THE SPIDER FAUNA OF BAKER WOODLOT AND VICINITY, MICHIGAN STATE UNIVERSITY, INCLUDING LIFE HISTORIES OF SELECTED SPECIES

Thesis for the Degree of M. S.

MICHIGAN STATE UNIVERSITY

Leslie C. Drew

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THE SPIDER FAUNA OF BAKER WOODLOT AND VICINITY,
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By

Leslie C. Drew

AN ABSTRACT OF

A thesis submitted to the College of Science and Arts
Michigan State University of Agriculture and
Applied Science in partial fulfillment of
the requirements for the degree of

MASTER OF SCIENCE

Department of Zoology

East Lansing, Michigan

1957

Approved T. Wayne Porter

THESIS ABSTRACT

The purpose of this study was to survey the spider fauna of a designated area and to reveal the life histories of three species of spiders.

The survey was restricted to a 250 acre plot located on the property of Michigan State University. Collecting was conducted over a period of 19 months. The spiders were collected by visual searching, sifting leaf litter, shaking bushes, sweeping with an insect net, and by placing pitfall traps in selected areas. The survey included data concerning habitat preference and distribution. The spiders were determined to the species level by use of available keys and publications. The determinations were confirmed by competent aranealogists or by comparison with confirmed specimens.

The life history studies were conducted under laboratory conditions in which the external environmental factors were not rigidly controlled. Throughout the course of these studies each spider was contained in a glass vial. Food, vestigial-winged <u>Drosophila</u> <u>melanogaster</u> Meigen, and water were added regularly. Data were recorded concerning the number of moults, the duration of stadia, the characteristics of the egg cases and eggs, and measurements of the body lengths of the spiders at various instars. The effectiveness of the methods used in rearing spiders under laboratory conditions

was tested by comparing results obtained for two species of spiders whose life histories were known with the results of other investigations of the same two species.

The total number of families of spiders represented in the area was 20. The results of the survey were presented in tabular form. Included in the table of species represented were data concerning the habitat, distribution, and number of mature specimens collected.

The developmental data concerning *Philodromus pernix* Blackwall. *Dictyna sublata* (Hentz) and *Theridion frondeum* Hentz were also presented in tabular form.

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INTRODUCTION

That spiders are of scientific significance is verified by the number of publications concerning these animals. The publications can be divided into four main categories. First, are the works which provide a basic foundation in Araneology. Among these are the works of Hentz (1875), Emerton (1878), Petrunkevitch (1911, 1923, 1933, 1939, 1942), Bristowe (1939, 1941), Comstock (1940), Kaston (1948), and Gertsch (1949). The second group, the taxonomic investigations, contains numerous separate papers on infrafamilial categories. Examples are Bishop (1924), Exline (1936), Gertsch (1939), and Levi (1953-1957). Ecological studies on spiders comprise the third category and include such workers as Lowrie (1942, 1948) and the Barnes' (1953, 1954, 1955a). Last to be mentioned are the life history studies. These studies or rearing experiments are largely restricted to the isolation of spiderlings and observations on their development with little reference to environmental factors. Studies by Ewing (1919), Gabritschevsky (1927) and Baerg (1928) are of this type. However, that such factors as food, light, temperature, and humidity affect the number of moults and the length of the stadia has been confirmed by Browning (1941, 1942), Jones (1941), and Deevey (1949).

The spider fauna of Michigan first received attention in 1894 at Agriculture College (East Lansing) by C. F. Baker. His list included 41 species of 33 genera representing ten families. During the past 25 years, A. M. Chickering of Albion College has investigated the diverse fauna of the state. He has compiled faunal lists for various geographical areas, listed families represented throughout the state, and prepared keys to the species in five families. Noland (1953) investigated the spider fauna of the Proud Lake Recreation Area, Oakland County, Michigan, with reference to ecological distribution.

The objectives of this study were to collect and determine the species of spiders of a designated area on the property of Michigan State University, East Lansing, Ingham County, Michigan, and to reveal the life histories of three species present in the area.

Included in the survey are data concerning habitat preference and distribution. Contained in the life history investigations are descriptions of egg cases and eggs, the number of moults from egg to sexual maturity, and the duration of the stadia.

