Femur of palpus from above slightly widened distally, a few small tubercles on both mesal and lateral sides distally; tibia rather thick, slightly longer than patella, armed only with short brown hairs; tarsus slender; ratio of length of tibia to tarsus as 12 to 20; femur from side only slightly arched above, ventrally with small tubercles; patella strongly arched above, ventrally with small tubercles; tibia thick, slightly swollen at base; tarsus slightly arched above, armed ventro-mesally with a definite row of small, black-tipped tubercles; tarsal claw denticulate; penis alate.

Color above bright golden yellow mottled lightly with darker and with a narrow dark margin on the carapace opposite insertion of the legs; central figure of thorax and abdomen lightly outlined and only slightly darker than adjacent areas; small yellow spots in transverse series on the abdominal segments. The central figure narrowest on the 2nd abdominal segment, widest on the 3rd, 4th and 5th and obsolete behind; eye-tubercle with black around the eyes, the canal brown; chelicera yellow, tips of claws black. Femur and patella of palpus brownish, tibia and tarsus yellow. Venter of abdomen yellow, coxae and genital operculum slightly darker; trochanters and extreme base of femora dark brown to black; distal fourth of femora, the patellae, and distal third of tibiae dark brown to black, rest of these segments brown; metatarsi and tarsi lighter, dull yellow; penis alate.

Female, length 9 mm.; width 4.5 mm.

Legs, I, 28 mm.; II, 54 mm.; III, 27 mm.; IV, 41 mm.

The female is larger than the male and noticeably darker above and with the colors in greater contrast; abdomen bluntly rounded behind; venter light, sternites yellow, contrasting with the dorsum; coxae slightly darker; trochanters dark brown, usually with lighter blotches dorsally; base of femora dark brown, other segments colored as in the male.

The relatively short legs of this species of *Leiobunum* and the dark trochanters have led to its being confused with *Hadrobunus*. The general coloration of the males is quite different, however, and the similarity of the females is only superficial. In the male of *Leiobunum nigripes*, femur I is nearly as long as the body, in *Hadrobunus*, less than one half as long. In the female of *L. nigripes*, femur I is three-fourths as long as the body, in the female *Hadrobunus*, only about one-third as long.

Type localities, Champaign Co., Illinois and Clermont, Franklin and Warren Counties, Ohio.

Distribution.—New York. JEFFERSON: Thousand Islands (Kingsley). ROCKLAND: Bear Mt., Jly. (Malkin); Orangeburg, Je. (Giles); Palisades, Je. Long Island. NASSAU: Flushing (K. W. C.); Sea Cliff (N. B.). KINGS: Brooklyn, Forest Park, Je. (Barnum). SUFFOLK: Cold Spring Harbor, Je.; Greenport, Jan. (R. L.); Manorville, Sept. (R. L.); Montauk, Je., Jly. (R. L.).

Specimens also examined from N. J., Princeton, Oct. (K. W. C.).

Leiobunum nigropalpi (Wood)

Pl. 5, figs. 69–73.

Phalangium nigropalpi Wood, Commun. Essex Inst. 6(1):22–23, fig. 3 a–c. 1870.
Liobunum nigropalpi, Weed, Amer. Nat. 21(10):935. 1887.
Liobunum nigropalpi, Weed, Bull. Ill. State Lab. Nat. Hist. 3:87–88. 1889; ibid, p. 101.
Liobunum nigripalpis, Weed, Amer. Nat. 24(286):918. 1890.
Liobunum nigropalpi, Weed, Trans. Amer. Ent. Soc. 19:187–188. 1892.
Liobunum nigropalpi, Weed, Proc. U. S. Nat. Mus. 16:547, pl. 59, figs. 1–2. 1893.
Liobunum nigropalpi, Banks, Can. Ent. 25(8):211. 1893.
Liobunum nigropalpi, Banks, Jour. N. Y. Ent. Soc. 2:41. 1894.
Liobunum nigripalpi, Banks, Amer. Nat. 35(416):675. 1901.
Liobunum nigropalpi, Roewer, Abhandl. a Gebiete Naturw. 19(4):213–214. 1910.
Leiobunum nigropalpi, Comstock, Spider Book, p. 73. 1912.
Liobunum nigropalpi, Roewer, Weberknechte der Erde, pp. 896–897. 1923.
Liobunum nigropalpi, Walker, Ohio Biol. Surv. Bull. 19, 4(4):163–164, pl. 2, fig. 14. 1928.
Leiobunum nigropalpi, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Leiobunum nigropalpi, Davis, Amer. Midland Nat. 15(6):682–684, pl. 31, fig. 6. 1934.
Leiobunum nigropalpi, Comstock, Spider Book, rev. ed., p. 73. 1940.

Male, length 6 mm.; width 3 mm.

Legs, I, 42 mm.; II, 80 mm.; III, 42 mm.; IV, 58 mm.

Dorsum very finely granular; no tubercles on anterior margin of carapace; openings of scent glands small, oval, directed upwards at base of trochanters of first legs; eye-tubercle black, nearly circular in outline, canaliculate, the carinae armed with low tubercles; abdomen widest at the basal third, pointed behind.

Venter. Coxae smooth, sparsely haired; coxae I and IV armed along anterior margin with a row of small denticles and coxae I, III and IV with an incomplete row on posterior margin; genital operculum smooth; sternites smooth; legs very long, armed sparsely with small denticles on femora, patellae and tibiae.

Femur of palpus nearly cylindrical, only slightly widened distally, from the side slightly curved, armed ventro-laterally on distal half with a row of sharp-pointed teeth; patella short, one half as long as femur, rounded above, armed distally above with a few teeth at margin; tibia from above with the sides nearly straight, from the side with a blunt protuberance at base, armed ventrally, on the protuberance, with a short row of small tubercles and ventro-mesally on the distal half with a similar row; tarsus a little longer than tibia, slender, armed ventro-mesally with a definite row of small, black evenly spaced denticles; claw with a few teeth at base below. Ground color above yellow or golden fading to light grey in some preserved specimens; lightly mottled and spotted with tan and brown; central figure poorly developed; abdominal segments, latered of central figure with transverse series of small, pale, brown spots; sides of abdomen lighter; eye-tubercle dark brown to black.

Venter lighter than dorsum, coxae and genital operculum nearly white in some, sternites slightly darker; trochanters of legs brown to black; femora dark brown or black at base, lighter brown distally; patellae dark brown; tibiae dark brown; metatarsi and tarsi light brown; chelicerae yellow. Femur of palpus light at base, dark brown to black distally; patella brown or black; tibia brown but lighter than patella; tarsus pale; penis slender, not alate.

Female, length 6 to 7 mm.; width 3.25 mm.

Legs, I, 33 mm.; II, 63 mm.; III, 34 mm.; IV, 46 mm.

Generally similar to male but a little larger and with brighter pattern; central figure usually better developed, especially on the basal half of abdomen; colors often silvery and light to dark brown; abdomen pointed posteriorly. Femur of palpus more widened distally than in the male, light at base, brown distally; patella brown, the disto-mesal angle produced into a blunt lobe; tibia yellow, not produced ventrally at base; tarsus yellow; legs generally as in the male but lighter.

Type locality, Huntington Co., Pa.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly. Aug.; Albany, Je. (N. B.), Jly.; Kenwood, Jly. (G. H. C.); Normansville, Jly. (C. R. C.). CHAUTAUQUA: Chautauqua, Jly., Aug. (C. W.). CAYUGA: Fairhaven, Jly. (H. B.). CHEMUNG: Elmira, Jly. CLINTON: Valcour Island, Lake Champlain, Aug. ESSEX: Wilmington, Aug. (C. R. C.). GENESEE: Bergen swamp, Jly. LIVINGSTON: Hemlock lake, Aug. ONTARIO: Coy Point, Canandaigua lake, Je.; Naples, Jly. SARATOGA: Ballston lake, Aug. (A. W.). SCHUYLER: Reynoldsville, Aug. TOMPKINS: Ellis Hollow, Jly.; Enfield Glen, Aug.; Ithaca, Je., Jly., Aug. (C. R. C.) Taughannock, Aug.; Turkey Hill, Jly. WYOMING: Letchworth Park, Jly. YATES: Italy Hill, Sept.; Lake Keuka, Sept. (C. R. C.). Long Island. QUEENS: Jamaica, Je. (A. W.). SUFFOLK: Montauk Point, Jly. (R. L.).

Specimens have also been examined from Ga., Tallulah Falls (J. C. B.); Conn., Storrs, Jly.; Ill., Chicago; Ky., Quicksand, Aug. (W. D. F.); Mich., Port Austin, Huron Co., Sand Point, Jly.; N. J., Caldwell, Je., Lake Verona, Je., Madison, Jly. (A. W.); Ohio, Buckeye lake, Cedar Point, Sept., Starke Co., Jly.; Pa., Cumberland Valley, Aug., Lehighton, Hazleton, Orangeville, Aug., President, Jly., Sunbury, Jly.

Leiobunum politum Weed

Pl. 5, figs. 74–79.

Liobunum politus Weed, Bull. Ill. State Lab. Nat. Hist. 3:89–90. 1889; ibid, p. 102.
Liobunum politus Weed, Amer. Nat. 24(286):918, 1890.
Liobunum politum Weed, Trans. Amer. Ent. Soc. 19:266–267, pl. 15, figs. 1–2. 1892.
Liobunum politum Weed, Proc. U. S. Nat. Mus. 16:548–550, pl. 61, figs. 1–2. 1893.
Liobunum politum Weed, Psyche, 6:428, pl. 15. 1893.
Liobunum politum, Banks, Can. Ent. 25(8):211. 1893.
Liobunum politum, Banks, Jour. N. Y. Ent. Soc. 2:41. 1894.
Liobunum politum, Banks, Proc. Acad. Nat. Sci. Phila., 52:541. 1900.
Liobunum politum, Banks, Amer. Nat. 35(416):676. 1901.
Liobunum politum, Roewer, Abhandl. a Gebiete Naturw. 19(4):219. 1910.
Leiobunum politum, Comstock, Spider Book, p. 75. 1912.
Liobunum politum Weed, Life Histories of American Insects, pp. 261–262, fig. 93. 1917. Original ed. 1897.
Liobunum politum politum, Roewer, Weberknechte der Erde, p. 900. 1923.
Leiobunum politum, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Liobunum politum, Walker, Ohio Biol. Surv. Bull. 19, 4(4):165, pl. 1, fig. 5. 1928.
Leiobunum politum, Davis, Amer. Midland Nat. 15(6):686–688, pl. 32, figs. 27, 30. 1934.
Leiobunum politum, Comstock, Spider Book, rev. ed. p. 75. 1940.

Male, length 3.5 to 4.5 mm.; width 2.5 to 2.75 mm.

Legs, I, 27 mm.; II, 57 mm.; III, 28 mm.; IV, 43 mm.

Dorsum very finely granular; no tubercles on surface of carapace; eye-tubercle canaliculate, the carinae with a few sharp-pointed tubercles; scent gland openings broadly oval in outline, opposite trochanters of first legs; abdomen widest at about mid-length then abruptly tapering to a blunt point behind. Venter. Surface of coxae and genital operculum smooth; coxae

I to III with a row of very fine teeth along anterior margin; genital operculum with a row of similar teeth on each side; sternites smooth; femora of legs with many small, sharp-pointed denticles, other segments nearly smooth.

Femur of palpus from above nearly cylindrical or slightly swollen on basal half, armed ventro-mesally at base with a row of four or five small, black teeth; patella short, widened distally, armed with a few denticles at distal end above; tibia a little longer than patella, from above slightly swollen on basal half, from the side, produced ventrally at base; tarsus slender, about as long as femur, slightly curved ventrally and armed ventro-mesally with a row of small black teeth; claw with a few fine teeth at base below.

Ground color above, golden yellow, the central figure of abdomen very faintly developed; eye-tubercle dark along the carinae, light in front; coxae, genital operculum and sternites yellow, the coxae slightly darker; trochanters and femora yellow; remaining segments light to dark brown; tibia of second legs with false articulations and banded distally with yellow or white; chelicerae yellow; palpi golden-yellow; the femora sometimes shaded distally. Penis compressed dorsally near tip.

Female, length 5.5 mm.; width 3 mm.

Legs, I, 24 mm.; II, 47 mm.; III, 24 mm.; IV, 34 mm.

Larger than the male and with the abdomen broader and more bluntly pointed behind. The pattern is more strongly developed so that the central figure is usually discernible, limited laterally with silvery-white blotches; tibia II white-tipped distally, as in *Leiobunum longipes;* venter in some, silvery.

Type locality, Champaign Co., Illinois.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly., Aug.; Kenwood, Aug. (F. C. P.); Normanskill, Jly. (C. R. C.); Voorheesville, Jly., Aug.; Watervleit Res., Aug. (M. D. L.). BRONX: Van Cortland Park, Sept. (F. C. P.). CATTARAUGUS: Allegany State Park, Aug. CAYUGA: Fairhaven, Jly. CLINTON: Valcour Island, Aug. COLUMBIA: Craryville, Aug. (A. W.); Hillsdale, Sept. DELAWARE: Meredith, Aug. DUTCHESS: Rhinebeck, Jly. ESSEX: Mt. Whiteface, Aug. (C. R. C.). FULTON: Woodworth's lake, Aug. GREENE: Hunter, Aug. HERKIMER: Wilmurt, Aug. (F. C. P.). LEWIS: Lowville, Aug. ONTARIO: Naples, Jly., Aug. ORANGE: Mountainville, Aug. (A. W.). RENSSELAER: Nassau lake, Sept. (A. W.); Rensselaer, Jly., Aug. (W. J. S.). SARATOGA: Ballston lake, Aug. (A. W.). SCHUYLER: Montour Falls, Sept. (C. R. C.). SCHENECTADY: High Mills Gorge, Aug. (A. W.) TIOGA: Spencer, Aug. TOMPKINS: Enfield Glen, Aug.; Etna, Nov.; Ithaca, Jly. (W. J. S.), Aug., Sept. (C. R. C.), Oct. (W. J. H.); Renwick, Ithaca, Jly. (C. R. C.): Taughannock, Jly., Aug. (C. R. C.). ULSTER: Highland, Aug.; West Park, Aug. (A. W.). WARREN: Hague, Aug. (M. D. L.). WASHINGTON:

Black Mt., Aug. (C. R. C.) ; Pearl Point, Jly. (C. R. C.). WAYNE: Clyde, Jly. YATES: Penn Yan, Aug. (C. R. C.) Long Island. QUEENS: Forest Hills, Sept. (C. R. C.). NASSAU: Sea Cliff, Sept. (N. B.). SUFFOLK: Amityville, Aug. (F. C. P.) ; Riverhead, Sept.

Specimens have also been examined from Fla., Camp Torreya, Jly.; Ga., Athens, Je. (C. R. C.), Bainbridge, Jly. (J. C. B.), Oglethorpe, Jly. (J. C. B.) ; Me., Orono, Jly. Aug.; Mass., Quincy, Jly.; Mo., Columbia, Jly. (C. R. C.) ; Pa., Hazelton. Canada, N. S., Truro, Jly.

Weed (1893, p. 428) described *L. politum magnum* as a subspecies of *politum* on the basis of some specimens from Mississippi with legs longer than those possessed by northern specimens. In species common to both the north and south, the southern specimens have longer legs and, in the case of some forms, there is a well defined cline. We prefer to regard *L. politum* as a distinct species.

Leiobunum serratipalpe Roewer

Pl. 6, figs. 80–83.

Liobunum serratipalpe Roewer, Abhandl. a Gebiete Naturw. 19(4) :222. 1910.
Liobunum serratipalpe Roewer, Weberknechte der Erde, p. 901, fig. 1055. 1923.
Leiobunum serratipalpe, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1075. 1928.
Leiobunum serratipalpe, Davis, Amer. Midland Nat. 15(6) :689–690, pl. 31, figs. 3–4, pl. 33, fig. 32. 1934.

Male, length 7 mm.; width 3.75 mm.

Legs, I, 33 mm.; II, 59 mm.; III, 32 mm.; IV, 45 mm.

Integument finely granular, moderately hardened; anterior margin of carapace with a cluster of small denticles at the center and on either side opposite the coxae of the first legs; eye-tubercle shallowly canaliculate and with three or four small tubercles on the carinae; openings of scent glands oval, directed upward opposite base of first trochanters; no transverse row of tubercles back of eye-tubercle or across abdomen.

Venter. Coxae and genital operculum granular, the latter also with scattered light hairs; sternites smooth or very finely granular; marginal row of tubercles on genital operculum present; coxae I to IV armed anteriorly along margin with a row of low tubercles, coxa III with an incomplete row posteriorly, and coxa IV armed more completely posteriorly. Femur of palpus from above slightly narrowed at base, somewhat widened distally and armed distally above with a cluster of black tubercles, from the side strongly arched above, swollen below, and armed ventro-laterally and at distal, lateral margin with a few conspicuous black denticles and mesally, at base, with a row of five to seven black denticles; patella short, one half as long as femur, arched above, widened distally and with the disto-mesal angle slightly produced, armed above with a few scattered denticles and at the distal end above with larger black denticles; tibia from above with the sides straight, from the side rather strongly curved, the ventral side at base swollen and armed with a cluster of black denticles and distally, on the mesal side, with a row of three or four small, sharp-pointed denticles; tarsus slender, slightly curved ventrally and armed ventro-mesally with a single row of small black denticles; tarsal claw with a few slender teeth at base below.

Above golden or silvery yellow with slightly darker mottlings forming irregular patches on the carapace and transverse lines of dark dots, sometimes interrupted mesally, marking the sutures between segments of the abdomen; very pale, light spots form transverse series across the abdominal segments and across the ridge back of eye-tubercle; central figure of abdomen very poorly defined, when present narrowest at the second segment and extending only to the sixth segment; eye-tubercle black around eyes, dusky orange on the front and along the groove; chelicerae and palpi yellow; venter yellow; trochanters and base of femora light brown, remaining segments of legs yellow in a specimen from Connecticut, light brown in New York specimens but dark brown, except trochanter and base of femora, which are light brown, in a specimen from Kentucky. Penis simple, not alate.

Female not known.

Type localities, Long lake, Adirondack Mts., N. Y.; Cold river, North America.

Distribution.—New York. HAMILTON: Long lake. Long Island (N. B.). NASSAU: Mineola, Jly. (R. L.).

Specimens also examined from Ala., Talladega Co., Je. (T. H. H.), Walker Co., Oct. (T. H. H.); Conn., Storrs, Jly.; Fla., Liberty Co., Jly. Nov. (T. H. H.); Ga., Decatur Co., Jly., Tallulah Falls, Jly.; Ky., Quicksand, Je. (W. D. F.), Pine Mt., Bell Co., Aug. (W. D. F.); Ohio, Clear Creek, Hocking Co., Sept. (T. H. H.); S. C., Greenwood, Oct. (T. H. H.)

Leiobunum speciosum Banks

Pl. 6, figs. 84–88.

Liobunum speciosum Banks, Proc. Acad. Nat. Sci. Phila. 52:541. 1900.
Liobunum speciosum Banks, Amer. Nat. 35(416):676. 1901.
Liobunum speciosum, Roewer, Abhandl. a Gebiete Naturw. 19(4):228–229, pl. 6, fig. 15. 1910.
Leiobunum speciosum, Comstock, Spider Book, p. 75. 1912.
Liobunum speciosum, Roewer, Weberknechte der Erde, pp. 904–905, fig. 1057. 1923.
Leiobunum speciosum, Crosby and Bishop, Jour. Elisha Mitchell Sci. Soc. 40:15–16, fig. 10. 1924.
Leiobunum speciosum, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1076. 1928.
Liobunum speciosum, Walker, Ohio Biol. Surv. Bull. 19, 4(4):166, pl. 2, fig. 17. 1928.
Leiobunum speciosum, Davis, Amer. Midland Nat. 15(6):690–691, pl. 32, fig. 21. 1934.
Leiobunum speciosum, Comstock, Spider Book, rev. ed., p. 75. 1940.

Male, length 5.5 mm.; width 4 mm.

Legs, I, 46 mm.; II, 90 mm.; III, 39 mm.; IV, 65 mm.

Dorsum very finely granular but entirely lacking in tubercles except on carinae of eye-tubercle and at front of carapace where there are three small ones at the center; eye-tubercle with a shallow canal; scent glands opening laterally opposite base of first trochanters, abdomen widest at about the middle of length, tapering to a blunt point behind. Coxae I to IV with anterior rows of square denticles; coxae I and IV with incomplete series posteriorly, generally lacking on rear of coxa III; genital operculum with numerous small denticles.

Femur of palpus long and slender extending above carapace three or four times the height of the eye-tubercle, from above slightly widened distally, armed mesally at base with a few small tubercles and ventro-laterally with a series of rather widely spaced, sharp-pointed teeth, from the side strongly curved ventrally; patella shorter than femur, widened distally, armed ventro-laterally with a row of teeth; tibia about as long as patella, cylindrical from above, armed with a few short teeth ventro-mesally on distal half and with a ventro-lateral series of teeth continuous with those of the femur and patella; tarsus slender at base, swollen distally and with a mesal series of small dark teeth; claw with a few slender teeth at base below; chelicerae slender, margins and tip of chela black.

Color above tan to brown with bright silvery blotches on the thorax and transverse lines of small, silvery spots back of eye-tubercle and multiple rows of these spots across abdominal segments; central figure of abdomen vase-shaped, faintly to well developed, when dark then sides of abdomen above silvery, mottled with tan or brown; eye-tubercle dark above, light in front; chelicerae and palpi yellow. Venter silvery-white or with tinges of tan or yellow; genital operculum and coxae silvery to light tan; trochanters dark brown to black, contrasting strongly in color with coxae; base of femora black, rest of legs light to dark brown without distinct annulations although sometimes shaded distally. Penis simple, not alate.

Female generally similar to male but larger, specimens from the southern part of range measuring to 7 mm. or longer.

Legs, I, 47 mm.; II, 92 mm.; III, 47 mm.; IV, 65 mm.

Type locality, vicinity of Auburn, Alabama.

Distribution.—New York. Long Island, SUFFOLK: Orient, Sept. (R. L.); Peconic, Sept. (R. L.); Sound Avenue, Aug. (R. L.).

Other specimens examined from Ala., Warrior river, Oct. (H. H. S.), Lauderdale Co. (H. H. S.); Ark., St. Clair Co., Oct. (H. H. S); Fla., Liberty Co., Jly., Nov. (T. H. H.); Ga., Decatur Co., Je., Jly. (J. C. B.), Spring creek, Jly., Tallulah Falls, Jly. (J. C. B.); Ky., Quicksand, Aug. (W. D. F.); S. C., Greenwood, Oct. (T. H. H.).

This is another species which reaches the northern limits of its distribution on Long Island where all known New York specimens were collected by Mr. Roy Latham of Orient.

Leiobunum uxorium Crosby and Bishop

Pl. 6, figs. 89–92.

Leiobunum uxorium Crosby and Bishop, Jour. Elisha Mitchell Sci. Soc. 40:13, 18–19, pl. 2, figs. 13–14. 1924.

Leiobunum uxorium, Davis, Amer. Midland Nat. 15(6):692–693, pl. 32, fig. 19; pl. 33, fig. 35. 1934.

Male, length 4.5 mm.; width 3 mm.

Legs, I, 41 mm.; II, 77 mm.; III, 43 mm.; IV, 56 mm.

Dorsum finely granular, usually a few very small tubercles at center of anterior margin of carapace; opening of scent glands very small, at margin of carapace opposite trochanters of first legs; eye-tubercle canaliculate, the carinae armed with small, sharp-pointed denticles; abdomen widest near tip, abruptly tapering to a blunt point behind. Coxae coarsely granular, genital operculum and sternites smooth or at most, finely granular; anterior margin of coxae I to IV armed with a row of small denticles.

Femur of palpus long and slightly curved, armed ventro-mesally, and sometimes ventro-laterally, with incomplete rows of small denticles; patella about one half as long as femur, widened distally, armed laterally at base with a few small denticles; tibia a little longer than patella, from above nearly cylindrical, from the side slightly swollen at base, armed ventro-laterally at base with a few small tubercles and ventro-mesally, on the distal half, with a row of about ten small denticles; tarsus slender, slightly curved ventrally, and armed ventro-mesally with a single row of small black denticles; claw with one or two small teeth at base below.

Ground color above orange-yellow, sometimes mottled with lighter on the thorax; central figure poorly developed, in some individuals scarcely evident; abdominal segments I to III marked on the sides with pale spots and segment IV with a complete row; in preservatives these spots usually disappear and the color above is mostly clear orange-yellow; eye-tubercle black. Venter of abdomen and genital operculum slightly lighter than dorsum, the coxae dusky orange to greyish brown, remaining segments of legs dark brown to black; palpus in some mottled orange-yellow, lighter below, in preservatives often fading to nearly uniform orange-yellow; chelicerae, orange-yellow; penis simple, not alate.

Female, length 7 mm.; width 4 mm.

Legs, I, 41 mm.; II, 73 mm.; III, 46 mm.; IV, 60 mm.

Female stouter than the male and with the abdomen bluntly pointed behind; dorsum mottled dark and light brown, the central figure more distinctly developed than in the male, interrupted on the posterior segments; coxae orange-yellow; trochanters brown to black; base of femora, the patellae and tips of tibiae dark brown to black; palpus, in some, mottled dark and light brown above.

Type locality, Oteen, N. C.

Distribution.—New York. Long Island, 3 ads. (N. B.).

Specimens also examined from Ala., Auburn, Sept. (H. G. G.) ; N. C., Aquone, Oct., Lake Waccamaw, Oct., Macon Co., Wayah creek, Oct., Oteen, Oct.; Ohio, Hocking Co., Clear Creek, Sept. (T. H. H.) ; Pa., Gettysburg, Oct.; S. C., Beaufort Co., Oct. (T. H. H.), Berkeley Co., Oct. (T.H. H.) ; Tenn., Gatlinburg, Oct.; Va., Buchanan Co., Oct., Strassburg, Oct.

This species is common in the southeastern states and ranges northward to Ohio and Long Island, New York.

Leiobunum ventricosum ventricosum (Wood)

Pl. 7, figs. 93–96.

Phalangium ventricosum Wood, Commun. Essx. Inst. 6(1) :32–34, 39, figs. 7–7a. 1870.
Liobunum ventricosum, Weed, Amer. Nat. 21(10) :935. 1887.
Liobunum ventricosum, Weed, Bull. Ill. State Lab. Nat. Hist. 3:104. 1889.
Liobunum ventricosum, Weed, Amer. Nat. 24(286) :918. 1890; ibid, pp. 264–265, 1 fig.
Liobunum ventricosum, Weed, Proc. U. S. Nat. Mus. 16:550–551, pl. 63, figs. 1–2, text fig. 1. 1893.
Liobunum ventricosum, Banks, Can. Ent. 25(8) :211. 1893.
Liobunum ventricosum, Banks, Jour. N. Y. Ent. Soc. 2:41. 1894; ibid, p. 146.
Liobunum ventricosum, Banks, Amer. Nat. 35(416) :677. 1901.
Liobunum ventricosum, Roewer, Abhandl. a Gebiete Naturw. 19(4) :225, pl. 3, fig. 23. 1910.
Liobunum ventricosum, Banks, Proc. Acad. Nat. Sci. Phila. 63:456. 1911.
Leiobunum ventricosum, Comstock, Spider Book, p. 75. 1912.
Liobunum ventricosum, Weed, Life Histories of American Insects, pp. 262–264, pl. 21. fig. 94. 1917.
Liobunum ventricosum ventricosum, Roewer, Weberknechte der Erde, p. 903. 1923.
Leiobunum ventricosum, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1076. 1928.
Liobunum ventricosum, Walker, Ohio Biol. Surv. Bull. 19, 4(4) :165–166, pl. 2, fig. 21 1928.
Leiobunum ventricosum, Davis, Amer. Midland Nat. 15(6) :693–695. 1934.
Leiobunum ventricosum, Comstock, Spider Book, rev. ed., p. 75. 1940.

Male, length 7 mm.; width 3.75 mm.

Legs, I, 33 mm.; II, 64 mm.; III, 32 mm.; IV, 44 mm.

Dorsal integument finely granular, the surface moderately hardened; three small tubercles at the anterior margin of carapace in front of eye-tubercle; carapace excavated opposite bases of legs, the angles each with a small tubercle; openings of scent glands at margin of carapace opposite insertion of first legs, oval, with raised edge; eye-tubercle slightly longer than wide, without a canal, tubercles when present, very poorly developed; abdomen long and pointed behind, widest opposite the trochanters of fourth leg.

Coxae with small scattered tubercles on surface; marginal rows of denticles on anterior side of coxae I to IV and posterior margin of coxae II and IV; genital operculum with a few scattered tubercles on surface and a marginal row on each side; sternites very finely granular; legs only moderately long in northern specimens, the femora, patellae and basal half of tibiae with small, black-tipped tubercles; distal ends of tibiae, metatarsi and tarsi clothed with very short, fine, brown hairs.

Femur of palpus moderately stout, from above nearly straight, armed with short black hairs mesally and small, sharp-pointed tubercles disto-laterally and across the distal end of segment above; from the side slightly curved ventrally with numerous small denticles and scattered short black hairs; patella short, widened distally, armed around distal margin with small dark denticles and short dark hairs mesally and laterally, from the side, thickened distally; tibia one and one half as long as patella, cylindrical, armed with short dark hairs and fine, soft under-hairs; tarsus as long as femur, slender, slightly curved ventrally, armed ventro-mesally with a definite row of small black denticles; claw with one or two small teeth at base below.

Ground color above golden-yellow to golden-brown mottled with lighter, silvery-yellow blotches on the carapace and sides of central figure anteriorly; central figure a little darker than adjacent areas, usually restricted to the first six abdominal segments and the transverse ridge back of eye-tubercle; eye-tubercle brown to black, lighter through center; abdominal segments with irregular transverse lines of light dots. Venter of abdomen, coxae and genital operculum silvery-yellow; trochanters concolorous with coxae; legs yellow to light brown, the distal ends of femora, patellae and distal third of tibiae slightly darker; palpi yellow to light brown; chelicerae yellow, the tips and margins of claws black. Penis alate.

Female, length 10 mm.; width 4.5 mm.

Legs, I, 32 mm.; II, 63 mm.; III, 31 mm.; IV, 43 mm.

The female attains a much larger size than the male and the abdomen is wider and less pointed posteriorly. The colors tend to be slightly darker, golden-brown, and the central figure better developed.

A southern representative of this species, *Leiobunum ventricosum hyemale,* attains a larger size and has longer legs.

Type locality, near Philadelphia, Pa., female.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Jly. (S. C. B. and R. C.); Karners, Aug. (F. C. P.); Kenwood, May, Jly. (F. C. P.); Thacher Park, May; Voorheesville, Je., Jly. (A. W.). BRONX: Bronx Park, Jly.; Van Cortland Park, Je. CATTARAUGUS: Allegany State Park, Je.; Otto, Jan. Aug. (J. H. C.); Rock City, Olean, Je. CAYUGA: Fairhaven, Jly. (H. B.); Howlands Island, Nov. CHAUTAUQUA: Chautauqua, Jly., Aug. (C. W.). COLUMBIA: Lake Charlotte, Je.; Queechy lake, May (W. J. S.); Riders Mills, May (H. P. C.). ESSEX: Adirondack Lodge, Jly.; Artist Brook, Je.; Chapel pond, Jly.; Sanford Club, Je. (C. R. C.); Upper Jay, Sept. FRANKLIN: Jly. (C. R. C.). FULTON: Johnstown, Je. GREENE: Haines Falls, Je.; Hunter Mt., Je., Jly. (F. C. P.). HAMILTON: Indian lake, Je.; Long lake, Aug. (C. R. C.). HERKIMER:

Old Forge, Jly. (F. C. P.). LIVINGSTON: Portage, Je. (C. R. C.). ONTARIO: Coy Point, Canandaigua lake, Je., Jly. ORANGE: Durlandville; Goshen, May. ORLEANS: Oak Orchard swamp, Je. (C. R. C.). PUTNAM: Tompkins Corners, Jly. (A. W.). RENSSELAER: Central Nassau, Jly.; East Greenbush, Je. (F. C. P.); Mill creek, May (F. C. P.); Rensselaer, Aug. (W. J. S.); Schodak Landing, Je. SCHUYLER: Cinnamon lake, Je. SULLIVAN: Callicoon, Jly.; Handsome Eddy, Je. ST. LAWRENCE: Oswegatchie, Je. TOMPKINS: Ithaca, May, Jly. Aug. Sept. (C. R. C.); McLean, May; Taughannock, Jly.; Taughannock Falls, Aug. (C. R. C.). ULSTER: Big Indian, Je.; Kingston, Je. WASHINGTON: Sleeping Beauty Mt., Jly. WAYNE: Clyde, Jly. WYOMING: Letchworth Park, Je. (C. P. Z.). YATES: Lake Keuka, Je. (C. R. C.). Long Island. KINGS: Brooklyn, Forest Park, May, Je. QUEENS: Flushing (K. W. C.). SUFFOLK: Cold Spring Harbor, Je. (W. J. G.); Greenport, Je. (R. L.); Montauk, Je., Jly. (R. L.); Orient, May (R. L.); Riverhead, Sept. (C. R. C.); Sag Harbor, Sept. (R. L.)

Specimens also examined from Ala., Roberts Rocks, University, Je. (H. H. S.); Shelby, Apr. (H. H. S.) Ga., Mountain City, Aug. (C. R. C.); Tallulah Falls (J. C. B.) Mass., Cambridge. Mo., Columbia, Je. (C. R. C.) N. H., Pike (P. H.) N. J., Madison, Jly. Pa., Hazelton. Va., Olney, Je. (C. R. C.).

Leiobunum verrucosum (Wood)

Pl. 7, figs. 97–100.

Phalangium verrucosum Wood, Commun. Essex Inst. 6(1):29, 1 fig. 1870.
Liobunum verrucosum, Weed, Trans. Amer. Ent. Soc. 19:189–190, pl. 6. 1892.
Liobunum verrucosum, Banks, Can. Ent. 25(8):211. 1893.
Liobunum verrucosum, Banks, Jour. N. Y. Ent. Soc. 2:41. 1894.
Liobunum verrucosum, Banks, Amer. Nat. 35(416):676. 1901.
Liobunum verrucosum, Roewer, Abhandl. a Gebiete Naturw. 19(4):217. 1910.
Leiobunum verrucosum, Comstock, Spider Book, p. 75. 1912.
Liobunum verrucosum, Roewer, Weberknechte der Erde, pp. 898–899. 1923.
Leiobunum verrucosum, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1076. 1928.
Liobunum verrucosum, Walker, Ohio Biol. Surv. Bull. 19, 4(4):166, pl. 2, fig. 19 1928.
Leiobunum verrucosum, Davis, Amer. Midland Nat. 15(6):695–696, pl. 31, fig. 9 1934.
Leiobunum verrucosum, Comstock, Spider Book, rev. ed., p. 75. 1940.
nec *Liobunum verrucosum,* Weed, Amer. Nat. 21(10):935. 1887. (equals *nigripes*)
nec *Liobunum verrucosum,* Weed, Bull. Ill. State Lab. Nat. Hist. 3:88–89. 1889 (equals *nigripes*)
nec *Liobunum verrucosum,* Weed, Amer. Nat. 24(286):918. 1890. (equals *nigripes*)

Male, length 5 mm.; width 3 mm.

Legs, I, 36 mm.; II, 44 mm.; III, 37 mm.; IV, 35 mm.

Dorsum granular, somewhat hardened, a group of small tubercles at anterior edge of carapace in front of eye-tubercle; sides of carapace noticeably notched opposite insertions of the legs; openings of scent glands oval, at edge of carapace opposite trochanters of first legs; eye-tubercle nearly circular in outline, more than its diameter from the front edge of carapace, canal when present very shallow, the carinae armed with a few low, round tubercles; abdomen widest just beyond middle of its length, bluntly pointed posteriorly.

Surface of coxae and genital operculum studded with numerous, sharp-pointed tubercles; coxae I and IV each with a regular row of tubercles along anterior margin, a row of sharp-pointed tubercles on posterior margin of coxa IV; sternites smooth except for a few low tubercles forming irregular transverse rows; legs moderately long; femora, patellae and tibiae with numerous small, dark sharp-tipped tubercles, metatarsi and tarsi clothed densely with very short, dark hairs.

Femur of palpus long, nearly straight, slightly widened distally, armed mesally and ventro-laterally with a few low tubercles; patella two-thirds as long as femur, widened distally, the disto-mesal angle slightly produced, armed laterally, mesally and dorsally, at the distal end, with a few sharp-pointed denticles; tibia a little longer than patella, stout, armed at distal margin above with two or three sharp-pointed tubercles; tarsus slender, nearly straight from above, as long as patella plus tibia, the ventro-mesal series of teeth small or nearly lacking; claw with numerous small teeth on basal two-thirds below.

Ground color above golden, the carapace mottled with irregular silvery-yellow blotches; central figure moderately well developed, slightly darker than adjacent sides; eye-tubercle brown to black; transverse ridge back of eye-tubercle with a series of small, silvery spots; abdominal segments with irregular silvery spots mostly confined to the central figure; venter silvery-white, coxae and genital operculum very light greyish-white; trochanters and bases of femora black, remaining segments of legs golden-yellow, slightly darker distally, so that there is a general banded appearance; chelicerae white or mottled pale yellow and white; claws black along the margins and at tip; palpi yellow; penis alate.

Female, length 8 mm.; width 4.5 mm.; specimens from southern parts of range, larger.

Legs, I, 33 mm.; II, 64 mm.; III, 34 mm.; IV, 49 mm. New York.
I, 48 mm.; II, 75 mm.; III, 48 mm.; IV, 67 mm. Georgia.

The female is larger and generally stouter than the male; when distended with eggs, the abdomen broadly rounded on the sides and pointed behind; when not carrying eggs, the tip of the abdomen may be broadly rounded, the color tends to be darker and the central figure obscure.

Type locality, unknown.

Distribution.—New York. NEW YORK: New York city, Aug. (R. L.). RICHMOND: Staten Island, Jly. (Burns). Long Island. QUEENS: Flushing, spring (K. W. C.). SUFFOLK: Calverton, Oct. (R. L.); East Quogue, Oct. (R. L.); Greenport, Sept. (R. L.); Manorville, Sept.

(R. L.); Montauk Point, Aug. (R. L.); Northwest, Je. (R. L.); Noyack, Sept. (R. L.); Orient, Aug., Sept. (R. L.); Ronkonkoma, Sept. (R. L.); Sag Harbor, Aug., Sept. (R. L.); Sound Avenue, Aug. (R. L.); Watchogue, Jly. (Barnes); Yaphank, Jly.

Specimens also examined from Ga., Spring Creek, Jly.; Mass., Wellfleet, Aug. (N. B.), Nantucket, Sept.; N. J., Great Notch; N. C., Fort Fisher, Oct.; S. C., Berkeley Co., Sept. (T. H. H.), Darlington Co., Oct. (T. H. H.).

Although this species was earlier recorded from some up-state localities, it is definitely a southern species and mainly confined, in New York, to the extreme southern parts of the State and Long Island.

Leiobunum vittatum (Say)

Pl. 7, figs. 101–104.

Phalangium vittatum Say, Jour. Acad. Nat. Sci. Phila. 2(2):65–66. 1821; ibid., pp. 66–67, *Phalangium dorsatum* Say.

Phalangium dorsatum, Wood, Commun. Essex Inst. 6(1):18–19, fig. 1 a–c. 1870; ibid., pp. 20–21, figs. 2 a–d, *L. vittatum.*

Liobunum vittatum, Weed, Amer. Nat. 2(10):935. 1887.

Liobunum dorsatum, Weed, Bull. Ill. State Lab. Nat. Hist. 3:83–84, 1 fig. 1889; ibid., pp. 85–87, *Liobunum vittatum;* ibid., p. 100, *L. dorsatum;* ibid., p. 101, *L. vittatum.*

Liobunum vittatum dorsatum, Weed, Trans. Amer. Ent. Soc. 19:263–264. 1892.

Liobunum dorsatum, Weed, Amer. Nat. 24(286):918. 1890; ibid., *L. vittatum.*

Liobunum vittatum, Weed, Amer. Nat. 26(312):999–1008, pls. 27–28. 1892; ibid., *Liobunum vittatum dorsatum.*

Liobunum vittatum, Weed, Proc. U. S. Nat. Mus. 16:545–546, pl. 57, figs. 102; pl. 58, figs. 1–2. 1893; ibid., pp. 546–547, pl. 57, fig. 3, *L. vittatum dorsatum.*

Liobunum vittatum, Banks, Can. Ent. 25(8):211. 1893.

Liobunum vittatum, Banks, Proc. Acad. Nat. Sci. Phila. 52:541. 1900.

Liobunum vittatum, Banks, Amer. Nat. 35(416):675. 1901.

Liobunum vittatum-dorsatum, Roewer, Abhandl. a Gebiete Naturw. 19(4):212–213. 1910.

Leiobunum vittatum, Comstock, Spider Book, p. 74. 1912.

Liobunum vittatum, Weed, Life Histories of American Insects, pp. 260–261, fig. 92, pl. 20. 1917.

Liobunum vittatum, Walker, Ohio Biol. Surv. Bull. 19, 4(4):163, pl. 2, figs. 16, 18. 1928; ibid., *L. vittatum dorsatum.*

Leiobunum vittatum, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1076. 1928.

Leiobunum vittatum, Davis, Amer. Midland Nat. 15(6):696–699, pl. 31, fig. 5; pl. 33, fig. 34. 1934.

Leiobunum vittatum, Comstock, Spider Book, rev. ed. p. 74. 1940.

Male, length 6 mm.; width 3 mm.

Legs, I, 35.5 mm.; II, 75 mm.; III, 37 mm.; IV, 51 mm.

Dorsal integument smooth or, at most, very finely granular, somewhat hardened; a cluster of small tubercles at center of anterior margin of carapace; eye-tubercle scarcely canaliculate, the carinae with a few small tubercles; openings of scent glands small, oval, directed upward at margin of carapace opposite trochanters of first legs; no tubercles on ridge back of eye-tubercle or across abdominal segments; surface of coxae with scattered, low, rounded tubercles; denticles well developed along anterior margin of coxae I to IV and at posterior margin of coxa IV; genital operculum with a few scattered tubercles, marginal series not developed; sternites smooth, unarmed.

Femur of palpus very long, extending above surface of carapace six to eight times the height of the eye-tubercle, from above slightly thickened distally, slightly curved laterally, armed distally above with an oblique row of six to eight small black, sharp-pointed denticles; from the side femur strongly curved ventrally, armed ventro-laterally with several rows of sharp-pointed denticles, mostly confined to distal half, armed mesally with a few small, black denticles at base; patella one half as long as femur, swollen distally, slightly curved ventrally, armed laterally with a single row of black-tipped denticles; tibia a little longer than patella, from above with the sides nearly straight, from the side, slightly swollen ventrally at base, armed laterally and ventro-laterally with numerous small, black-tipped denticles; armed mesally on the distal half with a single row of similar denticles; tarsus slender, slightly curved ventrally, a little longer than tibia, armed ventro-mesally with a single row of black denticles; claw dentate at base below.

Femora of legs armed with small scattered denticles; patellae with one or two denticles above at distal margin and a few on the dorsal surface; tibiae with only a suggestion of denticles but clothed with very fine hairs; metatarsi and tarsi with fine hairs over the surface and spines only at the articulations.

Ground color above silvery or golden yellow to deep red brown with brownish blotches and circular spots on the carapace and on each side of central figure of abdomen, on or between segments; central figure dark brown to black very well defined and extending anteriorly to involve eye-tubercle and posteriorly to the end of the abdomen, usually with a constriction on the second abdominal segment; transverse ridge back of eye-tubercle and segments of abdomen within the central figure with transverse rows of silvery-yellow dots; eye-tubercle golden-yellow in front, eyes encircled with black, the canal dark; palpus light to dark yellow; chelicerae yellow, the claws black-tipped. Venter yellow to yellowish orange, the coxae and margins of genital operculum often slightly darker; trochanters of legs and base of femora dark brown to black; remaining segments from light brown, often with brown or black patellae and dark tips to tibiae, to uniform dark brown. Penis slender, not alate.

Female, length 6 to 7.5 mm.; width 3 to 3.25 mm.

Legs, I, 37 mm.; II, 76 mm.; III, 37 mm.; IV, 51 mm.

Similar to male in general pattern but larger and with abdomen rounded posteriorly; legs lighter and often more strongly banded with black. Femur of palpus not greatly elongate as in male, extending above surface of carapace not more than the height of eye-tubercle; venter light in strong contrast to dorsum.

Type locality, Southern States.

Distribution.—New York. Albany: E. N. Huyck Preserve, Rensselaerville, Jly., Aug.; Albany, Jly. (S. C. B.), Aug. (H. P. C.); Normanskill, Jly (C. R. C.); Voorheesville, Jly., Aug.; Watervleit Res., Aug. (M. D. L.). Allegany: Richburg, Sept.; Wellsville, Sept. Bronx: Van Cortland Park, Sept. (F. C. P.). Cattaraugus: Allegany State Park, Aug., Sept., Nov. Cayuga: Fairhaven, Jly. Chautauqua: Chautauqua, Jly., Aug. (C. W.); Silver Creek, Sept. Clinton: Plattsburg, Sept. (C. R. C.); Valcour Island, Lake Champlain, Aug. Columbia: Craryville, Aug. (A. W.); Kinderhook, Aug. (W. J. S.); Kinderhook lake, Aug. (W. J. S.). Dutchess: Beacon, Aug. (A. W.); Fishkill, Sept. (F. C. P.). Essex: Ausable Chasm, Sept. (M. D. L.); Upper Jay, Sept. (F. C. P.); Wilmington, Aug. (C. R. C.). Fulton: Gloversville, Apr. (C. P.A .); Johnstown, Aug.; Mountain lake, Sept. (A. W.); Sacandaga Park, Aug.; Woodworth's lake, Aug. (C. R. C.) Greene: Hunter, Aug. Jefferson: Brownsville, Sept. (F. C. P.). Monroe: Charlotte, Sept. (F. C. P.); Glen Haven, Sept. (F. C. P.). New York: New York, Aug. (R. L.). Onondaga: East Onondaga, Sept. (F. C. P.). Ontario: Coy Point, Canandaigua lake, Je., Jly.; Naples, Jly., Aug. Orange: Cornwall, Aug. (A. W.); Mountainville, Aug. (A. W.). Rensselaer: Nassau lake, Sept. (A. W.); Rensselaer, Aug. (F. C. P.). Rockland: Bear Mt., May. Saratoga: Ballston lake, Aug. (A. W.). Schenectady: High Mills Gorge, Aug. (A. W.). Schuyler: Montour Falls, Sept. (C. R. C.). Steuben: Hornell, Sept. Tompkins: Ithaca, Jly., Aug., Sept. (C. R. C.); McLean, Sept. (C. R. C.). Ulster: Highland, Aug. (A. W.); Kingston; Saugerties, Jly., Aug.; West Park, Aug. (A. W.); West Shokan, Jly. Warren: Hague, Aug., Sept. (M. D. L.). Washington: Elizabeth island, Jly.; Juanita island, Jly.; Pearl Point, Jly. (C. R. C.); Shelving Rock Mt., Jly. (C. R. C.). Wayne: Clyde, Jly., Aug.; Lake Bluff, Sept. Yates: Lake Keuka (C. R. C.). Long Island. Kings: Brooklyn, Sept. Queens: Forest Hills, Sept. (C. R. C.); Forest Park, Sept., Oct.; North Beach, Jly. Suffolk: Amityville, Aug. (F. C. P.); Cold Spring Harbor, Je.; East Marion, Sept. (R. L.); East Port, Sept. (R. L.); East Quogue, Sept. (R. L.); Greenport, Oct. (R. L.); Hampton Bays, Sept. (R. L.); Montauk, Jly. (R. L.); Napeague, Oct. (R. L.); North Sea, Sept. (R. L.); Northwest, Sept. (R. L.); Orient, Sept. (R. L.); Peconic, Je. (R. L.); Pine Neck, May (R. L.); Riverhead, Sept. (C. R. C.); Sag Harbor, Sept. (R. L.); Shinnecock Hills, Sept. (R. L.); Sound Avenue, Aug. (R. L.); Southampton, Sept. (R. L.); Three-mile Harbor, Aug. (R. L.); Westhampton, Sept. (R. L.); Yaphank, Jly. (von Krockow).

Specimens also examined from Ala., Killen, Oct. (H. H. S.); Ark., Murfreesboro (C. R. C.); Ga., Tallulah Falls, Jly. (J. C. B.); Ill., Urbana, Jly.; Iowa; Ky., Brooklyn Bridge, Je., Lexington, Je., Nelson Co., Aug.;

La., Jennings; Mo., Columbia, Jly., Sept., Oct. (C. R. C.), Darlington, Aug. (C. R. C.), Maryville, Aug. (C. R. C.); N. J., Madison, Jly., Sept. (F. C. P.), Ridgewood, Aug. (M. D. L.); Ohio, Castalia, Sept. (C. R. C.), Cedar Point, Sept. (C. R. C.); Okla., Newkirk (P. H.); N. C., Raleigh, Je., Oct., Whitakers, Oct.; Va., Pannunky creek, Oct.

Canada. ONTARIO: Unionville, Sept. (M. D. L.); Perth Road, Buck lake, 35 miles north of Kingston.

Leiobunum vittatum is probably the most widely distributed species in the north. Although it has been collected in only about one half of the counties of New York State, it undoubtedly occurs in all of them.

Various authors have recognized *vittatum* and *dorsatum* as distinct species and as subspecies, based on differences in size and length of appendages. Weed (1892, p. 999) presented measurements of many specimens from various parts of the United States which seemed to indicate, by and large, that specimens from the south attained a larger size and had longer legs than individuals from the north. On the other hand, he also pointed out that, "the progressive lengthening from the north to the south is in no case greater than has been shown . . . to occur in a single locality." Since no structural differences have been pointed out, only the single species is recognized here.

The secretion of the scent glands is particularly offensive in this species and may have considerable protective value. Although the openings of the glands are on the dorsal side of the carapace, the fluid often immediately drains to the ventral side and hangs as a drop.

This is one of the many species that apparently pass the winter in the egg, the young appearing in May.

HADROBUNUS BANKS

The genus *Hadrobunus* was established by Banks (1900, p. 199) with *Phalangium grande* Say as the type. Two of the species, *grandis* and *maculosus*, have hitherto been confused because Banks (1901, p. 677) listed the former as from the eastern states and the latter from southern states. Say (1821, pp. 67–68) definitely stated that *Phalangium grande* "Inhabits the Southern states." In 1870 Wood (pp. 31–32, fig.) described *Phalangium maculosum* from Pennsylvania and recorded additional specimens from West Virginia. As a result of this confusion, most specimens in collections from the northern states have been labeled *H. grandis*. *H. maculosus*, however, is the northern species and reaches the southern limits of its distribution in Kentucky, Ohio and West Virginia. *H. grandis*, on the other hand, is apparently limited to the southeast and is particularly abundant in the Atlantic coastal states.

In our 1928 list of Opiliones from New York (p. 1076) we listed *H. grandis* from a number of localities. All these records apply to *H. maculosus*.

Hadrobunus maculosus (Wood)

Pl. 8, figs. 105–110.

Phalangium maculosum Wood, Commun. Essex Inst. 6(1):31–32, 1 fig. 1870.
Phalangium maculosum, Underwood, Can. Ent. 17(9):168.
Liobunum maculosum, Weed, Proc. U. S. Nat. Mus. 16:554–555, pl. 66, figs. 1–2. 1893.
Leptobunus grande, Banks, Jour. N. Y. Ent. Soc. 2:41. 1894.
Hadrobunus maculosum, Banks, Amer. Nat. 35(416):677. 1901 (not from "Southern States").
Hadrobunus maculosus, Roewer, Abhandl. a Gebiete Naturw. 19(4):256. 1910.
Hadrobunus maculosus, Comstock, Spider Book, p. 76. 1912.
Hadrobunus maculosus, Roewer, (part) Weberknechte der Erde, p. 919. 1923.
Hadrobunus grandis, Crosby, Wolf and Bishop, Cornell Univ. Agr. Exp. Sta. Mem. 101, p. 1076. 1928.
Hadrobunus maculosus, Comstock, Spider Book, rev. ed., p. 76, 1940.

Male, length 9 mm.; width 4.5 mm.

Legs, I, 19 mm.; II, 32 mm.; III, 20 mm.; IV, 27 mm.

Dorsal integument finely granular; anterior margin of carapace with a cluster of small denticles at the midline and lines of very small denticles curving inside the scent glands and diagonally back from the center to the base of the 3rd legs; a transverse row of denticles on ridge back of eye-tubercle and a small series on first abdominal segment. Eye-tubercle without a median groove but armed with small, light-tipped tubercles forming a row above each eye; eyes separated by less than the diameter of one of them. Abdomen moderately hardened but without denticles as in *H. grandis,* often finely granular.

Venter. Coxae strongly granular, anterior margins of all coxae armed with a regular series of tubercles and hind margins of coxae I and IV. Genital operculum with a row of denticles along each lateral margin and scattered tubercles over the ventral surface. Sternites relatively smooth.

Palpus. From above, femur stout, slightly thickened distally and with a few black hairs forming faint lines dorso-mesally and dorso-laterally and scattered denticles distally above, distal lateral and mesal angles produced into sharp points; patella short, stout, the distal half widened, armed with short hairs and a few scattered denticles; tibia short, only slightly longer than patella, with sides nearly parallel and armed with short hairs; tarsus slender with hairs but no denticles, ratio of length of tarsus to tibia as 22 to 15, tarsal claw denticulate. Femur of palpus from the side, evenly and broadly rounded above; patella strongly arched and thickened distally; tibia thicker at base than distally and with a few black denticles below; tarsus slightly curved ventrally and with a regular row of small black denticles ventro-mesally.

Color. Above golden yellow to deep brown with the central figure darker at margins and usually well defined except in old, dark individuals. Central figure narrow at the center of the 2nd abdominal segment, gradually widening over the 3rd, 4th and 5th segments, then narrowing again toward the tip of the abdomen. Transverse ridge back of eye-tubercle and abdominal segments with transverse lines of golden yellow dots on broad brownish bands and brownish spots on the narrower, lighter interspaces. Eye-tubercle black, slightly lighter over the center and behind. Chelicerae, yellow with a large, irregular blotch of brown above on basal segment; distal segment yellow, brown mesally at base; claws black tipped. Palpus. Femur brown, mottled distally; patella light brown, tibia and tarsus yellow; in old individuals palpus may be very dark.

Venter of abdomen whitish or yellowish to brown in old individuals and with transverse rows of light brown spots at the anterior edge of segments; coxae and genital operculum yellowish, somewhat darker than venter of abdomen; trochanters deep brown to black, mottled above with yellow and with the anterior and posterior margins bearing sharp-pointed teeth; base of femora black, remaining segments light to dark brown, darker distally; patellae somewhat swollen, brown; tibiae light on basal half, darker distally; tarsi yellowish, darker distally. All legs with sharp-pointed denticles on femora, patellae and tibiae. Femur I short, less than half the length of the body, femur III very slightly longer than I. Penis broad at base, tapering distally.

Female, length to 12 mm.

Legs, I, 21 mm.; II, 36 mm.; III, 22 mm.; IV, 32 mm.

Similar to male but often paler; femur of first leg about one-third length of body.

Hadrobunus maculosus differs from *H. grandis* in being generally lighter in color, in lacking conspicuous, sharp-pointed denticles on the dorsal surface of the body, in having the legs with a banded appearance rather than mottled or blotched, and in having more prominent transverse rows of light spots on the dorsal surface of the abdomen.

Type localities, Pennsylvania, West Virginia.

Distribution.—New York. ALBANY: E. N. Huyck Preserve, Rensselaerville, Aug.; Albany, Je.; Voorheesville, Jly. CATTARAUGUS: Otto, Aug. CAYUGA: Fairhaven, Aug. (H. Z.). COLUMBIA: Ancram, Je.; Lake Charlotte, Je. DUTCHESS: Poughkeepsie, (von Ingen). GREENE: Catskill, Jly. (F. C. P.); Hunter, Je. (F. C. P.). HERKIMER: Crooked lake, Je. (F. H. W.). SCHUYLER: Cinnamon lake, Je. SULLIVAN: Handsome Eddy, Je. TOMPKINS: Covert, Aug.; Enfield, Jly.; Ithaca, Jly., Aug. (C. R. C.); Ringwood, May (H. D.); Slaterville, Aug.; Taughannock Falls, Jly. ULSTER: Saugerties, Apr., Aug. Long Island. Doubtfully reported from SUFFOLK county, Cold Spring Harbor, Je.; Long Pond, Je.; Shinnecock Hills, Je.

We have also seen specimens from Ky., Quicksand, Aug. (W. D. F.); Mass., Boston, Salem (J. H. E.); N. J., Madison, Mar., Jly.; Ohio, Clear Creek, Hocking Township, Sept. (T. H. H.); Pa., Arendtsville, Aug.; Hazelton, Nov.; Palmerton, Jly.

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PLATE 1.

Fig.

1. *Erebomaster flavescens* Cope. Female, dorsal view.
2. Same, ventral view.
3. Same, lateral view, with ovipositor extended.
4. Same, right palpus, dorso-lateral view.
5. Same, coxae and trochanters.
6. *Crosbycus dasycnemus* (Crosby) Male, dorsal view.
7. *Sabacon crassipalpe* (L. Koch) Female, dorsal view.
8. Same, lateral view.
9. *Caddo agilis* Banks. Male, dorsal view.
10. Same, lateral view.
11. Same, right palpus, lateral view.
12. Same, female, dorsal view.
13. Same, juvenile, dorsal view.
14. Same, juvenile, lateral view.
15. *Caddo boöpis* Crosby. Male, lateral view.
16. Same, dorsal view.
17. Same, female with ovipositor extended (after Bishop and Crosby)
18. Same, right palpus, lateral view.

PLATE 1

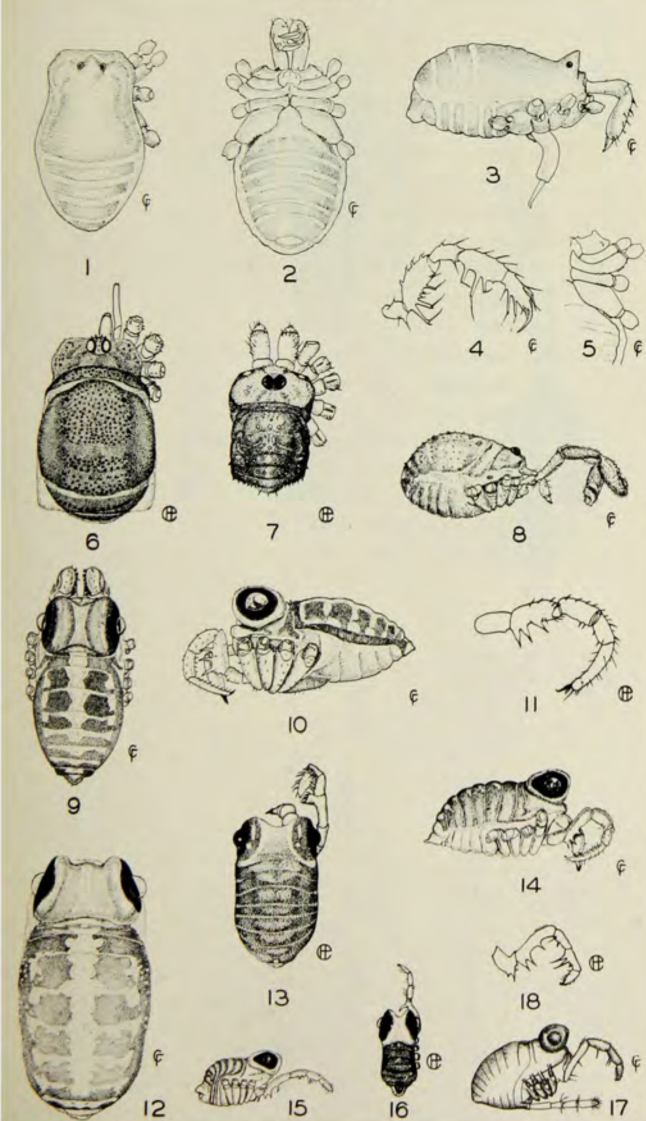


PLATE 2.

Fig.

