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AN ECOLOGICAL SURVEY OF INSECTS
OF A PENNSYLVANIA FARMSTEAD

Thesis for the Degree of M. S.
MICHIGAN STATE UNIVERSITY

Robert H. Angle

1956

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by

Robert H. Angle

AN ABSTRACT

Submitted in partial fulfillment of the
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Approved

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THESIS

ABSTRACT

This study is a survey and comparison, in a qualitative manner, of sample collections of the insect species from four different biological areas. Of the four areas studied two were of the meadow type, a marshy meadow and a dry meadow, and two were of the forest type, a hemlock forest and an oak-hickory forest. The dry meadow area was approximately 10 acres in size, while the marshy meadow area was approximately 8 acres. The oak-hickory forest area was approximately 20 acres in size, while the hemlock forest area was composed of some 35 acres. The areas studied are located on the Angle farm two miles west of Dingmans Ferry, Pennsylvania on the Edgemere Road. These areas were surveyed, using the same methods in each, from July 29, 1955 to September 20, 1955.

The principal method employed in the collection of insects from the surveyed areas was the use of the sweeping net. Other insects were collected by the use of funnel traps, by direct observation, by removal of bark from dead trees, examinations of wood piles, shelf fungi and mushrooms, rotten wood, by turning over stones and by the use of molasses smears. In addition, night collecting was done in all areas by the use of lights. Each of the areas surveyed was treated in the same manner in an attempt to collect representative specimens. Collection of all species which inhabit the various areas surveyed was impossible

due to the fact the survey was limited to a short period of time.

All the adult insect specimens collected were pinned and labeled as to area, date and collector. Identification of these adult specimens was accomplished with the use of the most recent entomological literature. All specimens were identified by the author, except where otherwise noted.

The species were listed in an attempt to ascertain which area supported the greatest number of species. Various sources of entomological literature were consulted in an attempt to better understand the total ecology, biology and distribution of each species collected. Four hundred and ninety-six species of insects were recorded from the four areas surveyed. The greatest number of insect species were recorded from the dry meadow area, being closely followed by the marshy meadow area. The oak-hickory forest was third in species representation, while the hemlock forest had the least number of species collected in the areas under study. It was found that the majority of species common to all the areas surveyed were either scavengers or predators. Few phytophagous species of insects were found to occur in all areas, with the majority being restricted to only one area. From these results it was concluded that the insect communities of the four areas studied differed both in the composition of species complex occurring in any one of the areas and the total number of species found in any one of the areas. The greater the number of plant species and

habitats offered by an area the greater was the number of species of insects occurring within that area. This conclusion was supported by the fact that the dry meadow offered the greatest variety of plants and habitats and that the greatest number of insect species were recorded from the area. It was further concluded that an increase in the plant species composition of a particular area is accompanied by an increase in phytophagous insect species and their various predators. The result is an increase in the total number of insect species found in a particular area.

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INTRODUCTION

The important role played by the more than 650,00 species of insects that inhabit the world is becoming more apparent each year, not only due to the attention paid to species of injurious nature, but the realization that many species are valuable to man. A tremendous number of these insects are phytophagous, some being classed as general plant feeders, and others as specific plant feeders. Many of these insect species that inhabit the world are of a predaceous nature, others are parasites and some are blood sucking. It has been generally agreed among biologists that insect communities have a definite relationship to plant communities. It is the purpose of this thesis to study this plant-insect community relationship and to determine what species inhabit the ecological areas studied, and which of these areas was best able to support the greatest number of species.

This study surveyed and compared in a qualitative manner the insects from four different biological areas. Of the four areas studied two were of the meadow type, a marshy meadow and a dry meadow, and two were of a forest type, a hemlock forest and an oak-hickory forest. The biological areas that were studied were located on a 110-acre farmstead in eastern Pennsylvania, near Dingmans Ferry, Pa. They were surveyed, using the same methods in each, from July 29, 1955 to September 20, 1955.

HISTORICAL REVIEW

General surveys and studies of meadow and forest areas date back to the early part of the nineteenth century. The purpose of these early studies dealt mainly with the interest in the insects themselves and showed little relationship to the association of plant-animal communities. Near the end of the nineteenth century a greater interest was shown in area relationship to insect populations. With an increase in the knowledge about insects it soon became apparent that they offered a definite threat to mankind and their economic importance was greatly stressed. Many studies were undertaken with particular species of economic importance to determine their life cycles, damage to particular plants and animals, and methods of controlling them. Little work has been done on relationships between plant and animal communities.

Adams (1906 and 1909) carried on studies of the relationship of animals to plant communities in a survey of the Isle Royale and Porcupine Mountains of Michigan. In this survey, insects were included as a part of the total animal community, with particular attention being devoted to the beetles. Shelford (1907) related species of Cicindela to the succession of plant communities. Shelford (1913) gave a description of the animal communities associated with various grasslands around Chicago. Vestal (1913) made a more detailed study of animal

communities associated with grasslands on the prairies of Illinois. Vestal based his ecological units largely upon the food habits of the animals. Shull (1911) studied the plant-insect communities of a sand dune area around the Saginaw Bay region in Michigan. He concluded that the physical condition of an area played a major role in the relationship of plant-insect communities. Shackelford (1929) studied animal communities on high and low prairies in Illinois. He concluded that there were two distinct communities, one on the high prairie and one on the low prairie. Those on the high prairie were more homogenous than low prairie forms and less able to withstand a wider range of environmental conditions.

Studies of forest areas have followed the pattern of Adam's (1906 and 1909) study and dealt with forest fauna with regard to total animal communities. Weese (1924) carried on quantitative studies of the biotic conditions in an elm-maple forest association. Random samples were taken in this area and the results showed two peaks in the population curve, occurring in the spring and fall, particularly in the case of herb and shrub strata. It was his belief that the increase in population in the fall was due to a migration of the insects from surrounding habitats to the forest when temperatures began to decline. The rise in population in the spring was the result of these insects coming out of hibernation and leaving the forest for the surrounding fields. Weese further concluded that the life cycles of the fauna are adjusted to the

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annual rhythm of physical conditions which are found in the savanna and temperate forest. Weese (1924) and Smith (1929 and 1930) carried on a series of animal ecology studies in a deciduous forest in central Illinois. Their work was largely quantitative and dealt mainly with the influence of physical factors on animals in deciduous forests and not the whole plant-animal community relationship. Another study of this type was conducted by Needham, Frost and Tothill (1928), in which they studied foliage-feeding insects living between the upper and lower epidermal layers of the leaves in a deciduous forest. They concluded that, in general, leaf miners have shorter life cycles than surface feeders and are highly specialized and usually more restricted as to food plant.

One of the more general studies of forest communities was carried on by Blake (1926) in which he compared the fauna of a coniferous and deciduous forest. In this study the animal communities of a climax pine-hemlock forest and climax elm-maple forest were compared in central Illinois, but not in the immediate vicinity of each other. The animals were discussed in relation to their occurrence in stratal subdivisions of the forest. He concluded that the animals of the coniferous and deciduous forest have different taxonomic composition with only 4.5 percent non-predominants being common to both.

METHODS AND MATERIALS

The principal method employed in the collection of insects from the surveyed areas was the use of the sweeping net. In the meadow areas grasses were swept, while in the forest areas herbs, shrubs and lower tree strata was swept where possible. Fumel traps containing dead animals were placed in each area and checked at intervals for carrion-feeding species of insects. Night collecting was done in all areas by the use of lights and also by baiting with molasses smears on tree trunks in the forest areas. Many insects were collected by direct observation, by removal of bark from dead trees, examination of wood piles, shelf fungi and mushrooms, rotten wood and by turning over stones. Insects in the upper strata of the trees were not surveyed. All specimens collected were saved for further study except those found in tremendous numbers, in which case a representative sample was saved. The insect specimens have been deposited in the entomology museum of Michigan State University. Collection of all species which inhabit the various areas surveyed was impossible due to the fact the survey was limited to a short period of time. Thus, this survey can only represent a sample of the total insect fauna indigenous to the surveyed area.

Each of the areas surveyed was treated in the same manner and under similar conditions in an attempt to collect repre-

sentative specimens. Collection was carried on under all climatic conditions except heavy rains.

All the adult insect specimens collected were pinned and labeled as to area, date and collector. Identification was accomplished with the use of the most recent entomological literature. All specimens were identified by the author, except where otherwise noted. Identification of certain groups of insects was done by the following individuals: W. A. Drew, Anthomyiidae, Muscidae and Tabanidae; O. Taboada, Cicadellidae; M. MacReynolds, Calliphoridae; R. L. Hodges, Lepidoptera; H. J. Reinhard, Larvaevoridae; C. L. Fluke, Syrphidae; M. R. Smith, Formicidae; and R. L. Fischer, Hymenoptera.

During the survey records were taken on weather conditions, unusual and interesting facts concerning large populations of insects present in any one area, the restriction of any species to a particular plant, and other biological data. These observations will be brought out in the discussion.

I. General Information

The area studied was a 110-acre plot of land located in the eastern part of Pennsylvania, near Dingmans Ferry. The town of Dingmans Ferry lies 45 miles east of Scranton, Pa., 32 miles north of Stroudsburg, Pa., 18 miles south of Port Jervis, N. Y., and approximately 90 miles west of New York City. The Angle Farm, on which this survey was conducted, is located two miles north of Dingmans Ferry on the Edgemere Road.

Of the portions of this 110-acre farm that were surveyed approximately 35 acres represented the hemlock forest, 20 acres represented the oak-hickory forest, 8 acres represented the marshy meadow and 10 acres represented the dry meadow.