Both aspects of the study were begun in June of 1955. Collecting for the survey was terminated in January of 1957. During this time, representatives of 20 families were obtained. The rearing experiments, which continued until April of 1957, provided the data necessary to record the life histories of *Theridion frondeum* Hentz, *Dictyna sublata* (Hentz), and *Philodromus pernix* Blackwall.

THE COLLECTING AREA

The collecting area (Fig. 1), which was located about

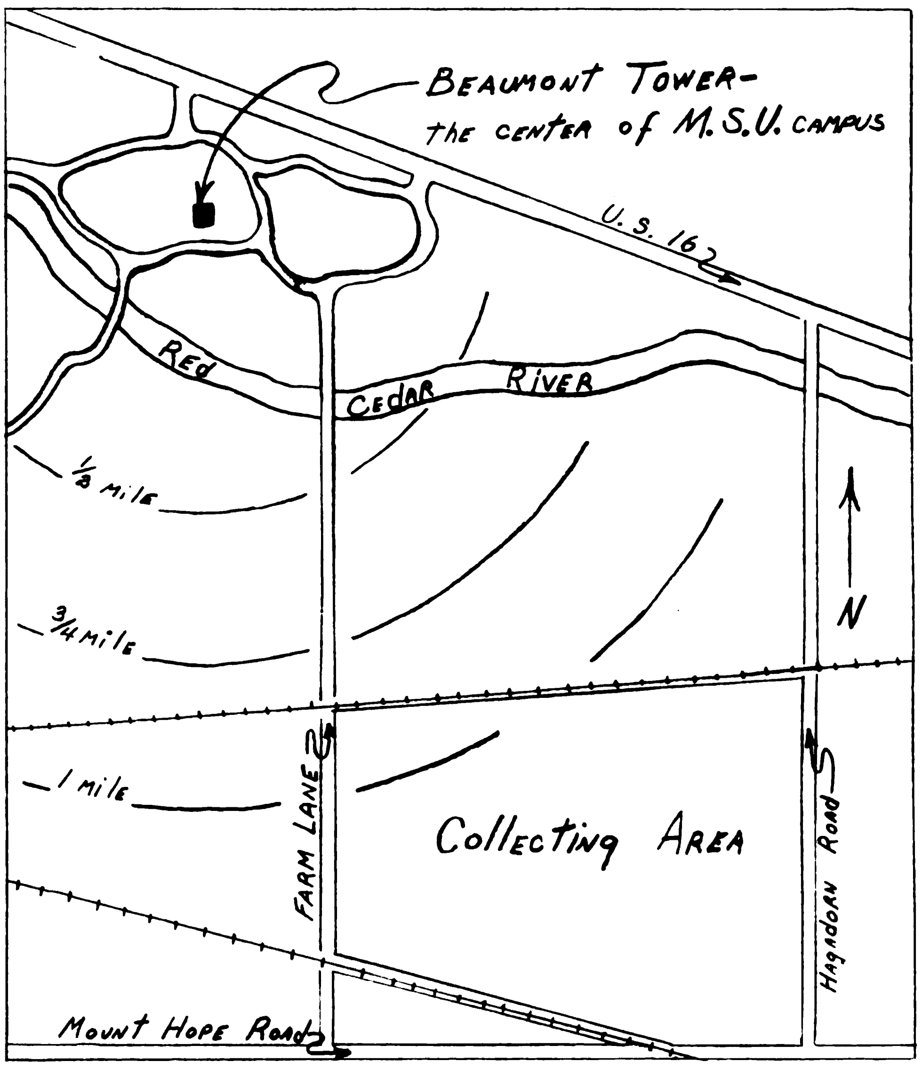

Figure 1. Site of the collecting area with reference to the center of the Michigan State University (Beaumont Tower).

one and one half miles southeast of the center of the Michigan State University Campus, contained approximately 250 acres.

It was bounded on two sides by well-traveled roads and on the remaining two sides by railroad tracks. The larger portion, or 200 acres (Fig. 2), was known as the Horticultural Experimental Plots. The remaining 50 acres was the Baker Woodlot.