19. *Mitopus morio* (Fabricius). Male, dorsal view.
20. Same, female, dorsal view.
21. Same, penis, dorsal view.
22. Same, penis, lateral view.
23. *Odiellus pictus* (Wood). Male, dorsal view.
24. Same, female, dorsal view.
25. Same, juvenile male, dorsal view.
26. Same, male showing variation in shape and pattern.
27. Same, penis, dorsal view.
28. Same, penis, lateral view.
29. *Phalangium opilio* Linnaeus. Male, lateral view.
30. Same, male, dorsal view.
31. Same, female, dorsal view.
32. Same, penis, dorsal view.
33. Same, penis, lateral view.

PLATE 2

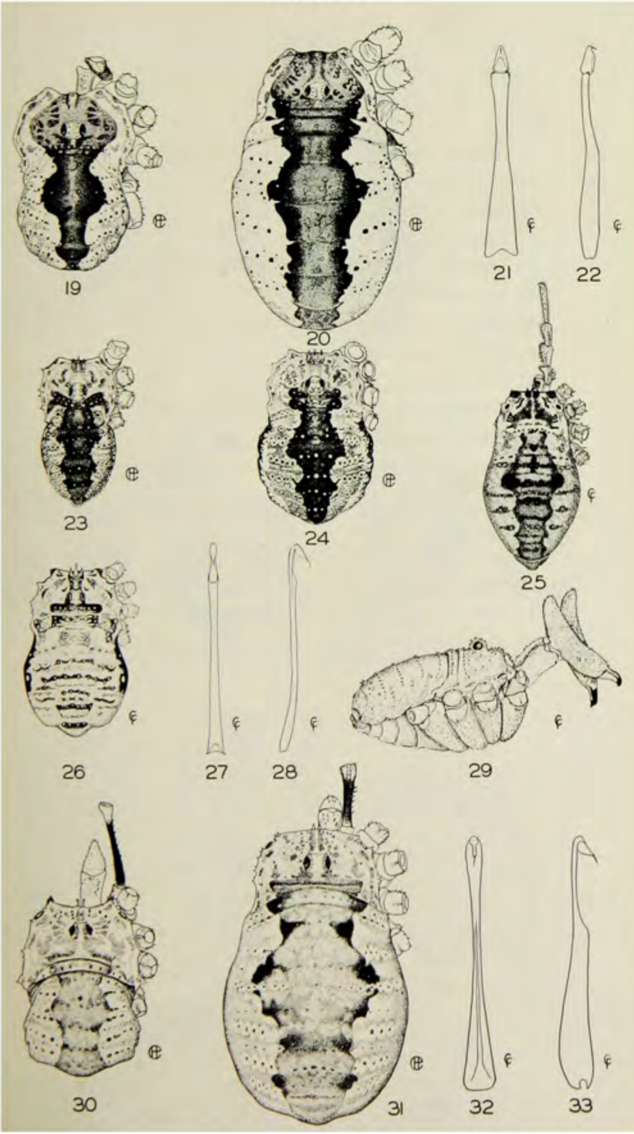


PLATE 3.

Fig.

34. *Opilio parietinus* De Geer. Male, dorsal view.
35. Same, female, dorsal view.
36. Same, penis, dorsal view.
37. Same, penis, lateral view.
38. *Leiobunum bicolor* (Wood). Male, dorsal view.
39. Same, female, dorsal view.
40. Same, juvenile, dorsal view.
41. Same, juvenile, ventral view.
42. Same, penis, dorsal view.
43. *Leiobunum calcar* (Wood). Male, dorsal view.
44. Same, female, dorsal view.
45. Same, male, ventral view showing exerted penis with basal haematodocha.
46. Same, male, lateral view, showing exerted penis and haematodocha.
47. Same, penis, dorsal view.
48. Same, penis, lateral view.
49. Same, right palpus of male, lateral view.
50. Same, right palpus, lateral view, showing spur of femur apposed to swollen base of tibia to form grasping organ.

PLATE 3

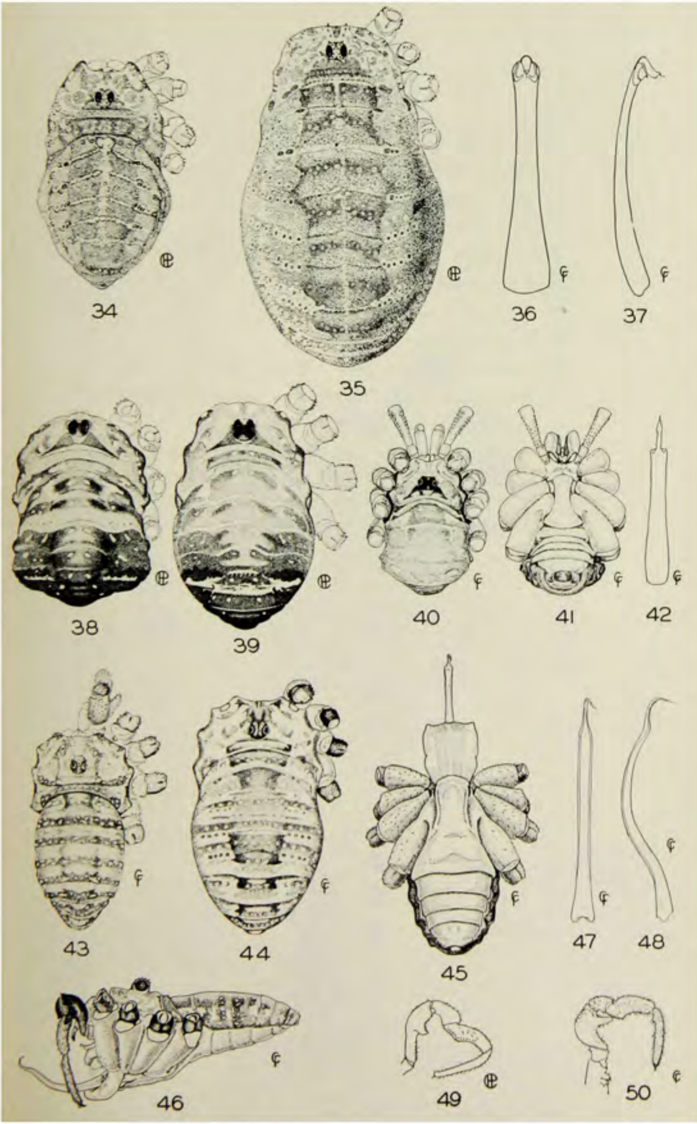


PLATE 4.

Fig.

51. *Leiobunum flavum* Banks. Male, dorsal view.
52. Same, female, dorsal view.
53. Same, penis, dorsal view.
54. Same, penis, lateral view.
55. *Leiobunum formosum* (Wood). Male, dorsal view.
56. Same, female, dorsal view.
57. Same, penis, dorsal view.
58. Same, penis, lateral view.
59. *Leiobunum longipes longipes* Weed. Male, dorsal view.
60. Same, male, dorsal view showing variation in pattern.
61. Same, female, dorsal view.
62. Same, male, lateral view showing penis extended and basal haematodocha.
63. Same, penis, dorsal view.
64. Same, penis, lateral view.

PLATE 4

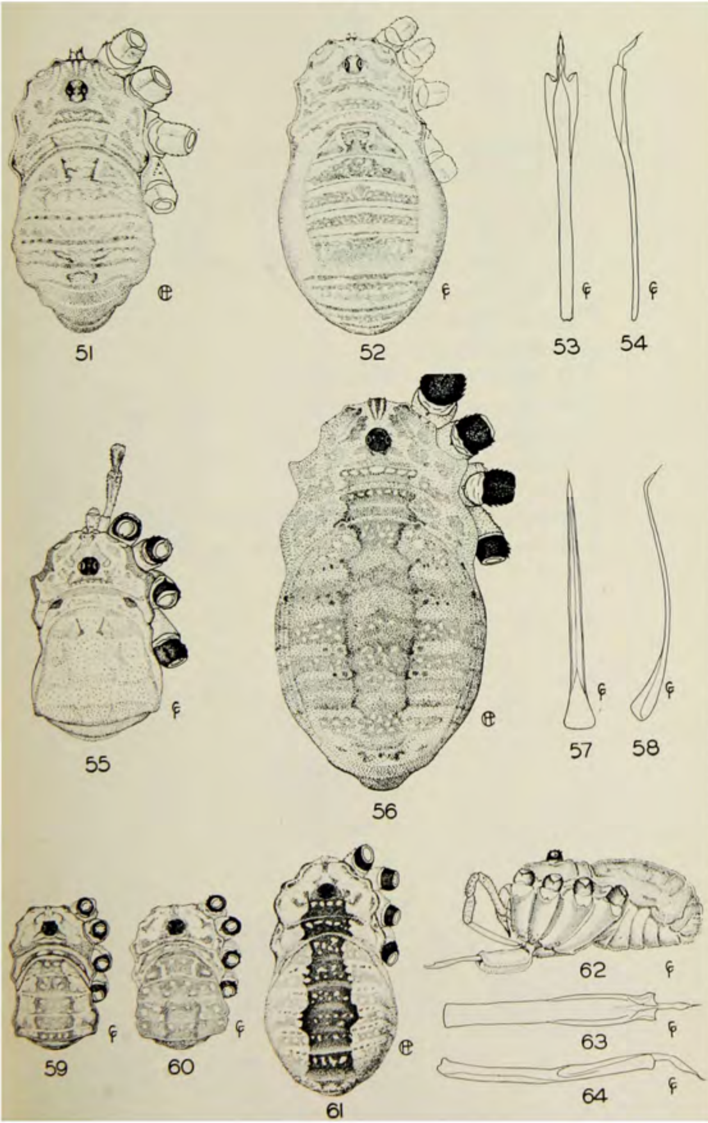


PLATE 5.

Fig.

65. *Leiobunum nigripes* Weed. Male, dorsal view.
66. Same, female, dorsal view.
67. Same, penis, dorsal view.
68. Same, penis, lateral view.
69. *Leiobunum nigropalpi* (Wood). Male, dorsal view.
70. Same, female, dorsal view.
71. Same, palpus.
72. Same, penis, dorsal view.
73. Same, penis, lateral view.
74. *Leiobunum politum* Weed. Male, dorsal view.
75. Same, female, dorsal view.
76. Same, penis, dorsal view.
77. Same, penis, lateral view.
78. Same, female, lateral view showing ovipositor extended.
79. Same, male, lateral view showing penis extended.

PLATE 5

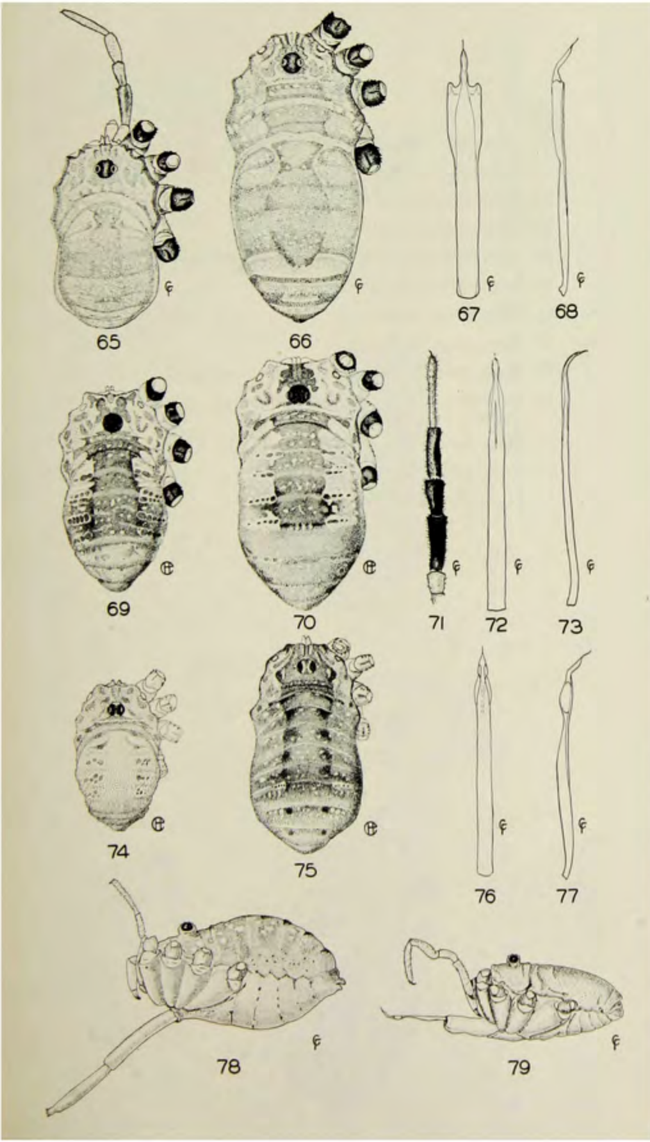


PLATE 6.

Fig.

80. *Leiobunum serratipalpi* Roewer. Male, dorsal view.

81. Same, right palpus, lateral view.

82. Same, penis, dorsal view.

83. Same, penis, lateral view.

84. *Leiobunum speciosum* Banks. Male, dorsal view.

85. Same, female, dorsal view.

86. Same, penis, dorsal view.

87. Same, penis, lateral view.

88. Same, male, lateral view to show long palpi.

89. *Leiobunum uxorium* Crosby and Bishop. Male, dorsal view.

90. Same, female, dorsal view.

91. Same, penis, dorsal view.

92. Same, penis, lateral view.

PLATE 6

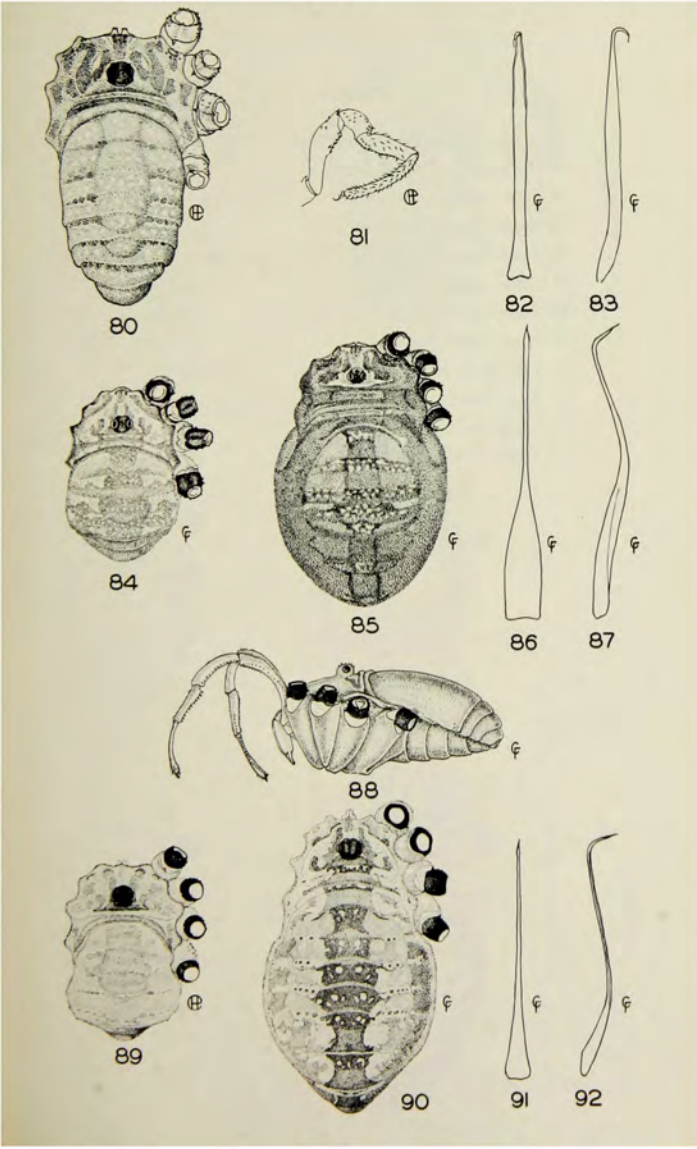


PLATE 7.

Fig.

93. *Leiobunum ventricosum* (Wood). Male, dorsal view.
94. Same, female, dorsal view.
95. Same, penis, dorsal view.
96. Same, penis, lateral view.
97. *Leiobunum verrucosum* (Wood). Male, dorsal view.
98. Same, female, dorsal view.
99. Same, penis, dorsal view.
100. Same, penis, lateral view.
101. *Leiobunum vittatum* (Say). Male, dorsal view.
102. Same, female, dorsal view.
103. Same, penis, dorsal view.
104. Same, penis, lateral view.

PLATE 7

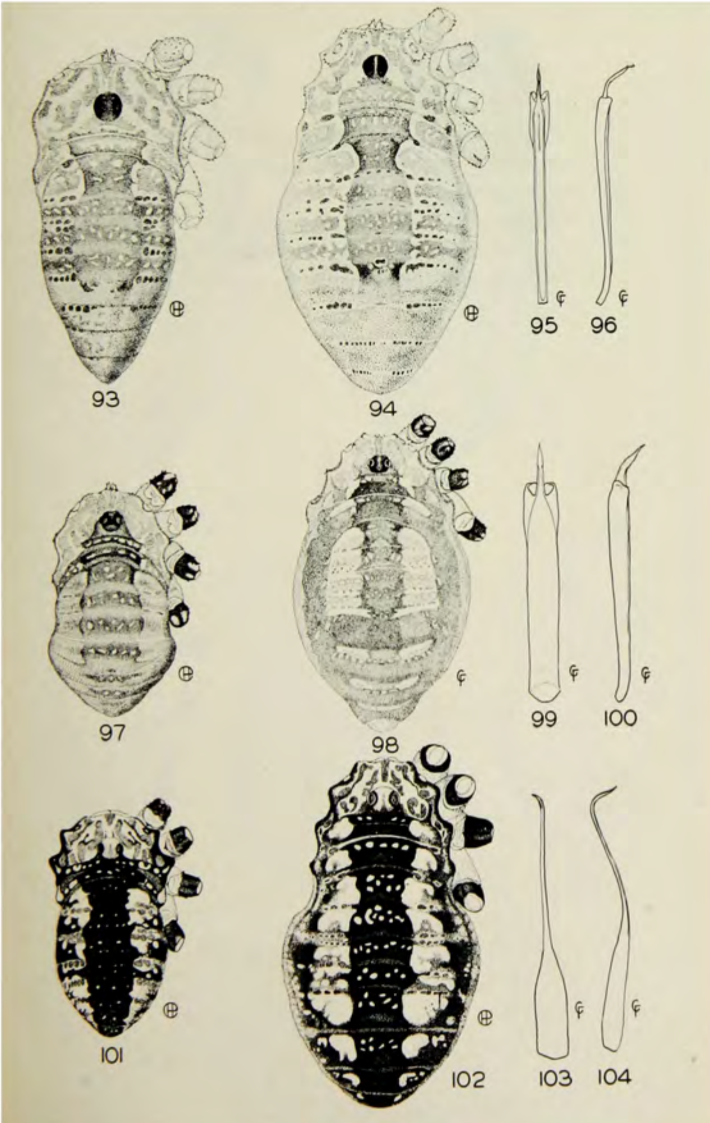
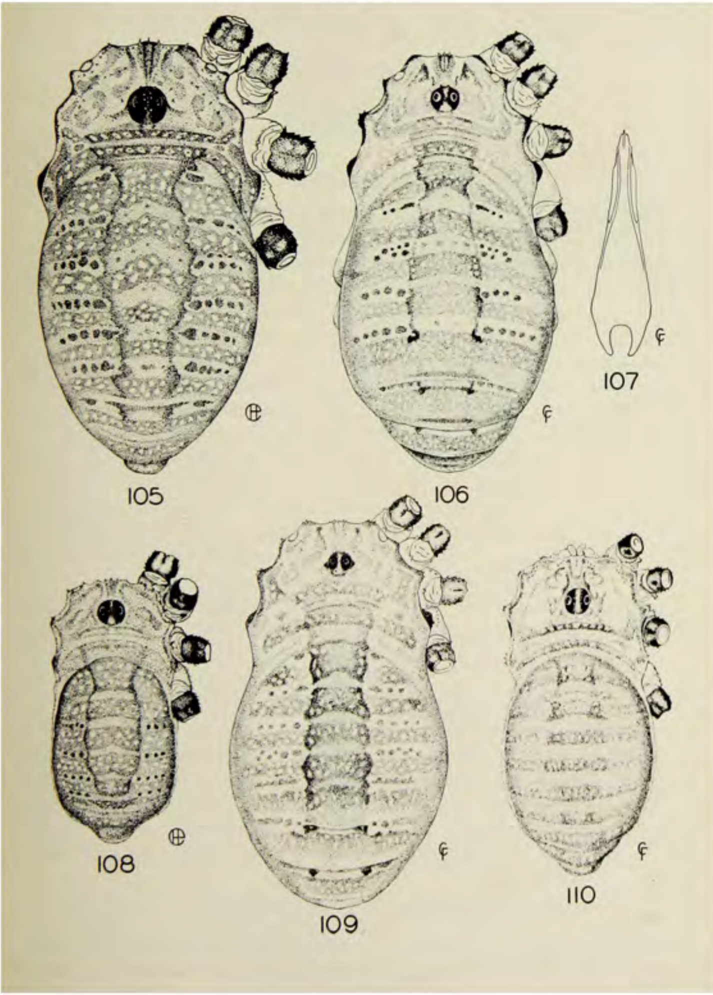


PLATE 8.

Fig.

105. *Hadrobunus maculosus* (Wood). Male, dorsal view.
106. Same, female, dorsal view.
107. Same, penis, dorsal view.
108. Same, male, to show variation in size and proportions.
109. Same, female, dorsal view, light colored individual.
110. Same, male, dorsal view of another individual to show variation in pattern.

PLATE 8



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THE VEGETATION OF BERGEN SWAMP

IV. The Algae

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INTRODUCTION

The algae are morphologically simple green plants without true roots, stems or leaves. They are separated from the bryophytes by the simplicity of their gametangia and sporangia and from the fungi by the fact that the algae contain pigments which enable them to produce their own food by means of photosynthesis.

Nearly all the large groups of algae are represented in Bergen Swamp except the Phaeophyceae, the brown algae. These groups can be included under the term "algae" because of its usefulness and convenience though none of them is closely related to another. The following groups of algae and "algae-like" organisms found in Bergen Swamp are included in this study: 1. Myxophyceae, 2. Chlorophyceae, 3. Rhodophyceae, 4. Heterokontae, 5. Chrysophyceae, 6. Dinophyceae, 7. Euglenophyceae, 8. Charophyta. The diatoms are treated separately by Hohn (1950).

Although the flora is rich and rewarding in algae, little work has been done previously on this group in Bergen Swamp. Stewart and Merrell (1937) mention *Chara* sp. as a contributor to the formation of marl: Muenscher (1946) discusses *Chara* sp. and also *Scytonema* sp., as marl formers; Brown (1948) lists *Protococcus viridis* among the epiphytic plants of Bergen Swamp. Extensive collecting for the present study was begun in 1946 and has continued to the present.

I wish to thank Professor Walter C. Muenscher of Cornell University who made many of the collecting trips possible and for his aid throughout the study. I am also indebted to Professor G. W. Prescott, Professor L. H. Tiffany, and Professor H. Skuja for their aid in determining certain species indicated in the catalogue. Financial assistance in carrying out the field work for the summer of 1949 was granted in the form of an honorarium by the New York State Science Service.

DISTRIBUTION OF ALGAE IN BERGEN SWAMP

Most algae are to be found in aquatic or subaerial situations. Aquatic habitats in Bergen Swamp range from small pools, ditches and brooks to large ponds, and streams. Other algae are aerial, growing on or in the

* Part I under this title, The Vascular Plants, by Walter C. Muenscher (Proc. Roch. Acad. Sci., 9: 64–117, 1946) includes a general discussion of Bergen Swamp, N. Y.

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soil, on moist rocks, on the bark of trees and similar places. Ten natural areas of Bergen Swamp have been designated by Muenscher (1946) according to the type of vegetation. This list of areas has been modified to more specifically indicate the habitat of certain algal species as follows: 1. Black Creek, 2. Spring Brooks, 3. The Pond, 4. Cattail Marsh, 5. *Carex riparia* Marsh, 6. Hardwood Swamp, 7. Thuja Swamp, 8. Open Marl area.

Each of these habitat areas is discussed briefly below to present its most distinctive aspects and to make clear its location in the general area of Bergen Swamp. These habitats differ from each other to the degree that the various environmental factors affecting plant growth are brought to bear upon them. Some of the more important of these environmental factors are topography, substratum, water, temperature, light and winds. It is obvious that these factors are interrelated and each must be considered in relation to the others.

1. *Black Creek.* Black Creek flows generally north down the slope of the Ontario Plain and along the western edge of Bergen Swamp where it strikes the east-west depression within which the swamp lies. Here it is turned eastward and flows along the northern edge of Bergen Swamp and thence to the Genesee River. During most of its course through Bergen Swamp it is a slow, sluggish, silt-laden stream with occasional riffles where the water splashes over gravel and cobbles. Better aeration of flowing water obtains where there are riffles or where the water rushes over boulders or logs. At the same time riffles usually improve the lighting conditions which are especially poor in turbid Black Creek; speed up the current whose washing effect prevents the accumulation of smothering debris and finally provide the substrate of rocks so useful for species of *Cladopora* and others.

During freshets, which may occur several times during a year, the water rises over its low, alluvial banks and floods the bordering woodlands and even some adjacent croplands. Upon receding the flood leaves behind silt and semi-permanent pools. *Botrydium granulatum* was found on exposed mudflats along Black Creek. The banks of the stream help retain the water in the Thuja swamp and open marl areas farther to the south. Sloughs and spring holes are also found along the creek. These contain species of *Vaucheria, Oedogonium, Spirogyra, Mougeotia* and *Zygnema.*

2. *Spring Brooks.* Flowing into Bergen Swamp from the south side are numerous clear, cold spring brooks remarkable for the constancy of their flow. Their number is not shown on the map but several flow under the railroad track along the south side of the swamp; others rise north of the railroad track. Most of the soils about Bergen Swamp are well supplied with lime, (Gustafson, 1933). As a result the waters are hard from the dissolved carbonates, and conditions are favorable for the depo-

sition of marl. Submerged twigs and plants may become heavily lime-incrusted. This alkalinity is probably unfavorable for the growth of desmids, some of which were rare. The spring brooks usually do not freeze over near their sources in the winter and do not show the extremes of high summer temperature found in shallow pools. The coolness of these brooks favors species of *Batrachospermum, Ulothrix, Draparnaldia, Tetraspora,* and *Cladophora* which grow in the swifter waters and species of *Spirogyra* and *Vaucheria* which grow in the quieter stretches. The brooks flow generally northward and supply water to the hardwood forest, Thuja swamp and open marl, sometimes disappearing underground and reappearing farther on.

Also worth mentioning are the low areas near spring brooks which are trampled by cattle making tracks that become filled with cool, quiet water enriched with manure and thus form ideal conditions for *Euglena* spp., *Chlamydomonas* spp., and other motile forms.

3. *The Pond.* Located at the southwest corner of the Bergen Swamp area is a small artificial pond formed by a dam in one of the small tributaries of Black Creek. The pond is about 400 yards long and 100 yards wide. Aquatic vegetation, both submersed and emersed, flourishes in the pond and about its edges. The stems and leaves of these plants, here as elsewhere, were often covered with algae. Several euplanktont species were collected only from this pond as was the rare desmid *Cosmarium Seelyanum.* The sluice below the dam was usually covered with species of *Phormidium.* This area is referred to in the catalogue simply as "the pond".

4. *Cattail marsh.* This area is so named because of the dominant species *Typha latifolia.* It is not continuous but lies in scattered areas especially in the southwest end, in the region south of the sandy knoll and about the southeast portion of the swamp. In some areas the cattail marsh is comparatively open with pools or small ponds especially at the southwest end. Ditches have been dug in various parts of the cattail marsh in unsuccessful attempts to facilitate drainage of the land. These ditches have been fruitful sources of species of *Nostoc, Cylindrospermum, Oscillatoria,* desmids and many other genera. On the dead culms of the cattails are found *Chaetophora* spp., *Coleochaete* spp. and *Rivularia* spp.

5. *Carex riparia* marsh. *Carex riparia* var *lacustris* is the dominant species in this area which lies mainly on the north side between the alluvial area and the Thuja and alder thickets. During freshets in Black Creek this area is flooded under several feet of water, but at other times the water here is only one or two feet deep. Blue-green algae and sometimes *Cladophora* sp. are found in this standing water. The lack of light is a limiting factor in the growth of algae among the dense stands of sedges and where duckweeds cover the surface of the water.

6. *Hardwood Forest.* This forest of birch-maple-elm type forms an irregular zone almost around the outer edge of Bergen Swamp. Algae taken here in small pools include species of *Vaucheria, Tribonema, Zygnema, Spirogyra* and desmids. In some pools covered with a continuous blanket of *Lemna minor,* examination revealed no algae at all. Species of *Protococcus* and *Stichococcus* were found on damp bark while others as *Microcoleus* sp. and *Vaucheria* spp. were found on the damp earth.

7. *Thuja Swamp.* This area filled with a dense growth of arbor-vitae completely encircles the open marl to which it is adjacent. The soil is low, wet and exposed to dense shade beneath the thick canopy of tree tops. Algae such as species of *Vaucheria* and *Zygnema* are found on the damp ground and in shallow pools.

8. *Open marl area.* This is the most characteristic area of Bergen Swamp. It lies in a central location surrounded by the Thuja swamp and with occasional clumps of Thuja within its borders. The water here in spring and early summer lies in broad, shallow pools only a few inches deep. These pools may be colored green by masses of *Zygnema pachydermum.* Later many of the pools dry up or become only an inch or so deep. On bright sunny days the temperature of the water in these pools may be well above that of the air temperature, sometimes going as high as 36° C. in summer. Of interest in this connection is the discussion of *Zygnema pachydermum* in the annotated catalogue below. On the other hand, *Gymnodinium albulum* was found only in the melted ice water of the open marl pools in the middle of January.

On the surface of the grayish white marl are found in abundance small, dark, brown mats of *Scytonema myochrous.* This species with *Chara contraria* is actively engaged in changing the substrate by aiding the precipitation of carbonates in the open marl.

The open marl is especially rich in many species of blue-green algae which thrive in its comparatively stagnant waters.

EXPLANATION OF THE CATALOGUE

In this catalogue are listed the species of algae identified from many collections made in Bergen Swamp during the course of about four years. After each species is a statement of its frequency, habitat and distribution within the swamp. The arrangement within the larger groups, except in the Dinophyceae and the Charophyta, is that found in Smith (1933). The arrangement within the Dinophyceae is that found in Thompson (1947). There is only one species represented in the Charophyta. Within the families, genera and species are arranged in alphabetical order.

ANNOTATED CATALOGUE OF THE ALGAE OF BERGEN SWAMP

CLASS I. — MYXOPHYCEAE

Order 1. Chroococcales

FAMILY 1. CHROOCOCCACEAE

Aphanocapsa Naeg., 1849.

Aphanocapsa elachista W. & G. West. Rare in open marl.
Aphanocapsa Grevillei (Hass.) Rabenh. Frequent in open marl, cattail marsh, Thuja swamp and the pond.
Aphanocapsa rivularis (Carmichael) Rabenh. Infrequent in open marl and cattail marsh.

Aphanothece Naeg., 1849.

(Note: Daily (1942) includes this genus and *Gloeothece* under *Anacystis* Menegh., 1837. Probably the three following species as well as *Gloeothece confluens* should be placed in *Anacystis marginata* Menegh.)
Aphanothece Castagnei (Breb.) Rabenh. Frequent in open marl.
Aphanothece microscopica Naeg. Infrequent in open marl.
Alphanothece Stagnina (Sprengel) A. Braun. Common in open marl.

Chroococcus Naeg., 1849.

Chroococcus dispersus (v. Keiss.) Lemmerman. Scarce in open marl.
Chroococcus limneticus Lemmerman. Occasional in the pond and open marl pools.
Chroococcus minutus (Kuetz.) Naeg. Occasional in open marl and cattail marsh.
Chroococcus pallidus Naeg. Scarce in open marl and cattail marsh.
Chroococcus rufescens (Breb.) Naeg. Occasional in open marl.
Chroococcus turgidus (Kuetz.) Naeg. Common in open marl, occasional in hardwoods and cattail marsh.

Chroothece Hansg., 1884.

Chroothece monococca (Kuetz.) Hansg. Occasional in open marl.

Coelosphaerium Naeg., 1849.

Coelosphaerium Kuetzingianum Naeg. Widespread and frequent.

Gloeocapsa Kuetz., 1843.

Gloeocapsa arenaria (Hassall) Rabenh. Rare in open marl.
Gloeocapsa fenestralis Kuetz. Rare in Thuja swamp.

Gloeothece Naegeli, 1849.

(Note: see note under *Aphanothece.*)

Gloeothece confluens Naeg. Infrequent in open marl.

Gomphosphaeria Kuetz., 1836.

Gomphosphaeria aponina Kuetz. Common in open marl; frequent in Thuja swamp.

Merismopedia Meyen, 1839.

Merismopedia convoluta Breb. Occasional in the pond.

Merismopedia elegans. A. Braun. Occasional in the pond and cattail marsh.

Merismopedia glauca (Ehr.) Naeg. Common in the open marl; occasional in the pond.

Merismopedia tenuissima Lemm. Occasional in cattail marsh.

Microcystis Kuetz., 1833.

(Note: Daily (1942) gives convincing reasons for reverting to the use of *Polycystis* in place of *Microcystis.*)

Microcystis aeruginosa Kuetz. Occasional in Black Creek, cattail marsh, Thuja swamp.

Microcystis ichthyoblabe Kuetz. Rare in cattail marsh.

Microcystis flos-aquae (Wittr.) Kirch. Occasional in cattail marsh and open marl.

Microcystis incerta Lemm. Frequent in cattail marsh.

Microcystis marginata (Meneghini) Kuetz. Occasional in open marl.

Microcystis pulverea (Wood) De Toni. Locally abundant in cattail marsh, occasional in open marl.

Order 2. Chamaesiphonales

FAMILY 2. CHAMAESIPHONACEAE

Chamaesiphon A. Braun and Grunow, 1865.

Chamaesiphon incrustans Grun. Rare in streams.

Order 3. Hormogonales

Suborder Homocystineae

FAMILY 3. OSCILLATORIACEAE

Arthrospira Stizenberger, 1852.

Arthrospira Gomontiana Setchell. Infrequent in spring brooks.

Arthrospira Jenneri Stizenberger. Infrequent in Black Creek.

Lyngbya Agardh, 1824.

Lyngbya aestuarii (Mertens) Liebman. Occasional in Thuja swamp, open marl and cattail marsh.

Lyngbya aerugineo-caerulea (Kuetz.) Gomont. Rare in Thuja swamp.

Lyngbya Birgei G. M. Smith. Occasional in Black Creek.

Lyngbya Lagerheimii (Mob.) Gomont. Occasional in Black Creek and open marl.

Lyngbya major Meneghini. Occasional in pools in hardwoods, Black Creek and cattail marsh.

Lyngbya Martensiana var. **calcarea** Tilden. Rare in open marl. This species appeared in a culture from this area.

Lyngbya nana Tilden. Frequent in the open marl.

Microcoleus Desmazieres, 1823.

Microcoleus vaginatus (Vauch.) Gomont. On a boulder, and on damp ground along railroad track.

Oscillatoria Vaucher, 1803.

Oscillatoria amoena (Kuetz.) Gomont. Occasional in pools.

Oscillatoria amphibia Agardh. Occasional in cattail marshes and in open marl.

Oscillatoria brevis Kuetz. Occasional in spring brooks and in cattail marshes.

Oscillatoria chalybea Mertens. Occasional in cattail marshes and the pond.

Oscillatoria chlorina Kuetz. Occasional in the Thuja swamp and the pond.

Oscillatoria curviceps Agardh. Occasional in open marl.

Oscillatoria formosa Bory. Occasional in spring brooks and cattail marshes.

Oscillatoria geminata Meneghinii. Rare in the open marl.

Oscillatoria cruenta Grunow. Occasional in Black Creek.

Oscillatoria limosa Agardh. Widespread and common.

Oscillatoria minnesotensis Tilden. Rare in open marl.

Oscillatoria Okeni Agardh. Rare in pools.

Oscillatoria princeps Vaucher. Frequent in spring brooks, open marl and cattail marshes.

Oscillatoria prolifica (Greville) Gomont. Infrequent in cattail marsh.

Oscillatoria sancta Kuetz. Occasional in spring brooks, cattail marshes.

Oscillatoria splendida Greville. Frequent in Thuja swamp, Black Creek and the pond.

Oscillatoria tenuis var. **natans** (Kuetz.) Gomont. Frequent in Black Creek, spring brooks.

Oscillatoria tenuis var. **tergestina Rabenh.** Occasional in open marl.
Oscillatoria violacea (Wallroth) Hassall. Rare in cattail marsh.

Phormidium Kuetz., 1843.

Phormidium ambiguum Gomont. Occasional in cattail marsh.
Phormidium autumnale (Agardh) Gomont. Occasional in Black Creek and cattail marsh.
Phormidium favosum (Bory) Gomont. Infrequent in creek below the pond.
Phormidium laminosum (Agardh) Gomont. Infrequent in cattail marsh.
Phormidium papyraceum (Agardh) Gomont. Infrequent in creek below the pond.
Phormidium Retzii Gomont. Frequent in Black Creek and spillway below the pond.
Phormidium tenue (Meneghini) Gomont. Occasional in Thuja swamp.

Spirulina Turpin, 1827.

Spirulina major Kuetz. Occasional in open marl and Black Creek.
Spirulina princeps (W. & G. S. West) G. S. West. Occasional in open marl and Black Creek.
Spirulina subtilissima Kuetz. Rare in open marl. It has been recommended that this species be transferred to the genus *Arthrospira.* See Crow, (1927); Smith, (1933).

Suborder Heterocystineae

FAMILY 4. NOSTOCACEAE

Anabaena Bory, 1822.

Anabaena laxa (Rabenh.) Braun. Rare in Black Creek.
Anabaena oscillarioides Bory. Frequent in Black Creek.
Anabaena torulosa (Carmichael) Lagerh. Occasional in Black Creek.
Anabaena variabilis Kuetz. Occasional in the pond, cattail marsh, Thuja swamp and Black Creek.

Cylindrospermum Kuetz., 1843.

Cylindrospermum majus Wood. Frequent in cattail marsh and in *Carex riparia* marsh.
Cylindrospermum minutum Wood. Occasional in cattail marsh.

Nodularia Mertens, 1822.

Nodularia spumigena Mertens. Occasional in cattail marsh.

Nostoc Vaucher, 1803.

Nostoc caeruleum Lyngb. Occasional in cattail marsh.

Nostoc commune Vaucher. Frequent in cattail marsh and along farm roads.

Nostoc comminutum Kuetz. Occasional in the pond and cattail marsh. The material appeared to be rather immature.

Nostoc depressum Wood. Rare in spring brooks.

Nostoc ellipsosporum (Desmazieres) Rabenh. Frequent in cattail marsh.

Nostoc gelatinosum Schousboe. Occasional in cattail marsh.

Nostoc muscorum Agardh. Occasional in cattail marsh, open marl and Thuja swamp.

Nostoc pruniforme (Linn.) Agardh. Frequent in cattail marsh.

FAMILY 5. SCYTONEMATACEAE

Scytonema Agardh, 1824.

Scytonema Arcangelii Born. & Flah. Rare in pools in hardwoods.

Scytonema Hofmanni Agardh. Frequent in open marl.

Scytonema myochrous (Dillwyn) Agardh. Abundant in open marl.

Tolypothrix Kuetz., 1843.

Tolypothrix distorta (Hofman-Bang) Kuetz. Occasional in open marl and cattail marsh.

Tolypothrix tenuis Kuetz. Rare in Thuja swamp.

FAMILY 6. STIGONEMATACEAE

Stigonema Agardh, 1824.

Stigonema informe Kuetz. Occasional in open marl.

Stigonema mamillosum (Lyngbye) Agardh. Occasional in open marl.

Stigonema ocellatum (Dillw.) Thur. Rare in hardwoods.

Stigonema turfaceum (Engl. Bot.) Cooke. Occasional in open marl.

FAMILY 7. RIVULARIACEAE

Calothrix Agardh, 1824.

Calothrix Braunii Born. & Flah. Infrequent in open marl.

Calothrix epiphytica W. & G. S. West. Occasional in the pond and open marl.

Calothrix fusca (Kuetz.) Born. & Flah. Occasional in cattail marsh.

Calothrix Juliana (Menegh.) Born. & Flah. Rare in spring brooks growing on *Batrachospermum* sp. Material referred to this species may constitute a new species.*

Calothrix parietina (Naegeli) Thuret. Infrequent in open marl.

Dichothrix Zanardini, 1856.

Dichothrix compacta (Ag.) B. & F. Rare on damp cinders along railroad track.

Dichothrix gypsophila (Kuetz.) Born. & Flah. Rare in spring brook.

Dichothrix Orsiniana (Kuetz.) Born. & Flah. Infrequent in open marl.

Rivularia Roth, 1797.

Rivularia coadunata (Sommerfelt) Foslie. Infrequent in *Carex riparia* marsh.

Rivularia dura Roth. Sometimes abundant on dead culms of cattails.

CLASS II. — CHLOROPHYCEAE

Order 1. Volvocales

FAMILY 1. CHLAMYDOMONADACEAE

Carteria Diesing, 1866.

Carteria globosa Korsch. Occasional in open marl and cattail marsh.

Chlamydomonas Ehrenberg, 1833.

Chlamydomonas globosa Snow. Locally abundant in temporary pools in hardwoods.

Chlamydomonas gracilis Snow. Abundant in cow tracks near spring brook.

FAMILY 2. VOLVOCACEAE

Eudorina Ehrenberg, 1832.

Eudorina elegans Ehr. Occasional in the pond and open marl.

Gonium Mueller, 1773.

Gonium pectorale Muell. Rare in pools of open marl and cattail marsh.

Pandorina Bory, 1824.

Pandorina morum Bory. Rare in open marl pools.

Platydorina Kofoid, 1899.

Platydorina caudata Kofoid. Rare in open marl pools.

* *Homoeothrix Batrachospermorum* Skuja in a personal communication from Skuja.

Pleodorina Shaw, 1894.

Pleodorina californica Shaw. Infrequent in open marl pools and the pond.

Volvox Linnaeus, 1758.

Volvox globator L. Infrequent in the pond and cattail marsh.

FAMILY 3. SPHAERELLACEAE

Sphaerella Sommerfelt, 1824.

Sphaerella lacustris (Girod.) Wittr. Occasional on boulders, in cattail marsh and open marl.

Order 2. Tetrasporales

FAMILY 4. PALMELLACEAE

Asterococcus Scherffel, 1908.

Asterococcus limneticus G. M. Smith. Infrequent in cattail marsh.

Gloeocystis Naeg., 1849.

Gloeocystis fenestralis (Kuetz.) A. Braun. Infrequent in hardwoods.

Gloeocystis gigas (Kuetz.) Lagerh. Occasional in the pond and cattail marsh.

Gloeocystis Paroliniana (Menegh.) Naeg. Infrequent in open marl.

Palmella Lyngbye, 1819.

Palmella mucosa Kuetz. Infrequent in the pond and open marl.

Sphaerocystis Chodat, 1897.

Sphaerocystis Schroeteri Chod. Common in the pond.

FAMILY 5. TETRASPORACEAE

Tetraspora Link, 1809.

Tetraspora gelatinosa (Vauch.) Desv. Occasional in spring brooks.

Order 3. Ulotrichales

FAMILY 6. ULOTRICHACEAE

Stichococcus Naeg., 1849.

Stichococcus flaccidus (Kuetz.) Gay. Infrequent on a dead log near Black Creek.

Ulothrix Kuetz., 1832.

Ulothrix aequalis Kuetz. Abundant in one spring brook.
Ulothrix moniliformis Kuetz. Infrequent in spring brooks.
Ulothrix oscillarina Kuetz. Infrequent in stream below the pond.

FAMILY 7. MICROSPORACEAE

Microspora Thuret, 1850; emend., Lagerheim, 1888.

Microspora amoena (Kuetz.) Rabenh. Occasional in Black Creek.
Microspora pachyderma (Willie) Lagerheim. Occasional in Thuja swamp.
Microspora Willeana Lagerheim. Occasional in hardwoods.

FAMILY 8. CYLINDROCAPSACEAE

Cylindrocapsa Reinsch, 1867.

Cylindrocapsa geminella Wolle. Infrequent in cattail marsh.

FAMILY 9. CHAETOPHORACEAE

Aphanochaete A. Braun, 1851.

Aphanochaete repens A. Braun. Occasional as an epiphyte on *Cladophora* in spring brooks and larger streams.
Aphanochaete vermiculoides Wolle. Rare in streams as an epiphyte on larger algae. Cell diameter 8–10 microns, several setae per cell, filaments short and arching.

Chaetophora Schrank, 1789.

Chaetophora elegans (Roth) Agardh. Frequent in cold spring brooks and in the Thuja and hardwoods areas.
Chaetophora incrassata (Huds.) Hazen. Occasional in the *Carex riparia* marsh.
Chaetophora pisiformis (Roth) Agardh. Frequent in streams in the hardwoods and in the cattail marshes.

Draparnaldia Bory, 1808.

Draparnaldia acuta (Ag.) Kuetz. Occasional in Thuja swamp.
Draparnaldia glomerata (Vauch.) Agardh. Occasional in cold spring brooks.
Draparnaldia platyzonata Hazen. Occasional in cold spring brooks.
Draparnaldia plumosa (Vauch.) Agardh. Abundant in cold spring brooks.

FAMILY 10. PROTOCOCCACEAE

Protococcus Agardh, 1824.

Protococcus viridis Ag. Widespread and common especially on tree trunks.

FAMILY 11. COLEOCHAETACEAE

Coleochaete de Brebisson, 1844.

Coleochaete divergens var. **minor** Hansg. Occasional on *Cladophora* in spring brooks and in *Carex riparia* marsh.

Coleochaete scutata Breb. Frequent on submersed *Typha* leaves and culms in cattail marshes.

FAMILY 11a. TRENTEPOHLIACEAE

Leptosira Borzi, 1883.

Leptosira Mediciana Borzi. Rare in pools near Black Creek.

FAMILY 12. CLADOPHORACEAE

Cladophora Kuetz., 1843.

Cladophora callicoma Kuetz. Occasional in spring brooks.

Cladophora glomerata (L.) Kuetz. Common on stones in spring brooks and Black Creek. Occasional in the marl area.

Cladophora insignis (Ag.) Kuetz. In stream at west end of the swamp. This material was smaller than usual being about 42 microns in diameter whereas Collins (1905) gives a range of 75 to 120 microns for this species.

Rhizoclonium Kuetzing, 1843.

Rhizoclonium hieroglyphicum (Ag.) Kuetz. Apparently rare in spring brooks.

Order 4. Oedogoniales

FAMILY 13. OEDONGONIACEAE

Bulbochaete Agardh, 1817.

Bulbochaete Brebissonii Kuetz. Occasional in pools in the hardwoods and open marl.

Bulbochaete repanda Wittrock. Occasional in open marl.

Bulbochaete (sp. undetermined). Occasional in cattail marshes. Diameter of vegetative cells 10–12 microns.

Oedogonium Link, 1820.

Oedogonium capilliforme Kuetz. Wittrock. Occasional along Black Creek.

Oedogonium capilliforme var. **diversum** (Hirn) Tiffany. Occasional in Black Creek sloughs of quiet water.

Oedogonium cardiacum (Hass.) Wittr. Frequent along Black Creek.

Oedogonium cryptoporum var. **vulgare** Wittr. Occasional in cattail marshes.

Oedogonium cymatosporum Wittr. and Nordstedt. Occasional in the open marl.

Oedogonium fragile Wittr. Occasional in pools in hardwoods.

Oedogonium grande var. **majus** Hansg. Occasional in the *Carex riparia* marsh.

Oedogonium landsboroughi (Hass.) Wittr. Occasional in the *Carex riparia* marsh.

Oedogonium oboviforme Wittr. Infrequent along Black Creek in flowing water. This material was examined by Tiffany who placed it in the *grande* complex but indicated that it was a bit too immature to be sure of the species. However he advised that if the mature material kept the same oogonial shape, he would place it in this species. Unfortunately no further material has been collected. This species has not previously been reported from the United States. (Tiffany, 1930)

Oedogonium pratense Transeau. Occasional in pools in hardwoods.

Oedogonium sp. undetermined. Black Creek.

Order 5. Chlorococcales

FAMILY 14. CHLOROCOCCACEAE

Chlorococcum Fries, 1820.

Chlorococcum humicola (Naeg.) Rabenh. Occasional on low damp ground; widespread.

Chlorococcum infusionem (Schrank) Menegh. Frequent on animal droppings in open marl pools in the cooler months.

FAMILY 15. ENDOSPHAERACEAE

Kentrosphaera Borzi, 1883.

Kentrosphaera Bristolae G. M. Smith. Rare in the cattail marsh. Cells 110 microns broad by 135 microns long. Walls thick with an external process. Cells filled with starch grains.

FAMILY 16. CHARACIACEAE

Characium A. Braun, 1849.

Characium Braunii Bruegger. Rare in open marl.

FAMILY 17. HYDRODICTYACEAE

Hydrodictyon Roth, 1800.

Hydrodictyon reticulatum (L.) Lagerh. Abundant in pond and in the stream above and below it.

Pediastrum Meyen, 1829.

Pediastrum biradiatum Meyen. Frequent in cattail marsh.

Pediastrum Boryanum (Turp.) Menegh. Common in cattail marshes, the pond, Black Creek; rare in Thuja swamp and the open marl.

Pediastrum Boryanum var. **longicorne** Raciborski. Frequent in the pond.

Pediastrum duplex Meyen. Frequent in cattail marsh.

Pediastrum duplex var. **clathratum** (A. Braun) Lagerh. Rare in cattail marsh.

Pediastrum integrum Naeg. Rare in cattail marsh.

Pediastrum tetras (Ehrenb.) Ralfs. Common in the pond and cattail marsh.

Sorastrum Kuetzing, 1845.

Sorastrum americanum (Bohlin) Schmidle. Rare in the pond.

Sorastrum spinulosum Naeg. Frequent with submerged aquatics such as *Chara* sp. in open stretches of cattail marshes.

FAMILY 18. COELASTRACEAE

Coelastrum Naeg., 1849.

Coelastrum cambricum Archer. Rare in pools.

Coelastrum microporum Naeg. Frequent in the pond and open areas of cattail marsh.

Coelastrum proboscideum Bohlin. Frequent in cattail marshes: sixteen-celled coenobia were most frequent. Another form was observed which closely resembled a figure in Smith (1920)* but was peculiar in that each cell had two outwardly projecting truncate papillae.

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* Part I, Plate 42, Fig. 7, p. 227.

FAMILY 19. OOCYSTACEAE

Ankistrodesmus Corda, 1838.

Ankistrodesmus falcatus (Corda) Ralfs. Occasional in cattail marshes.
Ankistrodesmus spiralis (Turner) Lemmermann. Occasional in cattail marshes.

Chlorella Beyerinck, 1890.

Chlorella vulgaris Beyerinck. Occasional near the pond.

Gloeotaenium Hansgirg, 1890.

Gloeotaenium Loitlesbergerianum Hansg. Frequent in the pond.

Kirchneriella Schmidle, 1893.

Kirchneriella obesa (W. West) Schmidle. Occasional in cattail marshes.

Nephrocytium Naeg., 1849.

Nephrocytium Agardhianum Naeg. Occasional in the pond.

Oocystis Naeg., 1845.

Oocystis elliptica W. West. Frequent in the pond and the cattail marshes.
Oocystis lacustris Chodat. Occasional in the cattail marshes.
Oocystis parva W. & G. S. West. Occasional in the cattail marshes.
Oocystis submarina Lagerh. Rare in the pond.

Palmellococcus Chodat, 1894.

Palmellococcus miniatus (Kuetz.) Chod. Infrequent in hardwoods.

Planktosphaeria G. M. Smith, 1918.

Planktosphaeria gelatinosa G. M. Smith. Frequent in the pond and cattail marshes.

Selenastrum Reinsch, 1867.

Selenastrum Bibraianum Reinsch. Rare in cattail marshes.
Selenastrum Westii G. M. Smith. Frequent in cattail marshes.

Tetraedron Kuetz., 1845.

Tetraedron minimum (A. Braun) Hansg. Occasional in cattail marshes.
Tetraedron regulare Kuetz. Rare in cattail marshes.
Tetraedron reticulatum (Reinsch) Hansg. Rare in cattail marshes.

Trochisia Kuetzing, 1845.

Trochisia granulata (Reinsch) Hansg. Frequent in cattail marshes.

Westella de Wildemann, 1897.

Westella botryoides (W. West) de Wildm. Occasional in cattail marshes.

FAMILY 20. SCENEDESMACEAE

Actinastrum Lagerheim, 1882.

Actinastrum gracillimum G. M. Smith. Rare in the pond.

Crucigenia Morren, 1830.

Crucigenia irregularis Wille. Rare in cattail marsh.

Micractinium Fresenius, 1858.

Micractinium pusillum Fresenius. Rare in the pond.

Scenedesmus Meyen, 1829.

Scenedesmus armatus (Chod.) G. M. Smith. Rare on rocks in stream below the pond.

Scenedesmus bijuga (Turp.) Lagerh. Frequent in the pond, Black Creek and cattail marshes.

Scenedesmus brasiliensis Bohlin. Rare in woodland pools.

Scenedesmus denticulatus Lagerh. Rare in cattail marsh.

Scenedesmus dimorphus (Turp.) Kuetz. Frequent in cattail marsh, Black Creek.

Scenedesmus obliquus (Turp.) Kuetz. Common in cattail marshes and the pond.

Scenedesmus quadricauda (Turp.) Breb. Common in cattail marshes, the pond and *Carex riparia* marsh.

Order 6. Siphonales

FAMILY 21. VAUCHERIACEAE

Dichotomosiphon Ernst, 1902.

Dichotomosiphon tuberosus (A. Braun) Ernst. Occasional in the Thuja swamp and open marl areas. This species is probably not as rare as the collecting records would indicate. Because it closely resembles species of *Vaucheria* it may be easily passed over in the field as just another piece of 'water felt'.

Vaucheria De Candolle, 1803.

Vaucheria geminata (Vauch.) De Candolle. Frequent in pools and on damp ground in hardwoods, Thuja swamp, spring brooks, *Carex riparia* marsh and cattail marsh. Not as common as the following variety with which it is often found.

Vaucheria geminata var. **racemosa** (Vauch.) Walz. Common in the same areas as the species.

Vaucheria hamata (Vauch.) De Candolle. Occasional in spring brooks and hardwood pools.

Vaucheria ornithocephala Agardh. Occasional in spring brooks and in pools and on damp ground in the hardwoods.

Vaucheria ornithocephala forma **polysperma** Heering. Occasional in the same areas as the species. This form is smaller than the species; the diameter of the filaments was 31 microns.

Vaucheria repens Hassall. Rare in pools in the hardwoods. Filaments 35–44 microns.

Vaucheria sessilis (Vauch.) De Candolle. Common in hardwoods pools, Thuja swamp, spring brooks and occasional in the marl area.

Vaucheria terrestris (Vauch.) De Candolle. Rare in Black Creek. The oogonia measured 147 microns in diameter.

Order 7. Zygnematales

FAMILY 22. ZYGNEMATACEAE

Mougeotia Agardh, 1824.

Mougeotia genuflexa (Dillw.) Agardh. Frequent in quiet pools along Black Creek.

Mougeotia quadrangulata Hass. Frequent in shallow pools in open marl.

Mougeotia robusta (De Bary) Wittr. Occasional in pools in Thuja swamp, open marl and spring brooks.

Spirogyra Link, 1920.

Spirogyra affinis (Hass.) Petit. Occasional in spring brooks. Vegetative cells 26 microns in diameter and zygospores up to 52 microns long.

Spirogyra bellis (Hass.) Cleve. Occasional in Black Creek.

Spirogyra catenaeformis (Hass.) Kuetz. Common in spring brooks, occasional in open marl, Thuja swamp and Black Creek.

Spirogyra fallax (Hansg.) Wille. Rare in hardwoods pools.

Spirogyra Farlowii Transeau. Occasional in Black Creek.

Spirogyra fluviatilis Hilse. Occasional in spring brooks.

Spirogyra gracilis (Hass.) Kuetz. Occasional in open marl.

Spirogyra Grevilleana Hass. Occasional in hardwoods and the pond.*

Spirogyra insignis (Hass.) Kuetz. Occasional in hardwoods ponds.*

Spirogyra groenlandica Rosenvinge. Occasional in open marl.*

Spirogyra jugalis (Fl. Dan.) Kuetz. Occasional in spring brooks.*

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* Species determined from vegetative characters alone.

Spirogyra Lagerheimii Wittr. Occasional in spring brooks.
Spirogyra maxima (Hass.) Wittr. Frequent in the pond.*
Spirogyra porticalis (Muller) Cleve. Occasional in open marl.*
Spirogyra tenuissima (Hass.) Kuetz. Occasional in open marl.
Spirogyra varians (Hass.) Kuetz. Occasional in spring brooks and hardwoods pools.

Zygnema Agardh, 1824.

Zygnema pachydermum W. & G. S. West. Common in shallow pools in the open marl, frequent in pools in the Thuja swamp and cat-tail marshes. Collections were made of this species throughout the year and seasonal changes in growth were noted. It was present in the vegetation condition throughout the winter and became more abundant by May. Conjugation took place in very late May and early June and the zygospores were retained in the filaments until the middle of July. During July little could be seen of the vegetative material. By mid-September however and throughout the fall vegetative growth was renewed and became abundant. Measurements showed the vegetative cells to be almost invariably 19 microns in diameter. No rhizoidal branches were observed.

During the cooler parts of the year and at the time of conjugation the cell walls were thin and without any sheath. But gradually after the first of June some of the filaments acquired a thick gelatinous sheath until they had a diameter of forty or fifty microns. At the same time the zygospores, which when young were thin-walled, developed a thick membrane which later became lamellate. The zygospores which were at first globose sometimes became distorted into various irregular globular shapes. Meanwhile the empty gametangial cells retained their original shape and size of 19 microns in diameter.

It was noticed that filaments from the shallow pools in the open marl had the most extremely thickened sheaths and distorted spores. In these pools the water was often only an inch or two deep and on sunny days became excessively warn. The temperature of the water under these conditions exceeded that of the air by several degrees. Collins (1909) suggested that the thick-walled spores of this species might be the result of the thermal conditions of the water in which it grew. It would seem that there was such a correlation here between thick-walled spores and high temperatures. It would also appear that there was a correlation between high temperatures and the formation of thick sheaths around the vegetative filaments. There are two indications for this correlation: (1) sheaths did not develop anywhere during

* Species determined from vegetative character alone.

the cooler months, and (2) filaments collected from shaded, cooler pools in the Thuja swamp near the end of June had only a slight sheath development. It is apparent that this species can withstand extremes of temperature both high and low and it is possible that the production of thick sheaths on the filaments and thick-walled, irregular spores is the result of relatively high temperatures of the water during the summer.

Zygnema stellinum (Muller) Agardh. Occasional in cattail marshes.*

FAMILY 23. MESOTAENIACEAE

Cylindrocystis Meneghini, 1838.

Cylindrocystis crassa De Bary. Infrequent in open marl.

Gonatozygon De Bary, 1856.

Gonatozygon Brebissonii De Bary. Rare in the pond.

Mesotaenium Naeg., 1849.

Mesotaenium Endlicherianum Naeg. Rare in the pond.

Mesotaenium macrococcum (Kuetz.) Roy & Biss. (possibly var **micrococcum** (Kuetz.) West and West.) Det. by G. W. Prescott. Occasional in Thuja swamp.

FAMILY 24. DESMIDIACEAE

Arthrodesmus Ehrenberg, 1838.

Arthrodesmus convergens Ehrenb. Occasional in pools in hardwoods.

Arthrodesmus triangularis Lagerh. Rare in pools in hardwoods.

Cosmarium Corda, 1834.

Cosmarium abbreviatum forma **minor** W. & G. S. West. Frequent in the pond and cattail marshes.

Cosmarium abruptum Lund. Rare in cattail marshes. Because of the apex which is faintly undulate and not retuse this species is closer to *Cosmarium Blyttii* Wille than the figure in West and West (1908).

Cosmarium angulosum Breb. var. **concinnum** (Rabenh.) W. & G. S. West. Rare in cattail marshes.

