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MUSEUM OF ZOOLOGY, UNIVERSITY OF MICHIGAN, NO. 53

THE CRANE FLIES (TIPULIDAE) OF THE GEORGE RESERVE, MICHIGAN

BY
J. SPEED ROGERS

ANN ARBOR
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APRIL 7, 1942

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FREDERICK M. GAIGE
Director of the Museum of Zoology
University of Michigan

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MAP

THE CRANE FLIES (TIPULIDAE) OF THE GEORGE RESERVE, MICHIGAN

INTRODUCTION*

THE present paper, one of a proposed series on the fauna of the Edwin S. George Reserve, is based upon intensive field studies of the crane-fly populations of the Reserve and its vicinity in the summers of 1936, 1937, and 1938, and in the spring of 1937. The primary object of this work was to determine what species comprise the crane-fly fauna, and to ascertain their relative abundance, habitat correlations, and seasonal distribution. Much time was also devoted to life-history studies and to such observations as could be made on the habits and biotic relationships of the various species.

Four hundred and twenty-four lots of specimens, comprising some 30000 adults and nearly 1000 larvae and pupae, were collected with detailed field data and preserved for subsequent study. To these were added approximately 2500 adult specimens collected with precise locality data by Messrs. Blair, Camburn, and Cantrall in the spring of 1938 and in the late autumns of 1936 and 1937. Each of these 33000 odd specimens has since been examined beneath a binocular microscope, its taxonomic determination checked, and its seasonal and ecological data tabulated.[1] A still larger number of seasonal, habitat, and population-count observations are based upon specimens that were determined in the field and recorded in the "species journal," but not retained.

Altogether, these records comprise data on 198 species. Of these species twenty-six were so rare (represented by less than ten separate records, or less than twenty-five specimens) as to constitute little more than species records for the region; but 123 are represented by twenty-five or more separate records, and seventy-eight by more than fifty. Without doubt, some species were missed, especially in the early spring and late fall; but I feel fairly confident that as it now stands, the Annotated List (see pp. 58–118) is not far short of 90 per cent complete.

ACKNOWLEDGMENTS

My field work in 1936 and 1937 was made possible by grants from the Museum of Zoology of the University of Michigan, and, in 1938, by a grant from Colonel Edwin S. George. I wish to express my sincere gratitude both to Mr. F. M. Gaige, Director of the Museum of Zoology, and to Colonel George for their very adequate assistance. I am further indebted to Mr.

* Contribution from the Edwin S. George Reserve.

[1] These specimens are now in the collections of the Museum of Zoology of the University of Michigan.

Gaige for many suggestions and for his continuous personal interest and encouragement. To my colleagues on the Reserve, Mr. Larry Camburn, the resident superintendent, and Dr. Blair and Dr. Cantrall, working on mammals and Orthoptera respectively, I am indebted for cordial co-operation that was expressed in many ways, and especially by the collections they made for me in the early spring and fall. Dr. Cantrall also kindly allowed me to make use of the carefully checked determinations he had obtained for various difficult species of sedges and grasses. I wish to acknowledge the almost unvaried courtesy of the local farmers, who freely gave permission to collect on private property in a region where week-end trespassing has compelled an active safeguarding of property rights. Publication was made possible by a grant from the Edwin S. George Special Fund.

The Edwin S. George Reserve

The Edwin S. George Reserve includes 1268 acres of rugged moraine and basin topography in southern Livingston County, Michigan, twenty miles northwest of Ann Arbor and ten miles due south of Howell. Except for some fifty acres of high level plain in the north central part, and a steep, ridge-like esker that extends from the southern end of this plain to the northeastern corner of the Reserve, hills and knobs alternate with kettle holes and basins. The extremes of altitude are from 890 to 1000 feet, with approximately 15 per cent of the area below the 900-foot contour line and another 10 per cent below 915.

In general the basins and deeper kettle holes are occupied by tamarack and poison sumac, or hardwood swamps; by grass-sedge-fern or shrub-sedge marshes; by sphagnum-leatherleaf bogs; or by mixtures of these types of vegetation. Hardwood forests or abandoned fields and pastures make up most of the land above the 915-foot contour. The hardwoods, which consist of some 320 acres, are remnants of the once widespread oak-hickory forests of this region; and the old fields, uncultivated and unpastured for more than twelve years, range from fairly luxuriant stands of timothy and wild grasses to thin patches of lichens on the poorer soils. Except where the sod is well formed or the soil too dry and thin, these old fields are now locally invaded by cedar, dewberry, and staghorn sumac.

Purchased and fenced as a game reserve by Colonel Edwin S. George in 1927, the area was presented by him to the University of Michigan in 1930 and has since been maintained as a wild-life sanctuary and research area by the Museum of Zoology. Before 1927 the area comprised about a dozen farms with tilled fields, small orchards, wood lots, pastures, and waste swamplands. Clearing and tillage were largely restricted to the level upland and more gentle slopes, and the acreage in cultivation had steadily decreased since about 1900; but the wood lots and marshes were pastured.

and the wood lots were moderately utilized for firewood. In 1918 a number of white oaks and hickories, a foot or more in diameter, were taken from the northwest hardwoods. These and some tamaracks harvested from the Big Swamp appear to have been the only trees cut since 1900.

At present, such drainage as exists is into Honey Creek, which lies just beyond the northern boundary of the Reserve. Some fifty years ago, however, about one-third of the southwestern part, including the region around Fishhook marsh, drained to Hell Creek on the south via the southwest swamp and Patterson Lake. At that time the southwest swamp was a grass-sedge marsh and, together with Fishhook marsh, was regularly harvested for marsh hay. With the construction of the present Patterson Lake road to Unadilla and Gregory, the former wet-weather slough that connected the southwest swamp and Patterson Lake was dammed, and a new overflow drainage was provided by means of a tile line into the big swamp.

Except that it does not include any streams or lakes, although it has three or four ponds, the George Reserve is typical of the rolling moraine topography of northern Washtenaw and southern Livingston and Oakland counties and is fairly typical of the more rugged moraine country of southern Michigan in general. Since there are both streams and lakes in the immediate vicinity of the Reserve, collecting was extended to include some near-by stations along Hell and Honey creeks. Both of these streams rise near the Reserve and flow eastward to empty into the Huron River by way of Portage Lake, which is some four and one-half miles east-southeast of the Reserve.

The Contrasting Seasons of 1936, 1937, and 1938

The three summers in the field varied markedly in rainfall; the first was abnormally dry, the second unusually wet, and the third nearly normal. Two drier than average years preceded 1936, which, after a normal January and February, had the driest March on record for twenty years. This marked the beginning of a comparative drouth that continued until the last week of August. According to the Weather Bureau summary for Michigan, the total rainfall from May 1 to August 17 was only 57 per cent normal, and on the Reserve the August rains did not begin until the twenty-fifth. During the last four months of 1936 there was abundant rainfall; and in 1937 the months from April through August, and particularly June, had an unusually high precipitation. The summer of 1938 was approximately normal, for although 1938 had only a slightly smaller total rainfall than did 1937, it was evenly distributed throughout the year.

The contrast in rainfall in 1936, 1937, and 1938, and particularly between the first and the last two, was clearly reflected in the water levels of the

marshes, swamps, streams, and lakes, in their seasonal fluctuations, and in the soil moisture and evaporation rates of the upland habitats. It was also correlated with marked differences in population of various crane-fly species over these three years and was probably the cause of most of these differences. The most striking and unexpected of these fluctuations was that more than a dozen species which require submerged, saturated, or definitely wet, immature-stage habitats were abundant in dry 1936, very rare in the wet summer of 1937, and then largely or wholly regained their former abundance in 1938. Among these were *Nephrotoma eucera, N. gracilicornis, N. polymera, N. sodalis, Tipula borealis, T. grata, T. latipennis, Limonia* (*D*) *haeretica,* and *Epiphragma fascipennis.*

Undoubtedly, almost all of these fluctuations were caused by the fact that in 1936 ovipositing females placed their eggs in situations that were destined to be continuously submerged throughout the normal emerging season of 1937, with the consequent wholesale drowning of larvae or pupae; the few females that did emerge in 1937 then oviposited into situations that were to remain suitable for larval life, pupation, and emergence in 1938. A somewhat different sequence of conditions was encountered by *Hexatoma* (*E.*) *gibbosa,* which was common in 1936 but remarkably rare in both 1937 and 1938. The low water levels of Hell Creek and lower Honey Creek in 1936 were in marked contrast to the bankfull conditions that obtained until mid-August in 1937 and 1938. In both of these years all of the gravel and sand bars and margins, where pupation takes place, remained continuously submerged far past the normal emerging season.

The characteristic marsh-inhabiting species were much less affected by the changes in water level that took place in their habitats, for the drouth of 1936 was not sufficient to dry up the between-hummock depressions, nor did the high water level of 1937 and 1938 submerge the tops of the hummocks. There was no marked contrast in the 1936 and 1937 numbers of the more characteristic inhabitants of the oak-hickory woods, but a number of more restrictedly distributed species, particularly such inhabitants of wet wood and fungi as *Limonia* (*L.*) *immatura, L.* (*L.*) *macateei, L.* (*R.*) *fidelis,* and *Elephantomyia westwoodi,* that were scarce in 1936, markedly increased in 1937 and still further in 1938. It is particularly noteworthy that in 1936 these species were almost wholly confined to the swamps or the wet marginal thickets, but in 1937 and 1938, particularly in 1938, were successfully populating the dead wood of the more mesic parts of the oak-hickory woods.

Methods of Work

The greater part of the collecting and sampling was done with an ordinary "American" insect net frame fitted with a slender, tough, four-foot handle and a comparatively short, conical, voile bag. Such a net can be handled

quickly when specimens are to be taken on the wing, and it is strong enough to withstand hours of steady sweeping through nearly all types of herbage.[2] Sweeping involves two functions—the direct capture of as many specimens as possible, and the efficient flushing of all the rest, so that they may be netted in flight. Such collecting is undoubtedly selective, and much of the selection is unconscious. Previous experience with the specific habits of the forms one seeks—the kinds of habitats the crane flies are likely to frequent in various kinds of weather and their behavior at various times of day—very largely influences the selection of the situations, the manner, and the persistence with which one sweeps.

It is nearly always best to select a small area and to go over it several times, exploring all possible hiding places with the net at each traverse. Some species, which usually flush well ahead of the net, require that one be alert to net them in flight and are most readily seen when one collects toward the light; other species rarely flush and are readily taken in the first sweep through the vegetation on which they rest; still others tend to stay on the ground or to hide among the lower stems and roots and are usually missed on the first sweeping, but, disturbed by the agitation of the herbage, flutter into positions from which they may be swept on the second or third traverse of the area. The size of the area one selects for sweeping may vary widely—often only a few square yards of dense herbage, but sometimes as much as an acre in upland woods where herbage and shrubs are relatively scant.

Net collecting was, of course, supplemented by slow careful searching of all likely situations, such as the trunks of trees and other sheltered spots on wet drizzly days, shaded wet banks and fallen logs, and damp marsh or woodland floors below the shrub or herb stratum. In these situations quietly resting crane flies can often be observed or, if one wishes, can be captured with forceps or an inverted vial. Such collecting is inefficient as measured by the number of captures per hour, but yields excellent data on habitats and many opportunities to observe behavior.

Lighting was at first regarded as a purely supplementary method of collecting and was relatively little employed in 1936 and 1937. In 1938, however, a considerable amount of lighting was done and proved to be very useful in obtaining data on a number of species that were difficult to collect in any other way. The light that was used was a muslin cylinder, six feet high and four feet in diameter, brightly illumined from inside by a gasoline lantern. The effect was that of a huge Japanese lantern or a gigantic gas mantle, visible for hundreds of yards through the night. Good lighting nights were relatively numerous in June, July, and August of 1938 and could frequently be foretold by the abundance of mating swarms at twilight

[2] Although the net bag is reinforced by a canvas rim or tubing, to take the metal net frame, a new bag is required about every week to ten days of actual collecting.

and the increased number of ovipositing females at the edges of the marshes in late afternoon. On such nights males were nearly or quite as abundant as females at the light. Often more than a score of, occasionally more than fifty, species were taken in one night; and twice the catch totaled more than a thousand individuals. Specimens "taken at light" are always valid for seasonal records and, when the habitat of a species has been ascertained by other methods, give very good checks on the relative abundance of a given species in various habitats or localities. In two instances a "light record" first called attention to a species that had been missed by other collecting methods.

The quadrat counts were based wholly on larvae, pupae, and pupal skins. A convenient unit of surface was selected and marked off—usually half a square meter for friable soils, and a smaller area for aquatic situations and marsh and swamp floors. The surface of the enclosed area was removed to a depth that would include all mature larvae and was sifted or washed through sieves. In May, before mosquitoes were too troublesome, about twelve such quadrats were examined in the field; after early June the mosquitoes made this procedure intolerable, and the soil, mud, or aquatic detritus was carried in pails to the breeze-swept margin of a lake for examination. Approximately fifty such quadrats were examined in detail.

All specimens that were collected for subsequent study were given a serial number that referred to a permanent field catalogue record of the data: time of day, weather conditions, exact locality, habitat, method of collecting, and special field notes on habits or behavior. The adults were deposited in small cyanide bottles and papered while still pliable (four hours or less after capture) in small white envelopes.[3] The papered specimens were next dried for twenty-four hours over gentle heat and then packed with naphtha flakes in tight dry boxes. Such specimens are not only preserved with a minimum expenditure of time, but retain their color, are much less fragile than if directly pinned, and are in excellent condition for subsequent mounting on points and convenient examination beneath a binocular microscope.

The immature-stage specimens were brought from the field alive and were sorted to species under a binocular microscope; some from each lot that were not definitely identified were placed in rearing jars. The remainder were killed in hot water and preserved in 80 per cent alcohol. Each lot was accompanied by its field catalogue number and a subnumber that referred to the appropriate rearing jar.

[3] Druggists' "Number 2" envelopes, three and one-half inches wide by two and one-eighth inches high, are excellent and inexpensive and furnish a very good space on which field data may be written or stamped and field determinations recorded. As many specimens may be arranged in one envelope as will lie along the bottom fold without overlapping.

Data concerning adults and immatures that were seen and determined in the field but not permanently collected were recorded on the appropriate "species sheet." This information included date, locality, habitat, frequence, abundance, and any other remarks that seemed pertinent. This record is particularly useful for the numerous species that, because they are so common and frequent, are never proportionately represented in the permanent collections and are likely to be unduly neglected.

Finally, all special and nonroutine observations and data were recorded in the form of separate field notes. These included observations on behavior or habits, notes on color and color patterns in life, queries as to exact taxonomic status, and data on the various habitats.

The plant names that are adopted are those given in the seventh edition of Gray's *Manual,* except for the genus *Cornus,* where Deam's *Shrubs of Indiana* has been followed, and for the ferns, where Small's *Ferns of the Vicinity of New York* was used. Hydrogen-ion concentration was measured with a Taylor slide comparator, and all readings were based upon a mid-range value of the appropriate indicator.

The taxonomic arrangement of the crane flies themselves follows Alexander's treatment of this group in the forthcoming "Diptera of Connecticut." Thanks to Dr. Alexander's generosity, I have had a carbon of his manuscript since its completion six years ago. When this excellent work on the Tipuloidea of northeastern North America finally appears, accurate and full keys to, figures of, and pertinent diagnostic remarks on more than 95 per cent of the Michigan crane flies will be available.

Estimates of Comparative Population Numbers

Some accurate, or at least objective, method of comparing the numbers of individuals of two or more species, habitats, or seasons was required in estimating population numbers. Theoretically, the most accurate method would seem to be some form of quadrat count; actually, the time required to collect all of the larvae and pupae from half a square meter, or to tent trap all of the adults that emerge from the same area, is a matter of hours, and it is out of the question to examine one one-hundredth of the samples that would be required in an ecologically varied area of two square miles.

Much work on the use of net collecting for comparative estimates, and even for quantitative data on insect populations, has been reported in published form. The data have been gathered by recording the number of individuals taken per uniform sweep of the net. Studies by DeLong, Gray and Treloar, and Beall, however, have shown that such counts are exceedingly inaccurate for quantitative data and have a dubious comparative value, even though made in such uniform situations as a field of alfalfa or of beans; for crane-fly populations in the vast majority of habitats, such a method would

be not only useless in estimating relative numbers, but would result in missing a large proportion of the species that are present. The reasons for this are numerous and varied—the inefficiency of a measured sweep in collecting specimens, the varied habits of different species, the change in behavior with variations in light, humidity, and temperature, and the tremendous differences in the "sweepableness" of the diverse types of habitats. The closest approach to efficient collecting by "uniform measured sweeps" of the net can be done in May, in some of the off-the-Reserve marshes that have been burned over the previous fall; but by June the growth of the herbage has made even these marshes almost unsweepable with any type of net. In most of the other habitats one can collect with a net throughout the summer, but in these a "uniform, measured sweep," if not physically impossible, is stultified by the definitely nonuniform dispersal of individuals and species.

A more dependable method of approximating comparative numbers is believed to be that of basing the estimates upon the maximum number of individuals of a species that can be collected in a given unit of time. Even the most secretive species of marsh-inhabiting crane flies becomes vulnerable to net collecting for at least a short period of the day—often at late dusk—when both sexes are on the wing. Such flight periods are specific; once known, they permit fairly accurate comparisons to be made between different localities and seasons for a given species; and, since specific differences in flight habits are generally much less marked than are differences in the resting habits and habitats, they cause fewer errors to be made in comparing the relative abundance of different species.

In practice, the time given to intensive collecting for maximum numbers varies with the local abundance of the species; when very abundant, a ten- or fifteen-minute sample may be adequate, and when scarce, an hour or more may be required, but all are converted to a common "maximum number per hour." The several recognized categories used to indicate number were:

Fewer than ten per hour—Rare or scarce—actual number used
From ten to twenty per hour—Numerous
From twenty to forty per hour—Common
From forty to fifty per hour—Very common
Many more than fifty per hour—Abundant

Since the majority of species do not have an even distribution throughout the more or less uniform complex of plant association and topography that is recognized as the habitat,[4] the "maximum number per hour" does not neces-

[4] In this paper the term habitat is used for such major, recognizable, and repeated complexes of plant association and topography as oak-hickory woods, grass-sedge-fern marshes, and Cassandra-sphagnum bogs, whereas those small parts or details of a habitat that, for a given species of crane fly, may be the essential and sole requirement for continuous existence within the area, are considered "microhabitats." There is a very evident correlation between certain crane flies and a definite microhabitat, and such

sarily indicate the extent of dispersal or frequence within the particular habitat. Consequently, it is also necessary to note whether a given species is restricted to limited spots within the habitat or may be found throughout. In practice, four degrees of frequence were recognized:

Very local .....confined to one or two restricted spots within the recognized habitat

Local .....present at intervals within the habitat but clearly absent from many parts of it

General .....distributed throughout the habitat and more or less equally numerous in all parts

Widespread .....generally distributed throughout the habitat and spreading into the surrounding ecotones

Such annotations are believed to have been fairly accurate for species that were taken or recorded from fifty to one hundred times or more. The various degrees of frequence are largely determined by two factors: how generally the specific microhabitat is conditioned or provided by a given formation, and the amount of spreading by the adult flies. For example, *Limonia macateei* and *Tipula translucida* are each represented by about the same number of specimens (175–80) seen or taken during the three summers in the field, but they differed greatly in abundance and frequence. *Limonia macateei* was found in only three spots, each less than 200 square yards in area, in the whole 320 acres of oak-hickory woods and thus was very local.[5] In these restricted spots, however, it was occasionally common or even abundant. *Tipula translucida* never yielded more than twelve specimens on any one date and hence was recorded as rare or barely numerous, but since it was repeatedly collected in all areas of the oak-hickory woods,[6] its frequence was rated as general. *Tipula disjuncta,* on the other hand, was both abundant and generally distributed throughout the oak-hickory, and the number of specimens actually seen ran into the thousands.

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species are typical of as many (often several) kinds of habitats as regularly provide that particular microhabitat. There appears to be a definite correlation between other species and the habitat itself, and in such instances it is probable that the essential requirement for the existence of the species consists of some major factor or combination of factors that is peculiar to that habitat. Generally speaking, rotten-wood, algae, and moss- and liverwort-inhabiting species are likely to belong to the first group and soil-inhabiting forms to the second; but there are some known exceptions to this generalization, and more exceptions may come to light when the life histories and ecology of the various species are more fully understood.

[5] *L. macateei* breeds in *Polyporus- or Poria*-grown logs, which are very rare on the Reserve, and the adults remain near the larval habitat.

[6] *Tipula translucida* breeds in the leaf mold and humus layer of the forest floor, and the adults range freely over this area.

SEASONAL DISTRIBUTION

The seasonal distribution of adults of the various species is listed in Table I (pp. 19–28). In order to present these data concisely and graphically, each month is divided into thirds; column 1 represents from the first through the tenth of the month, column 2 from the eleventh through the twentieth, and column 3 from the twenty-first through the thirtieth or thirty-first. Records for adults in the first or second half of any third of any month are expressed by a dash (–), a lower-case x, or a capital X in the appropriate column. The dash (–) denotes a comparatively small number of individuals, the lower-case x, greater numbers, and the capital X denotes maximum (or nearly maximum) numbers for that species. These symbols express comparison within the species rather than comparison between species, although x is not used unless the species was at least numerous, nor X unless it was common. The species are numbered consecutively and will be found listed in the same order in the "Annotated List" (pp. 58–118), where further details and comments on seasonal distribution are given in the first paragraph under each species.

Except for those species which are on the wing before May 10 or after September 12, I believe that Table I presents an accurate summary of the typical seasonal appearance, duration, and disappearance of the adults of the local crane-fly fauna. In nearly all species the seasonal dates for 1936, 1937, and 1938 were markedly consistent, and, although further collecting would undoubtedly extend the extreme dates for many species, I do not believe it would greatly shift the date or dates at which any species is characteristically on the wing.

Discussion of Seasonal Distribution

Table I indicates, to some extent, the great variety of specific seasonal appearances of the crane flies. Many species have single, clear-cut, and limited adult seasons and are definitely vernal, early summer, midsummer, late-summer, or autumnal forms. Other species make two separate appearances—one in the spring or early summer, the other in the late summer or autumn. Still others are on the wing continuously for several months and may or may not have one or more peaks of nearly maximum abundance.

Much of the peculiar seasonal behavior of each species is undoubtedly specific and inherent; but environmental factors are also clearly involved, and the seasonal appearance of any species is affected by both local and geographic influences. In at least a score of species of which valid comparisons were possible during 1936, 1937, and 1938, the more mesic habitats about Ann Arbor had slightly but persistently later dates and more extended seasons, and more than a dozen species that have but a single adult season in southern Michigan definitely have two in southern Indiana.

TABLE I

SUMMARY OF SEASONAL DISTRIBUTION OF ADULTS

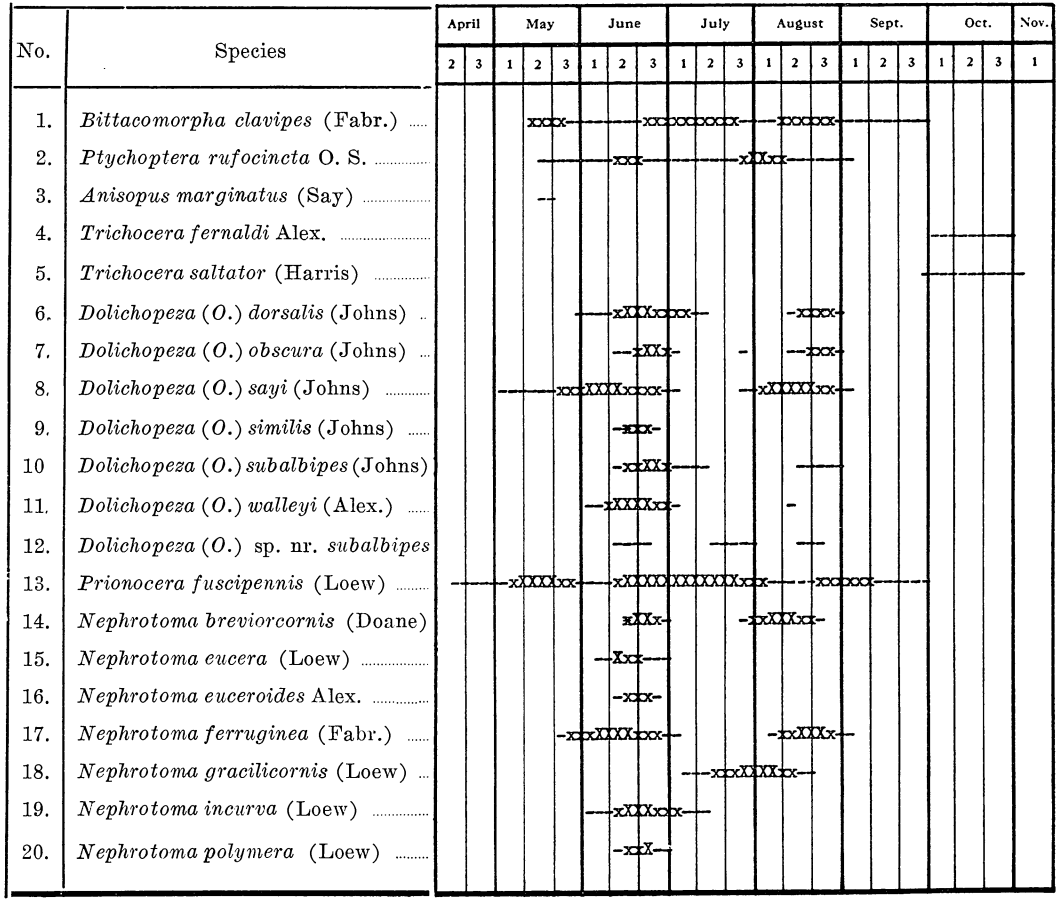


TABLE I (*Cont.*)

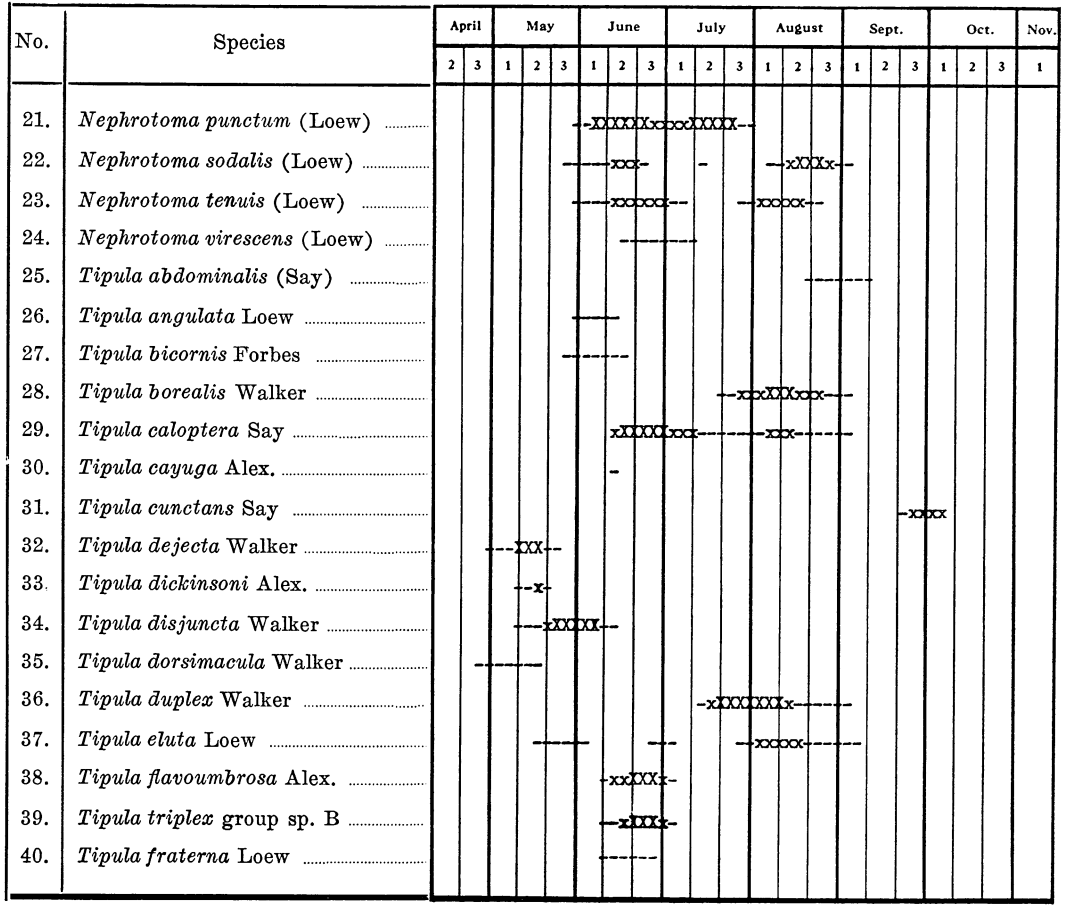

No.
Species
April
May
June
July
August
Sept.
Oct.
Nov.
2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1
21. Nephrotoma punctum (Loew)
22. Nephrotoma sodalis (Loew)
23. Nephrotoma tenuis (Loew)
24. Nephrotoma virescens (Loew)
25. Tipula abdominalis (Say)
26. Tipula angulata Loew
27. Tipula bicornis Forbes
28. Tipula borealis Walker
29. Tipula caloptera Say
30. Tipula cayuga Alex.
31. Tipula cunctans Say
32. Tipula dejecta Walker
33. Tipula dickinsoni Alex.
34. Tipula disjuncta Walker
35. Tipula dorsimacula Walker
36. Tipula duplex Walker
37. Tipula eluta Loew
38. Tipula flavoumbrosa Alex.
39. Tipula triplex group sp. B
40. Tipula fraterna Loew

TABLE I (*Cont.*)

No.	Species	April		May			June			July			August			Sept.			Oct.			Nov.
		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
41.	*Tipula fuliginosa* (Say)																					
42.	*Tipula furca* Walker																					
43.	*Tipula georgiana* Alex.																					
44.	*Tipula grata* Loew																					
45.	*Tipula hermannia* Alex.																					
46.	*Tipula hirsuta* Doane																					
47.	*Tipula illinoiensis* Alex.																					
48.	*Tipula kennicotti* Alex.																					
49.	*Tipula latipennis* Loew																					
50.	*Tipula longiventris* Loew																					
51.	*Tipula megaura* Doane																					
52.	*Tipula monticola* Alex.																					
53.	*Tipula parshleyi* Alex.																					
54.	*Tipula sayi* Alex.																					
55.	*Tipula serta* Loew																					
56.	*Tipula strepens* Loew																					
57.	*Tipula submaculata mallochi* Alex.																					
58.	*Tipula sulphurea* Doane																					
59.	*Tipula tephrocephala* Loew																					
60.	*Tipula translucida* Doane																					

TABLE I (*Cont.*)

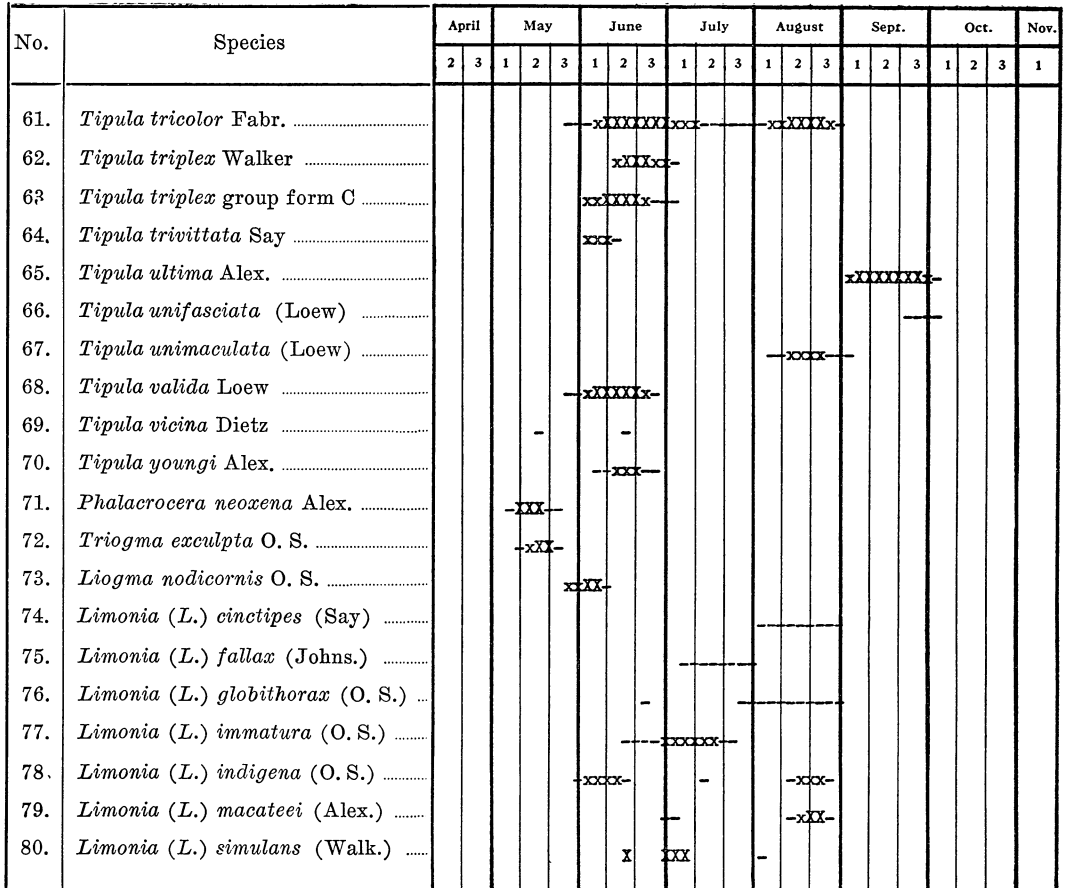

No.
Species
April
May
June
July
August
Sept.
Oct.
Nov.
2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1
61. Tipula tricolor Fabr.
62. Tipula triplex Walker
63 Tipula triplex group form C
64. Tipula trivittata Say
65. Tipula ultima Alex.
66. Tipula unifasciata (Loew)
67. Tipula unimaculata (Loew)
68. Tipula valida Loew
69. Tipula vicina Dietz
70. Tipula youngi Alex.
71. Phalacrocera neoxena Alex.
72. Triogma exculpta O. S.
73. Liogma nodicornis O. S.
74. Limonia (L.) cinctipes (Say)
75. Limonia (L.) fallax (Johns.)
76. Limonia (L.) globithorax (O. S.)
77. Limonia (L.) immatura (O. S.)
78. Limonia (L.) indigena (O. S.)
79. Limonia (L.) macateei (Alex.)
80. Limonia (L.) simulans (Walk.)