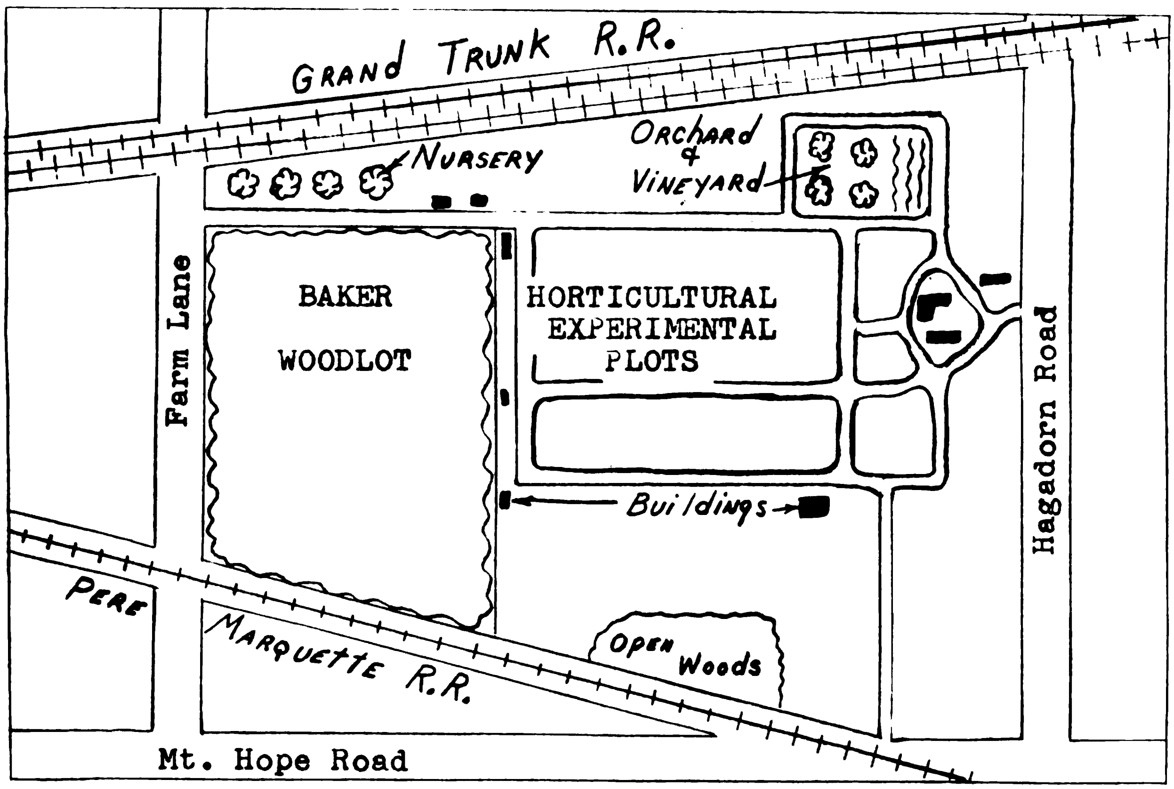

Figure 2. The collecting area

The experimental plots were not entirely under cultivation. A portion was covered by an open woods of oak and sumac. Nine permanent outbuildings were located on the area; and during the growing season, several temporary structures were erected in the fields. The area also included a tree nursery, an apple orchard, a vineyard, and extensive lawns which surrounded the main buildings. The majority of the plot area was, however, given over to cultivated fields and meadows. Dissecting the entire area were roadways bordered by occasional hickory and oak trees. Collecting was also conducted in the bordering railroad beds and embankments.

Baker Woodlot received considerable attention because of the diversity of habitats present there. This woodlot did not fit easily into a definite ecological description because of the heterogeneity of the vegetation. For this study, the area was divided into three sections on the basis of the drainage property of the predominating soil types, namely: well-drained, wet, and very wet (Fig. 3). The following paragraphs are devoted to an analysis of the vegetative strata which occurred on these soils.

The well-drained portion consisted of soils of the Hillsdale and Hillsdale-Miami complexes and was the largest of the three areas. The upper story was composed of red oak, *Quercus rubra* Linnaeus; sugar maple, *Acer saccharum* Marshall; beech, *Fagus grandifolia* F. Ehrhart; basswood, *Tilia americana* Linnaeus; and black cherry, *Prunus serotina* F. Ehrhart; with occasional tulip poplar, *Liriodendron tulipifera* Linnaeus; white ash, *Fraxinus americana* Linnaeus; white oak, *Quercus alba* Linnaeus; American elm, *Ulmus americana* Linnaeus; and slippery elm, *U. rubra* Muhlenberg. The understory had, along with tree reproduction, witch hazel, *Hamamelis virginiana* Linnaeus; arrowwood, *Viburnum recognitum* Fernald; elderberry, *Sambucus pubens* Michaux; Virginia creeper, *Parthenocissus quinquefolia*