Cosmarium Blyttii Wille. Frequent in the pond and cattail marshes.

Cosmarium circulare Reinsch. Occasional in cattail marshes.

Cosmarium cymatopleurum Nordst. Occasional in open marl and in pools in hardwoods. This species resembles the description in West & West (1908) except for its smaller size. Length of cells fifty-one microns, breadth forty-two microns, breadth of isthmus 14 microns.

Cosmarium Etchachenense Roy & Biss. Rare in pools in hardwoods.

Cosmarium formosulum Hoff. Occasional in the pond.

Cosmarium granatum Breb. Common in open marl and cattail marshes.

Cosmarium granatum var. **subgranatum** Nordst. Frequent in the pond.

Cosmarium Holmiense Lund. Occasional with *Chara* in open marl.

Cosmarium Holmiense var. **integrum** Lund. Rare in open marl.

Cosmarium humile (Gay) Nordst. Occasional in cattail marshes.

Cosmarium humile var. **danicum** (Borges) Schmidle. Frequent in cattail marshes.

Cosmarium impressulum Elfv. Common in cattail marshes, frequent in the pond and in Black Creek.

Cosmarium laeve Rabenh. Rare in open marl.

Cosmarium laeve var. **septentrionale** Wille. Frequent in cattail marsh.

Cosmarium Logiense Biss. Frequent in the pond. The cells were smaller than in the description in West & West (1908). The length of the cells was fifty-five microns, the breadth thirty-seven microns and the isthmus had a breadth of fifteen microns.

Cosmarium Meneghinii Breb. Common in the pond and cattail marshes.

Cosmarium minimum West & West. Occasional in pools in hardwoods.

Cosmarium obtusatum Schmidle. Frequent in the pond and cattail marshes.

Cosmarium pachydermum Lund. Occasional in the pond and cattail marshes.

Cosmarium Pokornyanum (Grun.) W. & G. S. West. Frequent in pools in hardwoods.

Cosmarium protuberans Lund. Rare in pools in hardwoods.

Cosmarium pseudarcteum Nordst. Rare in pools in hardwoods.

Cosmarium punctulatum Breb. Frequent in the pond, open marl, and cold spring brooks.

Cosmarium pygmaeum Arch. Frequent in the pond.

Cosmarium quadratulum (Gay) de Toni. Rare in pools in hardwoods.

Cosmarium reniforme (Ralfs.) Arch. Occasional in open marl and the pond.

Cosmarium repandum forma minor W. & G. S. West. Occasional in cattail marshes.

Cosmarium Seelyanum Wolle. Frequent in the pond; a rare species. Det. by G. W. Prescott.

Cosmarium sexangulare forma **minima** Nordst. Occasional in cold spring brooks.

Cosmarium speciosum var. **biforme** Nordst. Rare in open marl.

Cosmarium speciosum var. **simplex** Nordst. Rare in open marl.

Cosmarium subcostatum Nordst. Rare in Black Creek.

Cosmarium subcostatum forma **minor** W. & G. S. West. Frequent in the pond and cattail marshes, occasional in pools in hardwoods.

Cosmarium subcrenatum Hantzsch. Occasional in the pond, open marl and *Carex riparia* marsh.

Cosmarium Subcucumis Schmidle. Occasional in pools in hardwoods.

Cosmarium subprotumidum Nordst. forma. Occasional in cattail marshes. In granulation and form this species resembles Fig. 22, Plate 86, Volume III of West & West (1908).

Cosmarium Turpinii Breb. Frequent in cattail marsh and the pond.

Cosmarium Turpinii var. **podellicum** Gutw. Occasional in the pond.

Cosmarium undulatum var. **minutum** Wittr. Occasional in open marl.

Cosmarium vexatum West. Frequent in cattail marsh and occasional in Thuja swamp, in pools in hardwoods, and cold spring brooks.

Closterium Nitzsch, 1817.

Closterium acerosum (Schrank) Ehrenb. Frequent in the pond, Black Creek and in pools in hardwoods.

Closterium Ehrenbergii Menegh. Frequent in the pond.

Closterium gracile Breb. Rare in cattail marsh.

Closterium intermedium Ralfs. Rare in pools in hardwoods.

Closterium lanceolatum Kuetz. Rare in the pond.

Closterium Leibleinii Kuetz. Common in the pond, pools in hardwoods, cattail marshes and Black Creek.

Closterium moniliferum (Bory) Ehrenb. Common in the pond and scarcer in Black Creek and pools in hardwoods.

Closterium parvulum Naeg. Occasional in Black Creek, cattail marshes, and open marl.

Closterium Pritchardianum Arch. Rare in the pond.

Closterium pronum Breb. Rare in open marl.

Closterium siliqua W. & G. S. West. Rare in Black Creek. This species was twice as broad as the description in West & West (1904).

Closterium strigosum Breb. Rare in pools in hardwoods.

Closterium striolatum Ehrenb. Rare in pools in hardwoods.

Closterium Venus Kuetz. Frequent in pools in hardwoods and rare in Black Creek, cattail marshes and *Carex riparia* marsh.

Desmidium Agardh, 1825.

Desmidium Aptogonum Breb. Rare in pools in hardwoods.
Desmidium Swartzii Agardh. Infrequent in cattail marsh.

Euastrum Ehrenberg., 1832; emend., Ralfs., 1844.

Euastrum bidentatum Naeg. Rare in pools in hardwoods.
Euastrum binale forma **secta** Turn. Rare in pools in hardwoods.
Euastrum crassicolle Lund. Rare in pools in hardwoods.
Euastrum humerosum Ralfs. Rare in pools in hardwoods.
Euastrum sublobatum Breb. Rare in pools in hardwoods.
Euastrum pinnatum Ralfs. Rare in pools in hardwoods. This species resembles that figured in West & West (1905) but differs in the apical region. The apical sinus is deep and open and the two apical lobes are broad and retuse. The two outer angles are sharp and divergent while the two inner angles are broadly rounded. Length of cell 84 microns, breadth of cell 55 microns, breadth of isthmus 10 microns.

Gymnozyga Ehrenberg, 1841.

Gymnozyga moniliformis Ehrenb. Rare in pools in hardwoods.

Hyalotheca Ehrenberg, 1841.

Hyalotheca dissiliens (Smith) Breb. Rare in pools in hardwoods.

Micrasterias Agardh, 1827.

Micrasterias Sol (Ehrenb.) Kuetz. Rare in pools in hardwoods.

Penium de Brebisson, 1844.

Penium Libellula var. **intermedium** Roy & Biss. Rare in creek just below the pond.

Pleurotaenium Naeg., 1849.

Pleurotaenium Trabecula (Ehrenb.) Naeg. Rare in creek just below the pond.

Spondylosium de Brebisson, 1844.

Spondylosium tetragonum West. Rare in pools in hardwoods.

Staurastrum Meyen, 1829.

Staurastrum alternans Breb. Occasional in cattail marshes.
Staurastrum avicula Breb. Rare in pools in hardwoods.
Staurastrum gladiosum Turn. Rare in pools in hardwoods.
Staurastrum cyrtocerum Breb. Rare in pools in hardwoods.
Staurastrum dejectum Breb. Occasional in cattail marshes.

Staurastrum disputatum W. & G. S. West. Occasional in cattail marshes.

Staurastrum gracile var. **nanum** Wille. Occasional in pools in hardwoods and in cattail marshes.

Staurastrum furcigerum forma **eustephana** (Ehrenb.) Nordst. Infrequent in cattail marsh.

Staurastrum hirsutum Breb. Rare in pools in hardwoods.

Staurastrum inconspicuum Nordst. Rare in pools in hardwoods.

Staurastrum orbiculare Ralfs. (var.) Rare in pools in hardwoods. This species corresponds to the description in West & West (1911) but is smaller.

Staurastrum polymorphum Breb. Occasional in the pond.

Staurastrum striolatum (Naeg.) Arch. Occasional in pond.

Xanthidium Ehrenberg, 1837.

Xanthidium cristatum Breb. Rare in pools in hardwoods.

CLASS III. — RHODOPHYCEAE

Order 1. Nemalionales

FAMILY 1. CHANTRANSIACEAE

Audouinella Bory, 1823.

Audouinella violacea var. **expansa** (Wood) G. M. Smith. Rare in the area but abundant on the sluice below the pond.

FAMILY 2. BATRACHOSPERMACEAE

Batrachospermum Roth, 1797.

Batrachospermum Boryanum Sirod. Occasional in spring brooks. Determined by H. Skuja.

Batrachospermum ectocarpoideum Skuja. With *B. boryanum* Sirod. in spring brooks.

Batrachospermum moniliforme Roth. Occasional in spring brooks.

CLASS IV. — HETEROKONTAE

Order 1. Heterococcales

FAMILY 1. CHLOROTHECIACEAE

Characiopsis Borzi, 1895.

Characiopsis pyriformis (A. Br.) Borzi. Rare in cattail marsh.

FAMILY 2. OPHIOCYTIACEAE

Ophiocytium Naeg., 1849.

Ophiocytium cochleare (Eichw.) A. Braun. Occasional in Black Creek and the pond.

Ophiocytium majus Naegeli. Frequent in cattail marsh, the pond and hardwoods.

Ophiocytium parvulum (Perty) A. Braun. Occasional in cattail marsh.

Order 2. Heterotrichales

FAMILY 3. TRIBONEMATACEAE

Tribonema Derbes & Solier, 1856.

Tribonema bombycinum (Ag.) Derbes & Solier. Common in cattail marsh and temporary pools.

Tribonema minus (Wille) Hazen. Frequent in spring brooks.

Tribonema utriculosum (Kuetz.) Hazen. Common in pools and hardwoods.

Order 3. Heterosiphonales

FAMILY 4. BOTRYDIACEAE

Botrydium Wallroth, 1815.

Botrydium granulatum (L.) Grev. Infrequent along Black Creek.

CLASS V. — CHRYSOPHYCEAE

Order 1. Chrysomonadales

FAMILY 1. OCHROMONADACEAE

Dinobryon Ehrenberg, 1835.

Dinobryon sertularia Ehrenb. Infrequent in open marl.

Dinobryon sociale Ehrenb. Frequent and widespread in ponds and pools.

CLASS VI. — DINOPHYCEAE

Order 1. Gymnodiniales

FAMILY 1. GYMNODINIACEAE

Gymnodinium Stein, 1883; emend., Kofoid & Swezy, 1921.

Gymnodinium albulum Lindem. Occasional but seasonal (January) in open marl pools.

FAMILY 2. HETERODINIACEAE

Ceratium Schrank, 1793.

Ceratium hirundinella (O. F. M.) Schrank. Common in the pond.

CLASS VII. — EUGLENOPHYCEAE

Order 1. Euglenales

FAMILY 1. EUGLENACEAE

Euglena Ehrenberg, 1838.

Euglena chlamydophora Mainx. Frequent in cow tracks near spring brook.

Euglena deses var. **tenuis** Lemmermann. Frequent in cow tracks near spring brook.

Euglena fundoversata L. P. Johnson. Occasional in cattail marsh.

Euglena granulata Klebs. Occasional in slough near Black Creek.

Euglena intermedia Klebs. Occasional in cow tracks near spring brook; cattail marsh, and open marl.

Euglena oxyuris Schmarda. Infrequent in cattail marsh.

Euglena pisciformis Klebs. Frequent in cow tracks near spring brook.

Euglena viridis Ehrenb. Frequent in cow tracks near spring brook.

Phacus Dujardin, 1841.

Phacus longicauda (Ehrenb.) Duj. Occasional in cattail marsh.

Phacus pleuronectes (O. F. M.) Duj. Occasional in cattail marsh and Black Creek.

Phacus pyrum (Ehrenb.) Stein. Occasional in cattail marsh.

Phacus sp. Occasional in cattail marsh. This material has smooth walls and closely resembles *P. orbicularis* Hubner but is much smaller.

Trachelomonas Ehrenberg, 1833.

Trachelomonas hispida var. **punctata** Lemm. Common in cattail marsh, *Carex riparia* marsh.

Trachelomonas volvocina Ehrenb. Common in cattail marsh, *Carex riparia* marsh.

CLASS VIII. CHAROPHYTA

Order 1. Charales

FAMILY 1. CHARACEAE

Chara Vaillant, 1753.

Chara contraria A. Br. Widespread and common in marl pools and spring brooks.

SUMMARY

This study in the algae of Bergen Swamp is based upon numerous collections from the various habitats represented in the swamp during the period 1946–1949. The diverse habitats found in Bergen Swamp favor the establishment there of species in many different genera of algae. Observations on some of the environmental factors which control the distribution of algae indicate the importance of temperature, light, topography, pH reaction, substratum and winds especially as they affect the water within which most of the algae grow. The number of species and varieties recorded from each habitat area in Bergen Swamp is as follows:

1.	Black Creek	48
2.	Spring Brooks	45
3.	The Pond	71
4.	Cattail Marsh	120
5.	Carex riparia Marsh	12
6.	Hardwood Swamp	63
7.	Thuja Swamp	26
8.	Open marl area	84

The larger genera, represented in Bergen Swamp by 10 or more species, are the following:

Cosmarium, 36	Closterium, 14
Oscillatoria, 18	Staurastrum, 13
Spirogyra, 16	Oedogonium, 10

These species are not necessarily those which make up the quantitative bulk of the algal flora. Some of the species of *Cosmarium,* for example, are represented by only a few individuals.

Some of the less common species found in Bergen Swamp include: *Platydorina caudata, Gloeotaenium Loitlesbergerianum, Dichotomosiphon tuberosus, Cosmarium Seelyanum,* and *Gymnodinium albulum.*

A total of 342 species of algae was found in Bergen Swamp. These represent 111 genera in 42 families. The various classes are unevenly represented as is indicated in the following summary.

Class	Families	Genera	Species
Myxophyceae	7	27	100
Chlorophyceae	25	72	214
Rhodophyceae	2	2	4
Heterokontae	4	4	8
Chrysophyceae	1	1	2
Dinophyceae	2	2	2
Euglenophyceae	1	3	14
Charophyta	1	1	1
Totals	43	112	345

To the above total may be added 240 species of diatoms (Hohn, 1950) making a grand total of 585 species of algae found in Bergen Swamp to date. Future collecting will undoubtedly disclose still other species in this area.

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THE VEGETATION OF BERGEN SWAMP*

V. The Diatoms (Bacillarieae)

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Diatoms are unicellular plants, either free or colonial, that have a world wide distribution in both salt and fresh water. Certain genera, especially those in the Centrales, are composed mostly of marine species while a great majority of the genera in the Pennales are found in fresh water. Marine forms may also be found in salt ponds, in brackish water, or in maritime marshes.

Diatoms may be found as free unicellular organisms, that are pelagic in habit, or they may be epiphytic on filamentous algae or on submerged parts of vascular plants. A large number of species are colonial and form gelatinous masses attached to submerged plants or other objects that may be present.

The walls of the diatom cells are quite durable and persist long after death. These dead walls—the frustules—may accumulate on the bottom of a pond as "diatomaceous earth". The diatom walls are composed of two overlapping parts—the valves—which fit together somewhat like the two parts of a pill box. These valves are composed largely of silicaceous material and are provided with markings—ridges, grooves, and punctae in definite patterns—the sculpturing.

Material, abundant with living diatoms, may most easily be collected in the early spring or late fall since these organisms grow most readily in cool water. Plants that are submerged in water and covered with a slimy gelatinous material or filaments of algae that may be present will yield a wealth of diatoms. Plankton material may most easily be collected by the use of a plankton net made of a No. 20 silk bolting cloth. The collected material may be preserved in a 5% solution of formalin for an indefinite period.

Since diatoms are identified by the characteristic markings of their silicified cell walls, everything except these cell walls must be removed; this is called cleaning of diatoms. The methods used for cleaning diatoms may be found by consulting Van Heurck (1896). The cleaned diatoms are then mounted in hyrax or some other medium that has a high index of refraction and examined under the microscope.

Collections have been made in Bergen Swamp from 1945 to 1949 by Dr. Walter C. Muenscher of Cornell University and by myself. It has been possible to visit the swamp frequently throughout the year and to secure

* Part I under this title, The Vascular Plants, by Walter C. Muenscher (Proc. Roch. Acad. Sci., 9:64–117, 1946) includes a general discussion of Bergen Swamp, N. Y.

many gatherings during each season. Collections were made and labeled according to the habitat in the swamp as described by Muenscher (1946). It is from these gatherings that the material for this study was taken.

Specimens of nearly all the species found were mounted on prepared slides and deposited in the Department of Botany at Cornell University, Ithaca, New York.

I wish to thank Dr. Walter C. Muenscher of Cornell University who made many of the collecting trips possible and for his aid throughout this study. I should like also to acknowledge the aid of Dr. Paul S. Conger of the Smithsonian Institution, Washington, D. C. for verifying the identification of certain specimens.

SUMMARY

This study has revealed a total of 240 species and varieties of diatoms representing 38 genera in 13 families. The Pennales are represented by 230 species and the Centrales by only 10 species.

The genera with the greatest number of representatives are as follows: *Navicula,* 33; *Nitzschia,* 24; *Pinnularia,* 20; *Gomphonema,* 19; *Cymbella,* 17; *Synedra,* 15. The remainder of the genera are represented by less than 10 species with *Coscinodiscus, Rhizosolenia, Asterionella, Tabellaria, Rhoicosphenia, Amphipleura, Frustulia, Tropidoneis, Achnanthidium,* and *Campylodiscus* having only one representative each.

Several brackish water forms namely: *Tropidoneis lepidoptera* (Greg.) Cleve., *Navicula integra* (W. Smith) Ralfs., *Nitzschia tryblionella* var. *levidensis* (W. Smith) Grun., *Nitzschia tryblionella* var. *victoriae* Grun., *Cyclotella Kutzingiana* Thwaites., *Cyclotella striata* (Kutz.) Grun. were found in the marshy area at the head of the pond at the west end of the swamp. This is the only area in the swamp that shows any indication of a brackish water condition.

ANNOTATED CATALOGUE OF DIATOMS—(BACILLARIEAE)* IN BERGEN SWAMP

CLASS — BACILLARIEAE

Order I — Centrales

Suborder 1 — Coscinodisceneae

FAMILY 1 — COSCINODISCACEAE

Cyclotella Meneghiniana Kütz. Common throughout the swamp.
Cyclotella Kützingiana Thw. Frequent in marsh near west end.
Cyclotella striata (Kütz.) Grun. Frequent in marsh near west end.
Melosira crenulata Kütz. Common in pools in hardwoods and Carex riparia swamp.
Melosira granulata (Ehr.) Ralfs. Widespread and common.
Melosira granulata var. **angustissima** Müll. Common in pond at west end.
Melosira italica (Ehr.) Kütz. Frequent in pools in hardwoods.
Melosira varians Ag. Widespread and common.
Coscinodiscus subtilus Ehr. Rare in arbor-vitae swamp.

Suborder 2 — Rhizosolenineae (Solenoidineae)

FAMILY 2 — RHIZOSOLENIACEAE

Rhizosolenia eriensis H. L. Smith. Rare in pond at west end of swamp, mainly plankton.

Order II — Pennales

Suborder 1 — Fragilarineae

FAMILY 1 — FRAGILARIACEAE

Asterionella formosa Hassell. Abundant in pond at the west end, mainly plankton.
Fragilaria capucina Desmaz. Frequent in Black Creek.
Fragilaria capucina var. **mesolepta** (Rabh.) Grun. Rare in marsh near west end.
Fragilaria crotonensis Kitton. Widespread and common.
Fragilaria Harrissonii (W. Smith) Grun. Frequent in pools in hardwoods and creek south of Torpy Hill.
Fragilaria Harrissonii var. **rhomboides** Grun. Rare in creek south of Torpy Hill.
Fragilaria lapponica Grun. Widespread and common.
Fragilaria nitzschioides Grun. Frequent in Black Creek.

* The arrangement here follows that used by Boyer (1926–27).

Fragilaria parasitica (W. Smith) Heib. Frequent in Black Creek.

Synedra actinastroides Lemm. Frequent in arbor-vitae swamp.

Synedra acus Kütz. Frequent in hardwood pools and Black Creek.

Synedra acus var. **angustissima** Grun. Frequent in pond at west end and in the Carex riparia and arbor-vitae swamps.

Synedra acus var. **radians** (Kütz.) Hust. Frequent in arbor-vitae swamp.

Synedra aequalis Hust. Common in Black Creek and arbor-vitae swamp.

Synedra affinis var. **fasciculata** (Kütz.) Grun. Common in Black Creek and marsh near west end.

Synedra amphicephala Kütz. Frequent in open marl and pond at west end.

Synedra berolinensis Lemm. Frequent in pools in hardwood.

Synedra biceps W. Smith. Frequent in open marl and pools in hardwoods.

Synedra capitata Ehr. Widespread and common.

Synedra nana Meister. Frequent in arbor-vitae swamp.

Synedra oxyrhynchus Kütz. Widespread and common.

Synedra pulchella (Ralfs.) Kütz. Common in swampy areas and creeks, attached to submerged plants, stones, sticks, etc.

Synedra rumpens Kütz. Common in cattail marsh and pond at west end.

Synedra ulna (Nitzsch.) Ehr. Widespread and common.

FAMILY 2 — TABELLARIACEAE

Tabellaria fenestrata (Lyngb.) Kütz. Frequent in arbor-vitae swamp.

FAMILY 3 — MERIDIONACEAE

Meridion circulare (Grev.) Ag. Widespread and common.

Meridion constricta Ralfs. Frequent in creeks and in pools in hardwoods.

FAMILY 4 — DIATOMACEAE

Diatoma elongatum (Lyngb.) Ag. Common in Black Creek, abundant in pond at west end.

Diatoma vulgare Bory. Widespread and common, forming gelatinous masses on submerged plants, sticks, stones, etc.

Diatoma vulgare var. **breve** Grun. Common in marsh near west end.

Diatoma vulgare var. **ovalis** (Fricke.) Hust. Frequent in pools in hardwoods and arbor-vitae swamp.

Diatoma vulgare var. **productum** Grun. Frequent in pond at west end.

FAMILY 5 — EUNOTIACEAE

Eunotia arcus Ehr. Widespread and common.

Eunotia arcus var. **bidens** Grun. Common in Black Creek and cattail marsh.

Eunotia formica Ehr. Frequent in arbor-vitae swamp.

Eunotia gracilis (Ehr.) Rabh. Widespread and common.

Eunotia kocheliensis O. Müll. Rare in marsh near west end.

Eunotia lunaris (Ehr.) Grun. Common in creeks and ponds at west end.

Eunotia parallela Ehr. Frequent in open marl and arbor-vitae swamp.

Suborder 2 — Achnanthineae

FAMILY 6 — ACHNANTHACEAE

Achnanthes exigua var. **heterovalvate** Krasske. Frequent in Black Creek.

Achnanthes hungarica Grun. Frequent in marsh near west end.

Achnanthes lanceolata (Breb.) Grun. Widespread and common.

Achnanthes lanceolata var. **rostrata** Hust. Frequent in pond at west end.

Achnanthes microcephala (Kütz.) Cleve. Common in arbor-vitae swamp.

Achnanthidium flexellum (Breb.) Kütz. Widespread and common.

Cocconeis pediculus Ehr. Widespread and common.

Cocconeis placentula Ehr. Widespread and common.

Cocconeis placentula var. **lineata** (Ehr.) Cleve. Frequent in Black Creek and pond at west end.

Rhoicosphenia curvata (Kütz.) Grun. Widespread and common.

Suborder 3 — Naviculineae

FAMILY 7 — NAVICULACEAE

Amphipleura pellucida Kütz. Frequent in Carex riparia swamp and creek south of Torpy Hill.

Frustulia vulgaris (Thw.) De Toni. Rare in creek south of Torpy Hill and marsh near west end.

Caloneis alpestris (Grun.) Cleve. Common in Black Creek and arbor-vitae swamp.

Caloneis amphisbaena (Bory.) Cleve. Widespread and common.

Caloneis bacillum (Grun.) Mereschkowsky. Frequent in open marl area.

Caloneis formosa (Greg.) Cleve. Frequent in open marl area.

Caloneis obtusa (W. Smith) Cleve. Common in open marl areas, in pools in hardwoods and Black Creek.

Caloneis Schumanniana var. **biconstricta** Grun. Frequent in arbor-vitae swamp.

Caloneis silicula var. **alpina** Cleve. Frequent in arbor-vitae swamp.

Caloneis silicula var. **truncatula** Grun. Frequent in open marl area.

Caloneis silicula var. **tumida** Hust. Common in Black Creek and arbor-vitae swamp.

Mastogloia Braunii Grun. Widespread and common.

Mastogloia Grevillei W. Smith. Abundant in Black Creek.

Mastogloia Smithii Thwaites. Widespread and common.

Mastogloia Smithii var. **amphicephala** Grun. Common in Black Creek and arbor-vitae swamp.

Diploneis elliptica (Kütz.) Cleve. Common in Carex riparia and arbor-vitae swamps.

Diploneis ovalis (Hilse.) Cleve. Widespread and common.

Anomoeoneis exilis (Kütz.) Cleve. Frequent in arbor-vitae swamp.

Anomoeoneis sculpta (Cleve.) O. Müll. Widespread and common.

Anomoeoneis sphaerophora (Kütz.) Pfitzer. Common in Black Creek and cattail marshes.

Anomoeoneis zellensis (Grun.) Cleve. Rare in arbor-vitae swamp.

Neidium amphigomphus (Ehr.) Pfitzer. Frequent in open marl, Black Creek and marsh near west end.

Neidium affine var. **amphirhynchus** (Ehr.) Cleve. Common in creeks and pond at west end.

Neidium iridis (Ehr.) Cleve. Frequent in marsh near west end.

Neidium iridis fo. **vernalis** Reichelt. Frequent in marsh near west end.

Navicula anglica Ralfs. Frequent in Carex ripara and cattail marsh.

Navicula bacilliformis Grun. Frequent in pond at west end.

Navicula bicapitellata Hust. Frequent in arbor-vitae swamp and pond at west end.

Navicula cryptocephala Kütz. Common in marsh near west end.

Navicula cuspidata Kütz. Widespread and common.

Navicula cuspidata var. **ambigua** (Ehr.) Cleve. Widespread and common.

Navicula dicephala (Ehr.) W. Smith. Common in arbor-vitae swamp.

Navicula elegans W. Smith. Common in pools in hardwoods and Black Creek.

Navicula falisiensis Grun. Common in open marl areas and in pools in hardwoods.

Navicula gracilis Ehr. Frequent in marsh near west end.

Navicula hasta Pantocsek. Widespread and common.

Navicula hungarica Grun. Frequent in Black Creek.

Navicula hungarica var. **capitata** (Ehr.) Cleve. Frequent in Black Creek.

Navicula integra (W. Smith) Ralfs. Frequent in marsh near west end.

Navicula lacustris Greg. Rare in Black Creek.

Navicula lanceolata (Agardh.) Kütz. Frequent in pond at west end, cattail marsh, and Black Creek.

Navicula minima Grun. Common in arbor-vitae swamp.

Navicula muralis Grun. Rare in Black Creek.

Navicula oblonga Kütz. Widespread and common.

Navicula peregrina (Ehr.) Kütz. Frequent in marsh near west end.

Navicula placentula var. **Jenisseyensis** (Grun.) Meister. Widespread and common.

Navicula pupula Kütz. Frequent in Black Creek and arbor-vitae swamp.

Navicula pupula var. **capitata** Hust. Frequent in open marl area.

Navicula radiosa Kütz. Widespread and common.

Navicula Reinhardtii Grun. Frequent in creek south of Torpy Hill.

Navicula rhynchocephala Kütz. Frequent in marsh near west end.

Navicula Rotaeana var. **excentrica** Grun. Rare in pond at west end.

Navicula salinarum Grun. Frequent in creek south of Torpy Hill.

Navicula salinarum var. **intermedia** Grun. Frequent in marsh near west end.

Navicula tuscula (Ehr.) Grun. Frequent in Black Creek, open marl area and in pools in hardwoods.

Navicula vercunda Hust. Frequent in marsh near west end.

Navicula viridula Kütz. Widespread and common.

Navicula vulpina Kütz. Frequent in arbor-vitae swamp.

Pinnularia acrosphaeria Breb. Widespread and common.

Pinnularia dactylus Ehr. Widespread and common.

Pinnularia fasciata Lagerstedt. Frequent in Black Creek.

Pinnularia gibba var. **linearis** Hust. Frequent in open marl area.

Pinnularia gibba var. **subundulata** Meyer. Frequent in arbor-vitae swamp.

Pinnularia gibbula Cleve. Frequent in arbor-vitae swamp and cattail marsh.

Pinnularia gracillima Greg. Frequent in Black Creek.

Pinnularia interrupta W. Smith. Frequent in Black Creek, in pools in hardwoods, and marsh near west end.

Pinnularia legumen Ehr. Frequent in Black Creek and Carex riparia swamp.

Pinnularia limosa Kütz. Widespread and common.

Pinnularia limosa var. **gibberula** Grun. Frequent in arbor-vitae swamp and cattail marsh.

Pinnularia limosa var. **ventricosa** (Ehr.) Donk. Frequent in open marl area and pond at west end.

Pinnularia major Kütz. Widespread and common.

Pinnularia microstauron (Ehr.) Cleve. Frequent in Carex riparia swamp and cattail marsh.

Pinnularia microstauron var. **Brebessonii** (Kütz.) Hust. Frequent in open marl area and arbor-vitae swamp.

Pinnularia molaris Grun. Widespread and common.

Pinnularia nobilis Ehr. Frequent in arbor-vitae swamp.

Pinnularia stomatophora Grun. Frequent in pools in hardwoods, open marl area, and arbor-vitae swamp.

Pinnularia viridis (Nitzsch.) Ehr. Widespread and common.

Pinnularia viridis var. **rupestris** (Hantzsch.) Cleve. Frequent in marsh near west end and Black Creek.

Gyrosigma acuminatum (Kütz.) Cleve. Widespread and common.

Gyrosigma attenuatum (Kütz.) Cleve. Widespread and common.

Gyrosigma Spencerii (Quekett.) Cleve. Frequent in Black Creek and marsh near west end.

Stauroneis acuta W. Smith. Widespread and common.

Stauroneis anceps Ehr. Frequent in pond at west end, open marl area, and creeks.

Stauroneis anceps fo. **lineris** (Ehr.) Cleve. Frequent in open marl area.

Stauroneis phoenicenteron Ehr. Widespread and common.

Stauroneis phoenicenteron var. **amphilepta** (Ehr.) Cleve. Frequent in Black Creek.

Stauroneis pygmaea Krieger. Rare in pond at west end.

Stauroneis Smithii Grun. Frequent in Black Creek and open marl area.

Tropidoneis lepidoptera (Greg.) Cleve. Rare in marsh near west end.

FAMILY 8 — GOMPHONEMATACEAE

Gomphonema acuminatum Ehr. Frequent in pond at west end and cattail marsh.

Gomphonema acuminatum var. **Brebessonii** (Kütz.) Cleve. Common in marshy areas.

Gomphonema acuminatum var. **coronatum** (Ehr.) W. Smith. Widespread and common.

Gomphonema acuminatum var. **turris** (Ehr.) Cleve. Widespread and common.

Gomphonema angustatum (Kütz.) Rabh. Frequent in Black Creek and cattail marsh.

Gomphonema augur Ehr. Frequent in pond at west end.

Gomphonema constrictum Ehr. Common in Black Creek and pond at west end.

Gomphonema constrictum var. **capitatum** (Ehr.) Cleve. Widespread and common.

Gomphonema gracile Ehr. Common in marsh near west end.

Gomphonema intricatum Kütz. Widespread and common.

Gomphonema intricatum var. **pumila** Grun. Frequent in open marl area and cattail marsh.

Gomphonema lanceolatum Ehr. Frequent in marsh near west end.

Gomphonema longiceps fo. **gracilis** Hust. Frequent in pond at west end.

Gomphonema longiceps var. **subclavata** Grun. Common in arbor-vitae swamp.

Gomphonema olivaceum (Lyngbye) Kütz. Widespread and common, forms gelatinous masses on submerged plants, sticks, stones, etc.

Gomphonema parvalum Kütz. Widespread and common.

Gomphonema parvalum var. **micropus** (Kütz.) Cleve. Common in pools in hardwoods.

Gomphonema sphaerophorum Ehr. Common in Black Creek and pond at west end.

Gomphonema vibrio Ehr. Common in Carex riparia swamp and cattail marshes.

FAMILY 9 — CYMBELLACEAE

Amphora halsatica Hust. Frequent in Black Creek.

Amphora ovalis Kütz. Widespread and common.

Cymbella affinis Kütz. Widespread and common.

Cymbella amphicephala Naegeli. Common in pools in hardwoods, Carex riparia swamp and open marl area.

Cymbella angustata (W. Smith) Cleve. Frequent in streams and open marl area.

Cymbella aspera (Ehr.) Cleve. Widespread and common.

Cymbella austriaca Grun. Frequent in open marl area and arbor-vitae swamp.

Cymbella cistula (Hemprich) Grun. Widespread and common.

Cymbella delicatula Kütz. Frequent in open marl area and arbor-vitae swamp.

Cymbella Ehrenbergii Kütz. Rare in marsh near west end.

Cymbella laevis Naegeli. Frequent in open marl area.

Cymbella lanceolata (Ehr.) V. Heurck. Common in Black Creek, Carex riparia swamp and pond at west end.

Cymbella mexicana Ehr. Widespread and common.

Cymbella naviculiformis Averswald. Common in pools in hardwoods and Carex riparia swamp.

Cymbella parva (W. Smith) Cleve. Frequent in arbor-vitae swamp and cattail marsh.

Cymbella prostrata (Berkeley) Cleve. Widespread and common.
Cymbella tumida (Breb.) V. Heurck. Widespread and common.
Cymbella turgida (Greg.) Cleve. Widespread and common, enclosed in gelatinous sheaths attached to submerged objects.
Cymbella ventricosa Kütz. Widespread and common.
Epithemia argus Kütz. Common in Black Creek, open marl area and arbor-vitae swamp.
Epithemia argus var. **longicornus** Grun. Frequent in Black Creek and pond at west end.
Epithemia Muellerii Fricke. Rare in open marl area.
Epithemia sorex Kütz. Abundant in pond at west end.
Epithemia turgida (Ehr.) Kütz. Widespread and common.
Epithemia turgida var. **granulata** (Ehr.) Grun. Rare in Black Creek.
Epithemia zebra (Ehr.) Kütz. Widespread and common.
Epithemia zebra var. **porcellus** (Kütz.) Grun. Frequent in pools in hardwoods and cattail marsh.
Epithemia zebra var. **saxonica** (Kütz.) Grun. Frequent in pools in hardwoods, Black Creek and Carex riparia swamp.
Rhopalodia gibba (Ehr.) O. Müll. Widespread and common.
Rhopalodia gibberula (Ehr.) O. Müll. Rare in marsh near west end.
Rhopalodia parallela (Grun.) O. Müll. Widespread and common.
Rhopalodia ventricosa (Kütz.) O. Müll. Widespread and common.

Suborder 4 — Surirellineae

FAMILY 10 — NITZSCHIACEAE

Denticula elegans Kütz. Widespread and common.
Denticula tenuis var. **frigida** (Kütz.) Grun. Frequent in open marl area.
Nitzschia acicularis W. Smith. Frequent in pond at west end.
Nitzschia acuminata (W. Smith) Grun. Frequent in Black Creek, pond at west end, and cattail marsh.
Nitzschia amphibia Grun. Widespread and common.
Nitzschia angustata (W. Smith) Grun. Frequent in marsh near west end.
Nitzschia apiculata (Greg.) Grun. Frequent in marsh near west end.
Nitzschia commutata Grun. Frequent in marsh near west end.
Nitzschia denticula Grun. Frequent in Black Creek and cattail marsh.
Nitzschia dissipata (Kütz.) Grun. Frequent in pond at west end and creek south of Torpy Hill.
Nitzschia flexa Schumann. Rare in Black Creek.
Nitzschia fonticola Grun. Common in pools in hardwoods, arbor-vitae swamp and pond at west end.

Nitzschia gandersheimiensis Krasske. Common in Black Creek, open marl area and creek south of Torpy Hill.
Nitzschia gracilis Hantzsch. Common in Black Creek and arbor-vitae swamp.
Nitzschia hantzschiana Rabh. Common in open marl area.
Nitzschia holsatica Hust. Frequent in Carex riparia swamp.
Nitzschia hungarica Grun. Common in marsh near west end.
Nitzschia ignorata Krasske. Rare in Black Creek.
Nitzschia obtusa var. **scalpelliformis** Grun. Frequent in Black Creek.
Nitzschia recta Hantzsch. Rare in Black Creek.
Nitzschia sigma (Kütz.) W. Smith. Frequent in marsh near west end.
Nitzschia sigmoidea (Ehr.) W. Smith. Widespread and common.
Nitzschia spectabilis (Ehr.) Ralfs. Widespread and common.
Nitzschia thermalis Kütz. Frequent in marsh near west end.
Nitzschia tryblionella var. **levidensis** (W. Smith) Grun. Frequent in marsh near west end.
Nitzschia tryblionella var. **victoriae** Grun. Frequent in marsh near west end.
Hantzschia amphioxys (Ehr.) Grun. Frequent in Carex riparia swamp, creek south of Torpy Hill, and marsh near west end.
Hantzschia amphioxys var. **major** Grun. Frequent in Black Creek.
Hantzschia elongata (Hantzsch.) Grun. Frequent in Black Creek.
Hantzschia pseudomarina Hust. Frequent in creek south of Torpy Hill.

FAMILY 11 — SURIRELLACEAE

Campylodiscus noricus Ehr. Common in pools in hardwoods and creek south of Torpy Hill.
Cymatopleura elliptica (Breb.) W. Smith. Frequent in Black Creek.
Cymatopleura solea (Breb.) W. Smith. Widespread and common.
Surirella angustata Kütz. Frequent in pools in hardwoods and creek south of Torpy Hill.
Surirella didyma Kütz. Common in creek south of Torpy Hill.
Surirella elegans Ehr. Frequent in arbor-vitae swamp.
Surirella gracilis (W. Smith) Grun. Rare in pond near west end.
Surirella minuta Breb. Frequent in pools in hardwoods and marsh near west end.
Surirella ovata Kütz. Frequent in pools in hardwoods.
Surirella pinnata W. Smith. Frequent in pools in hardwoods.
Surirella rattrayi A. Schmidt. Rare in Black Creek.

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THE VEGETATION OF BERGEN SWAMP

VI. The Fungi

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This, the sixth in a series of papers on the vegetation of Bergen Swamp in Genesee County, New York, consists of a report of the fungi. A general discussion of Bergen Swamp has been presented earlier (Muenscher, 1946). The Myxomycetes known from the Swamp have been reported elsewhere (Muenscher, 1948).

The diversity of habitats and hosts in the Swamp is reflected in the extensive annotated list of fungi and host index here reported.

Most of the collections upon which this report is based were made by the authors between 1944 and 1949. Trips were made into the Swamp during every month of the year. In presenting this first report on the fungi they are aware that future explorations will add other species to the list now known from this area covering approximately five square miles.

The following table presents the classification of fungi as used herein with a statistical summary of the number of genera, species and varieties included in the list. A total number of 616 species and varieties of fungi is recorded for Bergen Swamp in this survey.

The arrangement of the orders and families of the Phycomycetes is essentially that of Fitzpatrick (1930). The Ascomycetes are arranged in a system patterned basically on that in Engler & Prantl (1897), but modifications based on the more recent works of Miller (1941) and Nannfeldt (1932) have been utilized. The systematic arrangement of the Basidiomycetes follows that in Engler & Prantl (1900) with some modifications (Wolf & Wolf, 1947). The Fungi Imperfecti are arranged according to the system used in Clements & Shear (1931) and Engler & Prantl (1900).

Throughout the list the genera are arranged alphabetically under the families, and the species are arranged alphabetically under each genus. Following the species name, the substrate or host is given (in this list, the "host", living or dead, is provided whenever it could be determined), and following this is a citation of the herbarium number of the specimens.

Cited numbers not preceded by a letter indicate that the specimens collected by the authors are deposited in the herbarium of the Department of Plant Pathology, Cornell University. Numbers preceded by "R" are in the personal herbarium of Mr. C. T. Rogerson, and a few, preceded by "K", are in the personal herbarium of Mr. R. P. Korf.

CLASSIFICATION AND STATISTICAL SUMMARY

	Genera	Species	Varieties
Class I. PHYCOMYCETES			
Order 1. Chytridiales			
Family 1. Synchytriaceae	1	2	
2. Cladochytriaceae	2	2	
2. Peronosporales			
3. Albuginaceae	1	4	
4. Peronosporaceae	3	11	
3. Mucorales			
5. Mucoraceae	1	1	
6. Pilobolaceae	1	3	
7. Endogonaceae	1	1	
Total Phycomycetes	10	24	—
Class II. ASCOMYCETES			
Order 4. Taphrinales			
Family 8. Taphrinaceae	1	2	
5. Gymnoascales			
9. Onygenaceae	1	1	
6. Pezizales			
10. Pezizaceae	19	48	
7. Helotiales			
11. Dermateaceae	6	10	
12. Phacidiaceae	4	6	
13. Orbiliaceae	1	2	
14. Hyaloscyphaceae	5	8	
15. Helotiaceae	6	11	
16. Geoglossaceae	4	5	
17. Sclerotiniaceae	1	1	
18. Patellariaceae	1	1	
8. Hysteriales			
19. Hysteriaceae	2	3	
9. Dothideales			
20. Dothideaceae	2	2	
21. Mycosphaerellaceae	1	1	
10. Pseudosphaeriales			
22. Pseudosphaeriaceae	11	15	1
11. Microthyriales			
23. Stigmateaceae	1	1	
24. Microthyriaceae	1	1	
12. Erysiphales			
25. Erysiphaceae	6	17	1
26. Englerulaceae	1	1	
13. Hypocreales			
27. Nectriaceae	2	9	
28. Hypocreaceae	4	6	
14. Sphaeriales			
29. Chaetomiaceae	1	2	
30. Sordariaceae	4	5	
31. Allantosphaeriaceae	3	4	
32. Diaporthaceae	2	7	
33. Phyllachoraceae	1	2	
34. Xylariaceae	4	14	
Total Ascomycetes	95	185	2

	Genera	Species	Varieties
Class III. BASIDIOMYCETES			
Order 15. Ustilaginales			
Family 35. Ustilaginaceae	3	7	
36. Tilletiaceae	1	2	
16. Uredinales			
37. Melampsoraceae	7	14	
38. Pucciniaceae	7	40	12
17. Auriculariales			
39. Auriculariaceae	1	1	
18. Dacrymycetales			
40. Dacrymycetaceae	4	7	
19. Tremellales			
41. Tremellaceae	4	7	
20. Agaricales			
42. Exobasidiaceae	1	1	
43. Thelephoraceae	8	25	
44. Clavariaceae	2	13	
45. Hydnaceae	5	10	
46. Polyporaceae	8	48	
47. Boletaceae	6	7	
48. Agaricaceae	35	112	1
21. Hymenogastrales			
49. Melanogasteraceae	1	1	
22. Lycoperdales			
50. Lycoperdaceae	2	9	
51. Geastraceae	1	2	
23. Sclerodermatales			
52. Sclerodermataceae	1	1	
Total Basidiomycetes	96	306	13
Class IV. Fungi Imperfecti			
Order 24. Sphaeropsidales			
Family 53. Sphaerioidaceae	18	38	1
54. Leptostromataceae	3	6	
25. Melanconiales			
55. Melanconiaceae	7	12	
26. Moniliales			
56. Moniliaceae	5	10	
57. Dematiaceae	7	12	
58. Stilbaceae	2	2	
59. Tuberculariaceae	5	5	
Total Fungi Imperfecti	47	85	1
Total	248	600	16

The authors wish to express their sincere thanks to Professor H. M. Fitzpatrick and Professor D. S. Welch, Department of Plant Pathology, Cornell University, for their aid in identification of several specimens, and especially to Mr. R. P. Korf who has identified or confirmed practically all of the discomycetes (Pezizales & Helotiales). Also, appreciation is expressed to other mycologists, C. Chupp, F. J. Czabator, J. W. Groves, H. S. Jackson, J. L. Lowe, G. W. Martin, P. Neergaard and R. Sprague, who have determined certain specimens referred to them.

The rest of the specimens have been identified by the authors. Every attempt has been made to use the more recent monographs and to compare most of the collections with authentic specimens of each species on deposit in the herbarium of the Department of Plant Pathology, Cornell University. The fleshy Agaricaceae, however, have been identified primarily by comparison with descriptions and illustrations (Atkinson, 1903 and Kauffman, 1918).

The earliest record of a fungus from Bergen Swamp as yet known to the authors is that of Peck (1905). Peck described *Phyllosticta pallidor* Pk. as a new species on *Smilacina* (Vagnera) *stellata*. This fungus is now considered to be a synonym of *Phyllosticta Convallariae* Pers. ex Seaver.

Dearness & House (1925) published *Pleospora herbarum* (Pers. ex Fr.) Rabenh. var. *Triglochinis* Dearn. & House on dead leaves of *Triglochin palustris,* based on a Peck collection from the Swamp.

House visited the area in 1918 and published (House 1921, 1923) three records of fungi from Bergen Swamp:
Didymosphaeria Parnassiae (Pk.) Sacc., *Peniophora Eichleriana* Bres. & *Phialea scutula* (Pers.) Gill. (*Helotium scutula* in this list). The latter has been recollected during this survey, but the others have not been seen in the Swamp nor have the herbarium specimens been seen.

H. H. Whetzel and H. S. Jackson accompanied by E. F. Hopkins and W. C. Muenscher visited the Swamp July 21–22, 1917. Some 41 species, all parasitic forms, were collected by them and deposited in the Cornell Plant Pathology Herbarium. All but 15 of these have been recollected during this survey. In the list, these 15 are cited with Whetzel & Jackson following the herbarium number.

No nomenclatorial changes are made in this paper. In a few cases where the authors feel that a species should belong in another genus, the following system has been adopted: *Pachyella* sp. (Peziza clypeata Schw.)

PHYCOMYCETES

Chytridiales

Synchytriaceae

Synchytrium aecidioides (Peck) Lagerh. On leaves and stems of *Amphicarpa bracteata,* 36486.

Synchytrium Vaccinii Thomas. On the lower leaves of *Vaccinium Oxycoccus,* 37820.

Cladochytriaceae

Physoderma vagans Schröter. On leaves and stems of *Sium suave,* 37621.

Urophlyctis pluriannulatum (Berk. & Curt.) Farl. On leaves, petioles and stems of *Sanicula marilandica,* 37663.

Peronosporales

Albuginaceae

Albugo Bliti (Biv.-Bern) O. Kuntze. On leaves of *Amaranthus retroflexus,* 36726.

Albugo candida (Pers. ex Lév.) O. Kuntze. On leaves of *Capsella Bursa-pastoris,* 36615; *Dentaria diphylla,* R3045; and *Lepidium campestre,* 37629.

Albugo Portulacae (DC.) O. Kuntze. On *Portulaca oleracea* in cultivated field bordering the swamp, 36614.

Albugo Tragopogonis (Pers.) ex S. F. Gray. On *Cirsium arvense,* 9973. (Whetzel & Jackson)

Peronosporaceae

Peronospora Arthuri Farl. On *Oenothera biennis,* 9942. (Whetzel & Jackson)

Peronospora Corydalis De Bary. On *Dicentra canadensis,* 37613.

Peronospora effusa (Grev.) Rabenh. On *Chenopodium album,* 37630.

Peronospora Hydrophylli Waite. On *Hydrophyllum virginianum,* 37757.

Peronospora parasitica (Pers.) Fr. On *Dentaria laciniata,* 37614.

Peronospora Potentillae De Bary. On *Geum canadense,* 9959. (Whetzel & Jackson)

Plasmopara Geranii (Peck) Berl. & DeToni. On *Geranium maculatum,* 37628.

Plasmopara Halstedii (Farl.) Berl. & DeToni. On *Eupatorium rugosum,* 9984. (Whetzel & Jackson)

Plasmopara pygmaea (Ung.) Schröter. On *Anemone canadensis,* 36424.

Plasmopara viticola (Berk. & Curt. ex De Bary) Berl. & DeToni. On *Vitis vulpina,* 36434; and *Parthenocissus* sp., R2233.

Sclerospora graminicola (Sacc.) Schröter. On *Setaria viridis,* 36886.

Mucorales

Mucoraceae

Mucor hiemalis Wehmer. On fox dung, 37386.

Pilobolaceae

Pilobolus crystallinus Tode. On deer dung, 37772.

Pilobolus Kleinii Van Tiegh. On horse dung, pasture along Black Creek, 37296.

Pilobolus umbonatus Buller. On deer dung, 37547.

Endogonaceae

Endogone pisiformis Link. Found only once in October at the tips of *Sphagnum fuscum* in the arbor-vitae woods, 37758.

ASCOMYCETES

Taphrinales

Taphrinaceae

Taphrina Polystichi Mix. On leaves of *Polystichum acrostichoides,* 37626.

Taphrina Robinsoniana Giesenhagen. On pistillate catkins of *Alnus incana,* 36406.

Gymnoascales

Onygenaceae

Onygena equina (Willd.) ex Pers. On old hoofs of cow skeleton, 35382.

Pezizales

Pezizaceae

Aleuria aurantia (Pers. ex Fr.) Fuckel. On the ground about maple stump, 37580.

Ascobolus immersus Pers. ex Fr. On deer dung, R2015.

Ascobolus viridulans Phill. & Plowr. On deer dung, R2464; on dung of grouse, R2972.

Ascophanus isabellinus Clem. On horse dung, 37291.

Ascophanus lacteus (Ck. & Phill.) Sacc. On deer dung, 37140.

Ascophanus ochraceus (Crouan) Boud. On deer dung, R2740.

Caloscypha fulgens (Pers. ex Fr.) Boud. On mossy ground under red maple, 37954.

Discina ancilis (Pers. ex Fr.) Sacc. On rotten log, 36959.

Galactinia brunneo-atra (Desm.) Boud. On the ground, mixed woods, K794.

Galactinia olivacea Boud. non Quélet sensu Grelet. On humus, mixed woods, 37429.

Galactinia praetervisa (Bres.) Boud. On burned-over soil, 37435.

Galactinia proteana (Boud.) Sacc. On burned hemlock duff, 37810.

Galactinia Saccardiana (Cooke) Boud. On the ground, mixed woods, 36449.

Galactinia subumbrina (Boud.) Boud. On the ground in open woods, 36632.

Galactinia succosella Le Gal & Romag. On soil in deciduous woods, 37522.

Galactinia sp. On the ground, mixed woods, K793.

Geopyxis carbonaria (Alb. & Schw. ex Fr.) Sacc. On burned hemlock duff, 37436.

Helvella crispa Scop. ex Fr. On the ground, moist woods, R1163.

Helvella elastica Bull. ex Fr. On the ground, mixed woods, 36629.
Helvella Klotschiana Corda. On the ground, mixed woods, R3088.
Helvella macropus (Pers. ex Fr.) Karst. On the ground, woods, 36631.
Helvella palustris Peck. On mossy ground, frondose woods, 36630.
Helvella sphaerospora Peck. On rotten log, 36935.
Helvella sp. On rotten log, R1256.
Humarina aggregata (Berk. & Br.) Seaver. On soil among mosses, R2855.

Humarina orthotricha (Cke. & Ell.) Seaver. Among mosses, 37438.

Humarina rufa (Pers.) Seaver (Humaria rubricosa (Fr.) Sacc.). On burned hemlock duff, 37811.

Lasiobolus longisetosus Povah. On deer dung, 37518.

Lasiobolus ruber (Quél.) Sacc. On deer dung, 37549.

Lasiobolus sp. On dung of large animal, 37439.

Morchella angusticeps Peck. On the ground, mixed woods, 37993.

Morchella crassipes Pers. ex Fr. On the ground, moist frondose woods, R1501.

Morchella esculenta Pers. ex Fr. On the ground, moist frondose woods, 37581.

Morchella semilibera Fr. On the ground, mixed woods, 37585.

Otidea grandis (Fr.) Rehm. On humus and mosses, 36532.

Pachyella sp. (*Peziza clypeata* Schw.) On rotten log of *Tilia americana*, 36692; and moss covered log of *Prunus serotina*, 37254.

Peziza repanda Pers. ex Fr. On rotten log, frondose woods, 36639.

Peziza sylvestris (Boud.) Sacc. & Trott. On rotten log of *Acer* sp., 37433; on the ground, under *Thuja*, R2327.

Peziza vesiculosa Bull. ex Fr. On the ground, moist woods, 36634.

Plectania coccinea (Scop. ex Fr.) Fuckel. On decaying twigs, among duff, 37548.

Pseudoplectania nigrella (Pers. ex Fr.) Fuckel. On log of *Tsuga canadensis*, R2322.

Rhizina undulata Fr. On burned hemlock duff. 38031.

Ryparobius sexdicimsporus (Crouan.) Sacc. On fox dung, R1986.

Scutellinia hemisphaerica (Weber ex Fr.) Kuntze. On the ground, under hemlock, R970.

Scutellinia Lusatiae (Cooke) Kuntze sensu Seaver non Le Gal. On rotten log, 36433.

Scutellinia scutellata (L. ex Fr.) Kuntze. On rotten frondose logs, R555.

Scutellinia setosa (Nees. ex Fr.) Kuntze. On rotten log, 36495.

Scutellinia sp. On rotten log of *Acer* sp., K1491.

Helotiales

Dermateaceae

Belonium bryogenum (Peck) Rehm. On mosses mixed with *Cladonia* sp., R3212.

Belonopsis sp. On dead stalks of *Leersia oryzoides,* 37521.

Dermea acerina (Peck) Rehm. On dead *Acer rubrum,* 37826.

Mollisia melaleuca (Fr.) Sacc. On decaying wood, 37550.

Mollisia sp. On rotten wood, K1504.

Pezicula carpinea (Pers.) Tul. On dead *Carpinus caroliniana,* 37881.

Pezicula cinnamomea (DC. ex Fr.) Sacc. On dead branch of *Quercus* sp., 37575. (Det. by J. W. Groves)

Tapesia fusca (Pers. ex Fr.) Fuckel. On wood and bark, 37520.

Tapesia melaleucoides Rehm. On rotten log, 37809.

Tapesia sp. On fallen twig, 37519.

Phacidiaceae

Coccophacidium Pini (Fr.) Rehm. On trunk of living *Pinus Strobus,* 37589.

Lophodermium nitens Darker. On fallen leaves of *Pinus Strobus* in sphagnum, 37882.

Lophodermium sphaerioides (Alb. & Schw. ex Fr.) Duby. On fallen leaves of *Ledum groenlandicum,* R2427.

Propolis faginea (Schrad.) Karst. On decorticated log, 36964.

Rhytisma acerinum Pers. ex Fr. On leaves of *Acer rubrum,* 36662; *Acer saccharinum,* R1300.

Rhytisma punctatum Pers. ex Fr. On leaves of *Acer spicatum,* 36655.

Orbiliaceae

Orbilia xanthostigma Fr. On dead branches of *Cephalanthus occidentalis,* 37288; on old sporophores of *Daedalea* sp., R2844.

Orbilia sp. On very rotted wood, K1489.

Hyaloscyphaceae

Arachnopeziza aurata Fuckel. On wood and bark, 37517.

Cistella sp. On decorticated wood, 37750.

Erinella miniopsis (Ellis) Sacc. On living trunk of *Acer rubrum,* 37590.

Hyaloscypha sp. On rotten wood, 37524.

Lachnum Britzelmayrianum (Rehm) Rehm. On rotten log. R3055.

Lachnum fuscescens (Pers.) Karst. On fallen leaves of *Ledum groenlandicum,* R2282.

Lachnum pudibundum (Quel.) Schröt. On herbaceous stem, 37523.

Lachnum virgineum (Batsch ex Fr.) Karst. On rotten log of *Acer* sp., 37817.

Helotiaceae

Cenangium salicellum Höhn. On dead twigs of *Salix discolor,* R2895. (Det. by J. W. Groves.)

Chlorociboria aeruginascens (Nyl.) Kanouse. On rotten log, 37193.

Chlorociboria aeruginosa (Oed. ex Fr.) Seaver. On rotten log, 37290.

Chlorociboria versiformis (Pers. ex Fr.) Seaver. On rotten log, 37289.

Coryne sarcoides (Jacq. ex Fr.) Tul. On hardwood stump, 36633.

Encoelia furfuracea (Fr.) Karst. On dead branches of *Alnus incana,* 36902.

Helotium citrinum (Hedw. ex Fr.) Fr. On hardwood log, 36670.

Helotium ?indeprensum Bizz. On fallen leaves of *Thuja occidentalis,* K790.

Helotium scutula (Pers. ex Fr.) Karst. On dead stems of *Solidago* sp., 37287; on dead stems of *Polymnia canadensis.* (Reported by House, 1921.)

Helotium caudatum (Karst.) Vel. On fallen leaves of *Myrica pennsylvanica,* R2752.

Holwaya leptosperma (Peck) Durand. On log of *Tilia americana,* 36691.

Geoglossaceae

Geoglossum glabrum Pers. ex Fr. On moss-covered log, 36649.

Geoglossum nigritum (Fr.) Cooke. On the ground under *Thuja* and *Tsuga,* 36907.

Leotia viscosa Fr. On the ground, mixed woods, 37250.

Microglossum rufum (Schw.) Underw. On mossy ground, mixed woods, 37179.

Trichoglossum hirsutum (Pers. ex Fr.) Boud. On the ground under *Thuja* and *Tsuga,* 36909.

Sclerotiniaceae

Sclerotinia sclerotiorum (Lib.) De Bary. On the ground under *Cornus alternifolia,* 37434.

Patellariaceae

Karschia lignyota (Fr.) Sacc. On log of *Ulmus* sp., 37851.

Hysteriales

Hysteriaceae

Hysterium angustatum (Alb. & Schw. ex Fr.) Chev. On decorticated branch of *Fraxinus nigra,* 37919.

Hysterographium gloniopsis (Gerard) Ell. & Ev. On decorticated wood, 37420.

Hysterographium Mori (Schw.) Rehm. Quite common on decorticated logs, 36826; on decorticated portion of dead *Acer rubrum,* R2944.

Dothideales

Dothideaceae

Dothidea Linderae Gerard. On dead twigs of *Lindera Benzoin,* 37920.

Rosenscheldia Heliopsidis (Schw.) Höhn. On dead stems of *Aster novae-angliae,* R2214.

Mycosphaerellaceae

Mycosphaerella Sarraceniae (Schw.) House. On dead leaves of *Sarracenia purpurea,* 37584.

Pseudosphaeriales

Pseudosphaeriaceae

Bertia moriformis (Tode ex Fr.) De Not. On rotten log, 37377.

Cryptomycina Pteridis (Rebent. ex Fr.) Höhn. On leaves of *Pteridium aquilinum* var. *latiusculum,* 38021.

Dibotryon morbosum (Schw. ex Fr.) Theiss. & Syd. On branches of *Prunus virginiana,* 36448; and *Prunus domestica,* in field along north edge of swamp, R1277.

Didymosphaeria brunneola Niessl. On dead stems of *Apocynum cannabinum,* 37884.

Didymosphaeria Parnassiae (Pk.) Sacc. On dead stems of *Parnassia caroliniana.* (Reported by House, 1921.)

Lasiosphaeria hispida (Tode ex Fr.) Fuckel. On log of *Fagus grandifolia,* 37777.

Lasiosphaeria ovina (Pers. ex Fr.) Ces. & De Not. On log of *Fagus grandifolia,* 37778.

Leptosphaeria clavigera (Cke. & Ell.) Sacc. On dead stems of *Phytolacca americana,* 37990.

Leptosphaeria doliolum (Pers. ex Fr.) De Not. On dead stems of *Daucus Carota,* 37974.

Leptosphaeria Michotii (West.) Sacc. On dead culms of *Juncus balticus* var. *littoralis,* 37852.

Leptosphaeria sp. (*Diaporthe albocarnis* Ell. & Ev.). On dead twigs of *Cornus alternifolia,* R2925.

Melanomma pulvi-pyrius (Pers. ex Fr.) Fuckel. On canker of trunk of *Acer saccharum,* 37378.

Nitschkia Fuckelii Nitsche. On dead *Acer rubrum,* 37881.

Ophiobolus cariceti (Berk. & Br.) Sacc. On dead culms of *Elymus virginicus,* 38029.