TABLE I (*Cont.*)

No.	Species	April		May			June			July			August			Sept.			Oct.			Nov.
		2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1
81.	*Limonia* (*L.*) *solitaria* (O. S.)																					
82.	*Limonia* (*L.*) *triocellata* (O. S.)																					
83.	*Limonia* (*L.*) *tristigma* (O. S.)																					
84.	*Limonia* (*L.*) new sp.																					
85.	*Limonia* (*Discobola*) *argus* (Say)																					
86.	*Limonia* (*D.*) *adirondacensis* (Alex.)																					
87.	*Limonia* (*D.*) *divisa* Alex.																					
88.	*Limonia* (*D.*) *gladiator* (O. S.)																					
89.	*Limonia* (*D.*) *haeretica* (O. S.)																					
90.	*Limonia* (*D.*) *humidicola* (O. S.)																					
91.	*Limonia* (*D.*) *immodesta* (O. S.)																					
92.	*Limonia* (*D.*) *iowensis* (Rogers)																					
93.	*Limonia* (*D.*) *liberta* (O. S.)																					
94.	*Limonia* (*D.*) *longipennis* (Schum.)																					
95.	*Limonia* (*D.*) *nycteris* (Alex.)																					
96.	*Limonia* (*D.*) *pudica* (O. S.)																					
97.	*Limonia* (*D.*) *rostrifera* (O. S.)																					
98.	*Limonia* (*D.*) new sp.																					
99.	*Limonia* (*A.*) *whartoni* (Ndm.)																					
100.	*Limonia* (*R.*) *fidelis* (O. S.)																					

TABLE I (*Cont.*)

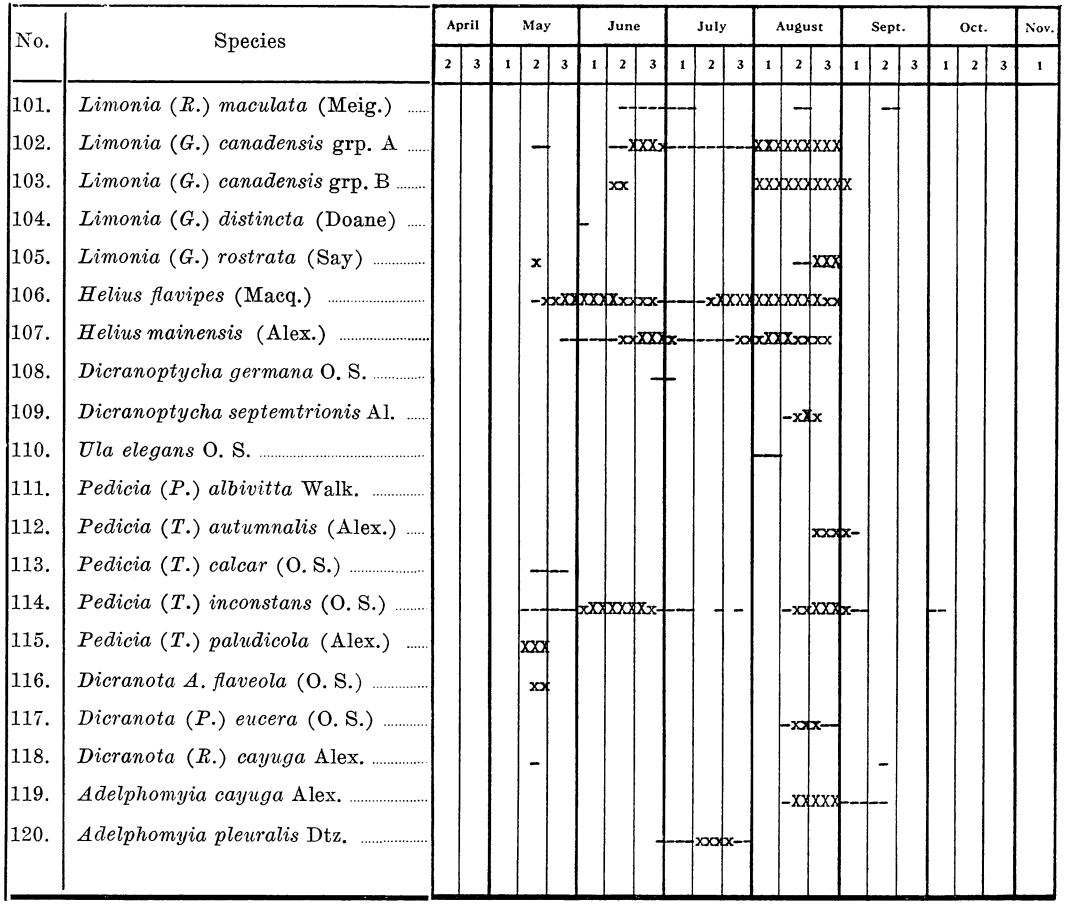

No.
Species
April
May
June
July
August
Sept.
Oct.
Nov.
2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1
101. Limonia (R.) maculata (Meig.)
102. Limonia (G.) canadensis grp. A
103. Limonia (G.) canadensis grp. B
104. Limonia (G.) distincta (Doane)
105. Limonia (G.) rostrata (Say)
106. Helius flavipes (Macq.)
107. Helius mainensis (Alex.)
108. Dicranoptycha germana O. S.
109. Dicranoptycha septemtrionis Al.
110. Ula elegans O. S.
111. Pedicia (P.) albivitta Walk.
112. Pedicia (T.) autumnalis (Alex.)
113. Pedicia (T.) calcar (O. S.)
114. Pedicia (T.) inconstans (O. S.)
115. Pedicia (T.) paludicola (Alex.)
116. Dicranota A. flaveola (O. S.)
117. Dicranota (P.) eucera (O. S.)
118. Dicranota (R.) cayuga Alex.
119. Adelphomyia cayuga Alex.
120. Adelphomyia pleuralis Dtz.

TABLE I (*Cont.*)

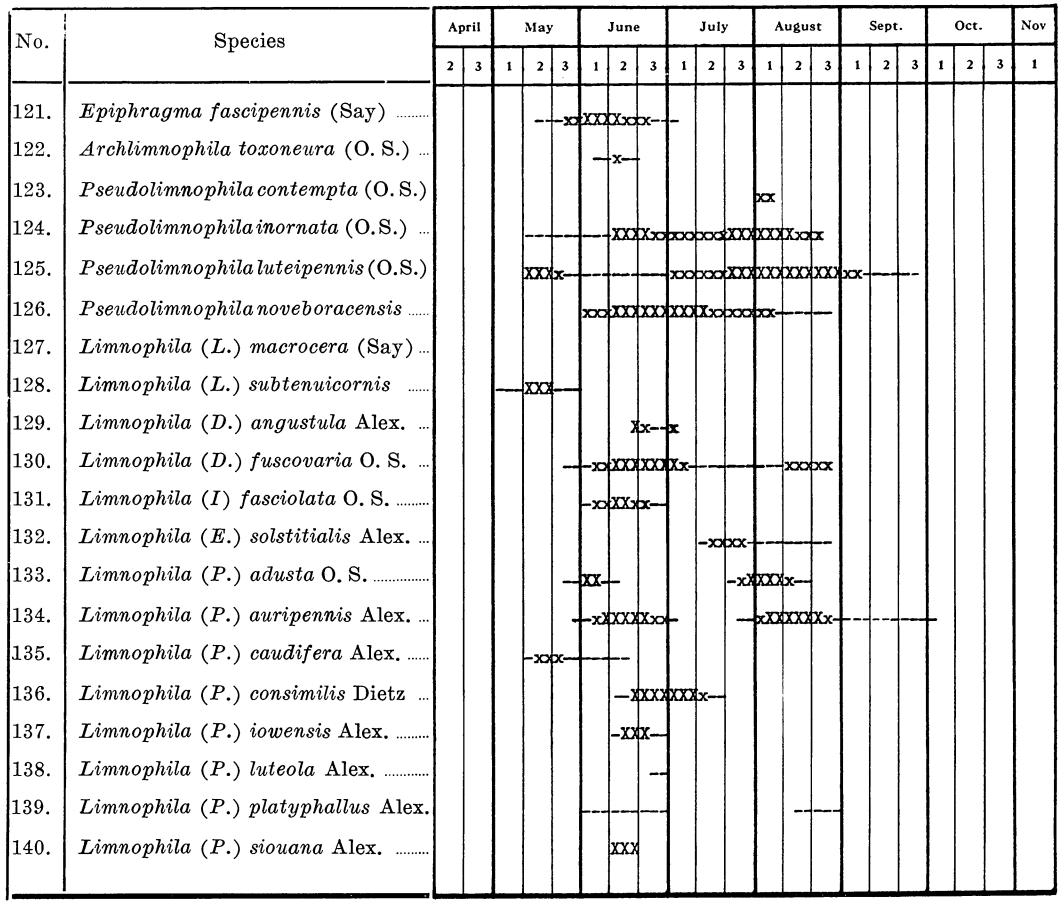

No.
Species
April
May
June
July
August
Sept.
Oct.
Nov
2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1
121. Epiphragma fascipennis (Say)
122. Archlimnophila toxoneura (O. S.)
123. Pseudolimnophila contempta (O. S.)
124. Pseudolimnophila inornata (O. S.)
125. Pseudolimnophila luteipennis (O. S.)
126. Pseudolimnophila noveboracensis
127. Limnophila (L.) macrocera (Say)
128. Limnophila (L.) subtenuicornis
129. Limnophila (D.) angustula Alex.
130. Limnophila (D.) fuscovaria O. S.
131. Limnophila (I) fasciolata O. S.
132. Limnophila (E.) solstitialis Alex.
133. Limnophila (P.) adusta O. S.
134. Limnophila (P.) auripennis Alex.
135. Limnophila (P.) caudifera Alex.
136. Limnophila (P.) consimilis Dietz
137. Limnophila (P.) iowensis Alex.
138. Limnophila (P.) luteola Alex.
139. Limnophila (P.) platyphallus Alex.
140. Limnophila (P.) siouana Alex.

TABLE I (*Cont.*)

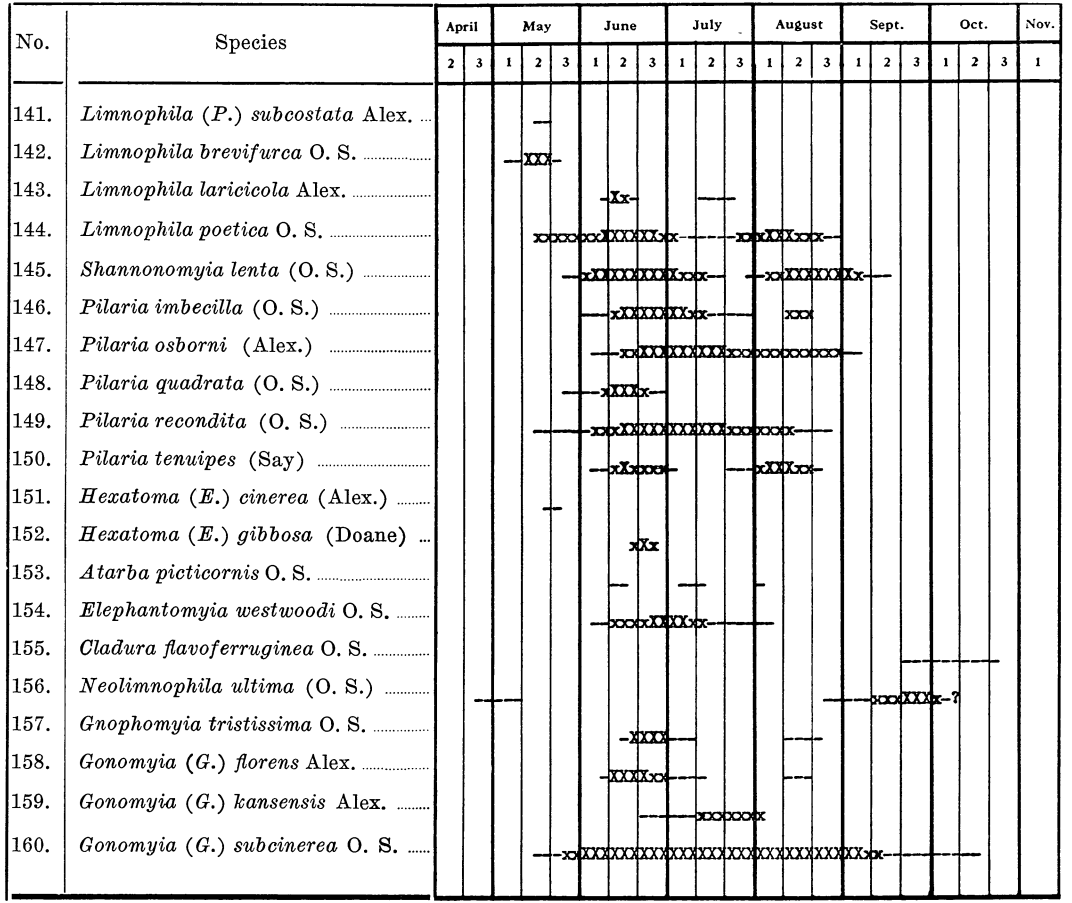

No.
Species
April
May
June
July
August
Sept.
Oct.
Nov.
2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1
141. Limnophila (P.) subcostata Alex.
142. Limnophila brevifurca O. S.
143. Limnophila laricicola Alex.
144. Limnophila poetica O. S.
145. Shannonomyia lenta (O. S.)
146. Pilaria imbecilla (O. S.)
147. Pilaria osborni (Alex.)
148. Pilaria quadrata (O. S.)
149. Pilaria recondita (O. S.)
150. Pilaria tenuipes (Say)
151. Hexatoma (E.) cinerea (Alex.)
152. Hexatoma (E.) gibbosa (Doane)
153. Atarba picticornis O. S.
154. Elephantomyia westwoodi O. S.
155. Cladura flavoferruginea O. S.
156. Neolimnophila ultima (O. S.)
157. Gnophomyia tristissima O. S.
158. Gonomyia (G.) florens Alex.
159. Gonomyia (G.) kansensis Alex.
160. Gonomyia (G.) subcinerea O. S.

TABLE I (*Cont.*)

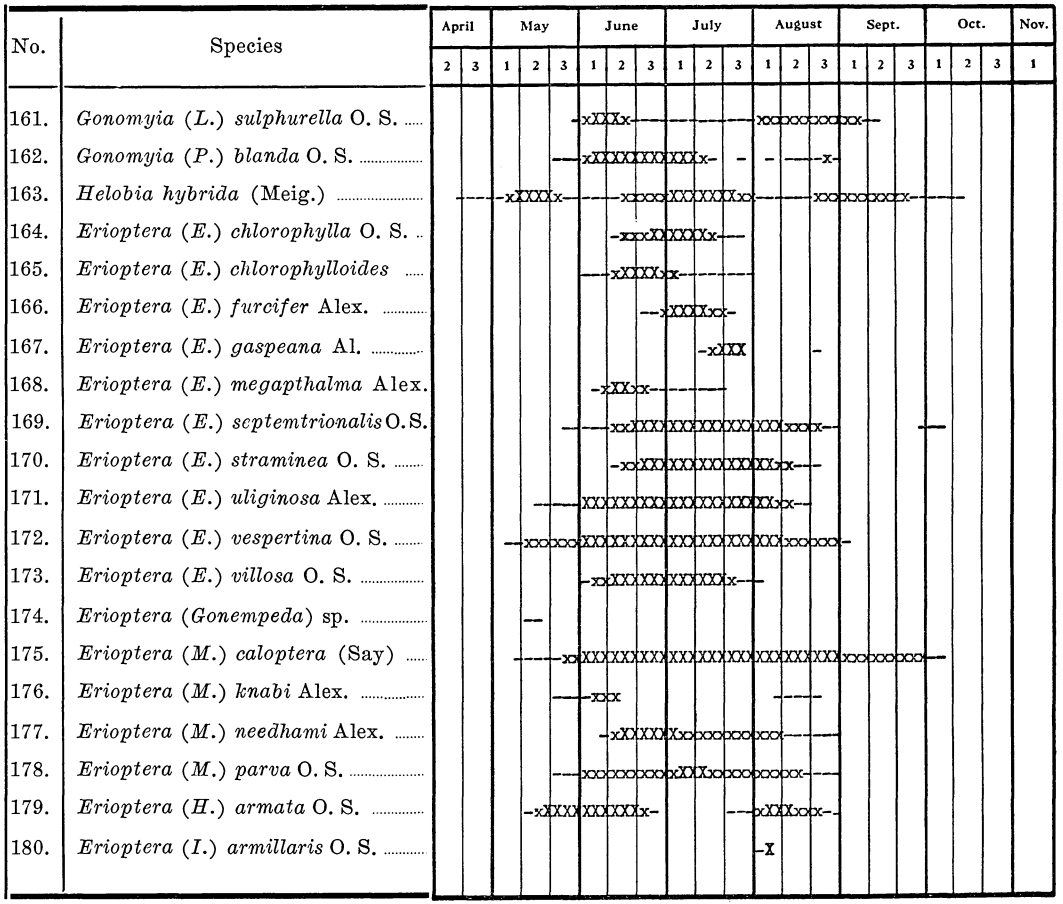
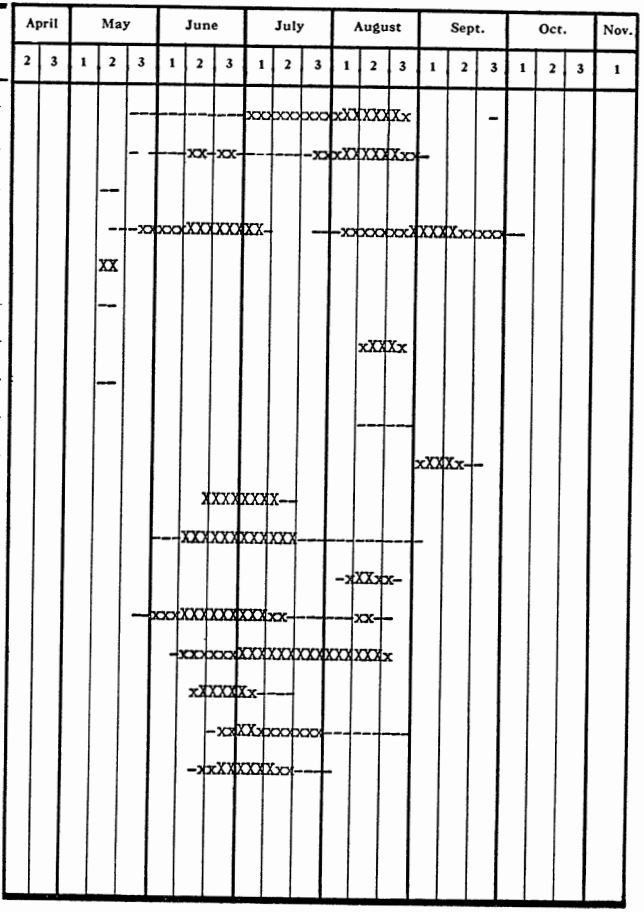

No.
Species
April
May
June
July
August
Sept.
Oct.
Nov.
2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1
161. Gonomyia (L.) sulphurella O. S.
162. Gonomyia (P.) blanda O. S.
163. Helobia hybrida (Meig.)
164. Erioptera (E.) chlorophylla O. S.
165. Erioptera (E.) chlorophylloides
166. Erioptera (E.) furcifer Alex.
167. Erioptera (E.) gaspeana Al.
168. Erioptera (E.) megapthalma Alex.
169. Erioptera (E.) scptemtrionalis O.S.
170. Erioptera (E.) straminea O. S.
171. Erioptera (E.) uliginosa Alex.
172. Erioptera (E.) vespertina O. S.
173. Erioptera (E.) villosa O. S.
174. Erioptera (Gonempeda) sp.
175. Erioptera (M.) caloptera (Say)
176. Erioptera (M.) knabi Alex.
177. Erioptera (M.) needhami Alex.
178. Erioptera (M.) parva O. S.
179. Erioptera (H.) armata O. S.
180. Erioptera (I.) armillaris O. S.

TABLE I (*Cont.*)

No.	Species
181.	*Erioptera* (*I.*) *graphica* O. S.
182.	*Erioptera* (*I.*) *venusta* O. S.
183.	*Ormosia bilineata* Dietz
184.	*Ormosia deviata* Dtz.
185.	*Ormosia frisoni* Alex.
186.	*Ormosia meigenii* (O. S.)
187.	*Ormosia monticola* (O. S.)
188.	*Ormosia nubila* (O. S.)
189.	*Ormosia pygmaea* Alex.
190.	*Ormosia rubella* (O. S.)
191.	*Dasymolophilus niphadias* Al.
192.	*Molophilus forcipulus* (O. S.)
193.	*Molophilus fultonensis* Alex.
194.	*Molophilus hirtipennis* (O. S.)
195.	*Molophilus huron* Alex.
196.	*Molophilus pubipennis* (O. S.)
197.	*Toxorhina magna* O. S.
198.	*Toxorhina muliebris* O. S.



At present there are too little data on specific life histories, the range of larval habitats, and even on adult seasons over large extents of the range of any species to make possible any broad generalizations or any very complete classification of species on the basis of seasonal distribution. These species with a single adult season very clearly have a single generation per year, and yet in many of these species the life cycle can be completed in one-third, or less, of the normal time in a breeding cage in which food, moisture, and temperature are kept as near as possible to optimum conditions. In several species on which extensive breeding-cage observations have been made (*T. caloptera, Tipula triplex, T. translucida, Epiphragma fascipennis, et al.*), either low temperature or too little moisture causes the larvae to become quiescent and remain so as long as the unfavorable conditions obtain. In the breeding cages such cessation of activity without death or injury can be maintained for months by second or third instar larvae, and activity and growth can be resumed when the cold or low moisture content is replaced by more nearly optimum conditions. I believe it is probable that many or all of the Reserve crane flies which have but a single generation per year undergo two main interruptions in their larval existence—the winter cold and a summer lack of moisture. What temperature and what degree of desiccation will produce cessation of activity undoubtedly varies widely from species to species, and the intensity of both of these factors (particularly the latter) is markedly affected by the kind of habitat. Certainly, in the oak-hickory woods, where nearly all of the typical species have a single generation per year, the midsummer and late-summer desiccation is very marked and must also reduce such known foods of larvae as rootlets and leaf-mold fungi.

The species in which there are two clear-cut adult seasons could have either two separate broods or two generations per year. For some of these there is good evidence that the latter explanation is correct, and I believe it is probably true in all instances in this region. Most of the species that are on the wing throughout much of the summer probably encounter no general check to development except the cold of winter and produce as many generations between spring and fall as their rate of development will permit. Local departures from optimum conditions in temperatures, food, and moisture produce considerable diversity in development so that some members of each generation are comparatively accelerated and others lag and a more or less continuous emergence of adults results—the laggards of an earlier generation living simultaneously with the accelerated individuals of the next generation. In most of these species two generations per year are probably usual, but, in favorable habitats, there may be a third generation, whereas in a few species, with potentially very short-life cycles three generations are probably the rule.

Although there were a number of well-marked exceptions, it is chiefly among the inhabitants of the continuously wet marshes, swamps, and stream margins that more than one generation per year was most frequently encountered, but in the continuously wet but persistently cool rills, mud, and seepage of Kalmbach's woods, most of the species had either one generation a year or two widely separated generations.

In the "Annotated List" I have attempted to state the number of known or highly probable generations a year. These statements are based chiefly upon field notes on increases and decreases in abundance, teneral individuals, and immatures, but they have, to some extent, been influenced by breeding-cage data obtained in this or other regions.

Seasonal Variation

In a rather large number of species, including *Tipula fuliginosa, T. latipennis, T. translucida, Helius flavipes, Epiphragma fascipennis, Pilaria recondita,* and *Pseudolimnophila noveboracensis,* there were both a seasonal variation in size and some change in the intensity of the color patterns. Generally speaking, specimens taken near the beginning of the peak of abundance were, on the average, distinctly larger and more intensely colored than specimens taken after the peak had passed. In 1938 some measurements were made on *H. flavipes, P. recondita,* and *P. noveboracensis.* In each species the last fifty specimens taken were compared with fifty specimens collected near the beginning of the main flight period. In *H. flavipes* and *P. noveboracensis* the wing length of specimens taken in the late season averaged about 20 per cent less, and in *Pilaria recondita* nearly 15 per cent less, and other dimensions appeared, at least, as greatly reduced. The late-season specimens were also distinctly more variable in size and coloration and appeared to include a larger number of such abnormalities as those of venation and of fusion or malformation of antennal joints. A similar variation with reduction in size and color intensity of late-emerging individuals is often noticed in breeding cages, where it is usually associated with a reduction in food and moisture.

Seasonal differences in the appearances of males and females were most noticeable in the change in the proportions of the two sexes as the season progressed. In nearly all species there was a noticeable majority of males at the beginning of the season, but they comprised a rapidly decreasing minority soon after the peak of abundance had been reached. Usually, the last records from a flight period are those for females, and in most instances the last female record was from one to several weeks later than the last record for a male.

HABITAT DISTRIBUTION

One of the chief objectives of the study of the crane flies of the George Reserve was to ascertain the correlations that exist between the various spe-

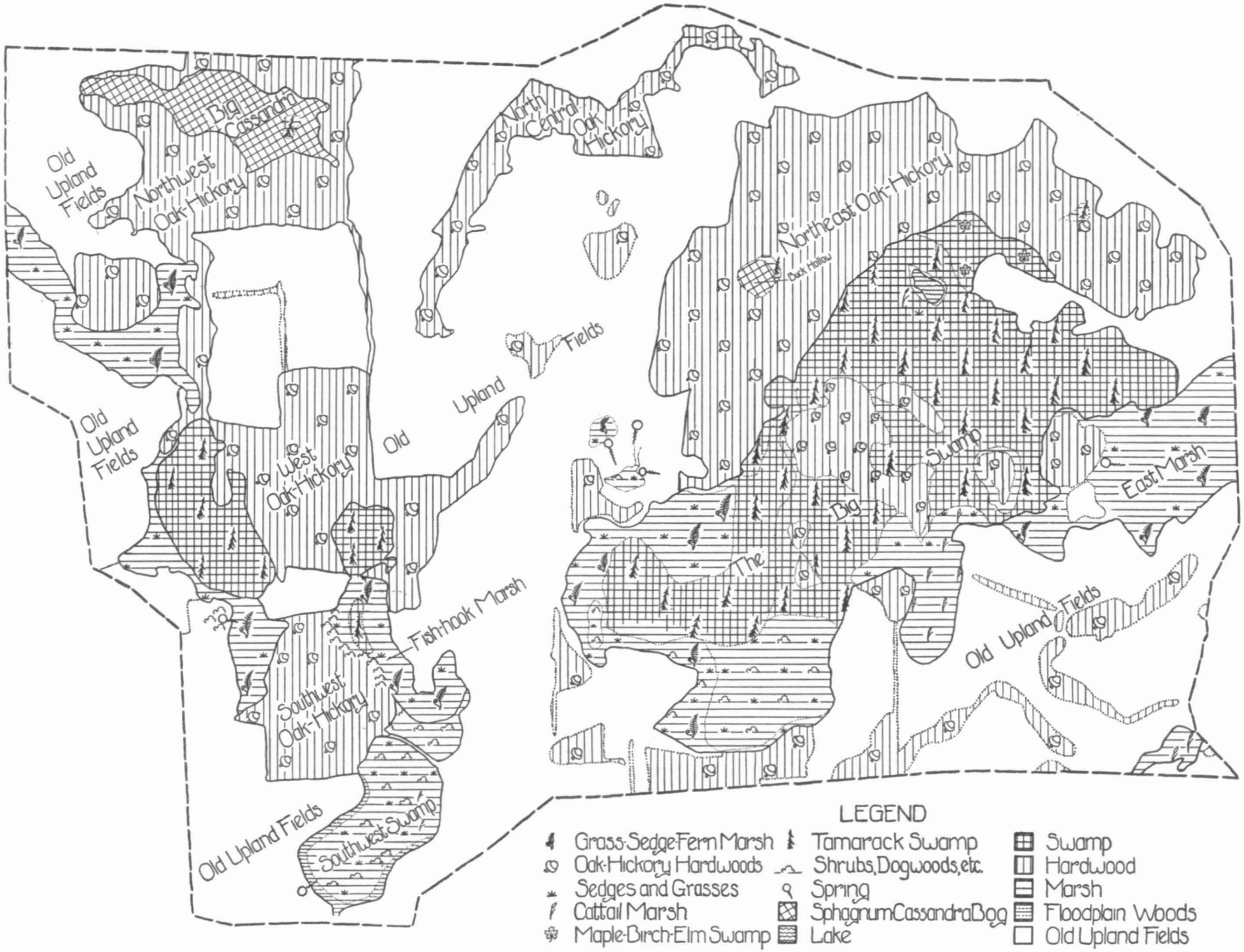
cies and the several complexes of plant association, topography, and drainage represented in this area, and an attempt to account for this correlation, insofar as possible, in terms of the actual habitats of the adult and immature stages. In order that the material may be presented as accurately and concisely as possible, the description of the several areas and stations at which detailed collections were made, and a proposed classification of these areas, or parts of them, into eleven more or less distinct habitats is followed by a tabular summary (Table II) of habitat distribution. Finally, in the "Annotated List" (pp. 58–118), where the species are listed in the same numerical order as in Table II, the habitat distribution of the adults and of the immature stages is given in somewhat greater detail.

Crane-fly Habitats of the Reserve

The oak–hickory woods

The oak-hickory woods of this region are apparently a stable preclimax on the well-drained soils. They occupy an aggregate of approximately 320 acres on the Reserve, about one-fourth of the entire area, and the individual woods, which vary from a few acres to 125 acres, include five separate areas of twenty-five acres or more (Map 1). In general, these woods consist of moderately open stands of well-developed or mature trees, with the dominant white oak (*Quercus alba*), black oak (*Quercus velutina*), and shagbark hickory (*Carya ovata*) constituting fully 90 per cent of the major forest. The relative density of timber stocking, however, and the relative development of shrubs, herbage, litter, and leafmold varies considerably, both with slope and exposure and with the relative maturity of the dominant trees. Saplings of oak and hickory are generally distributed; their numbers are more or less inversely proportional to the stand of the older trees; sassafras (*Sassafras officinale*) is the most abundant species of the tall-shrub stratum, but witch hazel (*Hamaelis virginiana*) and hazelnut (*Corylus americanus*) are common and usually conspicuous and tend to form numerous, small local thickets in most of the wooded areas. The huckleberry (*Gaylussacia baccata*) and the blueberry (*Vaccinium canadense*) are the most abundant low shrubs, the former being especially conspicuous on the drier slopes.

The herbage is more varied, and its appearance changes more with the season. The grasslike sedges *Carex communis* and *C. pennsylvanica* are always in sight and, with such grasses as *Poa compressa, Panicum tennesseense, Hystrix patula,* and *Danthonia spicata,* form definite grassy patches in many areas of the forest floor. Bedstraw (*Galium* sps.), the legumes *Desmodium nudiflorum* and *Vicia caroliniana,* and the procumbent rosettes of the aster (*Aster macrophyllus*) are generally distributed; other herbs that are often conspicuous at certain seasons are much more locally restricted. The horsemint (*Monarda fistulosa*) often marks the more open



MAP. 1. The major crane-fly habitats of the Edwin S. George Reserve. Drawn by Joseph C. Moore. Based on an original cover map prepared by the School of Forestry and Conservation.

areas, and May apples (*Podophyllum peltatum*) form occasional dense stands in the lower, more mesic woods; the bracken fern (*Pteris latiuscula*), generally numerous in many places, is strikingly abundant in several low, fairly open situations; and the yellow lady-slipper (*Cypripedium pubescens*), occasional clumps of *Hepatica,* and wild sarsaparilla (*Aralia nudicaulis*) are not uncommon near the bottoms of several of the north and east slopes.

Over most of the level areas and gentler slopes well-developed leaf litter and leaf mold are present; on the steeper slopes, large patches of bare soil alternate with pockets and depressions of well-formed leaf accumulations. The greater part of the litter is rather dry or only moderately moist, but its lower layers mix with the sandy loam beneath to form a damp but friable and aerated mold or humus. Over most of the woods the combined litter and mold are probably four to eight inches deep. Fallen twigs, branches, and trunks accumulate undisturbed in all of the wooded areas, but in most of the oak-hickory this deadwood is too dry to form a habitat for any local species of crane fly.

THE LOW OAK–HICKORY MARGINS

In several places the oak-hickory woods form the west or south boundary of a marsh, and here narrow dense thickets of tall shrubs are characteristically developed. Dogwoods (*Cornus* sps., especially *paniculata*) and elderberry (*Sambucus canadensis*) are dominant, with poison sumac (*Rhus vernix*) frequent on the marsh side and luxuriant thickets of hazelnut toward the woods, which here are largely white oak with an occasional slippery elm (*Ulmus fulva*) or hornbeam (*Carpinus caroliniana*). The soil of these thickets is black and wet, marshward it becomes a deep muck that for the most part is bare in the denser shade, but develops a luxuriant growth of touch-me-not (*Impatiens biflora*), bedstraw (*Galium* sp.), water purslane (*Ludwigia palustris*), sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), and tall grasses and sedges. The trees and limbs that fall from the oak-hickory undergo a wet, mycelium-riddled decay, and sodden logs covered with mosses and bracket fungi are common. Moss also develops on the wet soil, and the leaf litter is compacted into a sodden, silt-impregnated layer.

The transitions from oak-hickory woods to swamp are more varied. At the junction of the southwest oak-hickory and the southwest swamp, the ecotone is a broad gradient characterized by permanently wet to damp soil, a more luxuriant herbage, and wet, rotten wood. Between the northeast oak-hickory and the birch-maple-tamarack swamp there is an exceedingly sharp line of demarcation along most of the boundary. Elsewhere the oak-hickory and swamp margins are more or less intermediate, but all along the

margins a narrow zone within the oak-hickory proper is affected by the more persistent marshland moisture of both air and soil.

THE SOUTHWEST SWAMP

The southwest swamp is at once one of the richest crane-fly habitats of the region and the most anomalous area on the Reserve. The great complexity of its plant associations and crane-fly habitats, so difficult to classify, was no doubt caused largely by the change in drainage and in water level that took place about fifty years ago. Until then an area of some fifty to seventy acres, including Fishhook marsh, the tamarack swamp just north of it, the southwest swamp, and their adjacent slopes, had drained through the south end of the swamp into Patterson Lake. When this outlet was blocked by a road fill, the ponding water was diverted by a tile line from the north end of the southwest swamp into the Honey Creek drainage via the big swamp. Since that time the southwest swamp has had a much more widely fluctuating water level. In the spring months, water accumulates more rapidly than it can flow out through the tile line; then during midsummer or late summer, when the water has drained to the level of the outflow tile, the water level is belatedly but rapidly reduced by the high evaporation rate usual in that season.