Linnaeus; poison ivy, Rhus radicans Linnaeus; and some running strawberry, Euonymus obovatus Nuttall. The herbaceous

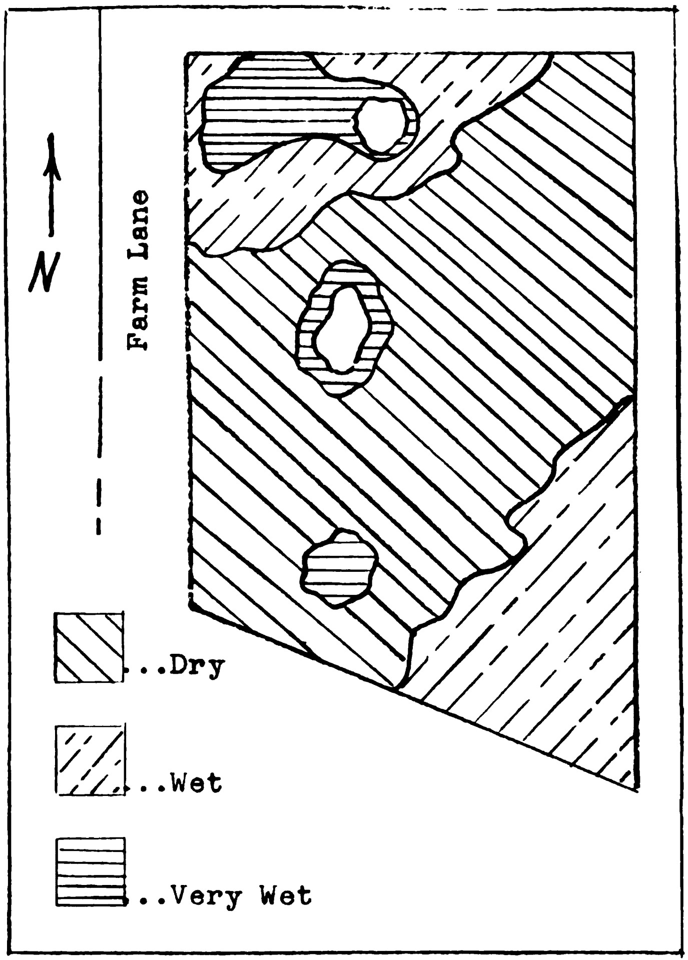

Figure 3. The extent and location of divisions of Baker Woodlot. This is the spring arrangement. As the summer approached and progressed, the dry area increased in extent.

layer of this soil type was composed of bedstraw, Galium triflorum Michaux; true Solomon's seal, Polygonatum pubescens Willdenow; along with spring flowers, e.g., adder's tongue, Erythronium albidum Nuttall; Viola spp.; dutchmen's breeches, Dicentra cucullaria Bernhardi; Trilium grandiflorum Michaux; which gave way, primarily to Aster spp. and goldenrod, Solidago spp., as the season progressed. This succession also occurred on the following soil types.

The wet portion of the woodlot had the Wauseon soil which was very poorly drained. The trees of this section were basswood, sugar and red maple, Acer rubrum Linnaeus; beech, American elm, white ash, bitternut, Carya cordiformis K. Koch; American hornbeam, Carpinus caroliniana Walter; and hop hornbeam, Ostrya virginiana K. Koch; with occasional swamp white oak, Quercus bicolor Willdenow; slippery elm and rock elm, Ulmus thomasi Sargent. The shrubby understory had tree reproduction of white ash, red maple, black cherry, alternate leaf dogwood, Cornus alternifolia Linnaeus, and elderberry. Species of Viola, Gramineae and Claytonia together with bedstraw, sweet cicely, Osmorhiza longistylis Torrey, and black snakeroot, Sanicula trifoliata Bicknell, were the predominating herbs.

The division classed as very wet (Fig. 3) was characterized by Carlisle muck which in this woodlot supported the vegetation in and around one vernal and two permanent ponds. The surrounding trees were cottonwood, Populus deltoides Marshall; black ash, Fraxinus nigra Marshall; black gum, Nyssa sylvatica Marshall; red maple, basswood, white ash, American elm, swamp white oak and burr oak, Quercus macrocarpa Michaux. The shrubby layer around or in the ponds was button bush, Cephalanthus occidentalis Linnaeus; American cranberry, Vaccinium macrocarpon W. Aiton; and black currant, Ribes americanum P. Miller. The herbs in this division were sedges, Carex spp., and floating aquatics such as duckweed, Lemna spp.