II. Topography

This area of Pennsylvania is on the eastern slopes of the Pocono Mountains, which are a branch of the Kittatinny Mountain range. The average elevation is between 800 and 900 feet above sea level (Plate I) and is rather hilly. The dry meadow and oak-hickory forest are rolling in contour and vary in elevation about 60 feet. The marshy meadow area is fairly level and varies no more than 20 feet. The hemlock forest area is divided into two parts by a mountain stream some 20 feet wide. On either side of this stream there are steep banks rising from an elevation of 640 feet to 800 feet. The steepness of these banks is more gradual on the northwest portion of the area.

III. Climatic Factors

Uvarov (1931) states that climate is an ever-present factor in insect life. Though it may not always be the factor on which existence of an insect depends entirely, other conditions of the environment are subordinate to it in importance. He further states that temperature, humidity, precipitation and other environmental factors do not have the same affect on all species of insects. Where a low temperature might prove to be fatal to one species of insect, another species might

benefit from it, thus climatic factors have varying effects on the different species of insects.

Sweetman (1936) states that generally speaking, climate and weather are the most important factors in limiting the abundance and prevalence of insects. Heavy rains may wash off and destroy large numbers of insects that feed, during their larval stages, on exposed surfaces of trees and shrubs. Cool weather during the developmental period may lengthen the developmental stages and allow large numbers of the species to fall prey to their predators. Moist warm weather may favor outbreaks of entomogenous diseases. Thus, it seems that the factors that go to make up climate have varying effects on the different species of insects and could be responsible for the increase or decrease in population levels in any one season of any particular species.

Climatic conditions for the months of July, August and September were so adverse that it may have had considerable influence on the species found. The following information is taken from the United States Department of Commerce Weather Bureau at Scranton, Pennsylvania. Only four climatic factors previously discussed will be considered here, arranged by months in which collecting was carried on. The temperatures mentioned are in degrees Fahrenheit.

A. July, 1955:

(a) This was the warmest July ever recorded in this area. The average monthly temperature was 77.4 degrees which was

4.8 degrees above normal. The maximum temperature was 98 degrees and the minimum was 54 degrees. The temperature was 90 degrees or higher on 14 days. The average high was 89.5 degrees and the average low was 65 degrees.

(b) The total precipitation for the month was 1.13 inches which was 3.30 inches below normal.

(c) The average humidity was 65 percent for the month of July, 1955.

(d) The average wind speed was 6.6 miles per hour with a high of 31 miles per hour.

B. August, 1955:

(a) The average monthly temperature was 74 degrees which was 3.3 degrees above normal. The average high was 84 degrees with an average low of 63.7 degrees. Maximum temperature was 96 degrees with seven days of the month showing temperatures of 90 degrees or higher.

(b) Total precipitation for the month was 11.76 inches which was 8.09 inches greater than the normal rainfall. The high of 4.58 inches for a 24-hour period, was recorded on August 18, which caused severe floods throughout the eastern part of the United States.

(c) The average relative humidity was 75 percent for the month of August, 1955.

(d) The average wind speed was 8 miles per hour with a high of 45 miles per hour.

C. September, 1955:

(a) The average monthly temperature was 61 degrees which was 3.10 degrees below normal. The average high was 71.8 degrees and the average low was 51.9 degrees. The maximum temperature was 86 degrees with the minimum being 40 degrees.

(b) Total precipitation for the month was 2.83 inches which was .39 inches below normal

(c) The average relative humidity was 70 percent for the month of September, 1955.

(d) The average wind speed was 6.5 miles per hour with a high of 33 miles per hour.

IV. Ecology of Localities Studied

Certain insect species may be found in most any geographical location, while other insects are restricted to certain ecological niches within rather small restricted localities. There are many factors which determine the distribution of insects and the particular locale in which an insect species might occur. One of the influential factors determining the habitat of a species is that of its feeding habits. It is known that food of insects includes most everything that can furnish nourishment to living things. According to Duncan and Pickwell (1939) insects can be grouped into four general categories as to their feeding habits. Omnivorous species, such as the Jerusalem Cricket, Stenopelmatus longispina (Scud.), eat almost anything. Many species of insects feed on only

vegetable matter and are termed vegetarians. This group may be further divided into generalized feeders, such as Anabrus simplex (Hald.), the Mormon cricket, which feeds on a variety of plant materials, and the more specialized feeders which are restricted to a few plants, certain parts of plants, or only one species of a plant. Another category includes carnivorous species which feed on other animals. In this case the term carnivorous is meant to include general feeding predaceous species, such as Brochymena sulcata (Fab.), the sulcate rough shield-bug, the more restricted predators like certain ladybird beetles which feed on scale insects and plant lice, and various types of parasitoid species. The last group includes the scavengers which feed on a variety of dead organic matter. Some of these scavengers are carnivorous, such as the larvae of the Calliphoridae, and some of these scavengers are vegetarians, such as the larvae of certain Diptera which feed on decaying plant matter. The insect habitat is also dependent on other factors such as breeding activities, geographical situations and weather conditions. All of these factors are interrelated and determine where one might find a particular species of insect.

The dry meadow area offered a variety of habitats, both macrohabitats and microhabitats, for the species of insects that occurred within that area. The topography of the land, soil types present and variety of vegetation all played a role in what species were found within this area. Four dis-

tinct ecological areas were found in the dry meadow. One of these areas consisted of a sandy, dry knoll covered sparsely with various grasses, briars and grapevines, which offered a type of habitat for many species. This area was located in the center of the dry meadow. On the boundaries of the sandy knoll was located an area covered rather heavily with timothy and clovers. A third area covered with mixed grasses and flowering plants, largely goldenrod, offered another type of habitat for many species. A fourth area consisting of grasses and a variety of mixed herbaceous plants was located on the outer margins of the dry meadow area. The northern boundary of the area joined the oak-hickory forest. The soil for the most part was sandy, running to a sandy-clay loam type on the fringes.

The marshy meadow area was more restricted in the variety of habitats it offered when compared to the dry meadow. The central portion of this area was densely covered with grasses and sedges. Goldenrod and other flowering plants were prevalent along the fringes of this area. A spring-fed creek was located along the eastern margins of the marshy meadow area. This creek was margined with many marshy swales and had various herbs and shrubs within and alongside of it.

The oak-hickory forest was composed of approximately 65 percent of various species of oak, Quercus spp., and 25 percent hickory which was mostly shag-bark, Carya ovata. The remaining 10 percent was made up of maple, beech and others.

The floor of the forest was fairly well covered with deciduous herbs, shrubs and small trees on the northern portions. Throughout the southern portion of the area, as the forest floor became more rocky, the understory vegetation was rather sparse. This area had been lumbered by select cutting three years prior to this survey.

The hemlock forest was composed of approximately 95 percent hemlock, Tsuga canadensis. A few scattered white pine, Pinus strobus, made up about 5 percent of the total number of trees present. The forest floor was nearly devoid of understory vegetation, except on the extreme eastern portion where small patches of deciduous herbs and shrubs were found. The western portion of this forest was lumbered by select cutting three years prior to this survey. Other than the lumbered area the forest is a stand of mature trees.

DISCUSSION OF RESULTS

A list of species of insects found during the survey and the areas in which they were found is presented as Table I, List of Species Recovered. A summary of the numbers of insect species recorded, arranged by orders, is located in Table II. The following discussion is concerned with the species of insects found in the four areas surveyed. Various species will be discussed as to their observed habits and the areas from which they were collected. It is assumed that scavengers and carrion feeding forms of insects could be found in all areas, thus final figures and results for each particular area are exclusive of these groups. The literature was reviewed in an attempt to better understand the total ecology, biology and distribution of each species collected. The observed and recorded habits and habitats are compared with those that have been reported in the literature.

Order Orthoptera

This order was represented by 27 species, of which 19 species were collected in the dry meadow area, 12 species were collected in the marshy meadow area, 5 species were collected in the oak-hickory forest and 7 species were collected in the hemlock forest. Eleven of these species were recorded from more than one area. Orchelimum bullatum Rh. and Heb., Melano-

plus differentialis (Thom.), and Conocephalus brevipennis (Scud.) were recorded from the dry meadow area, but they have been reported by Blatchley (1920a) to occur in tall grasses in low wet areas and in pine woods. Of the 12 species recorded from the marshy meadow and the 5 species recorded from the oak-hickory forest all have been reported by Blatchley (1920a) to occur in these areas. Oecanthus exclamations Davis was recorded in the hemlock forest, but according to Blatchley (1920a) this species feeds and oviposits on various deciduous plants, preferably oak. Of all the species collected in this order, Melanoplus femur-rubrum (DeG.) represented the largest number of specimens recovered.

Order Neuroptera

Only two species of this order were collected during the survey. Chrysopa plorabunda (Fitch.) was taken from the dry meadow, marshy meadow and hemlock forest by the use of lights during night collecting. Hemerobius humuli L. was collected in the hemlock forest and has been reported by Banks (1906) to feed on aphids in areas near streams.

Order Hemiptera

All of the habitats mentioned, unless otherwise stated are taken from Blatchley (1926). Of the 61 species of Hemiptera recorded during this survey, 46 species were collected in the dry meadow area, 36 species were collected in the marshy meadow area, 10 species were collected in the oak-hickory forest,

and 7 species were collected in the hemlock forest. Thirty-one of these species were collected from more than one area. Of the 46 species taken from the dry meadow area 4 have been reported to be native to other areas. Jalysus spinosus (Say) has been reported to occur on weeds and undergrowth in deciduous woodlots and marshy areas. Ischnorrhynchus resedae (Panz.) and Podops peninsularis Blatch., a fairly uncommon species, has been reported to feed on herbs and grasses in marshy areas, while Ligyrocoris obscurus Barb. has been reported to occur on flowers in wooded slopes near streams. Only 2 species of the 36 recorded from the marshy meadow area have been reported to be native to other areas. Coriscus eurinus (Say) has been reported to occur on high sandy margins of streams and lakes, while Ortholomus scolopax (Say) occurs on goldenrod in dry areas. Of the 10 species recorded from the oak-hickory forest all have been reported to occur in that area. Seven species were recorded from the hemlock forest, of which Ligyrocoris diffusus (Uhler) has been reported to occur in grasses on the margins of marshy areas.