The area here called the southwest swamp comprises approximately twenty-five acres. The northern half of its east-southeast margin is bounded by open, grassy fields, the north margin by Fishhook marsh, and the northwest by the southwest oak-hickory. Elsewhere—that is, for slightly more than the southwestern half of its periphery—it is bordered by a narrow belt of maple (*Acer saccharinum* and *A. rubrum*), elm (*Ulmus americanus*), ash (*Fraxinus americana* and *F. nigra*), and willow (*Salix* sp.), with an occasional butternut (*Juglans cinerea*) and small patches of aspen (*Populus tremuloides*). This area has very much the appearance of a flood-plain woods, often with a dense herbage of nettles (*Urtica* sp.), richweed (*Pilea pumila*), false nettle (*Boehmeria cylindrica*), smartweed (*Polyginus* sps.), and royal fern (*Osmunda regalis*); frequent clumps of sensitive fern (*Onoclea sensibilis*); and, among the aspen stands, large areas of lush grasses. The marshward margin is slightly inundated in the spring, and when the water recedes several types of wet strands are formed. Where the shade is densest the wet leaf-filled muck remains nearly bare; elsewhere, the recently exposed sodden brush, logs, and leaf mats develop a luxuriant growth of mosses, and the mud flats are invaded by a dense herbage that shades the stranded mats of algae, duckweed, and aquatic liverworts.

Except for this marginal flood-plainlike woods, the swamp consists of a low "island" of dense maple-ash-aspen swamp completely surrounded by diverse marshy areas. On the north a shrub-sedge marsh extends into a low

dogwood-aspen thicket before reaching the south margin of Fishhook marsh; on the east, a very wet grass-sedge-cattail marsh extends southward from the dogwood-aspen thicket to a small buttonbush (*Cephelanthus occidentalis*) swamp in the southeast corner. On the west a series of small grass-sedge (*Calamagrostis* = *Carex*), pure sedge (*Carex* sp.), and reed (*Scirpus*) marshes, more or less delimited by invading willows, separate the "island" from the southwest oak-hickory and the marginal tree zone south of it. South and southwest of the "island" the marsh is much more open. Here occasional clumps of *Carex, Scirpus,* and *Sparganum* are separated by frequent patches of *Sagittaria, Pontederia, Nymphaea adventa,* and the numerous small expanses of open water are covered with duckweed (*Lema* sps.) and floating liverworts (*Riccia* sps.). This area, which is separated from the marsh on the east by the small buttonbush swamp, becomes dry in late summer and is then invaded by a rank growth of smartweed and cocklebur seedlings.

In the dry summer of 1936 the maple-ash-aspen swamp on the "island" was free of standing water by mid-June, but the deeply shaded floor remained wet all through the summer, with clumps of royal fern and other swamp herbarge interspaced with areas of bare muck, sodden deadwood, and small shallow pools. Throughout that summer the swamp had an abundant crane-fly population; but in 1937 and 1938, when the floor remained completely inundated until well into August, this central island was almost devoid of crane flies from June to September. The same contrast between 1936, and 1937 and 1938 was apparent, although not nearly so marked, in the marsh areas, and was still less evident in the marginal maple-elm-ash zone.

THE TAMARACK SWAMPS

Approximately 150 acres, or nearly 12 per cent, of the George Reserve is occupied by tamarack swamps in various stages of development or retrogression. In all of the mature swamps most of the older trees have been killed by the larch sawfly, leaving a forest of dead standing trunks among which the younger tamaracks (*Larix laricina*), poison sumac (*Rhus vernix*), dogwoods (chiefly *Cornus racemosa* and *C. obliqua*), Michigan holly (*Ilex verticillata*), mountain holly (*Nemopanthus mucronata*), and chokeberry (*Pyrus arbutifolia atropurpurea*) often form a thick understory of small trees and tall shrubs, with spiraea, swamp birch, ferns, and sedges forming a well-developed lower stratum. The tamarack and poison sumac are everywhere dominant, the latter frequently making up nearly the whole of the understory and forming the dominant shrub of the ecotone with the shrub-sedge marshes. Throughout the tamarack swamps the soil is a black peat or muck that ranges from sodden to inundated. The surface water and silty mud is predominantly acid, with a pH between 5.0 and 6.0. The wet

soil and exposed roots are overgrown with mosses, and the occasional small pools and depressions are often filled with sphagnum. A generally high humidity is maintained below the upper shrub stratum, where a moderate to deep shade is generally prevalent.

Dead, sodden tamarack trunks are abundant on the swamp floor, but they rarely, if ever, provide a habitation for crane-fly larvae. This is in marked contrast to the much rarer sodden logs of such hardwoods as have fallen into these swamps from the bordering forests.

THE BIRCH–MAPLE–ELM SWAMP

The only well-developed birch-maple-elm swamp on the Reserve occupies a tract of five or six acres in the extreme north angle of the big swamp. The dominant trees are *Betula lutea, Acer rubrum,* and *Ulmus americana,* which, except near the margins, form the whole of the dense forest crown. Here a deep shade and a high humidity are more pronounced and more continuous than in any other part of the Reserve; practically no shrub stratum is developed, and the swamp floor is an expanse of sodden leaf mold and black, peaty muck strewn with dead limbs and branches and dotted with frequent clumps of royal fern (*Osmunda regalis*) and scattered individuals of wild sarsaparilla (*Aralia nudicaulis*). Numerous shallow pools remain for weeks after the higher water of early spring has receded, but their silty margins are bare of herbage, and a scant growth of sphagnum is usually the only plant life within the pool itself. The water and mud of the swamp floor has a pH that is usually below 5.5.

In contrast with the absence of an understory in the central part, the margins of this swamp have a marked development of shrubs and herbage. On the north, where the swamp is bordered by oak-hickory, is a marginal zone of tall poison sumacs, dogwoods (*C. racemosa*), and a rank herbage dominated by ferns, chiefly (*Osmunda regalis, O. cinnamomea,* and *Anchistea virginica*) on the low muddy hummock and root-bound platforms about the bases of the shrubs, and by skunk cabbage (*Symplocarpus foetidus*), with water arum (*Calla palustris*) in the pools between. On the south, where the swamp is bordered by a belt of young tamaracks and poison sumac, a dense thicket of dogwood (*C. racemosa*), mountain holly, Michigan holly, and high-bush huckleberry (*Vaccinium corymbosum*) grows from the peat, which is covered by sphagnum and the fern (*Anchistea virginica*). On the east, where the swamp is sharply separated from a grassy upland by a short, steep slope, the thicket is even denser than on the south and differs in including much chokeberry and in having a scant herbage of skunk cabbage, water arum, and fern, rather than sphagnum.

THE CASSANDRA BOGS

The Reserve includes two acid bogs dominated by Cassandra or leatherleaf (*Chamaedaphne calyculata*) and peat moss (*Sphagnum* sp.?). The

larger bog, "big Cassandra," occupies a basin of some fifteen acres; the smaller, "Buck Hollow," is about three acres in extent and lies at the bottom of a deep kettle hole within the northeast oak-hickory. Except for size and the relative development of the small areas of tamarack, the two bogs are much alike; in each a nearly pure stand of stiff, shrubby Cassandra bushes is swathed in a deep, dense, continuous mass of sphagnum, the two together forming an exceedingly springy bed of alternating mounds and depressions. The whole mass is sodden with water, the depressions visibly inundated in the spring and definitely wet throughout the year. The permanent water, which one can reach by depressing the sphagnum with the hand, has a pH that is consistently below 4.5, with occasional samples as low as 3.7.[7] The more shaded margins of both areas have a narrow submerged or wet zone where the Cassandra and sphagnum are replaced by tall sedges and grasses (chiefly *Carex lacustris riparia* and *Calamagrostis canadense*); here the pH of the water ranges from 4.5 to 5.0.

In Buck Hollow the eastern rim of the bog is occupied by a narrow but mature tamarack-shrub zone in which poison sumac is absent and all of the tamaracks are alive. Beneath their shade, and especially between them and the oak-hickory woods which ends abruptly at the margin of the bog, there is a mature thicket of tall swamp shrubs, much like that which borders the birch-maple-elm swamp on the south and east, except that here the high-bush blueberry is clearly dominant. The big Cassandra contains two small tamarack "islands." These, like the tamarack "zone" in Buck Hollow, consist of rather mature, living tamaracks and lack poison sumac, but they have a much less developed understory of shrubs. All three of these tamarack areas are frequented by deer, and their trampling has doubtless modified the herbage. Ferns (chiefly *Anchistea virginica*), mint (*Lycopus rubellus*), fireweed (*Erechtites hieracifolia*), smartweeds (*Polygonium* sps.), and nonsphagnum mosses dominate the muddy soil, with water arum (*Calla palustris*) abundant in the inundated depressions.

GRASS–SEDGE–FERN MARSHES

Although the marsh areas of the George Reserve can be subdivided into a number of types and stages, based on specific associations of marsh vegetation and a successional interpretation of their histories from the standpoint of the crane-fly faunas, not more than three intergrading types can be recognized. Of these, the extensive herbaceous marshes, dominated by bluejoint (*Calamogrostis canadensis*), sedge (*Carex* sps.), and marsh ferns (*Thelypteris thelypteris*), are perhaps the most important as a distinct crane-fly habitat.

[7] The 10 cc. samples had a surprisingly rich fauna of rotifers, large ciliates, and other forms, easily discernible with a 10 × hand lens.

Such marshes occupy three considerable basins on the west side of the Reserve and some fifty to sixty acres in the southeast and southwest parts of the big swamp. In early summer these marshes, when viewed from a short distance, appear to be level expanses of dense, tall marsh grasses, broken by an occasional individual or clump of taller shrubs—willow (*Salix* sp.), rose (*Rosa palustris*), and dogwoods (*Cornus stolonifera*)—that rise above the uniform stratum of tall herbage. Actually, there is considerable diversity in detail; a variety of sedges (*Carex*) occurs, and several species of these, as well as *Calamagrostis,* cut-grass (*Leesia oryzides*), and occasionally *Scirpus* and *Juncus,* occupy local areas in nearly pure stands. By midsummer the variety of the marsh vegetation is more evident, for then the frequent individuals of bur marigold (*Bidens* sps.), goldenrod (*Solidago*), joe-pye weed (*Eupatorium maculatum*), and other composites are in flower.

The dense dogwood-elderberry thickets on the shaded west and south borders of several of the marshes were briefly described in the discussion of the oak-hickory woods. Where the marsh borders are not so well sheltered, the marginal growth of shrubs may be scant. The eastern edge of Fishhook marsh has a narrow zone in which a considerable development of shrubby cinquefoil (*Potentilla fruticosa*) bushes is interspaced with the marsh herbage and, with a fringe of *Spiraea alba,* forms a transition to the grassy fields and dry, dewberry-grown slopes that bound the marsh on the east. The abrupt upland margin of the grass-sedge areas of the big swamp are marked by a scant but continuous line of low shrubs, with an occasional swamp white oak (*Quercus bicolor*).

The separate marshes differ considerably in the height and seasonal variations of their water levels. The two areas that form parts of the big swamp are more deeply and permanently inundated than those on the west side of the Reserve, with Fishhook marsh intermediate, but none can be crossed dry shod even at the driest season. The differences in water level affect the proportion and seasons of various crane-fly species that comprise the total population of each marsh, but are not correlated with the complete absence or unique presence of even a single species. The water and mud range from circumneutral to slightly basic. Several scores of pH samples, taken in June, July, and August, 1937, and representing all of the larger marshes, varied from 6.9 to 7.7. Samples from small open pools and deer trails in the deepest water areas ranged from 7.4 to 7.7, and here nearly every 10 cc. sample contained a number of Volvox.

Below the tops of the dominant herbage, these marshes are markedly similar in the ecological factors that govern crane-fly populations. The soil is a deep black muck, and much of the floor consists of pillar-like hummocks separated by narrow connected channels, that together produce a strikingly stippled topography. I have been told by a number of the long-time resi-

dents of this region that such a hummock formation is caused by trampling by cattle, and that once formed the hummock and channels are permanent. The latter statement is certainly borne out by the plant growth, for each hummock is the site of a dense clump of sedges and grasses, and of a luxuriant undergrowth of marsh fern (*Thelypteris*), their roots, rootstocks, and stolons binding the hummock into a tenacious sod, and the water-filled channels between are choked with the fallen and slowly rotting stems and fronds from the year before. The size of the hummocks varies somewhat with the average water level of the marsh, the taller ones being situated where the prevailing water level is higher. In general, each hummock is from one to one- and one-half feet high and about a foot in diameter, and most of the channels between hummocks are approximately one foot wide.

A variety of stable larval habitats is provided by the more or less permanent water of the channels: the semisuspended accumulation of plant debris, the saturated silt at the water line, the wet soil of the hummocks, the sodden lower stems and stolons of the herbage, and the nearly ubiquitous carpets and sheaths of algae and mosses that grow on the sides of the hummocks and swathe the bases of the tall herbage. Just above the water line and between the bases of the grass and sedge clumps, a maze of moist shaded passageways and resting places shelters a huge population of adults.

THE SHRUB–SEDGE MARSHES

These marshes are characterized by a dense stand of closely intermingled shrubs and a tall sedgelike herbage. The upper surface of this formation, unlike the grass-sedge-fern marshes, has a definitely uneven, rugged aspect, individuals and clumps of the taller shrubs protruding abruptly above the irregular level of lower shrubs and herbage. Spiraea (*Spiraea alba*), swamp birch (*Betula pumila*), and shrubby cinquefoil (*Potentilla fruticosa*) are the dominant shrubs; but dogwoods (chiefly *Cornus stolonifera*) are abundant, and poison sumac (*Rhus vernix*) is not infrequent. The herbage is dominated by sedges (*Carex, Eleocharis, Scirpus*) and grasses (*Calamogrostis, Leersia,* and others), with a dense lower growth of ferns and numerous plants of arrowhead (*Sagittaria latifolia*).

The soil is a black, deep, peaty muck, and except for that in the higher hummocks is mostly submerged in the spring and early summer. The deer paths, which are slightly deeper than the average between-hummock channels, are more than knee-deep in water in the spring, and ankle-deep in late summer. The floor above the water line has an extensive carpet of thin mosses, and the lower stems of the herbage and a narrow zone on the sides of the hummocks often bear thin films of emergent algae. Water and soil are generally slightly basic, but in this respect there is much local variation.

Unless one follows the numerous deer paths, progress through such a

marsh is slow and difficult; the shrubs are often higher than one's head and so thickly grown that they necessitate frequent detours, and the dense waist-high herbage conceals the hummocks and channels underfoot. Adequate collecting is almost impossible. Sweeping that can reach the resting places of the adult crane flies, deep within the fern stratum, is confined to the narrow deer paths and the somewhat similar "moats"[8] that encircle the clumps of taller shrubs. Most of the specimens and records from the shrub-sedge were obtained either by hunting on hands and knees through the more open, overgrown passageways or by net collecting from the upper stratum at late dusk.

The largest continuous area of shrub-sedge marsh occupies some fifty or sixty acres in the southwest end of the big swamp, and there are small patches and zones in many other parts of this same swamp. On the west side of the Reserve, a shrub-sedge marsh covers about six acres at the juncture of the southwest swamp, the southwest oak-hickory, and Fishhook marsh; there are also a few smaller areas of shrub-sedge marsh along the east borders of the west marshes.

THE CATTAIL MARSHES

Several areas definitely dominated by cattails (*Typha latifolia*) are found on the Reserve. One of these, by far the largest, is a continuous stand of six or seven acres. Here the water stands two to three feet deep in early summer, but steadily recedes, to expose most of the black-muck soil by late July or early August, when the luxuriant understory of smartweed (*Polygonium* sps.), touch-me-not (*Impatiens biflora*), and bur marigold (*Bidens* sp.) reaches its maximum development. The water and mud of all the well-developed cattail marshes were rather basic, with a pH of 7.7 to 7.9. Several other marshes in the vicinity of the Reserve have similar readings.

OTHER MARSH AREAS

The grass-sedge-fern, shrub-sedge, and cattail marshes of the Reserve have sufficiently uniform conditions to permit a fairly close correlation between each of these formations and a typical or predictable crane-fly population. A number of other marsh areas, however, are either so small or have such an individual combination of characteristics that they could not be identified with any recurring or recognizable type. The mixture of small, diverse marshes that occupy the western part of the southwest swamp has been already referred to; another fairly large nondescript area of marsh surrounds the small, almost extinct glacial lake or pond near the northern extremity of the big swamp.

This lake at one time doubtless included the whole basin now occupied

[8] These "moats" are probably caused by the trampling of the deer in browsing.

by the big swamp. At present it is reduced to two or three acres of shallow water, already invaded by floating and emergent vegetation. Around the lake an irregular zone of marsh, with a maximum width of about twenty-five yards, separates the open water from the encroaching tamarack swamp, and even this zone is dotted with isolated individuals of poison sumac and young tamaracks. Almost the entire marsh perceptibly quakes as one walks upon it, but a break-through, even at the inner edge, does not submerge one more than thigh-deep in the semisuspended, silty peat beneath. Here cattails, sedges, grasses, and even occasional mounds of sphagnum and rarer pitcher plants, are more or less intimately mixed. The pH of the water and silt ranges from about 6.6 at the edge of the open water to from 5.5 to 5.0 at the swamp margin.

The marshy areas associated with the various seepage areas have a marked individuality that is probably conditioned by the quantity and seasonal variations of the water supply and the amount of shade provided by adjacent slopes or trees. In all of these marshes, however, the dominant shrubs and herbage are various combinations of the same species that inhabit the grass-sedge-fern, shrub-sedge, and cattail marshes.

SPRINGS AND SPRING RILLS

The four permanent springs on the Reserve are all small, the largest somewhat modified by the insertion of a hydraulic ram and the diversion of about 10 per cent of the water for human use. All have a nearly constant temperature of from 48° to 50° Fahrenheit and are slightly basic—pH, 7.3 to 7.7. In the three smaller of these springs, the flow gives rise to small rills that, after a course of some fifteen to twenty yards, are lost in the adjacent marsh or swamp. In spite of their smallness and marked isolation (the two closest are more than 700 yards apart) all show small reaches of both sandy and silty bottom and margin and support a small but permanent population of at least a few rill-inhabiting species.

Close by the central and largest spring are two semipermanent springs or seepage areas that are fed by a pair of hillside kettle holes. In 1936 these semipermanent rills had ceased to flow by the end of June, but in 1937 and 1938 one of them lasted throughout the summer and the other well into July, and both had a small population of such species as *Tipula strepens* and *T. tephrocephala,* although lacking *Adelphomyia cayuga, Pedicia inconstans,* and *Limnophila brevifurca,* which were present, in at least small numbers, along the rills of the permanent springs.

Collecting Stations in the Vicinity of the Reserve

Several types of crane-fly habitats characteristic of the general region are not found on the Reserve, or are but poorly represented. For this reason several stations along Honey, Hell, and Unadilla creeks, the borders of

Sayl Lake, and Kalmbach's woods were included in the area studied. Most of these were in the immediate vicinity of the Reserve, and none was farther than three miles away.

WEST BRANCH OF HONEY CREEK

Upper Honey Creek has its origin near the northwest corner of the Reserve and flows eastward through low, marshy meadows parallel to and a few hundred yards north of the north boundary fence. In the spring and early summer the lower valley slopes of this brook are a morass of springs and seepage areas, and it is largely spring-fed throughout the year. Reputed to have once been a good trout brook, the channel and margins are now deep with silt and often almost choked with cress-grown, silty bars. The banks are overhung with tall herbage and an occasional willow or dogwood, and the valley floor for from twenty-five to fifty yards on either side is overgrown with marsh vegetation and an occasional clump of cattails or tamaracks.

NORTH BRANCH OF HONEY CREEK

The north branch, which joins the west branch about a mile east of the Reserve, is a small, lake-fed brook with distinctly warmer water and a silt-free, sandy bottom. Just before its juncture with the west branch this brook flows for about one-fourth of a mile through a low or gently sloping valley. The western side of this valley consists of some thirty acres of wet, seepage-filled, grass-sedge-fern and cattail marshes; the narrow upper eastern side contains several rills and chara-choked lagoons between the brook and the valley slopes, beyond which it widens into an extensive swampy thicket dominated by maple, ash, ninebark (*Physocarpus opulifolus*), high-bush cranberry (*Viburnum opulus americanum*), and shrubby St. John's-wort (*Hypericum prolificum*).

LOWER HONEY CREEK

Some two or three miles east of the Reserve, Honey Creek is dammed to form the Pinkney millpond and emerges from the spillway as a comparatively warm, sand-gravel-bottom creek that flows through a succession of grassy and wooded pastures to empty finally into Portage Lake. Here nearly all collecting was confined to the first hundred yards below the spillway.

HELL CREEK

Hell Creek begins a mile southeast of the Reserve as the outlet of a very old millpond now known as Highland Lake. For the first several hundred yards it is a large sand-gravel-bottom creek, flowing through a low, swampy, flood-plain woods; it then expands into a small, sluggish, marsh-bordered "lake." For about the next mile it follows a low, frequently flooded, marshy course, and beyond is a mile-long reach in which the creek traverses a belt of moraines in a well-defined valley. Here there are many pools and

riffles, flood-plain woods, and steep valley slopes. Below this section Hell Creek winds through another mile of low, marshy land into Portage Lake, by way of Little Portage.

The chief collecting stations on Hell Creek were the upper and lower reaches through wooded flood plains and two valley-slope spring rills between them.

THE TIPLADY ROAD MARSH

A few hundred yards north of Hell Creek, and just southwest of the crossing of the Tiplady and Toma roads, a seepage and spring-rill marsh occupies a basin of about twenty acres. Several springs and a small rill arising at the northern edge of the basin flow across it as indefinite, braided channels, in some places lost in the dense marsh vegetation. Dense stands of cattails, sedges, and grass-sedge-fern occupy most of the basin, but the northern edge has an extensive development of blue flag (*Iris versicolor*) and watercress (*Radicula nasturtium-aquaticum*); and near the center of the area a small thicket of dogwoods, young tamaracks, and ninebark shades a series of rootbound mossy platforms, that are interlaced with silty waterways and stagnant miniature lagoons. The areas dominated by marsh vegetation are very like those on the Reserve, except that here the water has a definite flow over much of the area, and the relatively high water level has a minimum of fluctuation.

UNADILLA CREEK

This is a small brook that forms the outlet of the Unadilla millpond. The reach from which collecting was done begins as a sand-bottom rill at the foot of a shaded, wooden spillway and continues for about one-half of a mile through alternating low grassy margins, steep shaded banks, and overhanging streamside thickets. Unlike Honey and Hell creeks, it is bordered by neither swamp nor marsh and has few springs or bankside seepage areas.

THE MARGINS OF SAYL LAKE

Sayl Lake, about one hundred yards south of the southwest corner of the Reserve, is now a marl, or semimarl, lake with about fifty acres of open water and extensive margins of marsh or swampy bog. On the north and northeast a wide belt of marsh exhibits a fairly well-developed zonation from the open water of the lake to the steep wooded hillsides that enclose the basin on the north; on the west the marsh zone is a narrow, grass-sedge-sphagnum, quaking mat, immediately beyond which is a definitely acid sphagnum-sumac-tamarack swamp or bog; elsewhere, a wide marsh zone of reeds and sedges is bordered by a low wooded shore, dominated by maple-ash-elm, with a considerable understory of swamp shrubs, including many poison sumacs.

The lake itself is definitely basic, with a pH of 7.9 to 8.3; most of the marsh has a pH of 7.6 to 7.2, with incrustations of marl on some of the stems

of the inner-zone herbage. These were the only marshes in the entire region in which there were luxuriant growths of sweet flag (*Acorus calamus*).

KALMBACH'S GRAVEL–PIT WOODS[9]

This station, nearly three miles south-southwest from the Reserve, was included as an excellent example of cold, swampy, hillside woods. Here, about halfway down the northern slope of a high moraine hill, a large spring and a wide area of diffuse seepage marks the upper edge of a densely shaded, boggy swamp that extends some hundred yards to the bottom of the hill. At the upper margin a rank, shaded growth of touch-me-not, ferns, skunk cabbage, *Sagittaria,* and water arum covers a morass of saturated, almost semi-suspended black silt and muck into which at many points, one may sink thigh-deep. Below this zone a series of small rills descends the hill in often braided, diffuse channels that are separated by wide areas of firmer, black, rich soil. The larger tree growth is dominated by elms, basswood (*Tilia americana*), red oak (*Quercus rubra*), and ash, with occasional large specimens of butternut and of walnut (*Juglans cinerea* and *nigra*) ; beneath the dense understory includes flowering and alternate-leafed dogwoods (*Cornus florida* and *alternifolia*), blue beech, and tall, almost treelike, poison sumacs. The herbage is rich in species; among the more characteristic are Clitonia (*Clitonia borealis*), wake-robin (*Trillium* sp.), Solomon's-seal (*Polygonatum biflorum*), spikenard (*Aralia racemosa*), wild sarsaparilla (*Aralia nudicaulis*), white baneberry (*Actea alba*), richweed (*Collonsonia canadensis*), and maidenhair fern (*Adiantum redatum*).

The spring and seepage waters have a temperature of 48° to 50° Fahrenheit throughout the summer and a pH of 7.5. Other samples of water and silt collected at random throughout the swamp and along the rill courses varied in pH from 7.1 to 7.7.

HABITAT CLASSIFICATION

Any attempt to classify the areas described above under a limited number of habitats involves two important considerations: (1) that they have discernible differences in their crane-fly faunas and (2) that recognizable and repeated examples of such complexes of vegetation, topography, and drainage are typical of the region. Actually, no two woods, marshes, bogs, or streams are precisely alike; but, except for the cold, hillside, seepage swamp of Kalmbach's woods, all the kinds of habitats listed below may be seen within a few miles' drive along any of the country roads of southern Livingston or northern Washtenaw counties; and Kalmbach's woods is not unique,

[9] This wood is situated in Lyndon Township, Washenaw County, about one mile south-southeast of Unadilla. It is designated as "Prospect Hill" on the map of the Stockbridge Quadrangle, but this name has been also applied to several similar hills in this region.

although such habitats are much rarer in this region than along the valley slopes of the larger streams.

Eleven types of crane-fly habitats are recognized for the Reserve and its vicinity, and each of these heads a column in the tabular summary of habitat distribution that follows:

I. Oak-hickory woods.

II. Oak-hickory ecotones. "The low oak-hickory margins" are ecotones with marsh, swamp, and bog, but chiefly with the first two. All are characterized by rather limited extents of truly mesic conditions, dominated by hardwoods.

III. Flood-plain woods. These include the true flood-plain woods along parts of Hell Creek and the woods practically indistinguishable from them along the southern half of the southwest swamp and along parts of the south shore of Sayl Lake.

IV. Birch-maple-elm swamp. Most of the data were obtained from the birch-maple-elm swamp on the Reserve, but these were well checked against data from a closely similar swamp between Sayl and Patterson lakes.

V. Tamarack-sumac swamp.

VI. Cold-seepage swamp. Kalmbach's gravel pit woods.

VII. Sphagnum-Cassandra bogs. Data upon sphagnum-Cassandra bogs were obtained in the "big Cassandra" and "Buck Hollow," but were checked against the data from collecting in a very similar bog in Oakland County.

VIII. Shrub-sedge marshes. Shrub-sedge and cattail marshes of nonseepage areas. Records from the cattail marshes are differentiated in the Annotated List.

IX. Grass-sedge-fern marshes. The marshes of nonseepage areas, including the lake margins.

X. Seepage marshes. Nearly always with various combinations, but hardly ever zones, of grass-sedge-fern, shrubs, and cattails; and *always characterized* by a definite though sluggish flow of marsh water.

XI. Brooks, creeks, and rills. These include only such rills as have definite, nonmarshy water courses. The distinction between these streams and the marshy or swampy situations that were often associated with them was not easy to make, but insofar as possible the correlation of any species with a stream is independent of any assignment to the bordering marshes.

A number of species that are not aquatic still had a consistent tendency to be confined to the immediate vicinity of

TABLE II

HABITAT DISTRIBUTION

First letter, Abundance: A—abundant; C—common; N—numerous; R—rare.
Second letter, Frequence: W—widespread; G—general; L—local; V—very local.
Third letter, S—adults spread into habitat; B—breeds here; ?—probably breeds here.
Principal habitat in italic; ( )—not aquatic; *—vicinity not within Reserve.

Species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
	Oak-Hickory Woods	Oak-Hickory Ecotones	Flood Plain Woods	Birch Maple-Elm Swamp	Tamarack Sumac Swamp	Cold Seepage Swamp	Sphagnum Cassandra Bog	Shrub Sedge Marsh	Grass Sedge-Fern Marsh	Seepage Marsh	Brook and Creek
1. *B. clavipes*				NLB	NLB	CLB		NLB	NLB	*CGB*	NLB
2. *P. rufocincta*								R	R	*CLB*	CVB
3. *A. marginatus*								?			?
4. *T. fernaldi*										?	
5. *T. saltator*	N??		N??								
6. *D. dorsalis*				NLB	NLB	NLB		*CGB*	CGB		
7. *D. obscura*	RVS			*CLB*	NLB						
8. *D. sayi*			CLB	*CGB*	NLB	NLB	NLB	*ALB*	*ALB*	NLB	
9. *D. similis*				RV?							
10. *D. subalbipes*			RVB	*AGB*	ALB						
11. *D. walleyi*			NGB	NGB	*NGB*						(NLB)
12. *D.* species?					RV?		RV?		RV?		
13. *P. fuscipennis*					RLS			AGB	AGB	*AGB*	
14. *N. breviorcornis*			NL?								(*CLB*)
15. *N. eucera*	R–S		*NL?*								
16. *N. euceroides*			NL?								
17. *N. ferruginea*	NL?	NLB	NLB				NL?	NLB			(NLB)
18. *N. gracilicornis*			*CL?*								(CL?)
19. *N. incurva*		RLS						NL?			(NL?)
20. *N. polymera*			RLS								(*CL?*)
21. *N. punctum*	R–S	R–S						NLB	*ALB*		
22. *N. sodalis*			NLB					RL?			(*ALB*)
23. *N. tenuis*					RG?			*RG?*	RG?	RG?	
24. *N. virescens*			RL–								(RL–)
25. *T. abdominalis*											*NLB*

TABLE II (*Cont.*)

Species	I Oak-Hickory Woods	II Oak-Hickory Ecotones	III Flood Plain Woods	IV Birch Maple-Elm Swamp	V Tamarack Sumac Swamp	VI Cold Seepage Swamp	VII Sphagnum Cassandra Bog	VIII Shrub Sedge Marsh	IX Grass Sedge-Fern Marsh	X Seepage Marsh	XI Brook and Creek
26. *T. angulata*		RVB	RVB								
27. *T. bicornis*	RLS	*RLB*									
28. *T. borealis*	CLS	CG?	*AG?*	NG?							
29. *T. caloptera*											*AGB*
30. *T. cayuga**											
31. *T. cunctans*							N	N	N		
32. *T. dejecta*			CLS					*AGB*	AGB	AGB	(CLB)
33. *T. dickinsoni*								NL?	*ALB*	RLB	
34. *T. disjuncta*	*AGB*										
35. *T. dorsimacula*			RLB							RLB	
36. *T. duplex*	*CGB*	CGB	CGB	RL							
37. *T. eluta*								NL?	NL?	NGB	*NGB*
38. *T. flavoumbrosa*	*CLB*	CGB	CLB								
39. *T. triples* grp.—B	*CLB*	CGB	NGB	NL?	NL?						(NL?)
40. *T. fraterna*											*NLB*
41. *T. fuliginosa*	*AGB*	NLB	NLB								
42. *T. furca*			R–S					NGB	NGB	*CGB*	*CGB*
43. *T. georgiana*	*RLB*										
44. *T. grata*			NL?								
45. *T. hermannia*		R–?	R–?			*CLB*					
46. *T. hirsuta*	*CLB*	CLB	N–S								
47. *T. illinoiensis*											
48. *T. kennicotti*								NL?	*CG?*	*CG?*	
49. *T. latipennis*	*CLS*	CGB	*AGB*								
50. *T. longiventris*	*CLB*	CGB									
51. *T. megaura*	N–S	N–S	N–?		N–?			CLB	*CLB*	CLB	
52. *T. monticola*	R–?										
53. *T. parshleyi*	NGB	*NGB*	*NGB*	N–S							
54. *T. sayi*								*CGB*	CLB		
55. *T. serta*								NL?	NL?	CG?	