The border of the woodlot differed from the interior in that sassafras, Sassafras albidum Nees von Esenbeck; black locust, Robinia pseudo-acacia Linnaeus; prickly ash, Xanthoxylum americanum; grapes, Vitis aestivalis Michaux; bittersweet, Celastrus scandens Linnaeus; and abundant tree reproduction were present.

THE SPIDER FAUNA OF BAKER WOODLOT AND THE HORTICULTURAL EXPERIMENTAL PLOTS

The purpose of this portion of the study was to reveal the spider fauna of the area by extensive collecting and determination of specimens to the species level. In conjunction with the collecting, data concerning habitat preference and distribution of the species was recorded.

Sexually mature individuals were used in determining the species of spiders. The basis of species determination, in most cases, is the arrangement of the structures composing the external genitalia.

Methods

Habitats investigated. After consulting the literature on the habits of spiders and before beginning collecting, this investigator analyzed the study area and selected certain habitats in which the collecting would be done.

The habitats selected in the experimental plot area were: in the soil; on the soil; permanent and temporary outbuildings; flower heads; herbaceous vegetation of the nursery, orchard, open woods and vineyard; vegetation of the cultivated fields and meadows; tree bark of the open woods, orchard, nursery and occasional trees along the roads; and leaves of shrubs and trees.

The habitats selected in the woodlot were: in the soil; in leaf litter; on stumps and fallen logs; on herbaceous vegetation of the woods, vernal pond, and in and surrounding the permanent ponds; on leaves of shrubs and trees; on and beneath bark of shrubs and trees; and on flower heads.

Types of collecting. Visual searching, which enables one to observe the exact habitat occupied by the spider, served as the primary method of collecting. In addition to visual searching and in order to secure a more complete sample of the spider fauna, shrubs were shaken over a cloth, areas of uniform vegetation were swept with an insect net, pitfall traps were placed in selected areas of the woodlot, and leaf litter which had to be thawed in the winter was sifted for spiders. Specimens of Agelenidae were frequently collected by blocking the escape tunnel of their funnel-shaped web with a small hand hatchet. Also, certain other spiders were collected as they dropped on a line of silk after their web had been lightly tapped.

Procedure in the field. Initially, the spiders were collected in a dry shell vial as recommended by Kaston (1948). By collecting in this manner, one could ascertain whether the spider was mature or not without causing injury. If the specimen was mature, it was transferred to a two-inch, screw-top vial containing a solution of 95% alcohol. Additional specimens taken in the same habitat were placed in this vial. By this method, one screw-top vial contained all the spiders collected in a specific habitat on one date.

Determinations

Procedure. The process of determination began with the vials containing the collection from a specific habitat for one date. As the specimens were separated to families and lower taxonomic categories, the ecological data contained in the above-mentioned vials accompanied each specimen. This resulted in working with an increased number of vials; but each specimen when finally determined to species level had with it the collection data as originally recorded.

Taxonomic characters and available keys. The taxonomic characters used at the family level are: the arrangement of eyes as in Salticidae, Lycosidae, Pisauridae, Scytodidae and Oxyopidae; leg armature in Theridiidae and the cribilates; spinneret arrangement of Agelenidae, and Hahniidae; general body shape as in Thomisidae and Tetragnathidae; size; and various combinations including the above and other characters such as tarsal claws and spiracle placement. The key used at the family level of determination was that contained in the monograph by Kaston (1948) which separates 29 families and is easily followed. The works by Comstock (1940) and Chickering (1952) also contain keys to the family level.

On the generic level, the taxonomic characters used in identification may be classed as finer divisions of those used for family determinations. Again, Kaston (1948) was used as were the papers by the following authors: Bishop (1924); Chickering (1939, 1940, 1944); and Archer (1951, 1951a).

Keys to the species level were found in several papers, e.g., Seeley (1928), Exline (1936), Chamberlin and Ivie (1940), and others. Kaston (1948) was particularly useful here as it contained numerous illustrations which aided in determination. Also, at this level, one has recourse to the revisionary papers by Gertsch (1934-1951), Levi (1953-1957), and others.