Nearly all the species of the families Coriscidae, Coreidae, Corizidae and Lygaeidae were collected in the meadow areas and have been reported to feed on various grasses and herbs. Mormidea lugens (Fab.) was the only species of the family Pentatomidae collected in the four areas surveyed and has been reported to feed on a variety of grasses, herbs and shrubs.

It was observed during the survey that Phymata fasciata (Gray), Phymata wolfii Stal., Sinea spinipes (H. and S.) and Sinea diadema (Fab.) were found in abundance on the flowers of goldenrod, especially during late August and September. Psel-liopus cinctus (Fab.) was recorded in both meadow areas and the oak-hickory forest, but the greatest numbers were collected on goldenrod wherever it occurred in the oak-hickory forest. The tarnished-plant bug, Lygus lineolaris (P. deB.) represented the largest number of specimens recovered during the survey and was recorded from all areas surveyed.

Order Homoptera

This order was represented by 30 species collected during the survey. Twenty species of these were collected in the dry meadow area, 18 species were collected in the marshy meadow, 2 species were collected in the oak-hickory forest and 15 species were collected in the hemlock forest. Eighteen of the species were recorded from more than one area. Draeculacephala spp. were collected in the dry meadow area, but according to Britton (1923) members of this genus occur in coarse grasses in swampy areas. Ceresa basalis Walk. was collected in the hemlock forest and has been reported by Britton (1923) to occur on rose, blackberry, clover and other plants and grasses. The species of Homoptera found in the greatest numbers during the survey was Acanalonia bivitta (Say), which was collected in both meadow areas and the hemlock forest.

Order Coleoptera

Due to the large number of Coleoptera recorded during this survey they will generally be discussed at family level. The various habitats of species mentioned, unless otherwise mentioned, have been taken from Blatchley (1920b).

One hundred and thirty-six species of Coleoptera were recorded during this survey, of which, 76 species were collected in the dry meadow area, 52 species were collected in the marshy meadow area, 59 species were collected in the oak-hickory forest, and 30 species were collected in the hemlock forest. Fifty-three of these species were recorded from more than one area. Species of the families Silphidae, Histeridae, Staphylinidae and Dermestes talpinus Mann., of the family Dermestidae, were collected from carrion and found to occur in all areas. All the species of the family Scarabaeidae, except Popillia japonica Newm., and Serica sericea (Ill.), were collected from carrion. The Japanese beetle, Popillia japonica Newm., was collected in all the areas surveyed except the hemlock forest and taken from a variety of plants and deciduous herbs. Serica sericea (Ill.) was found in great abundance in the oak-hickory forest and has been reported to occur beneath logs in open wooded areas. Many species of the families Lampyridae, Cantharidae and Coccinellidae were collected in meadow areas and have been reported to be predaceous on insects and other animals.

The greatest number of species of the family Carabidae were collected in the oak-hickory forest area. The species

of Lebia recorded during the survey were found to occur in great numbers on goldenrod, especially during late August and the early part of September. Anisodactylus interpunctatus Kby. was collected in all areas except the hemlock forest and has been reported to feed on other insects and seeds of various plants.

The species of the families Ostomidae, Cucujidae, Endomychidae, and nearly all the species of the family Tenebrionidae were collected under the bark of dead trees in the oak-hickory forest. Eucinetus testaceus Lec., the only species of the family Dascillidae recorded during the survey, was collected from under the bark of a hemlock tree near the stream. It has been reported to occur only under the bark of hemlock and generally quite close to water. Cryptorhopalum balteatum Lec., the other species of the family Dermestidae recorded during the survey, was collected in abundance in all areas from the flowers of goldenrod. It has been reported to occur on many flowering plants, especially on goldenrod during late August. Epicauta pennsylvanica (DeG.), of the family Meloidae, was collected, in great abundance, on goldenrod and has been reported to occur on a variety of plants, especially goldenrod. A cantharid, Chauliognathus pennsylvanicus DeG., was collected in tremendous quantities from the flower of goldenrod and represented in each of the areas surveyed.

The majority of the species of the family Chrysomelidae recorded during the survey were collected in the meadow areas,

where they have been reported to feed on a variety of grasses and herbs. Galerucella americana (Fab.) was recorded from each of the areas surveyed, but it has been reported to feed on plants in marshy areas, thus was foreign to the dry meadow. Systema frontalis (Fab.) and Systema hudsonias (Frost) were recorded from all the areas surveyed and have been reported to feed on ragweed and a variety of other grasses and herbs. It was observed that Chrysochus auratus (Fab.), of which some 30 specimens were collected, occurred only on Indian Hemp, Apocynum androsaemifolium, in the dry meadow area.

Euparius marmoreus (Oliv.), of the family Platystomidae, was recorded in the oak-hickory forest and has been reported to feed on fungus on oak. Many of the species of the family Curulionidae were found on specific plants and in rather limited habitats. Rhychites bicolor Fab. was collected from wild rose in the dry meadow area, while Balaninus rectus Say was collected in the dry meadow also, but it has been reported to feed on acorns of oak.

Order Mecoptera

The only specimen of Mecoptera recorded during the survey was Merope tuber Newm. which was collected in the early morning from the marshy meadow area. Little is known about the habits of this rare species, except it spends part of its life cycle in moist, rotting wood.

Order Trichoptera

Only two specimens of this order were collected, both belonging to the family Limnephilidae and taken in the marshy meadow and hemlock forest. According to Pennak (1953) members of this family spend part of their life cycle in water and are generally found near permanent bodies of water.

Order Lepidoptera

This order was represented by 32 species, of which 22 species were collected in the dry meadow, 19 species were collected in the marshy meadow, 11 species were collected in the oak-hickory forest and 3 species were collected in the hemlock forest. Nineteen species were collected from more than one area. It has been reported by Macy and Shepard (1941) that most species of butterflies depend entirely upon plants for food, but some, Feniseca, for example, are carnivorous in the larval stage. Practically all the species of butterflies collected during the survey were taken from goldenrod in both meadow areas. Colias philodice God. was observed visiting flowering plants in the forest areas. The majority of species of moths collected during this survey were attracted to lights during night collecting. Species of Feltia and Caenurgina were collected during the day from under loose bark of maple and oak trees. Specimens of Catocala insolabilis Gn. were not attracted to lights during night collecting, but rather, were taken in the oak-hickory forest during the day.

Order Diptera

As in the case of Coleoptera, this order will be generally discussed at the family level, due to the large number of species collected. All of the habitats mentioned, unless otherwise stated, are taken from Curran (1934).

One hundred and thirty species of Diptera were recorded during this survey, of which 86 species were collected in the dry meadow area, 75 species were collected in the marshy meadow, 18 species were collected in the oak-hickory forest and 29 species were collected in the hemlock forest. Forty-nine of these species were recorded in more than one area. Species of the families Tipulidae, Lauxaniidae, Drosophilidae, Borboridae, Sepsidae, Phoridae, Sarcophagidae and Calliphoridae have been reported to be scavengers on various types of decaying organic matter and could occur in all areas. A March fly, Bibio junipennis (Walk.) was collected from goldenrod in the dry meadow area and has been reported to be frequently found on flowers during early summer. Species of the families Simuliidae, Tendipedidae and Dolichopodidae were collected in the marshy areas and have been reported to be found in the vicinity of permanent and semi-permanent bodies of water. Culex apicalis Adams, was collected in the marshy meadow area and has been reported by King et al (1944) to spend most of its life within this type of an area. Species of the families Sciaridae and Fungivoridae were collected in marshy areas and have been reported to feed on fungus and decaying vegetation. Only one

species of Tabanidae, Stonemyia rasa (Loew.), was collected during this survey. It has been observed in previous years that many species of Tabanidae occurred in this area, but perhaps, due to weather conditions, absence of cattle or other hosts, and other biological conditions, their population was noticeably decreased. Species of the families Empidae and Therevidae occurred in all the areas surveyed and have been reported to be predaceous on many insects. The genus Asilus has also been reported to be predaceous, but their habitats are more restricted than species of Empidae and Therevidae.

Pipunculus similus Hough. and the members of the genus Dorilas were collected in both meadow areas where they have been reported to be parasites on various species of Miridae and Cicadellidae. Species of the family Conopidae were collected from the flowers of goldenrod and have been reported to be parasites on various bees and wasps. Many species of Syrphidae were collected in great numbers from the flowers of goldenrod where they have been reported, by Borror and DeLong (1954), to feed. Phytophagous species of the families Otitidae, Trupaneidae and Chloropidae were collected in all areas surveyed, but the largest numbers were found in the meadow areas where they have been reported to feed on the stems and leaves of various grasses. Eurosta corama (Wied.) was recorded in all the areas surveyed and occurred on grasses and deciduous herbs. The species of Anthomyiidae recorded show a variety of habitats. Many are phytophagous, others are scavengers and some are parasites on

other insects. It is noted that Halina aldrichi Snyder, (det. by W. A. Drew), was recently described in 1949 and has previously been reported only from Alaska, Wyoming and California.