TABLE II (*Cont.*)

Species	I Oak-Hickory Woods	II Oak-Hickory Ecotones	III Flood Plain Woods	IV Birch Maple-Elm Swamp	V Tamarack Sumac Swamp	VI Cold Seepage Swamp	VII Sphagnum Cassandra Bog	VIII Shrub Sedge Marsh	IX Grass Sedge-Fern Marsh	X Seepage Marsh	XI Brook and Creek
56. *T. strepens*										NLB	NVB
57. *T. submaculata*	*CLB*	CGB	CLB	NL?	NL?						
58. *T. sulphurea*								CGB	CGB	*AGB*	
59. *T. tephrocephala*										NLB	
60. *T. translucida*	NGB	*NGB*	NL?								
61. *T. tricolor*								CGB	CGB	*CGB*	*CGB*
62. *T. triplex*	*NGB*	NGB	NLB								
63. *T. triplex* form C	*ALB*	AGB	NLB								
64. *T. trivittata*		RLB	RLB								
65. *T. ultima*	N–S		N–S					*CGB*	CLB		
66. *T. unifasciata*	R??										
67. *T. unimaculata*			NL?			CG?					
68. *T. valida*	*AGB*	AGB	CGB								
69. *T. vicina*											NL?
70. *T. youngi*			NL?			RL?					
71. *P. neoxena*									NVB	CLB	
72. *T. exculpta*									RV?	*CVB*	
73. *L. nodicornis*								*NLB*	*RLB*		
74. *L. cinctipes*		RLB				*RLB*					
75. *L. fallax*				R–?		R–?					
76. *L. globithorax*		RVB		*RVB*							
77. *L. immatura*		*NLB*									
78. *L. indigena*		NL?				*CL?*					
79. *L. macateei*	CVB	CVB									
80. *L. simulans*											*ALB*

TABLE II (*Cont.*)

Species	I Oak-Hickory Woods	II Oak-Hickory Ecotones	III Flood Plain Woods	IV Birch Maple-Elm Swamp	V Tamarack Sumac Swamp	VI Cold Seepage Swamp	VII Sphagnum Cassandra Bog	VIII Shrub Sedge Marsh	IX Grass Sedge-Fern Marsh	X Seepage Marsh	XI Brook and Creek
81. *L. solitaria*				NV?	*CL?*			*CL?*	NV?	NV?	
82. *L. triocellata*		NLB	*NGB*	*NGB*							
83. *L. tristigma*		CL?	CL?	*CG?*	CL?			*CL?*			
84. *L.* (*L.*) species		RV?									
85. *L.* (*D.*) *argus*	RVS	RVB	NLB	RLB							
86. *L.* (*D.*) *adirondacensis*				CL?	CLB			*AGB*	*AGB*	*AGB*	
87. *L.* (*D.*) *divisa*			NLB	*CGB*	*CGB*	*CGB*	NL?	NLB	R–?		
88. *L.* (*D.*) *gladiator*		CL?		*AGB*	NL?			*AGB*	CLB	NLB	
89. *L.* (*D.*) *haeretica*			N–S					*AGB*	*AGB*	R–?	
90. *L.* (*D.*) *humidicola*											CVB
91. *L.* (*D.*) *immodesta*	NLS	*ALB*	NL?	*ALB*	*ALB*			CLB	NLB	NVB	
92. *L.* (*D.*) *iowensis*			RV?								
93. *L.* (*D.*) *liberta*			RV?		RV?					NL?	
94. *L.* (*D.*) *longipennis*								NLB	*CLB*	NLB	
95. *L.* (*D.*) *nycteris*								NLB	NGB	*AGB*	
96. *L.* (*D.*) *pudica*				R–?							
97. *L.* (*D.*) *rostrifera*							*CGB*		RL?	*ALB*	
98. *L.* (*D.*) species								NV?	CL?		
99. *L.* (*A.*) *whartoni*							RL?	NLB	*AGB*		
100. *L.* (*R.*) *fidelis*	RLB	RLB	RLB								
101. *L.* (*R.*) *maculata*			RLB	RLB		RLB					
102. *L.* (*G.*) "sp. A"		NLB						NLB	NLB	*NLB*	
103. *L.* (*G.*) "sp. B"										CVB	*ALB*
104. *L.* (*G.*) *distincta**										RV?	
105. *L.* (*G.*) *rostrata*								RVB	RVB	*NLB*	
106. *H. flavipes*	*AGS*	*AGS*	CGS	CLB	CLB			*NGB*	*NGB*	RV?	
107. *H. mainensis*								CLB	*CGB*	NLB	
108. *D. germana*	RV?										
109. *D. septemtrionis**			NV?								
110. *U. elegans*		RVB									
111. *P. albivitta*						NLB					*NLB*

TABLE II (*Cont.*)

Species	I Oak-Hickory Woods	II Oak-Hickory Ecotones	III Flood Plain Woods	IV Birch Maple-Elm Swamp	V Tamarack Sumac Swamp	VI Cold Seepage Swamp	VII Sphagnum Cassandra Bog	VIII Shrub Sedge Marsh	IX Grass Sedge-Fern Marsh	X Seepage Marsh	XI Brook and Creek
112. *P. autumnalis*		CLB						*CLB*	CVB		
113. *P. calcar**						*CL?*					
114. *P. inconstans*				NVB		NLB		RV?	RV?	*CLB*	NLB
115. *P. paludicola**										*NVB*	RL?
116. *D. (A.) flaveola*						*CLB*					
117. *D. (R.) eucera**						*RLB*					
118. *D. (R.) cayuga*						*RLB*					RV?
119. *A. cayuga*						*CLB*				NVB	*ALB*
120. *A. pleuralis*						*ALB*					
121. *E. fascipennis*	—S	*AGB*	*AGB*	AGB	NVS	CGB		N–S			
122. *A. taxoneura*		RV?		NG?	RL?						
123. *P. contempta*										NLB	
124. *P. inornata*	—S	—S		CLB				*ALB*	*ALB*		
125. *P. luteipennis*	CLS	CLS	CLS	NLB	CLB			*ALB*	*ALB*	*AGB*	
126. *P. noveboracensis*	*AGS*	AGS	AGS	CG?	CG?	NGB		–*GB*	–*GB*	–L?	
127. *L. macrocera*					RVB					RVB	RVB
128. *L. subtenuicornis*										*ALB*	
129. *L. angustula*						*ALB*				RVB	
130. *L. fuscovaria*			—S	CLB	NLB			CLB	NVB	*CGB*	NLB
131. *L. fasciolata*								NL?	NL?	NL?	
132. *L. solstitialis**						*CLB*					
133. *L. adusta*				RL?	RL?		*AG?*				
134. *L. auripennis*	N–S	N–S	C–S	*AGB*	*AGB*	N—	CG?	CG?			NL?
135. *L. caudifera*										RV?	
136. *L. consimilis*									NV?	CLB	*ALB*

TABLE II (*Cont.*)

Species	I Oak-Hickory Woods	II Oak-Hickory Ecotones	III Flood Plain Woods	IV Birch Maple-Elm Swamp	V Tamarack Sumac Swamp	VI Cold Seepage Swamp	VII Sphagnum Cassandra Bog	VIII Shrub Sedge Marsh	IX Grass Sedge-Fern Marsh	X Seepage Marsh	XI Brook and Creek
137. *P. iowensis*			NLS							*NLB*	
138. *P. luteola*										RL?	
139. *P. platyphallus*		RV?		NL?	RV?		NG?				
140. *L. siouana*		NV?									
141. *L. subcostata**						R–?					
142. *L. brevifurca*						NL?				*AG?*	
143. *L. laricicola*							*CG?*				
144. *L. poetica*			—S	CGB	CLB			AGB	*AGB*	AGB	—S
145. *S. lenta*		—S	—S	CLB	CLB	CLB	NL?	CLB	*ALB*	CL?	
146. *P. imbecilla*	—S	—S	*AGB*	CLB	NLB			RL?	RL?		
147. *P. osborni*				NL?	NL?			*ALB*	CLB		
148. *P. quadrata*	—S	*CLB*	NLB	RV?	RV?					RV?	
149. *P. recondita*	CLS	CGS	CGS	*AGB*	*AGB*	CGB		*AGB*	CGB	CLB	NLB
150. *P. tenuipes*		RLS		RLB				RV?	RV?	*CLB*	*CLB*
151. *H. cinerea*											RVB
152. *H. gibbosa*											*CGB*
153. *A. picticornis*				RVB		NLB					
154. *E. westwoodi*		RVB	NVB	*NLB*	NVB						
155. *C. flavoferruginea*	NGB										
156. *N. ultima*	AG?	AG?	AG?							AG?	
157. *G. tristissima*		RVB	NLB								
158. *G. florens*					RL?					RL?	RL?
159. *G. kansensis*					RL?					RL?	RL?
160. *G. subcinerea*	*AGS*	*AGS*	*AG?*	*AWB*	*AGB*	CGB	R–S	NL?	NL?		
161. *G. sulphurella*							RG?	RL?	RL?	NLG	*NGB*
162. *G. blanda*	CGS	CGS	CLS	CL?	CL?			N–?	N–*B*	N–*B*	
163. *H. hybrida*	N–S	N–S	N–S					NLB	CLB	*AGB*	
164. *E. chlorophylla*					NLB	NLB		NLB	CLB	*CLB*	(CLB)
165. *E. chlorophylloides*	NLS		NLS		NL?			*ALB*	ALB		
166. *E. furcifer*								*CVB*	RL?	CLB	RL?
167. *E. gaspeana*								NL?	RV?	NL?	

TABLE II (*Cont.*)

Species	I Oak-Hickory Woods	II Oak-Hickory Ecotones	III Flood Plain Woods	IV Birch Maple-Elm Swamp	V Tamarack Sumac Swamp	VI Cold Seepage Swamp	VII Sphagnum Cassandra Bog	VIII Shrub Sedge Marsh	IX Grass Sedge-Fern Marsh	X Seepage Marsh	XI Brook and Creek
168. *E. megopthalma*								NV?	NV?		
169. *E. septemtrionis*	NLS	NGS	NGS	*NGB*	*NGB*			NL?			RV?
170. *E. straminea*							NL?	NLB	NLB	*AGB*	
171. *E. uliginosa*				NL?	CLB		R—	*AGB*	*AGB*	NLB	
172. *E. vespertina*		RLB	RLS	NGB	NGB	NGB	NLB	NGB	CGB	NGB	NLB
173. *E. villosa*				NLB	*AGB*			CLB	*AGB*	NLB	RL?
174. *E.* (*Gonempeda*) sp.*										R—	R—
175. *E.* (*M.*) *caloptera*	CGS	CGS	CGS	*AGB*	CGB	CGB	NLB	CGB	*AGB*	CGB	CLB
176. *E.* (*M.*) *knabi*											CVB
177. *E.* (*M.*) *needhami*								CLB	*AGB*	CLB	NLB
178. *E.* (*M.*) *parva*	NLS	N–?	N–?	NGB	NGB	*CGB*	N—	NGB	NGB	*CGB*	CLB
179. *E.* (*H.*) *armata*										NVB	(*CLB*)
180. *E.* (*I.*) *armillaris*										RL?	RL?
181. *E.* (*I.*) *graphica*	CVB		*CLB*								(RVB)
182. *E.* (*I.*) *venusta*			CLB	NLB		*CLB*				*CLB*	(NLB)
183. *O. bilineata**											RL?
184. *O. deviata*	C–S	CGB	CGB	*AGB*	NGB	*CGB*		CBG	NL?	CL?	CL?
185. *O. frisoni*						NG?				NL?	CL?
186. *O. meigenii**						R–?					
187. *O. monticola*						*AGB*				R—	
188. *O. nubila**						R—				R—	R—
189. *O. pygmaea*						NL?					
190. *O. rubella*								CL?	NL?		
191. *D. niphadias*						*AGB*				CVB	NVB
192. *M. forcipulus*		*CVB*	CLB	*CGB*				NLB			
193. *M. fultonensis*										*AVB*	
194. *M. hirtipennis* ?		NL?			NL?			CL?	*CL?*	CL?	
195. *M. huron*				CLB	NLB	*AGB*					
196. *M. pubipennis*		NL?	NL?	NL?	NL?	CL?			NL?	NL?	
197. *T. magna*				NL?	NL?				NV?	NV?	
198. *T. muliebris*					NL?			NL?	CG?	*AG?*	

streams. As far as is known in the larval stage these species utilize the consistently moist soil of the banks and margins. Such species are indicated by parentheses ( ) in column XI of Table II.

Some Apparently Local Peculiarities of Habitat Distribution

Although the habitat distribution shown by the crane flies of the George Reserve is in general agreement with habitat records for the same species from other regions, there are not a few apparent discrepancies. Some of these are probably caused by the differences in terminology, particularly in the definition of such terms as swamp, marsh, and bog; and some may be accounted for by generalizations that have been based upon too few data or upon chance capture of specimens when the crane flies are spreading widely into adjacent habitats. In the main, however, I believe that most of the apparent discrepancies are caused by local peculiarities or juxtapositions in many of the habitats of a specific region.

Perhaps the most surprising discrepancy of habitat distribution on the Reserve is that a number of supposedly sphagnum-bog species were here far more typical of the circumneutral or slightly basic marshes than they were of the very acid sphagnum-Cassandra bogs. In the case of *Tipula dickinsoni, Limnophila fasciolata, L. poetica, Erioptera uliginosa, E. villosa,* and a few other species, Reserve records show that supposedly bog-inhabiting species were absent or but very poorly represented in the bogs and were widespread and common to very abundant in the marshes. Perhaps the bogs are here too acid, as they have a pH more or less uniformly between 4 and 4.5, for two of the above species, *Limnophila poetica* and *Erioptera villosa,* were frequent and common in the moderately acid tamaracks and birch-maple-elm where there was a large quantity of sphagnum. Other typical sphagnum-bog species, *Limnophila laricicola* and *L. adusta,* however, were practically confined to the bogs of the Reserve; and *Limonia rostrifera* and other species were found typically, if not chiefly, in this habitat.

Several of the most typical, abundant, and conspicuous adults of the local oak-hickory woods are dependent on the almost invariable proximity of marshes and swamps to the oak-hickory woods of this region for their immature-stage existence, and in other regions are nearly or wholly absent from oak-hickory woods or their equivalent. Again, the rather common occurrence of *Bittacomorpha clavipes* along the cold, shaded rills of Kalmbach's woods, and the total absence of the regional and much more typical *Bittacomorphella jonesi* is noteworthy, and the comparative abundance of such supposedly rare species as *Phalacrocera neoxena, Triogma exculpatata, Limnophila subtenuicornis, Limonia whartoni, Helius mainensis,* and *Pilaria osborni* is in marked contrast to the relatively or actually rare occurrence of

such species as *Limonia liberta* and *Limnophila macrocera,* which are clearly regional and which previous experience led me to expect in huge numbers in the seepage marshes of this region.

Three years of intensive collecting and much additional reconnaissance collecting in this region have failed to discover a number of species that are well represented from other collecting stations within a radius of thirty-five miles of the Reserve (Owosso, Corunna, and the Shiawassee River in Shiawassee County, on the north; near Milford, and other localities, in Oakland County, on the east; numerous localities about Ann Arbor and along the Huron River, Washtenaw County, and about Adrian, Devil's Lake, and the River Raisin in Lenawee County, on the south; and the collections of Dr. Sabrosky in the vicinity of East Lansing, in Ingham County, on the west).

Among the species that form a fairly conspicuous element in the fauna of two or more of these surrounding areas but are absent from the Reserve are several that are associated with larger, or more gravelly, streams and are probably excluded from the present region by the prolonged flood stages to which Hell and Lower Honey creeks are subjected; among these are *Tipula concava, Cryptolabis paradoxa,* and *Hexatoma longicornis.* Another apparently absent group of species is essentially a sand-bank or sand-bar fauna, which also is probably excluded by the generally muddy or silty character of the larger local streams and by the long flood periods of such streams—*Erioptera* (*L.*) *indianesis, Gonomyia cognatella, G. sacandaga,* and probably *G. novaboracensis, G. alexanderi,* and *G. mathesoni.*

Another group, well represented in the various cold, shaded, boggy ravines of the south slopes of the Huron River Valley near Ann Arbor, appeared to be entirely absent from the only similar habitat in the vicinity of the Reserve, the markedly isolated, cold, boggy, hillside woods and shaded rills of Kalmbach's woods—*Bittacomorphella jonesi, Tipula oropezoides, T. collaris,* and *T. nobilis, Limonia parietina, L.* (*D.*) *spinifer, Dicranota* (*R.*) *forceps, D.* (*R.*) *tenuipes, Adelphomyia minuta,* and *Ormosia innocens* (though the absence of this last species may have been caused by my missing its early and late flight periods).

The absence of any representative of *Tanyptera* or *Ctenophora* may be traced, perhaps, to the scarcity of well-developed mesic hardwoods (both of these are but moderately frequent elsewhere in Michigan and may have been missed because of their early flight period), but I am at a loss to account for the absence of such usually common species as *Nephrotoma lugens, N. macrocera,* and *Limonia* (*D.*) *sphagnicola.* The almost total absence of *Antocha* (a single *Antocha* sp.? female was taken at light on the Reserve) is also not understood, for both *obtusa* and *saxicola* are common about small brooks and creeks, not unlike parts of Hell, Honey, and Unadilla creeks, along the Huron River Valley.

Finally, it should be noted that the fauna of the Reserve is like that of other parts of southeastern Michigan in lacking a large number of the more southern forms that are found in southwestern Michigan. Among these are *Tipula perlongipes, Limonia (L.) rara, L. (R.) domestica, L. (R.) bryanti, Epiphragma solatrix,* and *Teucholabis complexa.*

RELATIONSHIPS OF THE CRANE-FLY FAUNA WITH THE OTHER MEMBERS OF THE BIOTA

The crane flies are usually regarded as a definitely minor group, neglected by the general collector and ignored in nearly all ecological surveys. On the Reserve, at least, their dismissal as quantitatively negligible would not be justified. The largest wild animal on the Reserve is the white-tailed deer, *Odocoileus virginianus,* and in 1936–38, the deer population was near the normal carrying power for this area, varying from one to two and one-half deer for each twenty acres, as estimated by a careful winter census. And yet conservative estimates (based upon the number of crane-fly larvae per quadrat, their average weight, and the acreage of suitable habitats within the Reserve, and checked by counts of the number of adults in unit areas) indicate that the total poundage of crane flies living on the Reserve can hardly be less, and may well be much greater, than that of the deer.

What role this huge total of crane-fly protoplasm plays in the natural economy of this area is almost wholly unknown. Actual quantitative data are almost nil, and the following is little more than speculation, based upon a long series of actual but random and sporadic observations. Breeding-cage experiments and intestinal smears from hundreds of wild larvae indicate that by far the majority of the local species, including most of those represented by tremendous numbers of individuals, are herbivorous in the broad sense of that term, feeding upon algae, mosses, liverworts, the mycelia of a huge variety of fungi, and various parts of higher plants, or upon dead tissues and detritus from these sources. The great majority of the Tipulini larvae feed upon the rootlets and underground stems of grasses and other herbage, as well as upon the leaf mold and its fungus and alga flora. A large proportion of the inhabitants of mud and semisuspended silt, including nearly all of the Eriopterini and *Pseudolimnophila,* depend largely upon the microscopic flora and detritus of this situation for food; and except for *Pilaria* and *Limnophila,* nearly all of the huge crane-fly population of the marshes feeds either upon algae, mosses, and liverworts, or upon the detritus from these and higher plants. Some half dozen genera (*Adelphomyia, Pedicia, Dicranota, Pilaria, Hexatoma,* and at least the great majority of *Limnophila*) are carnivorous, living largely upon other insect larvae, small annelids, and other like-sized aquatic of semiaquatic animals. Among these carnivorous forms, two species (*Limnophila poetica* and *Pilaria recondita*) have popula-

tions on the Reserve that are probably not much less than a million individuals each, and several other species from this group are represented by probably tens of thousands of individuals.

Numerous observations suggest that both immature-stage and adult crane flies provide a considerable or even a staple item in the diets of some of the smaller mammals, of numerous marsh and woodland birds, of the frogs and salamanders, and of many predacious arthropods. Vireos and warblers and at least two individual ovenbirds were frequently seen catching the abundant adult crane flies of the oak-hickory, or returning to their nestlings with several crane flies in their beaks at one time. Twice while watching the flight of a large *Tipula* that had flushed ahead of my net, an unidentified bird, possibly a catbird, darted down from an overhead perch to snap the crane fly from the air; and on several occasions I have seen one of the sparrows capture a slowly flying *Pedicia inconstans* above one of the marsh rill courses. Both woodcock and grouse were repeatedly flushed from the margins of the marshes, where the larvae of *Prionocera* and *Pseudolimnophila* were abundant, and, so far as I could discover, the commonest food organism present. These same marshes are visited in the spring by large numbers of sandpipers and plover which appear to find them a profitable feeding place.

Possibly because they are the least disturbed by a human observer, most of the organisms that have been actually seen feeding upon the crane flies are the dragonflies, damsel flies, spiders, robber flies, and dolichopodids. Of these the dragonflies, large robber flies and spiders capture the largest Tipulas as well as the smaller Limonini; damsel flies, smaller robber flies, and *Bittacus* apparently confine their attacks to medium- and small-sized species, with *Pseudolimnophila noveboracensis* near the upper size limit for damsel flies and *Bittacus*. A few instances of ants feeding upon pupae and emerging adults were noted on the Reserve, but the toll taken by ants appeared to be markedly less than it is farther south—in Florida, Tennessee, or even southern Indiana.

In the oak-hickory and in much of the flood-plain woods, where crane-fly larvae are an important element of the macroscopic soil fauna, they appear to perform a role very like that of earthworms in the grasslands. They aid in converting the leafmold into humus, not only by ingesting large quantities of dead leaves and distributing a huge aggregate of excreta, but because their burrowing helps to aerate sodden leaf mats and to distribute the spores of leafmold fungi. Similarly, the very large population of *Epiphragma fascipennis* probably makes this species of considerable importance in returning sodden limbs and twigs to the soil, both by reason of the relatively large amounts of solid material ingested by the larvae and because of the aeration of the waterlogged wood by their burrows.

The effect of the huge population of alga- and moss-devouring larvae on the natural economy of the marshes is probably equally great. The volume and weight of plant protoplasm and detritus that is turned into frass and fine organic debris is certainly large; and, judging from a few random microscopic examinations, the feeding habits of these larvae may well affect the taxonomic make-up and even the succession of the alga and moss flora. Almost invariably the minute trails made by the feeding larvae along the strands of filamentous green algae or over the leafy stems of the mosses are marked by invasions of blue-green algae, and there is a marked increase in the number of diatoms wherever the brownish sludge of decomposing frass is well developed.

The apparently low incidence of insect parasitization in the crane flies may be largely due to lack of data, but I found only four instances of parasitization in the thousands of crane flies from the Reserve that were examined as larvae, pupae, or adults. In each instance—that of one pupa and those of three adults—the crane flies were female Tipulines (one each of *T. megaura* and *T. flavoumbrosa,* and two *Nephrotoma ferruginea*), and the parasite was a six-millimeter-long larva of some tachinid fly. These larvae were placed in vials with moist friable soil and leafmold, but all of them failed to complete their development. External parasites in the form of small red mites were rather common, and an occasional *Pseudolimnophila* or *Gonomyia subcinerea* had such a heavy infestation as to appear red or reddish. Such individuals were definitely shriveled or shrunken, and I believe it doubtful that they could carry on normal reproduction. I have several times watched the emergence of *Pseudolimnophila luteipennis* and *Tipula tricolor,* when the protruding but unopened pupal case had several mites upon it; and these attached themselves to the soft tissues of the adult as the latter emerged from the pupal skin.

ANNOTATED LIST

PTYCHOPTERIDAE

1. *Bittacomorpha clavipes* (Fabricius)

1936–38; continuously on the wing from May 10 to September 30. Population peaks are in May, late June to early July, and mid-August; there are usually three, sometimes two, generations a year in this region, depending upon the habitat.

Common to abundant about permanent seepage areas and silty rills, whether deeply shaded or with open-marsh vegetation. Occasional but less characteristic in the vicinity of stagnant but permanent swamp and marsh pools. Active throughout the day in partly or wholly shaded situations; apparently inactive from late dusk to dawn, hanging from stems and leaf margins within the tall herb and shrub stratum of habitat.

Larvae common in inch-deep pools and in margins of small braided rills, where semisuspended particles of detritus accumulate; not found, although probably present, in shallow pools of stagnant swamp, marsh, and cattails.

2. *Ptychoptera rufocincta* O. S.

1936–38; May 18—September 3. Never abundant, rarely common, but recorded for every week between the dates given.

Almost wholly confined to the vicinity of seepage areas, spring rills, and silty brooks of relatively open, marshy situations. A single record from a deeply shaded situation. Apparently wholly diurnal.

Larvae from silty, slightly submerged, cress-grown bars and banks of a moderately basic, spring-fed brook. (I have taken larvae of this species in Florida from a sphagnum-choked pool that had a pH of 4.0.)

ANISOPIDAE

3. *Anisopus marginatus* (Say)

1937; May 15 and 20. Nine specimens swept from the still unleafed twigs of trees at the edge of a brook and at the edge of a marsh.

TRICHOCERIDAE

4. *Trichocera fernaldi* Alexander

1937–38; October 25–31. Three separate collections taken from the Reserve by Messrs. Camburn and Cantrall.

5. *Trichocera saltator* (Harris)

1936–38; October 7–28. Taken in numbers from the Reserve and its vicinity by Messrs. Camburn and Cantrall.

TIPULIDAE

TIPULINAE

6. *Dolichopeza* (*O.*) *dorsalis* (Johnson)

1936–38; June 4—July 14 and August 11–30. Two well-marked and distinct generations each summer.

Common in shrub and shrub-sedge marshes and near the shrub-bordered margins of the sedge-fern-grass marshes. Numerous but local or very local in a variety of other shaded wet situations: tamarack-sumac swamps, birch-maple swamps, and shaded seepage areas.

The larvae live in damp or wet mosses that partially cover the marsh hummocks; probably also in liverworts and algae in this same situation.

7. *Dolichopeza* (*O.*) *obscura* (Johnson)

1936–38; June 11—July 9 and August 11–13, with a single record for July 31. Two well-marked generations each summer.

Numerous to occasionally common in the most densely shaded birch-maple-elm and tamarack-sumac swamps. Numerous but very local in oak-hickory woods, where they were occasionally taken from the dark interior of a hollow stump or log. This species is strikingly negatively phototrophic and also often occurs in large aggregations, usually with the members in slight physical contact with one another. Migrations from the hollow logs of the oak-hickory take place after dark, and apparently the flights back to the hollow logs take place before daylight. Several hollow logs in the oak-hickory were inhabited each day for a week or more at a time, but were usually empty when examined between 9 : 30 and 11 : 30 P.M.

The larvae live in rather dry luxuriant mats of mosses, on dead logs, and on root-bound elevations of low woods and swamps.

8. *Dolichopeza* (*O.*) *sayi* (Johnson)

1936–38; May 1—July 7 and July 28—September 3. Two well-defined generations each year.

The most abundant member of its genus; common to abundant in the grass-fern-sedge and shrub-sedge marshes and but slightly less common in the birch-maple-elm swamp and the lower flood-plain woods. Numerous in the tamarack-sumac, in the leatherleaf bogs, and in seepage areas. Probably the least negatively phototrophic species of the genus; but rarely ventures above the tall herbage in its marsh habitat. Easily flushed and often spontaneously on the wing in the daytime in well-shaded swamps.

Larvae were taken from very wet carpet films of mosses on the saturated floor of a marsh.

9. *Dolichopeza* (*O.*) *similis* (Johnson)

1936–38; June 14–22. Only about twenty specimens taken in the three years. I believe, on the basis of 1931 collections about Ann Arbor, that the Livingston County records represent the latter part of a late-May and early-June flight period. An August generation was sought without success.

All twenty specimens, comprising six separate records, are from the deeply shaded birch-maple-elm swamp or from its margin with a tamarack-sumac swamp.

10. *Dolichopeza* (*O.*) *subalbipes* (Johnson)

1936–38; June 11—July 14 and August 14–28. Two well-defined generations each year.

Nearly all specimens were from the birch-maple-elm or tamarack-sumac swamps, where the species was common to abundant in June but rare in August. Two records for the flood-plain woods and one for the oak-hickory, where a single specimen was taken from a hollow log in company with some twenty or thirty specimens of *D. obscura.*

11. *Dolichopeza* (*O.*) *walleyi* (Alexander)

1936–38; May 28—July 9, with a few records for mid-August in 1938. I also have a mid-August record for Washtenaw County, Michigan (1931), but I believe that generally there is only a single generation a year in this region.

Numerous or occasionally common in the lower flood-plain woods, birch-maple-elm and tamarack-sumac swamps, and along shaded stream banks; not taken in the marshes where the closely allied *D. sayi* is common, although the habitats of the two species overlap to some extent in the swamps.

Larvae were not found in Michigan, but in Florida they have been taken from a luxuriant coat of wet mosses growing on sodden wood on the saturated soil of a shaded seepage area.

12. *Dolichopeza* (*O.*) sp. (near *subalbipes* Johns.)

1936–38; June 11–21, July 16–26 and August 15–22. This species is very like *subalbipes* from which it differs in the details of the male genitalia. It also appears to have a somewhat different habitat correlation. It was taken in small numbers, or as single individuals, from the grass-sedge-fern marshes, sphagnum-Cassandra bogs, and sphagnum-grown areas in the sumac-tamarack swamps. Never taken with *subalbipes* and absent from the fern-grown birch-maple-elm swamp, where *subalbipes* was most frequent.

13. *Prionocera fuscipennis* (Loew)

1936–39; April 15—September 30. There is some indication of three

peaks in the population of this abundant species, but only in early August was there a perceptible valley in the population graphs.

Abundant in all permanent marshes in May and June, and in dense seepage-area marshes throughout all of the summer except early August. Common to numerous in the permanent nonseepage marshes in July and in late August. Somewhat more common and generally distributed in and about the margins of cattail marshes than in sedge-shrub or grass-sedge-fern marshes. Only an occasional specimen from swamp or deeply shaded seepage areas.

Larvae in the sodden, partially or wholly submerged plant detritus of the marshes and seepage areas; especially characteristic of the stem-frond-leaf-filled "channels" of hummock marshes and the similar vegetation-choked pools in braided rills of the seepage marshes. In mid-May the channels of Fishhook marsh, a typical grass-sedge-fern formation, yielded twelve to fifteen larvae per square meter of channel surface.

14. *Nephrotoma breviorcornis* (Doane)

1936–38; June 12–27 and July 21—August 26. Two clear-cut generations a year.

Nearly all records are for open or partially shaded grassy stream banks and their vicinities. A few specimens from a partly cleared flood-plain woods, where the herbage was nettles rather than grasses.

The immature stages are unknown, but a female was observed ovipositing into wet soil at the edge of a grass clump, some six inches from the margin of a brook. This took place about three hours before sunset in a partially shaded situation.

15. *Nephrotoma eucera* (Loew)

1936–38; June 8–30. One generation a year.

Numerous, in one instance common, in a low flood-plain woods; a few specimens from a low wooded hillside above a hardwood swamp. Usually associated with such tall luxuriant herbage as wood nettles, richweed, and touch-me-not.

The immature stages are unknown, but are almost certainly spent in wet to damp rich soil.

16. *Nephrotoma euceroides* Alexander

1936, 1938; June 13–27. Numerous in the same situations as *eucera* and twice taken from the same situation at the same time. I could not detect any habitat differences and could not separate the two species with certainty, except with a fairly high-powered lens. There are good genitalial differences between the males of *eucera* and *euceroides;* much more constant and

reliable than those shown by the somewhat variable antennal segments. Nevertheless, it is not impossible that *euceroides* is merely a genetic variant of *eucera*.

17. *Nephrotoma ferruginea* (Fabricius)

1936–39; May 22—July 8, and August 8—September 3. Two distinct generations a year.

Numerous to common, but rarely abundant on the Reserve. Abundant in near-by alfalfa fields and in a well-watered bluegrass lawn. I believe that this species attains its greatest abundance in cultivated crops and pastures. On the Reserve it was taken in some numbers from about the marshes and, less frequently, from wet wooded situations. It was rare to absent in the old uncultivated fields, except for one area about a spring, but was rather common in the vicinity of streams. Apparently spreads widely from immature stage habitat.

The larvae live in moist friable soils and are often exceedingly abundant in cultivated areas.

18. *Nephrotoma gracilicornis* (Loew)

1936–38; July 6—August 18. A single generation a year.

Common to abundant along nonmarshy banks of brooks and creeks, and in the lower parts of flood-plain and lake-margin woods. Taken in greatest numbers each year from a partially cleared flood-plain woods, where there was a luxuriant growth of flood-plain herbage. Rare in deeply shaded situations.

Immature stages unknown, but probably in wet to moist soil.

19. *Nephrotoma incurva* (Loew)

1936–38; June 2—July 14. Apparently a single generation a year. No signs could be found of a second, August, generation, such as is well marked in southern Indiana and in the Carolinas.

Rare to numerous along streams and in flood-plain woods. A few individuals from the shrub-sedge marshes and their bordering thickets and swamp margins.

20. *Nephrotoma polymera* (Loew)

1936–37; June 14–29. A single generation a year.

Apparently very local and with an unusually short flight period. On one occasion abundant in a marshy meadow along Honey Creek; on two occasions common in low flood-plain forests; a few single records for lake-margin woods and slopes.

Immature stages unknown.

21. *Nephrotoma punctum* (Loew)

1936–38; May 30—July 30. Probably a single generation a year, the long season correlated with local differences in habitats.

Locally abundant in the margins of grass-sedge-fern marshes, from which it spreads into the grassy slopes above. Twice, on the occasion of emergence in large numbers, teneral and partially hardened adults were common among the cinquefoil and spiraea bushes at the edge of Fishhook marsh, with fully hardened adults common to abundant on the grassy briar-grown slope above. None was ever taken from well within a marsh. The shrubby margins or the slopes above nearly all grass-sedge-fern and shrub-sedge marshes yielded at least a few specimens, and an occasional individual was swept from the herbage of open woods, hundreds of yards from the nearest marsh.

22. *Nephrotoma sodalis* (Loew)

1936–38; May 27—June 23, and August 8—September 3, with a single, rather frayed female recorded for July 11. Two clear-cut generations a year.

Rare on the Reserve, where it was occasionally taken in June from the borders of a marsh and the "flood-plain" woods of the southwest swamp; common in June, and abundant in August, along grassy banks and shore lines of brooks and creeks. Characteristic of open or partly cleared situations; less characteristic of wooded flood plains or situations grown with tall rank herbage. The males sought for emerging females within a few feet of the brook margins.

23. *Nephrotoma tenuis* (Loew)

1936–38; June 4—July 8, and July 28—August 26. Two generations a year.

Rare but rather generally distributed about the borders of marshes and in the more open margins of swamps. No records for deeply shaded situations and very few for completely unshaded marshes or grasslands.

24. *Nephrotoma virescens* (Loew)

1936–38; June 14—July 9.

Rare; not more than a dozen specimens altogether. They were from the vicinity of streams and the wooded margins of the southwest swamp.

25. *Tipula abdominalis* (Say)

1936–38; August 23—September 10.

Not taken from the Reserve, but a total of six adult specimens were taken from three brooks and rills within a few miles of the Reserve boundaries.

All from sand-bottom or small pools and riffles. Not taken from the extensively collected, silt-bottomed Honey Creek.

The conspicuous larvae were taken in early and middle June from leaf drift of two small, sandy brooks. They apparently leave the stream for pupation in late June or early July, although emergence does not occur until six or eight weeks later. Several rearing-cage records have shown both the prepupal and pupal stages to be unusually long for a crane fly (at least two or three weeks each).

26. *Tipula angulata* Loew

1936, 1938–39; June 2–16.

A total of some twenty specimens from the low, wet, willow-ash-elm-maple (flood-plain) woods of the southwest swamp and from a low shrub-aspen thicket at the juncture of the oak-hickory woods and a shrub-sedge marsh.

A pupal skin of what seems to be this species was taken from a wet aspen log in the low aspen-shrub thicket.

27. *Tipula bicornis* Forbes

1936–38; June 9–20.

Not common. Nearly all of the score or more specimens were taken from grasslands or open woods near the margins of the marshes or near, but not in, open seepage areas.

The well-known larvae are frequently abundant or even pests in meadows and fertile grasslands. Apparently, there is little suitable soil for their habitat in the Reserve, most of it being either too well drained or else saturated or inundated in the spring and early summer.

28. *Tipula borealis* Walker

1936–38; July 2—September 4. One of the most conspicuous and stable members of the late summer fauna.

Abundant in low flood-plain woods, especially in the willow-ash-elm zone of the southwest swamp. Numerous to common in most other partly or well-shaded, permanently moist to wet situations.

The larvae were not taken, but almost undoubtedly live in saturated soil that has a considerable mixture of organic material.

29. *Tipula caloptera* Loew

1936–38; June 10—July 2, and August—September 4.

Probably two generations a year in the majority of instances, but except in early June, no well-marked peak of abundance.

Common to abundant along all of the creeks and brooks with sandy or gravelly bottoms or reaches. Distinctly a stream species, but never taken along the exclusively silt-bottomed brooks.

The larvae were taken in large numbers from the dense algal mats of the spillways of the dams in two creeks and in lesser numbers from well-submerged algal sheaths on hard clay or packed sand areas on the bottoms and submerged sides of streams. A few pupal skins were taken from just above the water line on near-by sloping or vertical clay banks. The single record from within the Reserve was a half-grown larva from an algae-moss mat in the short gravelly rill of a hillside spring.

30. *Tipula cayuga* Alexander

1938; June 12.