Confirmation of determinations. After using the above works to identify the specimens, the author was fortunate in being able to compare some of his determinations with those specimens contained in Dr. Chickering's extensive collection of Michigan spiders. Several identifications were confirmed in this way. Still other determinations were confirmed by the following araeneologists: Dr. R. D. Barnes, Gettysburg College; Dr. H. W. Levi, Harvard; and Dr. M. H. Muma, University of Florida.

Tabular presentation of determinations. The results of the determinations are included in Tables I and II. The first contains the families recorded and their breakdown into the number of genera and species represented. Table II is a complete listing of the species found together with the specific area where collected and the habitat occupied at the time of collection.

TABLE I

A LIST OF THE FAMILIES REPRESENTED IN THE HORTICULTURE EXPERIMENTAL PLOTS AND BAKER WOODLOT WITH THE NUMBER OF GENERA AND SPECIES PER FAMILY

Families	Genera	Species
Scytodidae	1	1
Pholcidae	1	1
Theridiidae	4	4
Linyphiidae	1	1
Micryphantidae	2	2
Epeiridae	7	12
Tetragnathidae	2	3
Agelenidae	4	11
Hahniidae	1	1
Pisauridae	2	3
Lycosidae	4	8
Oxyopidae	1	1
Gnaphosidae	1	1
Clubionidae	2	2
Anyphaenidae	2	2
Thomisidae	6	10
Salticidae	7	8
Dictynidae	1	4
Uloboridae	2	2
Amaurobiidae	1	1
Total 20	52	78

TABLE II

A LIST OF THE SPIDERS FOUND IN THE HORTICULTURE EXPERIMENTAL PLOTS AND BAKER WOODLOT SHOWING HABITATS OCCUPIED AT TIME OF COLLECTION

Abbreviations of the productive habitats of the two sections of the collecting area:

Experimental Plots	Baker Woodlot
VF - vegetation of fields	LL - leaf litter
VOW - vegetation of open woods	VW - vegetation of the woods
FH - flower heads	VVP - vegetation of vernal pond
OB - outbuildings	SFL - stumps and fallen logs
	SB - shrub bark
	LS - leaves of shrubs
	TB - tree bark

The figures listed with the abbreviations of the habitats refer to the number of mature specimens collected in that particular habitat.

Species	Baker Woodlot	Hort. Exp. Plots
Scytodidae		
1. *Scytodes thoracica* (Latreille)		OB 4
Pholcidae		
2. *Pholcus phalangioides* (Fuesslin)		OB 1
Theridiidae		
3. *Enoplognatha tecta* (Keyserling)	SFL 2	OB 1
4. *Steatoda borealis* (Hentz)	VW 4	OB 2
5. *Theridion frondeum* Hentz	VW 6	
6. *Achaearanea tepidariorum* (C. L. Koch)		OB 24

TABLE II continued

Species	Baker Woodlot		Hort. Exp. Plots	
Linyphiidae				
7. *Frontinella communis* (Hentz)	VW	2		
Micryphantidae				
8. *Ceraticelus fissiceps* (O. P. Cambridge)	LL	1		
9. *Erigone atra* Blackwall	LL	1		
Epeiridae				
10. *Argiope aurantia* Lucas			VOW	3
11. *Mastophora bisaccata* (Emerton)	VVP	1		
12. *Cyclosa conica* (Pallas)	VW	6		
13. *Mangora maculata* (Keyserling)	VW	1		
14. *Neoscona minima* F. O. P. Cambridge			VF	1
15. *N. benjamina* (Walckenaer)	VW	1	VF	1
16. *Aranea solitaria* (Emerton)	VW	1		
17. *Epeira dumetorum* (Villers)			OB	2
18. *E. raji* (Scopoli)	VVP	1		
19. *E. trifolium* Hentz	VW	2	VF	1
20. *E. displicata* Hentz	VW	2		
21. *E. pegnia* Walckenaer	VW	1		
Tetragnathidae				
22. *Leucauge venusta* (Walckenaer)	VW	1		
23. *Tetragnatha laboriosa* Hentz			VF	30
24. *T. versicolor* Walckenaer			VF	2