Pleospora herbarum (Pers. ex Fr.) Rabenh. var. **Triglochinis** Dearn. and House. On dead leaves of *Triglochin palustris*. (Reported by House, 1921.)

Venturia inaequalis (Cooke) Wint. On leaves of *Pyrus Malus*, 36437 (conidial stage).

Microthyriales

Stigmateaceae

Stigmatea Robertiani Fr. On the basal, overwintering leaves of *Geranium Robertianum*, 37537.

Microthyriaceae

Asterina Gaultheriae M. A. Curtis. On leaves of *Gaultheria procumbens*, 37885.

Erysiphales

Erysiphaceae

Erysiphe Cichoracearum DC. On *Ambrosia artemisiifolia*, R2742; *Aster macrophyllus*, 36709 (conidial stage); *Aster novae-angliae*, 36560 (conidial stage); *Aster prenanthoides*, 36542; *Aster umbellatus*, 36608 (conidial stage); *Eupatorium perfoliatum*, R1208 (conidial stage); *Eupatorium maculatum*, 36887 (conidial stage); *Helenium autumnale*, 36725 (conidial stage); *Inula Helenium*, 36592; *Mentha arvensis*, var. *canadensis*, R1305 (conidial stage); *Prenanthes alba*, 37787; *Rudbeckia hirta*, 36713 (conidial stage); *Rudbeckia laciniata*, 36609 (conidial stage); *Solidago canadensis*, 36559 (conidial stage); *Solidago serotina*, 36607; *Tanacetum vulgare*, R1195 (conidial stage); *Xanthium orientale*, 36710.

Erysiphe Galeopsidis DC. On *Chelone glabra*, 36623; *Stachys tenuifolia* var. *aspera*, 36711; *Verbena urticaefolia*, 36712.

Erysiphe lamprocarpa (Wallr.) Duby. On *Plantago major*, 36714.

Erysiphe Polygoni DC. On *Anemone canadensis*, 36604; *Aquilegia canadensis*, 36558 (conidial stage); *Ranunculus recurvatus*, 36438 (conidial stage); *Ranunculus septentrionalis*, 36606; *Trifolium pratense*, R1203 (conidial stage).

Microsphaera abbreviata Peck. On *Quercus bicolor*, 36708.

Microsphaera Alni (DC.) Wint. On *Alnus incana*, 37427; *Lonicera dioica*, 36535 (conidial stage); *Lonicera oblongifolia*, R576 (conidial stage); *Rhamnus alnifolia*, 37785; *Rhododendron nudiflorum* var. *roseum*, 36706; *Viburnum Lentago*, 36705.

Microsphaera Evonymi (DC.) Sacc. sensu Blumer. On *Evonymus atropurpureus*, 36603.

Microsphaera Grossulariae (Wallr.) Lév. On *Sambucus canadensis,* 36707.

Microsphaera Vaccinii (Schw.) Cooke & Peck. On *Gaylussacia baccata,* 36704.

Phyllactinia corylea Pers. ex Karst. On *Alnus incana,* 36717; *Celastrus scandens,* 36718.

Podosphaera Oxyacanthae (DC.) De Bary. On *Prunus virginiana,* 36727.

Sphaerotheca Humuli (DC.) Burr. On *Geum aleppicum* var. *strictum,* 38036.

Sphaerotheca Humuli (DC.) Burr. var. **fuliginea** (Schlecht.) Salmon. On *Bidens cernua,* 36715; *Veronica longifolia,* 36716.

Sphaerotheca macularis (Wallr.) Jacz. On *Agrimonia gryposepala,* 36605; *Rubus pubescens,* 36534.

Uncinula circinata Cooke & Peck. On *Acer spicatum,* 36654.

Uncinula Clintonii Peck. On *Tilia americana,* 37256.

Uncinula necator (Schw.) Burr. On *Parthenocissus quinquefolia,* 36702.

Uncinula Salicis (DC.) Wint. On *Populus candicans,* 36541; *Salix sericea,* 36540.

Englerulaceae

Schiffnerula pulchra (Sacc.) Petrak. On leaves of *Cornus stolonifera,* 36888.

Hypocreales

Nectriaceae

Hypomyces aurantius (Pers. ex Fr.) Tul. On pore surface of *Daedalea confragosa,* R2013.

Hypomyces chrysospermus (Bull. ex Fr.) Tul. On decaying *Boletus* sp., 37252 (sepedonium stage).

Hypomyces viridis (Alb. & Schw. ex Fr.) Berk. & Br. On gills of *Russula* sp., R2301.

Nectria atrofusca (Schw.) Ell. & Ev. On dead twigs of *Carpinus caroliniana,* 37808.

Nectria cinnabarina Tode ex Fr. On dead branches of *Rhus typhina,* 36905 (conidial stage); on dead twigs of *Ulmus americana,* R2914 (conidial stage).

Nectria coccinea Pers. ex Fr. On dead branch of *Fagus grandifolia,* 36734.

Nectria episphaeria Tode ex Fr. On *Diatrype stigma,* 37586; and on *Hypoxylon cohaerens,* R2869.

Nectria Pezizae Tode ex Fr. On decaying *Polyporus squamosus,* 38027.

Nectria sp. On mats of *Vaucheria* sp. in moist depressions, 37958.

Hypocreaceae

Creopus gelatinosa (Tode ex Fr.) Link. On a rotten log, mixed woods, 37195.

Claviceps nigricans Tul. On *Eleocharis rostellata*, 36613 (conidial stage).

Claviceps purpurea (Fr.) Tul. On *Agropyron repens*, 36612 (conidial stage).

Epichloe typhina (Pers. ex Fr.) Tul. On *Glyceria striata*, 36404.

Hypocrea aurantiaca Peck. On the pore surface of *Polyporus* sp., R2795.

Hypocrea patella Cooke & Peck. On rotten wood, 37194.

Sphaeriales

Chaetomiaceae

Chaetomium globosum Kunze. Obtained on filter paper from fox dung, 37573.

Chaetomium murorum Corda. On deer dung. R2974.

Sordariaceae

Bombardia arachnoidea (Niessl.) R. F. Cain. On horse dung, R2332.

Hypocopra merdaria (Fries) Fr. On rabbit dung, R2960.

Sordaria appendiculata Auersw. On rabbit dung, R3020.

Sordaria fimicola (Rabenh.) Ces. & De Not. Obtained on filter paper from deer dung culture, R2202.

Sporormia americana D. Griffiths. On rabbit dung, R2014.

Allantosphaeriaceae

Diatrype stigma Hoffm. ex Fr. On dead branches of *Acer* sp., 36954; and *Fraxinus* sp., R1572.

Eutypa spinosa (Pers.) ex Tul. On rotten wood, 37591.

Eutypella cerviculata (Fr.) Sacc. On dead *Carpinus caroliniana*, 37887.

Eutypella Radula (Pers. ex Fr.) Ell. & Ev. On dead twigs of *Populus tremuloides*, 37542.

Diaporthaceae

Gnomonia veneta (Sacc. & Speg.) Kleb. On leaves of *Quercus bicolor*, 36510 (conidial stage); and on *Platanus occidentalis*.

Valsa ceratophora Tul. On dead *Acer rubrum*, 37923.

Valsa Cornina Peck. On dead twigs of *Cornus rugosa*, 37916.

Valsa leucostoma (Pers.) ex Fr. On dead twigs of *Prunus serotina*, 37888.

Valsa nivea (Hoffm.) ex Fr. On dead twigs of *Populus tremuloides*, 37544.

Valsa Pini Alb. & Schw. ex Fr. On dead trunk of *Pinus Strobus*, 37775.

Valsa translucens De Not. On dead twigs of *Salix Bebbiana*, 36825.

Phyllachoraceae

Phyllachora graminis (Pers. ex Fr.) Fuckel. On leaves of *Asprella Hystrix*, 36539; and *Elymus virginicus*, 36890.

Phyllachora vulgata Theissen & Syd. On leaves of *Muhlenbergia racemosa*, 36611.

Xylariaceae

Daldinia concentrica (Bolt. ex Fr.) Ces. & De Not. On dead branches of *Betula lutea*, 38016.

Hypoxylon coccineum Bull. ex Fr. On dead *Fagus grandifolia*, 37389; on dead branches of *Acer spicatum*, R2922.

Hypoxylon cohaerens Pers. ex Fr. On bark of dead *Fagus grandifolia*, 36417, R1247; and dead trunk of *Alnus incana*, R2863.

Hypoxylon marginatum (Schw.) Berk. On bark of dead frondose tree, 37588.

Hypoxylon multiforme. Fr. On log of *Betula lutea*, 37546.

Hypoxylon nummularium Bull. ex Fr. On fallen *Fagus grandifolia*, 37383.

Hypoxylon pruinatum (Klotsch.) Cooke. On dead *Populus tremuloides*, 37940.

Hypoxylon rubiginosum Pers. ex Fr. On dead hardwood, 37822.

Hypoxylon serpens Pers. ex Fr. On dead hardwood, R1248.

Hypoxylon ustulatum Bull. ex Fr. On log of *Quercus* sp., R543; and *Fagus grandifolia*, R1356.

Rosellinia aquila (Fr.) Ces. & De Not. On rotten log of *Ulmus* sp., 37850.

Rosellinia Clavariae (Tul.) Wint. On lower half of the fruit body of *Clavaria cristata*, 37258.

Rosellinia mutans (Cooke & Peck) Sacc. On rotten log, 37384.

Xylaria digitata L. ex Grev. On rotten logs, 36441 (conidial stage).

BASIDIOMYCETES

Ustilaginales

Ustilaginaceae

Cintractia Caricis (Pers.) Magn. In the ovaries of *Carex sterilis*, 37617.

Cintractia Junci (Schw.) Trel. In the ovaries of *Juncus macer*, 37771.

Schizonella melanogramma (DC.) Schroet. On the leaves of *Carex* sp. (perhaps *Woodii*), 37622.

Ustilago Heufleri Fuckel. On leaves of *Erythronium americanum*, 37538.

Ustilago longissima (Sow. ex Schlecht.) Meyen. On leaves and stems of *Glyceria grandis*, 36508.

Ustilago nuda (Jens.) Rostr. On inflorescences of *Triticum aestivum,* in cultivated field along edge of swamp, 36975.

Ustilago utriculosa (Nees.) Tul. On inflorescences of *Polygonum hydropiperoides,* 36509.

Tilletiaceae

Doassansia Alismatis (Nees.) Cornu. On leaves of *Alisma Plantago-aquatica,* 37620.

Doassansia deformans Setch. On leaves and petioles of *Sagittaria latifolia,* 37619.

Uredinales

Melampsoraceae

Chrysomyxa Ledi (Alb. and Schw.) DeBary. On leaves of *Ledum groenlandicum,* 37608.

Chrysomyxa Pyrolae (DC.) Rostr. On leaves of *Pyrola americana,* 37611.

Coleosporium Campanulae (Pers.) Lev. On leaves of *Campanula rapunculoides,* 37605.

Coleosporium Solidaginis (Schw.) Thum. On leaves of *Aster lateriflorus,* 36593; *Aster lucidulus,* 36659; *Aster paniculatus,* 36693; *Solidago arguta,* 37782; *Solidago canadensis,* R1316; *Solidago graminifolia,* R1200; *Solidago nemoralis,* 36658; *Solidago ohioensis,* 36697; *Solidago patula,* 36660; *Solidago rugosa,* 36602; *Solidago serotina,* 36601; *Solidago uniligulata,* 36600.

Cronartium Commandrae Peck. On leaves of *Commandra umbellata,* 36598.

Cronartium ribicola Fischer. On leaves of *Ribes cynosbati,* 36533; *Ribes hirtellum,* R2358; *Ribes triste* var. *albinervium,* 36487.

Hyalopsora Polypodii (Pers.) Magn. On fronds of *Cystopteris fragilis,* 36447.

Melampsora Abieti-capraearum Tubeuf. On leaves of *Salix discolor,* 36555; *Salix nigra,* 36701; *Salix purpurea,* 36695.

Melampsora Bigelowii Thum. On leaves of *Salix amygdaloides,* 36499.

Melampsora Medusae Thum. On leaves of *Populus balsamifera,* 36698; *Populus tremuloides,* 37812.

Pucciniastrum Myrtilii (Schum.) Arth. On leaves of *Gaylussacia baccata,* 36594.

Pucciniastrum pustulatum (Pers.) Diet. On leaves of *Epilobium hirsutum,* 36503.

Uredinopsis mirabilis (Peck) Magn. On fronds of *Onoclea sensibilis,* 9944 (Whetzel and Jackson).

Uredinopsis Struthiopteridis Stormer. On fronds of *Dryopteris Thelypteris,* 10062 (Whetzel and Jackson).

Pucciniaceae

Gymnoconia Peckiana (Howe) Trotter. On leaves of *Rubus allegheniensis,* 36418; and *Rubus occidentalis,* 36693.

Gymnosporangium clavipes Cooke and Peck. On fruits of *Amelanchier intermedia,* R2392; *Crataegus monogyna,* R2410; and *Crataegus punctata,* 36507.

Gymnosporangium corniculans Kern. On young branches of *Juniperus horizontalis,* 37818.

Gymnosporangium globosum Farl. On *Crataegus macracantha,* 36505; *Crataegus punctata,* 36506; *Juniperus horizontalis,* 36835; and *Juniperus virginiana,* 35168.

Phragmidium Andersoni Shear. On leaves of *Potentilla fruticosa,* 36595.

Phragmidium Potentillae (Pers.) Karst. On leaves of *Potentilla norvegica* var. *hirsuta,* R1357; and *Potentilla recta,* 37662.

Pileolaria Toxicodendri (Berk. and Ravel) Arth. On leaves and petioles of *Rhus Toxicodendron,* 36488.

Puccinia Anemones-virginianae Schw. On leaves of *Anemone virginiana,* 37600.

Puccinia angustata Peck. On leaves of *Lycopus uniflorus,* 9979 (Whetzel and Jackson); *Scirpus atrovirens,* 37991, and *Senecio aureus,* 37609.

Puccinia Asteris Duby. On leaves of *Aster novae-angliae,* 36554.

Puccinia Bardanae (Wallr.) Corda. On leaves of *Arctium minus,* 36504.

Puccinia Calthae Link. On leaves of *Caltha palustris,* 37178.

Puccinia Caricis Schroet. On *Carex riparia* var. *lacustris,* 37992.

Puccinia Caricis (Schum.), Schroet. var. **Grossulariata** Arth. On leaves of *Ribes americanum,* 36425; and *Ribes hirtellum,* 36420.

Puccinia Caricis (Schum.), Schroet. var. **uniporula** (Ort.) Arth. On leaves of *Carex pallescens,* 10039 (Whetzel and Jackson).

Puccinia Caricis (Schum.), Schroet. var. **Urticata** (Kern.) Arth. On leaves of *Urtica procera,* 36421.

Puccinia Circaeae Pers. On leaves of *Circaea latifolia,* 36490.

Puccinia Cnici Mart. On leaves of *Cirsium lanceolatum,* 9962 (Whetzel and Jackson).

Puccinia coronata Corda. On leaves of *Avena sativa,* cultivated fields along edge of swamp, 36494; and *Rhamnus alnifolia,* 36403.

Puccinia Dayi Clinton. On leaves of *Steironema ciliatum,* 36891.

Puccinia Eleocharidis Arth. On leaves of *Eupatorium maculatum,* 9930, 9956 (Whetzel and Jackson); *Eupatorium perfoliatum,* 36498; and *Eupatorium rugosum,* 36435.

Puccinia extensicola Plowr., var. **Asteris** (Thum.) Arth. On leaves of *Aster umbellatus,* 9980 (Whetzel and Jackson).

Puccinia extensicola Plowr., var. **Solidaginis** (Schw.) Arth. On leaves of *Solidago canadensis,* 9932 (Whetzel and Jackson); *Solidago graminifolia,* 36420; *Solidago ohioensis,* 9978 (Whetzel and Jackson).

Puccinia graminis Pers. On leaves of *Agropyron repens*, 36492; *Berberis vulgaris*, 36402; *Cinna arundinacea*, R2866; and *Poa compressa*, R2426.

Puccinia graminis Pers. var. **Phlei-pratensis** (Ericks. & Henn.) Stak. and Piem. On leaves of *Phleum pratense*, 36491.

Puccinia Heucherae (Schw.) Diet. On leaves of *Mitella nuda*, 37783, and *Tiarella cordifolia*, 38035.

Puccinia Hieracii (Schum.) Mart. On leaves of *Taraxacum officinale*, 36500.

Puccinia Iridis (DC.) Wallr. On leaves of *Iris versicolor*, R1317.

Puccinia Lobeliae Ger. On leaves of *Lobelia siphilitica*, 36656.

Puccinia Malvacearum Bert. On leaves of *Althaea rosea*, escaped near entrance to swamp, 37610; and *Malva neglecta*, 36536.

Puccinia Menthae Pers. On leaves of *Mentha spicata*, 36699; *Pycnanthemum flexuosum*, 37661; *Pycnanthemum Torreyi*, 37660; and *Pycnanthemum virginianum*, 36556.

Puccinia obtegans (Link.) Tul. On leaves of *Cirsium arvense*, 36422.

Puccinia peridermiospora (Ell. and Tracy) Arth. On leaves of *Fraxinus pennsylvanica*, 36432.

Puccinia Podophylli Schw. On leaves of *Podophyllum peltatum*, 36430.

Puccinia Polygoni-amphibii Pers., var. **Convolvuli** (Alb. and Schw.) Arth. On leaves of *Polygonum Convolvulus*, 36700.

Puccinia Polygoni-amphibii Pers., var. **Persicariae** (Str.) Arth. On leaves of *Polygonum coccineum*, 36597; and *Polygonum hydropiperoides*, 36694.

Puccinia pygmaea Erikss. On leaves of *Oryzopsis asperifolia*, 36538.

Puccinia Pyrolae Cooke. On leaves of *Polygala paucifolia*, 37989.

Puccinia recedens Syd. On leaves of *Senecio aureus*, 9941 (Whetzel and Jackson).

Puccinia rubigo-vera (DC.) Wint., var. **Agropyrina** (Erikss.) Arth. On leaves of *Agropyron repens*, 37607.

Puccinia rubigo-vera (DC.) Wint., var. **Impatientis** (Arth.) Mains. On leaves of *Impatiens pallida*, 36423.

Puccinia rubigo-vera (DC.) Wint., var. **Tritici** (Eriks. and Henn.) Carl. On *Triticum aestivum*, 9972 (Whetzel and Jackson).

Puccinia sessilis Schneid. On leaves of *Iris versicolor*, 36405.

Puccinia tenuis (Schw.) Burrill. On leaves of *Eupatorium rugosum*, R2234.

Puccinia Violae (Schum.) DC. On leaves of *Viola blanda*, 37612; *Viola incognita*, 9976 (Whetzel and Jackson); *Viola pubescens*, 36599; *Viola renifolia*, R2211.

Tranzchelia Thalictri (Chev.) Diet. On leaves of *Thalictrum polygamum*, 36502.

Uromyces bicolor Ell. On leaves of *Allium canadense*, 36427.

Uromyces Caladii (Schw.) Farl. On leaves and flower spathes of *Arisaema Dracontium*, 36501; and *Arisaema triphyllum*, 36401.

Uromyces Fabae (Pers.) DeBary. On leaves of *Vicia villosa* Roth., 36610.

Uromyces Halstedii DeToni. On leaves of *Trillium grandiflorum*, 36974.

Uromyces Polygoni (Pers.) Fuckel. On leaves of *Polygonum aviculare*, 37601.

Uromyces Trifolii (Hedw. f.) Lév. On leaves of *Trifolium pratense*, 36562.

Auriculariales

Auriculariaceae

Herpobasidium deformans Gould. On leaves of *Lonicera oblongifolia*, 37599 (conidial stage).

Dacrymycetales

Dacrymycetaceae

Arrhytidia enata (Berk. and Curt.) Coker. On dead branches of *Crataegus punctata*, R2294. (Det. by G. W. Martin.)

Calocera cornea (Fr.) Link. On rotten log, 38033.

Dacrymyces deliquescens Duby. On log of *Thuja occidentalis*, 36900; and *Tsuga canadensis*, 36963.

Dacrymyces Ellisii Coker. On dead *Tilia americana*, 37823.

Dacrymyces minor Peck. On decaying frondose log, 37540.

Dacrymyces palmatus (Schw.) Bres. Apud. Höhnel. On log of *Tsuga canadensis*, 36636.

Dacryomitra nuda (Berk. and Br.) Pat. On frondose log, R1804.

Tremellales

Tremellaceae

Exidia nucleata (Schw.) Burt. On log of *Betula* sp., 36648.

Exidia repanda Fr. On dead *Carpinus caroliniana*, 37779.

Exidia spiculosa (S. F. Gray) Somm. On log of *Fagus grandifolia*, 36899.

Seismosarca alba Lloyd. On frondose log, 37574; and log of *Tilia americana*, R2781.

Tremella frondosa Fr. On log of *Tilia americana*, 36512.

Tremella tubercularia Berk. On stromata of *Diatrype* sp., 37541.

Tremellodon gelatinosus (Pers.) Fr. On stump of *Tsuga canadensis*, 36638.

Agaricales

Exobasidiaceae

Exobasidium Vaccinii (Fuckel) Wor. On leaves of *Gaylussacia baccata*, 36436; and *Vaccinium* sp., 37177.

Thelephoraceae

Aleurodiscus macrodens Coker. On bark of *Fraxinus americana*, 37587.

Aleurodiscus subgiganteus (Berk.) Höhn. On dead *Alnus incana*, 37385.

Coniophora alboflavescens (Ell. & Ev.) Höhn & Litsch. On rotten log, 37942. (Det. by H. S. Jackson.)

Coniophora puteana (Schum. ex Fr.) Karst. On log of *Thuja occidentalis*, 37773.

Corticium anceps (Syd. & Bres.) Gregor. On *Aralia nudicaulis*, 10057 (Whetzel & Jackson).

Corticium atrovirens Fr. On rotten log, R2835.

Corticium cremoricolor Berk. & Curtis. On dead branch of *Prunus virginiana*, 37821.

Cyphella fasciculata Berk. & Curtis. On dead branches of *Alnus incana*, 36688.

Cyphella minutissima Burt. On dead twigs, 37807.

Hymenochaete corrugata (Fr.) Lev. On rotten log, 37387.

Hymenochaete fuliginosa (Pers. ex Fr.) Bres. On dead twigs of *Betula lutea*, 37376.

Hymenochaete tenuis Peck. On decorticated log of *Thuja occidentalis*, 37776.

Peniophora cinerea (Pers. ex Fr.) Cooke. On dead branches of *Carpinus caroliniana*, 37379; *Corylus americana*, 36892; and *Prunus virginiana*, 37381.

Peniophora Eichleriana Bres. On fallen branches of *Acer rubrum*. (Reported by House, 1923.)

Peniophora incarnata (Pers. ex Fr.) Karst. On bark of deciduous tree, ?*Acer* sp., 37924.

Peniophora Sambuci (Pers.) Burt. On fallen branches, mixed woods, 37925.

Solenia anomala (Pers. ex Fr.) Fuckel. On dead *Betula lutea*, 37545; on twigs of *Salix discolor*, R2906.

Stereum fasciatum Schw. On frondose log, R2724.

Stereum hirsutum Willd. ex Fr. On trunk of *Betula lutea*, 36955; and log of *Tsuga canadensis*, 36893.

Stereum Pini (Schleich. ex Fr.) Fr. On young, dead, standing *Pinus Strobus*, 37936.

Stereum purpureum Pers. ex Fr. On dead *Alnus incana*, 37819.

Stereum rameale Schw. On dead branch of *Populus grandidentata*.

Stereum rufum Fr. On dead *Populus tremuloides,* 37973.
Stereum sericeum (Schw.) Morgan. On dead *Carpinus caroliniana,* 36619.
Stereum umbrinum Berk. & Curt. On frondose log, 37780.

Clavariaceae

Clavaria abietina Pers. ex Fr. On pine duff, R1178.
Clavaria cinerea Bull. ex Fr. On the ground, hemlock knoll, R1784.
Clavaria corniculata Schaeffer ex Fr. On the ground, mixed woods, R1156, R1785.
Clavaria cristata Holmsk. ex Fr. On rotten log of *Tsuga canadensis,* R1783; and on rich humus, mixed woods, R2409.
Clavaria fusiformis Sowerby ex Fr. On the ground, mixed woods, R1801; and under *Thuja occidentalis,* R2408.
Clavaria mucida Pers. ex Fr. On decorticated log covered with *Protococcus,* 36666; on log of *Ulmus americana,* R2902.
Clavaria Murrillii Coker & Couch. On duff under *Tsuga canadensis,* R1179.
Clavaria pistillaris L. ex Fr. On the ground under pine, R1180.
Clavaria rufipes Atk. On stump, mixed woods, R1800.
Clavaria stricta Pers. ex Fr. On decaying wood, R964.
Clavaria vermicularis Swartz ex Fr. On the ground under *Thuja* sp., R1142.
Clavicorona coronata (Schw.) Doty. On rotten log, 37579.
Clavicorona pyxidata (Fr.) Doty. On decaying logs, 36446.

Hydnaceae

Hericium coralloides Scop. ex S. F. Gray. On log of hardwood, 36642
Hericium laciniatum Leers ex Banker. On log of *Fagus grandifolia,* 36641.
Mycoacia fragilissima (Berk. & Curt.) Miller. On rotten log, R2341, R2721.
Mycoacia Himantia (Schw.) Miller. On rotten log, 37578.
Odontia arguta (Fr.) Quél. On rotten log, 37380. (Det. by F. J Czabator.)
Odontia spathulata (Fr.) Litsch. On rotten log, 37380; and on dead *Tilia americana,* 37391.
Phlebia merismoides Fr. On log of *Acer* sp., 36901.
Phlebia radiata Fr. On log of *Betula lutea,* 36646.
Phlebia strigosa-zonata (Schw.) Lloyd. On dead *Populus* sp., R2850
Steccherinum ochraceum (Fr.) S. F. Gray. On rotten log, 37814.

Polyporaceae

Daedalea confragosa (Bolt) ex Fr. On log of *Ulmus americana,* 36443
Daedalea quercina (L.) ex Fr. On stump of *Quercus macrocarpa,* 37592

Daedalea unicolor (Bull.) ex Fr. On dead *Fagus grandifolia,* R1799.

Favolus alveolaris (DC. ex Fr.) Quél. On dead branches of *Fagus grandifolia,* 36416.

Fomes connatus (Weinm.) Gill. On log of *Acer rubrum,* 36530; and *Fagus grandifolia,* 36730.

Fomes fomentarius (L. ex Fr.) Kichx. On *Populus grandidentata,* 36408; and *Betula lutea,* R1173.

Fomes fraxinophilus (Peck) Sacc. On *Fraxinus pennsylvanica,* 37826; and *Salix alba,* var. *vitellina,* 37327.

Fomes igniarius (L. ex Fr.) Gill. On log of deciduous tree, R1172.

Fomes pinicola (Swartz ex Fr.) Cooke. On *Tsuga canadensis,* 36728.

Fomes scutellatus (Schw.) Cooke. On dead *Alnus incana,* 37618.

Ganoderma applanatum (Pers. ex Wallr.) Pat. On dead *Ulmus americana,* 36410.

Ganoderma lucidum (Leyss.) Karst. On stump of *Tsuga canadensis,* 36407.

Ganoderma sessile Murr. On log of deciduous tree, 37789.

Lenzites betulina L. ex Fr. On dead hardwood, 36689.

Lenzites saepiaria Wulf. ex Fr. On logs of *Tsuga canadensis;* and on planks in trail, 36531.

Lenzites trabea Pers. ex Fr. On dry log, 36618.

Merulius tremellosus Schrad. ex Fr. On log of *Betula lutea,* 36653.

Polyporus abietinus (Dicks.) ex Fr. On log of *Thuja occidentalis,* 36518; and *Tsuga canadensis,* R1165.

Polyporus albellus Peck. On dead *Fagus grandifolia,* 37259; and *Fraxinus* sp., 37260.

Polyporus arcularius Batsch. ex Fr. On decaying twigs, 37593; on fallen branch of *Betula* sp., R2941.

Polyporus betulinus (Bull.) ex Fr. On dead *Betula lutea,* R1244.

Polyporus biformis Klotsch. On dead frondose tree, 36895.

Polyporus brumalis (Pers.) ex Fr. On slash twigs of hardwoods, 36667.

Polyporus cinnabarinus (Jacq.) ex Fr. On logs, 36640.

Polyporus cinnamomeus (Jacq.) ex Fr. On burned hemlock duff, 38026.

Polyporus conchifer (Schw.) Fr. On dead branches of hardwoods, 36445.

Polyporus croceus Pers. ex Fr. On dead *Ulmus americana,* 36894.

Polyporus delectans Peck. On living *Carya ovata,* 36616; and on *Salix alba,* var. *vitellina,* 37297.

Polyporus elegans (Bull.) ex Fr. On decaying branches of *Fagus grandifolia,* 36415; and on *Ulmus americana,* 36440.

Polyporus fumosus (Pers.) ex Fr. On log of *Carpinus caroliniana,* R2785; *Tilia americana,* 37295; and *Ulmus americana,* 37294.

Polyporus galactinus Berk. On dead *Betula lutea,* R1138.

Polyporus gilvus (Schw.) Fr. On log of *Ulmus americana,* 36617.

Polyporus hirsutus (Wulf.) ex Fr. On dead branches of *Betula* sp., 36644.

Polyporus pargamenus Fr. On log of *Tilia americana.*

Polyporus radiatus (Sow.) ex Fr. On dead *Betula* sp., 37292.

Polyporus resinosus (Schrad.) ex Fr. On log of *Tilia americana,* 36687; and *Tsuga canadensis,* 36643.

Polyporus squamosus (Huds.) ex Fr. On stump of *Salix nigra,* 36414.

Polyporus sulphureus (Bull.) ex Fr. On stump of *Salix alba,* var. *vitellina,* 36686.

Polyporus tephroleucas Fr. On dead *Tilia americana,* 36645.

Polyporus tulipiferus (Schw.) Overh. On dead branches of deciduous tree, 36622.

Polyporus versicolor Fr. On dead *Betula lutea,* R542; *Prunus Avium,* 36412; and *Ulmus americana.*

Poria ferruginosa (Schrad. ex Fr.) Karst. On dead *Acer rubrum,* 37388; *Hamamelis virginiana,* 36960; and wood of deciduous tree, 37261.

Poria fissiliformis Pilat. On rotten log of *Ulmus* sp., 37854.

Poria nigrescens Bres. On dead *Betula lutea,* 36897. (Det. by J. L. Lowe.)

Poria punctata (Fr.) Karst. On log of hardwood, 36896. (Det. by J. L. Lowe.)

Poria spissa (Schw.) Cooke. On rotten log, 36668; and on dead *Tilia americana,* 37390.

Poria subacida (Peck) Sacc. On log, 36731.

Poria Vaillantii (Fr.) Cooke. On bark of conifer, 37813.

Boletaceae

Boletinus pictus (Peck) Peck. On the ground, hemlock knoll, R952; and in sphagnum under *Pinus Strobus,* R2735.

Gyrodon merulioides (Schw.) Singer. On the ground under *Fraxinus* sp., R1143.

Leccinum scabrum (Bull. ex Fr.) S. F. Gray. On the ground under *Thuja* sp., and *Tsuga* sp., R2736.

Porphyrellus gracilis (Peck) Singer. On rotten stump, R2398.

Suillus americanus (Peck) Singer. On the ground, mixed woods, R1715.

Tylopilus felleus (Bull. ex Fr.) Karst. On the ground under hemlock, R950; and in mixed woods, R2399.

Tylopilus ferrugineus (Frost) Singer. On the ground, mixed woods, R1716.

Agaricaceae

Agaricus cretacella Atk. On the ground, coniferous woods, R2395.

Agaricus silvicola (Vitt.) Sacc. On the ground, mixed woods, R954.

Amanita flavaconica Atk. On rich humus, mixed woods, R1166, R2394.
Amanita mappa Fr. On the ground, mixed woods, R1148, R1770.
Amanita rubescens Fr. On the ground, hemlock knoll, R951.
Amanita spissa Fr. On the ground, hemlock knoll, R958.
Armillaria mellea Fr. Abundant in September and October about stumps, mixed woods, R1164, R2773, R2796.
Claudopus nidulans Fr. On trunk of dead hardwood, 36903.
Clitocybe catina Fr. On the ground under hemlock, R957; and on fallen, decaying leaves, mixed woods, R2771.
Clitocybe dealbata Fr. On leaf mold, R960.
Clitocybe decora Fr. On log, coniferous woods, R1794.
Clitocybe infundibuliformis Fr. On the ground, woods, R1508.
Clitocybe monadelpha Morgan. On rotten log, R2315.
Clitocybe multiceps Peck. Cespitose on the ground, mixed woods, R1812, R2316.
Clitopilus albogriseus Peck. On the ground, woods, R1184.
Clitopilus abortivus Berk. & Curtis. Both the aborted and normal forms present on the ground about stumps, mixed woods, R1152.
Collybia albiflavida (Peck) Kauff. On the ground, woods, R1154.
Collybia atratoides Peck. On rotten log, R1510.
Collybia butyracea Fr. On the ground, under conifers, R1793; and in mixed woods, R2804.
Collybia hariolarum Fr. On the ground, under hemlock, R955.
Collybia platyphylla Fr. On the ground, woods, R1511.
Collybia radicata Fr. On the ground under hemlock, R956.
Collybia stipitaria Fr. Among fallen pine needles, R1147.
Collybia velutipes Fr. Cespitose on log of *Tilia americana,* R1796; and on rotten logs, R2034, R2772.
Coprinus atramentarius Fr. On and about decaying stumps, R2767.
Coprinus comatus Fr. Open roadside north side of swamp, R1811.
Coprinus ephemerus Fr. On cow dung, pasture adjoining swamp, R2314.
Coprinus fimetarius Fr. On manure, pasture adjoining swamp, R2722.
Coprinus micaceus Fr. On rotting stump of *Ulmus* sp.
Coprinus radiatus Fr. On deer dung, R2653.
Cortinarius albidipes Peck. On the ground, mixed woods, R1151.
Cortinarius violaceus Fr. On the ground under hemlock, R1776.
Crepidotus dorsalis Peck. On rotten log, R2309.
Crepidotus putrigenous Berk. & Curtis. On rotten log, R2308; and log of *Tilia americana,* R544.
Crepidotus versutus Peck. On horse dung, R3027.
Eccilia atrides Fr. On the ground, coniferous woods, R2395.
Eccilia griseo-rubella Fr. On the ground, mixed woods, R3083.
Flammula carbonaria Fr. On wood, R953.

Flammula sapinea Fr. On stump of *Thuja occidentalis,* R2806.
Galera Hypnorum Fr. On sphagnum, R1176.
Hygrophorus ceraceus Fr. On mossy ground, woods, R2311.
Hygrophorus conicus Fr. On the ground, mixed woods, R1149, R1714; and coniferous woods, R1792.
Hygrophorus laetus Fr. On coniferous duff, R2401.
Hygrophorus miniatus Fr. On moss covered humus, mixed woods, R2400; and in coniferous woods, R2312.
Hygrophorus puniceus Fr. On the ground, mixed woods, R3080.
Hypholoma incertum Peck. On decaying log.
Hypholoma incertum Peck, var. **sylvestris** Kauffman. On the ground, open woods, R2307.
Hypholoma sublateritium Fr. On stumps, R1170.
Inocybe asterospora Quel. On the ground, mixed woods, R2732.
Inocybe destricta Fr. On humus, mixed woods, R2776.
Inocybe flocculosa Berk. On burned hemlock duff, R2729.
Inocybe rimosa Peck sensu Richen. On ground, mixed woods, R1774.
Laccaria laccata (Scop. ex Fr.) Berk. & Br. On the ground, mixed woods, R1773; and on sphagnum, R1798.
Lactarius colorascens Peck. On the ground under hemlock, R963.
Lactarius controversus Fr. On the ground, mixed woods, R1150, R2723.
Lactarius deliciosus Fr. On the ground under *Thuja* sp., R1158.
Lactarius piperatus Fr. On the ground, mixed woods, R1175; under hemlock, R949, R2725.
Lactarius subdulcis Fr. Scattered on the ground under *Thuja* sp., R1159, R2769.
Lactarius vietus Fr. On humus, mixed woods, R2770.
Lactarius volemus Fr. On the ground, mixed woods, R1771.
Lentinus lepideus Fr. On log of *Ulmus* sp., 36409.
Lentinus spretus Peck. On log of *Larix laricina,* R2303; and *Tsuga canadensis,* R2302.
Lentinus vulpinus Fr. On dead *Ulmus* sp., 36442; and log of *Betula lutea,* R1791.
Marasmius androsaceus Fr. On fallen twigs and pine needles, R1506.
Marasmius epiphyllus Fr. On fallen twigs and leaves, R1146.
Marasmius rotula Fr. On fallen twigs and leaves, R1505; and on rotten logs, R2304.
Marasmius urens Fr. On humus, mixed woods, R2721.
Mycena alcalina (Fr.) Quél. On stumps and logs of *Thuja occidentalis,* R2037.
Mycena corticola (Fr.) Quél. On bark of frondose tree, R2777.
Mycena delicatella (Peck) A. H. Smith. On fallen leaves of *Thuja occidentalis,* R2799.
Mycena galericulata (Fr.) S. F. Gray. On rotten logs, R962, R1509, R1778.

Mycena gracilis (Quél.) Kuhner. On moss and fallen logs under *Thuja* sp., R1797.

Mycena haematopus (Fr.) Quél. On rotten log, R2738.

Mycena inclinata (Fr.) Quél. On log of *Acer rubrum*, R966.

Mycena Leaiana (Berk.) Sacc. On log of *Acer* sp., R1512.

Mycena rosella (Fr.) Quél. On duff under *Pinus* sp., and *Thuja* sp., R2805.

Mycena vitilis (Fr.) Quél. On the ground, mixed woods, R1157.

Naucoria semiorbiculatus Fr. Scattered on mossy, sandy soil in the open, R2860.

Omphalia campanella Fr. On stumps and logs of *Tsuga canadensis*, R1160.

Omphalia Gerardianae Peck. On sphagnum, R2802.

Omphalia onisca Fr. On mossy ground, R2803.

Panaeolus retirugis Fr. On horse dung, R1167, R1760, R2036.

Panaeolus solidipes Peck. On dung, R2030.

Panus torulosus Fr. On rotting stump, R2305.

Paxillus atrotomentosus (Batsch. ex Fr.) Fr. On fallen log of *Tsuga canadensis*, R1772.

Paxillus involutus Fr. On the ground under hemlock, R2774.

Pholiota adiposa Fr. Cespitose on frondose log, R2768.

Pholiota marginata Batsch. ex Fr. On rotten log, R2737.

Pholiota praecox Fr. On the ground, open woods, R2200.

Pleurotus applicatus Fr. On log, 36647.

Pleurotus circinatus Fr. On rotten log, 36452.

Pleurotus cyphellaeformis Berk. On dead stems of *Carex riparia* var. *lacustris*, R1816.

Pleurotus osteratus Fr. On trunk of dead *Populus candicans*, 36411.

Pleurotus petaloides Fr. On rotten logs, R2310, R2798.

Pleurotus sapidus Kalchbr. On log, R2033.

Pleurotus serotinus Fr. On logs, 36690.

Pleurotus ulmarius Fr. On *Ulmus americana*, R2797.

Pluteus cervinus Fr. On rotten stump, R2306; and on sawdust pile, R2393.

Pluteus tomentosulus Peck. On rotten log, R3082.

Psilocybe larga Kauffman. On the ground, mixed woods, R2032.

Psilocybe murcida Fr. On mossy ground, woods, R2035.

Russula alutacea Fr. Gregarious along path, open woods, R3081.

Russula fragilis Fr. On the ground, mixed woods, R1775.

Russula purpurina Quél. & Schultz. On the ground under hemlock, R961; and in mixed woods, R1161.

Russula sanguinea Fr. sensu Kauffman. On the ground, mixed woods, R2397.

Russula subdepallens Peck. Under conifers, R1795.

Russula variata (Banning) Peck. On the ground under hemlock, R959.
Schizophyllum commune Fr. On dead branches, R971.
Stropharia albonitens Fr. Scattered, in open grassy pasture, R2801.
Stropharia semiglobata Fr. In open sandy field, on manure, R3043.
Tricholoma album Fr. On duff under pine and *Thuja* sp., 36451.
Tricholoma personatum Fr. On the ground, mixed woods, R1777.
Trogia crispa Fr. On dead *Betula lutea,* 36637.

Hymenogastrales

Melanogasteraceae

Melanogaster variegatus Vitt. A single fruit body was found on the ground in woods along Black Creek, 38022.

Lycoperdales

Lycoperdaceae

Bovista pila Berk. & Curt. Open field, 36908.
Lycoperdon Curtisii Berk. On the ground, woods, 36650.
Lycoperdon perlatum Pers. On the ground, woods, 36651.
Lycoperdon polymorphum Vitt. On the ground, mixed woods, 36652.
Lycoperdon pusillum Pers. Open pasture, R1395.
Lycoperdon pyriforme Pers. On hardwood stump, 36669; and on rotten logs, R1384.
Lycoperdon subincarnatum Peck. On rotten log, 36653.
Lycoperdon umbrinum Pers. On decaying stumps, R1403.
Lycoperdon Wrightii Berk. & Curt. Open field, 37788.

Geastraceae

Geastrum pectinatum Pers. On the ground under hemlock, 37255.
Geastrum triplex Jungh. On rich humus in mixed woods, 36620, R972, R1136.

Sclerodermatales

Sclerodermataceae

Scleroderma aurantium Pers. On humus about decayed stump, 36450.

FUNGI IMPERFECTI

Sphaeropsidales

Sphaerioidaceae

Ascochyta Lycopersici Brun. On *Solanum Dulcamara,* 9948 (Whetzel & Jackson).
Asteroma Tiliae Rud. On leaves of *Tilia americana,* 37786.

Cicinnobolus Cesatii De Bary. Parasitic on *Erysiphe cichoracearum* on *Solidago serotina,* 37426.

Cytospora ceratophora Sacc. On dead branches of *Fraxinus americana,* 36956.

Cytospora chrysosperma (Pers.) ex Fr. On dead *Acer rubrum,* R2942.

Cytospora Salicis (Corda) Rabenh. On dead branches of *Salix* sp., 37975.

Cytospora sp. On dead twigs of *Ulmus americana,* R2915.

Darluca filum (Biv.-Bern.) Cast. Parasitic on *Melampsora Abieti-capraearum* on *Salix nigra,* 36497; on *Puccinia pygmaea* on *Oryzopsis asperifolia,* 36538; *Puccinia Menthae* on *Pycnanthemum flexuosum,* R2499 and on *Pycnanthemum Torreyi,* R2499; on *Uromyces Polygoni* on *Polygonum aviculare,* 37602.

Dendrophoma Tiliae Peck. On dead twigs of *Tilia americana,* 36904.

Diplodia Linderae Ell. & Ev. On dead twigs of *Lindera Benzoin,* 37921.

Diplodina stenospora (Berk. & Curt.) Sacc. On dead *Acer* sp., 36957.

Gelatinosporium abietinum Peck. On dead *Tsuga canadensis,* 37938.

Micropera Drupacearum Lév. On dead branches of *Prunus avium,* 37935.

Phoma asclepiadea Ell. & Ev. On dead stems of *Asclepias syriaca,* 37922.

Phoma Corni Fuckel. On dead twigs of *Cornus Amomum,* 37879.

Phoma Phytolaccae Berk. & Br. On dead stems of *Phytolacca americana,* 38028.

Phoma polygramma (Fr.) Sacc., var. **Plantaginis** Sacc. On peduncles of *Plantago lanceolata,* 36723.

Phoma Solidaginis Cooke. On dead stems of *Solidago* sp., 37934.

Phomopsis linearis Trav. On dead stems of *Solidago* sp., 37937.

Phyllosticta Convallariae Pers. ex Seaver. On leaves of *Smilacina stellata,* 36493.

Phyllosticta cornicola (DC. ex Fr.) Rabenh. On leaves of *Cornus alternifolia,* 36722.

Phyllosticta fraxinicola (Currey) Sacc. On leaves of *Fraxinus americana,* 36721.

Phyllosticta minima (Berk. & Curt.) Ell. & Ev. On leaves of *Acer rubrum,* 36557.

Phyllosticta perforans Ell. & Ev. On leaves of *Solanum Dulcamara,* 38019.

Phyllosticta saccharini Ell. & Mart. On leaves of *Acer nigrum,* 36720.

Phyllosticta Tiliae Sacc. & Speg. On leaves of *Tilia americana,* 36719.

Phyllosticta ulmicola Sacc. On leaves of *Ulmus americana,* R2420.

Phyllosticta viticola (Berk. & Curt.) Thum. On leaves of *Parthenocissus quinquefolia,* 36511, and *Vitis vulpina,* 38020.

Septoria canadensis Peck. On leaves of *Cornus canadensis,* 37539.

Septoria conspicua Ell. & Martin. On leaves of *Steironema ciliatum*, 37883.

Septoria Davisii Sacc. On the lower overwintering leaves of *Solidago* sp., 37806.

Septoria Epilobii Westd. On leaves of *Epilobium hirsutum*, 9939 (Whetzel & Jackson).

Septoria malvicola Ell. & Martin. On leaves of *Malva neglecta*, 37793.

Septoria Mitellae Ell. & Ev. On leaves of *Mitella diphylla*, 37616.

Septoria musiva Peck. On leaves of *Populus* sp., 38018.

Sphaerographium Fraxini (Peck) Sacc. On dead twigs of *Fraxinus* sp., 36961.

Sphaeronema acerinum Peck. On dead twigs of *Acer rubrum*, 37577.

Sphaeropsis ulmicola Ell. & Ev. On dead twigs of *Ulmus americana*, 37886.

Stagonospora arenaria Sacc. On dead culms of *Deschampsia caespitosa*, 37877.

Leptostromataceae

Leptostroma Eupatorii Allesch. On dead stems of *Eupatorium* sp., 37917.

Leptostroma Pteridis Ehrenbg. On dead stems and fronds of *Pteridium aquilinum*, var. *latiusculum*, 37918.

Leptothyrium Periclymenii (Desm.) Sacc. On leaves of *Lonicera oblongifolia*, 10055 (Whetzel & Jackson).

Leptothyrium Pomi (Mont. & Fr.) Sacc. On fruits of *Pyrus Malus*, 37293.

Leptothyrium vulgare (Fr.) Sacc. On dead stems of *Eupatorium rugosum*, 37583.

Piggotia astroidea Berk. & Br. On leaves of *Ulmus americana*, 37603.

Melanconiales

Melanconiaceae

Cylindrosporium Iridis Ell. & Halstead. On leaves of *Iris versicolor*, 37816.

Cylindrosporium Padi Karst. On leaves of *Prunus* sp., 9949 (Whetzel & Jackson).

Gloeosporium Caryae (Peck) Ell. & Dearn. On leaves of *Carya ovata*, 36665.

Marssonina Delastrei (Delacr.) Magn. On leaves of *Silene Cucubalis*, 38025.

Marssonina Juglandis (Lib.) Magn. On leaves of *Juglans nigra*, 37606.

Marssonin Thomasiana (Sacc.) Magn. On leaves of *Celastrus scandens*, 37784.

Myxosporium nitidum Berk. & Curtis. On dead twigs of *Cornus alternifolia*, 36732; on dead twigs of *Cornus Amomum*, 37880.

Pestalotia funerea Desm. On dead foliage of *Thuja occidentalis*, 36968.

Septogloeum Convolvuli Ell. & Ev. On leaves of *Convolvulus sepium*, 28023.

Vermicularia coptina Peck. On dead leaves of *Coptis trifolia* subsp. *groenlandica*, 37572.

Vermicularia Dematium (Pers.) ex Fr. On dead stems of *Eupatorium rugosum*, 37582; on *Iris versicolor*, R3053; on samaras of *Fraxinus americana*, 38030.

Vermicularia punctans Schw. On dead leaves of *Sorghastrum nutans*, 36537.

Moniliales

Moniliaceae

Aspergillus ochraceus Wilhelm. On dung of grouse, R2973.

Botrytis cinerea Pers. ex Fr. On leaves of *Acorus Calamus*, 37615.

Botrytis Epichloes Ell. & Dearn. Covering the stromata of *Epichloe typhina* on *Glyceria striata*, R2320, R2415, R2502.

Didymaria didyma (Ung.) Schröt. On leaves of *Anemone canadensis*, 37392.

Ovularia obliqua (Cooke) Oud. On leaves of *Rumex crispus*, 36724.

Ramularia brunnea Peck. On leaves of *Tussilago farfara*, 36889.

Ramularia decipiens Ell. & Ev. On leaves of *Rumex verticillatus*, 38032.

Ramularia Impatientis Peck. On leaves of *Impatiens* sp., 37627.

Ramularia Saururi (Ell. & Ev.) Tharp. On leaves of *Saururus cernuus*, 38024.

Ramularia Tulasnei Sacc. On leaves of *Fragaris virginiana*, 37604.

Dematiaceae

Alternaria tenuis Auct. sensu str. Neergaard. On necrotic spots on the leaves of *Liriodendron Tulipifera*, 36657. (Det. by P. Neergaard.)

Cercospora dubia (Reiss.) Wint. On leaves of *Chenopodium album*, 38034. (Det. by C. Chupp.)

Cercospora omphakodes Ell. & Holw. On leaves of *Phlox divaricata*, 10073 (Whetzel & Jackson).

Cercospora Sii Ell. & Ev. On leaves of *Sium suave*, 9938 (Whetzel & Jackson).

Cladosporium graminum Cooke. On dead leaves of *Sorghastrum nutans*, R2859.

Cladosporium herbarum Link ex Fr. On the lower dead leaves of *Linnaea borealis*, var. *americana*, 37815; and on dead leaves of *Typha latifolia*, R2857.

Cladosporium velutinum Ell. & Tracy. On dead leaves of *Phalaris arundinacea,* 36513.

Ellisiella caudata (Peck) Sacc. On dead leaves of *Sorghastrum nutans,* 37878.

Gonatobotryum maculicola (Wint.) Sacc. On leaves of *Hamamelis virginiana,* 37941.

Helicoma olivaceum (Karsten) Linder. On rotten log, R2836.

Scolecotrichum maculicola Ell. & Kellerm. On leaves of *Phragmites communis,* 36663. (Det. by R. Sprague.)

Scolecotrichum typhae Ell. & Ev. On dead leaves of *Typha latifolia,* 38017.

Stilbaceae

Isaria farinosa Fr. On pupa of an insect. R1768.

Stilbum fimetarium (Pers.) Berk. & Br. On deer dung, R2698.

Tuberculariaceae

Bactridium flavum Kze. & Schm. On rotten log, 37824.

Epicoccum neglectum Desm. On leaves of *Lindera Benzoin,* 36664.

Exosporium Tiliae Link. On dead twigs of *Tilia americana,* 37543.

Trimmatostroma americanum Thüm. On dead twigs of *Salix discolor,* 37825.

Volutella ciliata Alb. & Schw. ex Fr., var. **stipitata** (Lib.) Sacc. On dung of deer, R2984.

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Acer nigrum Michx. f.; Phyllosticta saccharini.

Acer rubrum L.; Cytospora chrysosperma, Dermea acerina, Diplodina stenospora, Erinella miniopsis, Fomes connatus, Hysterographium Mori, Mycena inclinata, Nitschkia Fuckelii, Peniophora Eichleriana, Phyllosticta minima, Poria ferruginosa, Rhytisma acerinum, Sphaeronema acerinum, Valsa ceratophora.

Acer saccharinum L.; Rhytisma acerinum.

Acer saccharum Marsh.; Melanomma pulvi-pyrius.

Acer spicatum Lam.; Hypoxylon coccineum, Rhytisma punctatum, Uncinula circinata.

Acer sp. indet.; Diatrype stigma, Diplodina stenospora, Lachnum virgineum, Mycena Leaiana, Peniophora incarnata, Peziza sylvestris, Phlebia merismoides, Scutellinia sp.

Acorus calamus L.; Botrytis cinerea.

Agrimonia gryposepala Wallr.; Sphaerotheca macularis.

Agropyron repens (L.) Beauv.; Claviceps purpurea, Puccinia graminis, Puccinia rubigo-vera, var. Agropyrina.

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Allium canadense L.; Uromyces bicolor.
Alnus incana (L.) Moench.; Aleurodiscus subgiganteus, Cyphella fasciculata, Encoelia furfuracea, Fomes scutellatus, Hypoxylon cohaerens, Microsphaera Alni, Phyllactinia corylea, Stereum purpureum, Taphrina Robinsoniana.
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Asprella hystrix (L.) Humb.; Phyllachora graminis.
Aster lateriflorus (L.) Britt.; Coleosporium Solidaginis.
Aster lucidulus (Gray) Wieg.; Coleosporium Solidaginis.
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Aster novae-angliae L.; Erysiphe Cichoracearum, Puccinia Asteris, Rosenscheldia Heliopsidis.
Aster paniculatus Lam.; Coleosporium Solidaginis.
Aster prenanthoides Muhl.; Erysiphe Cichoracearum.
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Betula sp. indet.; Exidia nucleata, Hypoxylon multiforme, Polyporus arcularius, Polyporus hirsutus, Polyporus radiatus.
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Carex riparia Curtis, var. **lacustris** (Willd.) Kueken.; Pleurotus cyphelaeformis, Puccinia Caricis.
Carex sterilis Willd.; Cintractia Caricis.
Carex sp. indet.; Schizonella melanogramma.
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Carya ovata (Mill.) K. Koch.; Gloeosporium Caryae, Polyporus delectans.
Celastrus scandens L.; Marssonina Thomasiana, Phyllactinia corylea.
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Chelone glabra L.; Erysiphe Galeopsidis.
Chenopodium album L.; Cercospora dubia, Peronospora effusa.
Cinna arundinacea L.; Puccinia graminis.
Circaea latifolia L.; Puccinia Circaeae.
Cirsium arvense (L.) Scop.; Albugo Tragopogonis, Puccinia obtegens.
Cirsium lanceolatum (L.) Hill.; Puccinia Cnici.
Convolvulus sepium L.; Septogloeum Convolvuli.
Commandra umbellata (L.) Nutt.; Cronartium Commandrae.
Coptis trifolia (L.) Salisb., subsp. **groenlandica** (Oeder) Hulten.; Vermicularia coptina.
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Cornus Amomum Mill.; Myxosporium nitidum, Phoma Corni.
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Cornus rugosa Lam.; Valsa Cornina.
Cornus stolonifera Michx.; Schiffnerula pulchra.
Corylus americana Walt.; Peniophora cinerea.
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Crataegus monogyna Jacq.; Gynosporangium clavipes.
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Cystopteris fragilis (L.) Bernh.; Hyalopsora Polypodii.
Daucus Carota L.; Leptosphaeria Doliolum.
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Dentaria laciniata Muhl.; Peronospora parasitica.
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Dicentra canadensis (Goldie) Walp.; Peronospora Corydalis.
Dryopteris Thelypteris (L.) Gray; Uredinopsis Struthiopteridis.
Eleocharis rostellata Torr.; Claviceps nigricans.
Elymus virginicus L.; Ophiobolus cariceti, Phyllachora graminis.
Epilobium hirsutum L.; Pucciniastrum pustulatum, Septoria Epilobii.

Erythronium americanum Ker.; Ustilago Heufleri.

Evonymus atropurpureus Jacq.; Microsphaera Evonymi.

Eupatorium maculatum L.; Erysiphe Cichoracearum, Puccinia Eleocharidis.

Eupatorium perfoliatum L.; Erysiphe Cichoracearum, Puccinia Eleocharidis.

Eupatorium rugosum Houtt.; Leptothyrium vulgare, Plasmopara Halstedii, Puccinia Eleocharidis, Puccinia tenuis, Vermicularia Dematium.

Eupatorium sp. indet.; Leptostroma Eupatorii.

Fagus grandifolia Ehrh.; Daedalea unicolor, Exidia spiculosa, Favolus alveolaris, Fomes connatus, Hericium laciniatum, Hypoxylon coccineum, Hypoxylon cohaerens, Hypoxylon nummularium, Hypoxylon ustulatum, Nectria coccinea, Leptosphaeria hispida, Leptosphaeria ovina, Polyporus albellus, Polyporus elegans.

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Fraxinus americana L.; Aleurodiscus macrodens, Cytospora ceratophora, Phyllosticta fraxinicola, Vermicularia Dematium.

Fraxinus nigra Marsh.; Hysterium angustatum.

Fraxinus pennsylvanicus Marsh.; Fomes fraxinophilus, Puccinia peridermiospora.

Fraxinus sp. indet.; Diatrype stigma, Fomes fraxinophilus, Polyporus albellus, Sphaerographium Fraxini.

Gaultheria procumbens L.; Asterina Gaultheriae.

Gaylussacia baccata (Wang.) K. Koch.; Exobasidium Vaccinii, Microsphaera Vaccinii, Pucciniastrum Myrtilli.

Geranium maculatum L.; Plasmopara Geranii.

Geranium Robertianum L.; Stigmatea Robertiani.

Geum aleppicum Jacq.; var. **strictum** (Ait.) Fern.; Sphaerotheca Humili.

Geum canadense Jacq.; Peronospora Potentillae.

Geum sp. indet.; Peronospora Potentillae.

Glyceria grandis Wats.; Ustilago longissima.

Glyceria striata (Lam.) Hitchc.; Epichloe typhina.

Hamamelis virginiana L.; Gonatobotryum maculicola, Poria ferruginosa.

Helenium autumnale L.; Erysiphe Cichoracearum.

Hydrophyllum virginianum L.; Peronospora Hydrophylli.

Impatiens pallida Nutt.; Puccinia rubigo-vera, var. Impatientis.

Impatiens sp. indet.; Ramularia Impatientis.

Inula Helenium L.; Erysiphe Cichoracearum.

Iris versicolor L.; Cylindrosporium Iridis, Puccinia Iridis, Puccinia sessilis, Vermicularia Dematium.

Juglans nigra L.; Marssonina Juglandis.

Juncus balticus Willd., var. **littoralis** Engelm.; Leptosphaeria Michotii.
Juncus macer S. F. Gray; Cintractia Junci.
Juniperus horizontalis Moench.; Gymnosporangium corniculans, Gymnosporangium globosum.
Juniperus virginiana L.; Gymnosporangium globosum.
Larix laricina (DuRoi) Koch.; Lentinus spretus.
Ledum groenlandicum Oeder.; Chrysomyxa Ledi, Lachnum fuscescens, Lophiodermium sphaeroides.
Leersia oryzoides (L.) Sw.; Belonopsis sp.
Lepidium campestre (L.) R. Br.; Albugo candida.
Lindera Benzoin (L.) Bl.; Diplodia Linderae, Dothidea Linderae, Epicoccum neglectum.
Linnaea borealis L., var. **americana** (Forbes) Rehder; Cladosporium herbarum.
Liriodendron tulipifera L.; Alternaria tenuis.
Lobelia siphilitica L.; Puccinia Lobeliae.
Lonicera dioica L.; Microsphaera Alni.
Lonicera oblongifolia (Goldie) Hook.; Herpobasidium deformans, Leptothyrium Periclymenii, Microsphaera Alni.
Lycopus uniflorus Michx.; Puccinia angustata.
Malva neglecta Wallr.; Puccinia Malvacearum, Septoria malvicola.
Mentha arvensis L., var. **canadensis** (L.) Briq.; Erysiphe Cichoracearum.
Mentha spicata L.; Puccinia Menthae.
Mitella diphylla L.; Septoria Mitellae.
Mitella nuda L.; Puccinia Heucherae.
Muhlenbergia racemosa (Michx.) BSP.; Phyllachora vulgata.
Myrica pennsylvanica Lois; Helotium caudatum.
Oenothera biennis L.; Peronospora Arthuri.
Onoclea sensibilis L.; Uredinopsis mirabilis.
Oryzopsis asperifolia Michx.; Puccinia pygmaea.
Parnassia caroliniana Michx.; Didymosphaeria Parnassiae.
Parthenocissus quinquefolia (L.) Planch.; Phyllosticta viticola, Uncinula necator.
Parthenocissus sp. indet.; Plasmopara viticola.
Phalaris arundinacea L.; Cladosporium velutinum.
Phleum pratense L.; Puccinia graminis, var. Phlei-pratensis.
Phlox divaricata L.; Cercospora omphakodes.
Phragmites communis Trin.; Scolecotrichum maculicola.
Phytolacca americana L.; Leptosphaeria clavigera, Phoma Phytolaccae.
Pinus Strobus L.; Coccophacidium Pini, Lophodermium nitens, Stereum Pini, Valsa Pini.
Plantago lanceolata L.; Phoma polygramma, var. Plantaginis.
Plantago major L.; Erysiphe lamprocarpa.