Order Hymenoptera

All species habits, unless otherwise mentioned, were taken from Muesebeck, et al, (1951). This order was represented by 77 species, of which, 50 species were collected in the dry meadow area, 68 species were collected in the marshy meadow area, 7 species were collected in the oak-hickory forest and 16 species were collected in the hemlock forest. Thirty-five of these species recorded were collected in more than one of the four areas surveyed. Arge pectoralis (Leach) was recorded from the dry meadow area and has been reported to feed on Salix, while Tremex columba (L.) was recorded from the oak-hickory forest where it has been reported by Comstock (1950) to oviposit in a variety of deciduous trees, such as, maple, elm, oak, beech and others. Species of the families Braconidae and Ichneumonidae and many species of the superfamilies Chalcidoidea and Proctotrupoidea are endo- and ectoparasites on a variety of hosts.

The species of the family Formicidae have been reported to have a great variety of habits. Species of the genus Dolichoderus, which were collected in the marshy meadow area, have been reported to construct nests in the soil, in curled leaves and in hollow stems of plants and feed mainly on honeydew

and small arthropods. The species of the genus Formica, which were collected in all the areas surveyed, have an unusually wide distribution and occur in many diversified habitats. They have been reported to nest in the soil and rotting wood, while their food is largely honeydew and small arthropods. Species of the genus Lasius, which were recorded in both of the meadow areas, have been reported to live in small or moderate size colonies in the soil and in rotting wood. The workers of this genus have been reported to not only attend honeydew excreting insects but in some instances even foster them.

The species of the families Vespidae and Sphecidae have a variety of nesting habits. The food of most species of these families is of animal origin. Eumenes crucifera nearcticus Bequaert, has been reported to make juglike mud nests which are usually attached to twigs. Ancistrocerus antilope antilope (Panz.) and Rygchium foraminatum foraminatum (Panz.) have been reported to nest in hollow twigs or suitable burrows in logs. All three species provision their nests with caterpillars. Symmorphus pedestris pedestris (Saussure) and Symmorphus pennsylvanicus (Saussure), which were collected in both the meadow areas, have been reported to make their nests in hollow twigs and beetle burrows in wood. Sceliphron caementarium (Drury), which was recorded from the marshy meadow areas, has been reported to be a mud dauber and to make their nests of mud and store them with various species of spiders, Philanthus gibbosus (Fab.) and Philanthus

ventilabris Fab., which were recorded from the marshy meadow area, have been reported to construct tunnel nests in the soil and stock them with various bees. The adults of these species have been reported to be nectarivorous and are, consequently, often collected on flowers.

The majority of the species of the families Andrenidae, Halictidae and Apidae were collected from flowers of goldenrod in both meadow areas. Halictus ligatus Say and Apis mellifera L. were recorded in all the areas surveyed while Augochlora pura (Say) and Psithyrus ashtoni (Cr.) were recorded from the oak-hickory forest and hemlock forest, respectively. Those species that occurred in the meadow areas were taken from various flowering plants, especially goldenrod, while those species recorded in the forest areas were taken from small patches of goldenrod, grasses and deciduous herbs. It was observed that the species of the genus Agapostemon were collected only from the flower of burdock, Arctium lappa, which was located in the marshy meadow area. It was also observed that Apis mellifera L. visited flowers of goldenrod throughout the period of the survey, with the greatest number of specimens being both observed and collected during late August and early September.

SUMMARY AND CONCLUSIONS

During this survey 496 species of insects were recorded from the four areas studied. The dry meadow area, with 320 species of insects recorded, represented the area from which the greatest number of species were collected. It was also observed that this area offered a greater variety of plant species than the other areas studied and many types of both microhabitats and macrohabitats. The marshy meadow area recorded the second greatest number of insects species, with 283 species being collected. This area was more restricted in species of plants and varieties of habitats present when compared to the dry meadow area, but it was observed that of many species found in both areas, populations tended to be greater in the marshy meadow area. The 112 species of insects recorded from the oak-hickory forest area represented a greater number of species than were found in the hemlock forest area, but a fewer number of insect species than were found in either of the meadow areas. When comparing this area to the hemlock forest area, it may be noted that a greater variety of vegetation occurred in the oak-hickory forest area, but a lesser number of plant species than in either meadow areas. The hemlock forest area, with 109 species of insects recorded, represented the smallest number of insect species collected in any of the four areas that were studied. Of the total

number of insect species recorded, 218 of these were collected from more than one of the areas surveyed.

It is concluded that the insect communities of the four areas studied differ both in the composition of species complex occurring in any one of the areas and the total number of species found in any one of the areas. The greater the number of plant species and habitats offered by an area, the greater the number of species of insects occurring within that area. This conclusion is supported by the fact that the dry meadow area offered the greatest variety of plants and habitats and that the greatest number of insect species were recorded from the area. It is further concluded that an increase in the plant species composition of a particular area is accompanied by an increase in phytophagous species of insects and their various predators. The result is an increase in the total number of insect species found in a particular area.

APPENDIX

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LIST OF SPECIES RECOVERED

Comstock (1950) was used in the arrangement of the orders of insects found during the survey. The families of Coleoptera have been arranged according to Leng (1920), while the families of Homoptera were arranged according to Britton (1923). The families of Orthoptera have been arranged according to Blatchley (1920a), while families of Hemiptera were arranged according to Blatchley (1926). The Diptera have been arranged according to Curran (1934), except in the case of the calypterate members of this order, which were arranged according to Borror and Delong (1954). The Lepidoptera have been arranged according to McDunnough (1938), while Hymenoptera arrangement followed the arrangement of Muesebeck, et al, (1951). The smaller orders were arranged in no particular fashion. All genera were arranged alphabetically under their respective families.

In Table I, List of Species Recovered, certain symbols are used to denote the four areas surveyed. They are as follows: D.M. denotes the dry meadow area; M.M. denotes the marshy meadow area; O.H.F. denotes the oak-hickory forest area and H.F. denotes the hemlock forest area.

TABLE I
LIST OF SPECIES RECOVERED

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
ORDER ORTHOPTERA				
Family Blattidae				
<u>Parcoblatta</u> spp.			x	
Family Mantidae				
<u>Mantis religiosa</u> L.		x		
Family Phasmidae				
<u>Diapheromera femorata</u> (Say)			x	
Family Acrididae				
<u>Camula pellucida</u> (Scud.)	x	x		
<u>Dissosteira carolina</u> (L.)	x	x	x	
<u>Melanoplus confusus</u> Scud.	x			
<u>Melanoplus differentialis</u> (Thom.)	x			
<u>Melanoplus femur-rubrum</u> (DeG.)	x	x		x
<u>Melanoplus keeleri luridus</u> (Dog.)	x	x		
<u>Melanoplus</u> spp.	x	x		x
<u>Schistocerca alutacea</u> (Harris)	x	x		x
Family Tettigoniidae				
<u>Amblycorypha rotundifolia</u> (Scud.)				x
<u>Arethaea</u> spp.	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Tettigoniidae (con't)				
<u>Conocephalus brevipennis</u> (Scud.)	x	x		x
<u>Conocephalus fasciatus</u> (DeG.)	x			
<u>Conocephalus gracillimus</u> (Morse)	x			
<u>Conocephalus strictus</u> (Scud.)	x			
<u>Orchelimum bullatum</u> Rh. & Heb.	x			
<u>Scudderia curvicauda</u> (DeG.)		x		
<u>Scudderia furcata</u> Brun.	x			
<u>Scudderia texensis</u> Sc. & Pict.	x	x		
Family Gryllidae				
<u>Gryllus assimilis-pennsylvanicus</u> Brun.	x		x	
<u>Nemobius spp.</u>	x			x
<u>Neoxabea bipunctata</u> (DeG.)			x	
<u>Oecanthus exclamations</u> Davis				x
<u>Oecanthus nigricornis</u> Walk.		x		
<u>Oecanthus nigricornis</u> <u>quadripunctatus</u> Beut.	x	x		
ORDER NEUROPTERA				
Family Chrysopidae				
<u>Chrysopa plorabunda</u> (Fitch)	x	x		x
Family Hemerobiidae				
<u>Hemerobius humuli</u> L.				x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
ORDER HEMIPTERA				
Family Scutelleridae				
<u>Eurygaster alternatus</u> (Say)	x			
<u>Homaemus bijugis</u> Uhl.	x			
<u>Homaemus parvulus</u> (Germ.)	x	x		
Family Podopidae				
<u>Podops peninsularis</u> Blatch.	x			
Family Corimelaenidae				
<u>Corimelaena lateralis</u> (Fab.)		x		
<u>Corimelaena pulicaria</u> (Germ.)	x			
<u>Galgupha atra</u> Am. & Serv.		x		
Family Pentatomidae				
<u>Acrosternum hilare</u> (Say)	x	x		
<u>Banasa calva</u> (Say)			x	
<u>Banasa dimidiata</u> (Say)		x		
<u>Brochymena arborea</u> (Say)	x		x	
<u>Coenus delius</u> (Say)	x	x		
<u>Cosmopepla bimaculata</u> (Thom.)	x	x		
<u>Dendrocoris humeralis</u> (Uhl.)			x	
<u>Euschistus euschistoides</u> (Voll.)	x	x	x	
<u>Euschistus variolarius</u> (P.B.)	x			
<u>Euschistus tristigmus</u> (Say)		x		x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Pentatomidae (con't)				
<u>Menecles insertus</u> (Say)			x	
<u>Mormidea lugens</u> (Fab.)	x	x	x	x
<u>Neottiglossa undata</u> (Say)	x			
<u>Peribalus limbolaris</u> Stal.	x	x		
<u>Thyanta accerra</u> McAtes	x			
<u>Trichopepla semivittata</u> (Say)	x			
Family Coreidae				
<u>Euthochtha galeator</u> (Fab.)		x		
<u>Merocoris distinctus</u> Dall.	x			
Family Coriscidae				
<u>Coriscus conspersus</u> (Montd.)	x			
<u>Coriscus eurinus</u> (Say)	x	x	x	
<u>Coriscus pilosulus</u> (H. & S.)	x			
Family Corizidae				
<u>Corizus bohemani</u> Sign.	x	x		
<u>Corizus crassicornis</u> (L.)	x	x		x
<u>Corizus lateralis</u> (Say)	x	x		
<u>Harmostes reflexulus</u> (Say)	x	x		
Family Neididae				
<u>Jalysus spinosus</u> (Say)	x		x	