Although only a single specimen was taken in all of the three summers on the Reserve, this species is rather common along the permanent, wooded, ravine rills about Ann Arbor and along the Huron River a few miles east of the Reserve. In these situations *cayuga* and *tephrocephala* are equally common throughout most of June. On the Reserve, although *tephrocephala* is able to maintain itself in fair numbers, *cayuga* is extremely rare. I think it likely that the Reserve is habitable for *cayuga* in wet seasons or sequences of wet seasons, but that it cannot survive during dry years so well as does *tephrocephala.*

31. *Tipula cunctans* Say

1937–38; September 24—October 7. A single generation a year with a markedly autumnal flight period.

All of my records are due to the collecting of Dr. Blair and Dr. Cantrall, who swept this species from the margins of the marshes, and from the Cassandra bog of Buck Hollow and took several females at light.

I have taken the larvae and pupae in huge numbers from acid water-logged meadows in the "flats" of southern Indiana and from the muddy, but no longer submerged, waterways between hummocks in a sedge marsh in Lenawee County, Michigan.

32. *Tipula dejecta* Walker

1931, 1937; May 2–31. Extremely abundant May 10 to 20, 1937.

Abundant in and about the borders of all grass-sedge marshes and especially in the marshy seepage areas. Common along the grassy margins of brooks.

Larvae (Alexander 1920) have been taken from the black muck of an alder swamp.

33. *Tipula dickinsoni* Alexander

1937; May 17, 19, and 20, but on the last date a large hatch was just beginning to emerge on the Reserve. Probably on the wing until the first week of June.

All from grass-sedge or grass-sedge-cattail marshes. An occasional specimen was taken from the marshes of the low, cold, seepage valley slopes of Honey Creek on May 17 and 19; and nearly a hundred males and females, a number teneral, were taken from the margins of a grass-sedge-fern marsh on the Reserve on May 20. All of the pH samples from this marsh were slightly to definitely basic, although Dickinson collected the types of this species from a tamarack bog.

34. *Tipula disjuncta* Walker

1936–39; May 10—June 15, with a definite peak in about the middle of this period. A single, clear-cut generation each year.

Abundant in all of the oak-hickory woods and almost wholly confined to such woods. This is probably the most distinctive and characteristic species of the oak-hickory woods of the north central states, becoming much less common with the invasion of beech and maple, and rare or absent in well-developed beech-maple woods. General collections, made by sweeping, are apt to include a considerable preponderance of the more active males, which flush readily ahead of the collector. A slower and more careful scrutiny of the forest floor and the low vernal herbage shows that the dimorphic, dark, rather short-winged females are fully as numerous. The latter are capable of fairly good flight for at least short distances, but are more apt to run or flutter along the surface of the ground than to fly up above the low shrub stratum. The males come rather freely to light.

The larvae were taken in May in the damp but friable sandy loam, just beneath the coarser leaf mold. They appeared to be most numerous about the rootlets of small clumps of sedges and grasses, but some were taken at a distance of several feet from any herbage. Pupation appears to occur usually at the surface of the more compacted leaf mold and loam, often beneath the surface layer of loose leaves, so that the adult has to scramble through the loose surface leaves to reach full daylight. Empty pupal skins are most readily found by raking away the drier upper leaves of the forest floor.

The soil from two half-meter areas was sifted for immatures on May 12; one yielded one larva and open pupa; the other, three larvae.

35. *Tipula dorsimacula* Walker

1931, 1936–37, 1939; April 22—May 20. A single generation a year.

Rare, at least during the seasons in which I collected. About a dozen specimens from the vicinity of grassy hillside, vernal seepage areas, and from an open grassy area bordering the southwest swamp.

The larvae live in moist, friable soils of open woods and grasslands.

36. *Tipula duplex* Walker

1936–38; July 11—September 4. Apparently a single generation a year. The comparatively long adult season is probably caused by the varied range of forest soils inhabited by the immature stages.

Common to abundant in the oak-hickory and flood-plain woods; numerous in the thickets of the wood-marsh margins; occasional records from the bogs and swamps. The adults appear to range rather widely and to spend much of the daytime in the leaf clusters of the higher shrubbery and lower tree strata. Both males and females came to light in numbers, occasionally in copulation.

The larvae have been taken in Florida and in Indiana beneath and in the leaf mold of the forest floor.

37. *Tipula eluta* Loew

1936–38; May 30—June 22, July 28—September 10, and a single record for July 7, 1936. Apparently two generations a year.

Numerous to common in open grassy or marshy situations such as along brooks and creeks, about seepage areas, and in the grass-sedge-fern and shrub-sedge marshes.

I am not at all certain that *eluta* is distinct from *T. furca* Walker, and I cannot separate the larvae of the two species. It is possible that some of the larvae referred to *furca* pertain to this species. If *eluta* is distinct, there is no reason to suspect that its immature stage habitat differs markedly from that of *furca,* or to doubt that it is semiaquatic and may be associated with either lotic or semistagnant conditions.

38. *Tipula flavoumbrosa* Alexander

1936–38; June 13—July 4. A single generation a year with a clear-cut adult season in June.

Abundant in the lower parts of the oak-hickory woods and in the drier and more open parts of the flood-plain woods. The adults are conspicuous as they flush well ahead of the net from their resting places on the forest floor or the low shrubbery and fly for perhaps 15 to 30 yards, usually to alight on the upper leaves of the tallest shrubs or among the lower boughs of the forest trees.

Very teneral adults were frequently taken from the wet but hardly sodden soil of the ecotone between the southwest oak-hickory and the southwest swamp, and from the dogwood-aspen zone between the oak-hickory woods and the shrub-sedge marsh; and large larvae and a pupa of this (*triplex*) group, almost surely this species, were found beneath the wet, partially compacted layer of wet leaves in a low damp part of the oak-hickory. One rich collecting spot was a large patch of May apples (*Podophyllum peltatum*)

near the swamp margin of the southwest oak-hickory, where in all three Junes a number of males were found buzzing over the ground, apparently in search of emerging females.

39. *Tipula* sp. *triplex* group near *flavoumbrosa*

1936–38; June 13—July 2. One clear-cut generation a year.

Common to numerous in the flood-plain woods and the more mesic parts of the oak-hickory; occasional to numerous in swamps and marshes and along stream banks. Habitat distribution very like that of *flavoumbrosa,* but is characteristic of wetter situations and ranges more freely into the unshaded marshes.

I am uncertain as to the specific status of this form and, pending the further accumulation of material for the revision of the *triplex* group, prefer to leave it unnamed. It differs from *flavoumbrosa* in several distinct and constant details of the male genitalia, is slightly larger in size with longer but narrower wings, and has an even brighter orange-yellow, unmarked thoracic notum. In spite of these differences the close similarity of its habitat and range to those of *flavoumbrosa* indicate the possibility that it may be merely a genetic variant of that species. This crane fly is common throughout the southern half of Michigan and westward to Iowa and the Ozarks of southwestern Missouri.

40. *Tipula fraterna* Loew

1936–37; June 14–23. Apparently but a single generation a year in Michigan.

Not taken on the Reserve; but on several occasions this species was numerous along two different reaches of Honey Creek, and it was taken on several occasions along Hell Creek.

The larvae of what appears to be the same species have been taken from submerged patches of filamentous algae in sand-bottom brooks in northern Florida.

41. *Tipula fuliginosa* (Say)

1936–39; June 8—July 13, with a definite peak in the middle of June and only an occasional female after the first week in July.

Abundant in all of the oak-hickory woods, and common to numerous in the drier parts of the flood-plain woods. The females may be observed in late afternoon, and earlier on cloudy days, walking about over the forest floor in search of oviposition sites. Several times when the female's progress was blocked by a log or brush pile, she began to oviposit near its edge; in one instance she backed down through the accumulated loose leaves until she was out of sight to oviposit into the more compact layer of mold beneath.

Larvae were taken from three different areas of oak-hickory in May and early June. They were found in the lower leaf mold and upper soil of the forest floor and appear to be most numerous in areas that have the heaviest development of leaf mold.

The habitat distribution of this species on the Reserve is very like that of *T. disjuncta,* which has nearly disappeared by the time that *fuliginosa* is well on the wing. Unlike *disjuncta,* however, *fuliginosa* appears to be almost equally characteristic of the beech-maple woods of more mesic regions. The habits of the two species are rather similar except that both the males and females of *fuliginosa* are much more arboreal than are those of *disjuncta.* The fact that *fuliginosa* is more crepuscular than *disjuncta* in the oak-hickory woods may be the result of a higher evaporation rate in June than in May.

42. *Tipula furca* Walker

1936–38; May 12—June 16, and August 1—September 4. Apparently two rather clear-cut generations a year.

Common to abundant along brook and creek courses and about the open to moderately shaded seepage areas; numerous to common in the margins of the grass-sedge-fern and shrub-sedge marshes, but less numerous well within such marshes. A few records from the flood-plain woods.

Larvae are semiaquatic; found beneath the surface of the water, or in semisuspended silt and detritus, in shallow pools and margins; usually, with the spiracular disk in contact with the surface.

43. *Tipula georgiana* Alexander

1939; June 8. Three males swept by Blair from the rather open woods of a hillside which faces northwest. This rather surprising record for Michigan is not unique; I also have males of this species from Midland County, taken by R. R. Dreisbach on May 29 and 30, 1935.

I have taken the larvae and pupae of this species from the rather dry, sandy clay soil of an open oak-hickory woods in the upper piedmont of South Carolina.

44. *Tipula grata* Loew

1936–38; June 11—July 22, with a definite maximum in the last third of June.

Apparently not common, but occasionally recorded as numerous in the flood-plain woods of Hell Creek. On the Reserve it was numerous in 1936 in the wooded margin of the southwest swamp, but it was very rare in 1937 and 1938.

45. *Tipula hermannia* Alexander

1936–38; June 8—July 2, and July 31—August 19. Two generations a year, the adults of the first generation are very rare after June 20.

Common only in the deeply shaded, cold, boggy woods at Kalmbach's gravel pit, but an occasional specimen was found at the lower margins of the oak-hickory and in the flood-plain woods of the southwest swamp.

46. *Tipula hirsuta* Doane

1936–39; June 4–22. A single generation a year with a rather short clear-cut adult season. Rare in 1936–37; locally common in 1938.

Numerous to common in the more mesic parts of the oak-hickory. Even there it had a markedly spotted distribution, with two five-acre (or smaller) areas in much larger extents of woods (southwest oak-hickory and northwest oak-hickory) producing more than half of the sixty-odd specimens that were taken.

Except for this spottiness of distribution, the habits and habitats of this species are precisely like those of the very similar, and much more abundant, *T. valida.*[10]

47. *Tipula illinoiensis* Alexander

1936, 1939; May 20—June 16. A single generation a year.

The majority of my records for this form is based on the collections made by Blair, Camburn, and Cantrall in the last third of May and the first third of June. Nearly all of their specimens were taken by sweeping in the lower, more mesic woods.

48. *Tipula kennicotti* Alexander

1936–39; May 13—August 18, with indefinite peaks in mid-May, mid-June, and early August. Probably two generations a year without very definite seasonal correlations.

A typical marsh species, numerous or common in all of the grass-sedge-fern marshes, less numerous in the shrub-sedge, and more numerous in seepage marshes.

More crepuscular than *T. sulphurea* which occupies much the same range of habitats and is much more difficult to flush or sweep from the dense, tall marsh vegetation. In late twilight collecting, however, *kennicotti* is almost, or quite, as numerous as *sulphurea.*

49. *Tipula latipennis* Loew

1936–39; June 10—August 5, but rare after mid-July and with a definite maximum from mid-June through the first week of July.

[10] The not infrequent existence in the Tipulidae of two closely similar species that have identical or very similar geographic ranges and habitats merits further scrutiny. *T. hirsuta* and *T. valida, T. eluta* and *T. furca,* and several members of the *T. triplex* group are cases in point. The amassing of large series from all parts of the ranges and breeding experiments are needed. One can hardly doubt the distinctness of *valida* and *hirsuta,* and yet I do not believe that the possibility of genetic dimorphism within one species is to be absolutely dismissed.

One of the most abundant species of *Tipula* on the Reserve; in nearly all shaded wet situations and at times of maximum abundance it tends to spread for considerable distances into the oak-hickory. Most characteristic of low flood-plain woods, but common in the margins of the birch-maple and sumac-tamarack swamps and the shrub thickets at the margins of the marshes.

Larvae and pupae were taken from the almost saturated, black organic soil of an aspen-dogwood-maple thicket bordering the southwest swamp. This is one of the species that were extremely abundant in 1936, comparatively rare in 1937, and again abundant in 1938.

50. *Tipula longiventris* Loew

1936–39; May 22—June 15, the latest male, June 11.

My own collecting yielded two males and a dozen females, but the late May and early June, 1939, collections by Blair and Cantrall show that this species is abundant to common during the first ten days of June. Nearly all of their specimens were swept or flushed from the oak-hickory woods, and most of the collections from the various areas of oak-hickory yielded this species in early June. My own records, June 10 to 15, were largely from the lower, more mesic margins of the oak-hickory.

A female was disturbed while ovipositing into relatively damp leaf mold and soil near the lower edge of an oak-hickory slope. She had some difficulty in withdrawing her ovipositor, or perhaps terminal abdominal segments from the soil, ceased wing movements briefly after the initial fluttering, and then flew high into the branches of one of the larger trees. Apparently, the withdrawing of her ovipositor required the push of her legs against the ground and took considerable effort, but the whole performance was too brief to permit me to be sure of any details. I found the soil puncture made by her ovipositor but could not find an egg.

51. *Tipula megaura* Doane

1936–38; June 14—July 11. A single generation a year; the early midsummer adult season clear-cut.

This is the commonest member of the *bicornis* group on the Reserve. Locally abundant at the margins of the shrub-sedge marshes and common in 1936 about the recently exposed margins of a spring pond in the open grassland. Here numerous individuals emerged from sod that had been inundated ten days earlier. (In 1937 and 1938 this spring pond did not recede until early August and no *megaura* were taken there.) Locally numerous about the margins of seepage areas, rills, and grassy streams. *T. megaura* flies rather widely, and males and females are frequently swept from herbage and low shrubs well into the oak-hickory and the more open tamaracks.

Larvae and pupae were secured in definitely wet to sodden soil, a much wetter habitat than any from which I have taken *bicornis*.

52. *Tipula monticola* Alexander

1937–39; June 5–15. Rare; only seven records in four years. Possibly less rare in the ten-day period in late May and early June when collecting was, unfortunately, at a minimum. All from the oak-hickory woods.

53. *Tipula parshleyi* Alexander

1936–38; May 30—June 21. One generation a year. The adult season well defined.

Common to numerous in the lower oak-hickory and the more open floodplain woods. Occasionally spreading into the birch-maple-elm swamp from the adjoining oak-hickory.

54. *Tipula sayi* Alexander

1936–38; August 19—September 8. A single generation a year with a clear-cut late summer adult season.

Common and rather generally distributed about the margins of marshes. Rare within well-inundated areas and commoner about shrub-sedge marshes than about grass-sedge-fern.

The immature stages are spent in the soil of these areas; the pupae were from rather dry soil that had been wet; the larvae taken from much wetter situations. Apparently pupation and emergence is definitely correlated with the drying up of formerly inundated areas. Oviposition takes place in definitely wet or saturated soil, much wetter and softer than that in which pupae have been taken.

55. *Tipula serta* Loew

1936–38; May 16—June 15. One generation a year; the adult season clear-cut.

Common in the latter half of May and rather generally distributed in wet open areas such as the borders of marshes and especially in the vicinity of the vernal seepage spots that are frequent along the lower parts of many grassy hillsides in May.

56. *Tipula strepens* Loew

1937–39; May 20—June 16. Apparently but a single generation a year.

Very local, but common for a short season each year in the vicinity of small seepage rills where lush grasses and a carpet of mosses and algae grow.

Larvae semiaquatic in the moss and algal mats of the rills and trickles.

Adults were taken in May, 1939, from along an isolated rill course that had appeared dry in the late summer of 1938. Apparently, the larvae can survive such desiccation by aestivating in the damp soil.

57. *Tipula submaculata-mallochi* intergrades

1936–38; June 10—July 10. One generation a year.

Common to abundant in the more moist parts of the oak-hickory and in the drier flood-plain woods; occasionally numerous but rather local in the tamarack and hardwood swamps and in the ecotones between swamps and oak-hickory. Occasionally swept from herbage in unshaded situations.

Mature larvae were taken below the leaf mold of an oak-hickory and flood-plain woods ecotone. (Also taken in similar situations from mesophytic hummocks of Florida and Georgia.) The younger larvae were deeper in the forest soil.

The local specimens of this form are clearly intergrades although they range in characters from nearly pure *submaculata* to mid-intergrades or even closer to *mallochi*. It is noteworthy that the intergrading involves all characters and all combinations of characters that separate *submaculata submaculata* from *submaculata mallochi:* form of inner dististyle, shape of horns of tergite IX, the setae brushes of sternite VIII, and color of wings and thoracic notum.

I believe that the some five hundred specimens in the Museum of Zoology collections clearly indicate that *mallochi* and *submaculata* are good subspecies, but have an area of intergradation that is much wider than the range of either distinct subspecies. Nearly all from east of the Appalachians are *submaculata,* but most of the specimens from Michigan, Illinois, Indiana, Tennessee, Georgia, and Florida vary in intermediateness. Of some seventy specimens from the Reserve before me, all those taken before June 19 are closer to *mallochi* and all but one taken after June 28 are closer to *submaculata,* with a nearly fifty-fifty mixture for the last third of June.

58. *Tipula sulphurea* Doane

1936–39; May 20—August 29. Continuously on the wing throughout this period with definite peaks in June and early and mid-August. Probably two generations a year with considerable overlapping.

Abundant in all permanent marshes and restricted to such situations. More nearly diurnal than most of the marsh-inhabiting species; especially apt to be diurnal in the spring.

Larvae semiaquatic; taken from shallow semiflowing pools between hummocks. A pupa was taken from the film of algae just above the water line on the side of a hummock.

59. *Tipula tephrocephala* Loew

1936–38; May 31—June 24. A single generation a year.

Locally common to numerous about rills and seepage in partial or distinct shade. Rare in open situations. Two males were swept from a bog. This species was common for two years in a rill course that becomes dry in late summer, but is underlain by permanently wet soil at a slight depth. No larvae were found here, in spite of considerable search, but probably they were present.

60. *Tipula translucida* Doane

1936–38; July 12—August 13. A single generation a year, with a clear-cut, midsummer adult season.

Scarce to numerous throughout all oak-hickory woods on the Reserve and spreading in somewhat lesser numbers into the hardwoods and flood-plain woods. This species is hard to net because it flushes easily and flies high into the tree stratum. Often found resting among the leaves of the taller shrubs and lower boughs of trees. Apparently more tolerant of moderately low humidity than most crane flies.

The larvae have been taken beneath humus and leaf mold of the forest floor (Indiana and Missouri).

61. *Tipula tricolor* Fabricius

1936–39; May 27—August 30. Adults continuously on the wing throughout this season with fairly well-defined peaks in June and in mid-August. Probably two somewhat overlapping generations a year.

Common and generally distributed throughout all marshes, with the largest populations in unshaded marshes associated with permanent seepage and rills. Almost equally numerous along marshy streams.

Larvae in the semisuspended silt and debris of shallow often stagnant pools. Pupae have been taken from situations so wet that the pupae could be lifted easily from the semifloating scum, and also from only moderately moist soil and detritus at the margin of a pool.

62. *Tipula triplex* Walker

1936–38; June 13—July 5. A single generation a year.

Rare to numerous, but generally distributed, in the lower parts of oak-hickory and its ecotones with marsh or swamp. Occasionally numerous in the flood-plain woods of the southwest swamp.

The twenty-seven specimens now before me are not entirely typical of *triplex* as redefined by Alexander. Typical *triplex* is abundant in northern Michigan and common in the more mesic habitats of southern Michigan. The Reserve specimens are very close to this typical form in all respects

save a somewhat lighter body color and a few small and rather variable details of the male genitalia. They may well represent intergrades with the next form.

63. *Tipula triplex* group, form C

1936–38; June 4—July 4, with a pronounced peak in the second and third weeks of June. A single generation a year, with the adult season clear-cut.

Abundant in the more mesic parts and especially in the wetter ecotones of the oak-hickory; common to abundant in the more open flood-plain woods.

This is one of the more common and conspicuous *Tipula* of mid-June. In late afternoon many males are often in sight at one time, buzzing about over the damp, rather compressed leaf mold of the lower woods in search of emerging females.

The larvae have been taken in southern Indiana in wet soil beneath leaf mold or other forest litter.

This form is distinct from *triplex* and from what I believe probably to be *umbrosa.* It is very likely that this form was before Doane when he described *inermis,* although it certainly is not the form from which Snodgrass (1904: 215–16; Pl. 13, Figs. 89–93) described and figured the genitalia of a specimen that had been labeled *inermis* by Doane. Pending a planned revision of the *triplex* group and an examination of Doane's and Loew's types, it seems best to leave this form unnamed. At present, excluding *flavoumbrosa, perlongipes,* and *triplex,* which appear to be definitely placed, I have four more or less distinct subspecies of this complex, all but one connected by intergradation.

64. *Tipula trivittata* Say

1936, 1938–39; June 2–16. A single generation a year.

Rare and local; a total of about fifteen specimens in four years; all from low flood-plain woods of the southwest swamp or thicket-grown ecotones between oak-hickory and marsh.

The larvae have been frequently taken from damp to wet decayed stumps and logs by a number of collectors. Possibly it is a coincidence, but all of my records of immature stages have been from well-rotted stumps, where the immatures were beneath partially loosened bark. No larvae or pupae were found on the Reserve, but a pupal skin, referred to this species with a query, was taken from a crevice in the bark of the dead part of a fallen but coppicing willow in a low thicket.

65. *Tipula ultima* Alexander

1936–38; September 3—October 14. A single generation a year, with a clear-cut, autumnal adult season.

Common to abundant in and about the shrub-sedge marshes; somewhat less common and rather local about other types of marshes. Spreads into adjacent grasslands and open woods in considerable numbers.

The larvae have been taken in saturated to semisuspended silt and soil at the margins of marsh pools.

66. *Tipula unifasciata* (Loew) ?

1937–38; September 23—October 7. A single generation a year.

Apparently rather rare. The six specimens from the Reserve were all taken by Blair and Cantrall from open, oak-hickory-grown slopes. These specimens differ slightly in coloration from typical *unifasciata,* but I have typical *unifasciata* taken in other years from near-by localities, and it is probable that the Reserve specimens are somewhat teneral.

67. *Tipula unimaculata* (Loew)

1936–38; August 4—September 3. A single generation a year.

Numerous to common in a variety of low, rather dense woods; numerous in the flood-plain woods of the southwest swamp and the wetter but similar woods bordering Sayl Lake; almost common in the dense woods of a cold hillside seepage.

68. *Tipula valida* Loew

1936–39; May 30—June 27. A single generation a year, with a clear-cut adult season.

Abundant in the lower parts of all oak-hickory woods and common to numerous in nearly all areas of the oak-hickory. Common to abundant in all but the most dense of the flood-plain woods. This is one of the most characteristic and conspicuous members of the oak-hickory crane flies in June.

A fully grown larva was taken in rich, damp, but friable soil beneath leaf mold of a moraine woods in Iowa in 1920. Several nearly full-grown larvae, believed to belong to this species, were taken May 16 from the mellow soil of rather low oak-hickory woods on the Reserve but died in the culture jar.

69. *Tipula vicina* Dietz

1936–37; May 18—June 20. A single generation a year.

Rare; but once, May 18, 1937, rather numerous along the banks of the North Branch of Honey Creek, a small sand and gravel bottom brook about a mile from the Reserve. A single record for Unadilla Creek and two from the "pool and riffle" section of Hell Creek.

70. *Tipula youngi* Alexander

1937–39; June 7–26. A single generation a year.

Rare to numerous, and apparently very local. All records are either from the flood-plain woods of the southwest swamp or from the cool, deeply shaded hillside rill and seepage area of Kalmbach's woods.

CYLINDROTOMINAE

71. *Phalacrocera neoxena* Alexander

1937; May 12–20. May 12 was close to the beginning of the season in 1937, but it is probable that adults remain on the wing until early June. At most, a rather short and clear-cut adult season.

Locally common to abundant about the moss and *Myriophyllum* choked pools of unshaded seepage marshes. Not taken in association with *Sphagnum*. Numerous to rare about the margins of two grass-sedge-fern marshes on the Reserve.

On May 12 a very teneral female, barely able to crawl, was taken from a small emergent tuft of mosses in the midst of a cold, vegetation-filled pool of a seepage area, but no larvae or pupae were found. In the summer these seepage pools are nearly dry and are very inconspicuous, but retain a reduced growth of mosses beneath the luxuriant summer stand of tall sedges.

72. *Triogma exculpta* Osten Sacken

1937; May 15–20. A single generation a year.

Local to very local, but numerous to common in five restricted stations in this region. Fairly common in the seepage area on Honey Creek, from which *P. neoxena* was taken, and in a grassy seepage rill near the foot of Kalmbach's hillside woods; numerous along a short marshy spring rill that flows into Hell Creek; and somewhat less numerous on the borders of Fishhook marsh and about an unshaded permanent spring and rill on the west margin of the southwest swamp.

The immature stages occur in the floating mosses of the small marsh pools and probably in the submerged mosses as well.

73. *Liogma nodicornis* Osten Sacken

1939; May 30—June 4. A single generation a year.

All of the fifteen specimens from the Reserve were taken by Blair. Most of them are from the margins of shrub-sedge and grass-sedge-fern marshes and, judging from Blair's and Cantrall's extensive collecting from many parts of the Reserve at this season, must be very local in distribution.

My own collecting in southern Michigan places the season for this species from the last week in May to the second week in June. I have never taken the immature stages of this species, but have taken larvae and pupae of *Liogma nodicornis flaveola* Alexander from the emergent mosses of a small mountain rill at Highlands, North Carolina.

LIMONIINAE

74. *Limonia* (*Limonia*) *cinctipes* (Say)

1937–38; August 2–28.

Rare and local; all six records and nine individuals are from moist, mesic woods—the oak-hickory and swamp ecotones of the Reserve and Kalmbach's woods.

The immature stages live in moist decaying wood or, more commonly, in old, moist woody fungi.

Whether the Livingston County records represent the second generation of the year, the first having been totally missed in all three years, or a single generation per year is not known. I have Michigan and Minnesota records from June to September inclusive, but never both spring and fall records from a single locality. In southern Indiana there are two definite generations each year. It is of interest to compare the local seasonal records of this species with the very nearly allied *L. immatura.*

75. *Limonia* (*Limonia*) *fallax* (Johnson)

1937–38; July 8–27.

Rare and local; the few records are either from the margin of beech-maple swamps or from Kalmbach's woods.

I am not convinced that *fallax* is distinct from *solitaria.* The above specimens pertain to *fallax* if it is distinct, but many specimens in the large series of *solitaria* that were taken in this area approach *fallax* rather closely.

76. *Limonia* (*Limonia*) *globithorax* (Osten Sacken)

1936–38; June 21—July 31, and August 31. Two generations a year.

Rare to numerous and very local; all from the hardwood swamps or the oak-hickory and tamarack ecotones. The only station from which specimens were taken in all three years was the immediate vicinity of an aspen log that had fallen into the margin of a sumac-tamarack swamp. I have bred adults from sodden, fungus-riddled hardwood logs.

77. *Limonia* (*Limonia*) *immatura* (Osten Sacken)

1936–38; June 20—July 24. A single generation a year.

Numerous to rare, and markedly local. A total of twenty-three specimens were taken in the field, about a dozen more were seen, and some thirty-odd were reared from wet rotting wood and bark. All were from the thickets that form the oak-hickory and marsh ecotones. One fallen oak produced a few specimens in each of the three years.

None of these specimens showed any approach to *cinctipes,* and the larval habitat was in all cases in an earlier stage of a log's decay than any

from which I have ever taken *cinctipes*. Individuals taken early in the season were definitely larger than any that were taken after the first week of July.

78. *Limonia* (*Limonia*) *indigena* (Osten Sacken)

1936–38; June 2–16, July 16 (a single male), and August 13–26. Apparently two fairly clear-cut generations per year.

Numerous or rarely common and definitely local; rare in 1936. Nearly all specimens from the mesic thickets bordering oak-hickory or marsh, or from Kalmbach's woods.

79. *Limonia* (*Limonia*) *macateei* (Alexander)

1936–38; June 9—July 6, and August 14–23. Two generations a year.

Very local; rare to occasionally common. In the vicinity of the same oak log in the oak-hickory and marsh ecotone from which *L. immatura* was taken, and from two sodden, fungus-grown aspens of the oak-hickory above Buck Hollow.

The larvae and pupae live in such fungi as *Poria, Polyporus,* and *Fomes,* or in rotten wood riddled with mycelia. In the oak log, mentioned above, from which both *immatura* and *macateei* were bred, the *macateei* immatures were taken from limbs three to five inches in diameter, which lay in contact with the soil, well out into the wet thicket; the *immatura* larvae and pupae were from the basal portion of the trunk, nearer the oak-hickory and not in contact with the soil.

80. *Limonia* (*Limonia*) *simulans* (Walker)

1936–38; June 16—August 4. Probably two or more overlapping generations.

Local but usually abundant in its restricted habitat. All records are for single localities on Hell, Honey, and Unadilla creeks. The habitat was always some man-made situation: spillways, seepage, leaking from a dam, or the constantly wet abutments of a bridge. Here larvae, pupae, and adults were always to be found between the dates given. The larvae live in silken tubes among the algae that coat the wet surfaces and protrude their anterior ends in order to feed or even leave the tubes altogether. Feeding was observed both in subdued daylight and at night. The adults were never seen more than a few yards from the immature stage habitat and often stood in thin trickles or rested beneath the small cascades of water that jutted from crevices and tiny ledges. Both *Dolomedes* and wolf spiders take a considerable toll of adults.

81. *Limonia* (*Limonia*) *solitaria* (Osten Sacken)

1936–38; May 13—July 8, and July 21—September 5. Two generations a year and probably only two; most numerous in June.

Moderately local, but common to abundant wherever it occurs. Most characteristic of the margins of shrub-sedge marshes and the more open tamarack-sumac swamps; numerous about the margins of the grass-sedge-fern marshes and in the vicinity of seepage and spring rills, spreading to some extent into the hardwoods but rarely far from wet soil. Adults were not infrequently taken in Cantrall's molasses traps, glass jars buried to the brim in the soil and baited with crude molasses.

82. *Limonia* (*Limonia*) *triocellata* (Osten Sacken)

1936–38; June 9–14, July 8—September 1, and October 3. At least two generations a year. The June records are for the last of a spring and early summer flight period in which the number of individuals is small; the peak of abundance in midsummer is in late July and early August. The October record may represent a third and rather exceptional generation. There is considerable evidence that this species has two generations a year as far north as the northern third of the Lower Peninsula.

Never common, but generally distributed in the birch-maple-elm swamps, the lower flood-plain woods, and the more mesic thickets that border the oak-hickory.

This species has been bred from woody fungi and wet rotting hardwoods.

83. *Limonia* (*Limonia*) *tristigma* (Osten Sacken)

1936–38; June 17—July 31. One generation a year with a definite peak of adult abundance in the first half of July.

This is the most abundant member of the subgenus Limonia on the Reserve. Common to abundant in the birch-maple-elm swamp and in the shrubby margins of shrub-sedge marshes. Locally common in the wetter parts of the flood-plain woods and somewhat less common in the more open tamarack-sumac swamps. At the height of its abundance it is apt to spread somewhat into the lower oak-hickory.

I do not know the immature stage habitat, but, judging from the situations from which the adults are taken in numbers, sometimes teneral, it is likely that the larvae live in the mossy carpets of persistently wet soil.

84. *Limonia* (*Limonia*), new species "37 A"

1937–39; June 2—July 8.

Five specimens altogether: two taken July 8, 1937; two July 8, 1938; and one (Blair) June 2, 1939. All from a strip of low aspen-maple-oak-willow-dogwood woods that separates Fishhook marsh from a small tamarack-sumac swamp. The first four specimens all came from an area of less than a quarter of an acre, and the fifth was taken within one hundred yards, or less, of this area.

Superficially, this species looks very like *L.* (*L.*) *fusca* Meigen in body color and in the conspicuously hairy wings, but it is actually a very different fly and from a very different habitat than that occupied by *fusca.*

85. *Limonia* (*Discobola*) *argus* (Say)

1936–38; June 11—July 5, July 23—August 25, and October 20. At least two generations a year with an occasional third generation under favorable circumstances.

Rare to numerous and fairly local. Taken in greatest numbers, in all three years, from the flood-plain woods bordering the southwest swamp. Here all adults were taken within fifty yards of a gigantic, fallen, but partially living, willow. Other records are for different areas in the flood-plain woods, the birch-maple-elm swamp, and the more mesic margins of the oak-hickory. This is one of the species that became definitely more numerous in 1937 and 1938, the more mesic part of the oak-hickory being near the dry limit of tolerance for this species.

Limonia argus has been bred from moist, partially decayed (usually beneath loose bark) willow, aspen, and birch.

86. *Limonia* (*Dicranomyia*) *adirondacensis* (Alexander)

1936–39; June 1—October 4; continuously on the wing throughout this season, with a marked peak from June 10 to July 10 and lesser peaks in late July, early August, and September. Probably three generations a year.

Abundant in nearly all marshes; numerous to common in the more open parts and margins of tamarack-sumac and birch-maple-elm swamps.

Adults emerged from moss brought in from hummocks of a marsh, but the immature stages were not found—at least not determined.

I am inclined to believe that this species may represent a race of *brevivena.* The series examined from the Reserve included more than five hundred individuals; and a dozen or so specimens, representing one extreme from the series, if taken alone would have been determined as *brevivena.* (I have bred *brevivena* in Florida from flatwoods mosses and collected it in great numbers without finding any individuals that approach *adirondacensis.*)

87. *Limonia* (*Dicranomyia*) *divisa* Alexander

1936–39; May 13—September 23. Continuously on the wing throughout this season; definite peaks in late June and in August. Generally two, but occasionally three, generations a year.

Numerous to common in nearly all well-shaded mesic and hydric situations. Generally distributed in the birch-maple-elm and tamarack-sumac swamps; somewhat more local in the flood-plain woods; rare to barely numer-

ous in the marshes and bogs. (This apparent rarity may be caused chiefly by the difficulty of netting the flies in such situations.)

The immature stages occur in moist to wet moss and in films and mats of algae, both on wet wood and the swamp or marsh floors.

88. *Limonia* (*Dicranomyia*) *gladiator* (Osten Sacken)

1936–38; a few records, June 30—July 5; a conspicuous and clear-cut adult flight period August 13—September 8. I believe in most instances there is but a single generation a year.

Abundant to common and generally distributed in the birch-maple-elm swamps and shrub-sedge marshes; common but more local in and about other marshes. Absent from bogs and rare along streams; rare to absent in oak-hickory and flood-plain woods.