Platanus occidentalis L.; Gnomonia veneta.
Poa compressa L.; Puccinia graminis.
Podophyllum peltatum L.; Puccinia Podophylli.
Polygala paucifolia Willd.; Puccinia Pyrolae.
Polygonum aviculare L.; Uromyces Polygoni.
Polygonum coccineum Muhl.; Puccinia Polygoni-amphibii, var. Persicariae.
Polygonum Convolvulus L.; Puccinia Polygoni-amphibii, var. Convolvuli.
Polygonum hydropiperoides Michx.; Puccinia Polygoni-amphibii, var. Persicariae, Ustilago utriculosa.
Polymnia canadensis L.; Helotium scutula.
Polystichum acrostichoides (Michx.) Schott.; Taphrina Polystichi.
Populus balsamifera L.; Melampsora Medusae.
Populus candicans Ait.; Pleurotus ostreatus, Uncinula Salicis.
Populus grandidentata Michx.; Fomes fomentarius, Stereum rameale.
Populus tremuloides Michx.; Eutypella Radula, Hypoxylon pruinatum, Melampsora Medusae, Stereum rufum, Valsa nivea.
Populus sp. indet.; Phlebia strigosa-zonata, Septoria musiva.
Portulaca oleracea L.; Albugo Portulacae.
Potentilla fruticosa L.; Phragmidium Andersoni.
Potentilla norvegica L., var. **hirsuta** (Michx.) Lehm.; Phragmidium Potentillae.
Potentilla recta L.; Phragmidium Potentillae.
Prenanthes alba L.; Erysiphe Cichoracearum.
Prunus avium L.; Micropera Drupacearum, Polyporus versicolor.
Prunus domestica L.; Dibotryon morbosum.
Prunus serotina Ehrh.; Pachyella sp., Valsa leucostoma.
Prunus virginiana L.; Corticium cremoricolor, Dibotryon morbosum, Peniophora cinerea, Podosphaera Oxyacanthae.
Prunus sp. indet.; Cylindrosporium Padi, Solenia anomala.
Pteridium aquilinum Kuh., var. **latiusculum** (Desv.) Underw.; Cryptomycina Pteridis, Leptostroma Pteridis.
Pycnanthemum flexuosum (Walt.) BSP.; Puccinia Menthae.
Pycnanthemum Torreyi Benth.; Puccinia Menthae.
Pycnanthemum virginianum (L.) Dur. & Jackson; Puccinia Menthae.
Pyrola americana Sweet; Chrysomyxa Pyrolae.
Pyrus Malus L.; Leptothyrium Pomi, Venturia inaequalis.
Quercus bicolor Willd.; Gnomonia veneta, Microsphaera abbreviata.
Quercus macrocarpa Michx.; Daedalea quercina.
Quercus sp. indet.; Hypoxylon ustulatum, Pezicula cinnamomea.
Ranunculus recurvatus Poir.; Erysiphe Polygoni.
Ranunculus septentrionalis Poir.; Erysiphe Polygoni.
Rhamnus alnifolia L'Her.; Microsphaera Alni, Puccinia coronata.

Rhododendron nudiflorum (L.) Torr., var. **roseum** (Lois.) Wieg.; Microsphaera Alni.
Rhus Toxicodendron L.; Pileolaria Toxicodendri.
Rhus typhina L.; Nectria cinnabarina.
Ribes americanum Nutt.; Puccinia Caricis, var. Grossulariata.
Ribes Cynosbati L.; Cronartium ribicola.
Ribes hirtellum Michx.; Cronartium ribicola, Puccinia Caricis, var. Grossulariata.
Ribes triste Pall., var. **albinervium** (Michx.) Fern.; Cronartium ribicola.
Rubus allegheniensis Porter; Gymnoconia Peckiana.
Rubus occidentalis L.; Gymnoconia Peckiana.
Rubus pubescens Raf.; Sphaerotheca macularis.
Rudbeckia hirta L.; Erysiphe Cichoracearum.
Rudbeckia laciniata L.; Erysiphe Cichoracearum.
Rumex crispus L.; Ovularia obliqua.
Rumex verticillatus L.; Ramularia decipiens.
Sagittaria latifolia Willd.; Doassansia deformans.
Salix alba L., var. **vitellina** (L.) Koch.; Fomes fraxinophilus, Polyporus delectans, Polyporus sulphureus.
Salix amygdaloides Anders.; Melampsora Bigelowii.
Salix Bebbiana Sarg.; Valsa translucens.
Salix discolor Muhl.; Cenangium salicellum, Melampsora Abieti-capraearum, Solenia anomala, Trimmatostroma americanum.
Salix nigra Marsh.; Melampsora Abieti-capraearum, Polyporus squamosus.
Salix purpurea L.; Melampsora Abieti-capraearum.
Salix sericea Marsh.; Uncinula Salicis.
Salix sp. indet.; Cytospora Salicis.
Sambucus canadensis L.; Microsphaera Grossulariae.
Sanicula marilandica L.; Urophlyctis pluriannulatum.
Sarracenia purpurea L.; Mycosphaerella Sarraceniae.
Saururus cernuus L.; Ramularia Saururi.
Scirpus atrovirens Muhl.; Puccinia angustata.
Senecio aureus L.; Puccinia angustata, Puccinia recedens.
Setaria viridis (L.) Beauv.; Sclerospora graminicola.
Silene Cucubalis Wibel.; Marssonina Delastrei.
Sium suave Walt.; Cercospora Sii, Physoderma vagans.
Smilacina stellata (L.) Desf.; Phyllosticta Convallariae.
Solanum Dulcamara L.; Ascochyta Lycopersici, Phyllosticta perforans.
Solidago arguta Ait.; Coleosporium Solidaginis.
Solidago canadensis L.; Coleosporium Solidaginis, Erysiphe Cichoracearum, Puccinia extensicola, var. Solidaginis.
Solidago graminifolia (L.) Salisb.; Coleosporium Solidaginis, Puccinia extensicola, var. Solidaginis.

Solidago nemoralis Ait.; Coleosporium Solidaginis.

Solidago ohioensis Riddell.; Coleosporium Solidaginis, Puccinia extensicola, var. Solidaginis.

Solidago patula Muhl.; Coleosporium Solidaginis.

Solidago rugosa Mill.; Coleosporium Solidaginis.

Solidago serotina Ait.; Coleosporium Solidaginis, Erysiphe Cichoracearum.

Solidago uniligulata (DC.) Porter.; Coleosporium Solidaginis.

Solidago sp. indet.; Helotium scutula, Phoma Solidaginis, Phomopsis linearis, Septoria Davisii.

Sorghastrum nutans (L.) Nash.; Cladosporium graminum, Ellisiella caudata, Vermicularia punctans.

Stachys tenuifolia Willd., var. **aspera** (Michx.) Fern.; Erysiphe Galeopsidis.

Steironema ciliatum (L.) Raf.; Puccinia Dayi, Septoria conspicua.

Tanacetum vulgare L.; Erysiphe Cichoracearum.

Taraxacum officinale Weber; Puccinia Hieracii.

Thalictrum polygamum Muhl.; Tranzchelia Thalictri.

Thuja occidentalis L.; Dacrymyces deliquescens, Coniophora puteana, Flammula sapinea, Helotium indeprensum, Hymenochaete tenuis, Mycena alcalina, Mycena delicatella, Pestalotia funerea, Polyporus abietinus.

Tiarella cordifolia L.; Puccinia Heucherae.

Tilia americana L.; Asteroma Tiliae, Collybia velutipes, Crepidotus putrigenous, Dacrymyces Ellisii, Dendrophoma Tiliae, Exosporium Tiliae, Holwaya leptosperma, Odontia spathulata, Pachyella sp., Phyllosticta Tiliae, Polyporus fumosus, Polyporus pargamenus, Polyporus resinosus, Polyporus tephroleucas, Poria spissa, Seismosarca alba, Tremella frondosa, Uncinula Clintonii.

Trifolium pratense L.; Erysiphe Polygoni, Uromyces Trifolii.

Triglochin palustris L.; Pleospora herbarum, var. Triglochinis.

Trillium grandiflorum (Michx.) Salisb.; Uromyces Halstedii.

Triticum aestivum L.; Puccinia rubigo-vera, var. Tritici, Ustilago nuda.

Tsuga canadensis (L.) Carr.; Clavaria cristata, Dacrymyces deliquescens, Dacrymyces palmatus, Fomes pinicola, Ganoderma lucidum, Gelatinosporium abietinum, Lentinus spretus, Lenzites saepiaria, Omphalia campanella, Paxillus atrotomentosus, Polyporus abietinus, Polyporus resinosus, Pseudoplectania nigrella, Stereum hirsutum, Tremellodon gelatinosus.

Tussilago Farfara L.; Ramularia brunnea.

Typha latifolia L.; Cladosporium herbarum, Scolecotrichum Typhae.

Ulmus americana L.; Clavaria mucida, Cytospora sp., Daedalea confragosa, Ganoderma applanatum, Nectria cinnabarina, Phyllosticta ulmicola, Piggotia astroidea, Pleurotus ulmarius, Polyporus croceus, Polyporus elegans, Polyporus fumosus, Polyporus gilvus, Polyporus versicolor, Sphaeropsis ulmicola.

Ulmus sp. indet.; Coprimus micaceus, Karschia lignyota, Lentinus lepideus, Lentinus vulpinus, Poria fissiliformis, Rosellinia aquilla.

Urtica procera Muhl.; Puccinia Caricis, var. Urticata.

Vaccinium Oxycoccus L.; Synchytrium Vaccinii.

Vaccinium sp. indet.; Exobasidium Vaccinii.

Verbena urticaefolia L.; Erysiphe Galeopsidis.

Veronica longifolia L.; Sphaerotheca Humuli, var. fuliginea.

Viburnum Lentago L.; Microsphaera Alni.

Vicia villosa Roth.; Uromyces Fabae.

Viola blanda Willd.; Puccinia Violae.

Viola incognita Brainerd.; Puccinia Violae.

Viola pubescens Ait.; Puccinia Violae.

Viola renifolia Gray, var. **Brainerdii** Fern.; Puccinia Violae.

Vitis vulpina L.; Phyllosticta viticola, Plasmopara viticola.

Xanthium orientale L.; Erysiphe Cichoracearum.

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THE VEGETATION OF BERGEN SWAMP

VII. The Bryophytes

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The present survey is intended to supplement the analyses of other plant groups in Bergen Swamp in Genesee County, N. Y., either completed (Muenscher, 1946, 1948, Brown, 1948) or now in progress. The work of collecting mosses and liverworts was begun in 1944 and carried forward to 1949. By then the number of bryophyte collections had risen to 1035 and these were held sufficient to warrant a summation to date. No implication is made, however, as to the exhaustiveness of this study; further careful collecting undoubtedly will yield additional species.

To a great extent the sampling error deriving from the work of a single collector has been overcome by a joint effort. The writer is indebted to several workers from the Department of Botany, Cornell University who have generously "picked mosses" while visiting the Swamp for other purposes. Chief among these is Professor W. C. Muenscher whose efforts account for more than half the collections and without whose inspiration there is little likelihood the survey would have been begun. Once undertaken the interest of the work has increased from the peculiar fascination of the Swamp and the associated plant species growing there.

In process of completion the report has benefited materially by the helpful criticism of Professor Muenscher and by the light shed on the analysis of certain critical species by Dr. A. L. Andrews. Dr. B. I. Brown has furthered the inclusiveness of the species list by the addition of four species representing recent collections.

The relative richness of the bryophyte flora of Bergen Swamp is best emphasized by comparing its area with that of North America north of Mexico and by following this with a comparison of the incidence of bryophyte taxonomic groups in the two areas. Such a comparison is summarized in the following table.

Total	North America north of Mexico	Bergen Swamp	Percentage of Total in Bergen Swamp
Area	8,264,772 sq. mi.	5 sq. mi.	0.00006
Bryophyte Families	72	38	51.0
Bryophyte Genera	335	91	27.0
Bryophyte Species	1585	165	11.0

This relatively great concentration in so limited an area, 41 species representing 33 genera of Hepaticae and 122 species and 3 varieties representing 91 genera of Musci, could be realized only by a considerable diversity of ecologic factors within Bergen Swamp. These factors are summarized in the ten vegetation types postulated by Muenscher (1946).

It is the present purpose to add the bryophytic units to the ten vegetation types represented in the Swamp. The species occurring commonly on boulders mostly in areas 7, 8, 9 and 10 have been listed in group 11.

1. AQUATIC PLANTS

Ricciocarpus natans
Riccia fluitans
Fissidens Julianus
Brachythecium acutum
Brachythecium rivulare
Drepanocladus fluitans
Hygroamblystegium fluviatile
Hygroamblystegium irriguum
Leptodictyum riparium
Fontinalis dalecarlica
Fontinalis Duriaei
Fontinalis novae-angliae
Fontinalis novae-angliae var. latifolia

2. CAREX RIPARIA SWAMP

Leptodictyum riparium
Fontinalis novae-angliae
Fontinalis novae-angliae var. latifolia

3. ALLUVIAL SOIL PLANTS

Grimmia alpicola

4. OPEN MARL BOG

Riccardia pinguis
Campylium stellatum
Drepanocladus revolvens
Scorpidium scorpioides

5. SECONDARY MARL BOG

Blepharostoma trichophyllum
Dicranum Bonjeani
Dicranum fuscescens
Tortella fragilis
Tortella tortuosa
Thuidium abietinum

(A test plot in the secondary marl received an application of 5–10–5 fertilizer. Funaria hygrometrica, Physcomitrium turbinatum, and Bryum bimum appeared abundantly in this treated area.)

6. SPHAGNUM BOG

Microlepidozia setacea
Cephalozia connivens
Cephalozia media
Mylia anomala
Geocalyx graveolens
Pellia epiphylla
Pallavicinia Lyellii
Riccardia latifrons
Riccardia palmata
Riccardia pinguis
Sphagnum capillaceum
Sphagnum fuscum
Sphagnum Girgensohnii
Sphagnum palustre
Dicranella varia
Aulacomnium palustre
Bryum bimum

7. ARBOR-VITAE SWAMP

Lepidozia reptans
Calypogeia Neesiana
Cephalozia connivens
Cephalozia media
Odontoschisma denudatum
Cephaloziella myriantha
Geocalyx graveolens
Jamesoniella autumnalis
Riccardia pinguis
Marchantia polymorpha
Preissia quadrata
Sphagnum capillaceum
Sphagnum fimbriatum
Sphagnum fuscum
Sphagnum Girgensohnii
Sphagnum palustre
Sphagnum Warnstorfii
Tetraphis pellucida
Polytrichum juniperinum
Fissidens adiantoides
Fissidens cristatus
Dicranella heteromalla
Dicranum flagellare
Dicranum fuscescens

7.—continued.

Dicranum montanum
Dicranum rugosum
Paraleucobryum longifolium
Leucobryum glaucum
Bryum bimum
Bryum caespiticium
Bryum capillare
Pohlia Wahlenbergii
Mnium punctatum
Amblystegium varium
Calliergonella cuspidata
Calliergonella Schreberi
Camptothecium nitens
Campylium stellatum
Entodon cladorrhizans
Eurhynchium strigosum
Hypnum cupressiforme
Hypnum Patientiae
Hypnum reptile
Platygyrium repens
Rhytidiadelphus triquetrus
Thuidium delicatulum
Thuidium recognitum

8. ALDER SWAMP

Ptilidium pulcherrimum
Calypogeia Neesiana
Cephalozia bicuspidata
Geocalyx graveolens
Porella platyphylla
Fissidens adiantoides
Brachythecium salebrosum
Climacium americanum

9. PINE-HEMLOCK FOREST

Ptilidium pulcherrimum
Trichocolea tomentella
Calypogeia Trichomanis
Cephalozia connivens
Cephalozia media
Nowellia curvifolia
Odontoschisma denudatum
Lophocolea heterophylla
Geocalyx graveolens
Jungermannia lanceolata
Riccardia latifrons
Sphagnum capillaceum
Sphagnum fimbriatum
Sphagnum fuscum
Sphagnum imbricatum var. affine
Sphagnum magellanicum
Sphagnum palustre
Sphagnum squarrosum
Sphagnum Warnstorfii
Tetraphis pellucida
Atrichum undulatum
Fissidens adiantoides
Dicranum flagellare
Dicranum scoparium
Barbula unguiculata
Bryum bimum
Pohlia nutans
Mnium spinulosum
Amblystegium Juratzkanum
Brotherella recurvans
Climacium americanum
Cratoneuron commutatum
Hypnum imponens
Hypnum molluscum
Hypnum Patientiae
Hypnum reptile
Plagiothecium denticulatum
Thuidium delicatulum

10. BIRCH-MAPLE-ELM FOREST

Bazzania trilobata
Calypogeia Trichomanis
Cephalozia catenulata
Cephalozia media
Nowellia curvifolia
Odontoschisma denudatum
Lophocolea heterophylla
Chiloscyphus pallescens
Geocalyx graveolens
Barbilophozia barbata
Jamesoniella autumnalis
Porella platyphylloidea
Frullania eboracensis
Cololejeunea Biddlecomiae
Pellia epiphylla
Moerckia Flotowiana
Conocephalum conicum
Tetraphis pellucida
Atrichum undulatum
Fissidens cristatus
Ceratodon purpureus
Seligeria campylopoda
Dicranella varia
Dicranum flagellare
Dicranum scoparium
Acaulon rufescens
Encalypta ciliata
Hedwigia ciliata
Ulota crispa
Aulacomnium heterostichum
Bryum bimum
Bryum caespiticium
Bryum capillare
Bryum cuspidatum
Rhodobryum roseum
Mnium affine
Mnium cuspidatum
Mnium punctatum
Amblystegium Juratzkanum
Amblystegium serpens

10.—continued.

Amblystegium varium
Brachythecium oxycladon
Brachythecium rutabulum
Calliergon cordifolium
Campylium chrysophyllum
Campylium hispidulum
Campylium polygamum
Climacium americanum
Cratoneuron filicinum
Entodon seductrix
Heterophyllum Haldanianum
Homomallium adnatum
Hypnum curvifolium
Hypnum imponens
Plagiothecium denticulatum
Plagiothecium sylvaticum
Platygyrium repens
Leskea polycarpa
Thelia hirtella

11. BOULDERS

Seligeria campylopoda	c *
Encalypta ciliata	g
Weisia viridula	c
Grimmia hygrometrica	g
Hedwigia ciliata	g
Orthotrichum anomalum	c
Bryum argenteum	
Bryhnia nova-angliae	
Campylium hispidulum	

* c = calcareous; g = granitic

ANNOTATED LIST OF THE BRYOPHYTES OF BERGEN SWAMP

The binomials used in the following list of 165 species correspond with those last published by the Sullivant Moss Society, Andrews (1940), Evans (1940), Grout (1940). Because of the number of collectors involved it has seemed desirable to note the times collected for each species. These are indicated by numbers concluding the note on each species. This figure will serve as a rough estimate of the species' abundance in most cases. Certain species as *Sphagnum capillaceum, Camptothecium nitens, Drepanocladus revolvens,* and *Drepanocladus aduncus* occur locally in great masses, so that the number of times collected is a poor criterion of their relative importance in the Swamp flora.

All identifications are based on microscopic examinations of leaf and stem water mounts. A compound microscope giving magnifications of 100 and 440 was used. Packets of dried material of each species have been deposited in the Wiegand Herbarium of Cornell University and also in the writer's herbarium at Union College.

Hepaticae — Liverworts

PTILIDIACEAE

Blepharostoma trichophyllum (L.) Dumort. On rotting wood about marl pools, 2.

Ptilidium pulcherrimum (Web.) Hampe. On bark of living tree trunks and on rotting logs, 23.

Trichocolea tomentella (Ehrh.) Dumort. On swampy humus under evergreens, 6.

LEPIDOZIACEAE

Bazzania trilobata (L.) S. F. Gray. On humus among hardwoods, 4.

Lepidozia reptans (L.) Dumort. On rotting *Thuja occidentalis,* 4.

Microlepidozia setacea (Web.) Joerg. On the base of sphagnum hummocks near the water table, 4.

CALYPOGEIACEAE

Calypogeia Neesiana (Massal. & Carest.) K. Müll. Abundant on shaded humus or rotting wood, 8.

Calypogeia Trichomanis (L.) Corda Abundant on humus, 15.

CEPHALOZIACEAE

Cephalozia bicuspidata (L.) Dumort. On sticks and tree bases, 5.

Cephalozia catenulata (Hüben.) Spruce On rotting wood, 3.

Cephalozia connivens (Dicks.) Lindb. On rotting wood, 6.

Cephalozia media Lindb. Abundant on humus, 15.

Nowellia curvifolia (Dicks.) Mitt. On rotting logs, 6.

Odontoschisma denudatum (Mart.) Dumort. Abundant on much rotted logs and stumps, 6.

CEPHALOZIELLIACEAE

Cephaloziella myriantha (Lindb.) Schiffn. Shaded *Thuja occidentalis* log, 1.

HARPANTHACEAE

Chiloscyphus pallescens (Ehrh.) Dumort. Shaded muck and rotted log, 2.

Geocalyx graveolens (Schrad.) Nees. Shaded humus, 18.

Lophocolea heterophylla (Schrad.) Dumort. On bark of living tree trunks and rotted wood, 29.

Mylia anomala (Hook.) S. F. Gray Sphagnum hummocks, 4.

PLAGIOCHILACEAE

Plagiochila asplenoides (L.) Dumort. On lower trunk of *Ulmus americana,* 1.

JUNGERMANNIACEAE

Barbilophozia barbata (Schmid.) Loeske. Near base of *Ulmus americana,* 1.

Jamesoniella autumnalis (DC.) Steph. Rotting wood, 6.

Jungermannia lanceolata L. Humus earth, 2.

PORELLACEAE

Porella pinnata (L.) Dumort. Common on base of *Acer rubrum,* 1.

Porella platyphylla (L.) Lindb. Base of *Salix amygdaloides,* 1.

Porella platyphylloidea (Schwein.) Lindb. Base of trees, 10.

RADULACEAE

Radula complanata (L.) Dumort. Common on bark of hardwood tree trunks, 24.

FRULLANIACEAE

Frullania eboracensis Gottsche On bark of tree trunks, 21.

LEJEUNEACEAE

Cololejeunea Biddlecomiae (Aust.) Evans. Common on bark of tree trunks, 14.

PELLIACEAE

Pellia epiphylla (L.) Corda Rotting logs, 3.

PALLAVICINIACEAE

Moerckia Flotowiana (Nees) Schiffn. In marly depression, 3.
Pallavicinia Lyellii (Hook.) S. F. Gray On debris of *Typha latifolia* at water level, 1.

RICCARDIACEAE

Riccardia latifrons Lindb. On sphagnum hummocks and moist wood in marly parts, 10.
Riccardia multifida (L.) Dumort. Shaded sphagnum tussocks over muck, 3.
Riccardia pinguis (L.) S. F. Gray Emergent on sphagnum about pools in marl area, 15.

MARCHANTIACEAE

Conocephalum conicum (L.) Dumort. On shaded wet soil and rotting wood, 8.
Marchantia polymorpha L. On humus in wet depression, 9.
Preissia quadrata (Scop.) Nees. On humus above marl water, 6.

REBOULIACEAE

Reboulia hemisphaerica (L.) Raddi. Moist sandy soil, 1.

RICCIACEAE

Riccia fluitans L. Floating among algae in cattail marsh, 3.
Ricciocarpus natans (L.) Corda On muck among *Cephalanthus occidentalis*, 7.

Musci — Mosses

SPHAGNACEAE

Sphagnum capillaceum (Weiss) Schrank Forming hummocks in marl pool area and in encircling forest, 14.
Sphagnum fimbriatum Wils. Swampy humus in coniferous zone, 7.
Sphagnum fuscum (Schimp.) H. Klinggr. Forming hummocks in sphagnum area. 10.
Sphagnum Girgensohnii Russow Forming hummocks in sphagnum area, 2.
Sphagnum imbricatum var. affine (Ren. & Card.) Warnst. On mucky humus in forest, 2.
Sphagnum magellanicum Brid. On muck in drying forest pool, 1.

Sphagnum palustre L. Over swampy forest humus, occasional in hummocks of sphagnum area, 9.

Sphagnum squarrosum Crome Humus depressions under *Thuja occidentalis,* 5.

Sphagnum Warnstorfii Russ. Forming tussocks in *Thuja occidentalis* zone, occasional in hummocks of sphagnum area, 4.

TETRAPHIDACEAE

Tetraphis pellucida Hedw. Common on shaded humus, 19.

POLYTRICHACEAE

Atrichum angustatum (Brid.) Bry. Eur. In cut-over area in cedar swamp, 1.

Atrichum undulatum (Hedw.) Beauv. Shaded humus soil, 2.

Polytrichum commune L. On open ridges, 2.

Polytrichum juniperinum Hedw. Humus soil, 4.

Polytrichum ohioense Ren. & Card. In swampy swale, 1.

Polytrichum strictum Banks On soil beside rotting logs, 2.

FISSIDENTACEAE

Fissidens adiantoides Hedw. Shaded humus, 15.

Fissidens cristatus Wils. Rotted wood, 4.

Fissidens Julianus (Mont.) Schimp. Immersed in pool attached to root of *Acer saccharinum,* 1.

DITRICHACEAE

Ceratodon purpureus (Hedw.) Brid. Soil, logs, sawdust pile, 6.

SELIGERIACEAE

Seligeria campylopoda Kindb. On calcareous boulder, 1.

DICRANACEAE

Dicranella heteromalla (Hedw.) Schimp. Shaded humus soil, 3.

Dicranella varia (Hedw.) Calcareous earth, 2.

Dicranum Bonjeani DeNot. Dry humus marl, 2.

Dicranum flagellare Hedw. Rotting wood and bark of living trees, 17.

Dicranum fuscescens Turn. On trees and moist humus, 3.

Dicranum montanum Hedw. Rotting wood and bark of living trees, 12.

Dicranum rugosum (Hoffm.) Brid. On humus in drying pools, 2.

Dicranum scoparium Hedw. Rotting wood and humus, 5.

Paraleucobryum longifolium (Hedw.) Loeske Humus in marl area, 2.

LEUCOBRYACEAE

Leucobryum glaucum (Hedw.) Schimp. Shaded humus soil, 2.

ENCALYPTACEAE

Encalypta ciliata Hedw. Granite boulders, 2.

POTTIACEAE

Acaulon rufescens Jaeger. Earth at base of *Ulmus americana,* 1.
Barbula fallax Hedw. On log, subject to immersion, 1.
Barbula unguiculata Hedw. Decaying log, 1.
Didymodon tophaceus (Brid.) Jur. Rotting wood in marl water, 1.
Tortella fragilis (Hook. & Wils.) Limpr. On marly peat, 1.
Tortella tortuosa (Turn.) Limpr. On dry marl, 2.
Weisia viridula Hedw. Calcareous rock, 2.

GRIMMIACEAE

Grimmia alpicola Hedw. Granite boulders, 4.
Hedwigia ciliata Hedw. Granite boulders, 4.

FUNARIACEAE

Funaria hygrometrica Hedw. Soil and rocks, 5.
Physcomitrium turbinatum (Mx.) Brid. On fertilized plot in marl, 1.

ORTHOTRICHACEAE

Orthotrichum anomalum Hedw. On lime rocks, 2.
Orthotrichum strangulatum Sulliv. On trunks of living trees, 3.
Ulota crispa (Hedw.) Brid. Bark of living trees, 10.

AULACOMNIACEAE

Aulacomnium heterostichum (Hedw.) Bry. Eur. On humus, 2.
Aulacomnium palustre (Web. & Mohr) Schwaegr. Moist humus, 5.

BRYACEAE

Bryum argenteum (L.) Hedw. On rock, 1.
Bryum bimum Schreb. Humus and humus soils, 16.
Bryum caespiticium (L.) Hedw. Various humus substrates, 10.
Bryum capillare L. Base of trees, 2.
Bryum cuspidatum (Bry. Eur.) Schimp. Rotting sticks in muck, 1.
Bryum cernuum (Sw.) Lindb. On sawdust pile, 1.

Pohlia nutans (Hedw.) Lindb. Moist humus, 6.
Pohlia Wahlenbergii (Web. & Mohr) Andrews. Humus, 1.
Rhodobryum roseum (Bry. Eur.) Limpr. Humus soil, 7.

MNIACEAE

Mnium affine Bland. On moist humus at margin of forest pool, 2.
Mnium cuspidatum Hedw. Humus, 6.
Mnium punctatum Hedw. Various humus substrates, 7.
Mnium punctatum var. **elatum** Schimp. Over moist sticks in marshy spring, 1.
Mnium spinulosum Bry. Eur. Humus soil, 1.
Mnium stellare Reich. Rotted log, 1.

HYPNACEAE

Amblystegiella subtilis (Hedw.) Loeske Base of *Salix amygdaloides* in marshy spring area, 1.
Amblystegium Juratzkanum Schimp. Rotting logs, 2.
Amblystegium serpens (Hedw.) Bry. Eur. Wood and stones in moist places, 9.
Amblystegium varium (Hedw.) Lindb. On shaded humus, 21.
Brachythecium acutum (Mitt.) Sull. Immersed or emergent on sticks, 5.
Brachythecium oxycladon Jaeger & Sauerb. On living trees and humus soils, 25.
Brachythecium rivulare Bry. Eur. Emergent on soil, stones, and sticks, 9.
Brachythecium rutabulum (Hedw.) Bry. Eur. Humus, 4.
Brachythecium salebrosum (Web. & Mohr) Bry. Eur. On humus soil and sticks, 6.
Brotherella recurvans (Mx.) Fleisch. On living trees, humus soil and sticks, 15.
Bryhnia novae-angliae (Sull. & Lesq.) Grout On rock, 1.
Calliergon cordifolium (Hedw.) Kindb. Emergent in mucky pools, 5.
Calliergon trifarium (W. and M.) Kindb. Immersed on base of hummocks in marl pools, 1.
Calliergonella cuspidata (Brid.) Loeske On much rotted logs and humus swales, 5.
Calliergonella Schreberi (Bry. Eur.) Grout On humus hummocks, 3.
Camptothecium nitens (Schreb.) Schimp. Humus at margin of marly area, 3.
Campylium chrysophyllum (Brid.) Bryhn Humus soil, living trees, and sticks in moist shaded places, 23.
Campylium hispidulum (Brid.) Mitt. On rock, 1.
Campylium polygamum (Bry. Eur.) Bryhn Immersed, attached to sticks, 2.

Campylium stellatum (Hedw.) Lange & C. Jens. Abundant over soil, sticks, other mosses, etc. in marl area of Swamp, 24.
Climacium americanum Brid. Humus and wet humus soils, 7.
Cratoneuron commutatum (Hedw.) Roth Swampy humus, 1.
Cratoneuron filicinum (Hedw.) Roth. Partly flooded mucky soil, 7.
Drepanocladus aduncus var. **Kneiffii** (Bry Eur.) Warnst. Immersed in pools and sluggish streams, 10.
Drepanocladus aduncus var. **typicus** (Ren.) Wynne Immersed and emergent, carpeting several acres of cattail swale at the west end of Swamp, 13.
Drepanocladus exannulatus (Gümb.) Warnst. Emergent from cool marly pools, 6.
Drepanocladus fluitans (Hedw.) Warnst. Immersed in swampy inlet, west end of Swamp, 6.
Drepanocladus revolvens (Turn.) Warnst. Abundant about the marl pools, 9.
Entodon cladorrhizans (Hedw.) C. Mull. Rotted wood, 1.
Entodon seductrix (Hedw.) C. Mull. Shaded humus, 4.
Eurhynchium rusciforme (Neck.) Milde Humus soil, stream margin, 1.
Eurhynchium strigosum (Hoffm.) Bry. Eur. Shaded boulder and log, 2.
Heterophyllum Haldanianum (Grev.) Kindb. Rotted logs, 3.
Homomallium adnatum (Hedw.) Broth. Granite rocks and tree trunks, 7.
Hygroamblystegium fluviatile (Hedw.) Loeske. Spillway of dammed pond, west end of Swamp, 1.
Hygroamblystegium irriguum (Wils.) Loeske Immersed and emergent, swamp pool, 2.
Hypnum cupressiforme Hedw. *Thuja occidentalis* log, 1.
Hypnum curvifolium Hedw. Rotted sticks and humus, 4.
Hypnum imponens Hedw. On tree trunks and humus, 9.
Hypnum molluscum Hedw. Rotted log of *Tsuga canadensis,* 1.
Hypnum Patientiae Lindb. Logs and humus soil in shaded wet places, 13.
Hypnum reptile Mx. On tree trunks and rotting wood, 6.
Leptodictyum riparium (Hedw.) Warnst. Immersed and emergent on sticks and rocks, 20.
Plagiothecium denticulatum (Hedw.) Bry. Eur. On tree trunks and shaded humus, 29.
Plagiothecium turfacium Lindb. On hummocks in woods, 1.
Plagiothecium sylvaticum (Brid.) Bry. Eur. Humus, 2.
Platygyrium repens (Brid.) Bry. Eur. Bark of living trees, 34.
Pylaisia intricata (Hedw.) Bry. Eur. On base of trees, 1.
Rhytidiadelphus triquetrus (Hedw.) Warnst. Over humus of drying pools, 1.

Scorpidium scorpioides (Hedw.) Limpr. Immersed in pools, open marl area, 3.

LESKEACEAE

Anomodon attenuatus (Hedw.) Hüben. On humus over rocks, 23.
Anomodon rostratus (Hedw.) Schimp. On moist humus, 2.
Leskea polycarpa Hedw. Logs and tree bases, 5.
Thelia hirtella (Hedw.) Sull. Over roots of *Acer rubrum*, 1.
Thuidium abietinum (Brid.) Bry. Eur. Humus and marly peat, 2.
Thuidium delicatulum (Hedw.) Mitt. On moist shaded humus, 17.
Thuidium recognitum (Hedw.) Lindb. Humus, 1.

LEUCODONTACEAE

Leucodon sciuroides (L.) Schwaeg. On exposed trunks of trees, 4.

FONTINALACEAE

Fontinalis dalecarlica Bry. Eur. Immersed on stones, Black Creek, 1.
Fontinalis Duriaei Schimp. Immersed in open pool, 1.
Fontinalis novae-angliae Sull. Swamp brooks and pools and Black Creek, 9.
Fontinalis novae-angliae var. **latifolia** Card. Black Creek and pools, 10.

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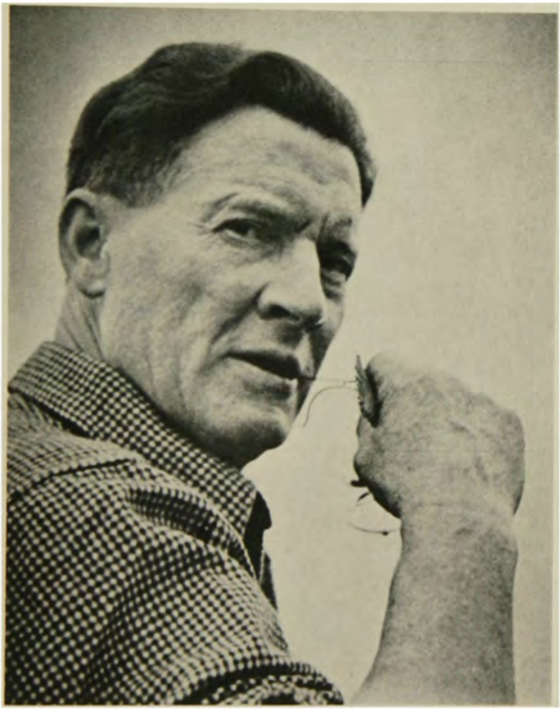

SHERMAN C. BISHOP
1887-1951

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SHERMAN BISHOP was a naturalist from childhood; and his fascinated study of the ballooning spider, the hibernating snake, the spawning fish was a bright thread in the fabric of his adult life. Out of this, perhaps, grew his abiding concern and outspoken efforts for sound policies to conserve and replenish the wild life of this state.

As a student of Wright and Crosby at Cornell and by his own later independent work, he became an eminent arachnologist and herpetologist, constantly consulted by others. His best-known work was his Handbook of Salamanders. Out of his studies also came a rich and steady harvest of 131 papers or monographs since 1911 and valuable collections, particularly of arachnids and amphibians. These specimens, now deposited in the American and Chicago Museums of Natural History, will continue to serve students and investigators. Other fruits of his work will gradually ripen as specialists at these museums and at Cornell and Florida bring into print his unpublished research notes, illustrations, bibliographies and records, and so long as some twenty-four persons who were his graduate students at the University of Rochester since 1928 remain productive biologists.

He was a wonderful man. Son of a church organist and grandson of a minister, brought up in a small town, he saw the world in terms mostly of individuals, seldom of institutions. He was sometimes refractory towards the rules and formalities of social aggregates, but the image of courtesy and considerateness to any person singly. He was a great raconteur, his stories being set in the Clyde of his youth, the top of a mountain in North Carolina, Cornell, the Okefenokee swamp, the State Museum of New York, or any place he had been and worked. His was the rare gift of winning lasting friendships wherever he went, uncourted except by his unconscious charm; his was the good fortune of the man whose work is also his play and rest.

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THE VEGETATION OF BERGEN SWAMP

VIII. The Lichens

BABETTE I. BROWN[1]

Among the plants comprising the vegetation of Bergen Swamp certainly none are less familiar generally than the lichens. Small indeed are their thalli, or plant bodies; yet they cover the sides of stumps, fallen logs, occasional fence rails, drier soil in exposed, cut-over areas, and even the tree trunks in certain zones of the swamp. Thus, en masse, they can hardly be called inconspicuous. Lichens are unusual plants in that they consist of aggregations of organisms. Each lichen is a unit composed of two different species of plants living together harmoniously, intimately and so successfully that the resulting thallus may assume one of several vegetative forms:—a continuous or areolate crust—an assemblage of small leaf-like structures—a larger, spreading, irregular, more or less flattened expanse of tissue—or an erect or dependent, intricately branched, minute or extensive mass. In brief, the life form of a lichen may be crustose, squamulose, foliose or fruticose with a varying amount of the thallus within, on or free from the substratum. Thalli vary in color from white, pale or ashy gray to green, brilliant yellow, orange, olive, brown and black.

In each such thallus the hyphal, colorless threads of a fungus (which in the majority of lichens belongs to the Ascomycetes, or in a few to the Basidiomycetes or Fungi Imperfecti) constitute the bulk of the plant. Enmeshed among the fungus hyphae, which usually have a definite pattern of organization, is to be found, typically close to the top surface, a gonidial layer of algae composed of numerous cells belonging to one of the genera of Myxophyceae or Chlorophyceae. When, in 1867, Schwendener enunciated the hypothesis of the dual and composite nature of lichens, he believed the relationship between fungus and alga to be one of some sort of parasitism. Reinke, however, pointed out that in a lichen one plant is not eventually destroyed by the other, but that the lichen represents a state of interdependence and mutual growth in which a kind of organism different from either of its constituents is produced. The term consortium was suggested by him to describe the reciprocal parasitism between the alga and the fungus of a lichen. Somewhat later, DeBary, seeing in the lichen partnership a situation beneficial, though not always in equal degree, to both partners, designated it a case of symbiosis. No more successful examples of symbiotic relationship are to be found in nature than the lichens. Investigations have shown that the fungus partner absorbs and holds moisture, also obtains and supplies certain substances including compounds

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of nitrogen and carbon and, in addition, protects the algal cells from severe desiccation. The component algae for their part synthesize carbohydrates from which the fungus certainly derives some of the energy required for its growth.

Ecologists agree that lichens are among the early colonizers of new surfaces of the earth which become available for occupancy by plants and that they are among the initiators of the cycle of plant succession known as the xerosere. In high latitudes and altitudes lichens may form climax communities. Essential factors for their development include fresh, pure air and abundant light. Water in some form, as fog, dew, clouds, rain, etc., must be available to lichens at certain periods, although they are remarkably successful in withstanding prolonged periods of desiccation, intense insolation and high winds. Rock walls, shelves and ledges, as well as isolated boulders, offer excellent situations for the growth of lichens with little competition from other organisms. Poor, sandy, leached out and thin soils are frequently well populated with certain kinds of lichens as is also the bark of living tree trunks and branches. Various lichens, seeming to prefer a more organic substratum, colonize rotting stumps and logs while others invade the moist base of living trees and the soil below trees in forests and shrubs in bogs and swamps. A few lichen genera have representatives that grow best on rocks in flowing water or in the intertidal zone along the seacoast. Such diversity of habitat has led certain workers to recognize different communities of lichens based on differences in the substratum on which they grow.

Prominent communities of lichens in Bergen Swamp have been noted. Arboreal communities include associated lichens found on leaves, on bark and on wood, epiphyllous, corticolous and lignicolous communities, respectively. Thus far no communities of the first type have been found. A conspicuous corticolous community, growing on trees in the alluvial zone of the swamp along Black Creek, includes among its dominant members *Candelaria concolor* var. *effusa, Physica tribacia, P. endochrysea, P. hispida* and *Parmelia sulcata*. These species may or may not all be present together on any given tree and invariably are accompanied by one or several of the following: *Parmelia rudecta, P. caperata, P. olivacea, Physcia stellaris* or *P. pulverulenta* and *Graphis scripta*. On *Thuja occidentalis* in the cedar swamps a limited community consisting of *Parmelia rudecta, P. sulcata* and *P. physodes* occurs while around the base of hemlocks in another zone of the swamp a *Cladonia* community embracing *Cladonia coniocraea* and its common forms, *C. cristatella* and *C. caespiticia* has been observed.

Lignicolous communities on prostrate logs and rotting stumps are dominated by *Cladoniae*. In those on stumps, *C. coniocraea, C. cristatella* and *C. chlorophaea* are most common but scattered among these are *C. macilenta, C. Grayi* f. *cyathiformis* and *C. caespiticia*. Communities on decaying logs consistently include *C. coniocraea* in several forms with varying admixtures of *C. cristatella, C. chlorophaea,* and their varieties and forms along with *C. Grayi* f. *cyathiformis, C. gracilis, C. verticillata, C. caespiticia, C. conista* and in small amounts others such as, *C. pyxidata, C. delicata* f. *quercina, C. squamosa, C. fimbriata, C. cryptochlorophaea, C. bacillaris* and *C. cylindrica.*

Terricolous communities on duff and humus in wooded areas of the swamp are fewer than the lignicolous communities and are dominated likewise by *C. coniocraea* with *C. conista, C. cristatella* and often *C. Grayi* as secondary species and a scattering of one or several others such as, *C. chlorophaea, C. macilenta* and *C. gracilis.* On certain peaty hummocks in the open marl zone of the swamp *C. glauca, C. squamosa, C. verticillata* and *C. conista* may be found in a common association, but on other hummocks where there appears to have been some disturbance pure stands of *C. rangiferina* abound. In moist, shady woodlands on soil pure stands of *C. furcata* occur.

Glacial boulders, the only available rock substrate for lichens, are of sandstone, limestone and granite principally. Intermixed on all types are communities including *Candelariella sp., Lecanora spp., Caloplaca sp.* and *Lecidea spp.,* these being less conspicuous among the saxicolous lichens of the swamp than *Parmelia conspersa* which is more prominent and more abundant than the smaller crustose lichens.

Of the approximately forty-six families of lichens recognized today, only seventeen appear to be represented in Bergen Swamp. Although the swamp provides a wide variety of habitats for higher plants, especially the Angiosperms, there is less variety in the habitats available for lichens. The shady character of many of the forested areas in the swamp offers less direct sunlight than that required by many lichens. The relatively uniform terrain provides no altitudinal variation. Glaciation has covered the underlying bedrock of the swamp with till, among which relatively few glacial boulders of granite, limestone and sandstone supply a paucity of rock surface for colonization. The most abundant habitats are those of stumps, decaying fallen trees, the trunks and branches of living trees and the swamp forest floor. Several pastures on the north and south sides of the swamp with their scattered boulders, drier soil and old cedar fences contribute a little more variety of habitat. Neither the numerous hardwater springs, which come to the surface in the hardwood and cedar swamps, nor Black Creek with its normally turbid waters appear to offer much inducement to lichens. Bergen Swamp, therefore, does not possess a rich lichen flora though its lichen vegetation may be somewhat conspicuous. This can be attributed to the lack of rock habitats available for invasion and the predominance of swamp forest conditions permitting the dominance of other plants in the successional history.

Best developed among the genera of lichens in the swamp is the genus *Cladonia* represented by some twenty–eight species and their numerous varieties and forms. This situation may be expected since, as stated by Evans (1930), the majority of the Cladoniae "require or prefer soil as a substratum". Those species of *Cladonia* which grow well on rotting tree trunks and stumps flourish in the swamp and are frequently found in mixed stands of several species, as indicated above, each species often represented by several, different, recognized forms.

The genus *Parmelia,* with seven species, follows *Cladonia* in number of species found in the swamp. The *Parmeliae* inhabit the bark of living trees except for *Parmelia conspersa,* the most conspicuous of the epilithic lichens in the swamp.

Physcia is another genus with several species accounting for its presence in the swamp. Species of *Physcia* are particularly well developed in communities on the bark of hardwoods in the alluvial area.

Most genera of lichens found in Bergen Swamp are represented by only one or a few species, and most of these do not appear to occur in very great abundance. The lichen flora of the swamp, therefore, to borrow a term from the algologists, appears to be "Baltic" in character, that is, consisting of relatively few species. Some of these, a definite minority, however, do occur in pronounced abundance.

All zones of the swamp have been visited and studied in preparing the catalogue of the lichens, but all parts of the swamp have not yet been explored thoroughly. Although it seems unlikely that any of the abundant and conspicuous lichens might have been overlooked, it is nevertheless true that further exploration in certain areas will undoubtedly yield additional species, especially of the crustose types.

The writer is indebted to Professor W. C. Muenscher of Cornell University for his interest in the lichens of the swamp and his assistance in making the collections. She is grateful to Professor A. W. Evans of Yale University and to Mr. Mason Hale for help in the determination of the *Cladoniae,* to Dr. John W. Thomson of the University of Wisconsin for checking determinations in the genus *Peltigera,* to Mr. G. G. Nearing for helpful suggestions regarding the identity of various crustose lichens, to Dr. Grace E. Howard of Wellesley College for verifying and assisting in the determination of a number of specimens in several difficult genera and to Mrs. Volney H. Jones for determining *Bacidia Schweinitzii* (Tuck.) Schneid. and *Bilimbia lignaria* (Ach.) Mass.

In the following annotated list of the lichens of Bergen Swamp data based on observation of the frequency of occurrence, habitat and in most cases zone of the swamp, numbers of the herbarium specimens and, when pertinent, other comments are supplied. Statements regarding frequency are based on the following scale:

1 – 3 stations	= Rare
4 – 9 stations	= Infrequent
10 – 20 stations	= Common
21 or more stations	= Abundant

Herbarium specimens of most of the lichen species and their varieties and forms from the same stations and the same collection so that they bear the same collection number have been deposited in the lichen collection at Cornell University, the lichen herbarium of the New York Botanical Garden and the personal herbarium of the author. Several species previously reported from Bergen Swamp (Brown, 1948) have been omitted from the series of specimens.

The annotated list follows the taxonomic arrangement and the nomenclature used in Fink's *Lichens of the United States* except for the *Cladoniae* which are arranged according to the system recently suggested by Mattick (1940). Nomenclature for varieties and forms of *Cladonia* is that found in the work of Evans (1930–1950); that for varieties and forms of *Peltigera* follows Thomson (1950).

ANNOTATED LIST OF THE LICHENS OF BERGEN SWAMP

Verrucariaceae

Verrucaria nigrescens Pers. Infrequent with other crustose lichens, on sandstone and limestone boulders particularly along the borders of the swamp, 50.

Pyrenulaceae

Pyrenula nitida (Weig.) Ach. Infrequent on the bark of hardwoods.

Graphidaceae

Graphis scripta (L.) Ach. Common on bark of hardwoods.

Diploschistaceae

Urceolaria actinostoma Pers. Rare on glacial boulders, 530.
Urceolaria scruposa (Schreb.) Ach. Rare on sandstone boulders, 151a.

Collemaceae

Leptogium tremelloides (L.) S. F. Gray. Infrequent on bark of hardwoods, 66.

Peltigeraceae

Peltigera canina (L.) Willd. Represented by the following varieties:

var. **rufescens** (Weis.) Mudd. Infrequent on decaying logs, at the bases of living and dead tree stumps and on moist hummocks in the cedar swamp, 506.

var. **spuria** (Ach.) Schaer. Rare on hummocks formed from decaying stumps, 331a.

var. **ulorrhiza** (Floerke) Schaer. Rare on duff among mosses at base of trees in hardwood swamp, 508.

Peltigera polydactyla (Neck.) Hoffm. (represented by var. **typica** f. **microphylla** Anders) or **Peltigera horizontalis** (Huds.) Baumg. (represented by var. **typica** f. **Zopfi** (Gyel.) Thomson). Rare on logs, cedar stumps and granite boulders in damp woodlands, 116. All of the material collected was sterile in which state the above-mentioned varieties and forms of the two species indicated are indistinguishable according to Dr. Thomson. One collection from a granite boulder in the damp hardwood swamp yielded fine specimens for showing regeneration along cracks. Without apothecia, however, final determination could not be made.

Lecideaceae

Bacidia Schweinitzii (Tuck.) Schneid. Rare on bark of *Fraxinus americana*, 525.

Bilimbia cupreorosella (Nyl.) Bausch. Rare on limestone boulders, 177.

Bilimbia lignaria (Ach.) Mass. Rare growing over moss on glacial boulder, 526.

Lecidea melancheima Tuck. Rare on dry, dead wood, 243.

Lecidea parasema Ach. Represented by var. **theioplaca** (Tuck.) Zahlbr. Rare on sandstone boulders, 509.

Lecidea platycarpa Ach. Rare on sandstone boulders, 337b.

Psora ostreata Hoffm. Rare on bark of conifers, 62.

Mycoblastus sanguinarius (L.) Norm. Represented by var. **alpinus** (E. Fries) Stein. Rare on bark of hardwoods.

Cladoniaceae

Cladonia bacillaris (Ach.) Nyl. Infrequent on rail fences and decaying wood. Usually found with other common members of the genus, 82.

Cladonia macilenta Hoffm. Represented by f. **styracella** (Ach.) Vainio. Infrequent, mixed with other *Cladoniae,* around and on the base of stumps, 390e.

Cladonia incrassata Floerke. Rare on stumps and hummocks in open marl bog, 398.

Cladonia cristatella Tuck. The species as such occurs rarely, but is represented by the following forms:

f. **abbreviata** Merrill. Rare on decaying wood with f. *vestita,* 90.

f. **Beauvoisii** (Del.) Vainio. Infrequent on bark and around base of *Thuja occidentalis* and on duff in cedar swamp, 405b.

f. **pleurocarpa** Robbins. Rare on hummocks in secondary marl bog with f. *vestita,* 120.

f. **ramosa** Tuck. Rare on soil in cedar zone, 343a.

f. **scyphulifera** Sandst. Rare on soil with other *Cladoniae,* 434.

f. **squamosissima** Robbins. Infrequent on fallen trees and decaying wood, 2.

f. **vestita** Tuck. Abundant on stumps, decaying trunks of both conifers and hardwoods, on base of living conifers and on soil throughout the swamp. Usually mixed with other *Cladoniae,* 19a, 510.

Cladonia pleurota (Floerke) Schaer. Represented by f. **frondescens** (Nyl.) Sandst. Rare on decaying logs with other members of the genus, 446b.

Cladonia capitata (Michx.) Spreng. Represented by f. **imbricatula** (Nyl.) Evans. Infrequent on soil and decaying logs in hardwood and cedar swamps, 80b, 100, 131d.

Cladonia gracilis (L.) Willd. Represented by var. **dilatata** (Hoffm.) Vainio. Rare among *Cladonia cristatella* f. *vestita,* 19b.

f. **anthocephala** (Floerke) Vainio. Rare on fallen, decaying tree trunks, 339, 446a.

f. **dilacerata** (Floerke) Vainio. Rare on logs in marl bogs, 219b.

Cladonia verticillata (Hoffm.) Schaer. Infrequent on decaying and damp logs with other species of the genus, 378a. Also represented by:

f. **evoluta** (Th. Fr.) Stein. Common on logs, rocks, duff and soil, often among mosses, especially in cut-over, open cedar swamps, 150, 187a, 344a, 366.

f. **aggregata** (Del.) Oliv. Infrequent mixed with other forms of the species, 150, 187a, 344a, 366.

f. **apopicta** (Ach.) Vainio. Rare mixed with other forms of the species, 320.

f. **phyllocephala** (Flot.) Oliv. Infrequent mixed with f. *evoluta,* 320, 366.

Cladonia pyxidata (L.) Hoffm. Represented by var. **neglecta** f. **simplex** (Ach.) Harm. Infrequent on rail fences, boulders, fallen logs and hummocks in the woodland, 324a, 344c. Originally this species was believed to be a common cup or goblet lichen in the swamp; as now delimited, it is rarely found in collections of cup lichens in Bergen Swamp.

Cladonia chlorophaea (Floerke) Spreng. Rare on soil and dead branches and stumps, 378c. Represented also by:

f. **pachyphyllina** (Wallr.) Sandst. Rare on glacial boulders, 6.

f. **simplex** (Hoffm.) Arn. Common on soil and duff, on dead stumps and logs of both conifers and hardwoods and on fence rails and boulders, in marl bog, cedar and hardwood swamps and in pasture, 376.

Cladonia Grayi Merrill. Represented by:

f. **carpophora** Evans. Rare on *Sphagnum* hummocks in open marl zone, 501.

f. **cyathiformis** Sandst. Abundant on decaying logs and stumps of conifers and hardwoods and on soil around the bases of trees throughout the swamp, 3, 352.

f. **peritheta** Evans. Infrequent mixed with other forms of the species, 244a.

f. **squamulosa** Sandst. Abundant throughout the swamp, 244aa.

Cladonia cryptochlorophaea Asahina. Infrequent on decaying logs and on stumps in both cedar and hardwood swamps and on open hummocks in the former, 405a. This species is one of the segregates of *Cladonia chlorophaea* based on microchemical tests.

Cladonia merochlorophaea Asahina. Rare to infrequent with other *Cladoniae* on decaying logs, on stumps and on hummocks in the open marl bog and cut-over cedar swamp, 207. This species is also a segregate from *Cladonia chlorophaea* on the basis of microchemical tests.

Cladonia fimbriata (L.) Fr. Infrequent on decaying cedars and on rotting logs in the hemlock zone, 5.

Cladonia conista (Ach.) Robbins. Represented by f. **simplex** Robbins. Infrequent on decaying logs, damp stumps, on hummocks in cedar swamp and on soil in pasture, 182.

Cladonia coniocraea (Floerke) Spreng. Represented by:

f. **ceratodes** (Floerke) Dalla Torre and Sarnth. Abundant on decaying stumps and logs, around the bases of living trees, on soil and boulders in all parts of the swamp, 340a, 343e. This appears to be the most widespread and abundant lichen in the swamp.

f. **truncata** (Floerke) Dalla Torre and Sarnth. Abundant in the same habitats as f. *ceratodes* with which it is often mixed, 345b.

f. **phyllostrata** (Floerke) Vainio. Rare on decaying wood, 425.

f. **pycnotheliza** (Nyl.) Vainio. Rare on decaying cedar logs, 340aa.

f. **robustior** (Harm.) Sandst. Rare on decaying stumps in pine-hemlock zone, 521.

Cladonia cylindrica Evans. Rare on stumps with other members of the genus, 236b.

Cladonia ochrochlora (Floerke) Sandst. Rare on boulders, 85a.

Cladonia borbonica (Del.) Nyl. Rare on rail fences and duff, 304.

Cladonia pityrea (Floerke) Fr. Rare on rail fences. Represented also by var. **Zwackhii** f. **subacuta** Vainio. Rare on decaying logs, 504.

Cladonia caespiticia (Pers.) Floerke. Infrequent to common on rail fences, decaying stumps and on fallen trunks in hardwood swamp, 326a, 332a.

Cladonia delicata (Ehrh.) Floerke. Rare in a sterile state on rail fence in hardwood swamp. Represented also by f. **quercina** (Pers.) Floerke. Rare on fallen cedars, 330.

Cladonia glauca Floerke. Rare on hummocks. Represented also by f. **capreolata** (Floerke) Sandst. Infrequent on duff in cedar swamp and on hummocks in open marl bog, 8.

Cladonia squamosa (Scop.) Hoffm. Common on cedar stumps and logs, on rail fences in hardwood swamp and with other *Cladoniae* on hummocks in open marl bog, 240, 442. Represented also by f. **levicorticata** Sandst. Rare on stumps of *Thuja occidentalis,* 170a.

Cladonia multiformis Merrill. Represented by f. **Finkii** (Vainio) Evans. Rare under and on *Juniperus horizontalis* in secondary marl zone, 344b.

Cladonia caroliniana (Schweinitz) Tuck. Rare on *Sphagnum* hummocks in marl bogs, 502.

Cladonia furcata (Huds.) Schrad. Represented by:

var. **pinnata** f. **foliolosa** (Del.) Vainio. Common on boulders, decaying logs, organic soil in moist hardwood swamp and on cedar logs and around bases of living cedar trees, 137.

var. **racemosa** f. **squamulifera** Sandst. Infrequent on soil among mosses and on boulders and logs in hardwood swamp, 234.

Cladonia rangiferina (L.) Web. Common on denuded *Sphagnum* hummocks in open marl bog, 9. Represented also by:

f. **incrassata** Schaer. Rare on hummocks in open marl zone, 142.
f. **patula** Flot. Infrequent on hummocks in open marl zone, 246.
f. **setigera** Oxner. Infrequent on hummocks in open marl zone, 92, 342.

Acarosporaceae

Acarospora fuscata (Schrad.) Arn. Rare on sandstone boulders, 59.

Pertusariaceae

Pertusaria multipuncta (Turn.) Nyl. Rare on bark of dying hardwoods, 153a.

Lecanoraceae

Candelariella vitellina (Ehrh.) Müll. Arg. Abundant on sandstone, limestone and granite boulders and on rail fences with other crustose forms on all borders of the swamp, 512a, 201.

Lecanora Hageni Ach. Infrequent on sandstone and limestone boulders with other crustose lichens in the open areas along the margins of the swamp and on bark, 50, 51a.

Lecanora muralis (Schreb.) Rabh. Infrequent to common on sandstone boulders in open places around the borders of the swamp, 58, 382.

Lecanora pallida (Schreb.) Rabh. Rare on bark of hardwoods in the alluvial zone, 194b.

Lecanora polytropa (Ehrh.) Rabh. Rare on sandstone boulders on borders of the swamp, 406.

Parmeliaceae

Candelaria concolor (Dicks.) Arn. Represented by var. **effusa** (Tuck.) Merrill and Burnh. Infrequent on bark of hardwoods both living and dead especially in the alluvial area along Black Creek, 193a, 221.

Parmeliopsis aleurites (Ach.) Nyl. Infrequent on dead branches of *Larix laricina* on *Sphagnum* hummocks in marl bogs as well as on decorticated trunks and branches of *Thuja occidentalis* in the same area, 63.

Parmelia caperata (L.) Ach. Common on hardwoods as well as *Tsuga canadensis* and *Thuja occidentalis* throughout the swamp.

Parmelia conspersa (Ehrh.) Ach. Common on sandstone boulders on the open margins of the swamp, usually with other rock lichens, 41. Represented also by f. **isidiata** Anzi. Rare on boulders, 148.

Parmelia olivacea (L.) Ach. Common on bark of hardwoods throughout the swamp.

Parmelia pertusa (Schrank) Schaer. Rare on bark of conifers on hummocks in the marl bog.

Parmelia physodes (L.) Ach. Common on bark of conifers and hardwoods in cedar and hardwood swamps and in marl bogs, 190.

Parmelia rudecta Ach. Common on bark of living conifers and hardwoods throughout the swamp, 236c.

Parmelia sulcata Tayl. Rare on dead branches as well as on the bark of living hardwoods in the alluvial zone along Black Creek and on hardwoods and cedars in the respective swamps, 184.