TABLE II continued

Species	Baker Woodlot		Hort. Exp. Plots	
Agelenidae				
25. Coras juvenilis (Keyserling)	TB	1		
26. C. medicinalis (Hentz)	TB	1		
27. C. lamellosus (Keyserling)	SFL	8		
28. Wadotes calcaratus (Keyserling)	VW	1		
29. W. new species	VW	1		
30. W. hybridus (Emerton)	SFL	1		
31. Circurina robusta Simon	SFL	1		
32. Agelenopsis pennsylvanica (C. L. Koch)	VW	3	VF	1
33. A. utahana (Chamberlin and Ivie)	VW	3		
34. A. emertoni Chamberlin and Ivie	VW	3		
35. A. potteri (Blackwall)	VW VVP	4 1		
Hahniidae				
36. Neoantistea radula (Emerton)	LL	3		
Pisauridae				
37. Pisaurina mira (Walckenaer)	VW	13		
38. P. mira var subinflata (Hentz)	VVP	1		
39. Dolomedes tenebrosus Hentz	VVP	1		
Lycosidae				
40. Pirata arenicola Emerton	LL	1		
41. P. maculatus Emerton	LL	1		
42. Schizocosa crassipes (Walckenaer)	LL	1		

TABLE II continued

Species	Baker Woodlot		Hort. Exp. Plots	
43. Lycosa punctulata Hentz	VVP	1		
44. L. helluo Walckenaer	VW	2		
45. Pardosa moesta Banks	VVP	3		
46. P. milvina (Hentz)	LL	1		
47. P. saxatilis (Hentz)			VF	3
Oxyopidae				
48. Oxyopes salticus Hentz			VF	2
Gnaphosidae				
49. Herpyllus vasifer (Walckenaer)	VW	1		
Clubionidae				
50. Clubiona obesa Hentz	LS	1		
51. Trachelas tranquillus (Hentz)	LS	1		
Anyphaenidae				
52. Aysha gracilis (Hentz)	LS	12		
53. Anyphaena celer (Hentz)	LS	3		
Thomisidae				
54. Misumena calycina (Linnaeus)			FH	4
55. Misumenops asperatus (Hentz)	VW	3	FH	4
56. Coriarachne versicolor Keyserling	LL	1		
57. Xysticus triguttatus Keyserling	VW	1		
58. X. funestus Keyserling	VW	1		
59. Philodromus pernix Blackwall	TB	2		
60. P. placidus Banks	VW	1		

TABLE II continued

Species	Baker Woodlot		Hort. Exp. Plots	
61. *P. imbecillus* Keyserling			VF	6
62. *Tibellus oblongus* (Walckenaer)	VVP	5	VF	1
63. *T. maritimus* (Menge)	VW	2		
Salticidae				
64. *Habrocestum pulex* (Hentz)	LL	1		
65. *Habronattus viridipes* (Hentz)			VF	1
66. *Metaphidippus protervus* (Walckenaer)	VW	5		
67. *M. exiguus* (Banks)	VW	1		
68. *Paraphidippus marginatus* (Walckenaer)	TB	1		
69. *Phidippus audax* (Hentz)	VVP	5	VF	4
70. *Icius hartii* Emerton	TB	1		
71. *Maevia vittata* (Hentz)	LL	1		
Dictynidae				
72. *Dictyna sublata* (Hentz)	LS	4		
73. *D. volucripes* Keyserling	VW	3		
74. *D. muraria* Emerton	VW	1		
75. *D. hentzi* Kaston	VW	2		
Uloboridae				
76. *Uloborus americanus* Walckenaer	VW	3		
77. *Hyptiotes cavatus* (Hentz)	SB	9		
Amaurobiidae				
78. *Amaurobius bennetti* (Blackwall)	VW LL	3 1		

Discussion

Twenty families were obtained in the collecting area described above. Comparing this total with the 24 families found in Michigan (Chickering, 1952), one can readily see the diversity of fauna in this limited area. This comparison needs further explanation as two systems of family classification were used. The author followed Kaston (1948) while Chickering (1952) used the work of Petrunkevitch (1939) in part. The latter pair of workers considered Argiopidae as one family; whereas Kaston classified it as three separate families, Epeiridae, Theridiosomatidae and Tetragnathidae. If one employed the classification of Kaston, the total for the state would number 26 families. Of this total, the family Dysderidae has yet to be recorded for the state bringing the actual number of families for Michigan to 25.

Using the family classification of Kaston (1948), the five families not represented in this survey are Mimetidae, Atypidae, Oecobiidae, Oonopidae, and Theridiosomatidae.