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Lygaeidae				
<u>Blissus leucopterus</u> (Say)	x	x	x	
<u>Cymus angustatus</u> Stal.	x	x		
<u>Cymus robustus</u> Barb.		x		
<u>Geocoris uliginosus</u> (Say)	x	x		
<u>Ischnorrhynchus resedae</u> (Panz.)	x	x		
<u>Ligyrocoris diffusus</u> (Uhl.)	x	x		x
<u>Ligyrocoris obscurus</u> Barb.	x			
<u>Lygaeus dicrucis</u> (Stal.)		x		
<u>Lygaeus kalmii</u> Stal.	x			
<u>Myodocha serripes</u> Oliv.	x			
<u>Oedancala dorsalis</u> (Say)	x	x		
<u>Ortholomus scolopax</u> (Say)	x	x		
<u>Perigenes constrictus</u> (Say)	x			
<u>Phlegyas abbreviatus</u> (Uhl.)	x	x		
Family Tingidae				
<u>Corythuca marmorata</u> (Uhl.)		x		
Family Phymatidae				
<u>Phymata fasciata</u> (Gray)	x	x	x	
<u>Phymata wolffii</u> Stal.	x	x	x	x
Family Reduviidae				
<u>Pselliopus cinctus</u> (Fab.)	x		x	

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Reduviidae (con't)				
<u>Sinea diadema</u> (Fab.)	x	x		x
<u>Sinea spinipes</u> (H. & S.)	x	x		x
Family Nabidae				
<u>Nabis ferus</u> (L.)	x	x		
<u>Nabis subcoleoptratus</u> (Kby.)	x	x		
Family Miridae				
<u>Adelphocoris linsolatus</u> (Goeze)	x			
<u>Adelphocoris rapidus</u> (Say)	x	x		
<u>Lopidea media</u> (Say)		x		
<u>Lygus lineolaris</u> (P. deB.)	x	x	x	x
<u>Miris dolabratus</u> (L.)	x			
<u>Plagiognathus politus</u> Uhl.		x		
ORDER HOMOPTERA				
Family Fulgoridae				
<u>Acanalonia bivittata</u> (Say)	x	x		x
<u>Aphelonema simplex</u> Uhl.		x	x	
<u>Bruchomorpha oculata</u> Newm.		x		
<u>Phylloscelis atra</u> Germ.	x			x
<u>Phylloscelis atra albovenosa</u> (Mel.)	x	x		
<u>Scolops sulcipes</u> Say	x	x		x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Cicadellidae				
<u>Amblysellus curtisii</u> (Fitch)			x	
<u>Athysanus</u> spp.	x	x		
<u>Chlorotettix</u> spp.	x	x		
<u>Cloanthanus</u> spp.	x			
<u>Draeculacephala</u> spp.	x			
<u>Empoasca</u> sp.	x			
<u>Graphocephala coccinea</u> (Forst.)		x		x
<u>Gypona</u> spp.	x			
<u>Gyponana</u> spp.	x	x		x
<u>Jassus olitorius</u> Say	x			
<u>Neokolla gothica</u> (Sign.)	x	x		x
Family Membracidae				
<u>Campylenchia latipes</u> (Say)	x	x		
<u>Ceresa basalis</u> Walk.				x
<u>Ceresa brevis</u> Walk.	x	x		
<u>Ceresa bubalus</u> (Fab.)	x	x		x
<u>Stictocephala inermis</u> (Fab.)		x		
Family Cercopidae				
<u>Aphrophora quadrinotata</u> Say				x
<u>Lepyronia quadrangularis</u> (Say)	x			x
<u>Philaenus leucophthalmes</u> <u>impressus</u> (DeL.)	x	x		x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Cercopidae (con't)				
<u>Philaenus leucophthalmes marginellus</u> (Fab.)		x		x
<u>Philaenus leucophthalmes pallidus</u> (Zett.)	x	x		x
<u>Philaenus leucophthalmes spumerius</u> (Fall.)	x	x		
Family Chermidae				
<u>Psylla floccosa</u> (Patch)				x
<u>Psylla galeaformis</u> (Patch)				x
ORDER COLEOPTERA				
Family Carabidae				
<u>Agonoderus pallipes</u> (Fab.)	x			
<u>Amara cupreolata</u> Putz.			x	
<u>Amphasia interstitialis</u> (Say)			x	
<u>Anisodactylus interpunctatus</u> Kby.	x	x	x	
<u>Calleida punctata</u> Lec.	x	x		
<u>Carabus limbatus</u> Say			x	
<u>Carabus serratus</u> Say			x	
<u>Cylindrocharis rostrata</u> (Newn.)				x
<u>Dicaelus politus</u> DeG.			x	
<u>Euferonia stygica</u> (Say)			x	x
<u>Lebia ornata</u> Say	x	x		x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Carabidae (con't)				
<u>Lebia pumila</u> Dej.	x			
<u>Lebia viridis</u> Say	x	x		x
<u>Leiocnemis avida</u> (Say)			x	
<u>Melanius luctuosus</u> (Dej.)			x	
<u>Nebria pallipes</u> Say			x	x
<u>Patrobus longicornis</u> (Say)			x	
<u>Pinacodera platicollis</u> (Say)			x	
<u>Platynus angustatus</u> Dej.			x	x
<u>Platynus cincticollis</u> (Say)			x	
<u>Platynus decens</u> Say			x	
<u>Platynus spp.</u>			x	
<u>Poecilus lucublandus</u> Say			x	
<u>Pterostichus adoxus</u> (Say)			x	x
<u>Refonia superciliosa</u> (Say)				x
Family Silphidae				
<u>Necrophorus tementosus</u> Web.	x		x	x
<u>Silpha americana</u> L.	x	x		
<u>Silpha surinamensis</u> Fab.				x
Family Staphylinidae				
<u>Aleochara curtula</u> Goeze	x		x	
<u>Creophilus maxillosus villosus</u> (Grav.)	x	x	x	x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Staphylinidae (con't)				
<u>Ocypus ater</u> (Grav.)		x		
<u>Ontholestes cingulatus</u> (Grav.)			x	
<u>Quedius fulvicollis</u> Steph.	x			
<u>Staphylinus fossator</u> Grav.	x			x
<u>Staphylinus maculosus</u> Grav.			x	
<u>Tachinus fimbriatus</u> Grav.			x	
Family Histeridae				
<u>Hister abbreviatus</u> Fab.	x		x	
<u>Hister furtivus</u> Lec.	x			
<u>Hister interruptus</u> Beauv.			x	
<u>Platysoma depressum</u> Lec.	x		x	
<u>Saprinus assimilis</u> Payk.	x	x	x	x
<u>Saprinus spp.</u>	x			
Family Lampyridae				
<u>Lucidota corrusca</u> (L.)	x		x	
<u>Lucidota decipiens</u> (Harr.)	x			
Family Cantharidae				
<u>Cantharis cruralis</u> Lec.	x	x		
<u>Chauliognathus pennsylvanicus</u> DeG.	x	x	x	x
<u>Silis bidentatus</u> (Say)	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Melyridae				
<u>Attalus terminalis</u> (Er.)		x		
<u>Collops quadrimaculatus</u> (Fab.)	x	x		
Family Cleridae				
<u>Cymatodera undulata</u> (Say)		x		
<u>Hydnocera pallipennis</u> Say	x		x	
Family Mordellidae				
<u>Mordella melaena</u> Germ.	x			
<u>Mordellistena comata</u> (Lec.)	x			
<u>Mordellistena intermixta</u> Hellm.	x	x		
Family Meloidae				
<u>Epicauta marginata</u> (Fab.)	x			
<u>Epicauta pennsylvanica</u> (DeG.)	x	x		x
Family Elateridae				
<u>Elater mixtus</u> Hbst.		x		
<u>Melanotus communis</u> (Gyll.)			x	
Family Dascillidae				
<u>Eucinetus testaceus</u> Lec.				x
Family Dermestidae				
<u>Cryptorhopalum balteatum</u> Lec.	x	x	x	x
<u>Dermestes talpinus</u> Mann.	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Ostomidae				
<u>Tenebroides corticalis</u> (Melsh.)			x	
Family Cucujidae				
<u>Brontes dubius</u> Fab.			x	
Family Corydiidae				
<u>Lasconotus pusillus</u> Lec.			x	
Family Endomychidae				
<u>Endomychus biguttatus</u> Say	x		x	
Family Phalacridae				
<u>Olibrus semistriatus</u> Lec.	x	x		
Family Coccinellidae				
<u>Anisosticta bitriangularis</u> Say		x		
<u>Brachyacantha ursina</u> (Fab.)	x		x	
<u>Ceratomegilla fuscilabris</u> (Muls.)	x			
<u>Coccinella novemnotata</u> Hbst.	x	x		
<u>Coccinella perplexa</u> Muls.		x		
<u>Coccinella transversoguttata</u> Fald.	x			
<u>Cycloneda sanguinea</u> (L.)	x	x		
<u>Hippodamia convergens</u> Guer.	x	x		x
<u>Hippodamia glacialis</u> (Fab.)	x	x		
<u>Hippodamia parenthesis</u> (Say)	x	x		
<u>Hyperaspis proba</u> (Say)	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M..	O.H.F.	H.F.
Family Coccinellidae (con't)				
<u>Hyperaspis signata</u> (Oliv.)	x			x
<u>Psyllobora viginti-maculata</u> (Say)	x	x	x	
<u>Scymnus terminatus</u> Say			x	
Family Tenebrionidae				
<u>Alobates pennsylvanica</u> (DeG.)			x	
<u>Blapstinus moestus</u> Melsh.			x	
<u>Phaleria spp.</u>	x		x	
<u>Tenebrio picipes</u> Hbst.			x	
<u>Xylopinus saperdioides</u> (Oliv.)			x	
Family Scarabaeidae				
<u>Aphodius sp.</u>	x			
<u>Canthon laevis</u> (Dr.)	x			
<u>Copris minutus</u> (Dr.)	x			
<u>Copris tillius</u> Oliv.	x			
<u>Dialytes truncatus</u> (Melsh.)	x		x	
<u>Onthophagus hecate</u> Panz.	x			
<u>Popillia japonica</u> Newm.	x	x	x	
<u>Serica sericea</u> (Ill.)			x	
<u>Trox tuberculatus</u> (DeG.)			x	
Family Cerambycidae				
<u>Cyllene robiniae</u> (Frost)	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Chrysomelidae				
<u>Anoplitis nervosa</u> (Panz.)				x
<u>Chaetocnema confinis</u> Cr.	x			
<u>Chaetocnema denticulata</u> (Ill.)		x		
<u>Chlamys gibbosa</u> (Fab.)		x		
<u>Chrysochus auratus</u> (Fab.)	x			
<u>Cryptocephalus venustus</u> Fab.		x		
<u>Diabrotica duodecimpunctata</u> (Fab.)	x	x		x
<u>Diabrotica vittata</u> (Fab.)				x
<u>Disonycha pennsylvanica</u> (Ill.)		x		
<u>Donacia subtilis</u> Kunze		x		
<u>Exema conspersa</u> (Mann.)		x		
<u>Galerucella americana</u> (Fab.)	x	x	x	x
<u>Graphops curtipennis</u> (Melsh.)				x
<u>Haltica cuprascens</u> Blatch.	x	x		
<u>Metachroma angustulum</u> Cr.	x	x		
<u>Metachroma parallelum</u> Horn		x		
<u>Microrhopala vittata</u> (Fab.)	x	x		
<u>Nodonota tristis</u> (Oliv.)		x		
<u>Systema elongata</u> (Fab.)	x	x	x	
<u>Systema frontalis</u> (Fab.)	x	x	x	x
<u>Systema hudsonias</u> (Frost)	x	x	x	x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Chrysomelidae (con't)				
<u>Xanthonia decemnotata</u> (Say)	x		x	x
<u>Xanthonia villosula</u> (Melsh.)			x	
Family Platystomidae				
<u>Euparius marmoreus</u> (Oliv.)			x	
Family Curculionidae				
<u>Balaninus rectus</u> Say	x			
<u>Baris dolosa</u> Csy.	x	x		x
<u>Brachyrhinus ovatus</u> (L.)	x		x	
<u>Brachyrhinus sulcatus</u> Fab.			x	
<u>Brachyrhinus spp.</u>	x	x		x
<u>Cnemogonus lecontei</u> Dietz		x		
<u>Conotrachelus albicinctus</u> Lec			x	
<u>Conotrachelus cratagii</u> Walsh	x			
<u>Cryptorhynchus obliquus</u> Say	x			
<u>Gelus oculatus</u> (Say)		x		
<u>Gymnetron tetrum</u> (Fab.)	x	x		
<u>Hypera punctata</u> (Fab.)	x	x		
<u>Lixus concavus</u> Say	x			
<u>Madarellus undulatus</u> (Say)		x		
<u>Odontocorynus scutellum-album</u> (Say)	x	x		
<u>Rhynchites bicolor</u> Fab.	x			
<u>Sitona hispidulus</u> (Fab.)	x	x	x	