Cetraria ciliaris Ach. Rare on *Larix laricina* growing on *Sphagnum* hummocks in marl bogs.

Usneaceae

Evernia prunastri (L.) Ach. Rare on *Larix laricina* and *Thuja occidentalis* in marl bog, 154.

Alectoria chalybeiformis (L.) Röhling. Rare on *Larix laricina* growing on *Sphagnum* hummocks in marl bog.

Ramalina calicaris (L.) Röhling. Rare on isolated hardwoods in hardwood swamp.

Usnea baorbata (L.) Wigg. Rare on *Larix laricina* growing on *Sphagnum* hummocks in marl bogs, 500.

Caloplacaceae

Caloplaca cerina (Ehrh.) T. Fries. Common on sandstone and limestone boulders with other crustose lichens on the north and south borders of the swamp, 386a, 406.

Buelliaceae

Buellia punctata (Hoffm.) Mass. Rare on bark of *Ulmus americana* in alluvial zone along Black Creek, 193bb, 245b.

Rinodina ocellata (Hoffm.) Arn. Rare on sandstone boulders, 386.

Physciaceae

Physcia astroidea (Clem.) Nyl. Common on bark of *Pinus strobus* and hardwoods in alluvial area and hardwood swamp.

Physcia endochrysea (Hampe) Nyl. Common on bark of hardwoods throughout the swamp, 191.

Physcia hispida (Schreb.) Frege. Infrequent on trunks and branches of hardwoods in the alluvial area and on *Pinus strobus*, 193a, 194.

Physcia pulverulenta (Schreb.) Nyl. Infrequent on bark of hardwoods in the alluvial area along Black Creek, 175a.

Physcia stellaris (L.) Nyl. Rare on bark of *Pinus strobus* and hardwoods, 189, 193c.

Physcia tribacia (Ach.) Nyl. Infrequent on bark of hardwoods and *Pinus strobus*, especially along Black Creek, 193b, 195, 245a.

Lepraríaceae

Amphiloma lanuginosum (Hoffm.) Nyl. Infrequent on some hardwoods and conifers throughout the swamp, 139, 153b.

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THE BERGEN SWAMP PRESERVATION SOCIETY, INC. has contributed most generously toward the publication of the series of papers on the vegetation of Bergen Swamp of which this is the last. The authors and the Rochester Academy of Science are grateful to the Society for this assistance which has helped to further one of the primary aims of the Academy—the dissemination of knowledge of the natural history of the Rochester area.

THE VEGETATION OF BERGEN SWAMP

IX. Supplement

WALTER C. MUENSCHER[1]

It is axiomatic that a field botanist takes advantage of abundance of materials and makes the best of exceptional plant associations and habitats. An exceptional opportunity to study the vegetation of Bergen Swamp presented itself a third of a century ago. Then, in 1945 the late Dr. Sherman C. Bishop, a charter member and until his death an ardent supporter and trustee of the Bergen Swamp Preservation Society Inc., suggested that I prepare a paper on The Vegetation of Bergen Swamp. Part I. Vascular Plants, was published under the above title (Muenscher, 1946) with the full realization that additional explorations required to cover other groups of plants known to be represented in the swamp surely would amplify the known list of vascular plants. With the collaboration of several former graduate students seven additional papers have been published between 1948 and 1951. (Cf. references to the various groups covered at the end of this paper.)

The present paper, Part IX. Supplement, concludes this series. In its preparation I have received substantial aid from Dr. Clark T. Rogerson in providing the supplement to the fungi and from Dr. Robert F. Thorne whose field work expanded our knowledge of the species of Carex growing in Bergen Swamp.

[1] Department of Botany, Cornell University, Ithaca, New York.

SUPPLEMENT TO ANNOTATED LIST OF VASCULAR PLANTS

Polypodiaceae

Dryopteris Goldiana (Hook.) Gray. Goldie's Fern. Local in moist rich woodland along southwest border of swamp.

Ophioglossaceae

Botrychium dissectum Sprengel ssp. *typicum* Clausen. In open woods.
Botrychium dissectum Sprengel var. *obliquum* (Muhl.) Clausen. In open woods.
Botrychium simplex Hitchc. In hardwood forest.

Potamogetonaceae

Potamogeton Friesii Rupr. In pond near west end of swamp.

Gramineae

Andropogon furcatus Muhl. Beard Grass. In dry open places near south edge of swamp.
Bromus commutatus Schrad. Brome Grass. In open places near south side.
Bromus japonicus Thunb. On dry grassy knoll.
Bromus purgans L. In opening in cutover cedar swamp.
Bromus tectorum L. Along path, entrance to swamp.
Danthonia spicata (L.) Beauv. Open places, south side of swamp.
Digitaria sanguinalus (L.) Scop. Along trail.
Eragrostis poaeoides Beauv. Along trails.
Glyceria borealis (Nash) Batch. In swale along north edge near Black Creek.
Panicum virgatum L. Switch Grass. On gravelly ridge, near southwest edge of swamp.

Cyperaceae

Carex alopecoidea Tuckerman. In woods on alluvial soil.
Carex Careyana Torr. In rich woods.
Carex cephalophora Muhl. In rich hardwoods.
Carex comosa Boott. In alluvial woods near Black Creek.
Carex crinita Lam. In woods on alluvial soil.
Carex Deweyana Schwein. In moist woods.
Carex hirtifolia Mack. In rich woods.
Carex Hitchcockiana Dewey. Rich woods near southwest entrance.
Carex Jamesii Schwein. In rich hardwoods.
Carex laevivaginata (Kuken) Mack. In mucky woods.
Carex molesta Mack. Along border of swamp, near Black Creek.

Carex normalis Mack. Along woodland borders near Black Creek.
Carex laxiculmis Schwein. On sandy wooded slope.
Carex leptonervia Fern. In rich woods.
Carex lurida Wahl. On alluvial soil.
Carex oligocarpa Schk. In rich woods.
Carex scabrata Schwein. In mucky woodland.
Carex sparganioides Muhl. In rich hardwoods.
Carex Woodii Dewey. In rich woodland.

Araceae

Peltandra virginica (L.) Kunth. Arrow Arum. In opening in cattail swamp.

Liliaceae

Trillium undulatum Willd. Painted Trillium. On gravelly hemlock-beech ridge.

Iridaceae

Iris Pseudacorus L. Yellow Iris. Along Black Creek.

Juglandaceae

Juglans nigra L. Black Walnut. Two large trees and several saplings along stream, west end; saplings in cut-over Thuja swamp.

Betulaceae

Corylus americana Walt. Hazelnut. Along north edge of swamp.

Chenopodiaceae

Chenopodium polyspermum L. Goosefoot. Along Black Creek.

Portulacaceae

Portulaca oleracea L. Purslane. Edge of field.

Ranunculaceae

Aquilegia vulgaris L. Garden Columbine. Along path by hemlock knoll.
Ranunculus repens L. Creeping Buttercup. In pasture along edge of swamp.
Ranunculus bulbosus L. Bulbous Crowfoot. In open pasture, near west end.

Magnoliaceae

Liriodendron tulipifera L. Tulip Tree. A large tree and several saplings in rich woods.

Cruciferae

Alyssum Alyssoides L. On grassy slopes near southwest border. Previously reported from along railroad track.

Brassica nigra (L.) Koch. Black Mustard. In disturbed open places along Black Creek.

Rosaceae

Agrimonia parviflora Ait. Agrimony. In grassy opening.
Rosa Eglanteria L. Along edge of thicket, border of swamp.
Potentilla canadensis L. On open grassy hummocks.

Leguminosae

Vicia villosa Roth. Hairy Vetch. In open place along west edge of swamp.

Euphorbiaceae

Euphorbia vermiculata Raf. (*E. hirsuta* (Torr.) Wieg.). Near Black Creek.

Hypericaceae

Hypericum majus (Gray) Britton. In wet depressions on sandy knoll.

Haloragidaceae

Myriophyllum exalbescens Fernald. Water Milfoil. In pond near west end of swamp.

Ericaceae

Moneses uniflora (L.) Gray. One-flowered Pyrola. Forming small patches scattered over about an acre of moist cedar-pine woods. Reported many years ago by Macauley but not seen by the writers before 1948.

Gentianaceae

Gentiana Andrewsii Griseb. Edge of Thuja thicket, east end of swamp.

Boraginaceae

Lithospermum arvense L. Along paths, edge of Torpy Hill.

Labiatae

Melissa officinalis L. Established, probably from discarded trash, along base of Torpy Hill.
Pycnanthemum flexuosum (Walt.) BSP. Mountain Mint. In marly swale, south part of swamp.
Pycnanthemum Torrei Benth. In marly swale, south side of swamp.
Pycnanthemum virginianum (L.) Dur. & Jackson. South edge of swamp.

Caprifoliaceae

Lonicera Morrowi Gray. Honeysuckle. In cut-over Thuja swamp.
Symphoricarpus albus (L.) Blake. Snowberry. Along south border of swamp.

Viburnum alnifolium Marsh. Hobble-bush. On hemlock-beech knoll.

Viburnum Opulus L. European Cranberry Bush. Several specimens about four meters high were observed in marl bog, among *Thuja occidentalis*.

Campanulaceae

Campanula rapunculoides L. Bellflower. Edge of swamp.

Compositae

Helianthus grosse-serratus Martens. In open swale, probably naturalized.

Petasites palmata (Ait.) Gray. In open hardwood forest.

Picris hieracioides L. Along paths in openings in woods.

Silphium laciniatum L. Rosin Weed. Apparently introduced; near railroad right-of-way along south edge of swamp.

SUPPLEMENT TO THE FUNGI OF BERGEN SWAMP[1]

Since the publication of a list of the fungi of Bergen Swamp (Rogerson and Muenscher, 1950) additional visits to the swamp have been made with the inevitable finding of new records of fungi.

As a result thirty additional species of fungi including representatives of eight additional genera have been collected in the swamp. Specimens of three species not recorded heretofore were found in the herbarium of Charles Peck at the New York State Museum and a specimen of one species was found in the Durand herbarium at Cornell University. Of these thirty-four additional records of species, thirteen are Ascomycetes, nine are Basidiomycetes and twelve are Fungi Imperfecti. Four additional genera of Ascomycetes, two of Basidiomycetes and two of Fungi Imperfecti are recorded.

A total of 634 species and sixteen varieties representing 256 genera of fungi are now known to occur in Bergen Swamp.

In the following list ** represents a new genus and species record, * represents a new species record, and † represents a new host record for the swamp.

ASCOMYCETES

Pezizaceae

Scutellinia albospadicea (Grev.) Kuntze. On rotten stump, 38055 (Det. R. P. Korf).

Scutellinia sp. (*Lachnea hemisphaerioides* Mouton). On burned hemlock duff, K2131. (Det. R.P. Korf).

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[1] ROGERSON, CLARK T. and WALTER C. MUENSCHER. 1950. The Vegetation of Bergen Swamp. VI. The Fungi. Proc. Roch. Acad. Sci. 9: 277–314.

Dermateaceae

****Fabraea maculata** (Lev.) Atk. On Amelanchier arborea, R3469. (conidial stage).

Orbiliaceae

***Orbilia curvatispora** Boud. On rotten log, R3054.

Hyaloscyphaceae

***Arachnopeziza delicatula** Fckl. On wood, Durand Herb., Cornell Univ. No. 83–125. (Det. R. P. Korf).

***Hyaloscypha hyalina** (Pers. ex. Fr.) Boud. On rotten log, R3042.

***Lachnum Caricis** (Desm.) Hoehn. On dead stems of Scirpus caespitosus, R989.

***Lachnum inquilinum** (Karst.) Schroet. On overwintered stems of Equisetum arvense, K2130. (Det. R. P. Korf).

Helotiaceae

****Phialea** sp. On rotten stem, K2136.

****Stamnaria Persoonii** (Fr.) Fckl. On overwintered stems of Equisetum arvense, K2133. (Det. R. P. Korf).

****Trichoscyphella calycina** (Schum. ex. Fr.) Nannf. On dead twigs of Larix laricina, R2151.

Pseudosphaeriaceae

***Pleospora herbarum** (Pers. ex Fr.) Rabenh. On dead stems of Triglochin palustris, Herb., N. Y. State Museum. (Det. by H. H. House).

Erysiphaceae

Uncinula Salicis (DC.) Wint. On †Populus tremuloides, 38050.

Nectriaceae

Hypomyces aurantius (Pers. ex Fr.) Tul. On pore surface of †Polyporus versicolor, R 3455.

***Hypomyces polyporinus** Peck. On pore surface of Polyporus versicolor, 38052.

***Hypomyces rosellus** (Fr.) Tul. On small deformed agaric, R3317. (conidial stage).

Nectria episphaeria Tode ex Fr. On †Hypoxylon multiforme, R3323.

Nectria Pezizae Tode ex Fr. On dead †Betula lutea, R3456.

BASIDIOMYCETES

Ustilaginaceae

***Ustilago striaeformis** (Westend.) Niessl. On leaves of Dactylis glomerata, R3458.

Melampsoraceae

*__Melampsora Abieti-canadensis__ C. A. Ludwig. On cones of Tsuga canadensis, R3454.

Pucciniaceae

Puccinia Caricis (Schum.) Schroet. On leaves of †Carex blanda, R3326.

*__Puccinia tumidipes__ Pk. On leaves of Lycium halimifolia, 38049.

Auriculariaceae

Herpobasidium deformans Gould. On leaves of Lonicera oblongifolia, R3457. (basidial stage).

Clavariaceae

**__Pistillaria capitata__ (Pat.) Sacc. On dead leaves of Carex sp., R2852.

Hydnaceae

**__Caldesiella ferruginosa__ (Fr.) Sacc. On log of Betula lutea, 38053.

*__Odontia crustosa__ (Fr.) Quel. On rotten log, 38054.

Agaricaceae

*__Clitopilus novaboracensis__ Pk. In woods, Herb. N. Y. State Museum. (Det. C. Peck).

*__Hygrophorus flavescens__ (Kauff.) Smith & Hesler. On the ground, mixed woods, R3473.

FUNGI IMPERFECTI

Sphaerioidaceae

*__Cytospora ambiens__ Sacc. On dead branches of Ulmus americana, R2915.

*__Phomopsis oblonga__ (Desm.) Hoehn. On dead twigs of Ulmus americana, R2915.

*__Septoria increscens__ Pk. On leaves of Trientalis borealis, R3470.

Melanconiaceae

**__Colletotrichum liliacearum__ (Desm.) Hoehn. On leaves of Polygonatum pubescens, R3460.

*__Cylindrosporium Cicutae__ Ell. & Ev. On leaves of Cicuta maculata, R3467.

*__Cylindrosporium lutescens__ Higgins. On leaves of Prunus virginiana, R3468.

*__Cylindrosporium Steironematis__ Atk. On leaves of Steironema ciliata, R3471.

Moniliaceae

***Botrytis geniculata** Corda. On Hypoxylon sp., R3475.

****Monilia angustior** (Sacc.) Reade. On fruits of Prunus virginiana, R3459.

Stilbaceae

***Isaria flabelliformis** (Schw.) Lloyd. On rotten log. R3476, 3477. (Det. J. A. Stevenson).

Dematiaceae

***Cladosporium aphidis** Thum. On aphids on Phragmites communis, Herb., N. Y. State Museum. (Det. C. Peck).

Additions to the Host Index

Amelanchier arborea (Michx.) Fernald; Fabraea maculata.
Betula lutea Michx.; Caldesiella ferruginosa, Nectria Pezizae.
Carex blanda Dewey; Puccinia Caricis.
Cicuta maculata L.; Cylindrosporium Cicutae.
Dactylus glomerata L.; Ustilago striaeformis.
Equisetum arvense L.; Lachnum inquilinum, Stamnaria Persoonii.
Larix laricina (DuRoi) Koch.; Trichoscyphella calycina.
Lycium halimifolium Mill.; Puccinia tumidipes.
Polygonatum pubescens (Willd.) Pursh; Colletotrichum liliacearum.
Populus tremuloides Michx.; Uncinula Salicis.
Prunus virginiana L.; Cylindrosporium lutescens, Monilia angustior.
Scirpus caespitosus L.; Lachnum Caricis.
Steironema ciliatum (L.) Raf.; Cylindrosporium Steironematis.
Trientalis borealis Raf.; Septoria increscens.
Triglochin palustris L.; Pleospora herbarum.
Tsuga canadensis (L.) Carr.; Melamspora Abieti-canadensis.
Ulmus americana L.; Cytospora ambiens, Phomopsis oblonga.

SUPPLEMENT TO THE ALGAE

One novelty, a large diatom, has been collected from slightly brackish water by the west end of Bergen Swamp on October 24, 1948. This has been described and named *Navicula bergeni* sp. nov. It will be published by Dr. Matthew H. Hohn in an early issue of the Transactions of the Microscopical Society of America, 1952. The type slide (No. 161) is deposited in the Wiegand Herbarium of Cornell University.

SUMMARY

In summarizing this supplement it can now be stated that the list of plants known from Bergen Swamp, an area covering approximately 3000 acres, includes 2392 species of plants. These consist of:

Vascular plants	860
Myxomycetes	73
Algae	586
Fungi	634
Mosses and Liverworts	164
Lichens	75
Total	2392

REFERENCES TO THE VEGETATION OF BERGEN SWAMP

Walter C. Muenscher—I. The Vascular Plants. 1946. Proc. Roch. Acad. Sci., 9: 64–117.

Babette I. Brown—II. The Epiphytic Plants. 1948. Ibid., 9: 119–129.

Walter C. Muenscher—III. The Myxomycetes. 1948. Ibid., 9: 131–137.

Arland T. Hotchkiss—IV. The Algae. 1950. Ibid., 9: 237–264.

Matthew H. Hohn—V. The Diatoms. 1950. Ibid., 9: 265–276.

Clark Rogerson and Walter C. Muenscher—VI. The Fungi. 1950. Ibid., 9: 277–314.

William T. Winne—VII. The Bryophytes. 1950. Ibid., 9: 315–326.

Babette I. Brown—VIII. The Lichens. 1951. Ibid., 9: 327–338.

Walter C. Muenscher—IX. Supplement. 1951. Ibid., 9: 339–347.

STRATIGRAPHY AND STRUCTURE OF THE BATAVIA QUADRANGLE

by

ROBERT G. SUTTON[1]

ABSTRACT

A geologic map has been prepared and a survey made of the structural aspects in the Batavia Quadrangle of western New York State. Southward dipping formations of Lower(?), Middle and Upper Devonian age crop out in this Quadrangle. The Clarendon-Linden monocline trends approximately north-south through the central portion of the area and locally deflects the dip to the west.

Twenty-four formations or members were identified and traced across the area. The Ledyard and Wanakah shale members of the Ludlowville formation were not separated as defined by Cooper (1930).

The trends of the jointing and broken anticlines were also measured and an attempt has been made to correlate this data with adjacent areas as well as major structural features in the Quadrangle.

TABLE OF CONTENTS

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ILLUSTRATIONS

ACKNOWLEDGMENTS

The writer wishes to express his sincere thanks to Dr. William Evitt for his guidance in the stratigraphic and paleontologic problems; to Dr. William F. Jenks for his help in structural aspects and in preparation of the map and to Dr. Harold L. Alling without whose knowledge of western New York Geology many of the problems could not be visualized in their true aspect. Gratitude is also extended to John Van Ostrand who aided the author in the field and in the preparation of the maps and to my wife, Betty, without whose aid and encouragement this work would not have been completed.

INTRODUCTION

The Batavia Quadrangle is situated in western New York, approximately twenty-eight miles east of Buffalo and twenty-five miles southwest of Rochester. The city of Batavia is located at the northern boundary and Warsaw is at the southern edge of the sheet. The quadrangle is over seventeen miles long and thirteen miles wide with an area of 225 square miles. More precisely, the United States Geological Survey topographic map is bounded by the latitudes, 42° 45′ N and 43° 00′ N and by the longitudes, 78° 00′ W and 78° 15′ W.

The geology of western New York has been under intense scrutiny since the time of James Hall (1843) when an excellent groundwork was laid. Later revisions and refinements were carried out by John M. Clarke and D. Dana Luther. Their energetic program included the mapping of most of the 15′ quadrangles in western New York. Unfortunately the Batavia Quadrangle manuscript was never published. The Caledonia Quadrangle to the east has suffered the same fate. A report on it prepared by William Grossman (1938) has not yet been published.

In recent years, the regional stratigraphy has received much attention from such men as G. Arthur Cooper (1929) who has produced the most complete and up-to-date work on the Middle Devonian, and George H. Chadwick (1933) who has made outstanding revisions of the Upper Devonian. Dr. Chadwick is responsible for the discovery of the Clarendon-Linden monocline, a portion of which occurs in this quadrangle.

It is upon this groundwork that more detailed studies must be made. Even this paper on the Batavia Quadrangle represents only a reconnaissance study of the area. Problems concerned with the Ledyard-Wanakah members still exist. Their solution may be found by careful examination and measurement of the Ludlowville sections from Lake Erie to the Genesee Valley.

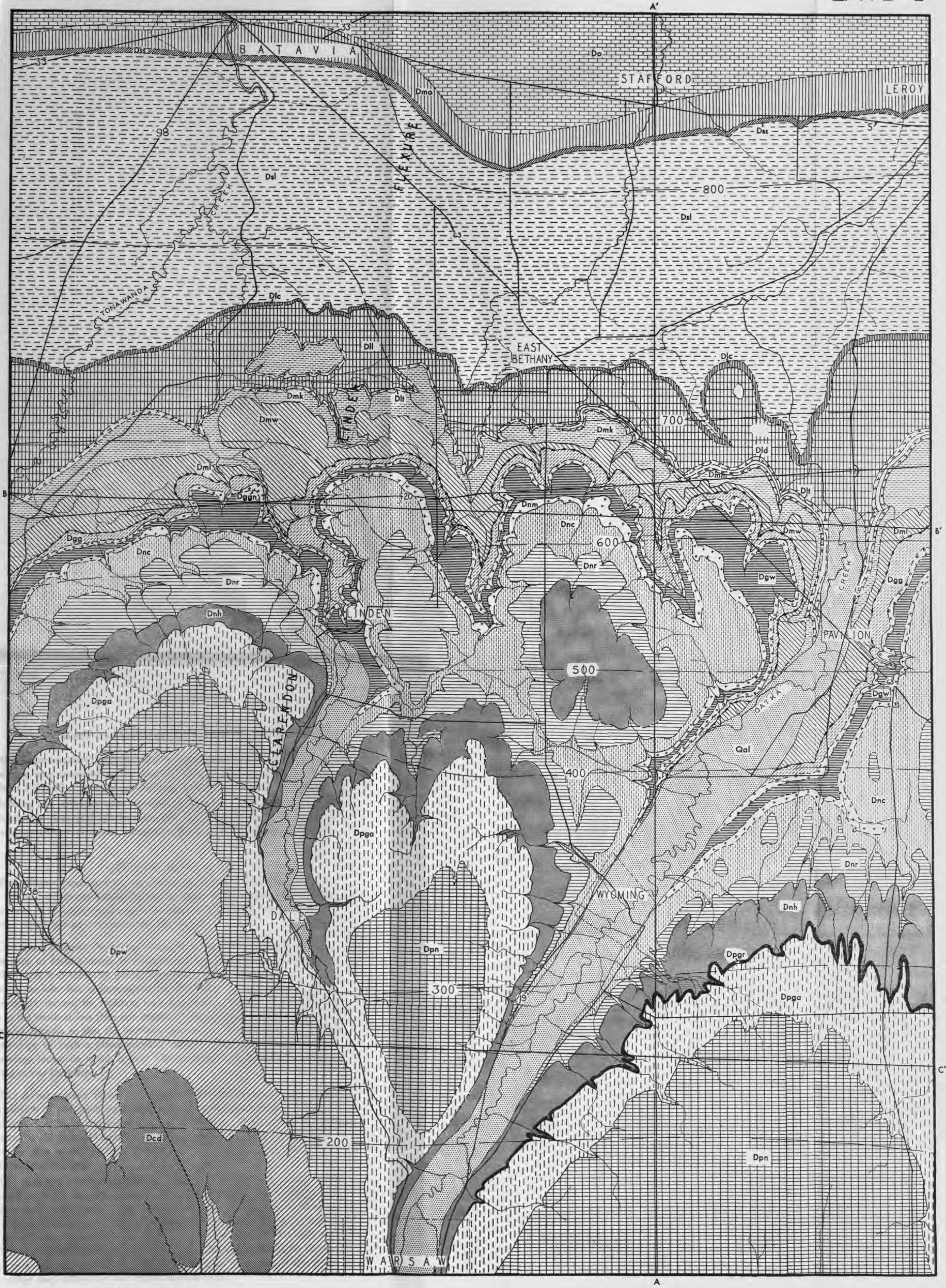
The author has included some data on structure. It will be necessary for others to add information from each quadrangle so that when all the data is compared and critically analyzed, we may have a more accurate picture of what has happened to the bed rock since deposition.

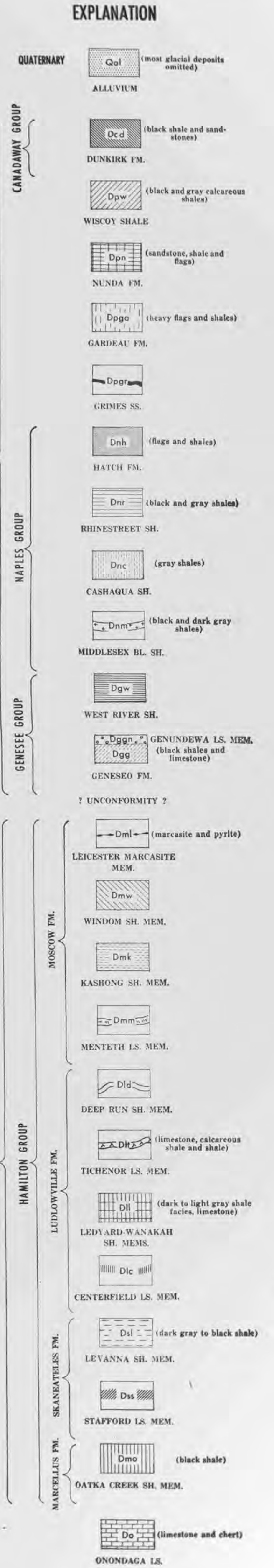
Many paleontological problems still remain. Among these are ones of a paleo-ecological aspect. The Hamilton formations should prove most useful for studies of this type because of their extremely fossiliferous character and excellent exposure.

The study began with a few weeks of field work in the summer of 1948 and was completed in the summer of the following year. Over 120 geologic

GEOLOGIC MAP

PLATE I





BATAVIA QUADRANGLE, NEW YORK

SCALE $\frac{1}{63,360}$

1 0 1 2 3 4 MILES

MAGNETIC

DECL. 8° NO ANNUAL MAGNETIC CHANGE-1943

400

STRUCTURE CONTOURS ON THE ONONDAGA LS.

sections were measured with the aid of a Jacobs staff and Brunton compass. The base map consisted of the four $7\frac{1}{2}$ minute quadrangle maps on the scale of 1:31,680. The final product was reduced to the scale of 1:63,360.

Jointing and structure were recorded by means of the Brunton compass. The broader structural relationships were discernable only by comparison of stratigraphic sections but minor structures could be measured directly.

PHYSIOGRAPHY

Two distinct physiographic provinces are found in this area. One is the Central or Interior Lowlands and the other is the Appalachian Plateau Province. The entire quadrangle has been well glaciated but a discussion of this aspect has been omitted from the report.

CENTRAL LOWLAND PROVINCE—In western New York State the southern shore line of Lake Ontario is characterized by relatively low, flat terrain broken here and there by glacial deposits. The land surface dips north toward the lake but is interrupted by northward facing cuestas. These cuestas are formed by resistant rock formations, usually limestone, that dip to the south at less than one degree. One of these cuestas occurs just north of Batavia so that the northern portion of the area is on the gentle south-slope of such a physiographic feature. The resistant rock is the Onondaga limestone which is over 140 feet thick and forms an east-west cuesta across the state.

THE APPALACHIAN PLATEAU PROVINCE—The plateau area in the southern portion of the quadrangle represents the type of topography found in southern New York and Pennsylvania. Fenneman (1938) terms this the "Glaciated Allegheny Plateau" and states that if it were not for the glaciation, the area would be very similar to the unglaciated portions of the Plateau farther south.

The province is characterized by rather uniformly high relief, with summit surfaces of approximately the same elevation into which deep valleys have been incised. The northern boundary is marked in western New York (and this area) by a northward facing cuesta which is formed by the resistant Upper Devonian strata. The area south of Pavilion and Linden is considered to be in this province. The Upper Devonian formations crop out in a belt which defines this cuesta. The area to the south has rather deep valleys cut into these resistant rocks.

The plateau surface, while not well defined, may be represented by the higher flat-topped hills in the southern portion. These hills are underlain by resistant beds of sandstone. Although glacial deposits are abundant, the outcrops of resistant formations can often be traced.

STRATIGRAPHY

Introduction

Formations of Lower or Middle, Middle and Upper Devonian age crop out in this area. The oldest formations appear in the northern part and successively younger ones occur to the south. This is due to a slight southward dip and the higher topography in the south.

Only the Onondaga limestone may be of Lower Devonian age. Its classification in this report is Lower or Middle Devonian. The Hamilton Group overlies the Onondaga limestone and is definitely Middle Devonian. Above this is the Genesee Group which elsewhere is Middle or Upper Devonian but here is placed in the Upper Devonian because of reasons outlined later. The overlying Naples Group and formations above are of Upper Devonian age.

The lithologic units are discussed in ascending order. A history of the nomenclature, followed by the extent, type locality, and thicknesses, is included. Important outcrops in the area are located and lithology and fauna are treated in detail wherever possible. The faunas are those collected and identified from exposures in this area. No attempt was made to produce detailed faunal lists but only representative specimens were collected.

"Lexicon of Geologic Names of United States" by M. Grace Wilmarth (1938) was used as a general reference for the history of the nomenclature, supplemented by the writings of the particular workers. The works of G. Arthur Cooper (1930) were consulted for the stratigraphy of the Hamilton Group while material on the Upper Devonian was obtained from the writings of George H. Chadwick, John Clarke and D. Dana Luther. References to these and other writers will be made in the appropriate places.

Source of the sediments in this area was to the east. The Onondaga limestone represents a long period of quiescence. It was not terminated abruptly but the first Hamilton clastic sedimentation began in the eastern part of New York State. The border of this clastic sedimentation moved westward so that the limestone was progressively covered from east to west.

Black shales and interbedded limestones were deposited in the lower Hamilton. This type of sedimentation grades into the gray shale and limestone of the middle and upper. Hamilton deposition ended abruptly with an influx of black shales of the Genesee Group, followed by black and gray shales of the Naples and finally the clastics of the overlying formations.

Deposition was rather continuous throughout the Middle and Upper Devonian in this part of New York State. It is possible that disconformities exist at the top of the Onondaga limestone, at the top of the Hamilton Group and in the Genesee Group.

All of these sediments represent outpourings of clastics from the east.

Figure 1

Figure 2

Figure 3

Figure 4

PLATE III. *Fig. 1*—Onondaga ls. quarry 1 mile west of Stafford, N. Y. *Fig. 2*—Closer view of chert bed in quarry wall. *Fig. 3*—"Strophalosia" bed of westward dipping Ledyard-Wanakah shales at East Bethany section. *Fig. 4*—Septaria in Cashaqua shale 2 miles S.W. of West Bethany.

The deposits have been described as a large delta (Chadwick, 1933). When stratigraphic units are traced eastward, they are found to grade into or interfinger with coarser deposits. Marine shales of the Hamilton Group grade into coarser clastics and finally red continental shales in the Catskill Mountain area. Moreover, the facies changes have in many instances brought about a change in the faunal content of contemporaneous beds so that the problems of correlation have been extremely difficult. Many problems of this type still exist.

As sedimentation continued, the facies migrated. Red beds came to lie over marine sandstones, while the sandstones were deposited over areas which had previously received silts and muds. This is especially true of the Upper Devonian when the migration to the west was rather rapid. Nor was this change in facies of a uniform nature. In the Upper Devonian, oscillations occurred which changed the lithology rather rapidly and produced an intertonguing of these facies. It is however, still possible to divide the clastics into formational units based upon dominant types of sediments and characteristic fauna.

Formations generally thin to the west. Thin limestone beds of the Hamilton that are separated by shale, are collectively treated as a member. Thicknesses of the members usually reflect the westward thinning of the shales and not the limestone beds. Exceptions are the Onondaga limestone and some of the black shales. The Upper Devonian black shales increase in thickness westward until they constitute the dominant type of sediment in Ohio. Devonian sedimentation in New York State may be described as a wedge of clastics with time lines converging westward.

LOWER OR MIDDLE DEVONIAN

The Onondaga limestone represents the only formation of possible Lower Devonian age. The problem concerning its stratigraphic position is most interesting. The Onondaga has two faunas, according to Cooper et al. (1942). The lower one is called the *Amphigenia* fauna (a brachiopod) which is correlated with the Schoharie of eastern New York and the Camden of western Tennessee. Above this is found a *Paraspirifer* fauna. The Genus *Paraspirifer* ranges from the Onondaga well up into the Marcellus (Lower Hamilton).

In Germany, Paraspirifer characterizes Upper Coblenzian (Lower Devonian) and Eifelian (Middle Devonian). The Onondaga seems to correlate with the Coblenzian while the Marcellus correlates with the Eifelian.

Onondaga Limestone

History of the Nomenclature—The term was first used by Hall in 1839. At that time it was defined as the limestone which underlies the Seneca limestone and succeeds Oriskany sandstone. The name, "Gray Sparry limestone", had previously been applied to it in earlier New York reports. The name Onondaga was used for the salt group beneath and subsequently abandoned by Dana in 1863. Later, Hall (1843) defined it as overlying the Schoharie grit and underlying the Corniferous limestone.

Finally, Emmons (1846) revised it to include the limestone between the Marcellus slate (shale) and the Schoharie grit. This is the use today. Hall, for many years, followed his definition of 1843. Clarke and Luther applied the term as used by Emmons.

In this area the Onondaga is found between the Oriskany sandstone (or its horizon) and the Marcellus shales of the Hamilton Group.

The type section is in Onondaga County, New York. This is 90 miles to the east of the Batavia Quadrangle. It extends from the Catskill area, westward across New York State, to Ohio. There is a general thickening of the formation toward the west. The following table demonstrates this change in the western part of the State:

75 feet at Seneca Lake
125 feet at Canandaigua Lake
135 feet at the Livonia Salt Shaft
140 feet in the Caledonia Quadrangle
168 feet at Lake Erie

Only the upper portion of the Onondaga is found in this area. The best exposure is at a quarry west of Stafford, just south of Route 5. The limestone quarried here is being used for road metal. A total of 61 feet is exposed. This is believed to be the uppermost part of the formation, although the upper contact was not located. The total thickness in this area is approximately 150 feet.

LITHOLOGY AND FAUNA—It appears as a massive, fine-grained limestone with layers and lenses of chert between the more massive beds (see Plate III, Figs. 1 and 2). There are also irregular masses of chert in the limestone beds. The layers of chert range up to eight inches in thickness and the masses average two inches in diameter. The surface, when weathered, has a light gray, powdery appearance, but is dark gray on fresh fracture. There is very little recrystallization.

Most of the fossils are grouped in separated beds, two or three inches thick. Others are found in the thicker limestone beds. The base of the quarry has massive beds up to three feet thick, but higher, these become thinner and the chert increases in proportion.

The following list of fossils represent the most common forms in the quarry. For a more complete faunal list, refer to J. M. Clarke, and D. D. Luther (1904).

Heliophyllum halli
Favosites argus
Favosites sp.
Stareolasma rectum
Atrypa reticularis
A. spinosa
Brevispirifer gregarius
Camarotoechia billingsi
Leptaena rhomboidalis
Megastrophia hemisphaerica
Stropheodonta demissa
Crinoid columnals
Clathrodictyon sp.

MIDDLE DEVONIAN

The Hamilton Group overlies the Onondaga and is Middle Devonian in age. As previously stated, the genus *Paraspirifer* ranges well up into the Hamilton and correlates the lower part with the Eifelian of Europe (Cooper et al., 1942). The lowermost formation, Marcellus, had been correlated with the Givetian (Middle Devonian) because the Onondaga had been considered the "reefy" equivalent of the Eifelian (lower Middle Devonian). More recently it was discovered that the "reefy" facies in North America is represented by limestones on top of the Marcellus equivalent and not by the Onondaga. Therefore, the Marcellus is moved down to correlate with the Eifelian (lower Middle Devonian). The Onondaga thus moves down to become Coblenzian (Lower or Middle Devonian) in age.

A possible disconformity may mark the Onondaga-Marcellus contact. The contact is abrupt but whether this is caused by a time break or rapid facies change is not certain.

HAMILTON GROUP

The name was first applied by Lardner Vanuxem (1840) to the sequence of shales which were above the Skaneateles shale and beneath the Moscow shale. This sequence later become known as the Ludlowville shale. He then extended the term to include all the rock from the base of the Skaneateles shale to the base of the Tully limestone.

Hall expanded the term in 1851 to include the Chemung Group, the Portage Group and the Marcellus shale. Many changes had occurred in its usage from 1851 to 1890, when Prosser (1890) and others placed the base of the Hamilton at the top of the Marcellus and the top at the base of the Tully limestone, just as Vanuxem had done some fifty years before.

J. M. Clarke and nearly all other geologists followed this established definition until Cooper (1930) included the Marcellus in the Hamilton. This last definition includes all the strata from the Onondaga limestone to the "Tully pyrite". In 1935, Cooper and Williams included the "Tully pyrite" in the Hamilton Group. Now the Group includes four formations, the Marcellus, Skaneateles, Ludlowville, and Moscow. In this paper the "Tully pyrite" will henceforth be called the Leicester marcasite.

All of the formations of the Hamilton Group outcrop in this quadrangle. The Marcellus is represented by the Oatka Creek member which is between the Onondaga limestone and the Stafford limestone. The Skaneateles formation is composed of two members. They are the Stafford limestone and the Levanna shale.

Following this is the Ludlowville formation with the Centerfield, Ledyard-Wanakah, Tichenor and Deep Run members. The Ledyard and Wanakah are separated by Cooper but their division is not feasible in this area. The youngest formation is the Moscow which consists of the

Menteth, Kashong, and Windom, according to Cooper. The Leicester marcasite is added as the top member of the Moscow.

The Leicester marcasite represents the top of the Middle Devonian in western New York. Above it and possibly unconformable with it are the beds of the Genesee Group with a strikingly different sedimentation and fauna. The stratigraphic terminology for the Hamilton Group is that of Cooper with the following exceptions:

1. The Ledyard and Wanakah members of the Ludlowville formation are included as one unit.
2. The contact of the Kashong and Windom is defined upon a limestone zone instead of one of the many *Ambocoelia-Chonetes* zones.
3. The Leicester marcasite (formerly called the "Tully pyrite") is included as the top member of the Moscow formation.

The type locality is at West Hamilton, in Madison County. The formations of the Hamilton outcrop from the Hudson River to Lake Erie and, in general, the thicknesses increase from west to east. The following is a table of thicknesses of the Hamilton, in part from Cooper (1930).

1465	feet at Chenango Valley
670	feet at Cayuga Lake
625	feet at Canandaigua Lake
560	feet in the Livonia Salt shaft
525	feet in the Caledonia Quadrangle
230	feet at Lake Erie

The Hamilton is well exposed in the Batavia Quadrangle. The total thickness of the group is approximately 482 feet. Outcrops are numerous but most of them are small. Therefore a composite section must be made with minor parts of the column not exposed.

Lithology and Fauna—The beds of the Hamilton consist, for the most part, of shales with a few interbedded limestones. The lower part is characterized by dark gray and bituminous shales, grading into progressively lighter beds until the upper ones appear as bluish shales. The limestones form a small percentage of the rock section but are valuable horizon markers. Their persistence across the State served as the basis for Cooper's reclassification.

The lower black shales have a characteristic *Leiorhynchus* fauna (Chadwick, 1933) which reappears above in the black and dark gray shales. The Hamilton limestones also may carry a characteristic fauna so that a repetition of thin limestones serves as a source of confusion in the solution of problems in Hamilton stratigraphy.

Marcellus Formation

The name was first proposed by Hall (1839) to include the shale at Marcellus (Onondaga County) between the Onondaga limestone and the horizon marking the first appearance of the Hamilton fauna.

In 1840, Lardner Vanuxem (1840) further subdivided it. He described the upper Marcellus shales as being less highly colored than the lower shales and showing peculiar concretionary characters. Hall (1843) then admitted the division and stated that the lower part is very black, slaty, and bituminous, containing iron pyrite and concretions. This division is terminated upward by a thin band of limestone, above which the shale is more fissile and gradually passes from black to olive or dark slate color.

Clarke and Luther (1904) subdivided the Marcellus into the Marcellus (lower) and the Cardiff (upper) but their correlations to the west were confused according to Cooper (1930, p. 129), who says:

> "But they fell into confusion because farther west (of the Canandaigua Lake region) the shale below the Stafford is jet-black and the shale above the Stafford is lithologically like the Cardiff. They therefore defined the Cardiff as lying above the Stafford when actually it lies on the Marcellus and is overlain by the Mottville, which is the eastern equivalent of the Stafford, as clearly defined by Smith. Since the Stafford is actually the equivalent of the basal bed of the Skaneateles, it is necessary to exclude this member from the Marcellus."

Therefore, the only representative of the formation in this area is the Oatka Creek member.

Oatka Creek Shale Member

This shale was named by Cooper (1930) as the upper member of the Marcellus from Cayuga Lake westward to Seneca Lake, being overlain by the Mottville member of the Skaneateles shale, and underlain by the Cherry Valley limestone member of the Marcellus. To the west of Seneca Lake it comprises all of the Marcellus.

The type section is below the Main Street bridge over Oatka Creek at LeRoy where the whole section of thirty feet is exposed. In all localities studied by Cooper, it is overlain by the thin Stafford limestone. It thickens to the east and west of the type section.

The upper part of the shale is displayed in an outcrop just to the north of the Fargo and Adams road junction, two and one-half miles southwest of Stafford. Here the Oatka Creek shale and the Stafford limestone occur in the road ditch on the west side of the road and in the northwestward flowing stream, just east of the road. Only the top part of the member is exposed.

Since good exposures of the shale are lacking in the area, the writer studied the outcrop at the type locality which is less than one–half mile east of the quadrangle.

Lithology and Fauna—The lower ten feet consists of a black, bituminous, resistant, blocky, shale and its exposure reveals excellent joint patterns in the resistant beds. The upper twenty feet are less resistant with a few concretionary layers and black, fissile shales which contain pyrite crystals. It is in these fissile beds that most of the fossils are found. The top ten feet have zones so fossiliferous that when the shale is split the fossils cover the entire surface. Here the fauna is represented for the most part by the brachiopods, *Leiorhynchus limitare, L. laura* and in even greater numbers, the pteropod, *Styliolina fissurella.* The following fossils are most abundant and easily collected:

Chonetes lepidus	Liopteria laevis
Leiorhynchus laura	Nuculites triqueter
L. limitare	Panenka linklaeni
Orbiculoidea minuta	Platystoma euomphaloides
Productella truncata	Styliolina fissurella
Cornullites flabella	Orthoceras subulatum

The type of deposition and the presence of pyrite seems to indicate the environment in which these forms lived. Most of the fossils are characterized by thin shells and seem to be adapted to foul bottom conditions.

Skaneateles Formation

This is the name that Vanuxem (1840) applied to the poorly exposed shales that occur between the upper Marcellus and his Hamilton Group at Skaneateles Lake. He justifies the retention of the name by a much clearer report on the Skaneateles shale at Cayuga Lake. This is the second *Leiorhynchus* zone of Cleland (1903). The Centerfield limestone was included by Luther (1914) as the top member of the formation. It was not until Cooper (1930) correlated the Hamilton sections, that the Stafford limestone was included at the base and the Centerfield placed in the overlying Ludlowville formation.

The Skaneateles formation is found to outcrop from east-central New York to the extreme western limits of the State. The following table not only indicates the general westward thinning but the irregular nature of the thickness:

200	feet at Cayuga Lake
225	feet at Canandaigua Lake
216	feet at the Livonia salt shaft
234	feet in the Caledonia quadrangle
83–98	feet in Darien and vicinity
60	feet at Lake Erie

In this quadrangle the thickness is estimated to be 215 feet, which is represented by the Stafford limestone member and the overlying Levanna shale member.

Stafford Limestone Member

Although first mentioned by Clarke (1894) in his description of the Livonia salt shaft section, the type locality referred to was Stafford, New York. The limestone was considered to be contained in the Marcellus, as discussed before, until Cooper (1930) correlated it with the Mottville limestone member to the east. The Mottville is the basal member of the Skaneateles. Therefore, the Stafford is now considered the basal Skaneateles to the west.

The Stafford limestone is exposed just north of the Fargo and Adams road junction, two and one-half miles southwest of Stafford. The outcrops are in a road ditch on the west side of the road and in a stream just a few yards to the east. In the stream bank, large pieces of it have weathered sufficiently to display the fauna. At LeRoy, where the limestone makes the cap rock of the falls under the Main Street bridge, a faunal collection can be made only with difficulty.

No outcrop of the limestone could be found southeast of Stafford where the type locality has been described. It is suggested that the outcrop southwest of the town be used as the standard of reference because of its nearness to Stafford.

In general, the limestone zone increases in thickness from a few inches at Seneca Lake to fifteen feet at Lake Erie. Near Stafford it is two feet thick. The following measurements indicate this general change:

6 inches at Seneca Lake
2 feet at the Livonia salt shaft
8.5 feet at Lancaster
15 feet at Lake Erie

Lithology and Fauna—The limestone is massive, fossiliferous, and dark gray, and weathers to a brownish or buff color. The crystals of calcite are barely visible to the unaided eye. It is composed of two massive beds with a shale parting, making a total thickness of slightly more than two feet.

The Stafford contains fewer species than the younger Hamilton limestones. The most abundant forms found were:

Ambocoelia umbonata
Camarotoechia sappho
Chonetes coronatus
C. mucronatus
Leiorhynchus mysia
L. limitare
Meristella barrisi
Productella spinulicosta
Crinoid columnals
Euryzone itys
Mourlonia itys (?)
Styliolina fissurella
Orthoceras sp.
Greenops boothi
Phacops rana

Many Cephalopods of the orthoconic type are found in the limestone but time did not permit a detailed study of them.

Levanna Shale Member

This name was proposed by Cooper (1930) for the shale between the Stafford or Mottville member of the Skaneateles formation and the Centerfield member of the Ludlowville formation, where it is essentially the "Marcellus or *Leiorhynchus* facies" of the Skaneateles formation and cannot be differentiated into members.

Previously, Clarke (1903) had proposed the name, Shaffer shale, for the Skaneateles equivalent on Shaffer Creek (Ontario County), but it is poorly exposed there.

The Levanna shale extends from Cayuga Lake to the shore of Lake Erie and the type locality is near the town of Levanna on Cayuga Lake, 100 miles east of this quadrangle. Although the thickness decreases toward the west, the thinning is not uniform. The following measurements indicate this:

200 feet at Cayuga Lake
225 feet at Canandaigua Lake
214 feet in the Livonia salt shaft
75–90 feet at Darien and vicinity
43 feet at Lake Erie

Grossman (1938) reports a thickness of 128 feet for the Batavia quadrangle. Although the thickness of the member is not known in the western part of the quadrangle, the thickness in the eastern part is estimated to be 213 feet from well number nine (Genesee County) of the Bradley and Pepper report (1938).

The most complete section of the Levanna occurs along Oatka Creek from the Main Street bridge in LeRoy, southwest along the stream and then along White Creek to a point just east of East Bethany where the Centerfield limestone crops out in the stream bank. Smaller exposures occur at Canada, in the streams just west of School No. 5 on the Center (Bethany) road and again just north of the junction of route 63 and the Town Line road.

Lithology and Fauna—The basal part of the member is composed of black, bituminous shale, similar to the Oatka Creek shale below, and carries the *Leiorhynchus* fauna so prevalent in the dark gray shales of the member. The brachiopod, *Orbiculoidea minuta,* is present in great numbers.

Twenty-three feet from the base is a limestone, one and three tenths of a foot thick, which is brownish gray, crystalline, and rather fossiliferous. Wood (1901) recognized eight different limestone beds of the Stafford in the Lancaster region (forty miles to the west). It is possible that a lentil similar to the ones described by Wood, extends eastward and correlates with this limestone. If this were true, the twenty-three feet of shales beneath would then be included in the Stafford member.

Above the limestone, the shales are fissile and dark to medium gray. This represents the dark gray or *Leiorhynchus* facies interfingering from the west. Upper portions are characterized by calcareous shales which are dark gray to black, irregularly bedded and rather fossiliferous. The *Leiorhynchus* fauna still dominates as in the underlying strata. Most of the fauna listed was collected from the upper part of the member.

Ambocoelia umbonata
Chonetes mucronatus
C. lepidus
Leiorhynchus laura
L. limitare
Orbiculoidea minuta
Productella truncata
Crinoid columnals
Nuculites oblongus
N. triqueter
Pleurotomaria sp.
Styliolina fissurella
Orthoceras sp.
Bairdia sp.
Plant remains

Ludlowville Formation

The name Ludlowville was first used by Hall (1839) for the sequence on Cayuga Lake from the base of the Centerfield member to his "Encrinal limestone", (now the Tichenor). Cooper (1930) points out that this Cayuga Lake section does not have a complete exposure of the formation but, since the name of Ludlowville is so well entrenched in the literature, the sequence on Paines Creek at Aurora should be the type section. This is 70 miles east of the Batavia Quadrangle.

The formation crops out from Schoharie Valley to Lake Erie. In the eastern part of the State, subdivisions are lacking because of the uniform lithology and fauna. Toward the west, however, the formation can be separated into members. The lower part is composed of a dark shale having the *Leiorhynchus* fauna but the upper part, according to Cooper, consists of soft gray shales and carries "the typical Hamilton fauna".

As in the case of the other Hamilton formations, the Ludlowville generally thins toward the west. This is demonstrated by the following thicknesses:

535 feet at the Chenango Valley
181 feet at Canandaigua Lake
130 feet at Jaycox Run (Caledonia Quadrangle)
88 feet at Darien
100 feet at Lake Erie

It is interesting to note the thickening of the formation in the Lake Erie area. In the Batavia Quadrangle the thickness is approximately 113 feet.

Cooper (1930) has divided the Ludlowville formation into five members. They are, from the base, the Centerfield, Ledyard, Wanakah, Tichenor and Deep Run. This classification is followed with the exception that the Ledyard and Wanakah are treated as one unit. Reasons for this change will be discussed later.

Centerfield Limestone Member

This is the name proposed by Clarke (1903) for a group of limestones exposed on Shaffer Creek, one mile north of Centerfield. By 1909 Luther included the Centerfield in the Ludlowville shale but later (1914) treated it as the top member of the Skaneateles. Cooper again placed the Centerfield limestone in the Ludlowville formation as its basal member.

This member extends from Cayuga County to Blossom, Erie County. West of this the typical Centerfield is not present but is thought to be represented by a one and one-half foot limestone. This westward extension was called the "Pteropod bed" by Grabau (1898) from its exposure in the cliff at Bayview, Lake Erie.

East of Blossom it thickens from four and one-half feet to nineteen feet in the Livonia Salt Shaft and consists of thin limestones and shale bands. Still farther east of the type section, it becomes more homogeneous, being a bluish, arenaceous limestone with an increase in the percentage of sand toward the east. The thicknesses are tabulated as follows:

50 feet at Skaneateles Lake
35 feet at Cayuga Lake
19 feet in the Livonia Salt Shaft
11 feet in the Caledonia Quadrangle
4.5 feet at Blossom

In the Batavia Quadrangle, the thickness is not definitely known, since outcrops are usually on small streams or in open fields where glacial drift and soil mantle obscure the complete section. The Centerfield is at least two feet thick. It is known to be composed of a massive crinoidal limestone bed over one foot thick and calcareous shales at least one foot thick.

Several excellent exposures may be found in this quadrangle. They are, from east to west:

1. One and one-half miles east of East Bethany along Transit Road, one-fourth mile south of the Delaware, Lackawanna and Western Railroad.
2. Three-fourths of a mile east of East Bethany on White Creek.
3. North of Bethany, along the Delaware, Lackawanna and Western Railroad, on either side of the Center Road overpass.
4. Three miles west of East Bethany, east of the Francis Road along the D. L. and W. R. R. and in a westward flowing stream just north of the railroad.
5. One mile north of outcrop 4, on either side of Francis Road where it crosses a southern branch of a westward flowing stream.

LITHOLOGY AND FAUNA—The member may best be described as a massive limestone, one foot thick, underlain by calcareous shales. This limestone is a hard, compact, crystalline, fossiliferous, steel gray bed while the underlying shale is calcareous, bluish gray, fossiliferous and irregularly bedded. Upon weathering, the limestone has a brownish appearance due to the oxidation of its iron content.

At the White Creek exposure, a piece of the limestone reveals a very interesting replacement phenomenon. A thin section of it shows the fossils to be partially replaced with what is now iron oxide. The matrix still retains the appearance of a recrystallized limestone but the fossils were irregularly replaced. The iron is found in zones radiating from some point on the surface of the fossil with the rest of the shell composed of calcite.

There are thin beds of marcasite in the Ludlowville and Moscow formations. The origin of the iron and its relation to the faunal content of these beds is unknown.

This limestone reveals one of the greatest faunal developments in the Hamilton, and records an environment in which hundreds of different species thrived in great numbers. Clarke and Luther (1904) listed fourteen crustaceans, eleven gastropods, eleven pelecypods, twenty-nine brachiopods and twenty corals from the Centerfield in the Canandaigua Lake area. Specimens found by the author in this area are listed below. For a more complete list refer to Slocum (1906).

Aulopora tubaeformis (?)
Amplexus hamiltoniae
A. intermittens (?)
Ceratopora dichotoma
C. jacksoni
Craspedophyllum archiaci
Cyathophyllum sp.
Favosites arbuscula
F. argus
F. clausus
F. hamiltoniae
F. placenta
Heliophyllum halli
H. halli var. confluens
Streptelasma ungula
Syringopora sp.
Trachypora limbata
Athyris spiriferoides
Atrypa reticularis
Brachyspirifer audaculus
Cryptonella rectirostra
Cyrtinia hamiltonensis
Elytha fimbriata
Fimbrispirifer divaricatus
Meristella haskinsi
Mucrospirifer mucronatus
Parazyga hirsuta
Pentamerella pavilionensis
Rhipidomella penelope
R. vanuxemi
Spirifer sculptilis
Strophodonta demissa
S. inequistriata
Tropidoleptus carinatus
Cladopora sp.
Fenestrellina emaciata
Pleurotomaria lucina (?)
Rhombopora lineata (?)
Crinoid fragments
Grammysia arcuata
Platyceras sp.
Orthoceras sp.
Phacops rana
Aechmina sp.
Amphissites sp.
Bairdia sp.
Bollia sp.
Bufina sp.
Ctenobolbina papillosa
Ctenoloculina sp.
Euglyphella sp.
Healdia sp.
Hollina sp.
Janetina sp.
Jenningsina sp.
Jonesina sp.
Kirkbyella sp.
Ponderodictya bispinulata
Quasillites sp.
Richina sp.
Ropolonellus sp.
Strepulites sp.

The member is characterized by *Favosites hamiltoniae* in this area but Cooper points out that *Fimbrispirifer divaricatus* (= *Spirifer divaricatus* Hall), *Pustulina pustulosa* (= *Vitulina pustulosa* Hall), and *Pentamerella pavilionensis* are the important forms. The notable abundance of *Heliophyllum halli* must not be overlooked but its presence in the Tichenor limestone prevents it from being diagnostic.

Ledyard-Wanakah Member

The name Ledyard was applied by Cooper (1930) to 100 feet of black shale succeeding the Centerfield limestone on Paines Creek, Ledyard township, in the Cayuga Lake area. This is approximately 75 miles to the east of the Batavia quadrangle. It had been called the "third Leiorhynchus zone" by Cleland (1903) and designated the Canandaigua shale by Clarke (1903–4).

Extending from Lake Erie to the east, the Ledyard changes from a Marcellus fauna and black shale to a Hamilton fauna (i. e., the fauna of the higher gray shale and limestone facies) and a blue-gray arenaceous shale, so that the name Ledyard eventually loses its significance. It rests on the Centerfield limestone or its westward extension and its upper limits are defined, according to Cooper, by a thin limestone, the "Strophalosia" bed. This bed contains *Productella truncata* (formerly *Strophalosia truncata*) in great numbers hence the name of the limestone. Cooper believes this bed overlies the Ledyard from Lake Erie to the Genesee Valley. Farther east, the "Strophalosia" bed being absent, Cooper defined the top of the Ledyard as being at the Pleurodictyum (= Michelinia) zone.

Grabau (1917) applied the name of Wanakah to the Hamilton shales underlying the "Encrinal limestone" (now Tichenor) at Eighteenmile Creek but did not define it further. This is 50 miles to the west of the Batavia Quadrangle. Later, the "Strophalosia" bed and *Pleurodictyum* bed, as discussed above, were designated at the base of the Wanakah by Cooper. He then traced the Wanakah from the type section as far east as Seneca Lake. According to him, its lithology varies in that it consists of a number of light and dark blue-gray shales and also contains a number of thin bands of limestone which persist for nearly 100 miles.

These thin limestones are named for their characteristic fauna and listed below:

1. *Pleurodictyum* bed—from Lake Erie to Cayuga Lake.
2. Trilobite beds—Lake Erie to Canandaigua Lake.
3. *Stropheodonta demissa zone*—Cazenovia Creek to Darien.

These represented some of the units upon which the two shale members of the Ludlowville were correlated from type sections 120 miles apart.

It is now necessary to study the thickness of these two members and the relation of these thicknesses to the section in the Batavia Quadrangle. The Ledyard has the following measurements:

60 feet at Cayuga Lake
50 feet at the Livonia Salt Shaft
52 feet at Jaycox Run (Caledonia Quad.)
? 46.5 feet at East Bethany ?
53–75 feet at Darien and vicinity
30 feet at Lake Erie

The Wanakah in turn thins from the Seneca Lake area to Lake Erie in following manner:

60 feet at Seneca Lake
74 feet at Canandaigua Lake
55 feet at the Livonia Salt Shaft
? 40 feet at Murder Creek and East Bethany ?
48 feet at Darien and vicinity
46 feet at Lake Erie

The question marks in the tables above are my own.

These sections for the Batavia Quadrangle not only represent unusual thicknesses in relation to those of the adjacent areas, but the Ledyard shale was remeasured and found to be approximately 90 feet to the "Strophalosia" bed. The section in question is three miles west of East Bethany, along the Delaware, Lackawanna and Western Railroad and in the streams just to the north and south of the railroad. These small streams eventually flow into the Little Tonawanda Creek. This general area now will be referred to as the East Bethany Section (see figs. 3 and 9).

LITHOLOGY AND FAUNA—The great difference in the thickness of the Ledyard at the East Bethany Section, as measured by Cooper and myself, is not due to a stratigraphic error. His measurements would be very accurate if the beds in the outcrops were horizontal. But they are not. A structural feature, unique in western New York geology, occurs in the area of this outcrop. This is the Clarendon-Linden monocline. In general it strikes a little east of north and dips to the west. (This structure is discussed in greater detail in the portion of this paper dealing with structure.) The dip ranges up to three and one-half degrees at the outcrop of the "Strophalosia" bed and since the section here is a composite one, error resulting because of the dip was not accounted for.

Below is the section as measured by Cooper:

Cooper, (Ph.D. Thesis)
pages 194–95
Section three and one-half miles west of East Bethany

The section presented below is located along the Lackawanna railroad tracks three and one-half miles west of the village of East Bethany.

Ludlowville shale Fm.

Shale	15 ft.

Spring Brook shale member (See note below)

Impure ls.	0′.6 in.
This ls. contains *Modimorpha sublata, Bucanopsis leda, Euryzone itys.* It is the concret. bed below the upper Trilobite bed. The bed "M" of Grabau was not observed, therefore the upper limit of the Spring Brook is not here precisely defined.	
Shale, middle Trilobite bed	1′8 in.

Impure ls. containing *Streptelasma rectum.* (This bed is the lower Trilobite bed) .... 10 ft.

Shale, soft gray .... 7 ft.