Immature stages almost certainly in lush mosses on marsh and swamp floors as adults were taken in tent traps over thick mossy carpets.

L. (*D.*) *gladiator* varies considerably geographically in coloration. The Livingston County specimens are unmistakably *gladiator* in all details of the male genitalia and in the fuscous blotches at the base of the sternal valves of the ovipositor, but differ from the types (Washington, D. C.), and from more southern lowland specimens in general, in lacking the lateral stripes of the thoracic dorsum and the brown blotches on the mesosternum.

89. *Limonia* (*Dicranomyia*) *haeretica* Osten Sacken

1936–39; May 22—June 11, June 20—August 30, September 23. Probably two generations a year are the usual life cycle, but the peak of adults in July is very pronounced. I think it very probable that emergence is markedly affected by the water level.

Common to abundant about the more open and more inundated marshes; particularly abundant in the marshes of the southwest swamp in 1936 and 1938, about the margins of the open water in Sayl Lake, and in the wetter sedge-grass-fern and shrub-sedge marshes on the south margin of the big swamp. Much rarer in the drier Fishhook and west marshes. Rare to absent in well-shaded situations.

The larvae live in the moss and algal carpets at the margins of open pools in the marshes.

My series of several hundred specimens give some indication of being intergrades between *haeretica* and the more western *penicillata* Alexander, if the latter is to be separated from *haeretica.*

90. *Limonia* (*Dicranomyia*) *humidicola* (Osten Sacken)

1936–38; May 15–20, and August 13–26. At least two generations a year; with apparently clear-cut spring and late summer adult seasons. (I

have, however, a number of adults taken in July from the vicinity of Ann Arbor.)

Very local but usually abundant to numerous in the few situations where it was taken at all; abundant on the abutment of a small bridge over a spillway from Pinckney Millpond (Honey Creek) in May; fairly common on the vertical earth banks of the main spring that emerges in Kalmbach's woods; numerous about a small seepage rill that flows into Hell Creek; and rare in the vicinity of a small spring on the Reserve.

Alexander (1920) has described the immature stages from specimens taken in wet mosses at the margin of a rocky ravine stream. I have also taken them from the thin filmy network of strands of algae on wet banks, at or near the water line. In several of the situations in Livingston County from which specimens were taken in spring and late summer, there is a definite midsummer drying up that very possibly results in a midsummer aestivation on the part of the larvae.

91. *Limonia* (*Dicranomyia*) *immodesta* (Osten Sacken)

1936–39; June 9—October 7, with marked peaks in mid-June and in August. At least two generations a year; probably two or three, depending upon the habitat.

Generally distributed throughout most situations, except bogs, that have a permanently wet soil and, at times of population peaks, spreading somewhat into the lower parts of the oak-hickory. Abundant in the birch-maple-elm and tamarack-sumac swamps; common in the shrub-sedge marshes and the wetter margins of the flood-plain woods; numerous to common in the grass-sedge-fern marshes. Only occasionally taken in the vicinity of streams and seepage areas.

The larvae live in the film or carpet of algae and mosses that flourish on the wet soil of the swamps and marshes.

92. *Limonia* (*Dicranomyia*) *iowensis* (Rogers)

1931, 1938–39; May 31—June 2–10, and July 24.

Evidently very rare and local in the vicinity of the Reserve. I took six specimens from the southwest swamp in May, 1931, and four specimens were swept from the same area in early June of 1939 by Blair. Specimens were collected persistently and in detail in this same area from June 10 to early September in 1936–38 without a record. The July 24 record is for a male taken at light near a marsh. Records for other regions in southern Michigan show that this species is most numerous in early June and in late summer.

I have twice taken the larvae and pupae of this species from the algal coat growing on the coarse submerged gravel of a creek bottom (Huron

River at Ann Arbor). Some of the larvae were as much as twelve inches beneath the surface and three feet or more from the water's edge.

93. *Limonia* (*Dicranomyia*) *liberta* (Osten Sacken)

1936–38; May 11, June 12–26, and August 24.

Apparently rare and local. The thirty-odd specimens recorded are almost all from the vicinity of the spring-rill seepage on Hell Creek or the tamarack-sumac swamps or flood-plain woods of the Reserve. Other Michigan records suggest that it may have been more numerous in early spring and late fall, when intensive collecting was impossible.

94. *Limonia* (*Dicranomyia*) *longipennis* (Schummel)

1936–38; June 19—August 17, with a definite peak in early July.

Numerous to fairly common in the open marshes surrounding the small relict lake in the big swamp and about Sayl Lake; numerous in the wetter parts of shrub-sedge and seepage marshes; rare among cattails and in grass-sedge-fern marshes except those of the lake margins. Never taken from shaded areas. It is probable that this species is more abundant than my records would indicate, for it is particularly difficult to flush from the dense marsh growths that it frequents.

The larvae were taken from thin, inconspicuous films of algae on saturated soil near the lake margin. I have also reared this species in Iowa from larvae washed from wet organic soil in a low marshy area. In the latter instance algae were probably present but not noticed.

Among some one hundred specimens taken from the Reserve, four have the discal cell (First M–2) closed in one wing.

95. *Limonia* (*Dicranomyia*) *nycteris* (Alexander)

1931, 1937–38; May 10–20, and July 31—August 7. Two generations a year, the spring adult season far more conspicuous than the midsummer one.

In May abundant and generally distributed throughout all areas of unshaded seepage marshes, common along spring and rill banks, and numerous in the sedge-grass-fern and shrub-sedge marshes of the Reserve. All July and August records are for specimens found in cool, permanent seepage marshes along Honey Creek or a small seepage area on Unadilla Creek.

The larval stage is almost certainly spent in wet mosses and algae.

96. *Limonia* (*Dicranomyia*) *pudica* (Osten Sacken)

1937–39; May 23—June 22. Rare; most of the few records are for specimens "taken at light." One specimen swept from the birch-maple-elm swamp on June 22.

As far as my records go, this is a rather rare species in Michigan; all of the score or so of records are for May and early June. In southern Indiana, May 9, 1937, I took a large series of males and females of this species, swarming at twilight about the terminal branches of a budding cherry tree. This tree was near the margin of a wet, spring-seepage drainage where *Helobia hybrida* and *Limonia* (*D.*) *liberta* were emerging in numbers. It is probable that the peak of the season for *pudica* at the Reserve is between May 21 and June 8 when collecting was at a minimum.

97. *Limonia* (*Dicranomyia*) *rostrifera* (Osten Sacken)

1937–38; August 22—September 5. Apparently a single generation a year, with a clear-cut, late-summer, adult season.

Very local, but briefly abundant where it does occur; abundant in the last third of August in both 1937 and 1938 in a small area of very wet, open marsh at the juncture of the north and west branches of Honey Creek; common to numerous at this same season in Buck Hollow and along the margins of the big Cassandra bog; two specimens from grass-sedge-fern marshes of the Reserve.

To judge by the adult habitat and observations on the larvae of the allied *adirondacensis* and *brevivena,* the immature stages probably live among wet mosses on the floor of the adult habitat.

98. *Limonia* (*Dicranomyia*) species 37–A

1936–38; June 18—July 18.

Apparently very local, but numerous, perhaps common, in two areas of wet grass-sedge-fern and shrub-sedge marsh in the big swamp. An occasional specimen was taken from other dense wet marshes.

This species is apparently allied to *sphagnicola* Alexander and *cramptoniana* Alexander, which it resembles in its huge complicated genitalia. This is one of the definitely marsh species and, like other members of this fauna, can rarely be found except at late dusk when both sexes and, occasionally, mating pairs may be seen and swept from among the tips of the tall herbage.

99. *Limonia* (*Alexandriaria*) *whartoni* (Needham)

1936–39; May 24—July 3, and July 26—August 31. Apparently two generations a year; certainly two rather distinct peaks of adult abundance, late June and mid-August.

This forms one of the main surprises of the faunal list of the Reserve. It had previously been known only from the unique female type, taken by Needham at Walnut Lake, Michigan, in 1906; but on the Reserve it proved to be an abundant species in nearly all of the wetter marshes with a few

specimens from the margins of the sphagnum bogs. Apparently absent from all marshes that become definitely dry at any season of the year.

Larvae and pupae were taken from wet sheaths of algae that encased the lower stems of the sedges, and several adults were reared from the quarter-inch thick mats of algae that spread over the wet hummocks and float at (not on) the surface of the water.

During 1936 and 1937 *whartoni* was still regarded as a rare species. Although the marshes were hunted carefully until it was too dark to see, no signs of swarming individuals or mating pairs were discovered, and only an occasional specimen could be found resting on the lower stems of the sedges and ferns. Then, on June 23, 1938, more than two hundred mating pairs came to a light near the edge of a marsh between 9:30 and 10:45 P.M. At subsequent lighting both males and females and many pairs in copulation came to light between complete nightfall and 11:00 P.M. All of these nights were warm and humid. Very few specimens were taken after 11:00 P.M. or if the light was more than fifty yards from a wet marsh.

100. *Limonia* (*Rhipidia*) *fidelis* (Osten Sacken)

1936–39; May 30—June 27.

Rare and local in the flood-plain and lower oak-hickory woods. A total of sixteen specimens were taken as adults and four others bred from a moist, but not sodden, aspen log that lay in the ecotone between a marsh and the oak-hickory woods. (I have also taken the larvae of this species, from beneath the loosened bark of an oak log, in the southern Appalachians.)

101. *Limonia* (*Rhipidia*) *maculata* (Meigen)

1936–38; June 16—July 10, August 17, and September 15.

Rare and local. A few specimens each year from the vicinity of a huge, fallen, coppiced willow in the flood-plain woods of the southwest swamp; and an occasional, isolated specimen was swept from the birch-maple-elm swamp and from Kalmbach's woods. A single specimen from the oak-hickory in three years.

A Note on *Limonia* (*Geranomyia*) *canadensis* (Westwood)

I have large series of three distinct species that key to *canadensis* Westwood and perfectly answer the rather general descriptions for that species. Of these three species "A" and "B" are widespread over the eastern part of the United States and Canada, and "C" is confined to Florida, where it is abundant. Species "A" is the one determined as *canadensis* by Osten Sacken. I examined the four specimens in the Osten Sacken collection at the Museum of Comparative Zoology at Harvard in February, 1939; one of these bears the red type label (M.C.Z. No. 10211) for *Geranomyia communis*

Osten Sacken, which Osten Sacken synonymized with *canadensis*. This specimen and the other three determined by Osten Sacken are all cospecific. Since Westwood's type of *canadensis* may still be in existence and could very possibly be species "B," I have hesitated to give names to these species. The species for which the life history and immature stages are so fully described and figured by Alexander and Malloch (1920) is undoubtedly species "B."

102. *Limonia* (*Geranomyia*) *canadensis* group, species "A"

1937–38; May 16, and June 13—August 28, with fairly distinct peaks in June and August.

Rare to numerous, and rather local. Numerous in the marshes and in the vicinity of unshaded seepage areas; fairly numerous in the vicinity of a nearly permanent pond in the oak-hickory woods. In three instances it was taken in some numbers when lighting was done within or close by a wet marsh. Never from a stream unless it was definitely marshy.

103. *Limonia* (*Geranomyia*) *canadensis* group, species "B"

1936–38; June 12–16, and August 4—September 4. At least two generations a year, but probably breeds continuously throughout the summer with as many as three generations under favorable conditions.

Usually common to abundant in its typical habitats, the continuously wet to slightly submerged film of algae on abutments, spillways, and pilings. Never taken from marshes that were more than a score of yards from some wooden, stone, or concrete structure on which algae grew. Females of this species were twice taken while ovipositing into a permanent trickle on the outside of a concrete watering trough fed by a spring. Twenty yards below, where this spring was lost in a hillside marsh grown with sedges, cattails, and a rich moss carpet, species "A" was taken. Species "B" was never taken from the marsh, nor "A" from the watering trough.

The larvae and pupae were present in large numbers on the vertical faces of the permanently wet or trickle-covered wooden or stone structures. The larvae form slender silken tubes among the strands of algae and feed on the algae. Feeding takes place in well-shaded daylight and at night, and the undisturbed larvae protrude far from the mouth of the tubes or even leave them entirely to wander through the algal strands. Pupation takes place in the mouth of the larval tube within a second cocoon-like sheath, usually in a permanently wet but unsubmerged zone. In most instances the algal film that was inhabited was rather thin, the strands spreading thinly over, but not concealing, the wood or masonry beneath.

104. *Limonia* (*Geranomyia*) *distincta* (Doane)

1936–37; July 1–12.

Rare and very local; four specimens from a small marshy, unshaded, semipermanent seepage area along upper Honey Creek. A prolonged search for other specimens in 1936–38 was unavailing.

105. *Limonia* (*Geranomyia*) *rostrata* (Say)

1936–38; May 17, and August 18–29.

A very rare species in 1936 and 1937, somewhat more numerous in 1938. All from unshadowed marshes, particularly such marshes as surround seepage areas and rills.

The larvae and pupae live in wet mosses, liverworts, and saturated but not submerged algal mats.

106. *Helius flavipes* (Macquart)

1936–39; May 20—August 30. Two generations a year with well-marked peaks of adult abundance in early June and from mid-July to mid-August. Almost disappears in late June and early July.

Abundant and widespread. The adults emerge in huge numbers from nearly all of the marshes, swamps, and pools in woods and spread into all parts of the oak-hickory and flood-plain woods, where they form a conspicuous element of the crane-fly fauna. Less numerous in wholly unshaded situations, but often present. Particularly abundant during the main "hatches" on steep hillsides, where the adults are concentrated as they fly from the marsh and swamp margins. Sometimes almost a nuisance in sweeping because the large numbers of individuals taken in a few sweeps obscure the presence of less common species.

The immature stage habitat ranges from detritus-filled pools and channels in the swamps and marshes to the sodden, algae-covered margins of the hummocks and pool margins. Full-grown larvae were abundant in the vegetation-choked channels of Fishhook marsh in May.

Net collecting of the adults assigns this species to the oak-hickory, where it does not breed, and shows but few netted adults from the marshes, although it was often common on all sides of the marsh. Pairs in copulation are numerous in nearly all of the daytime habitats, but oviposition appears to take place nearly always after sunset. At this time the females return to the marshes in numbers, and sometimes as many as a dozen can be found ovipositing at one time about the sides of the hummocks. Oviposition takes place both below the waterline and in wet ooze just above the water. Teneral flies can often be found on the floor of the marshes, and I believe that most of the flight from the marshes by emerged adults and to the marshes by females ready to oviposit takes place at times of reduced light—toward dusk or after nightfall.

107. *Helius mainensis* (Alexander)

1936–39; May 24—August 24. Two generations a year with peaks in the last third of June and in mid-August. The peaks not so well marked as they are for *flavipes,* possibly because the adults of *mainensis* are more difficult to collect.

Common to abundant in permanent wet marshes, both grass-sedge-fern and shrub-sedge; less abundant but often common among cattails. Not taken elsewhere. Both males and females remain well concealed among the dense marsh vegetation until late dusk, when they begin to appear among or above the tips of the tallest sedges and grasses. A swarm of about twenty males, about a foot above the tips of the tallest sedges was taken fully an hour after sunset one evening in late June. They came to light in large numbers when the light was placed at or near the edge of a marsh, but rarely came to light as much as fifty yards away.

Several unreared larvae, identified by comparison with Alexander's (1920) descriptions and figures, were washed from the semisuspended detritus dredged from between-hummock channels of a grass-sedge-fern marsh. Alexander's larvae were taken from the semisuspended, black, plant-filled soil of a swamp (Larch Meadows) at Ithaca, New York.

108. *Dicranoptycha germana* Osten Sacken

1936; June 26 and July 3.

Two specimens only, both from the steep, well-wooded slopes in the oak-hickory.

As far as my own collecting goes, this is a very rare species in southern Michigan, becoming more numerous in the northern third of the Lower Peninsula.

109. *Dicranoptycha septemtrionis* Alexander

1937–38; August 13–23.

Rare to numerous. All from a moderately open flood-plain woods, just below the cold, boggy hillside of Kalmbach's woods.

One of Alexander's paratypes came from about twenty miles south of the Reserve, and this species is much more common in the region just south of the Livingston County moraines.

110. *Ula elegans* Osten Sacken

1938; August 4.

Three specimens were taken from a tamarack-sumac swamp that had a considerable mixture of maples, elms, and shrubs. *Ula* is not rare in the more mesic beech-maple woods south, east, and west of this region; but the dearth of *Polyporus* and *Fomes* on the hardwood logs of the Reserve prob-

ably indicates that the oak-hickory of this region is too dry for the local species of this genus, which are often abundant in the beech-maple and birch-maple-hemlock woods of Michigan.

111. *Pedicia* (*Pedicia*) *albivitta* Walker

1937–38; June 15–21, and July 31—August 19. Probably two generations a year; but some indication that there are two broods, each with a single generation.

Rare to numerous and rather local; all from the vicinity of small, cold rills. All adults were either from a spring that flows into Hell Creek or from Kalmbach's woods, but a larva was taken from the cold permanent spring at the west end of the southwest swamp.

112. *Pedicia* (*Tricyphona*) *autumnalis* (Alexander)

1936–38; August 21—September 8. A single generation a year with a clear-cut, distinctly autumnal adult season.

In all these years local, but abundant in a few definite areas: two shaded or partly shaded shrub-sedge marshes, and the shaded margins of two grass-sedge-fern marshes. Never taken from about a rill course. Usually associated with sensitive fern, touch-me-not, and saturated black peat soils.

The larvae were washed from semisuspended black peaty silt scraped to a depth of two inches, just marshward of the wet thicket that separates Fishhook marsh from the oak-hickory.

113. *Pedicia* (*Tricyphona*) *calcar* (Osten Sacken)

1937; May 20.

Numerous to common about the deep, boggy areas that margin the upper rill courses and springs of Kalmbach's woods.

114. *Pedicia* (*Tricyphona*) *inconstans* (Osten Sacken)

1936–39; May 19—October 14. Probably two generations a year; perhaps three under favorable conditions.

Locally abundant in the vicinity of permanent seepage and of marshy or swampy rill courses; sometimes numerous about the pools of the stagnant birch-maple-elm swamp; rare about or in the stagnant marshes. All records after July 7 are for the cold shaded rill courses of Kalmbach's woods. This species does not appear to spread very far from the immature stage habitat, even when emerging in numbers. Almost as numerous in shaded as in unshaded situations.

The immature stages take place in saturated or semisuspended silt and organic mud, most abundantly in areas where there is some movement of the soil water.

115. *Pedicia* (*Tricyphona*) *paludicola* (Alexander)

1931, 1937; May 10–20. A single generation a year.

Common in May about wet seepage areas and along the borders of small rills through marsh areas where the adults may be found running or buzzing about over the saturated earth. At this time of year one often sinks more than knee-deep in the marshy soil on which they occur.

No larvae could be found; but a pupal skin, assigned with confidence to this species, was found protruding from a tiny turreted chimney—much like a miniature crawfish chimney—just outside of a tiny rivulet through the marsh. (A very similar chimney is often at the mouth of the pupal burrow of *inconstans* and *johnsoni*.)

This species is exceedingly variable in size, in venation, and in size of wing. In a series of fifty-four specimens from Livingston County, wing length ranges from 5 to 9.5 mm.; the body length from 5 to 8.5 mm. in the males, and from 8 to 11.5 mm. in the females. The range, both in size and in venational details shown by specimens taken from the same ten square yards at one time, includes all of the characters of *paludicola* and of *pumila* Alexander.

116. *Dicranota* (*Amalopina*) *flaveola* (Osten Sacken)

1937–28; May 18–20, August 13–26. Two generations a year. Numerous to common along the seepage bogs and swamp rill course of Kalmbach's woods. Two specimens from a partly shaded spring rill course on the Reserve.

Alexander (1920) has reared adults from larvae taken from "rich, organic mud" of a wet woods.

117. *Dicranota* (*Paradicranota*) *eucera* (Osten Sacken)

1938; August 14–26.

Rare to barely numerous along the cool, shaded rill courses of Kalmbach's woods. My records for the region about Ann Arbor and other parts of southern Michigan suggest that I missed the early spring generation and possibly much of the fall generation. Ann Arbor date limits are May 4 and September 25.

118. *Dicranota* (*Rhaphidolabis*) *cayuga* (Alexander)

1937, 1939; May 20 and September 18.

Seven of my eight specimens were from the rill margins of Kalmbach's woods in May; a specimen was taken by Cantrall from a small rill course on the Reserve in September. Probably actually rather rare, although the peak of the spring season and all of the fall season were probably outside of the

extreme date of my own collecting. Although I could only find seven specimens at Kalmbach's woods on May 20, this species was abundant in a ravine in the Huron River bluffs near Ann Arbor on May 19.

119. *Adelphomyia cayuga* Alexander

1936–38; August 10–31. One generation a year with a clear-cut, late-summer adult season.

Common to abundant in the immediate vicinity of small rill courses; hardly any permanent rills, whether deeply shaded or sunny, are without at least a small population in this region; usually more abundant in situations with moderate shade. Very local along the larger brooks and creeks and usually associated with a small seepage area of the banks. The permanent rill courses of the Reserve are small and separated by many hundreds of yards of varied terrain, yet each rill course had its population of this species in all three years.

The immature stages live in the fine semisuspended or submerged silt of the rill margins; pupation taking place slightly above the water line.

120. *Adelphomyia pleuralis* Dietz

1937–38; July 5–31. A single generation a year with a clear-cut, mid-summer adult season.

Abundant along the deeply shaded seepage areas and rill banks of Kalmbach's woods, but nowhere else in this vicinity. Common about Ann Arbor.

I have taken the immature stages of this species from much the same sort of saturated silt as that inhabited by the larvae of *cayuga*. From Tennessee southward this species has two generations a year.

121. *Epiphragma fascipennis* (Say)

1936–39; May 20—July 8, but no males later than June 26. A single generation a year with a distinctly spring and early summer adult season.

An abundant and conspicuous element of the late May and June fauna. Abundant in the flood-plain woods, the hardwood swamps, and all wooded ecotones between the oak-hickory and swamps or marshes. Common in much of the shrub-sedge marshes and spreading into other areas at times of greatest abundance. Markedly reduced in numbers in 1937.

The immature stages are spent in very wet to sodden or temporarily submerged wood, from logs to small branches not much larger than a lead pencil. Often scores of larvae may be taken from a two-foot length of a limb or trunk six inches in diameter. Apparently confined to hardwoods. Larval development may be stopped for as long as two months by partial desiccation without killing the larvae. The immature stages appear to utilize any sodden wood and often occur in limbs that fall into open marshes or into the

mud of unshaded seepage areas and rill margins. I have observed oviposition take place in the frass-packed old tunnels of *Passalus cornutus* as well as in the sodden wood of logs from which the bark had fallen away.

122. *Archlimnophila toxoneura* (Osten Sacken)

1936–38; June 11–18. A single generation a year. Possibly more numerous in the first week of June.

Rare. A few specimens were taken each year from the birch-maple-elm swamps, the tamarack-sumac swamps, and the lower margins of the oak-hickory woods.

123. *Pseudolimnophila contempta* (Osten Sacken)

1937–38; August 1–7.

Rare or locally numerous. All from marshy spring rills and seepage areas. The apparent rarity of this species is puzzling, for it is abundant in many other parts of southern Michigan.

The larvae live in semisuspended silt at the margins and in the channels of rills and seepage areas and appear to be rather clearly correlated with nonstagnant conditions.

124. *Pseudolimnophila inornata* (Osten Sacken)

1936–39; May 18—August 26. Apparently most abundant in mid-June, late July, and early August, but no clear-cut peaks of abundance.

Abundant in the marshes surrounding the marly Sayl Lake and spreading from these marshes to be generally common in the low woods and shrub thickets surrounding this lake. Common in the birch-maple-elm swamp, and numerous to common in the shrub-sedge and grass-sedge-fern marshes. This species is a marked "spreader." It accumulates in huge numbers on hillsides near the marshes it inhabits and extends well into the woods at times of considerable emergence.

Larvae were taken from semisuspended vegetation of shallow pools among the lake-margin marshes.

125. *Pseudolimnophila luteipennis* (Osten Sacken)

1936–39; May 10—September 23. Continuously on the wing throughout this season but with some indication of two main peaks—May and early June, and late July and August.

Although this species never reached the tremendous numbers of *P. noveboracensis* nor had the huge peaks of *P. inornata,* it was often an abundant element in the fauna, and when the population was at its peak it spread into many habitats not ordinarily occupied. Abundant in the grass-sedge, sedge-

shrub, and cattail marshes of seepage areas and rill courses; common to abundant in the nonseepage marshes of the Reserve and spreading as adults into the lower, more densely shaded part of the flood-plain and oak-hickory woods; common to abundant at the margins of the birch-maple-elm swamps. At times of large "hatches," which often reach their peak before or at midday, this species accumulates in conspicuous multitudes in slightly sheltered spots near the foot of steep slopes and then spreads out from such spots during the night.

The larvae exist in huge numbers in the almost fluid, semisuspended silt and organic debris of marsh pool margins and wet marshes. Several fully grown larvae were washed from such semiliquid material dipped from the center of a large area of cattails. Two weeks before, this area had been nearly a foot under water, with no hummocks or other earth emergent. Some larvae were washed from the muddy margins of deeply shaded pools at the edge of the birch-maple-elm swamps.

126. *Pseudolimnophila noveboracensis* (Alexander)

1936–39; June 2—August 28. Probably but a single generation a year.

The adult season, which has a conspicuous broad peak in middle and late June, is probably prolonged by the occurrence of laggard emergence after the first third of July, when this species rapidly becomes less common and finally rare.

This is probably the most abundant species of the Reserve; certainly it produces the greatest mass of adult crane flies. Throughout June and early July it is extraordinarily abundant in all of the oak-hickory and flood-plain woods and is common to abundant in most of the swamps. Intensive sweeping would indicate that the adults are rare in the marshes, although numerous to common about the shaded margins.

The larvae appear to be typical inhabitants of the grass-sedge-fern and shrub-sedge marshes. A few were taken after a long search from small pools in the swamps, but could hardly have been abundant. In the marshes the larvae are present in the semiliquid silt near the water line of the hummocks and in the thicker mats of floating or semifloating plant debris.

The emerged adults apparently leave the marshes soon after ceasing to be teneral, usually at dusk or later, spend all of the adult life in moderately to deeply shaded situations, and return to the marsh only for oviposition. In the woods the adults spread throughout the whole of the oak-hickory, although they occur in greatest abundance on the slopes and in the more mesic lower margins. Here they rest on the herbage and lower shrubs. They are relatively inactive during the day, although copulation becomes frequent toward late afternoon.

This species was tremendously abundant in all of the three years I col-

lected and was sometimes a nuisance when other species were sought in the same habitat. Only mosquitoes surpass them in numbers of individuals taken in a random sweeping through the low woods herbage, and then only at the season when the mosquitoes were almost intolerable and when the collecting was done in areas where mosquitoes were particularly abundant. Numerous counts were made of the number of individuals taken when an insect net was brought down vertically against the ground, catching only the individuals in an area of 1.25 square feet; and the average number of adults throughout the oak-hickory during the period from June 10 to July 10 could hardly have been less than three a square yard and may have been much larger than that. At this time they were considerably preyed upon by the birds of the oak-hickory and by robber flies, Odonata, and, in July, by *Bittacus*.

127. *Limnophila* (*Lasiomastix*) *macrocera* (Say)

1936–37; June 16 and July 22.

Rare. Six specimens in the three years. All in the vicinity of marshy or swampy rills. I am at a loss to explain why this usually common species should have been so rare, but I am sure that the rarity was real.

128. *Limnophila* (*Lasiomastix*) *subtenuicornis* Alexander

1931, 1937–38; May 4–31. A single generation a year with a clear-cut, vernal adult season.

Abundant about the braided courses of marshy rills and locally common about seepage areas of unshaded creek banks. The spring rills are wettest at this time of year and tend to spread out among sprouting lizard's-tails and sedges; the adults are frequently seen singly and in copulation on this low herbage.

Larvae were washed from the semiliquid silt and mud of the boggy unshaded margins of the rills. Later in the summer these spots were much drier and covered with luxuriant marsh herbage.

I believe it very possible that *subtenuicornis* will prove to be a western race of *tenuicornis*.

129. *Limnophila* (*Dicranophragma*) *angustula* Alexander

1937–38; June 16—July 5.

Common to abundant along the cold, shaded rills and seepage areas of Kalmbach's woods. A few other specimens, referred to this species, from a shaded rill course and seepage on the Reserve.

130. *Limnophila* (*Dicranophragma*) *fuscovaria* Osten Sacken

1936–39; May 30—August 27. Apparently two generations a year with rather clear-cut adult seasons.

Common to abundant in nearly all permanently wet situations except the bogs and grass-sedge-fern marshes. More abundant in regions of spring rill seepage, both shaded and unshaded; common to abundant in the southwest swamp, at the margin of the flood-plain woods and the open marshes, in the birch-maple-elm swamps and the tamarack-sumac swamps; numerous to common about the margins of many of the shrub-sedge marshes; numerous locally along many of the brooks. The species spreads, at times of greatest abundance, into the lower parts of the oak-hickory. Immature stages take place in saturated organic earth and silty margins.

If *fuscovaria* and *angustula* are really distinct—and I believe that they probably are—the collections in and about the Reserve gave the best evidence I have seen of considerable ecological differences in the habitats of the two species. *L. angustula* was confined to cold rills with muddy banks in considerable to deep shade; *fuscovaria* was much more characteristic of open to moderately open marshy situations. Both were taken at Kalmbach's woods, but even there *fuscovaria* was largely in the more open marginal parts. A similar distinction, although less clear-cut, is shown by my records for other regions. The overlapping may be caused by the tendency of the adult *fuscovaria* to spread for considerable distances from the larval habitat.

131. *Limnophila* (*Idiolimnophila*) *fasciolata* Osten Sacken

1936–39; June 1–30. A single generation a year.

Numerous to common in nearly all of the open marshes; somewhat less numerous from the shrub-sedge marshes than from the grass-sedge-fern. A few specimens from the birch-maple-elm swamps, spring rill margins, and a cattail marsh.

Although the two bogs were regularly hunted, no specimens were taken from either one. This was the more surprising to me because the only situation in which I have ever found this species strikingly abundant was the Cassandra-sphagnum mat surrounding First Sister Lake near Ann Arbor. Here hundreds of specimens were swept from the quaking mat, June 2–5, 1931.

132. *Limnophila* (*Eleaophila*) *solstitialis* Alexander

1937–38; July 14—August 23.

Numerous to common along the shaded rills and seepage areas of Kalmbach's woods.

I have taken the larvae of this species (in Florida) from the wet, silty, semisuspended mud of rill margins.

133. *Limnophila* (*Phylidorea*) *adusta* Osten Sacken

1936–39; May 22—June 11, and July 21—August 18. Two generations a year; the adult seasons clear-cut and relatively brief.

A definite bog inhabitant; here it is common to abundant for a brief season, and numerous to common for about a week before and after the peak of the flight period. Few individuals wander beyond the limits of the bogs. The rare to barely numerous specimens from the birch-maple-elm and the tamarack-sumac swamps may breed in the occasional sphagnum patches of the swamps.

I did not find the immature stages, but took very teneral adults from about the bases of high-bush huckleberry at the margin of the sphagnum and tamarack border in Buck Hollow.

134. *Limnophila* (*Phylidorea*) *auripennis* Alexander

1936–39; May 27—July 1, and July 26—October 7. Two generations a year; the adult seasons longer than those for *adusta.* Most of the specimens taken in the last ten days of each season were female.

Common to abundant through a rather wide range of habitats. Abundant in the birch-maple-elm and tamarack-sumac swamps and along the woods-marsh margin of the southwest swamp; common to abundant in the Cassandra-sphagnum bogs and along the shaded margins of the shrub-sedge marshes; often numerous along brooks and creeks and in cattail-sedge marshes. At times of greatest abundance this species spreads rather widely so that there are occasional records for nearly all situations.

Larvae, clearly *Phylidorea,* and referred to this species with considerable confidence, were washed from the inch-deep, surface layer of the silt and plant detritus at the margin of a small pool in a sedge-cattail marsh.

135. *Limnophila* (*Phylidorea*) *caudifera* Alexander

1931, 1937–38; May 13—June 13. One generation a year.

Rare; six records of one to five specimens each. Possibly more numerous in the last week of May and first week of June, but not taken in the extensive collecting of Blair, Camburn, and Cantrall, who collected from appropriate situations in this period. All specimens from about unshaded or partly shaded rill courses and seepage areas.

136. *Limnophila* (*Phylidorea*) *consimilis* Dietz

1936–38; June 12—July 16. A single generation a year, with a definite peak in the last week of June and first week of July.

Locally abundant along small streams where the banks have boggy seepage areas, and in the marshes of seepage areas and rill courses; occasionally numerous in restricted areas of the grass-sedge-fern marshes of the Reserve, usually in spots where there had been seepage during the spring. All local areas inhabited in 1936 were also occupied in 1937 and 1938.

A few larvae and several pupae were taken from a boggy mud bar along

the banks of upper Honey Creek. Here a small spring or seepage area produces a bank of oozy mud at the margin of the creek. Emerging adults and several ovipositing females were taken from the mud bar and from the slightly firmer, but still saturated, black mud a foot or so shoreward from the bar. More than two hundred fully hardened adults were netted not more than twelve yards from this spot within two successive days.

The series of more than three hundred adults from the Reserve and its vicinity has given a great deal of difficulty. Wide variations in wing, leg, and body color are evident; and the two hundred specimens taken on July 8 and 9, 1936, from a single area of a few square yards possess all extremes of these variations. Isolated specimens from this series would key to *consimilis, fumidicosta, persimilis,* and perhaps to *luteola,* and in each case would answer the detailed descriptions of these species. Alexander kindly loaned me his slides of genitalia (including the types), and specimens from my series appear to include all differences that might be appealed to in separating these species on the basis of genitalial differences. Moreover, some of the Livingston County specimens have a leg coloration like that of the species allied to *similis,* and there is considerable indication that leg coloration is correlated with sex, the females have much less pigmentation of the femur, although a small percentage of individuals of each sex do not conform to this difference. For the purposes of the present paper at least, I am regarding *fumidicosta* and *persimilis* as cospecific with *consimilis.* Possibly *luteola* should be included, but a small series determined as *luteola* can be separated from those here referred to *consimilis* and may be distinct.

137. *Limnophila* (*Phylidorea*) *iowensis* Alexander

1936–38; June 14–28. A single generation a year.

Numerous, but definitely local. Small series from two wet seepage marshes, the margin of the open marsh and flood-plain woods of the southwest swamp, and from local marshy spots on Hell and Honey creeks.

These specimens, together with several larger series from other regions in southern and central Michigan, give considerable evidence of being intermediate between the eastern *adustoides* and the more western *iowensis,* although somewhat closer to the latter. Much more material is needed, however, before the limits of *adustoides* and *iowensis* and of intergradation between them are definitely stated.