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
ORDER MECOPTERA				
Family Meropeidae				
<u>Merope tuber</u> Newm.		x		
ORDER TRICHOPTERA				
Family Limnephilidae				
Undetermined spp.		x		x
ORDER LEPIDOPTERA				
Family Papilionidae				
<u>Papilio ajax</u> L.		x		
<u>Papilio troilus</u> L.	x	x		
Family Pieridae				
<u>Colias eurytheme</u> Bvd.	x	x		
<u>Colias philodice</u> God.	x	x		
<u>Pieris rapae</u> (L.)	x	x		
Family Danaidae				
<u>Danaus plexippus</u> (L.)	x	x		
Family Satyridae				
<u>Minois pegala</u> (Fab.)				
Family Nymphalidae				
<u>Argynnis aphrodite</u> (Fab.)	x	x		
<u>Argynnis cybele</u> (Fab.)	x	x		

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Nymphalidae (con't)				
<u>Brenthis bellona</u> (Fab.)	x	x		
<u>Brenthis myrina</u> (Cram.)	x	x		
<u>Nymphalis antiopa</u> (L.)			x	
<u>Phyciodes tharos</u> (Dr.)	x	x		
Family Lycaenidae				
<u>Lycaena hypophlaeas</u> (Bvd.)	x			
Family Hesperidae				
<u>Ancyloxypha numitor</u> (Fab.)	x	x		
<u>Polites peckius</u> (Kby.)	x	x		
Family Amatiidae				
<u>Scepsis fulvicollis</u> Hbn.	x	x	x	
Family Arctiidae				
<u>Apantesis parthenice</u> Kby.	x	x		
<u>Eubaphe aurantiaca</u> Hbn.	x	x		
Family Phalaenidae				
<u>Amphipyra pyramidoides</u> Gn.				x
<u>Autographa falcifera</u> Kby.	x	x		
<u>Caenurgina</u> sp.			x	
<u>Catocala insolabilis</u> Gn.			x	
<u>Feltia</u> spp.	x	x	x	x
<u>Heliothis paradoxa</u> (Grt.)	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Phalaenidae (con't)				
<u>Lacinipolia renigera</u> Steph.	x			
<u>Nephelodes emmedonia</u> Cram.			x	x
<u>Papaipema purpurifascia</u> (G. & R.)			x	
<u>Plusia aerea</u> (Hbn.)	x			
<u>Schinia arcigera</u> Gn.			x	
Family Geometridae				
<u>Deuteronomos magnarius</u> Gn.			x	
<u>Nepytia regulata</u> (B. & McD.)	x	x	x	
ORDER DIPTERA				
Family Tipulidae				
<u>Tipula</u> spp.		x	x	x
<u>Pedicia</u> sp.		x		
Family Simuliidae				
<u>Simulium venustum</u> Say		x		
Family Tendipedidae				
Undetermined spp.		x		x
Family Culicidae				
<u>Culex apicalis</u> Adams		x		x
<u>Psorophora ciliata</u> (Fab.)			x	x
Family Sciaridae				
<u>Sciara</u> spp.	x	x	x	

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Fungivoridae				
<u>Macrocera formosa</u> Loew		x		
<u>Mycetophila jucunda</u> Johannsen				x
Family Bibionidae				
<u>Bibio junipennis</u> (Walk.)	x			
Family Tabanidae				
<u>Stonemyia rasa</u> (Loew)		x		
Family Rhagionidae				
<u>Ptiolina</u> sp.		x		
Family Asilidae				
<u>Asilus</u> spp.	x	x		
Family Therevidae				
<u>Psilocephala frontalis</u> Cole	x	x		
Family Bombyliidae				
<u>Geron arenicolus</u> (n. sp.)	x			
Family Empidae				
<u>Euhybos</u> spp.	x	x		
<u>Rhamphomyia</u> spp.	x	x	x	x
Family Dolichopidae				
<u>Chrysotus obliquus</u> Loew		x		
<u>Chrysotus subcostatus</u> Loew	x	x		x
<u>Dolichopus comatus</u> Loew	x	x		x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Dolichopidae (con't)				
<u>Dolichopus funditor</u> Loew				x
<u>Gymnopternus exilis</u> Loew				x
<u>Gymnopternus</u> spp.	x			
<u>Pelastoneurus vagans</u> Loew	x	x		
Family Longchopteridae				
<u>Lonchoptera dubia</u> (Cur.)	x	x		
Family Phoridae				
<u>Phora aterrima</u> Fall.	x			
Family Dorylaidae				
<u>Dorilas</u> sp.		x		
<u>Pipunculus similus</u> Hough.	x			
Family Syrphidae				
<u>Cartosyrphus tristis</u> (Loew)	x			
<u>Cnemodon</u> sp.	x			
<u>Eristalis arbustorum</u> (L.)	x			
<u>Eristalis barda</u> Wk.	x			
<u>Eristalis transversus</u> (Wd.)	x	x		x
<u>Epistrophe felix</u> (O.S.)	x			
<u>Helophilus fasciatus</u> Wk.	x			
<u>Heliophilus quadrimaculata</u> (Loew)		x		
<u>Heringia salax</u> (Loew)	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Syrphidae(con't)				
<u>Mesograpta marginata</u> (Say)	x	x		
<u>Mesograpta polita</u> (Say)	x	x		
<u>Pipizella pubescens</u> (Loew)	x			
<u>Spilomyia fusca</u> Loew		x		
<u>Spilomyia longicornus</u> Loew	x			x
<u>Syritta pipiens</u> L.	x	x		
<u>Syrphus torvus</u> O.S.	x			
<u>Toxomerus geminata</u> (Say)	x			
<u>Xanthogramma flavipes</u> Loew			x	
Family Conopidae				
<u>Physocephala</u> spp.		x		
<u>Zodion</u> spp.	x			
Family Otitidae				
<u>Chaetopsis</u> sp.	x			
<u>Herina</u> sp.		x		
<u>Pseudotephritis</u> sp.		x		
Family Trupaneidae				
<u>Euaresta bella</u> Loew	x	x		
<u>Eurosta comma</u> (Wied.)	x	x	x	x
<u>Eutreta sparsa</u> Wied.	x	x		
<u>Neaspilota albidipennis</u> (Loew)		x		