Streptelasma rectum	Sprifer pennatus
Adolfia audacula	Athyris spiriferoides
Nucleospira concinna	Rhipidomella penelope

Ledyard sh. member

Impure ls. .... 6 in.

Strophalosia truncata	Styliolina fissurella
Modiella pygmaea	Geisonoceras subalatum
Nuculites oblongatus	Primitoipsis punctilifera

This bed is the Strophalosia bed

Soft shale .... 30 ft.

This bed is not completely exposed along the tracks. Its most important fossil is *Leiorhynchus laura.*

A small tributary to Little Tonawanda Creek rises on the north side of the Lackawanna RR. tracks two and one-half miles west of East Bethany. From the point where this brook passes under the tracks to its head, there are a few outcrops as follows:

Covered .... 16 ft.

The soil which covers the rock and forms this interval contains enormous numbers of fossils that have weathered free of the matrix. It is very probable that this material represents disintegrated rock thrown out during the excavation of the railroad cut and dumped along the brook. This covered interval must include a large part of the Ledyard shale

Centerfield member

Hard ls. abounding in corals .... 8 in.

Shale, very fossiliferous .... 1′5 in

This shale and limestone represent a part of the Centerfield member. The fossil species at this place have been listed by Slocum 1906 and Monroe 1902.

NOTE: The Spring Brook Shale member and the shale above (Eighteenmile Creek member) were the stratigraphic divisions of the Ludlowville shale formation made by Cooper in the Lake Erie sections. These names were used by him in his unpublished thesis but he has since modified the stratigraphy by combining the Spring Brook Shale and the Eighteenmile Creek to form the Wanakah shale member.

The Centerfield is well exposed for over one mile along the railroad east of this section. At a point two and one-half miles west of East Bethany, it dips to the west and is again found exposed in the stream just north of the railroad.

The East Bethany Section (condensed)
as measured by Sutton, 1949

The section begins at the outcrop of Centerfield in the stream bed just to the north of the railroad.

Bed 8. Shale, brownish gray. Contains—*Chonetes lepidus, Ambocoelia umbonata, Nuculites oblongus, Phacops rana* 2 ft. plus

Bed 7.	Limestone, shaly, gray weathering brown, not recry. Contains—*Orthoceras sp., Stereolasma rectum, Modiomorpha subalata, Buchanopsis leda, Styliolina fissurella*	.4 ft.
Bed 6.	Shale, gray, fossil, medium bedded. Contains—*Streptelasma rectum, Pleurodictym stylopora, Ambocoelia umbonata, Athyris spiriferoides, Chonetes lepidus, C. scitulus, Rhipidomella penelope, Mucrospirifer mucronatus*	9.6 ft.
Bed 5.	Limestone, shaly, not too massive, "Strophalosia" bed. Contains—*Productella truncata, Mucrospirifer mucronatus, Euryzone itys, Buchiola retrostriata, Platyceras symmetricum, Nuculites oblongus, Phacops rana, Dalmanites boothi*	.6 ft.
Bed 4.	Shale, dark brownish gray, unfossiliferous in lower part grading to light gray fossil. shale in upper part. Covered from four ft. to fourteen ft.—*Leiorhynchus limitare, Chonetes setigarus, C. lepidus, Phacops rana, Tentaculites bellulus*	33 ft.
Bed 3.	Shale, brownish gray, fissile.—*Leiorhynchus laura, Chonetes lepidus*	9 ft.
Bed 2.	Limestone, concretionary in places, very fossil. also a calcareous shale. Contains—*Leiorhynchus limitare, Nuculites triquiter, Chonetes viscinus, C. lepidus, Ambocoelia umbonata, Styliolina fissurella*	.5 ft.
Bed 1.	Begins at railroad track, first four feet covered. Shale, brownish gray drying to light bluish gray, not too fossiliferous. Contains—*Chonetes lepidus, Ambocoelia umbonata, Leiorhynchus limitare, Dalmanites boothi, Phacops rana, and Styliolina fissurella*	23 ft.
Covered	....	22.0 ft.
Centerfield Ls.	.... A massive limestone one foot thick underlain by one foot of calcareous shale (see faunal list under Centerfield ls.). Covered below.	2.0 ft.

Overlying the Wanakah is a rather thin, fossiliferous limestone, called the Tichenor which would define the top of the Wanakah shale. This was found in the stream parallel to the West Bethany road one mile south of the East Bethany section. Moreover, the "Strophalosia" bed was traced south along this stream from the East Bethany section to a point near the Tichenor outcrop so that less than fifteen feet of beds are known to exist between the "Strophalosia" bed and the Tichenor. Weathered portions of the "Strophalosia" bed and the Tichenor occur together on top of the hill northeast of the bridge. This would indicate that the Wanakah shale is less than fifteen feet thick in this area. The total thickness of the Ledyard-Wanakah is approximately 103 feet in this quadrangle, with fifteen feet assigned to the Wanakah shale.

It can be seen from the remeasured section that the "Strophalosia" bed still represents a distinct change in the lithology and fauna so that the underlying Ledyard part of the section is a rather homogeneous unit and cannot be divided at any horizon below this bed.

These lower or Ledyard type beds consist of dark gray or dark brownish gray shales interfingering with gray fissile shales and a few rather thin limestones or concretionary zones. Weathering produces a light gray powder on the shales so that the exposures appear to be composed of a much lighter gray shale than is actually the case.

The fauna is a modified Leiorhynchus type which carries *Leiorhynchus laura* and *L. limitare* but in addition has some of the common species of *Chonetes* in greater abundance than the Levanna shales. The *L. limitare* is most abundant in the lower beds and reappears in the upper zones. The shales in the middle seem to contain mostly *L. laura*. *Ambocoelia umbonata* is very common in the lower beds exposed at East Bethany. A trilobite zone containing *Phacops rana* was also discovered in the lower dark shales. It is exposed at the East Bethany section on the small stream just north of the railroad. In contrast to the 19 Genera of ostracodes in the Centerfield limestone, the dark shales carry only *Ponderodictya bispinulata* in great abundance with *Quasillites sp.*, *Richina sp.* and *Hollina sp.* in fewer numbers.

The "Strophalosia" bed is an argillaceous limestone, of light gray color and very fossiliferous, containing *Productella truncata* as the diagnostic and most abundant fossil. This bed is only six tenths of a foot thick but its fauna differs greatly from the dark shales below. It contains *Phacops rana*, *Mucrospirifer mucronatus*, and *Nuculites oblongus*. It does, however, contain the ostracode, *Ponderodictya bispinulata* which is so abundant in the dark shale below.

The beds above this have a different lithology and fauna. They would be classified as Wanakah in the terminology of Cooper. Although the entire section is not exposed, the beds are diagnostic enough to be identified from relatively poor outcrops. Bed 7 of the East Bethany section was identified in the stream one mile south and here the Tichenor limestone occurs about 100 yards to the east.

The basal part of Bed 7 consists of gray fossiliferous shales with abundant specimens of the coral *Stereolasma rectum* and the brachiopods, *Mucrospirifer mucronatus*, *Athyris spiriferoides* and *Rhipidomella vanuxemi*. Overlying this is an impure limestone containing abundant specimens of *Stereolasma rectum*.

The overlying Wanakah strata contain light gray shales and thin limestones with a fauna similar to that of the Tichenor, except for the lack of *Heliophyllum halli* and Bryozoa. *Pleurodictyum stylopora* does occur but its horizon was not located. The following is a list of fossils collected from the Ledyard-Wanakah.

Favosites argus
Pleurodictyum stylopora
Stereolasma rectum
Ambocoelia umbonata
Athyris spiriferoides
Chonetes lepidus
C. setigerus
C. scitulus
C. viscinus
Leiorhynchus laura
L. limitare
Mucrospirifer mucronatus
Orbiculoidea lodensis
Productella truncata
Rhipidomella penelope
R. vanuxemi
Tropidoleptus carinatus
Buchiola retrostriata
Leoptera laevis
Modiella pygmaea
Modiomorpha sublata
Nucula bellistriata
Nuculites oblongus
N. triqueter
Pterochaenia fragilis
Buchanopsis leda
Diaphorostoma sp.
Euryzone itys
Loxonema hamiltoniae
Platyceras symmetricum
Styliolina fissurella
Geisonoceras sublatum
Orthoceras sp.
Tentaculites bellulus
T. gracilistriatus
Dalmanites boothi
Phacops rana
Hollia sp.
Ponderodictya sp.
Quasillites sp.
Richina sp.
Plant remains

Tichenor Limestone Member

The Tichenor limestone overlies the Ledyard-Wanakah and extends from Seneca Lake to Lake Erie. Clarke (1903) applied the name to the limestone above his Canandaigua shale (= Ludlowville shale). Formerly, the Centerfield and Tichenor were believed to be the same limestone and were referred to as the Encrinal limestone. The present names were introduced when it was discovered that two separate limestones existed. In the Lake Erie area, Grabau (1917) suggested the name Morse Creek for the Tichenor which appears there as a thin limestone only one and one-half feet thick. Cooper found that the bed, when traced eastward, was only one of several limestones with intervening shale facies.

The type section is in Tichenor Point Ravine on Canandaigua Lake. This is approximately 40 miles to the east of the Batavia Quadrangle. At Tichenor Point, Cooper united the compact one foot of limestone with the ten feet of fossiliferous shale below. At Jaycox Run, in the Caledonia Quadrangle, it is also eleven feet thick with ten feet of shale capped by a one foot limestone layer. From here it thins to Lake Erie where it consists of a one and one-half foot hard pyritiferous, crinoidal limestone. The thickness varies principally because of the associated shale.

1 foot at Seneca Lake
11 feet at Canandaigua Lake
11 feet at Jaycox Run
4.5 feet at Murder Creek
2.3–4.6 feet at Darien and vicinity

The member is nine feet thick in the eastern part of the Batavia Quadrangle and appears to thin toward the western part. Listed from east to west, the outcrops are:

1. The only complete exposure of the Tichenor is found in a small stream three quarters of a mile southeast of Pavilion Center. The stream is flowing southwest and joins Oatka Creek. The exposure may be found downstream from Branch Road.

Here the uppermost Ledyard-Wanakah shales are capped by a thin limestone three tenths of a foot thick. Above this, eight and two tenths feet of shale is assigned to the Tichenor because it is capped by a crinoidal limestone, one foot thick.

Numerous other localities occur where the outcrop is not as complete but weathering has freed its diagnostic fauna from the matrix so that it may be readily studied.

2. One and one-half miles southeast of East Bethany on a hilltop just north of the Transit and Keller Road junction.
3. The uppermost shale beds and overlying crinoidal limestone are exposed in a stream which is crossed by Route 63, one and one-half miles southeast of East Bethany. The outcrop may be examined just a few yards upstream (to the southwest) from the road. This section is excellent for the overlying Moscow formation.
4. Shallow well dredging one mile south of East Bethany, six hundred yards east of East Road. This affords excellent collecting, although the bedrock itself is covered by water.
5. Large pieces of the limestone bed and its fauna are found on top of a hill just north of the East Bethany section, approximately 200 yards east of Francis Road. A much better exposure occurs at the outcrop one mile south of the East Bethany section. This is in the stream bank just north of the West Bethany Road.
6. The westernmost exposure in the quadrangle can be found on Little Tonawanda Creek just south of the Gilhooley Road bridge, nine-tenths of a mile south of East Alexander.

LITHOLOGY AND FAUNA—Lithologically, the member consists of a series of calcareous shales interbedded with limestone beds. The limestone is a semi-crystalline, bluish gray bed. It is more argillaceous than the Centerfield. The Tichenor is also underlain by calcareous shales and argillaceous shales which are exceedingly fossiliferous. The corals are found in the resistant limestone beds as well as in the shales. The Tichenor must be treated as a series of beds because at outcrop 1, mentioned above, the resistant limestone bed is only one foot thick but at outcrop 2, mentioned above, the limestone is no longer a massive one foot bed but is composed of several thin limestones with shale between making a total measurement of one and seven tenths feet. This seems to represent lentils of shale interfingering with the limestone but its effect on the outcrop is to greatly reduce the resistance of the bed and give the effect of a different lithology.

Farther west, the limestone bed again becomes massive, measuring over one foot in thickness with no shale partings.

The fauna indicates a return of the Centerfield type of deposition and results in an abundant fauna similar to that of the Centerfield. Upon closer examination, the fauna is shown to be reduced in the number of species represented, (as noted by Grossman (1938) in his study of the Tichenor limestone) at Jaycox Run. Since the faunal study in this area was not detailed enough to warrant such a conclusion, the writer feels compelled to leave a critical analysis of this sort to other workers.

The coral, *Heliophyllum halli,* indicates the change to calcareous deposition. It is lacking in the shales and limestone below (in the Ledyard-Wanakah) and so is the most diagnostic fossil of the Tichenor. Many other types of corals as well as abundant Bryozoa, brachiopod and ostracode species may be found. The pelecypods and gastropods are all well represented.

Aulopora serpens
Craspedophyllum archiaci
Favosites arbuscula
F. argus
F. placenta (?)
Heliophyllum halli
H. halli var. confluens
Stereolasma rectum
Ambocoelia umbonata
Athyris spiriferoides
Brachyspirifer audaculus
Camarotoechia congregata
C. sappho
Chonetes lepidus
Cyrtinia hamiltonensis
Elytha fimbriata
Lingula spatula
Meristella barrisi
Mucrospirifer mucronatus
Pholidostrophia iowensis
Rhipidomella vanuxemi
Spinocyrtia granulosa
Spirifer sculptilis
Stropheodonta demissa
S. concava
Tropidoleptus carinatus
Fenestrellina planiramosa (?)
Reteporina striata (?)
Rhombopora hexagona
Crinoid fragments
Cypricardinia indenta
Nuculites oblongus
Diaphorostoma lineatum (?)
Loxonema delphicola
Pleurotomaria itys
Amphissites sp.
Bollia sp.
Bufina sp.
Ctenobolbina sp.
Ctenoloculina sp.
Euglyphella sp.
Healdia sp.
Jenningsina sp.
Jonesina sp.
Kirkbyella sp.
Ponderodictya sp.
Quasillites sp.
Richina sp.
Ropolonellus sp.
Strepulites sp.
Tubulibairdia sp.

Deep Run Member

This is the name applied to the brittle bluish shales that overlie the Tichenor limestone and underlie the Menteth limestone. It forms the uppermost member of the Ludlowville formation and extends from Seneca Lake to the Batavia Quadrangle.

Previously, Clarke (1885) had united the lower shales of this member with the Encrinal or Tichenor limestone. Later, (in 1904) he termed the whole shale sequence the "lower division" of the Moscow shale.

Cooper placed the Deep Run in the Ludlowville because it is overlain by the Menteth limestone. He discovered that the Menteth, when correlated to the Cayuga Lake section, is the basal bed of the Portland Point limestone. At Cayuga Lake, the Portland Point is the basal member of the Moscow formation. This places the Deep Run shales in the Ludlowville formation.

The type locality is Deep Run ravine, near Cottage City, Canandaigua Lake. Here it is 55 feet thick but rapidly thins westward until it wedges out in the Batavia Quadrangle. East of the type section it thins somewhat and measures 49 feet at Seneca Lake. East of Seneca Lake it is not distinguished but is correlated by Cooper with the King Ferry member (uppermost Ludlowville). Below is a table of thicknesses for the Deep Run, as measured by Cooper:

49 feet at Seneca Lake
55 feet at Canandaigua Lake
9 feet at Jaycox Run, Caledonia Quadrangle*
3 feet at Hills Gulch, Caledonia Quadrangle
* Grossman's measurement for the Deep Run at Jaycox Run is seven feet.

The Deep Run outcrops in the eastern part of the quadrangle, three-quarters of a mile southeast of Pavilion Center. Here it consists of three and six tenths feet of calcareous shale and is overlain by Menteth limestone six tenths of a foot thick. This section is outlined under the discussion of the Tichenor, (outcrop 1). Farther west at locality 2 (see Tichenor), five feet of calcareous shales were assigned to the Deep Run chiefly on faunal content although the overlying Menteth was reduced to a thin limestone measuring less than two tenths of a foot in thickness.

LITHOLOGY AND FAUNA—The shales are bluish gray, calcareous, irregularly bedded and fossiliferous with the weathered surface stained brown to yellow. The faunal content is significantly different from that of the shale members above and below it. Its pelecypods are very characteristic. Among those found were *Pterinopecten undosus* and *Aviculopecten princeps*. Specimens of the brachiopod, *Tropidoleptus carinatus*, are much smaller than those in the Moscow. A few of the species found in the shale are:

Ambocoelia umbonata	Pentamerella pavilionensis
Camarotoechia congregata	Tropidoleptis carinatus
Chonetes coronatus	Bryozoa
C. mucronatus	Aviculopectin princeps
C. setigerus	Parallelodon hamiltoniae
C. viscinus	Pterinopectin undosus
Lingula sp.	Greenops boothi
Mucrospirifer mucronatus	Phacops rana

Moscow Formation

Hall (1839) described the Moscow formation from the complete exposures near the village of Leicester (formerly Moscow). He reported that the shale and fossils are different from those below. He further described the color of the shale as bluish, in places olive, and locally, near the top as black. His references to the change in the sediments obviously applied to the difference between the Moscow shales and the underlying Ludlowville shales.

Hall's definition of the Moscow formation included that part between the "Encrinal" limestone and the Tully limestone. But what he did not know and what Cooper discovered later (1930) was that he had put the base of the formation on what is now termed the Tichenor limestone and thus had confused the Tichenor and Menteth limestones in their correlation from the Leicester section to the Canandaigua Lake section. Thus Cooper was forced to redefine the Moscow formation with the Menteth forming the basal limestone member.

Cooper recognized three members in the Moscow formation: the Menteth limestone, Kashong shale and Windom shale. It is proposed here to add a fourth member, the Leicester marcasite, as the uppermost member. The formation can be traced as far east as the Unadilla Valley and as far west as Lake Erie. The type section is only five miles east of the Batavia Quadrangle but significant changes in sedimentation occur to the west. These require the use of different criteria to distinguish the Kashong-Windom contact in the Batavia Quadrangle.

The formation thins irregularly from east to west. Cooper recorded the following thicknesses for the extent of its outcrop.

215 feet at Unadilla Valley
270 feet at Chenango Valley
140 feet at Cayuga Lake
165 feet at Canandaigua Lake
135 feet in the Caledonia Quadrangle*
70 feet at Darien and vicinity
60 feet at Cazenovia Creek
17 feet at Lake Erie

* The thickness of the formation is supplied by Grossman (1938). In the Batavia Quadrangle the formation is 72 feet thick.

Lithologically, the formation consists of bluish gray shales and thin limestones. The shales form a homogeneous unit and the Kashong and Windom members are differentiated upon their faunal content. A series of fossiliferous limestones occur at the top of the Kashong member and another series just below the Leicester marcasite.

Cooper differentiates the Kashong and Windom shale members upon a faunal zone called the "Ambocoelia-Chonetes Zone." The writer found that several horizons could possibly fit this definition but that a persistent limestone horizon could be identified in several outcrops across the quadrangle. This was chosen instead for the contact but has not been traced into the areas to the east or west to verify its stratigraphic importance.

Menteth Limestone Member

The name Menteth was applied to a thin limestone in the ravines at Tichenor and Menteth Points at Canandaigua Lake. Clarke and Luther (1904) defined it here as the limestone bed which lies seventy-five feet above the Tichenor. This had been previously termed the "Encrinal" limestone by Hall (1839) in the Cayuga Lake region. Cooper (1930) redefined it as the basal bed of the Moscow formation. He correlated it with the basal beds of the Portland Point member farther east. Since the Portland Point (also defined by Cooper) forms the basal member of the Moscow in the Cayuga Lake area, this makes the Menteth limestone the basal member to the west.

The Menteth limestone has a stratigraphic position fifty-five feet above the Tichenor at Canandaigua Lake, but when traced westward, it approaches the Tichenor horizon due to the rapid thinning of the Deep Run. According to Cooper, after the disappearance of the Deep Run, the Menteth rests on the Tichenor but dies out before reaching Lake Erie.

If the Menteth is equivalent to the basal beds of the Portland Point to the east, the Portland Point would extend in outcrop from the Unadilla Valley in the east to the Depew Quadrangle. The Menteth forms the basal limestone of the Moscow to the west of Canandaigua Lake. Therefore it is here treated as correlating with the Portland Point and extends from Canandaigua Lake to Spring Brook. Thicknesses of the member from the Canandaigua Lake section to the west are:

15 feet at Canandaigua Lake (Portland Point including basal Menteth layer)
.6 foot at Jaycox Run
.5 foot at Hills Gulch

Identification of the limestone was made at two places. The easternmost outcrop is outcrop 1 (see Tichenor) where a limestone bed six tenths of a foot thick was found to overlie the Deep Run shales. Farther west at outcrop 2 (see Tichenor) the only limestone found to overlie the shales was a thin bed of shaly limestone less than two tenths of a foot in thickness. It is questionable whether this represents the Menteth horizon but no limestone was found in this section to conform with the characteristics of the Menteth, as observed in the outcrops to the east.

A rather massive limestone bed occurs at the top of the Tichenor in the western part of the quadrangle. This limestone, over one foot in thickness, may be either (a) the Menteth limestone lying directly upon the Tichenor, or (b) a massive lens of limestone of the Tichenor with the Menteth absent. The author feels that the latter is true because of the presence of a shale above the limestone bed which abounds in crinoid columnals. This is very similar to the Deep Run shales in the eastern part of the quadrangle and would suggest that the Menteth, not the Deep Run, terminates in the eastern part of the quadrangle.

LITHOLOGY AND FAUNA—The limestone appears as a dark bluish gray, fossiliferous bed with comparatively little recrystallization. This is markedly different from the "dark gray resistant cherty limestone" described by Grossman at Jaycox Run. An increase in the amount of clay present may account for the facies change from Jaycox Run to the two exposures in the Batavia Quadrangle. Most notable was the high Bryozoa content with the brachiopod fauna next in importance. A few specimens identified from the limestone are:

Camarotoechia congregata	Crinoid columnals
Chonetes coronatus	Paracyclas lirata
C. viscinus	Styliolina fissurella
Pentamerella pavilionensis	Phacops rana
Tropidoleptus carinatus	

Kashong Shale Member

This is the name proposed by Cooper for a shale sequence above the Portland Point and underlying the Windom shale. This was the equivalent of the Moscow shale as used by Hall and others. The type locality is in Kashong Creek, Seneca Lake but it extends from Cayuga Lake to the Western edge of the Depew Quadrangle.

The beds consist of soft shale with the brachiopods *Adolfia marcyi* and large specimens of *Tropidoleptus carinatus*. From its eastern limit to Canandaigua Lake its upper boundary is defined by four feet of hard sandy rock upon which the Windom shale was deposited with a basal zone of soft shale carrying *Ambocoelia umbonata* and *Chonetes mucronatus*. West of Canandaigua Lake the sandstone is absent but the *Ambocoelia-Chonetes* zone persists. Therefore the basal beds are defined, not by a lithologic change in sedimentation, but upon the *Ambocoelia-Chonetes* zone.

The Kashong has a maximum thickness of 85 feet in the Genesee Valley and thins to the east and west.

24 feet at Seneca Lake
45 feet at Canandaigua Lake
80 feet in the Livonia Salt Shaft
61 feet in the Caledonia Quadrangle
43 feet at Darien and vicinity
Disappears at western edge of Depew Quadrangle

In the Batavia Quadrangle the shale has a thickness of approximately 38 feet.

LITHOLOGY AND FAUNA—One of the best exposures of the Kashong shale is on the west branch of White Creek, southwest of Route 63. Less complete exposures of the member occur on Little Tonawanda Creek from Town Line road at West Bethany southeast to Route 20 but here the section is much more difficult to measure because of the effects of monoclinal structure.

The top of the member is defined in the Batavia Quadrangle by a group of thin limestones which are traceable over the entire distance. Cooper's *Ambocoelia-Chonetes* zone was not found but thick beds of *Ambocoelia umbonata* occur in several parts of the Windom so that the contact would be poorly chosen on this basis. The group of thin limestones contain *Adolfia marcyi* which places them in the Kashong. Above these limestones (in the Windom) is a thin pyrite bed. Frequently, the weathered rocks in normally poor exposures have a very good display of the limestone fauna with weathered limonitic nodules from the shales above as an excellent horizon marker.

The following description was compiled principally from the exposures on White Creek with the limestone faunal list supplemented from other definitely identifiable outcrops where weathering has allowed the fossils to be freed from the matrix.

The basal part of the member consists of a soft greenish to bluish gray, fossiliferous shale which is irregularly bedded and contains a large amount of ferruginous material. Most abundant are the crinoids and Bryozoa which decrease in number in the overlying strata. It is possible that the first foot or so which lies on the Menteth limestone may belong to the Menteth but no sharp faunal break is clear so its upper contact would be more difficult to define than the one used here. The shale zone continues for sixteen feet with bedding much more regular and shale appears more bluish in color. A few fossils identified from these shales are: *Chonetes coronatus, Chonetes viscinus, Mucrospirifer mucronatus, Nucula lirata* and *Platyceras sp.* At a horizon of ten and six-tenths feet, above the base of the member, the shale was noticeably darker gray and carried few forms compared to the bluish gray shales above and below. Apparently a slight change in sedimentation was sufficient to produce unfavorable conditions for the Moscow fauna.

The next fifteen feet consist of bluish gray shales with a few thin shaly limestones which usually measure one or two tenths of a foot. The calcareous beds often show heavy staining by limonite. The fauna in the shales consists of large forms of *Phacops rana,* and most abundant is *Tropidoleptus carinatus.* Others found were *Camarotoechia sappho, Paracyclas lirata* and many crinoid columnals.

The top nine feet are distinguished by three limestones each separated by four feet of shale. The lower and thinner limestone contains *Tropidoleptus carinatus* and *Atrypa reticularis.* The next limestone is five tenths of a foot thick and forms a falls in the stream. The shales just beneath it are extremely fossiliferous carrying large numbers of *Mucrospirifer* *mucronatus*, *Elytha fimbriata* (which had been found only in the Centerfield and Tichenor limestones in this area) and abundant crinoid columnals. The uppermost limestone bed is eight feet thick and forms the top bed of the Kashong. Specimens collected from the limestone and the underlying calcareous shale revealed the following fauna:

Mucrospirifer mucronatus	Cypricardella bellistriata
Chonetes mucronatus	Orthonota undulata
Palaeonillo tenuistriata	Liopteria conradi
Orbiculoidea sp.	Greenops boothi

This nine foot calcareous zone is traceable across the entire quadrangle and is identifiable in poor outcrops by its association with nodules of limonite from a thin pyrite bed one foot above.

The following is a complete list of fossils identified from the member.

Adolfia marcyi	Fenestella sp.
Ambocoelia umbonata	Crinoid columnals and plates
Athyris spiriferoides	Cryptonella retrostriata
Atrypa reticularis	Cypricardella bellistriata
Camarotoechia sappho	Grammysia arcuata
Chonetes coronatus	Grammysia sp.
C. mucronatus	Liopteria conradi
C. scitulus	Nucula lirata
C. viscinus	Orthonota undulata
Elytha fimbriata	Palaeonilo tenuistriata
Lingula spatula	Paracyclas lirata
Meristella barrisi	Platyceras sp.
Mucrospirifer mucronatus	Greenops boothi
Orbiculoidea sp.	Phacops rana
Tropidoleptus carinatus	Plant remains

Windom Shale Member

The name Windom was given by Grabau (1917) to seventeen feet of shale exposed near the village of Windom, Erie County. Grabau thought this was equivalent to the Ludlowville and Moscow formations farther east.

Cooper (1930) redefined the term as a member of the Moscow formation. This member when traced eastward was found to overlie the Kashong. In the Lake Erie section it is the only member present.

The type locality is approximately 40 miles to the west of the Batavia Quadrangle but the member extends from the Unadilla Valley in the east to Lake Erie in the west. In the eastern part of its exposures, the Windom is more arenaceous than the underlying Kashong and carries a pelecypod fauna in contrast to a brachiopod fauna in the argillaceous facies farther west. In western New York it is not unlike the underlying Kashong in lithology but has sufficient faunal differentiation to distinguish it from the shales below.

The member may be studied at the following locations:

1. One and one-half miles northwest of Pavilion on northeastward flowing stream, northeast of its intersection with Route 63.
2. West branch of White Creek, north of Route 20.
3. Three-eighths mile south of Bethany on eastward flowing stream, east of Center road.
4. Two and one-half miles west of Bethany on Little Tonawanda Creek, north and south of Route 20.

The following thicknesses have been measured by Cooper:

265 feet in Unadilla Valley
120 feet at Cayuga Lake
65 feet at Canandaigua Lake
50 feet in Genesee Valley
27 feet at Darien and vicinity
52 feet at Windom (Cooper 1930)
17 feet at Lake Erie

LITHOLOGY AND FAUNA—The thickness of the Windom on White Creek is 32 feet. The lower part, which is approximately twenty-one feet thick, is composed primarily of shale. These soft bluish-gray shales are very similar to the underlying Kashong but here *Chonetes mucronatus* and *Ambocoelia umbonata* predominate with fairly abundant specimens of *Mucrospirifer mucronatus* and *Stropheodonta inequistriata*. One and five-tenths feet from the base occurs a thin marcasite bed which contains nodules of marcasite, some of which contain the remains of organisms. A fossiliferous zone occurs fifteen feet from the base with numerous *Ambocoelia umbonata* and *Chonetes mucronatus*. This may possibly correlate with the Kashong-Windom contact of Cooper but it is only one of several such horizons and is only seventeen feet from the top of the member.

The upper eleven feet of the Windom is distinctly different from the lower portions. It contains a series of limestones or concretionary layers separated by soft shale. Both the shale and the limestone of this zone are exceedingly fossiliferous. One fossiliferous limestone occurs at the base of this upper section (eleven feet from the top). Another is found two feet above the first. Above this is more limestone and shale with the remaining upper five feet composed of soft argillaceous shale and concretionary layers.

The fauna of this zone is much more similar to that of the Hamilton limestones than it is to the shale fauna. Accompanying the large bryozoa and crinoid population are such brachiopods as *Brachyspirifer audaculus, Spirifer tullius, Atrypa reticularis, Athyris spiriferoides, Chonetes coronatus, Rhipidomella vanuxemi,* and *Stropheodonta inaequistriata*. Corals are also fairly abundant being represented by *Amplexus hamiltoniae, Heliophyllum halli* and *Pleurodictyum sp*.

The limestone zone is persistent across the entire quadrangle and, with the overlying resistant Geneseo black shales, forms small falls in the local streams.

The following fauna have been identified in the Windom:

Amplexus hamiltoniae	Spirifer tullius
Heliophyllum halli	Stropheodonta concava
Pleurodictyum stylopora	S. inaequistriata
Ambocoelia umbonata	Tropidoleptus carinatus
Arthyris spiriferoides	Crinoid columnals
Atrypa reticularis	Nuculites triquiter
A. spinosa	Styliolina fissurella
Brachyspirifer audaculus	Orthoceras sp.
Camarotoechia sappho	Tentaculites gracilistriatus
Chonetes coronatus	Greenops boothi
C. lepidus	Bufina sp.
C. mucronatus	Ctenobolbina sp.
C. setigerus	Ctenoloculina sp.
C. viscinus	Hollina sp.
Elytha fimbriata	Quasillites sp.
Mucrospirifer mucronatus	Ulrichia sp.
Rhipidomella vanuxemi	Bryozoa

Leicester Marcasite

The name, Leicester Marcasite Member is proposed for the marcasite zone which overlies the Windom member. The member is exposed to best advantage along the banks of Beards Creek, one-quarter mile northwest of Leicester, New York and is five miles east of the Batavia Quadrangle. The exposure at Beards Creek is suggested as the type locality because of the unusually thick lens (six inches) present there and the length of the exposure in the bank. Here it exhibits its characteristic thickening and thinning which is not so readily seen in smaller outcrops.

The member had previously been called the "Tully pyrite". Vanuxem (1839) applied the name Tully to the limestone formation farther east. The Tully limestone is absent in this area but the marcasite bed was thought to be the westward continuation of the limestone. Later it was found by Pohl (1930) and Cooper (1935) to correlate with the *Spirifer tullius-Vitulina* zone at the top of the Hamilton. Grossman (1938), who used the term "Tully pyrite", suggested Beards Creek as the standard of reference.

Since it was not equivalent in age to the Tully limestone, it is necessary to divorce the bed from any connection with the Tully. Its significant stratigraphic position at the top of the Hamilton and its diagnostic fauna make it an object of intense study. Extending from the west shore of Canandaigua Lake to Lake Erie, it forms a bed or series of beds of marcasite and pyrite. These beds or lenses measure up to six inches in thickness. They may be entirely lacking in any one section and reappear in the next.

Outcrops where the Leicester marcasite may be studied in the Batavia Quadrangle are listed in order from east to west.

1. One and one-half miles northwest of Pavilion on northwestward flowing stream, northeast of its intersection with Route 63.
2. West branch of White Creek, north of Route 20.
3. Three-eighths mile south of Bethany on eastward flowing stream, east of Center Road.
4. North of falls at Linden, near junction of eastward flowing stream and Little Tonawanda Creek.
5. Two and one-half miles west of Bethany on Little Tonawanda Creek, south of Route 20.

LITHOLOGY AND FAUNA—The beds are composed of marcasite and pyrite. Cooper (1935) refers to this as marcasite while Grossman (1938) found specimens from Jaycox Run that are composed entirely of pyrite. The lenses are yellowish brown, sometimes nodular with a sponge-like appearance under the microscope. When weathered, the material crumbles into a reddish brown limonitic powder which frequently stains the underlying rocks.

The lenses are extremely fossiliferous but the forms are much smaller than those in the beds above or below. Loomis (1903) terms this a dwarfed fauna. He rules out the possibility of their being young forms because a whole fauna cannot exist in immature forms alone and the uniformity of their size can only express adult growth. The Goniatites show a reduction in size but have the mature chambers as well as the primitive whorls.

He explains that the dwarfing agent has totally eliminated the corals and that the brachiopods are most uniformly and extensively dwarfed. Other groups are more variable and generally less dwarfed than the brachiopods. Loomis states that the sessile types or bottom dwellers are the most dwarfed since the iron tends to settle. Variation in dwarfing seems to be due to differing locomotive abilities. If we accept the hypothesis that the fauna is a dwarfed one, the genera are variations of the Hamilton forms.

Loomis (1903) has listed thirty-one forms from the Leicester marcasite.

UPPER DEVONIAN

Disagreement exists as to the contact of Middle and Upper Devonian formations in New York State. According to Cooper et al. (1942, p. 1735) "A slight break in sedimentation occurs at the top of the Hamilton resulting from formation of a shoal on the site of Lake Erie probably in connection with movements of the Cincinnati arch. At any rate the movement is shown in a slight break traceable nearly to Schoharie Valley where all evidence of disconformity is lost."

Another break, at least a faunal one, has been claimed in recent writings. This is the Geneseo-Genundewa break (Genesee Group) where the Genundewa limestone represents a greater amount of time than do the shales

Figure 5

Figure 6

Figure 7

Figure 8

PLATE IV. Structures in the Upper Devonian Formations; Jacobs staff is horizontal. *Fig. 5*—Jointing (N 40° W) in Rhinestreet, 1½ miles S.W. of Wyoming, N. Y. *Fig. 6*—Broken anticline (axis N-S) in Rhinestreet 2 miles west of Linden. *Fig. 7*—Portion of broken anticline (axis N 21° E) in Hatch, 1 mile N.W. of LaGrange. *Fig. 8*—Anticlinal character of Gardeau, ½ mile N.W. of Warsaw.

above and below. The Geneseo is dated as Middle Devonian while the Genundewa is placed in Upper Devonian. The writer questions the validity of this because of a lithologic inseparability of the two. This problem will be discussed in more detail under the appropriate formations.

GENESEE GROUP

Lardner Vanuxem (1942) applied the term "Genesee slate", to the rocks which underlie the "Portage Group" and overlie the Tully limestone. In succeeding years the names Genesee beds, Genesee shale, and Genesee group were supplied to these beds but the boundary between was placed at the top of the "Lower Black Band" and by others at the base or ten to fifteen feet below the base of this "Band".

In 1903, J. M. Clarke introduced Middlesex black shales for the "Lower Black Band" and Rhinestreet black shale for the "Upper Black Band" both of which he included in the Portage Group. In 1904, Clarke and Luther applied the term Genesee beds to the strata between the overlying Middlesex shale and the underlying Tully limestone. They divided the Genesee Group into the Standish flags and shales (at top but not present here), West River shale, Genundewa limestone and Genesee shale.

The term Genesee was used in a broad sense meaning the group and in a restricted sense when applied to the lowermost black shales. This twofold use persisted until Chadwick (1920) proposed to replace the restricted Genesee shale with the name, Geneseo black shale. The latter usage is followed in the present work. In the Batavia Quadrangle the Genesee Group is made up of the Geneseo black shale, which overlies the Leicester marcasite of the Moscow formation and contains the Genundewa limestone member at the top, and the overlying West River shale.

The beds of the Genesee Group constitute one of the most intriguing problems in Devonian stratigraphy. The committee on Devonian Correlation (Cooper et al., 1942) place the Geneseo and Tully formations in the Taghanic Stage (Middle Devonian). The Genundewa limestone and West River are formations of the Genesee Group, the Finger Lakes Stage of the Upper Devonian. The Geneseo is separated from the Genundewa limestone because of the postulated presence of a disconformity at the top of the Geneseo. They believe the accumulation of the Genundewa limestone represents considerable time and a distinct break in black shale deposition. The relation of the Geneseo and Genundewa will not be discussed in detail here, but it is sufficient to say that the Genundewa limestone is not a single bed but consists of lenses which are not persistent and are separated by typical Geneseo black shale. Grossman in his study of the Genesee Group (1944, p. 58) states:

> "A widespread submarine disconformity might be indicated by the Styliolina beds (Genundewa limestone) on the assumption that the disposition of great multitudes of Styliolina involved a long time.

> The significance of these lentils in defining a continuous break in western New York is doubtful however, because of the highly irregular and only local occurrence of the pteropod lenses."

The United States Geological Survey in 1936 at the request of W. H. Bradley, adopted Genesee group to include the following formations: Standish sandstone (absent in Batavia Quadrangle), West River shale, and Geneseo shale (redefined to include the Genundewa limestone lentil at the top). This group is included in the Upper Devonian. In this report the Genundewa will be designated as the upper member of the Geneseo black shale formation and the group will be considered upper Devonian in age.

The type locality of the group is at the exposures along the Genesee River in the gorge just south of Mt. Morris. The group decreases in thickness from east to west.

174 feet at Canandaigua Lake
165 feet at Livonia salt shaft
155 feet in Caledonia Quadrangle
15 feet at Lake Erie

Local sections studied show a decrease in thickness from over 60 feet in the eastern part to less than 35 feet in the western part. Both measurements were made well inside the borders of the quadrangle so that the change in thickness is well over 25 feet. Details of sedimentation and fauna will be discussed in more detail on the following pages.

GENESEO FORMATION

Geneseo Black Shale

As mentioned above, the name Geneseo was used by Chadwick (1920) to distinguish the black shales of the group from the group itself since the name "Genesee" had applied to both. He designated the 84 feet of black shales of Fall Brook as the type locality. Fall Brook is just south of Geneseo and only 12 miles east of the quadrangle.

The formation extends from Chenango Valley to Lake Erie. To the east of the Chenango Valley the beds laterally grade into coarser clastics to which the name Sherburne is applied. The black shale increases in thickness westward from there until it reaches a maximum in the Canandaigua Lake area. From there it thins westward until it measures only a few inches at Lake Erie. The following thicknesses have been reported:

35 feet at Casenovia Valley
75 feet in the Geneva Quadrangle
90 feet at Seneca Lake
111 feet at Canandaigua Lake
92 feet at Murder Creek
3 feet at Cazenovia Creek
8 inches at Lake Erie

The thickness of these sections includes the Genundewa limestone beds at the top of the formation. They will be discussed as a distinct member of the formation.

In the Batavia Quadrangle, the formation thins from east to west. Sections measure over 33 feet in the eastern part of the area but thin to 25 feet in the west. The following sections are considered as excellent exposures for the study of this formation. From east to west they are:

1. Two miles southwest of Pavilion on southeasterly flowing stream which crosses the Hudson Road just at the Genesee-Wyoming County line. Section is exposed in the stream north of the road except for the lower portion of the Geneseo which is covered.
2. West branch of White Creek has excellent exposure of formation just north of Route 20 with the Genundewa limestone member exposed in the stream on both sides of the road.
3. Three-eighths mile south of Bethany on eastward flowing stream, east of Center Road.
4. At Linden, the falls in Little Tonawanda Creek and section to the north.
5. Two and one-half miles west of Bethany on Little Tonawanda Creek, south of Route 20.
6. One and one-quarter miles southwest of West Bethany on northward flowing stream. Outcrop just south of Route 20.

LITHOLOGY AND FAUNA—The formation is composed of four types of beds, one distinct from the other three and thus treated separately as the Genundewa limestone member. The others are (1) black fissile shales, (2) dark gray concretionary beds and thin limestones. The black shales demonstrate a distinct change in sedimentation from the underlying soft bluish shales of the Hamilton. Their resistent nature and fissile character resulted in the term "slate" being applied to them by early geologists. Interbedded with these are thinner zones of less fissile, lighter shales which are still much darker than the Hamilton type. Both types of shale are often found coated with iron stains and the fissile type has concretions of pyrite-marcasite in the beds. The dark gray shale is almost entirely lacking in the western sections mentioned above.

The fauna is greatly reduced when compared to the formation below but in zones of the lower portion such brachiopods as *Chonates lepidus, C. setigerus,* and *Leiorhynchus quadricostatus* occur in large numbers. The pteropod, *Styliolina fissurella* is probably the most abundant form being found at almost all horizons and in great numbers.

The third type of bed observed in this area is the concretionary bed or a continuous limestone equivalent. It is usually composed of shaly limestone which is almost as dark as the surrounding shales. At section number 4 (Linden) the first ten feet are composed of alternating black shales and concretionary beds less than one foot apart. No fossils were noted in these. The next five feet is composed only of black shale. Above this the alternating black shales and concretions again occur at approximately the same interval with the uppermost limestones becoming continuous but unlike the overlying Genundewa limestone in appearance and fauna.

Lateral changes are most outstanding. The dark gray shales thin rapidly to the west while the concretionary beds become thicker until at section 5 (Little Tonawanda Creek) a resistant limestone forms a low falls at a horizon twelve feet above the Leicester marcasite. Another eleven feet of Geneseo exists above this with several more thin limestones exposed in the stream bank. Apparently there is sufficient calcareous material to form the continuous limestone while to the southeast only concretions were formed.

The Geneseo shales contain the following common fossils in the Batavia Quadrangle:

Chonetes lepidus	Pterochaenia fragilis
C. mucronatus	Styliolina fissurella
C. setigerus	Tentaculites gracilistriatus
Leiorhynchus quadricostatus	Cephalopoda
Lingula spatula	Plant remains

For the complete fossil list of this and other Upper Devonian groups, see Chadwick (1935).

Genundewa Limestone Member

For many years the uppermost limestone beds were referred to as the *Styliola* limestone because they contain great numbers of the pteropod *Styliola* (*Styliolina*) *fissurella*. In 1903, Clark referred to the formation as the "Geneseo shale including the Genundewa limestone". Later he treated the limestone as a distinct unit and it remains so if treated as the basal unit of the Upper Devonian. If the correlation of Bradley (1936) and the United States Geological Survey is used, the Genundewa limestone is included in the Geneseo shale. The latter correlation is used in this report and the reasons are discussed below.

The type locality is at Bare Hill, formerly Genundewa Hill, Canandaigua Lake which is forty miles east of the quadrangle. The member extends from Seneca Lake to Lake Erie and consists of limestone beds and black, bituminous shale. The thickness generally decreases toward the west. A total of sixteen feet have been assigned to the member in the Canandaigua Lake area while six feet exist at Fall Brook and only six inches at Lake Erie.

LITHOLOGY AND FAUNA—The Genundewa is composed of beds of limestone with interbedded Geneseo-type black shale. The limestone beds range in thickness from one tenth to almost one foot. They consist of crystalline dark brownish gray, nodular limestones with some beds more argillaceous. Usually three or four beds are found with the thickest beds as the uppermost layer. The top limestone forms the cap rock of the falls at Linden.

The irregularity of these beds was noted by Grossman (1938) who pointed out the possible error in using the limestones for horizon markers. Nothing assures the worker that the beds can be correlated over any reasonable distance. The thicknesses assigned to the Genundewa are measured from the lowermost to the uppermost limestone containing *Styliolina fissurella* in profusion. Changes in this thickness seem to depend upon the variations of the interbedded shale. The limestone beds are usually four in number, the first three are from one-tenth to five-tenths feet in thickness while the uppermost bed is the thickest and probably recognized by earlier workers as "the Genundewa limestone." This top layer of limestone has a very irregular appearance. The surface is covered with nodules which contain abundant *Styliolina fissurella.* This would indicate the nodules are not concretions. Beds of dark shale conform to the upper nodular surface. In general, the overlying shales are unlike the "Geneseo type".

Within the limestone beds, *Styliolina fissurella* is by far the most abundant form. Others are:

Lingula spatula	Bactrites aciculum
Pterochaenia fragilis	Orthoceras sp.
Lunulicardium encrinitum	Plant remains

West River Shale

The name West River was given by Clarke and Luther (1904) to the dark gray and black shales between the Genundewa limestone and the Standish flags and shales (absent here). The West River was included in their "Genesee beds or group" as they used the term in the broad sense. Previously the West River had been called the "Upper Genesee shale" but the new name was applied to exposures in West River Valley in Yates County. The type locality is approximately 50 miles to the east of the quadrangle.

The formation crops out from Cayuga Lake to Lake Erie. To the east its equivalents are the Sherburne and Standish sandstones. These sandstones interfinger westward with the West River so that its lithology is quite different from that in this area. The following thicknesses demonstrate its changes in facies.

46 feet at Canandaigua Lake
71 feet at Livonia salt shaft
60–70 feet in Caledonia Quadrangle
12 feet at Lake Erie

The presence of the Standish sandstone tongues probably accounts for the eastward thinning of the shales between Canandaigua Lake and the Caledonia Quadrangle. In the Batavia Quadrangle, the West River thins from an estimated 40 feet on the eastern edge of the area to 20 feet farther west. When these measurements are compared to those obtained by Grossman in the Caledonia Quadrangle, the westward thinning seems extremely rapid. Several explanations are possible for this change. First, the westernmost section measured by Grossman occurs in Rocky Creek which is four and one-half miles east of the Quadrangle border. Rapid change in thickness may be the case. Secondly, the sections measured in the Caledonia Quadrangle are up to six miles farther south than those in the Batavia Quadrangle. Measurements are usually compared in an east-west direction with little thought of the north-south distribution of the outcrops or well sections studied. Perhaps this may also partially explain the "rapid thinning" since the Devonian formations do generally thicken to the south.

Sections where the West River may be studied are:

1. Three-quarters mile southeast of Pavilion in westward flowing stream, one quarter mile west of Perry Road—Route 63 intersection. Here only lower beds are exposed but when this section is correlated with section (Cashaqua) one-half mile to northwest, the maximum thickness possible for the West River would be forty feet.
2. Two miles southwest of Pavilion on southeasterly flowing stream which crosses the Hudson Road just at the Geneseo-Wyoming County line. The formation is exposed in the stream north of the road and north of a falls with the cap rock of Genundewa limestone.
3. At Linden just south of the falls in Little Tonawanda Creek.
4. One and one-quarter mile southwest of West Bethany on northward flowing stream. Outcrop is south of Route 20.

LITHOLOGY AND FAUNA—The West River shale is composed of dark gray and black shales. The basal two feet are dark gray shale; the next thirteen feet consists of alternating dark gray and black shales with a concretionary bed at the seven foot horizon in the formation. Similar concretionary beds were noted in several outcrops of the West River. Usually a thicker fissile bituminous bed is found toward the top which is very similar to the overlying Middlesex black shales. This bed may be from one to three feet thick and is overlain by dark gray shales to the top of the formation. In the westernmost exposure (section 4 above) thin limestones appear in the upper part of the formation.

Although the gray shale is more fossiliferous than the black bituminous beds, the fauna is not very abundant and poorly preserved. Such forms as the pteropod, *Styliolina fissurella,* the brachiopod, *Orbiculoidea lodensis* and *Pterochaenia fragilis* are the most common in the dark gray shales. The following fossils were found:

Orbiculoidea lodensis	Styliolina fissurella
Buchiola retrostriata	Bactrites gracilier
Lunulicardium curtum	Plant remains
Pterochaenia fragilis	

NAPLES GROUP

In 1885, Clarke substituted the term "Naples beds" for that part of the section above the Genesee Group. The section above has been called the Portage Group. The formations in the region of Naples, Ontario County, could not be subdivided so Clarke substituted the name Naples. He described what was later termed the Naples fauna which he then attempted to trace to the east and west. To the east this fauna was replaced by the Ithaca fauna but it can be traced to the west. By 1903, Clarke had divided the Naples beds into several units, the Middlesex black shale being the basal one and the Wiscoy shale the topmost one.

The name, Naples, seems to have fallen into disuse until revived by Chadwick in 1935. In his classification, the Naples is restricted to the lower part of the section to which it had been applied by Clarke. Chadwick divided his restricted Naples into the Enfield or Attica member above (which includes Hatch and Rhinestreet) and Ithaca or Sonyea member below (which includes Cashaqua and Middlesex shales). These four formations occur in this area and are described in detail below.

Reason for the division into the Naples group is a faunal one. Chadwick (1935) lists about 400 species in the black shales of the Naples Group. Of these, 185 are restricted to the Group itself, eighty-nine have persisted from Hamilton time and 40% of these continued on. Approximately forty-five originated in Genesee but only 30% of these persisted beyond.

Sedimentation seems to have been one of gradual change for the Middlesex and Rhinestreet were dominantly black shale, not unlike the "Genesee type" of disposition. The Cashaqua and Hatch were characterized by gray shales and eventually fine clastics heralding the coarser materials to follow in the overlying Portage beds. This group seems to represent a transition in facies from the black shale to the clastics which were moving westward from the Catskill delta region.

The group can be traced, according to Chadwick, from Lake Erie where it measures a total of 225 feet, through all the facies changes to a maximum of nearly 5000 feet of Catskill continental strata forming the main mass of the Catskill mountains. In the Batavia Quadrangle the thickness measures approximately 320 feet.

Middlesex Black Shale

This name was applied by Clarke (1903) to the basal part of his Naples Group. Previously it had been the upper part of the "Genesee black slate" (Hall, 1839) and later the "Lower black band" of Clarke's (1885) Portage Group.

The Middlesex is named for abundant exposures in the town of Middlesex, Yates County and extends from Seneca Lake to Lake Erie. In the eastern part it is decidedly arenaceous with thin flags but westward it assumes thin bedded, bituminous, black shale characteristics.

The following thicknesses indicate the general thinning toward the west as well as the interfingering eastward with coarser clastics.

15 feet at Gorham
35 feet at Middlesex
25 feet at Honeoye Lake

40 feet in Livonia salt shaft
20–30 feet in Caledonia Quadrangle
6 feet at Lake Erie

Locally the shales thin from fifteen feet in the eastern part of the Quadrangle to ten feet in the westernmost section measured. The following localities are best suited for study of this formation.

1. Two miles southwest of Pavilion on southeasterly flowing stream which crosses the Hudson Road just at the Geneseo-Wyoming County line. The formation is exposed in the stream north of the road and north of a falls with the cap rock of Genundewa limestone.
2. One mile northeast of Linden in westerly flowing stream, just north of Smith Road and west of Marsh Road.
3. One-half mile northwest of Linden in easterly flowing stream, just east of Silver Road.
4. One and one-quarter miles southwest of West Bethany on northward flowing stream. Outcrop is south of Route 20.

LITHOLOGY AND FAUNA—The formation consists of two black fissile zones of resistant shale separated by dark gray soft shales. The marked jointing and resistant nature of these beds results in falls and narrow valleys.

The shale yielded only the pteropod, *Styliolina fissurella* and occasional evidences of plant life. (For faunal lists, see Chadwick 1935, and J. M. Clarke 1904). The large amounts of bituminous material present in these shales probably originated in the same manner as that in the overlying and underlying black shales. Absence of abundant fauna, the extremely fissile character, the presence of the dark gray shale zone, and absence of concretionary beds, distinguish the Midlesex from the Geneseo black shale.

CASHAQUA SHALE FORMATION

Named by Hall (1840) for exposures on Cashaqua Creek. In 1933 it was combined by Chadwick with the Middlesex shale and called Sonyea.

The Cashaqua shales consist of soft bluish gray and greenish gray shales which extend from Seneca Lake to Lake Erie. In the eastern portion, the beds are more arenaceous but westward the shale becomes dominant with a few flags near the top and a few thin layers of black shale in the lower zone. The formation thins to the west from Canandaigua Lake.

230 feet at Canandaigua Lake
190 feet in Caledonia Quadrangle
110 feet in Letchworth Park
33 feet at Lake Erie (Eighteenmile Creek)

Exposures in the Batavia Quadrangle indicate a thinning from 110 feet in the east to 90 feet in the west. Although few sections show a complete section of the formation, the following outcrops are considered excellent for its study. From east to west they are:

1. Wyoming, in southeasterly flowing stream, Cashaqua exposed for one mile upstream (from the village line west).
2. One and one-half miles northwest of Linden in easterly flowing stream; intermittent exposures from point just east of Silver Road, westward to Erie Railroad.
3. One and one-quarter miles southwest of West Bethany in northerly flowing stream.
4. Two and one-quarter miles southwest of West Bethany in westerly flowing stream. Contact with overlying Rhinestreet shale in stream bank just north of Dry Bridge and Chaddock Road Junction.

LITHOLOGY AND FAUNA—The Cashaqua is characterized by soft, somewhat fissile, olive gray and bluish gray shales. Thin limestone, concretionary beds and dark gray to black shales also occur. Upon weathering, a bluish or brownish coating covers the exposed surfaces. The fauna is more abundant than in the black shales of the older formations, but most of the forms are poorly preserved (see Plate III fig. 4).

The first 30 feet of shale are soft, colored shales with a few concretionary beds. For the next 20 feet the gray shales are interbedded with dark gray and black shales with only one concretionary bed noted. Following this is a 25 foot zone of gray shale and numerous concretionary horizons with a few thin limestone lentils. Most of the fossils found were confined to this zone and more particularly to the shales above and below the concretionary and limestone beds. Speciments of the pelecypod, *Buchiola retrostriata,* and the cephalopod *Bactrites aciculum,* as well as plant remains were found. The fossils were collected at a limestone horizon near the bottom of this zone. Possibly this horizon is correlative with the Parrish limestone lentil farther east. (The Parrish lentil occurs in the Canandaigua Lake area and eastward. There it rests 50 feet from the top of the formation.) The upper part of the formation contains gray shales with dark gray and black shales increasing in amount in the last few feet.

Flags, which appear in the Cashaqua to the east and south, are absent here but many of the beds which are called "shale" in the hand specimen are composed of very fined grained quartz.

Apparently the coarser material failed to reach this area. The black shales are like those characteristic of the overlying Rhinestreet and the underlying Middlesex shales. The limestone and concretionary beds are believed to be nonpersistent because it was difficult to trace them for even short distances. The zones described above showed less variation and were recognizable from one section to another.

The following fossils were found:

Buchiola retrostriata
Styliolina fissurella
Plant remains

Rhinestreet Shale Formation

Named by John M. Clarke (1903), the Rhinestreet overlies the Cashaqua and underlies the Hatch gray flags and shales. Both upper and lower contacts are gradational and no distinct break in sedimentation is apparent. It is composed of black, fissile and dark gray shales.

To the east the Rhinestreet and Hatch are contemporaneous with the Enfield shale. Westward, the Hatch has increasing amounts of black shale until in the Attica region it is indistinguishable from the Rhinestreet. Luther (1903) unknowingly included both the Rhinestreet and Hatch equivalents in his measurements of the Lake Erie section. Chadwick (1919) corrected this by combining the two formations under the name Attica. The westward equivalent of the Rhinestreet is, therefore, the lower portion of the Attica. It extends from Seneca Lake to Attica, New York (western edge of Batavia Quadrangle) and the type locality is at Rhinestreet, north of Naples in Ontario County. At Rhinestreet, approximately 32 miles east of the area, the formation is only 21 feet thick but it thickens persistently to the west.

1 foot at Seneca Lake
21 feet at Canandaigua Lake (Rhinestreet)
50 feet in Caledonia Quadrangle

The Rhinestreet attains its maximum thickness in the Batavia Quadrangle before it loses its identity. It thickens from 70 feet at the eastern edge to approximately 85 feet.

Many excellent exposures of the formation occur in this area. Only a few will be listed.

1. One and one-half miles north of LaGrange, on northerly flowing stream paralleling and to the east of the LaGrange Road.
2. Two miles northwest of LaGrange, in northerly flowing stream, paralleling and to the west of the Cowic Road.
3. One mile northwest of Wyoming on stream flowing southwest into village. (Good exposures also in streams on west side of Oatka Creek Valley, south of Wyoming.

Lithology—The Rhinestreet is black shale only in part. It can be divided into three portions. The lower portion (measuring 20 feet) is composed of extremely black, bituminous, resistant beds. The middle (45 feet) contains alternating bands of black and gray shale. Above this, the top portion (15 feet) is composed of black fissile shales.

If the formation is treated as a unit, the amount of black shale decreases from the base to the middle beds. Above this, the trend is reversed and black shale deposition increases until it reaches a maximum at the top of the formation.

Not all black shale beds in the Rhinestreet are fissile. Some are calcareous with very weak bedding planes. A few concretionary beds occur in the lighter shales but only one was noted in the black shale and it was found in the upper portion.

The fauna was again reduced in number during this time. Only evidences of plant life were recognized and poorly preserved, unidentifiable specimens were found in the lighter shales. For fossil lists see J. M. Clarke and D. Dana Luther (1904) or G. H. Chadwick (1935).

Hatch Formation

The Hatch formation was the name given by J. M. Clarke (1903) to the flags, gray shales and black shales which overlie the Rhinestreet. The Hatch is overlain by the Grimes sandstone in the southeastern part of the Quadrangle and in its absence, by the Gardeau formation. The Hatch beds had been considered lower Gardeau by Hall but were separated by Clarke and Luther because of the Naples fauna they contained.

The formation extends from Seneca Lake to Attica, New York, with its type section at Hatch Hill near Naples. Eastward its equivalent is the upper beds of the Enfield formation while westward, the increasing black shales make it lithologically like the underlying Rhinestreet so the two are called the Attica shale.

Upper and lower contacts are gradational except where the Grimes occurs. These contacts consist of alternating beds of fine and coarser grained clastics, of dark and light shales. Divisions were made on the basis of the lithology alone and perhaps another worker at the same outcrops would choose a different horizon, perhaps as much as five feet higher or lower. It is necessary to be consistent from one stream outcrop to another. It is also necessary to judge what the dominant sediment was at any particular place in the section.

The formation thins westward from its type locality.

290 feet at Naples
185–190 feet in the Caledonia Quadrangle

In this area it thins from 160 feet to less than 100 feet on the western edge of the sheet. This rather rapid change is caused by thinning and interfingering of the black shales from the west.

Many streams in the Warsaw-Wyoming and Linden-Dale valleys show complete sections. Those listed below are chosen for their accessibility as well as completeness of the section.

1. One and one-half miles northwest of LaGrange on northerly flowing stream, paralleling and to the west of the Cowic Road.
2. One and one-half miles northwest of Wyoming on stream flowing southwest into the village.
3. One mile north of Dale in stream on east side of valley.
4. Two and three-quarter miles north of Attica Center on northwestward flowing stream. Outcrop is east of road bridge.

LITHOLOGY—Sections in the eastern part show four types of sediments. The two most abundant are gray shales and black shales. Thin flags and concretionary beds are found in upper part but represent a small percentage of the column. The formation comprises two distinct units; the lower black and gray shale beds, 90 feet thick, and the upper gray shales interbedded with concretions and flags.

In the western section, however, the upper unit has almost disappeared. Only black and gray shales are found. Black bituminous beds, similar to those of the Rhinestreet, are common. They comprise much more of the section here than they do farther east. But there is sufficient light shale to distinguish the Hatch from the underlying Rhinestreet.

According to Clarke (1904), the fauna is representative of the Cashaqua types but in decreased quantity. No specimens were collected from these beds.