138. *Limnophila* (*Phylidorea*) *luteola* Alexander

1936–37; June 26 and 27.

Two small series referred to this species were taken a year apart from the same cold spring seepage and iris bog along Hell Creek. They differ from specimens referred to *consimilis* in having a much brighter wing colora-

tion, especially basally, and in being slightly larger. It is not improbable that these specimens represent a closely inbred population of *consimilis,* but I believe that for the present they should be referred to *luteola.* (See also the discussion of *L. consimilis.*)

139. *Limnophila* (*Phylidorea*) *platyphallus* Alexander

1936–39; June 2–25, and August 15–28. Two generations a year; the adult seasons, apparently, are very short.

Rare to numerous and rather local. Most of the specimens came from sphagnum-Cassandra bogs or from birch-maple-elm swamps; a few from tamarack-sumac and the wet thickets between Fishhook marsh and the oak-hickory.

140. *Limnophila* (*Phylidorea*) *siouana* Alexander

1938; June 13–16.

Some twenty specimens from one small area in the ecotone between an arm of the northwest marsh and the west central oak-hickory. Here an area of vernal seepage and a temporary rill are marked by skunk cabbage, sedges, iris, and royal and cinnamon ferns growing from the black muddy soil.

141. *Limnophila* (*Phylidorea*) *subcostata* Alexander

1937; May 20.

Three specimens taken from along the cold shaded rill courses of Kalmbach's woods.

142. *Limnophila* (*Limnophila*) *brevifurca* Osten Sacken

1931, 1937; May 13–20. A single generation a year.

Abundant about most of the unshaded rill courses and seepage areas; much less numerous about swampy rills and in Kalmbach's woods. Possibly emergence is slightly later, and so was largely missed, in the latter situations.

143. *Limnophila* (*Limnophila*) *laricicola* Alexander

1937–38; June 9—July 21, but no males after July 11. A single generation a year.

Numerous to common in the sphagnum-Cassandra bogs and spreading from these for a few score yards into the bordering oak-hickory woods.

This is one of the most definite and characteristic sphagnum-bog species. It is not uncommon over much of Michigan and is always taken from sphagnum-Cassandra bogs; in Tennessee and Indiana, however, it is taken from sphagnum bogs where Cassandra is lacking.

144. *Limnophila* (*Limnophila*) *poetica* Osten Sacken

1936–39; May 12—August 29, with well-marked peaks of abundance in

June and in mid-August. Probably two generations a year, but possibly two distinct broods.

Abundant in nearly all of the wetter marshes—grass-sedge-fern, shrub-sedge, cattail—in spring and early summer, becoming rare in July and fairly common in August. Common to abundant in the birch-maple-elm and tamarack-sumac swamps in August, but only numerous to common in these situations in June. A number of specimens were also taken from the flood-plain woods and along the stream banks, but I believe that the adults had spread into these situations from near-by marshes and swamps. Only a single specimen (a male) was taken from the sphagnum-Cassandra bogs in spite of persistent searching in both Buck Hollow and the big Cassandra.

I did not find the larva; but three adults were reared from a peck or so of wet silt, plant detritus, and mosses that were gathered from between and on the sides of the hummocks in Fishhook marsh in May and left in large jars until my return to the Reserve in June. The small, comparatively short-winged, darker female, although capable of fairly rapid flight, remains near the floor of the marshes and swamps and is much more difficult to flush or to take by sweeping than the male. Consequently, although the sexes appear to be approximately equal in numbers, most collecting yields a disproportionately large number of the more active males.

145. *Shannonomyia lenta* (Osten Sacken)

1936–39; May 30—July 18, and July 28—September 14, with definite peaks in June and in the latter two-thirds of August. Two generations a year.

This is an abundant and characteristic species over most of the Reserve. Common to abundant in all of the marshes, the flood-plain woods, and the birch-maple-elm and tamarack-sumac swamps, it is also often numerous in the lower part of the oak-hickory and in and about the bogs.

Taken emerging from the wet margins of a small temporary pond in a low, unshaded, semimarshy area.

146. *Pilaria imbecilla* (Osten Sacken)

1936–39; June 2—July 12, and August 11–19, and a single specimen on July 23 and another on July 28. Probably at least a part of the population has two generations a year, although the adults are far more common in June than in the short August season.

Common, occasionally abundant, in the flood-plain woods of the southwest swamp, in the birch-maple-elm swamps, and in the lower, more densely shaded parts of the tamarack-sumac swamps; spreading rather freely from these situations into the more mesic parts of the oak-hickory. Numerous in

a few local spots in the shrub-sedge marshes and in the wetter thickets that border grass-sedge-fern marshes.

Larvae and pupae were washed from the semisuspended silt at the margin of open marsh and flood-plain woods in the southwest swamp.

147. *Pilaria osborni* (Alexander)

1936–39; June 10—August 29, with a definite peak in late June and the first half of July. Probably two overlapping generations a year.

Locally common to abundant in a variety of rather open to semishaded wet marshes and swamp margins; abundant and rather generally distributed in all wet, well-developed stands of cattails. In the grass-sedge-fern marshes, where this species was locally common to abundant, it was very difficult to obtain by sweeping, except at late dusk; in more shaded situations, however, *osborni* was active throughout most of the day and could be flushed or netted much more readily. In the cattail marshes individuals could often be seen on the wing in early afternoon, flying just above the tops of the lower story of such plants as smartweeds and bur marigold.

Larvae were found in the ooze and semisuspended silt of the hummock margins and the edges of the marsh pools, and a pupa that emerged two days later was taken floating vertically in the stagnant muddy water of a muskrat runway.

148. *Pilaria quadrata* (Osten Sacken)

1936–39; May 28—June 23. Apparently but a single generation a year.

Locally common in a number of definitely well-shaded situations—low thickets, the wooded margins of two widely separated ponds in the oak-hickory woods, and wooded seepage areas. Rare to numerous in the birch-maple-elm and tamarack-sumac swamps. The correlation of this species with bare, shaded, muddy areas is very evident.

Alexander (1920) took immatures of this species from temporary rain pools in a low woods.

149. *Pilaria recondita* (Osten Sacken)

1936–39; May 19—August 26. Probably two widely overlapping generations a year.

This is the most abundant *Pilaria* and one of the most abundant crane flies on the Reserve. Abundant and generally distributed throughout the birch-maple-elm and tamarack-sumac swamps, the wooded parts of the southwest swamp, the low thickets, and the cattail marshes; common in the marshes, the flood-plain woods, and along streams; spreading into the oak-hickory for considerable distances; not found in the bogs.

The immature stages were found in the semisuspended silt of the swamp

pools and were particularly numerous in the thin layers of silt between sodden, partly decayed leaves in the pool margins.

150. *Pilaria tenuipes* (Say)

1936–39; June 2—July 5, and July 22—August 26. Two generations a year.

This was the least common *Pilaria* taken in this region. Rare to barely numerous in and about the marshes, swamps, and low thickets; common only in the vicinity of streams and seepage areas. There it was more frequent in shaded or semishaded situations.

The larvae were taken from the fine semisuspended or colloidal silt of stream and pool margins. Pupae were taken from the same situations and from distinctly drier, though still wet, mud a foot or more from the water's edge.

Among the series taken from the Reserve I have a male specimen with veins M-1 and M-2 fused to the tip in one wing, thus obliterating cell M-1. In another male specimen from this same series, veins M-1 and M-2 are fused at the tips, leaving cell M-1 a short closed cell no longer than the fused tips of M-1-2. These specimens lend weight to Alexander's recent surmise that his *Pilaria edwardi* may have been based upon an abnormal specimen of *tenuipes,* with M-1 obliterated in both wings.

151. *Hexatoma* (*Eriocera*) *cinerea* (Alexander)

1937; May 18 and May 26 (?)

I took a single male of this species on May 18 from Honey Creek, just below the Pinckney Mill Dam. Camburn returned to this spot several times within the following week and just before dusk on May 26 observed a large swarm too far overhead to net. I have large series of this species (May 19 to June 10) from along the Huron River and from Fleming Creek, near Ann Arbor.

Alexander (1914 and 1920) obtained the immature stages of this species in large numbers from a gravelly sand bank along Fall Creek, near Ithaca, New York. Here adults were emerging on April 30.

152. *Hexatoma* (*Eriocera*) *gibbosa* (Doane)

1936, 1938; June 16–27. A single generation a year.

Numerous to common along the pool and riffle sections of Hell and lower Honey creeks in 1936, not taken at all in 1937, and only two specimens found in 1938. Never taken swarming, but males and females were swept from the shrubs that overhang the water.

The larvae were taken from hard-packed sand, somewhat overgrown with algae and beneath four to six inches of water, just below a slight riffle. In the breeding jar these migrated well above the water level before pupating.

Although I am referring these and other southern Michigan specimens to *gibbosa* (Doane), I believe that the latter will prove to be, at most, a northern race of *fuliginosa* (Osten Sacken).

153. *Atarba picticornis* Osten Sacken

1937–38; June 16, July 6–11, and August 4.

Rare to barely numerous and very local. On one occasion numerous in Kalmbach's woods, and twice taken in small numbers in the birch-maple-elm swamp. Other records are for single specimens from the birch-maple-elm, the southwest swamp, and a few mesic areas of the oak-hickory.

The immature stages live in sodden rotting hardwood logs.

154. *Elephantomyia westwoodi* Osten Sacken

1936–39; June 10—August 1. Probably a single generation a year.

In 1936 this species was confined to the birch-maple-elm swamp, where it was twice recorded as numerous and a number of single individuals were taken. In 1937 and 1938 it was common in this swamp and numerous to common, but very local, in the tamarack-sumac swamps and in the flood-plain woods of the southwest swamp. In 1938 it was also fairly common in two other restricted areas—one a low oak-hickory and the other a thicket between the oak-hickory and a marsh.

The larvae live in wet decaying hardwoods, and nearly all of the specimens from this region could be referred to the vicinity of a definite log. One maple log in the birch-maple-elm swamp was inhabited in 1936, 1937, and 1938; and an aspen log in the tamarack-sumac was inhabited in both 1937 and 1938. The adults do not spread into the drier woods, even when common near their margins.

155. *Cladura flavoferruginea* Osten Sacken

1936–38; September 23—October 25. One generation a year with a markedly autumnal adult season.

All of my records are due to the collecting of Blair and Cantrall, who swept a considerable series from the oak-hickory woods and reported many more that were seen on the wing in October.

Dr. and Mrs. Alexander took the larvae and pupae of this species from the rather dry soil of an open woods near Urbana, Illinois (Alexander, 1922).

156. *Neolimnophila ultima* (Osten Sacken)

1936–39; April 25—May 10, and August 31—October 7. Two generations a year.

Rather generally distributed, in the spring spreading widely from the

vicinity of vernal seepage areas, in the fall from the vicinity of rills and seepage. All of the spring records from the Reserve and its vicinity are from Camburn's collecting. The fall records are partly mine, but are chiefly those of Blair, Camburn, and Cantrall.

157. *Gnophomyia tristissima* Osten Sacken

1936–38; June 18—July 9, and August 11–22. Two generations a year.

Rare to numerous and very local. Chiefly from the flood-plain woods of the southwest swamp, but several records from the birch-maple-elm swamp, the lower areas of oak-hickory, and the thickets between oak-hickory and marsh.

The larvae live in wet decaying wood, particularly beneath the wet loose bark of a partly dead standing tree or beneath the loosening bark of recently fallen logs. On the Reserve a standing but damaged willow was inhabited in 1936, 1937, and 1938, producing adults in June and again in August of each year. Larvae and pupae were also taken from a fallen aspen in a low moist thicket between Fishhook marsh and the southwest swamp.

158. *Gonomyia* (*Gonomyia*) *florens* Alexander

1936–38; June 12—July 11, and August 11–15. Two generations a year.

Rare to numerous and rather local. Most frequently taken from along the courses of Hell, Honey, and Unadilla creeks; occasionally numerous about the margins of the marshes and of the tamarack-sumac swamps on the Reserve.

159. *Gonomyia* (*Gonomyia*) *kansensis* Alexander

1937–38; June 23—August 2.

Rare, except for numerous specimens that came to light. Those collected in the field were from the margins of the tamarack-sumac swamp and from along the course of a small rill.

Elsewhere, in Washtenaw and Lenawee counties, Michigan, southern Indiana, and southwest Missouri, I have always found this species definitely associated with sand and gravel bars and the banks of streams.

160. *Gonomyia* (*Gonomyia*) *subcinerea* Osten Sacken

1936–39; May 20—October 30. Except for June and early July, when this species is at a peak, there is a more or less constant level of high abundance throughout the summer. Probably a mixture of two and three generations during the year.

Next to *Pseudolimnophila noveboracensis,* this is the most abundant species on the Reserve; and it may even equal that species in numbers of individuals. The adults are abundant and generally distributed through-

out the oak-hickory, the flood-plain woods, and the swamps, and are numerous to common in nearly all moist situations. They are particularly concentrated on the slopes above marshes and swamps.

Larvae have been taken from a rather wide variety of situations, but always in wet to semisuspended, black, silty mud: seepage areas, margins of pools and streams, and permanently muddy areas in swamps. They are able to thrive in very thin strata of wet silt, such as cow tracks and other miniature depressions.

161. *Gonomyia* (*Lipophleps*) *sulphurella* Osten Sacken

1936–39; May 31—September 15, with definite peaks in early June and in August. Two generations or more a year.

Locally numerous to common along Hell, Honey, and Unadilla creeks; numerous to (rarely) common in early June along some of the short rill courses and about some of the seepage areas of the Reserve; rare to numerous during the rest of the season about the margins of the bogs and marshes.

I have taken the immature stages only from saturated sand or sandy silt at the margins of streams, ponds, and lakes, where the larvae and pupae are often abundant. Such situations were very restricted and local on the Reserve, and no immatures were found in the few that were examined. It seems probable that the immatures are able to live in much less sandy situations than any from which they have actually been taken.

162. *Gonomyia* (*Ptilostena*) *blanda* Osten Sacken

1936–39; May 24—August 31, with well-marked peaks in June and in late August. Probably two generations a year.

The adults of this species are among the most persistent spreaders into the upland woods. They were common in most of the oak-hickory and often abundant on oak-hickory slopes that extended from the margins of swamps or marshes; common in the flood-plain woods, the birch-maple-elm and tamarack-sumac swamps, and numerous to common along rills and brooks and in seepage and shrub-sedge marshes. An occasional specimen was taken from nearly every sort of habitat.

The immature stages have been taken (Berrien County, Michigan, and southern Indiana) from the very wet to saturated silt of marshes and seepage areas.

163. *Helobia hybrida* (Meigen)

1936–39; April 25—October 25, with well-marked peaks in April–May, early July, and in late August–September. Of these, the spring and fall peaks are much more conspicuous. At least a few records for every week of this long season; probably three generations a year.

Abundant in the spring about nearly every area of vernal seepage, although many of these areas become very dry during the summer. After early June most of the records are from the oak-hickory, the thickets, and the flood-plain woods in the vicinity of marshes and seepage areas. In the summer most of the specimens are taken from definitely shaded areas, but in the spring they are equally numerous in the open grasslands. *H. hybrida* is a marked spreader as an adult, individuals moving comparatively long distances from the place where they emerged.

The immature stages are spent in wet soil, and the larvae and pupae have been taken from seepage areas, rill margins, marshes, and especially from areas in grasslands that are boggy in early spring even though they become friable or comparatively dry in summer.

164. *Erioptera* (*Erioptera*) *chlorophylla* Osten Sacken

1936–38; June 20—July 30, with a well-marked peak in midseason.

Locally abundant along the streams, particularly in the vicinity of small seepage areas and in marshes traversed by rills; common to abundant, but rather local, in the grass-sedge-fern marshes and in the birch-maple-elm swamp; locally numerous (rarely common) in the shrub-sedge marshes, the flood-plain woods, and the tamarack-sumac swamps. Daytime collecting in such open situations as the grass-sedge-fern marshes would indicate that this species is much less abundant than it actually is, but toward late dusk individuals and small swarms appear in numbers above or in the tips of the tallest grasses and sedges.

The immatures were taken from the semisuspended, almost semifluid mud of a diffuse seepage spring on the sloping banks of Hell Creek. Other, unreared larvae, almost certainly this species, were taken from the black, semisuspended silt of pools in the birch-maple-elm swamp.

165. *Erioptera* (*Erioptera*) *chlorophylloides* Alexander

1936–39; June 8—July 26. Apparently but a single generation a year.

Abundant in the grass-sedge-fern, shrub-sedge, and cattail marshes; numerous to common in the flood-plain woods and tamarack-sumac swamps; locally numerous in the oak-hickory; rare in the vicinity of streams and seepage areas. The specimens from the flood-plain woods, tamarack swamps, and oak-hickory are doubtless spreaders from the marshes.

Unreared larvae, almost certainly this species, were taken from the black, oozy mud of the cattail marshes and from the saturated silt of a hummock margin in a very wet, grass-sedge-fern marsh.

Although the habitats of this species overlap with those of *chlorophylla*, it is much more characteristic of the marshes and is relatively rare along the streams and seepage areas that form the most characteristic habitat of

chlorophylla in this region. *E. chlorophylloides* was particularly abundant in the cattail marshes and in a very wet ecotone between a grass-sedge-fern and a shrub-sedge marsh in the big swamp. Both sexes were on the wing from early to late dusk (about 6:30 to 8:30 P.M., E. S. T.) in the last days of June, but they began to settle down on the leaves of the tallest herbage and shrubs, or among the leaves of the lower boughs of the trees that bordered the marshes, before it was too dark to see a crane fly against the sky. In this interval numerous swarms of males formed in the vicinity of projecting tall shrubs or beneath the overhanging boughs of bordering trees. Often a dozen swarms of perhaps twenty males each could be seen at one time. A swarm rarely moved more than a few feet from the spot where it formed, and it re-formed in the same place if it was dispersed by a net. One swarm was repeatedly collected from for half an hour and, although no more than twenty individuals were ever present at a time, continued collecting of from two to six individuals at a time yielded over sixty individuals. Four of the sixty were female. Ordinarily a lone female flies into the swarm, zigzags a moment or two with the moving males, and is seized in copulation by the first male that touches it. The pair then flutters to a near-by support to complete copulation. The few pairs that were seen to leave a swarm in copulation quickly moved to the underside of the leaf or blade of grass upon which they had alighted.

166. *Erioptera* (*Erioptera*) *furcifer* Alexander

1936–38; June 25—July 27. A single generation a year.

Much less common than either *chlorophylla* or *chlorophylloides,* this was the third most common member of the *chlorophylla* group. Apparently much more local than either *chlorophylla* or *chlorophylloides;* it was occasionally numerous in the vicinity of a marshy spring rill that flows into the southwest swamp, in a seepage marsh along Hell Creek, and in several cattail marshes—both those along seepage rills and in small ponds in isolated areas. At least two of these isolated cattail ponds gave a considerable number of individuals in both 1936 and 1937. Occasional specimens were taken from tamarack-sumac swamps, from grass-sedge-fern and shrub-sedge marshes, and from along stream courses.

167. *Erioptera* (*Erioptera*) *gaspeana* Alexander

1936–39; July 14–29, August 24.

Locally numerous in the shrub-sedge and cattail marshes, and in one wet shrub-sedge and swampy thicket along Honey Creek. A few specimens were taken from the grass-sedge-fern marshes. Cantrall took this species in some numbers at light in late July.

168. *Erioptera* (*Erioptera*) *megopthalma* Alexander

1936–39; June 3—July 17.

Locally numerous in the shrub-sedge and grass-sedge-fern marshes, especially in the ecotone between Fishhook marsh and a tamarack-sumac swamp at its northern end, where a few specimens were taken in each of the three summers.

Alexander (1920) took the larva from the rich organic mud of a cold hillside swampy woods. (I did not find the species at all in the only similar habitat of the present region, Kalmbach's woods.)

169. *Erioptera* (*Erioptera*) *septemtrionis* Osten Sacken

1936–39; May 28—October 7, with a pronounced midsummer peak. Probably two generations a year with a marked midsummer overlapping.

Numerous to occasionally common, to judge by net collecting; abundant at light. The netted specimens were swept from the herbage of the birch-maple-elm and tamarack-sumac swamps and the bordering slopes of the oak-hickory in some numbers; somewhat less numerous in the grass-sedge-fern marshes and along the streams. This species is markedly nocturnal. It is the most characteristic and persistent visitant of lighted sheets of any crane fly, and both sexes come to light in large numbers, frequently in copulation. Indeed wherever I have collected throughout its range, lighting produces far more specimens than all other methods of collecting combined; and specimens often come to light on nights that appear to be too cold or too windy to permit any other species to be attracted.

Alexander (1920) describes the larvae as taken from the "rich, organic mud of a cool, shaded woods."

170. *Erioptera* (*Erioptera*) *straminea* Osten Sacken

1936–38; June 14—August 23, with a definite peak in late June and the first half of July.

Abundant in marshes that are dominated by flowing water, whether braided rills or seepage areas; locally numerous in the shrub-sedge and grass-sedge-fern marshes and the bogs of the Reserve. Absent from all well-wooded situations.

The immature stages were taken from the semisuspended silt that was washed from the roots and stems of sedges that had been pulled up from a very wet marsh; other larvae were taken by seining through a coffee strainer the muddy water of a vigorously trampled area of a marsh.

E. straminea appears to be the most characteristic and abundant *Erioptera* of marshy seepage areas in this region and could always be taken in large numbers from the extensive rill and seepage areas of Hell and Honey creeks; but it was definitely much less common and much more local than *chloro-*

phylla, chlorophylloides, uliginosa, vespertina, or *villosa* in the more stagnant marshes and swamps of the Reserve.

171. *Erioptera* (*Erioptera*) *uliginosa* Alexander

1936–39; May 20—August 17. Probably two broadly overlapping generations a year.

Abundant and generally distributed throughout nearly all extensive permanent marshes of the region except the seepage marshes, where it is comparatively rare; numerous to common in the birch-maple-elm and tamarack-sumac swamps. Spreading very slightly beyond these areas. Absent or very rare in the local sphagnum-Cassandra bogs, although taken in large numbers from tamarack-invaded sphagnum bogs of Washtenaw and Jackson counties.

Larvae were found in the saturated or semi-inundated silt and plant detritus of the marshes, particularly in the wet silty deposits between the bases of the older sedge stems.

E. uliginosa becomes very active about twilight, when small swarms fly for short periods in rather loose, horizontally disk-shaped groups, slightly above the grass and sedge tips. These swarms, unlike those of *chlorophylloides,* do not center about projecting shrubbery and are not more common near the edges of the marshes. Usually, the participating individuals settle down again into the grass-sedge stratum after a few moments of flight. On June 27, 1938, a swarm of a dozen or so individuals was found every few feet over many acres of grass-sedge marsh in the big swamp, and a similar distribution of small swarms was noted several times at dusk in Fishhook marsh.

172. *Erioptera* (*Erioptera*) *vespertina* Osten Sacken

1936–39; May 5—September 3. Probably three generations a year is usual.

Never abundant, but numerous to fairly common in nearly all situations in which definitely wet or muddy soil is persistent throughout most of the year. This includes all marshes and swamps, muddy stream margins, rills and seepage areas, and the margins of the bogs. The adults do not spread into the oak-hickory.

The larval habitat is saturated silty mud, ranging from almost semifluid to moderately plastic; often in the one- to two-millimeter-deep accumulations of silt in the depressions of sandy stream margins. In early July of 1936 females of this species were observed ovipositing in the recently exposed, saturated black silt at the edges of the then receding relict lake in the big swamp, and teneral adults were taken from this spot on September 3.

173. *Erioptera* (*Erioptera*) *villosa* Osten Sacken

1936–39; June 1—August 2. I believe that one generation a year is the rule.

Abundant in the wetter grass-sedge-fern and shrub-sedge marshes and in the ecotones between these marshes and the tamarack-sumac swamps; locally numerous to common in the birch-maple-elm and tamarack-sumac swamps and the cattail marshes; occasional specimens from the flood-plain woods and from along streams. Very few from the sphagnum-Cassandra bogs.

Unreared larvae, referred to this species with confidence, were washed from the silt and plant debris of the marsh channels and from the semi-suspended black muck of the semi-inundated ecotone between a marsh and a tamarack-sumac swamp.

E. villosa was often taken in the same net sweep with *uliginosa;* and in late summer, when a considerable number of smaller and darker individuals of *villosa* are on the wing, it was often difficult to separate the two species without inspection of the genitalia. Generally speaking, *villosa* is active much earlier in the afternoon and ranges more freely away from the marshes than does *uliginosa. E. villosa* was much more characteristic of the swamps than was *uliginosa,* so that on days when the two species were taken in almost equal numbers from the marshes of the big swamp, the tamarack-invaded ecotones would yield ten *villosa* for every individual of *uliginosa.*

174. *Erioptera* (*Gonempeda*) sp.

1937; May 15, 18, and 20.

Five specimens swept from the marsh vegetation along Honey and Hell creeks. This species differs notably from *nyctops* Alexander in the much darker body coloration and in the male genitalia.

175. *Erioptera* (*Mesocyphona*) *caloptera* (Say)

1936–39; May 8—October 8. Common to abundant throughout this season; probably two or three generations a year.

Numerous to abundant in every habitat on the Reserve; rather generally distributed and a marked spreader from the larval habitat. Least numerous in the bogs.

The immature stages live in semisuspended silt and mud and can utilize very small areas and very slight depths for completion of their development, if persistently wet conditions are maintained. Data on the emergence of adults of this species on September 3, 1936, from the margin of the rapidly shrinking relict lake of the big swamp, when checked with the recorded water levels of this lake during the summer, indicate that the combined length of egg, larval, and pupal stages could not have been longer

than eight weeks. This agrees rather well with some of the breeding cage records for this species.

Swarms of the males of *E. caloptera,* on the same dates and under the same conditions as swarms of *E. needhami,* differed distinctly from those of the latter in both behavior and shape. Swarms of *E. caloptera,* seen on June 29, 1938, were more or less spherical in shape and from four to ten feet above the top of the marsh vegetation. All were beneath the overhanging boughs of tall marsh shrubs (poison sumac) or the swamp white oaks that here and there border the marshes.

As in all other regions from which I have examined large series of this species, the local series vary a great deal in the extent and intensity of wing, body, and leg coloration, although they do not approach the markedly melanistic condition of specimens from the southern states.

176. *Erioptera* (*Mesocyphona*) *knabi* Alexander

1936–39; May 24—June 13, and August 8–23. Apparently two generations a year.

Rare on the Reserve, where several light records were obtained, but locally common to abundant along very sandy shores of several of the near-by lakes; once taken in some numbers from a sand bar of lower Honey Creek.

This species, originally described from Mexico, has since proved to be well represented in Florida, Texas, Oklahoma, southwestern Missouri, and southern Indiana, and has lately been taken from three counties in southern Michigan. All records, except the few from light on the Reserve, have been from sandy stream or lake margins.

177. *Erioptera* (*Mesocyphona*) *needhami* Alexander

1936–39; June 5—August 29, with a definite peak in June. At least two generations a year.

Common to abundant in the grass-sedge-fern and shrub-sedge marshes; somewhat more common in the large, nonseepage marshes of the Reserve than in the seepage marshes and rill margins; an occasional specimen from along the brook courses.

I have elsewhere and on a number of occasions taken the immature stages from the sandy margins of small rill courses; but it is evident that on the Reserve the immature stages must thrive in the organic silt that covers the peaty soil of the marshes.

On June 27, 28, and 29, 1938, this species was found swarming between 7:15 and 7:45 P.M. in almost incredible numbers over some ten acres of grass-sedge-fern marsh in the west end of the big swamp, and in the near-by shrub-sedge marsh of a kettle hole. The swarms varied from six or eight to more than thirty individuals, and separate swarms were found every twelve

to fifteen feet. The individuals comprising each swarm flew rather rapidly, zigzaging back and forth in a horizontal plane just above or between the tips of the tallest grasses. The back-and-forth movement of each individual was about a foot or eighteen inches, and the entire swarm drifted about over a a radius of two or three feet. Whenever the complete calm was broken by a slight breeze, the members of the swarm instantly settled down among the grasses, to reappear almost as quickly when the breeze died down. The position and behavior of these swarms were noticeably different from the swarms formed by *E. caloptera* in a very similar habitat on June 29.

178. *Erioptera* (*Mesocyphona*) *parva* Osten Sacken

1936–39; May 24—August 31, with a slight peak in early July. Probably two and three generations a year.

Nearly ubiquitous except for the driest parts of the oak-hickory, but most common in the vicinity of the marshes and along the stream courses. Once noted swarming (June 21) just above the leaves of a tall growth of skunk cabbage in a muddy, shaded margin of the northwest marsh. Next to *E.* (*E.*) *septemtrionis, E. parva* is the most persistent species taken at light.

179. *Erioptera* (*Hoplolabis*) *armata* Osten Sacken

1936–39; May 13—July 1, and July 22—August 31. Two generations a year.

Locally abundant along the stream courses, especially in the vicinity of sloping or vertical, more or less bare earth banks; rare to barely numerous and very local on the Reserve, always in the vicinity of permanent or vernal rills.

The immature stages live in wet, but not sodden, soil; most frequently taken from moist but fairly well-drained stream banks in rich barely friable soil.

This species was found swarming in large numbers on May 17, at 6:00 P.M., along Unadilla Creek. The swarms are much more like those of various *Erioptera* than of *Mesocyphona.* They are larger, more persistent, of much greater vertical depth than the latter, and tend to form beneath the lower boughs of the near-by trees, four to twelve feet above the ground.

180. *Erioptera* (*Ilisia*) *armillaris* Osten Sacken

1936, 1938; August 3–9.

Very local; taken several times in some numbers from a short reach of Unadilla Creek, where it flows between fairly high grass and shrub-grown earthen banks with small seepage areas at the bottom of the banks. Two light records for the Reserve.

181. *Erioptera* (*Ilisia*) *graphica* Osten Sacken

1936–39; May 30—August 25, and September 23, with a distinct peak in mid-August. Two generations a year.

Common to abundant about the margins of permanent woods ponds in the oak-hickory and in the flood-plain woods of the Southwest Swamp; spreading slightly into adjoining shaded areas. These situations yielded specimens each year, but the *E. graphica* was rare elsewhere, with an occasional specimen from along Hell and Unadilla creeks and at light.

Unreared larvae, undoubtedly of this species, were washed from the muddy, nearly bare soil at the margin of a woods pond. They were hardly separable from the known larvae of *venusta*.

182. *Erioptera* (*Ilisia*) *venusta* Osten Sacken

1936–39; May 27—August 26, with definite peaks in June and August. Two generations a year.

Common, occasionally abundant, in the rather open parts of spring rill and seepage marshes and along Hell and Honey creeks; numerous to common in the birch-maple-elm swamp and in the lower parts of the flood-plain woods of the southwest swamp. Absent or very rare from the nonflowing extensive marshes of the Reserve.

I have taken the larvae at Ann Arbor from the thin surface layer of saturated silt along the muddy margins of various spring rills. I believe that the habitat is less affected by shade than by the need of areas of bare mud, not thickly grown with herbage nor covered with mosses or algae.

183. *Ormosia bilineata* Dietz

1937; May 12–18. I have no records of an autumnal generation in Michigan.

Numerous along upper Honey and Unadilla creeks. Not taken on the Reserve.

184. *Ormosia deviata* Dietz

1936–39; May 13—July 9, and July 27—October 14. Scarce throughout July. Two generations a year.

Common and widespread in all wooded situations; abundant in the lower flood-plain woods and the swamps; common in the shrub-sedge marshes, but rarely taken in the grass-sedge-fern or cattails; locally numerous along the streams. Not taken in the bogs. This species appears to be primarily associated with bare saturated soils of shaded areas, but tends to spread rather widely into the shaded herb stratum of adjoining habitats.

185. *Ormosia frisoni* Alexander

1937; May 12–20. (I have never found an autumnal generation of this species although it is abundant in the spring in Michigan and Indiana.)

Common to abundant along the marshy course of both branches of Honey Creek; numerous along the rills of Kalmbach's woods and a short, permanent spring rill on the Reserve. (See remarks on *O. meigenii.*)

186. *Ormosia meigenii* (Osten Sacken)

1937; May 15.

Eleven specimens from along the course of the rills of Kalmbach's woods.

I had always regarded *frisoni* as forming a midwestern vicariate of *meigenii,* which, until lately, I had never taken in Indiana or Michigan. The records from Livingston County are further substantiated by a series of *meigenii* taken at Lansing, Michigan, by Sabrosky. These all appear to be typical *meigenii* without any indication of intergradation.

187. *Ormosia monticola* (Osten Sacken)

1936–38; August 13–26. Apparently but a single generation a year.

Abundant along the rill courses of the cold hillside of Kalmbach's woods; rare, once barely numerous, about the small shaded rill that flows into the southwest marsh.

188. *Ormosia nubila* (Osten Sacken)

1937; May 15–16.

About a dozen specimens from three separate rill courses near Unadilla. From other Michigan records it is likely that I missed the peak of the spring generation of late April and May, and I may have wholly missed an autumnal generation of late September. It is clear, however, that this species is far less common in the vicinity of the Reserve than about Ann Arbor.

189. *Ormosia pygmaea* Alexander

1938; August 13–26.

Rare to barely numerous in Kalmbach's woods; nowhere else in the region of the Reserve. (Both a May–June and an August–September generation recorded from the shaded rills and ravines about Ann Arbor, where this species is much more numerous.)

190. *Ormosia rubella* (Osten Sacken)

1936–38; September 4–23. Apparently but a single generation a year, with a markedly autumnal adult season.

Locally numerous to common in the grass-sedge-fern and especially the shrub-sedge marshes of the Reserve.

191. *Dasymolophilus niphadias* Alexander

1936–38; June 17—July 16. A single generation a year.

Locally abundant in the vicinity of shaded rills and seepage areas; in this region, and in Michigan in general, usually associated with skunk cabbage growths. Twice taken from a small seepage rill that flows into the north branch of Honey Creek, twice from a small rill course on the Reserve, and in 1937 and 1938 swept in huge numbers from the deeply shaded herbage of Kalmbach's woods.

I did not find the larvae, but have taken adults of the closely related *D. ursinus* in a small tent trap set at the muddy margin of a tiny rill (Mountain Lake, Virginia).

192. *Molophilus forcipulas* (Osten Sacken)

1936–39; June 4—September 3, with a definite peak in late June and early July. Probably two generations a year.

Common to abundant in the birch-maple-elm swamp; numerous to common but rather local in the flood-plain woods, the muddy dogwood thickets between oak-hickory and marsh, the tamarack-sumac swamps, and the cattail marshes.

The larvae are found in the black, saturated organic silt, especially in areas where matted leaves form a considerable element of the sodden mud.

193. *Molophilus fultonensis* Alexander

1936–38; August 10–24. One generation a year.