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Trupaneidae (con't)				
<u>Rhagoletis cingulata</u> Loew		x		
<u>Trupanea actinobola</u> Loew	x			
Family Sepsidae				
<u>Meroplus</u> sp.		x		
<u>Pandora</u> sp.		x		
<u>Sepsis</u> sp.		x		
Family Lauxaniidae				
<u>Minettia lupulina</u> (Fall.)	x	x		x
<u>Sapromyza</u> spp.		x		
Family Drosophilidae				
<u>Drosophila quimaria</u> Loew			x	
<u>Scaptomyza graminum</u> (Fall.)	x	x		x
Family Agromyzidae				
<u>Agromyza</u> spp.	x			
<u>Odinia</u> spp.		x		
Family Milichiidae				
<u>Desmometopa halteralis</u> Coq.	x	x		
<u>Desmometopa latipes</u> Meigen	x	x		
Family Chloropidae				
Undetermined spp.	x	x	x	x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Canaceidae				
<u>Xanthocanace</u> spp.		x		
Family Borboridae				
<u>Leptocera frontinalis</u> (Fall.)	x	x	x	
Family Chamaemyiidae				
<u>Paraleucopis</u> spp.	x			
Family Tetanoceridae				
<u>Dictya borealis</u> Cur.	x	x		
<u>Dictya expansa</u> Steys.	x	x	x	
<u>Limnia saratogensis</u> Fitch	x	x		
<u>Melina fuscipes</u> Maca.		x		
<u>Sepedon pusillus</u> Loew	x	x		
<u>Tetanocera pallida</u> Loew	x			
<u>Tetanocera plebeia</u> Loew	x		x	
<u>Tetanocera triangularis</u> Loew	x	x		x
Family Helomyzidae				
<u>Suillia quinquepunctata</u> (Say)				x
Family Dryomyzidae				
<u>Neuroctena anilis</u> (Fall.)				x
Family Anthomyiidae				
<u>Halina aldrichi</u> Snyder	x	x	x	
<u>Halina troene</u> (Walk.)	x			x

TABLE I continued

Family And Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Anthomyiidae (con't)				
<u>Hylemya cilicrura</u> (Rond.)	x	x		x
<u>Hylemya variata</u> (Fall.)	x	x		
<u>Limosia atrata</u> Walk.	x	x	x	x
<u>Limosia nigrescens</u> Stien			x	
<u>Limosia</u> sp.	x			
<u>Lispocephala</u> sp.	x			
<u>Mydaea brevipilosa</u> (Mall.)		x		
<u>Ophyra</u> sp.				x
<u>Pegomyia affinis</u> Stien	x	x		
<u>Pegomyia lipsia</u> (Walk.)		x		
<u>Pegomyia littoralis</u> (Mall.)	x	x		
Family Muscidae				
<u>Graphomya</u> sp.	x			
<u>Muscina stabulans</u> Fall.		x		
<u>Platycoenosia</u> sp.	x			
<u>Pyrellia</u> sp.				x
<u>Stomoxys calcitrans</u> L.	x			
Family Calliphoridae				
<u>Apaulina metallica</u> (Tns.)		x		
<u>Apaulina</u> sp.	x			
<u>Callitroga macellaria</u> (Fab.)	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Calliphoridae (con't)				
<u>Lucilia illustris</u> (Meigen)	x	x	x	x
<u>Phaenicia caeruleiviridis</u> (Macq.)	x	x		
<u>Phaenicia sericata</u> (Meigen)	x			
<u>Phormia regina</u> (Meigen)	x	x	x	x
<u>Pollenia rudis</u> (Fab.)	x	x	x	x
Family Sarcophagidae				
<u>Sarcophaga rapax</u> Wlk.	x			
<u>Sarcophaga</u> spp.	x	x	x	x
Family Larvaevoridae				
<u>Alophorellopsis purpurascens</u> Tns.	x			
<u>Apinops ater</u> Coq.	x			
<u>Archytas aterrimus</u> R.D.		x		
<u>Archytas californicus</u> Wlk.		x		
<u>Ceracia dentata</u> Coq.	x			
<u>Cistogaster unicolor</u> Brks.	x			
<u>Doryphorophaga macella</u> Rnh.	x			
<u>Gonia senilis</u> Will.		x		
<u>Gymnoclytia occidua</u> Wlk.	x			
<u>Gymnosoma canadensis</u> Brks.	x			
<u>Gymnosoma occidentale</u> Cn.		x		
<u>Gymnosoma par</u> Wlk.	x		x	
<u>Hyalomyodes triangulifera</u> Loew	x			

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Larvaevoridae (con't)				
<u>Lydina areos</u> Wlk.	x	x		
<u>Micromintha melania</u> Tns.		x		
<u>Ophyra aenescens</u> Wd.	x			x
<u>Peleteria apicalis</u> Wlk.		x		
<u>Phrynofrontina discalis</u> Cog.	x	x		
<u>Phylacteropoda tarsalis</u> Cog.	x			
<u>Pseudogermaria georgiae</u> Ald.	x			
<u>Ptilodexia spp.</u>		x		
<u>Trichiopoda pennipes</u> Fab.	x			
<u>Xanthomelanodes arcuata</u> Say	x			
Family Fanniidae				
<u>Fannia spp.</u>	x	x		
ORDER HYMENOPTERA				
Family Argidae				
<u>Arge pectoralis</u> (Leach)	x			
Family Tenthredinidae				
<u>Tenthredo verticalis</u> Say				x
Family Siricidae				
<u>Tremex columba</u> (L.)				x

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Braconidae				
<u>Agathis</u> sp.		x		
<u>Chelonus</u> sp.	x	x		
<u>Rogas</u> sp.		x		
Other undetermined spp.	x	x	x	x
Family Ichneumonidae				
<u>Aphion</u> sp.				x
<u>Gelis</u> sp.		x		
Glyptini				
Pimplini				
Rhyssini				
Other undetermined spp.	x	x	x	x
Family Eulophidae				
Undetermined spp.		x		
Family Pteromalidae				
Undetermined spp.		x		
Family Eurytomidae				
Undetermined spp.	x	x		
Family Chalcididae				
<u>Spilochalcis</u> <u>side</u> (Walk.)		x		
Family Cynipidae				
Undetermined sp.		x		

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Gasteruptiidae				
<u>Gasteruption assectator arca</u> (Coup.)		x		
Family Proctotrupidae				
<u>Proctotrupes</u> sp.				x
Other Undetermined spp.			x	x
Family Bethyliidae				
<u>Pristocera armifera</u> (Say)	x			x
Family Mutillidae				
<u>Dasymutilla</u> sp.		x		
Family Formicidae				
<u>Aphaenogaster</u> sp.	x			
<u>Camponotus americanus</u> (May.)	x			
<u>Camponotus noveboracensis</u> (Fitch)				x
<u>Camponotus pennsylvanicus</u> (DeG.)	x			
<u>Crematogaster</u> sp.		x		
<u>Dolichoderus mariae</u> (Forel)		x		
<u>Dolichoderus pustulatus</u> (Mayr.)		x		
<u>Dolichoderus</u> sp.		x		
<u>Formica fusca subsericea</u> Say	x			x
<u>Formica lasioides</u> (Em.)		x		
<u>Formica microgyna</u> (Whlbr.)		x		

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Formicidae (con't)				
<u>Formica pallide-fulva</u> <u>nitidiventris</u> (Em.)	x	x	x	x
<u>Formica</u> spp.	x			
<u>Lasius brevicornis</u> (Em.)	x			
<u>Lasius claviger</u> (Rog.)	x			
<u>Lasius umbratus aphidicola</u> (Walsh)		x		
<u>Lasius</u> spp.	x	x		
<u>Myrmica lobicornis fracticornis</u> (Em.)	x	x		x
<u>Myrmica</u> spp.	x			
<u>Ponera coarctata pennsylvanica</u> (Bk.)		x		
<u>Prenolepis imparis</u> (Say)	x	x		
<u>Tapinoma sessile</u> (Say)		x		
Family Vespidae				
<u>Ancistrocerus antilope</u> <u>antilope</u> (Panz.)		x		
<u>Eumenes crucifera nearcticus</u> Beq.				x
<u>Polistes annularis</u> (L.)	x	x		
<u>Polistes fuscatus pallipes</u> Lep.	x	x		x
<u>Rygchium foraminatum</u> <u>foraminatum</u> (Panz.)	x			
<u>Symmorphus pedestris</u> <u>pedestris</u> (Saus.)	x	x		

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Vespidae (con't)				
<u>Symmorphus pennsylvanicus</u> (Saus.)		x		
<u>Vespa crabro germana</u> Christ	x	x		
<u>Vespula (Dolichovespula)</u> <u>maculata</u> (L.)			x	
<u>Vespula (Vespula) vulgaris</u> (L.)				x
Family Pompilidae				
<u>Anoplius aethiops</u> (Cr.)		x		
<u>Auplopus architectus</u> <u>architectus</u> (Say)	x			
<u>Calicurgus hyalinatus</u> <u>alienatus</u> Sm.	x			
<u>Ceropales fraterna</u> Sm.		x		
<u>Episyron biguttatus</u> (Fab.)	x			
Family Sphecidae				
<u>Astata bicolor</u> Say				x
<u>Astata unicolor</u> Say				x
<u>Cerceris fumipennis</u> Say		x		
<u>Ectemnius 4-cinctus</u> (Fab.)	x	x		
<u>Ectemnius comptus</u> (Lep. & Br.)		x		
<u>Lestica interrupta</u> <u>interrupta</u> (Lep. & Br.)	x			
<u>Lestica producticollis</u> (Pack.)	x	x		