FORMATIONS ABOVE THE NAPLES GROUP

Four formations overlie the Naples Group. No group name is applied to them, although they belong to the Chemung Stage. They had previously been included in the Portage Group but Chadwick (1933) returned the name, Portage, to a formational status.

The following are recognizable units in the Batavia Quadrangle: the Grimes sandstone, Gardeau flags and shales, Nunda sandstone and Wiscoy shale. Contacts are gradational and facies changes are rather rapid so that tracing these units, with the lack of good faunal horizons, is exceedingly difficult.

Flags in the upper Hatch beds represented the beginning of an invasion of coarser clastics into this area from the east. The Grimes sandstone is present in the eastern part of the quadrangle but is lost in the sections west of Wyoming. Coarser clastics occur in the upper part of the Gardeau and the Nunda represents the climax of this type of sedimentation. Wiscoy shales bring a return of the finer clastics and the black shales interfinger from the west. In the Lake Erie sections, the fine grained equivalent of the Grimes and Gardeau is the Angola shale.

GRIMES SANDSTONE

The Grimes was named by Luther (1902) for the sandstones which overlie the Hatch in Grimes Gully near Naples, New York, 35 miles to the east of this area. Hall (1840) had included it first in his Gardeau Group and later (1843) in his Portage or Nunda Group.

The sandstone is a recognizable unit from Seneca Lake to the Warsaw-Wyoming Valley. The westward thinning is demonstrated by the following thicknesses:

75 feet at Seneca Lake
50 feet at Naples
25 feet in the Caledonia Quadrangle

Streams on the southeast side of the Warsaw-Wyoming Valley have rather massive beds of fine grained sandstone which form falls in the gullies. West of here sandstone beds do occur but they are not persistent and may be represented by one or two beds of sandstone in one section, several thin beds in another or none at all in the third. This type of deposition indicates either unstable condition of the bottom with possible vertical movements in small areas, or deltaic deposition of the clastics when poured out from a much closer shoreline into shallow water, or both. In general the thickness decreases from four feet in the east to one or two feet farther west. At exposure No. 2 below, the Grimes is represented by two massive sandstone beds, two feet thick each and separated by a one-half foot shale parting.

The irregular nature of the Grimes is demonstrated by the following exposures:

1. One mile northwest of LaGrange in northward flowing stream, parallel to and west of the Cowic Road.
2. Two miles northeast of Warsaw, in northwesterly flowing stream, paralleling the extension of Burke Hill Road.
3. One mile northeast of Dale in stream flowing into Little Tonawanda Creek just north of the town.

Lithology—The Grimes in this area consists of gray layers of fine grained sandstone from one-tenth to one foot in thickness, some of which are compact, calcareous and argillaceous. Light gray shales separate these beds. The thicker sandstone beds occur as a distinct change in sedimentation, while in other sections where the sandstones are thinner, the contacts are gradational. No fauna was noted in these beds.

Gardeau Formation

Gardeau was used by Hall (1840) as a Group name for the strata in the Mount Morris section along the Genesee River. This included the Rhinestreet, Hatch, Grimes, Gardeau (of Chadwick, 1933) to the Table Rock sandstone. J. M. Clarke (1908) later moved the Gardeau and Portage contact upward about 200 feet placing it above the Grimes sandstone. Chadwick (1933) restricted the term Gardeau and called the overlying beds Table Rock sandstone and Letchworth shale.

Measured sections in this quadrangle showed no division of Clarke's Gardeau possible. No sandstone beds (Table Rock) are present, so if Chadwick's terminology is used, the section might be considered as Angola shale. But this Angola includes the Nunda sandstone (or Chadwick's Portage) so that use of the term Angola would be incorrect. It is necessary to apply the name Gardeau as Clarke had used it.

The Gardeau is composed of shale, and heavy flags. It overlies the Grimes sandstone and is overlain by the Nunda sandstone. The name is from an old Indian reservation in Livingston and Wyoming counties, southeast of this area. Its extent is not well defined. In the Canandaigua Lake area it is known as the West Hill flags and shale. To the west it is correlated with part of the Angola in the Lake Erie section. In general, the thicknesses decrease to the west. The West Hill at Canandaigua Lake measures 550 feet while in the Genesee Valley section it is 428 feet. Measured sections in the Batavia Quadrangle show a decrease from over 300 feet in the central part to 200 feet at the western edge.

Because of the thickness of the formation, few streams have a complete section. But since the overlying Nunda sandstone is more resistant, unusually complete exposures do occur where the Nunda forms the underlying rock of the upland areas. The following sections are most complete.

1. Two miles northeast of Warsaw, in northwesterly flowing stream, paralleling the extension of Burke Hill Road.
2. North of Warsaw in streams on west side of valley.
3. One and one-quarter miles north of Dale in stream on west side of valley.
4. One mile northwest of Attica Center in stream flowing through the village.

LITHOLOGY—Black fissile shales, soft gray shales and flags are characteristic of the Gardeau. The lower portions have black shales, gray shales and very thin flags. This is found in the first 70 to 80 feet. Above this the bituminous beds become very thin, the flags are a little heavier and the formation is more resistant. The uppermost 50 feet is composed of heavier flags, some ranging to four tenths of a foot with almost no black shale seams. The shales are blue-gray to olive brown and probably contain silt size particles of quartz. There are light bluish gray sandstones and flags that weather to brownish or olive brown color. This description applies to the sections in the east-central part of the Quadrangle but is generalized to cover all outcrops. Westernmost outcrops have more black, bituminous shale, fewer flags and are thinner. It is impossible to correlate sections four or five miles apart because of these changes so that it is necessary to follow its outcrop from stream to stream. This is true of the lower contact in the western exposures; the upper contact is rather sharp and easily identified.

NUNDA SANDSTONE

The name was introduced by Clarke and Luther (1908) to replace "Portage sandstones" as defined by Hall. It was named from the exposures at Nunda, New York (12 miles southeast of the area) where 215 feet of blue-gray sandstone beds occur. It is overlain by Wiscoy formation. The formational name Nunda was applied when "Portage" was elevated to a Group status.

Chadwick (1933) changed the name of this formation to Portage and returned the name of Nunda to the group. G. A. Cooper et al. (1942)

in the N. R. C. correlation chart have used Nunda for the sandstones in the Canandaigua Lake area with Portage shale as its equivalent in the Genesee Valley. Chadwick may be correct in applying the term Portage as Hall used it and elevating the name "Nunda" as a group term but the use of both terms for equivalent beds seems unnecessary and confusing. The author, therefore, will use the name, Nunda, for the formation and avoid the term Portage.

The Nunda extends from the Canandaigua Lake area to west of the Batavia Quadrangle. It correlates to the east with the lower portion of the Wellsburg shale and sandstone and to the west with the uppermost part of the Angola shale.

100 feet at Canandaigua Lake
(Highpoint Sandstone)
215 feet in the Nunda area

The formation is over 180 feet thick in the southern part of the Quadrangle and thins to 160 feet in the exposures at Attica Center. The following exposures are most suitable for the study of this formation.

1. Lowermost beds outcrop on top of Burke Hill (northeast of Warsaw). Exposures are found in uppermost reaches of the streams flowing westward into the Warsaw-Wyoming Valley. Best one is in stream two miles northeast of Warsaw where it is crossed by the Burke Hill Road.
2. The Nunda southwest of Wyoming is exposed in a westward flowing stream one and one-half miles southeast of Dale.
3. Exposures occur all along the Linden-Dale Valley especially south of the village.
4. In northwesterly flowing stream, two miles northeast of Attica Center.
5. In northwesterly flowing stream through Attica, just west of the village.

LITHOLOGY—Three gradational zones may be observed in the Nunda. The lower consists of thick flags, calcareous sandstone beds (over one foot) and gray shale. Thin beds of black, bituminous shale do occur but in minor amounts. Most important is the calcareous nature of the sandstones. The worm burrow *Scolithus verticalus* is exceedingly abundant and appears in the sandstone beds only. This lower part of the formation measures about 50 feet.

The middle zone shows a marked decrease in the amount of sandstone. It is composed of beds one to two feet thick but separated by as much as five feet of gray shale. No bituminous beds are present and all the sandstones are non-calcareous. *Scolithus verticalus* occurs here also. The middle zone usually measures about 60 feet.

The uppermost zone has thinner sandstone beds with the sandstone and shale in about equal proportions. The beds become thicker toward the top until they attain a thickness of over two feet. Both shale and sandstone are non-calcareous as in the middle zone and total over 60 feet. The beds are rather barren of fossils except for the worm burrow but no attempt was made to collect fossils.

Wiscoy Shale

The Wiscoy shale and sandstone overlies the Nunda in this area and was named by Clarke (1899) for the exposures at the falls in Wiscoy Creek of Alleghany County (20 miles south of this area). The Prattsburg sandstone is its equivalent to the east while westward it is divisible into the Pipe Creek black shales (below) and the Hanover shales (above).

Recognizable west of Canadaigua Lake, the Wiscoy extends into the Lake Erie area where further division is possible.

225 feet in Naples region
(Prattsburg sandstone)
170–190 feet in Wyoming and Erie Counties

In the Batavia Quadrangle the Wiscoy is approximately 200 feet thick. Only the lowermost part of the formation is completely exposed in this area, although the entire formation is present. Upper beds are displayed in small scattered outcrops so that correlation between them is impossible and the lithology is only generally known. Two of the best exposures are:

1. Two miles southwest of Dale in upper reaches of northeasterly flowing stream, that is west of school No. 15 and northeast of school No. 7.
2. Two miles northeast of Attica Center, in northwestward flowing stream where road crosses stream (basal beds only).

Lithology—The intermittent outcrops show great variation in lithology for the Wiscoy. The lowermost beds are composed of gray shales with some black bands, which extend for 70 feet in the section. Above this over 70 feet of black bituminous shales, interbedded with calcareous shales and limestones occur. In this zone, dark bluish gray shale is interbedded with argillaceous limestones with the limestone increasing in percentage until beds over one foot thick are formed. Little is known of the overlying strata contained in the Wiscoy but occasional outcrops indicate some sandstone beds, flags and gray to black shales.

Nodules of marcasite are found in the black bituminous beds. Some of these range up to two inches in length and one inch in diameter.

CANADAWAY GROUP

This is the name applied by G. H. Chadwick (1933) to the strata overlying the formations of the Chemung Stage. The Canadaway includes all the strata from the Dunkirk black shale to the Cuba sandstone. It had been previously called "Chemung" by earlier writers when "Chemung" was thought to overlie Hall's "Portage" in the Genesee Valley. Chadwick (1935) proved that the Portage and Chemung were of the same age and the "Chemung" in this area was younger than the Chemung farther east. Thus he applied the name Canadaway for the group and the faunal assemblage was termed the "Canadaway fauna". The Dunkirk is the youngest formation present in this area.

Dunkirk Shale

J. M. Clarke (1903) designated the black shales above the West Hill as the Dunkirk. Above this is the Portland gray shale, part of which was placed in the Dunkirk by Chadwick (1924).

The formation receives its name from the exposures at Dunkirk, on the shore of Lake Erie, 56 miles southwest of the area. It outcrops from Lake Erie to Mansfield County, Pennsylvania, where the facies interfingers with the Mansfield beds which are continental.

Little is known of the thicknesses of the Dunkirk shale. At Holland, New York, 14 miles southwest of the Batavia Quadrangle, it measures over 160 feet. Its thickness in this Quadrangle probably is well over 200 feet because of the eastward thickening of sandstones in this part of the section. Both the lower and upper contacts of the formation are estimated. It is possible that still younger strata occur on top of the Dunkirk but no proof exists, hence the strata will be treated as Dunkirk entirely.

Only two small outcrops occur in the southwestern corner of this area. They are:

1. Eastward flowing stream, one and one-half miles northeast of Orangeville Center. Outcrop is west of Crook Road.
2. Two miles northeast of Orangeville Center where northeasterly flowing stream crosses Buffalo Road. Outcrop is just south of road.

Lithology—Dark gray shale is most abundant with black bituminous shale beds in the lower part. This is characteristic of the lowermost 50 feet exposed but approximately 60 feet is believed to be covered below this. Twenty-five feet of lighter gray shales with thin flags are found above the dark gray shales. These beds are similar in appearance to the Cashaqua. At the top is 10 feet of sandstone beds, each over five-tenths of a foot thick, interbedded with light and dark gray shales. These sandstone beds may be the equivalent of Clarke's Portland. No fossils were found. The highest point in the area is still 60 feet above this but no rock exposures could be found.

STRUCTURE

Introduction

The rock formations in western New York have a general dip to the south. The oldest formations outcrop to the north and lie on the Pre-Cambrian Canadian shield. Successively younger formations appear to the south. This southerly dip is approximately 30 feet per mile. Minor undulations are known to occur which cause substantial deviations. The regional dip increases to 60 feet in the southern part of the State where the undulations are more evident.

In the Batavia Quadrangle, one set of undulations has a northeast trend while another trends almost east-west. They are so gentle that they are discovered only by careful observation.

A flexure is known to exist in the west-central part of the quadrangle, (Chadwick, 1920). Its importance lies in its effect on the regional stratigraphic correlations and its distance from other comparable structures. The flexure dips to the west and strikes just east of north. This is believed to be of a different origin from the regional features discussed above. Structures of a local nature consist of well-developed joint systems and broken anticlines. Both seem to have a regional trend and will be discussed in more detail on succeeding pages.

The Batavia Quadrangle is situated north and west of the folded Appalachian belt. It is also east of the anticlinal structures in Ohio. Structures in the Batavia area will have to be correlated with or differentiated from both of these regions. The possibility of origins in the Pre-Cambrian basement must not be overlooked.

STRUCTURES IN OHIO

According to Ver Steeg (1944) the major structural features of Ohio are the Cincinnati arch, the Parkersburgh-Lorain syncline, the Cambridge arch, and a few other related folds in the eastern portion of the state. The alignment is north-south. The faults in Ohio have little throw, and strike a few degrees east or west of north. They are chiefly normal and related to the major warping.

More than two-thirds of the minor folds described by Ver Steeg fall in the quadrant N 0°–90° W. They show a shift in direction from almost north-south in northeastern Ohio to east-west in the southern portion of the state. A corresponding change is noted in the orientation of jointing in the coal beds and, in general, the joint sets are not parallel to the axes of the folds. The importance of the orientation of the joints with respect to the folds will be demonstrated on the following pages.

The Cincinnati arch, Parkersburgh-Lorain syncline and Cambridge arch have a trend about N 10° W. East of the Cambridge arch (which is in the vicinity of Akron and Cleveland) the normal east dip of the formations is broken by minor flexures which trend generally northwest. In southeastern Ohio the two trends are nearly at right angles to each other. The major structures are not parallel with the Appalachian folds nor are they in line with those of the Michigan Basin.

Most of the joints are vertical or nearly so and give no definite clue to the forces which produced them because it is difficult to distinguish them as tension or shear joints. About the joints, Ver Steeg (1944 p. 137) says:

> "Whether a particular set of joints was formed by tension or shear is none too clear. All we can be sure of is that these joint systems were caused by regional stresses in brittle rocks under conditions in which lateral relief was easier than upward relief. Sets of nearly vertical joints may be formed by tensile stresses in gently folded sediments, showing a close relation to the folds. One set—the strike joints—parallels the general strike of the folds, and the other—the dip set—follows the direction of dip. . . It is probable that many joints in Ohio are of the tension type. On the other hand, observations in the field show that a great number of well-developed joint faces are not ragged and irregular, like those one might expect in tension fractures, but cut across lithologic irregularities with smooth planes, such as are produced by shearing stresses."

With few exceptions, the faults in Ohio are not of great throw and they cannot be traced any great distance. The Bowling Green-Findlay fault, which has a length of 12 miles and an estimated throw of 200 feet, is most important. The faults have a general trend, approximately north-south, but ranging somewhat east or west of north.

Ver Steeg considered the Ohio structure to be a westward extension of foreland structures in western New York and Pennsylvania.

STRUCTURE IN NORTHWESTERN PENNSYLVANIA AND CENTRAL NEW YORK

A broad southward plunging synclinal trough is present in central New York. The regional dip, according to Wedel (1932), instead of being due south is southeast, west of the Dansville meridian. East of Seneca Lake the dip to the south has a small westward component. Between Dansville and Seneca Lake the dip is to the south.

In south-central New York, according to Wedel, a series of low parallel

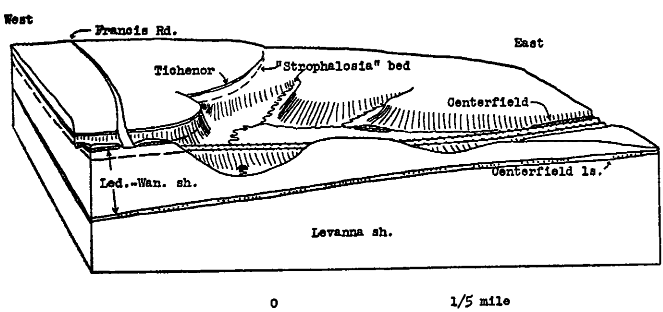


Fig. 9—SECTION THREE MILES WEST OF EAST BETHANY

but persistent folds are found. These dip from 0° to 10° and are usually small. The folds south of the Pennsylvania line trend about N 80° W in the eastern portion but swing to N 60° E in the west.

The dip on the south flank of the anticlines is usually much more pronounced than those on the north flank. The net effect is the increase of regional dip above average for the area. The folds in this area seem to be correlated with and a northward continuation of the structures in north-central Pennsylvania.

The direction of jointing in the area falls into two main groups or sets, the strike joints and the dip joints. Apparently these two sets are conjugate and form a system. Tabulation of percentages of joints in the area indicates that the strike of the joints also changes from east to west. For instance, the direction of the dip joints changes from due north in the eastern part of the area to about N 45° W in the western. The strike joints change from N 80° W to about N 55–60° E. This progressive variation in the strike of joints corresponds almost exactly with a similar change in the trend of the axes of the folds.

In a more recent study of regional jointing in the Paleozoic strata of east, central and southern New York, J. M. Parker (1942) has found that the major joint systems do change in trend from east to west. There is, however, a lack of consistent relationship of the joints to other structures.

Parker—(1942 p. 382) says:

> ". . . the tracing of a dip set across the area into the strike position, indicates that the joints formed independently of, and earlier than, the folds, faults and regional dip."

There are some indications of possible major faulting. Throws of 100 feet are indicated by some stratigraphic correlations, but sharp flexures may also account for this. According to Wedel, one such structure may exist between Seneca Mills and Cascade Mills one mile to the east. Here the western side has Tully limestone 100 feet higher than that on the eastern. This means either a very sharp flexure trending approximately north-south, or else a north-south fault with the eastern side downthrown. Detailed studies of the joint planes in the Cayuga Lake region (by P. Sheldon, 1912) led to conclusions similar to those described above. Not only do the joints parallel the dip and strike of the folds, but they are usually vertical and much stronger than those which strike between the major sets.

Correlations with Pennsylvania structure would put this south-central part of New York State in the outer perimeter of the folded Appalachians. The folds gradually diminish to the northwest indicating that the structures of south-central New York are to be assigned to the Appalachian orogeny of Pennsylvania.

According to Sheldon, the master joints were formed during the earlier part of the folding which took place here during the Appalachian revolution.

The joints are younger than the faults which were formed during the same orogeny, since the faults displace some joints.

Working in Steuben and Yates Counties, (western portion of the area covered by Sheldon and Wedel), Bradley and Pepper (1938) found the gentle folds swinging to a northeast-southwest trend. Again the measurements of the joint directions clearly indicate the pattern established by the earlier workers.

Bradley and Pepper date the faulting in the area as occurring when the Gowanda and overlying shales were being deposited. This is concluded because of the penecontemporaneous deformation in the formation.

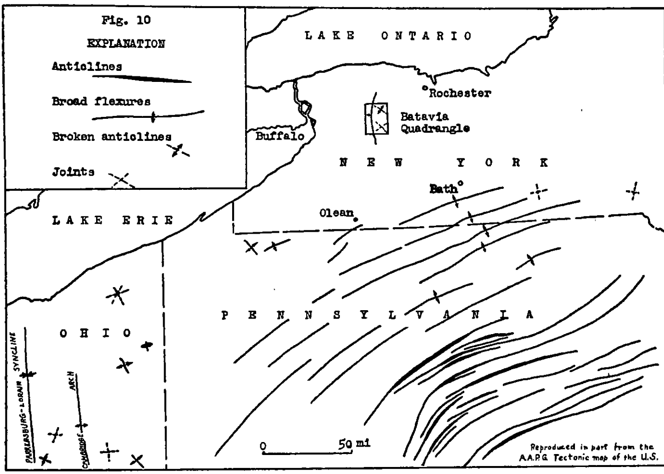


Fig. 10—STRUCTURES IN THE WESTERN NEW YORK, PENNSYLVANIA, AND OHIO REGION

Yet they state that faulting increases with depth which could only be accomplished by faulting during deposition followed by one or many periods of movement along the same fracture.

In northwestern Pennsylvania the anticlinal-synclinal folds are very strong and can be easily traced. The Pennsylvania salient of the Appalachian mountains has a northeast-southwest trend in the north-central part which swings to a north-south trend in the western part of the state.

R. M. Leggette (1936) has noted a split in the structural trend in Warren County. An anticline, the Kinsua-Emporium, trends northwest-southeast. This and parallel structures may swing toward Lake Erie and eventually parallel those of northeastern Ohio. Warren County is perhaps a key area, structurally speaking, where both Appalachian structures and structures of the stable platform type, such as those in Ohio, are found.

In McKean County, just to the east of Warren, definite anticlinal and synclinal trends are found. Such structures as the Bradford and Simpson anticlines indicate a close relationship with the Appalachian structures farther east. Therefore, it seems likely that structure in northwestern Pennsylvania and western New York may be related to the Ohio structure, to the Appalachian structure of Pennsylvania, or be a resultant of these two.

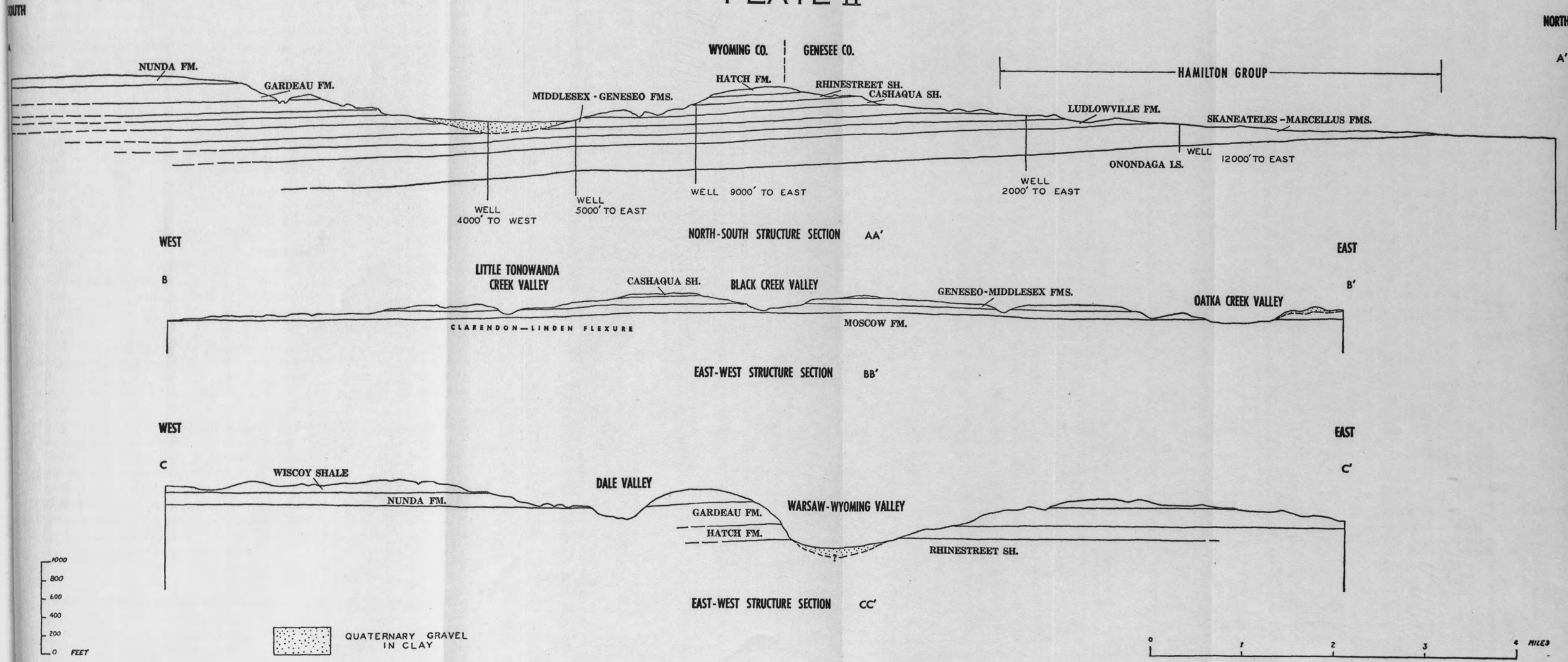
Major Structures of the Batavia Quadrangle

As stated before, the formations in western New York have a southerly monoclinal dip away from the Pre-Cambrian shield in the north. Superimposed upon this dip are gentle undulations which can be determined by careful stratigraphic measurements. The accompanying Geologic map of the Quadrangle (Plate I) shows contour lines drawn on top of the Onondaga limestone. The contour interval is 100 feet but even on this scale the changes in dip of the limestone can be observed. An increase in dip occurs between the elevations of 600 and 700 feet. Another occurs between 400 and 500 feet. Between these elevations the dip is less so it is called a terrace. This structure produces gentle undulations with a general east-west trend. The Quadrangle is too small an area to give an accurate picture of their direction. The dip also increases in the southern portions. Whether this is due to another gentle undulation or to the general increase in dip in southern New York, is not known.

Structures trending north-south may also be present. One of these, the Clarendon-Linden flexure occurs in the central part of the quadrangle (see Plate I). This flexure was discovered by G. H. Chadwick (1920) when he suggested the possible existence of a large fault which occurred between the towns of Clarendon and Linden. In the distance of 22 miles between the towns, he found a displacement of Onondaga and Niagara escarpments with the western side farther north. In the vicinity of Linden the formations to the west were at a much lower elevation than had previously been supposed. This led to the supposition of a fault in the area with the downthrown side on the west. Re-examination of the problem led Chadwick, (1932) to modify his previous statement by calling the southern portion, the Linden monocline and regarding the northern part as the Clarendon fault; the whole structure constituting the Clarendon-Linden displacement.

Careful study of the outcrops in the quadrangle supplemented by the subsurface stratigraphy indicates the existence of the flexure but with no apparent fracture. The formations dip to the west up to three degrees (Plate III Fig. 3) with a stratigraphic displacement of over 100 feet in the Linden area. This dip fully accounts for the position of formations in every case. Furthermore, the Nunda sandstone may be traced from

PLATE II


SOUTH
NORTH
A
A'
WYOMING CO.
GENESEE CO.
HAMILTON GROUP
NUNDA FM.
GARDEAU FM.
HATCH FM.
RHINESTREET SH.
CASHAQUA SH.
MIDDLESEX - GENESEO FMS.
LUDLOWVILLE FM.
SKANEATELES - MARCELLUS FMS.
WELL
12000' TO EAST
ONONDAGA LS.
WELL
2000' TO EAST
WELL 9000' TO EAST
WELL
5000' TO EAST
WELL
4000' TO WEST
NORTH-SOUTH STRUCTURE SECTION AA'
WEST
EAST
B
B'
LITTLE TONOWANDA
CREEK VALLEY
CASHAQUA SH.
BLACK CREEK VALLEY
GENESEO-MIDDLESEX FMS.
OATKA CREEK VALLEY
CLARENDON—LINDEN FLEXURE
MOSCOW FM.
EAST-WEST STRUCTURE SECTION BB'
WEST
EAST
C
C'
WISCOY SHALE
NUNDA FM.
DALE VALLEY
GARDEAU FM.
HATCH FM.
WARSAW-WYOMING VALLEY
RHINESTREET SH.
?
EAST-WEST STRUCTURE SECTION CC'
1000
800
600
400
200
0
FEET
QUATERNARY GRAVEL
IN CLAY
0
1
2
3
4
MILES

Warsaw northwest across the structure to a point north of Dale with no evidence of a break whatsoever. The flexure trends N 10° E in the northern part of the quadrangle, curving to a north-south direction in the vicinity of Linden and then to a northwest-southeast direction in the Dale area. Its southern termination is not known. Evidence indicates it is still present at a latitude three miles north of Warsaw but lack of well records and outcrops in the southwestern portion of the quadrangle prevent its accurate determination. Alling (1928) suggested that the structure may exist as far south as Bliss. It is possible that this passes into a fault north of Batavia but no detailed work has been done up to the present.

The subsurface contours on the Onondaga are based upon the salt well records of Alling (1928) and the gas well records compiled by Bradley and Pepper (1938). These well logs are incomplete since many were drilled before accurate records were kept. The top of the Onondaga was an important horizon in all these drilling operations and so its record of depth probably is more accurate than other horizons of a less noticeable lithologic change.

Eastward from the flexure zone, the formations are gently arched so that the entire surface appears to be an asymmetrical anticline with the flexure forming the steep side. The Warsaw-Wyoming Valley may be structurally controlled in that the stream occupies a synclinal position in the structure. Little is known of the attitudes of the formations east of the valley but the Oatka Creek shale was found to dip one-half degree to the west in an outcrop at LeRoy, just east of the Batavia Quadrangle. The geologic map shows the upper contact of the Onondaga limestone trending northeast in the eastern part of the area, suggesting the eastern flank of this gentle anticline.

Structures of this type are so gentle in their attitudes that their position and extent can be determined only by careful mapping over a large area. It is possible that detailed studies and mapping will reveal the position not only of north-south trends but of the east-west irregularities as well. A combination of the east-west and north-south structures produces domes where the positive portions of both structural trends intersect each other. Such a structure exists between Wyoming and Dale where the formations are at a somewhat higher elevation than they would be if a normal southerly dip with no variations were the case.

Jointing

The direction of 72 joints was measured in the Batavia Quadrangle. An east-west and northwest-southeast trend was found to dominate forming two distinct sets. Minor sets trending north-south and northeast-southwest also occur. The maximum number occur at N 45° W and N 75° E. The data included all joints regardless of what part of the quadrangle they were found in or in what formation they occur (See Pl. IV fig. 5).

The jointing is much more apparent in the black shales than in any other type of sediment. All fractures are clean breaks with no evidence of distinction between shear and tension in their origin. The joint faces are almost all vertical with a few showing hades up to three or four degrees. These were in the area of the Clarendon-Linden flexure.

An apparent structural relationship exists between the jointing and the structures mentioned previously. In areas where the structure is known to exist, the jointing, in many places, parallels the structure. South of Dale, the trend of the jointing changes as does the valley itself and the Clarendon-Linden flexure. Larger valleys seem to be controlled by the major structures, while small streams may have a course which follows one or more sets of joints. This control is also more apparent where streams are cutting rapidly into bedrock where a major stream, like Oatka Creek and Little Tonawanda Creek has a deep valley with small streams flowing into it with a steep gradient. The streams flowing into Oatka Creek south of Wyoming, clearly show the control of drainage by the jointing.

Broken Anticlines

The broken anticlines are a minor structural feature found in central and western New York. In this quadrangle they are exposed in streams cutting Upper Devonian strata. While the outcrops showing these folds are not large, their size does not seem to be over a mile in length or over 100 yards wide. The term, broken anticlines, has been applied to the structures because the beds dip away from an axial plane and are usually fractured at the crest (see Plate IV Figs. 6 and 7). Small streams may have their course controlled by this structure so that the stream flows parallel to or on top of the crest. In other cases, however, the stream direction may be at right angles to the axis of the fold. These anticlines are known to exist over a wide area in New York State and are found in formations of Silurian and Devonian age.

The axes of the anticlines have a definite trend in the Batavia Quadrangle. Twenty-four were discovered and two-thirds of these have a northwest trend. The rest have scattered trends with no apparent minor direction. The northwesterly trending anticlines fall into two groups; those which trend about N 45° W and those which strike N 65° W. It must be noted that one of the major joint directions is N 45° W. The relationship of the joints to the anticlines is not, however, well understood.

Just what forces produced these structures and when this occurred is not known. It is possible that they have their origin in movements resulting from solution of salt in the Silurian rocks beneath. It is difficult to correlate this theory with the obvious structural trend which exists in this area. This trend suggests that more widespread forces produced the structures than mere removal of salt lenses from the strata below.

The structures certainly were not formed by a release of the rock load by stream erosion. If this were the case, the axis of the anticline would parallel the stream course and in many instances that stream is at right angles to the anticline and the broken beds can be seen to disappear into the bed rock of the stream bank.

The author believes that no definite conclusions can be drawn from the meager evidence at hand but that most of the evidence indicates an origin connected with possible faults in the Pre-Cambrian basement rocks. Movement along hypothetical faults in the basement rocks may not be entirely vertical. Instead a horizontal component might produce stresses which would form those broken anticlines. The following evidence is used to support this theory:

1. The direction of trend suggests a plane of tension at an angle of 45° to the Clarendon-Linden flexure.

2. Drilling on these structures indicates that the anticline becomes a fault in depth. Continued movements along faults in the basement rock could best explain this phenomenon.

3. Since a portion of the northwesterly trending anticlines coincide in direction with a major joint set, it is possible that this joint direction served as a plane of weakness along which the beds moved to release stresses.

Summary

A survey of the structures in the Batavia Quadrangle, or more generally in western New York, indicates a closer relationship with the Ohio area than with central New York and Pennsylvania. At first, it might appear that the structural changes might be of a gradational character between these two extremes. Closer inspection, however, reveals basic differences between the structures in the Batavia area and those present in central New York.

Let us, first of all, examine the joint systems in Ohio, Pennsylvania, central New York and the Batavia area. While the joint sets may be parallel to regional folds in some places, in other areas they are not. Ver Steeg pointed this out in Ohio and Parker found this to be true in southern New York. Sheldon suggests that the jointing is earlier than the faults in central New York. We can then assume that a joint pattern existed before the time of the Appalachian orogeny. It is difficult to understand why such a joint system would not be present during the later Paleozoic Periods since many minor disturbances undoubtedly did affect the sediments in a minor way. The broken anticlines also suggest that a joint pattern existed and that stresses in some instances were relieved by buckling along a major joint direction.

The major structures have a north-south alignment in Ohio, and east-west trend in central New York. The Clarendon-Linden flexure trends just east of north in the Batavia area. It may be due to movements in the

Pre-Cambrian basement rock and is strikingly similar to the Bowling Green-Findlay fault, both in trend and probable amount of throw.

Minor folds in Ohio trend northwest as do the broken anticlines in the Batavia area. In both cases, they are not parallel to the major structure.

The structures in the Batavia Quadrangle seem to be the result of vertical movement. If faulting is present in depth in the Clarendon-Linden flexure, the more resistant formations, such as the Onondaga limestone or the Lockport dolomite (Silurian in age) may have fractured. Then the less competent beds were not broken but distorted to form the flexure as observed in the Batavia area.

It is possible that minor basins and domes existed in western New York during the Silurian and Devonian time. The stratigraphic correlation problems of many formations and members within a short geographic distance, such as that between Seneca and Canandaigua Lakes, represents something more than a coincidence. Possible movements occurred during sedimentation and continued the structural trends already existing. The relations of these interdependent factors is not fully understood but it is firmly believed that detailed studies of sedimentation and structures may shed new light on existing stratigraphic and paleontological problems.

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THE PLANKTON ALGAE OF THE SOUTHEAST END OF CHAUTAUQUA LAKE

By

BERNICE MCKEAN GIEBNER

"JAMESTOWN COMMUNITY COLLEGE fills a need long felt by the citizens of Jamestown. Milton J. Fletcher in 1927 and 1932 was alert to the importance of a Junior College serving the Jamestown area, and so recommended in his Reports as Superintendent of Public Schools. In 1933 the Y.W.C.A., through its President, Secretary, and Chairman of the Committee, George B. Pitts, Jr., and others developed plans for the City College which opened in January, 1934. During 1934 it became possible to offer courses for college credit, and the Jamestown College Center was established under the sponsorship of Alfred University, with the cooperation of the Federal Emergency Relief Administration.

When federal funds were withdrawn in 1937, the College Center was reorganized under the joint sponsorship of Alfred University, the Citizens' Committee, and the Jamestown Board of Education. Early in 1950, the State University of New York and the City Council of Jamestown jointly established Jamestown Community College, incorporating the former Alfred University Extension as the Liberal Arts Division and adding a Technical Program.

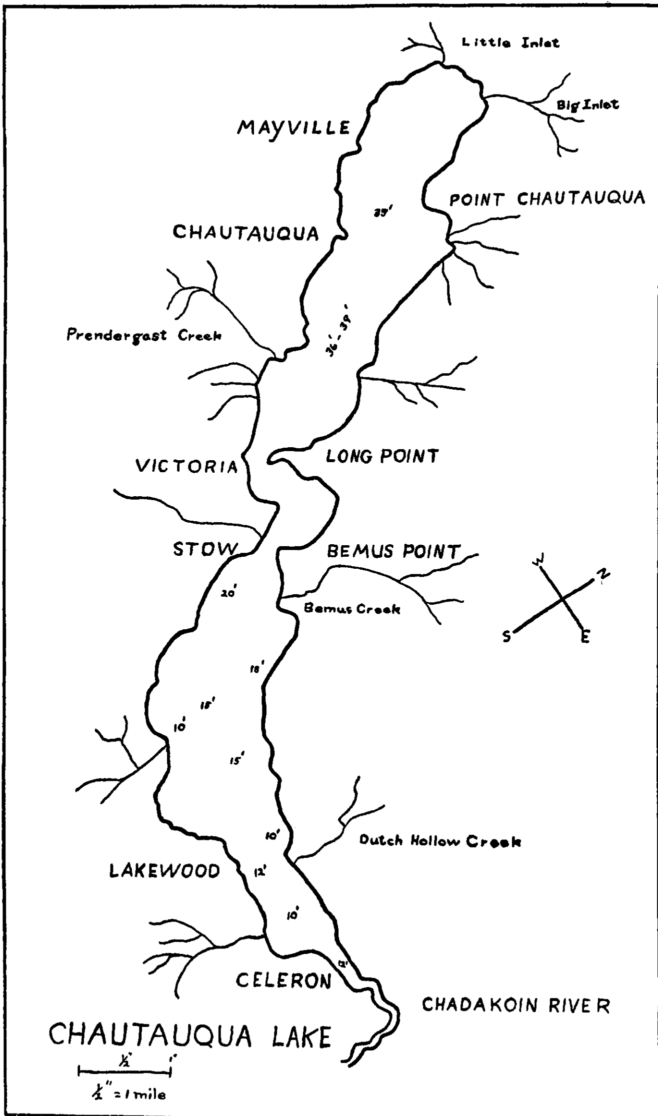
The purpose of a community college is to make available to post high school students within a commuting distance of the college, higher educational opportunities of both a liberal arts and technical nature at the lowest possible cost."

from THE COLLEGE CATALOGUE.

Chautauqua Lake is situated in a valley eight miles southeast of the shore of Lake Erie in Western New York State. It has a length of 21 miles (14,160 acres) extending in a northwest southeast direction. It holds a volume of 14,472 million cubic feet. It is fed by water from numerous tributaries and from land drainage. The lake, about half way from either end, has two constrictions, one at Bemus Point, and one a mile and a half west at Long Point, which divides it into two approximately equal bodies of water making an "upper" and "lower" lake. The outlet of the lake is the Chadakoin River.

According to Odell (1937) the depth along a line drawn between Chautauqua and Chautauqua Point is about 35 feet. From this line to Long Point most of the lake is from 36 to 39 feet deep. The mean depth of the upper portion (Tressler 1937) is 30 feet although there are several kettle holes of limited area which have a maximum depth of 77 feet. Along the east shore at Bemus Point dock (Odell 1937) there is a small area which has a depth of 29 feet. From Bemus Point to the outlet the lake becomes gradually shallower and McVaugh (1937) gives the maximum depth as 19 feet. In the region of Celoron, the lake depth is 12 feet.

Chautauqua Lake, according to Tressler, is not a clear water lake. He determined the transparency by means of the Secchi disc and found a


Little Inlet
Big Inlet
MAYVILLE
POINT CHAUTAUQUA
CHAUTAUQUA
Prendergast Creek
36'-39'
VICTORIA
LONG POINT
STOW
BEMUS POINT
20'
Bemus Creek
W
N
S
E
15'
10'
15'
Dutch Hollow Creek
10'
LAKEWOOD
12'
10'
CELERON
CHADAKOIN RIVER
CHAUTAUQUA LAKE
¼" = 1 mile

marked correlation between transparency and the amount of organic matter present. He states that the transparency gradually increased until July 20, 1937, when it then reached a maximum of 3.5 meters. On this date the least amount of organic matter was recorded. The lowest transparency occurred on August 24, 1937, when the organic matter was highest and the highest transparency was in December 1936, when the organic matter was lowest. In every month except May 1937, the transparency decreased as the organic matter increased.

The water of Chautauqua Lake is of medium hardness. During the winter (1936–1937) Tressler found that the water at all depths gave an alkaline pH reaction with the methyl orange alkalinity test. He found that a decrease in alkalinity began in January 1937 and continued until summer, when a slight rise occurred and that during the summer the water to a depth of three meters below the surface gave a decided alkaline pH reaction. The surface pH of 7.3 rose during that summer to a maximum of pH 8.8 in late August and then declined in September. Tressler states that at the beginning and end of summer the water to a depth of eight meters was alkaline, but that during mid-summer the water at the same depth was neutral or only slightly alkaline. His data show that the surface water was nearly always less alkaline than the bottom water and that during June and July the bottom water was slightly acid (pH 6.8) and then became somewhat alkaline in August.

According to McVaugh (1937), the bottom of the "Lower Lake" is muddy or sandy and the shore sandy or gravelly with a few marshy areas. He states that the most extensive weed beds occur in the lower east portion of the lake. The predominant plants are *Elodea canadensis, Potamogeton Robbinsii, Potamogeton amplifolius, Potamogeton Richardsonii, Myrophylium exalbesscens, Vallisneria americana,* and *Najas flexis.* I, also, have checked these plants.

The figures in Table I show the period of ice coverage during the years 1944–1949.

TABLE I

Year	Months	Open Period	Total Days
1944–1945	Nov. 23 to Mar. 22	....	121
1945–1946	Nov. 25 to Mar. 16	....	113
1946–1947	Nov. 27 to Mar. 27	....	121
1947–1948	Dec. 4 to Mar. 17	....	105
1948–1949	Dec. 26 to Mar. 26	Feb. 27	85

The average period of ice coverage during the years 1944–1949 was 109 days. There was a short open period in 1949 around February 27. This is in general agreement with Tressler who states that the period of ice coverage in 1936–1937 was 112 days extending from December 1, to April 15, with an open period from January 1–22.

The writer selected the region from the outlet of the lake to a mile beyond the Celoron dock for collecting samples of plankton algae. A few samples were taken near Lakewood, New York. The water here is shallow and this is the reason for choosing this area; and the plankton algae are particularly abundant. Collections were made by towing a #20 bolting silk net from a boat during summer, and by collecting from the shore during early spring and late fall. Whenever possible the collections were examined in the living condition. When this was not feasible, the collections were preserved in Transeau's solution: 6 parts water, 3 parts of 95% alcohol, and 1 part formalin.

The present report is a survey of the genera and species and seasonal variation of some plankton algae in the lower portion of Chautauqua Lake as represented at Celoron. This report deals with the Myxophyceae, Heterophyceae, Chrysophyceae and the unicellular and colonial Chlorophyceae, omitting the consideration of such filamentous Chlorophyceae as Zygnemataceae and Oedogonaceae which can be identified only in the fruiting condition. Only the most numerous forms of the Bacillarieae are recorded. Previous knowledge of the algae of Chautauqua Lake was based on the limnological studies made by Tressler and Bere (1936–1937) and by Tressler, Wagner and Bere (1940). These reports are mainly concerned with listing algal genera and give brief accounts of seasonal variations.

The figures in Table II show the distribution by classes of the various genera and species reported for the lower portion of Chautauqua Lake. Although many of the algae have previously been reported, several genera and species are new records for Chautauqua Lake. These are indicated by an asterisk.

TABLE II

Classes	Genera	Species
Myxophyceae	19	61
Heterophyceae	1	3
Chrysophyceae	4	6
Chlorophyceae	41	121
Total	65	191

MYXOPHYCEAE

Anabaena catenula (Kuetzing) Bornet and Flahault
Anabaena circinalis (Kuetzing) Rabenhorst
Anabaena flos-aquae (Lyngbye) Brebisson
Anabaena lemmermanni P. Richter
Anabaena microspora Klebahn var. **robusta** Lemmermann
Anabaena planctonica Brunnthaler
Anabaena spiroides Klebahn
Anabaena spiroides Klebahn var. **crassa** Lemmermann
Aphanizomenon flos-aquae (Lemmermann) Ralfs

Aphanocapsa elachista W. & G. S. West
Aphanocapsa elachista var. **conferta** W. & G. S. West
Aphanocapsa elachista var. **planctonica** G. M. Smith
Aphanocapsa grevillei (Hassall) Rabenhorst
Aphanocapsa rivularis (Carmichael) Rabenhorst
Aphanothece clathrata W. & G. S. West
Aphanothece prasina A. Braun
Aphanothece saxicola Naegeli
*__Calothrix Castellii__ –(Massalongo) Bornet & Flahault
Chroococcus dispersus (V. Keissler) Lemmermann
Chroococcus dispersus var. **minor** (Kuetzing) Naegeli
Chroococcus limneticus Lemmermann
Chroococcus limneticus var. **distans** G. M. Smith
Chroococcus limneticus var. **elegans** G. M. Smith
Chroococcus limneticus var. **purpureus** Snow
Chroococcus minutes (Kuetzing) Naegeli
Chroococcus turgidus (Kuetzing) Naegeli
Coelosphaerium dubium Grunow
Coelosphaerium kuetzingianum Naegeli
Coelosphaerium naegelianum Unger
Dactylococcopsis antarctica Fritsch
Dactylococcopsis rhaphidioides Hansgirg
Dactylococcopsis smithii R. & F. Chodat
*__Gloeocapsa magma__ (Brebisson) Rabenhorst
*__Gloeothece rupestris__ (Lyngbye) Bornet
Gloeotrichia echinulata (J. E. Smith) P. Richter
Gloeotrichia natans (Hedwig) Rabenhorst
*__Gomphosphaeria aponina__ Kuetzing
*__Gomphosphaeria lacustris__ Chodat
*__Holopedium geminatum__ Lagerheim
*__Holopedium irregulare__ Lagerheim
Merismopedia convoluta Brebisson
Merismopedia elegans A. Braun
Merismopedia glaucum (Ehrenberg) Naegeli
Merismopedia punctata Meyen
Merismopedia teniussima Lemmermann
Microcystis aeruginosa Kuetzing
Microcystis aeruginosa var. **major** (Wittrock) G. M. Smith
Microcystis flos-aquae (Wittrock) Kirchner
Microcystis pseudofilamentosa Crow
Microcystis pulverea (Wood) Migula
Microcystis pulverea var. **incerta** (Lemmermann) Crow
*__Nostoc pruniforme__ (Linnaeus) Agardh
Oscillatoria lacustris (Klebahn) Geitler

Oscillatoria limosa Kuetzing
Oscillatoria princeps Vaucher
Oscillatoria splendida Greville
Oscillatoria tenuis C. A. Agardh
*__Pleurocapsa fluviatilis__ Lagerheim
*__Pleurocapsa fuliginosa__ Hauck
*__Plectonema wollei__ Farlow
*__Tolypothrix distorta__ (Hofman-Bang) Kuetzing
*__Tolypothrix tenuis__ Kuetzing

HETEROPHYCEAE

Botryococcus braunii Kuetzing
Botryococcus protruberans W. & G. S. West
Botryococcus sudeticus Lemmermann

CHRYSOPHYCEAE

Dinobryon bavaricum Imhof
Dinobryon setularia Ehrenberg
Dinobryon stipitatum Stein
*__Rhizochrysis limneticus__ G. M. Smith
*__Synura uvella__ Ehrenberg
*__Uroglena volvox__ Ehrenberg

CHLOROPHYCEAE

*__Apiocystis brauniana__ Naegeli
*__Characium curvatum__ G. M. Smith
*__Chlorella vulgaris__ Beyerinck
*__Closteriopsis longissima__ Lemmermann
Closterium acerosum (Schrank) Ehrenberg
Closterium lunula (Mueller) Nitzsch var. **coloratum** Klebahn
Closterium moniliforme (Bory) Ehrenberg
Closterium venus Kuetzing
*__Coccomyxa dispar__ Schmidle
Coelastrum microporum Naegeli
Coelastrum reticulatum (Dangeard) Senn
Coelastrum sphaericum Naegeli
Cosmarium granatum Brebisson
Cosmarium laeve Rabenhorst
Cosmarium logiense Bissett
Cosmarium protractum (Naegeli) DeBary
Cosmarium rectangulare var. **hexagonum** (Elfving) W. & G. S. West
Cosmarium regnelli Wille
Cosmarium reniforme (Ralfs) Archer
Crucigenia apiculata (Lemmermann) Schmidle

Crucigenia apiculata var. **eriensis** Tiffany & Ahlstrom
Crucigenia fenestra Schmidle
Crucigenia irregularis Wille
Crucigenia lauterbornei Schmidle
Crucigenia retangularis (Naegeli) Gay
Dictyosphaerium ehrenbergianum Naegeli
Dictyosphaerium planctonicum Tiffany & Ahlstrom
Dictyosphaerium pulchellum Wood
*__Dimorphococcus lunatus__ A. Braun
*__Errerella bornhemiensis__ Conrad
*__Euastrum denticulatum__ (Kirchner) Gay
*__Eudorina elegans__ Ehrenberg
*__Eudorina unicocca__ G. M. Smith
*__Geminella minor__ (Naegeli) Heering
Gloeocystis ampla Kuetzing
Gloeocystis gigas (Kuetzing) Lagerheim
Gloeocystis parolinana (Meneghini) Naegeli
Gloeocystis vesiculosa Naegeli
Golenkinea radiata Chodat
*__Gonium pectorale__ Mueller
*__Hydrodictyon reticulatum__ (Linnaeus) Lagerheim
Kirchneriella contorta (Schmidle) Bohlin
Kirchneriella lunaris (Kirchner) Moebius
Kirchneriella obesa (W. West) Schmidle
Kirchneriella obesa var. **aperta** (Teiling) Brunnthaler
Kirchneriella obesa var. **major** (Bernard) G. M. Smith
*__Micractinium pusillum__ Fresenius
*__Myrmecia aquatica__ G. M. Smith (Little known algae. The cells had the appearance of and are reported as being **M. aquatica.**)
Nephrocytium agardhianum Naegeli
Nephrocytium limneticus G. M. Smith
Nephrocytium lunatum W. West
Oocystis borgei Snow
Oocystis crassa Wittrock
Oocystis lacustris Chodat
Oocystis parva W. & G. S. West
Oocystis pusilla Hansgirg
Oocystis submarina Lagerheim
*__Pandorina morum__ Bory
Pediastrum araneosum Raciborski
Pediastrum araneosum var. **rugulosum** (G. S. West) G. M. Smith
Pediastrum biradiatum Meyen
Pediastrum boryanum (Turpin) Meneghini
Pediastrum boryanum var. **longicorne** Raciborski

Pediastrum duplex var. **clathratum** (A. Braun) Lagerheim
Pediastrum duplex var. **gracilium** W. & G. S. West
Pediastrum simplex Meyen
Pediastrum simplex var. **duodenarium** (Baily) Rabenhorst
Pediastrum tetras (Ehrenberg) Ralfs
Phacus longicauda (Ehrenberg) Dujardin
Phacus pleuronectes (O. F. Mueller) Dujardin
*__Pleodorina californica__ Shaw
Quadrigula closterioides (Bohlin) Printz
Quadrigula lacustris (Chodat) G. M. Smith
Scenedesmus acutiformis Schroeder
Scenedesmus arcuatus Lemmermann
Scenedesmus arcuatus var. **platydisca** G. M. Smith
Scenedesmus denticulatus Lagerheim
S. bijuga (Turpin) Lagerheim
Scenedesmus bijuga var. **alternans** (Reinsch) Borge
Scenedesmus denticulatus. Lagerheim
Scenedesmus dimorphus obliquus (Turpin) Kuetzing
Scenedesmus longus var. **naegeli** Brebisson
Scenedesmus opoliensis P. Richter
Scenedesmus quadricauda (Turpin) Brebisson
Scenedesmus quadricauda var. **longispina** (Chodat) G. M. Smith
Scenedesmus quadricauda var. **maximus** W. & G. S. West
Scenedesmus quadricauda var. **parvus** W. & G. S. West
Schroederia ancora G. M. Smith
Schroederia setigera (Schroeder) Lemmermann
Sphaerocystis schroeteri Chodat
Spondylosium ellipticum W. & G. S. West
Spondylosium monilforme Lund
Spondylosium planum (Wolle) W. & G. S. West
Spondylosium pygmaeum (Cooke) W. West
Staurastrum apiculatum Brebisson
Staurastrum brevispinum Brebisson
Staurastrum chaetoceras (Schroeder) G. M. Smith
Staurastrum cuspidatum Brebisson
Staurastrum curvatum var. **elongatum** G. M. Smith
Staurastrum dejectum Brebisson
Staurastrum dubium West
Staurastrum floriferum W. & G. S. West
Staurastrum gracile Ralfs
Staurastrum grallatorium Nordstedt
Staurastrum longiradiatum W. & G. S. West
Staurastrum paradoxum var. **parvum** West
Staurastrum pelagicum W. & G. S. West

*Stylosphaeridium stipitatum **(Bachman) Geitler & Gimesi
*Tetradesmus wisconsinensis** G. M. Smith
Tetraedron gracile (Reinsch) Hansgirg
Tetraedron limneticum Borge
Tetraedron lobulatum (Naegeli) Hansgirg
Tetraedron minimum (A. Braun) Hansgirg
Tetraedron quadricuspidatum (Reinsch) Hansgirg (The spines are stouter than in the figure given by Pascher but the basic cell structure appears to place it in this species.)
Tetraedron regulare Kuetzing
Tetraedron tumidulum (Reinsch) Hansgirg
*Tetrastrum heteracanthum **(Nordstedt) Chodat
*Tetrastrum staurogeniaeforme** (Schroeder) Lemmermann
*Ulothrix zonata **(Weber & Mohr) Kuetzing
*Volvox globator** Linnaeus
*Volvox mononae **G. M. Smith
*Westella botryoides** (W. West) Wildemann

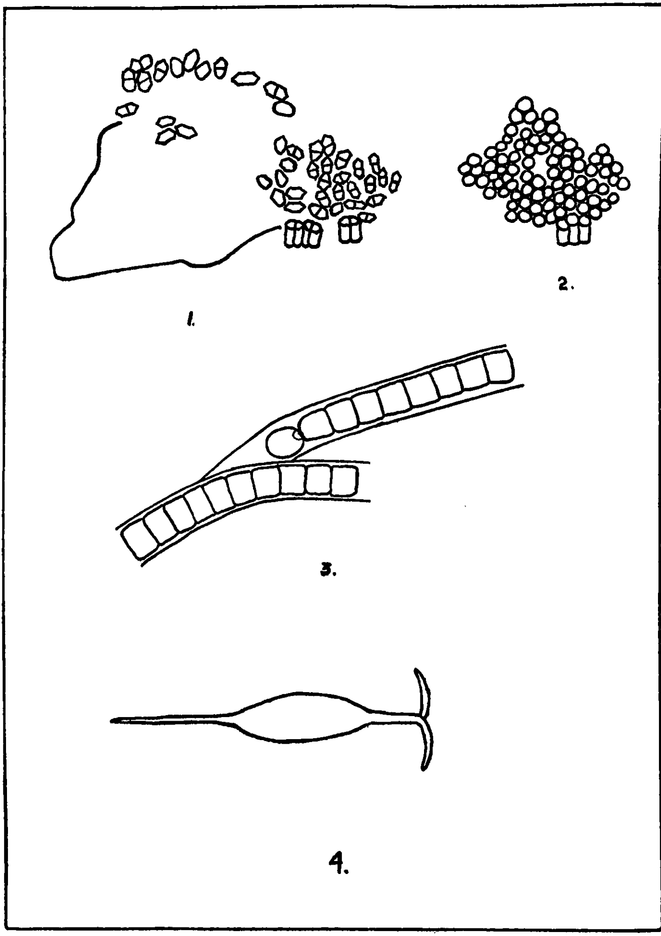
The most unusual or most interesting algae found in Chautauqua Lake by the writer are illustrated in a plate on page 418, of this survey.

The following genera, reported by Tressler and Bere, have not been observed by the writer during this survey: *Ankistrodesmus, Elakatothrix, Gonatozygon,* and *Lagerheimia.*

Seasonal Variation

The writer found that in the "lower" lake, diatoms were present in large numbers in the early spring and that *Melosira* was the dominant form reaching a maximum by July 21. *Tabellaria* and *Fragellaria* were second in number and *Asterionella* was also abundant. Each year after July 21, there was a pronounced decrease in all genera of diatoms, and their numbers remained low until September 3, when there was a slight increase in the number of *Melosira, Asterionella* and *Fragellaria.* By November 24, *Asterionella* was the dominant form; *Melosira* and *Fragellaria* being represented by only a few individuals (See Table III). Tressler (1937) found that diatoms were numerous in the early summer, with *Melosira* the dominant form; *Cyclotella* was second in number and *Asterionella* and *Fragellaria* were also abundant. By mid-summer *Melosira* was the dominant form and of the other forms only a few individuals were represented. *Melosira* decreased in mid-August and *Fragellaria* was again abundant.

The Myxophyceae in the lower lake almost entirely disappear in winter and they were never very abundant in the spring or early part of summer. In this study, they gradually increased in number until about July 21, after which they decreased slightly. By August 20, they have returned

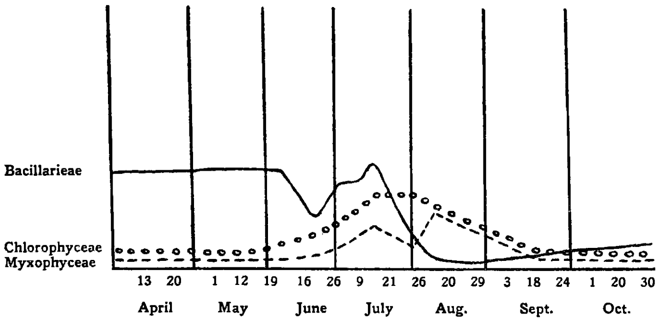


EXPLANATION OF PLATE

Fig. 1 *Holopedium irregulare* Lagerheim
Fig. 2 *Holopedium germinatum* Lagerheim
Fig. 3 *Tolypothrix tenius* Kuetzing
Fig. 4 *Schroederia ancora* G. M. Smith

and a maximum established with *Coelosphaerium, Anabaena, Aphanizomenon, Microcystis* and *Aphanocapsa* being the dominant forms (See Table III). *Gleotrichia echinulata* (J. E. Smith) P. Richter appeared on July 7, and gradually increased until it reached a maximum on August 3 caus-

FIGURE 1 *



* Data based on above findings—derived by comparing the abundance of Bacillarieae, Chlorophyceae and Myxophyceae by their appearance in my collections by month for each year then comparing my results with the findings of Tressler. For example: if the blue-greens in my collection were abundant at a certain day or week of a certain month of a year, then I check it against the same time for the following years.

ing a bloom along the shore. On August 13, 1949 *Anabaena* was abundant enough near the shore to form a bloom. By September 17, 1949 *Microcystis* had replaced *Anabaena.*

The writer agrees with Tressler that during the summer members of the Chlorophyceae are well represented. They make their appearance early in March and gradually increase in numbers until a maximum is reached around July 21. After that their numbers gradually decrease until, by the beginning of October, they are about as numerous as in the early part of March. (See Figure I.) No single genus was dominant, but on June 26 *Volvox, Eudorina,* and *Pandorina* were abundant and reached their maximum on July 10. At this same time *Dictyosphaerium* which had gradually been increasing reached its maximum, while *Coelastrum* became abundant about August 6.

The author is grateful to Dr. C. Taft, algologist, at Ohio State University, Columbus, Ohio, Botany Dept., who was kind enough to review this paper before publication.

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