Very local but abundant in three restricted spots in the immediate vicinity of spring rills and seepage areas, where the adults appeared at about the same season each year. One of these places was a short, shrub-bordered rill course on a hillside above the southwest marsh, another was a short marshy rill course that extends from a hillside spring to Hell Creek, and the third was a seepage area and rill course in the valley of the north branch of Honey Creek. Elsewhere this species was rare to barely numerous and always in the vicinity of springs or seepage. (See also the remarks under *M. huronis*.)

194. *Molophilus hirtipennis* (Osten Sacken)

1936–39; May 26—August 23, with definite peaks in June and mid-August. Probably two generations a year.

Numerous to common in the marshes and especially in their ecotones with the tamarack-sumac swamps and with a few low areas of oak-hickory. Locally abundant in the vicinity of spring-rill and seepage marshes; spreading somewhat into the shrub and herb strata of surrounding habitats.

In spite of a diligent inspection of many hundreds of individuals and a definite and prolonged search for males, only females of this species were found in the three years of my own collecting and only females were in

the considerable series sent me by Blair, Camburn, and Cantrall. This species is not *M. soror* (of which I have large series from tamarack-sphagnum bogs in Washtenaw, Oakland, and Jackson counties) and cannot be separated from the types of *hirtipennis* or from Osten Sacken's description of that species. I have for a number of years taken many large series, of females only, of what appears to be this same species in other parts of Michigan, and in Indiana, Tennessee, Georgia, and Florida. I have also before me females taken in association, but not in copulation, with males of *M. cramptoni* Alexander, *M. quaraspinosus* Alexander, and of the form assigned to *hirtipennis* by Alexander. The Livingston County females include all of the discernible characters of the females referred to these species.

Alexander (1927) has suggested the possibility of parthenogenesis in the case of *M. soror* (my own series of *soror* are consistent with this suggestion), and I have much circumstantial evidence that suggests that parthenogenesis occurs in several species of *Molophilus,* probably forming the usual method of reproduction in *pubipennis* and *hirtipennis,* and present with bisexual reproduction in *auricomas.* To date, rearing experiments to check this surmise[11] have been unsuccessful.

195. *Molophilus huron* Alexander

1936–39; June 5—August 23, with an apparent peak in July. I think that the July peak is very possibly the result of an overlapping of adults of a first and second generation.

Abundant and widespread throughout Kalmbach's woods, in which numerous individuals spread for some distance into the more open adjacent woods; locally and occasionally numerous to common in the birch-maple-elm and tamarack-sumac swamps.

Unreared larvae, assigned to this species on the basis of comparisons to the known larvae of *M. floridensis* and *M. fultonensis* (from North Carolina), were common in the black, saturated silt of the rill margins in Kalmbach's woods.

A series of several hundred specimens of this species or complex from the Reserve and Kalmbach's woods, and equally large series from other parts of Michigan and from the southern Appalachians, were carefully studied in an attempt to be positive of the specific identity of the specimens from the Reserve and its vicinity. Alexander also very generously placed his collec-

[11] I believe that the rather dimorphic male now assigned to *pubipennis* may well be a normal variant of *fultonensis,* having the combination of three considerable departures from the mean: small size, light coloration, and retention of spicules on the inner dististyle. It also seems to be at least a tenable hypothesis that *hirtipennis* has progressed far toward adoption of parthenogenesis, with the occasional production of males that vary considerably into local types.

tion of genitalia of this group and his wing slides, including the types of *fultonensis, huron,* and *paludicola,* at my disposal. I did not see the pinned remainders of the specimens from which the genitalia and wings were taken, but did have Alexander's detailed and exceedingly clear descriptions. Many of my specimens would key to *paludicola* and fit the descriptions and slides exactly, others taken at the same time and place were just as definitely *huronis,* and the majority of the specimens had various intermediate structures or combinations of characters of the two. The above remarks pertain to material from the Reserve, but a similar intermixing was found for material from other parts of Michigan and the Appalachians. I am inclined to believe that characters ascribed to *huronis* and *paludicola* are individual variations not disclosed in small series or by certain locally isolated, highly inbred populations.

Although my series of *M. fultonensis* from the Reserve and Hell and Honey creeks can be positively separated from the specimens I am recording as *huron,* this may be because all of my *fultonensis* were taken from definitely isolated spots, where the populations maintained themselves in unmixed descent year after year. These specimens, although very uniform in coloration and in the structure of the outer dististyle, varied markedly in the spines of the mesal lobe of the basistyles, some specimens definitely approaching the condition characteristic of *huron* and *paludicola,* and the disk of the outer dististyle varied from almost totally glabrous (at least any setulae were undetectable with an 8 or 4 mm. objective) to bearing conspicuous and numerous setulae when viewed with the 16 mm. objective or the higher powers of a binocular. I have many specimens from other regions in Michigan that I cannot definitely refer to *fultonensis* as clearly distinct from *huron* or from the male form assigned to *pubipennis.*

196. *Molophilus pubipennis* (Osten Sacken)

1936–38; June 13—July 18. Probably but a single generation a year.

Numerous to common in a rather wide variety of damp to wet and usually shaded situations. Taken rather frequently from along marshy streams and rills, the thickets separating marsh from oak-hickory, the birch-maple-elm swamps and tamarack-sumac swamps, and the wetter parts of the flood-plain woods. Never found in large numbers, although searched for particularly whenever a specimen was netted.

All specimens were females, and the only other *Molophilus* with which they were taken (and with this frequently) was *M. forcipulus* in which the males and females have been definitely associated by rearing and by numerous pairs taken in copulation. (See also remarks under *M. hirtipennis* and under *M. huron.*)

197. *Toxorhina magna* Osten Sacken

1936–38; June 22—August 29.

Numerous in the northwest end of the big swamp where they were taken from the birch-maple-elm, tamarack-sumac, and mixed marshes surrounding the relict lake; somewhat less numerous in the marshes surrounding Sayl Lake and in the grass-sedge part of the extensive rill-course marsh near lower Hell Creek (Toma and Tiplady roads marsh); a few other single specimens from other parts of the big swamp.

This large, supposedly Austral and Lower Austral, species was not wholly a surpise, since I had taken an occasional specimen, indistinguishable from this species and clearly not *muliebris,* in the extensive cattail-sedge marshes along the Huron River at Ann Arbor in 1931 and 1933.

198. *Toxorhina muliebris* Osten Sacken

1936–38; June 18—August 1.

Common to abundant in most of the well-developed marshes, especially those associated with rills and seepage areas; rarely taken more than a few yards from definitely wet marsh conditions. Often taken in small, loose swarms at, or just above, the level of the tallest herbage from late afternoon to early dusk.

In addition to the more than fifty specimens clearly referable to *magna* (indistinguishable from a series of Florida or Georgia specimens) and some hundreds of typical *muliebris,* the same localities from which *magna* was taken yielded a score or more specimens that appear intermediate in size and color and that either have one wing with first M-2 closed and the other with it open, or are of the size of *muliebris* with first M-2 closed in both wings. In view of the marked variation in size in any considerable series of *magna,* I am loath to regard these specimens as intermediates without further data.

ADDITIONAL NOTES: THE SPRING OF 1941

In 1941 I had an opportunity to revisit the George Reserve from May 25 to June 5, inclusive. Since these twelve days fill the only important seasonal gap in my former field work on the Reserve, it seemed desirable to include the additional data with the original report. The manuscript, however, was already in press, and it was found more feasible to present the 1941 results in the form of an addendum, rather than attempt to interpolate them into the completed manuscript and tabular summaries for 1936–38.

I. Additions to the Species List

199.[12] *Dolichopeza* (*D.*) *americana* Needham

1941; May 30. Rare; two males from the swampy ecotone between north-

[12] One hundred and ninety-eight species were recorded in the original annotated list.

west marsh and west central hardwoods. Here abundant wet logs and the exposed roots of living trees bear a rich flora of mosses and liverworts, and the wet forest-floor shows alternate patches of rank herbage and of bare, sodden leaf mold. One specimen was flushed from a mossy log, the other was swept from a clump of ferns.

Field observations in other regions lead me to believe that this species is much more typical of regions where damp shaded cliffs and mossy rocks are common, than of the glacial drifts and moraines of southern Michigan.

200. *Tipula nobilis* (Loew)

1941; May 28, June 2. Two males and two females from rather boggy, shaded rills; Kalmbach's woods and the small springy area bordering the rill above southwest marsh.

201. *Tipula oropezoides* Johnson

1941; May 27—June 3. Common to abundant in the vicinity of cool, shaded spring rills; rare to barely numerous along the very old, almost rill-like, intermittent ditch that traverses the swampy hardwood ecotone between west tamaracks and northwest marsh. On May 28 this species was abundant in Kalmbach's woods, but appeared to be definitely on the wane there by June 3. Each of three visits (May 27—June 2) to the little, isolated spring rill above southwest marsh yielded several specimens.

The immature stages live in the wet to damp mosses of permanently wet soil or rocks.

202. *Tipula penobscot* Alexander

1941; May 27, 30. Two females; both from low, wet, shaded ecotones between the oak-hickory and a marsh or bog.

203. *Tipula senega* Alexander

1941; May 28. Three males and one female that seem to pertain clearly to this species were taken in Kalmbach's woods, along with about a dozen males that appear to be intermediate between *senega* and *illinoiensis*. The latter species was common on damp grassy hillsides and about the margins of low woods at this season.

In several of the "intermediate males" the median plate of the eighth sternite has an irregular and unsymmetrical arrangement of the lateral spines, and the thoracic and abdominal markings vary independently of each other, and of the median plate of the eighth sternite, in the several specimens.

204. *Adelphomyia minuta* Alexander

1941; May 27—June 2. Abundant about the margins of the rill through Kalmbach's woods; common along the spring rill above southwest marsh on

May 27–30, a single female from this same spot on June 2. These flies appeared to be already past the peak of their season on May 27 and 28, for only about thirty males were taken with some seventy females.

The immature stages live in the wet silt or sandy silt of rill courses and rill margins. Several empty pupa skins were taken from saturated silt about three inches shoreward of the rill margin above southwest marsh.

205. *Prolimnophila areolata* (Osten Sacken)

1941; May 30—June 5. Locally rare to abundant in well-developed shrub or shrub-tree margins between various grass-sedge-fern marshes and the bordering, open, grassy, upland fields; rare in the swampy ecotone between northwest marsh and west central hardwoods.

On May 30 a few teneral males were found in an area of dogwood thicket that borders the southwest marsh, some twenty yards north of the spring; and by June 2, both males and females were emerging here in large numbers. The more teneral adults were restricted to the narrow zone just within the marshward edge of the thicket. Here the wet but friable, black soil is filled with mycelia-riddled twigs and well-decayed leaf mold, and bears frequent small splotches of thin, procumbent mosses. One male was taken while emerging from a pupa case that protruded slightly from the soil, about a foot inside of the shrub zone.

The other local areas where this species was taken yielded only a few specimens in spite of several hours of careful searching.

206. *Limnophila* (*Prionolabis*) *rufibasis* Osten Sacken

1941; May 28—June 1. Numerous to common in Kalmbach's woods; two males from the low swampy ecotone between the northwest marsh and the west central hardwoods; and a single male from the wall of a cottage on Silver Lake.

Nearly all of my previous records for this species had been from the close vicinity of brooks, creeks, or small rivers, where small swarms of males are occasionally seen swarming beneath tall boughs that overhang the water. None of the specimens taken this spring, however, are referable to any stream larger than the small rill through Kalmbach's woods, and the two males from the Reserve were nearly a mile from any permanent stream. It thus seems probable that the immature stages should be sought in wet, organic soil rather than in the definitely aquatic situations I had formerly suspected.

II. Further Observations on Species Previously Recorded

Of the 198 species already known from this area 103 were again taken in the spring of 1941. The habitat distributions of nearly all of these ap-

peared to conform closely with those given in the tabular summary and in the Annotated List (pages 46–52 and 58–118) except that twelve species, which reach the peak of adult abundance in the late spring, showed a greater abundance, a somewhat wider, or a more definite habitat distribution than had been evident from the records that were formerly available. The previously recorded seasonal distributions of nineteen of the 103 species (including five of the twelve that showed additions for habitat data) require extensions of from five to nineteen days; or, in the case of *Ormosia pygmaea,* add a spring generation to the late summer generation already known for this region. These twenty-six species are discussed below; the number that precedes each specific name is the same that it has in the tabular summaries of seasonal distribution and habitat (pages 19–28 and 46–52, respectively), and in the Annotated List.

7. *Dolichopeza* (*O.*) *obscura* (Johnson)

1941; May 30 (twelve days earlier than formerly recorded). Two separate groups of about a score of individuals each, were found resting in deeply shaded nooks in the birch-maple swamp.

9. *Dolichopeza* (*O.*) *similis* (Johnson)

1941; May 26—June 5 (nineteen days earlier than formerly recorded). Locally abundant in the birch-maple swamp on May 26; apparently in much diminished numbers and with a definitely higher proportion of females on June 2. Although taken from the same area of the swamp as *D.* (*O.*) *obscura, sayi,* and *subalbipes, similis* appeared to be restricted to a much narrower habitat than was *sayi* or *subalbipes* and to a rather different type of situation than that occupied by *obscura.* Until disturbed by my wading and splashing about, scores of individuals could be seen on the ceilings of the dimly-lit, miniature cavelike recesses that are formed where the mossy roots or root-bound platforms project over the water or the semisuspended silt margins of the swamp pools. Such low, dank, recesses were sometimes shared by *obscura, sayi,* or *subalbipes,* but *similis* was the most abundant species here and was practically confined to these spots.

10. *Dolichopeza* (*O.*) *subalbipes* (Johnson)

1941; June 2–5 (eight days earlier than formerly recorded). Abundant in the birch-maple swamp on June 5, and spread for 150 feet or more into the adjacent oak-hickory woods on the lower slopes of the esker. Apparently a huge "hatch" had taken place on June 3, 4, or 5, for only a few teneral males could be found in the swamp on June 3.

14. *Nephrotoma breviorcornis* (Doane)

1941; May 27—June 2 (sixteen days earlier than formerly recorded).

Half a dozen males from the southwest swamp and the low, wet woods between this swamp and Fishhook marsh.

20. *Nephrotoma polymera* (Loew)

1941; June 4 (ten days earlier than formerly recorded). Eleven males from the flood-plain woods of lower Hell Creek. All of these were recently emerged and all but three so very teneral that the markings on wings and abdomen were scarcely indicated.

29. *Tipula caloptera* Loew

1941; May 29 (twelve days earlier than formerly recorded). Both sexes were common in the vicinity of bridge abutments and spillways on Hell, Mill, and Dexter creeks.

43. *Tipula georgiana* Alexander

1941; May 26—June 5 (previously taken by Blair on June 2). Numerous to almost common in the more open upland woods; apparently more characteristic of the drier margins of the larger woods and of small woodlot-like areas than of the more typical oak-hickory forest.

45. *Tipula hermannia* Alexander

1941; May 28—June 2 (eleven days earlier than formerly recorded). Numerous, with females predominating, in Kalmbach's woods and in the extensive dogwood thickets above and partly surrounding the hillside spring above the southwest marsh.

47. *Tipula illinoiensis* Alexander

1941; May 25—June 4. This species proved to be common in a variety of little-shaded, moderately moist habitats: the more open areas in the lower woods, grassy hillsides that are still moist with early summer seepage, and the grassy, willow-shaded slopes below the central spring.

This species, in common with *Tipula bicornis, T. georgiana, T. serta,* and *Nephrotoma ferruginea,* all grassland or open woods inhabitants, appeared to congregate at night in the peripheral leaf clusters of the nearby oaks and willows. Collections and observations at late dusk showed that isolated trees (or the single row that marks a former fence line), if in the vicinity of moist grassy slopes or kettle-holes, become the nightly refuge of scores or even hundreds of individuals of these species.

50. *Tipula longiventris* Loew

1941; May 25—June 5. This species reached and passed the crest of its flight period within the twelve days I was on the Reserve. During this

time it rivaled *Tipula disjuncta* as the most abundant and conspicuous member of the oak-hickory woods fauna. Although the females were more frequent in the lower parts of the oak-hickory and its ecotones with swamp, marsh, and bog, the males were widespread throughout all but the driest parts of the hardwoods and were frequently observed toward dusk, searching for females well up the slopes of the hillside woods. More than a dozen pairs were observed in copulation, all but two pairs well after nightfall. All of these pairs, except one which was netted in flight, were resting vertically within one or two feet of the ground, on the trunk of a tree or sapling. In every instance the male was fully hardened, the female slightly or very teneral; but it was evident from their resting position (female uppermost and facing upward, the male facing downward) that the female had towed the male into the position in which they were observed. Although I have not observed the whole process of mating for any one pair, I believe that as a rule the searching male finds an emerging or recently emerged female and seizes her at once; copulation is effected immediately or as soon as her abdomen is free of the pupal skin. This takes place on the ground, usually at dusk or slightly later; the pair remain in copulo until the female has considerably hardened, and flight is a part of the later stages of copulation, probably due to the efforts of the female to free herself from the copulatory grasp of the male.

Two pupae were found just below the surface of the damp, friable woodland soil, beneath an inch-deep layer of leaf mold.

55. *Tipula serta* Loew

1941; May 25—June 5. This species should be rated as abundant rather than common, and as tending to spread into the woods and swamps. Its primary habitat, however, as judged from numerous teneral specimens and the behavior of the males, appears to be open, moist woods and grassy areas that have a vernal or even a slight permanent seepage.

57. *Tipula submaculata-mallochi* intergrades

1941; May 28 (thirteen days earlier than previously recorded). Two somewhat teneral males from Kalmbach's woods. Both are to be classed as approximately midintergrades; each has a *submaculata*-like ninth tergite, but the inner dististyles and eighth sternite have definitely *mallochi* structures.

59. *Tipula tephrocephala* Loew

1941; May 27—June 4. Should be rated as abundant rather than common on the basis of the 1941 records, and as widespread throughout nearly all wet situations except the unshaded marshes. The adults range widely from the springs, rills, and permanent or semipermanent seepage areas that provide the immature stage habitat.

64. *Tipula trivittata* Say

1941; May 25—June 5 (eight days earlier than previously recorded). This species, previously rated as "rare and local" was found to be abundant in nearly all moist to wet hardwood formations, especially in the low ecotones between the oak-hickory and the adjacent marshes, swamps, and bogs.

This abundant population of *trivittata* gave considerable evidence of a very brief adult season. Males formed the great majority of the individuals from May 25 to 27, and all of the specimens taken on these dates, though not often teneral, appeared to have rather recently emerged; by June 4 and 5, however, three-fourths of all the specimens observed were females, and fully half of the dozen or so males taken on these dates showed considerable signs of having been on the wing for some days—damaged wing margins, missing legs, and the slightly shrunken abdomens that are seen in week-old, cage-reared specimens.

73. *Liogma nodicornis* Osten Sacken

1941; May 26—June 4. Common to abundant and widely distributed throughout nearly all types of wet, shaded or partly shaded situations. Most abundant and most generally distributed in the tamarack-sumac swamps and along the wooded margins of the marshes; in fact their distribution more or less parallels that of the more luxuriant wet soil and shallow pool mosses. It was not taken, however, in either of the sphagnum bogs. Like *Tipula trivittata,* this species shows evidence of having a very short adult season.

85. *Limonia* (*Discobola*) *argus* (Say)

1941; June 4 (seven days earlier than formerly recorded). A single male.

91. *Limonia* (*Dicranomyia*) *immodesta* (Osten Sacken)

1941; May 27—June 4 (thirteen days earlier than formerly recorded). Already numerous in the swamps and along the wooded borders of the marshes.

94. *Limonia* (*Dicranomyia*) *longipennis* (Schummel)

1941; May 31 (nineteen days earlier than formerly recorded). Came to light in some numbers along with *Limonia* (*Alexandraria*) *whartoni, L.* (*D.*) *divisa, L.* (*D.*) *haeretica, L.* (*D.*) *pudica, Helius mainensis,* et al.

96. *Limonia* (*Dicranomyia*) *pudica* (Osten Sacken)

1941; May 26—June 2. Formerly recorded as "rare," this species proved to be numerous to almost common in a number of partly shaded, wet situations, particularly the shrub-tree margins of the grass-sedge-fern marshes.

101. *Limonia* (*Rhipidia*) *maculata* (Meigen)

1941; May 31 (sixteen days earlier than formerly recorded). Two males.

113. *Pedicia* (*Tricyphona*) *calcar* (Osten Sacken)

1941; May 28 (eight days later than formerly recorded). Still common in the rank vegetation of the boggy, hillside-seepage areas of Kalmbach's woods.

122. *Archlimnophila toxoneura* (Osten Sacken)

1941; May 26—June 5 (sixteen days earlier than formerly recorded). This species had been rated as rare to barely numerous on the basis of former records, but in the spring of 1941 was locally abundant in several of the low, swampy ecotones that border the grass-sedge-fern marshes, and occasional, but hardly numerous, in the hardwood and tamarack-sumac swamps. It is probable that the individuals which emerge in the deeper swamps average several days later in seasonal appearance than do those from the more open margins of the marshes, and that the "June 11–18" records for 1936–38 unduly stress the deeper swamps as the typical habitat.

152. *Hexatoma* (*Eriocera*) *gibbosa* (Doane)

1941; June 4 (twelve days earlier than formerly recorded). A fully hardened male was swept from the bough of a tree overhanging Hell Creek. The creek was at an unusually low stage for this time of year, with considerable areas of low, sandy margin above the water line.

186. *Ormosia meigenii* (Osten Sacken)

1941; May 28 (thirteen days later than formerly recorded). Two males and some twenty females from along the rill through Kalmbach's woods. Since no males of *O. frisoni* were found, it was *assumed* that the females all pertain to *O. meigenii.*

189. *Ormosia pygmaea* Alexander

1941; May 28. Three females from Kalmbach's woods. These were undoubtedly among the last survivors of the spring generation. Formerly known only from the late summer generation in this region.

196. *Molophilus pubipennis* (Osten Sacken)

1941; May 28—June 5 (sixteen days earlier than formerly recorded). Common to abundant in a number of wet, shaded situations, particularly in the vicinity of springs, seepage areas, and the margins of the less acid swamp pools. Still no males among the more than one hundred specimens that were collected this spring.

III. Seasonal Distribution in 1941

There may be some reason to question whether the seasonal records obtained from May 25 through June 5, 1941, are to be regarded as at all typical. There is no doubt but that in April and early May of 1941 the season was almost unprecedentedly advanced. The appearance of the spring flora and the leafing out of the trees was reported to be fully three weeks earlier than average for southeastern Michigan, on May 1. My own observations at Toronto, Ontario, where I had the opportunity to carry on field work from early April until May 22 were entirely in accord with this estimate. By May 1, 1941, the spring flora and hardwood foliage about Toronto were fully as far developed as they had been on May 20 in 1937, on the George Reserve; and at Toronto such early spring crane flies as *Tipula apicalis, T. dejecta, T. dorsomacula, T. vicina, Pedicia calcar, P. pauludicola, Dicranota currani, D. flaveola, D. eucera, Limnophila brevifurca, Limonia nycteris, Ormosia arcuata,* and *O. notmani,* made their first appearance from a week to ten days earlier than they have ever been recorded in southern Michigan, where the season should be at least a week earlier.

During May, however, and in spite of almost continuously warm weather, the calendar season began to catch up with phenological events. The crane flies that were on the wing about Toronto by May 15, were a much more typical seasonal assemblage than had been the list that had emerged by May 1; and by May 25, the seasonal distribution shown by the crane flies on the Reserve was certainly very close to normal. This is borne out by comparisons between the 1941 and the 1936–38 records for a number of common and conspicuous species.

A. *Early Summer Species that Began to Appear on the Wing at About the Same Dates in 1941 and in 1936–38*

41. *Tipula fuliginosa*—first 1941 record, a teneral male, June 5.
46. *Tipula hirsuta*—first 1941 record, one very teneral male, May 31.
53. *Tipula parshleyi*—first 1941 record, a single, rather teneral male, June 2.
68. *Tipula valida*—first 1941 records, about a dozen, mostly teneral males, May 30—June 5.
126. *Pseudolimnophila noveboracensis*—less than a dozen specimens were taken before June 1, and these were all from the marshes or their margins; not yet common in the oak-hickory woods by June 5.

I believe that the 1941 observations on *Tipula georgiana, T. illinoiensis, T. longiventris, T. serta, T. trivittata,* and *Liogma nodicornis,* described under II, "Further Observations," above, are also in line with this evidence.

B. *Species That Had Not Yet Appeared by June 5, 1941, Although on the Wing by June 10–13, in 1936–38*

38. *Tipula flavoumbrosa*
39. *Tipula triplex*-group, "form B"
49. *Tipula latipennis*
51. *Tipula megaura*
62. *Tipula triplex*
63. *Tipula triplex*-group, "form C"
154. *Elephantomyia westwoodi*

Limnophila laricicola (No. 143), may also be cited here, although not conspicuous and hardly abundant. A detailed search for this species was made in 1941 in both of the sphagnum bogs, where it was taken in considerable number by June 15 of 1937 and 1938, but no specimens could be found.

C. *Definitely Vernal Species Still on the Wing After May 25, 1941*

113. *Pedicia* (*T.*) *calcar*—still common and males as numerous as females on May 28. Had disappeared by June 10–13 in 1936–38.
128. *Limnophila subtenuicornis*—females were still fairly numerous on May 28, 29, 1941. Had disappeared by June 10, 1936–38.
142. *Limnophila brevifurca*—a few males and females were taken May 28—June 2, 1941. Had disappeared by June 10, 1936–38.

Ormosia meigenii and *O. pygmaea,* although neither common nor conspicuous in this region, appear to belong with this group as do the 1941 additions to the species list with the exception of *Dolichopeza americana* and possibly *Tipula senega.*

In general, I believe that the seasonal records for May 25—June 5, 1941, may be accepted as normal and more or less typical for this region. All of the collecting stations visited in 1941 were ones that had been intensely worked between May 11 and 19, 1937, and between June 10 and 15 in 1936–38, and it is probable that at least six of the eight additional species taken in 1941 are restricted to comparatively short flight periods in late May and early June, in this region.

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PLATES

PLATE I

FIG. 1. View north from a hillside, just within the south gate to the George Reserve. The curving line of shrubs that extends from near the left foreground into the center of the picture marks the eastern boundary of the southwest swamp. Beyond, in the left background, is shown the eastern margin of the southwest oak-hickory. The small open spot in the middle distance is a part of Fishhook marsh; the woods beyond, in the middle and right-hand background, is the eastern extension of the west central oak-hickory, approximately half a mile from the camera. The right foreground, middle distance, and the extreme right background show areas of old, cleared fields.

FIG. 2. View southwest from near the top of a high moraine in the northeast corner of the Reserve. The scattered shrubs in the steeply rolling foreground include both erect and recumbent junipers; between them many areas of the thin soil are grown with foliose lichens. The tamarack swamp in the middle distance is a part of the big swamp, and the sky line to the left and in the center is formed by oaks and hickories growing from "islands" near the center of this swamp. The somewhat higher sky line in the right-hand fifth of the background is formed by the oak-hickory on the southern end of the esker (northeast oak-hickory).

PLATE I

Fig. 1

Fig. 2

PLATE II

FIG. 1. Oak-hickory woods on the western side of the esker, northeast oak-hickory. Buck Hollow lies immediately below the part of the slopes shown here.

FIG. 2. The more mesic oak-hickory of the lower slopes, southwest oak-hickory. The tall shrubs in the foreground and right middle distance are sassafras.

PLATE II

Fig. 1

Fig. 2

PLATE III

FIG. 1. The eastern side of the southwest swamp. View north from a steep hill at its southeast boundary. The treetops in the extreme right foreground mark the eastern extent of the flood-plain woods along the southern border of the swamp. This picture was taken some one hundred yards west and about thirty-five feet above the spot on which the camera was placed for Figure 1 of Plate I.

FIG. 2. West near the southwest end of the southwest swamp. The trees on the right are on the southern edge of the maple-ash-aspen-elm "island," those on the left are the marshward margin of the flood-plain woods that curve northward around the southwest margin of the swamp to form the center background. The low area in the foreground and middle distance is the dry, ponded area of spring and early and midsummer. Patches of buttonbush, *Scirpus, Pontedaria,* and sedges can be noted on the wet mucky soil.

PLATE III

Fig. 1

Fig. 2

PLATE IV

FIG. 1. The relict lake of the big swamp, low water stage. View east across the northern half of the lake. The dead tamaracks in the distance were killed about 1925 by the larch saw fly.

FIG. 2. Near the northwest corner of the big swamp. View south along the poison sumac and dogwood-invaded margin of the birch-maple-elm swamp near its juncture with the northeast oak-hickory. Note the profusion of moss- and fern-covered logs. This photograph was taken at very low water in late August.

PLATE IV

Fig. 1

Fig. 2

PLATE V

FIG. 1. Southern end of the big swamp. View east from a hillside of the cleared upland. The open area just beyond the left foreground is the very wet grass-sedge-fern marsh that margins much of this end of the swamp; the rather wide zone in which this marsh intergrades with small tamaracks and poison sumacs is well shown in the right and central middle distance. The band of cleared upland in the distance, between the far side of the swamp and the upland woods, is some six hundred yards from the camera.

FIG. 2. A sphagnum-Cassandra bog. Looking west from the eastern end of the "big Cassandra." The tamarack island in the left middle distance is nearer to the camera than to the western end of the bog. The rounded, almost mammaeform surface of the bog is best shown in the foreground; and the only glimpse of the water, elsewhere hidden by the vegetation, is in a small spot in the left foreground.

PLATE V

Fig. 1

Fig. 2

PLATE VI

FIG. 1. Shrub-sedge and grass-sedge-fern marsh. View west-southwest from a small hardwood island in the southern end of the big swamp. The foreground is occupied by shrub-sedge; and the lighter area in the background, between the shrub-sedge and the foot of the cleared slopes, is grass-sedge-fern.

FIG. 2. Fishhook marsh, a typical grass-sedge-fern marsh. View south-southwest from near the northeast margin. The background is formed by the eastern margin of the southwest oak-hickory with a shrub thicket at the margin of woods and marsh. In the right-hand middle distance a narrow belt of tamaracks and poison sumacs that projects into the marsh from the marginal thicket can be seen against the background of taller hardwoods.

PLATE VI

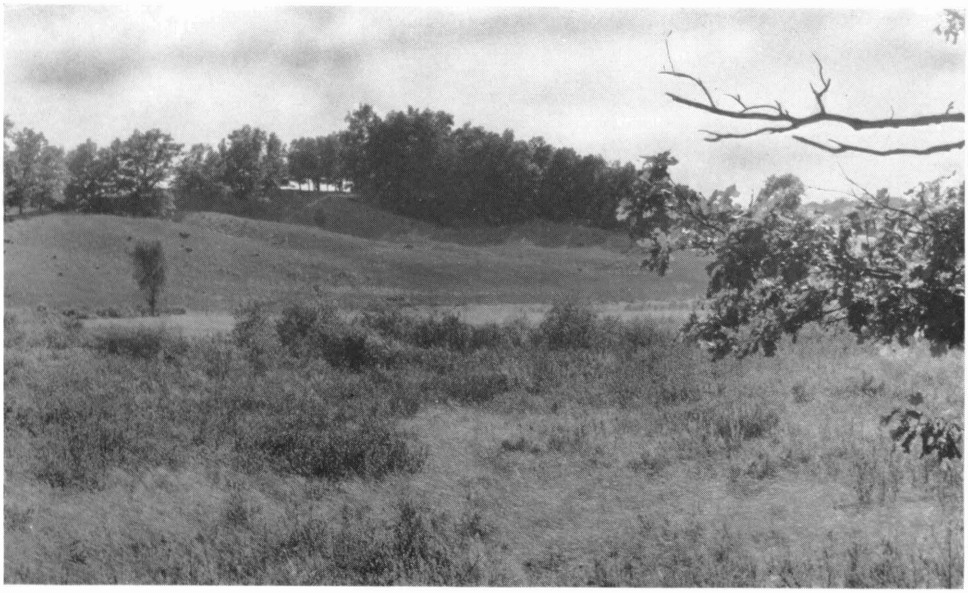

Fig. 1

Fig. 2

PLATE VII

FIG. 1. The shrub-sedge marsh of a small kettle hole. This kettle hole is connected with the western margin of the big swamp by a small valley between morainal hills and is always damp, being the source of a small intermittent rill, that flows toward the big swamp.

FIG. 2. The spring-fed seepage marsh at the juncture of the Toma and Tiplady roads, just north of Hell Creek and some two miles southeast of the George Reserve. This marsh is from ankle- to knee-deep with the cold waters of the braided rills and includes both pure stands and mixtures of iris, shrub-sedge-cattail, and grass-sedge-fern vegetation.

PLATE VII

Fig. 1

Fig. 2

PLATE VIII

FIG. 1. The north branch of Honey Creek, south from Michigan Highway 36. All of the unwooded area is a seepage marsh, filled with vernal springs and rill courses and with numerous channels and depressions that range from inundated to wet throughout the summer.

FIG. 2. Hell Creek, just east of the Toma Road bridge, low-water stage. Here Hell Creek has cut a definite valley through a belt of moraines and shows a good development of pools and riffles. Its valley is here marked with flood-plain woods.

PLATE VIII

Fig. 1

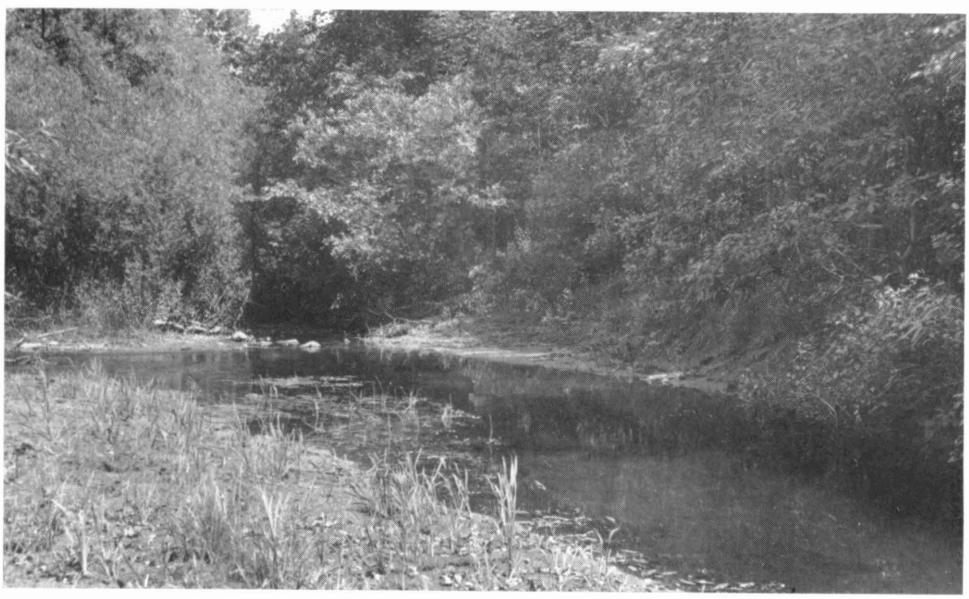

Fig. 2

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