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Sphecidae (con't)				
<u>Philanthus gibbosus</u> (Fab.)		x		
<u>Philanthus ventilabris</u> Fab.		x		
<u>Sceliphron caementarium</u> (Dr.)		x		
<u>Sphex ichneumoneus</u> <u>ichneumoneus</u> (L.)		x		
Family Colletidae				
<u>Colletes similans armatus</u> (Patt.)	x	x		
<u>Colletes</u> spp.	x	x		
<u>Hylaeus cressoni cressoni</u> (Ckll.)	x	x		
Family Andrenidae				
<u>Andrena helianthi</u> Robt.		x		
<u>Andrena hirticincta</u> Prov.	x	x		
<u>Andrena nubecula</u> Sm.	x	x		
<u>Andrena solidaginis</u> Robt.	x	x		
<u>Perdita octomaculata</u> (Say)	x			
Family Halictidae				
<u>Agapostemon radiatus</u> (Say)		x		
<u>Agapostemon texanus texanus</u> (Cr.)		x		
<u>Agapostemon virescens</u> (Fab.)		x		
<u>Augochloropsis humeralis</u> <u>humeralis</u> (Patt.)	x	x		

TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Halictidae (con't)				
<u>Augochlora pura</u> (Say)			x	
<u>Augochlora striata</u> Prov.	x	x		
<u>Halictus ligatus</u> Say	x	x	x	x
<u>Lasioglossum</u> spp.	x	x		x
<u>Sphecodes arvensis</u> Patt.		x		
Family Megachilidae				
<u>Coelioxys octadentata</u> (Say)	x			
<u>Megachile (Litomegachile)</u> <u>brevis</u> Say	x	x		
Family Apidae				
<u>Apis mellifera</u> L.	x	x	x	x
<u>Bombus affinis</u> Cr.	x	x		
<u>Bombus americanorum</u> (Fab.)		x		
<u>Bombus bimaculatus</u> Cr.	x	x		
<u>Bombus griseocollis</u> (DeG.)		x		
<u>Bombus impatiens</u> Cr.	x	x		
<u>Bombus vagans</u> F. Sm.	x	x		
<u>Ceratina calcarata</u> Robt.	x	x		
<u>Ceratina</u> spp.	x	x		
<u>Melissodes desponsa</u> Sm.	x			
<u>Psithyrus ashtoni</u> (Cr.)				x

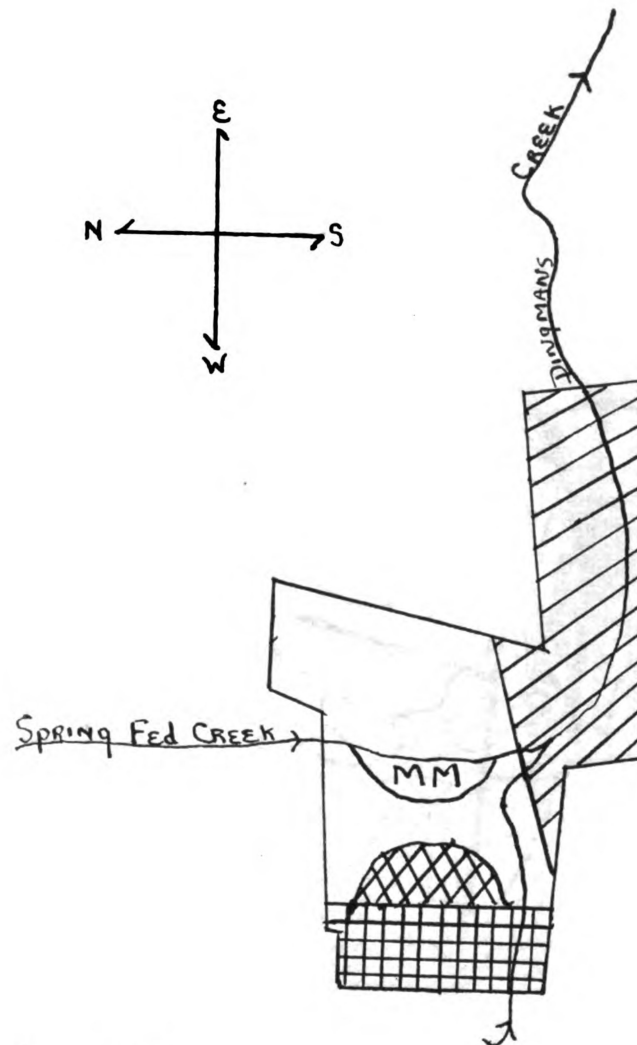
TABLE I continued

Family and Scientific Name	D.M.	M.M.	O.H.F.	H.F.
Family Apidae (con't)				
<u>Psithyrus laboriosus</u> (Fab.)	x	x		
<u>Xylocopa virginica</u> (L.)	x	x		

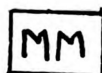
TABLE II
SUMMARY OF INSECTS TAKEN DURING THE SURVEY

	<u>FAMILIES</u>	<u>GENERA</u>	<u>SPECIES</u>
1. Orthoptera	6	16	27
2. Neuroptera	2	2	2
3. Hemiptera	14	45	61
4. Homoptera	5	23	30
5. Coleoptera	25	106	136
6. Mecoptera	1	1	1
7. Trichoptera	2	-	-
8. Lepidoptera	11	28	32
9. Diptera	39	107	130
10. Hymenoptera	23	59	77
Totals	128	387	496

Topography of AREAS STUDIED

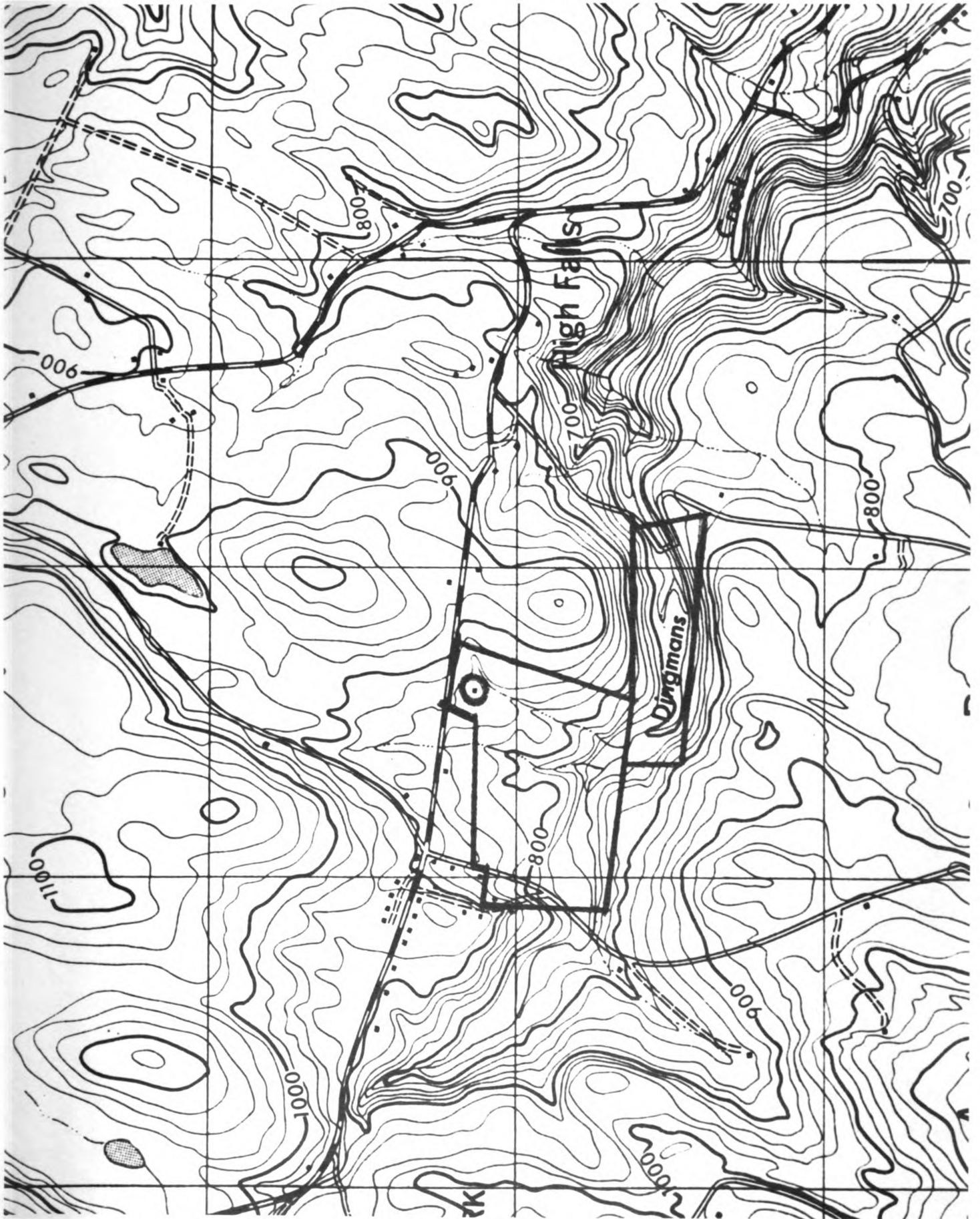


 - DRY MEADOW AREA

 - MARSHY MEADOW AREA

 - OAK-HICKORY FOREST AREA

 - HEMLOCK FOREST AREA



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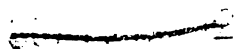
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