Of these listed above, only Mimetidae would occur with any regularity as two genera and four or five species are represented in the state (Chickering, 1952). A possible explanation for the absence of this family could be directly related to the lack of food. Bristowe (1941), reported that species of Theridiidae, specifically Theridion spp., and Linyphiidae were the principal source of food for mimetids.

Tables I and II indicate that only four genera of the theridiids and one genus of the linyphiids were collected in this area.

Each of the four remaining families have been recorded three or fewer times in the state. Atypidae, the only Mygalomorphae known to occur in Michigan, is represented by a single species Atypus milberti (Walckenaer). Lowrie (1948) recorded a specimen from Berrien County and Chickering (1952) recorded the same species from Jackson County. The distribution of Atypus milberti as given by Gertsch (1936) included "Northeastern United States from Massachusetts to Wisconsin and south to Ohio, Pennsylvania, and North Carolina." It would appear that the occurrence of this species in Michigan should be more common than has been recorded. Oecobiidae, Oonopidae and Theridiosomatidae, all small spiders not exceeding 3 mm., have one genus recorded for each in the state. In addition to their size, the secretive habits of the Oecobiidae and Oonopidae may have resulted in my inability to detect them. According to Kaston, the preferred ecological niche of the Theridiosomatidae is ". . . damp, dark situations such as bushes and rocks on the banks of creeks and in wet moss on the faces of cliffs." Such habitats were absent in the collecting area of this study.

In Table II, which gives the genera and species of the families, Gnaphosidae and Clubionidae are sparsely represented. Both are quite abundant in the state (Chickering, 1939, 1952). These families, together with Anyphaenidae, are part of the group known as "running spiders" (Gertsch, 1949). The habitats preferred are on the soil and on leaves of vegetation. The collecting methods used in this study were effective in obtaining representatives of Lycosidae and Pisauridae which occur in the same general habitats. Two species of Anyphaenidae represented in the state by only three or four species (Chickering, 1939) were also collected. The Gnaphosidae and Clubionidae are essentially night hunters (Gertsch, 1949) and hide in retreats in debris and vegetation during the day. If these families were strongly represented in the area, they would have been more abundant as were the specimens of Lycosidae and Pisauridae.

Spiders were found in only 11 of the 17 habitats initially selected. These productive habitats with the percentage of the total number of spiders collected in each are listed in Table III. This table is based on the 270 mature specimens collected in this survey.

The burrowing Lycosidae, Geolycosa, was not found in the area. The author has collected specimens of G. wrightii (Emerton), one of two species of Geolycosa occurring in Michigan (Wallace, 1942), in Clinton and Kent Counties.

A factor influencing the spider population of the herbaceous vegetation of the vineyard, nursery, and orchard was the frequent use of insecticides. A few immature specimens of Tetragnathidae, Salticidae, and Thomisidae were collected

TABLE III

PRODUCTIVE HABITATS OF THE EXPERIMENTAL PLOT AREA AND BAKER WOODLOT

Experimental Plot Area		Baker Woodlot	
Percent of total[1]	Habitat	Percent of total[2]	Habitat
56.6	Vegetation of fields	47.5	Vegetation of woods
33.0	Outbuildings	13.8	Vegetation of vernal pond
7.6	Flower heads	10.9	Leaf litter
2.8	Vegetation of open woods	10.9	Leaves of shrubs
		7.1	Stumps and fallen logs
		4.9	Bark of shrubs
		4.9	Bark of trees

[1]The total number of specimens collected in the Experimental Plot Area was 105.

[2]The total number of specimens collected in Baker Woodlot was 165.

here. The spraying either reduced the insect population which served as food or was effective in killing spiders.

From the totals of each section of the collecting area (Table III), it can be seen that Baker Woodlot supported over 25% more spiders in its 50 acres than did the 200 acre experimental plot. This was due in part to the multiple vegetative strata of the woodlot which increased the area of the substratum and with it the number of ecological niches occupied by species of spiders. In comparison, three of the four productive habitats of the experimental plots were limited to the single herbaceous vegetative stratum. This correlation between vegetative stratification and increased spider fauna has been recorded by Lowrie (1948), R. D. Barnes (1953), B. M. and R. D. Barnes (1954), and R. D. and B. M. Barnes (1955) in their respective ecological studies.

Seasonal variation in the species complex of the mature spider fauna of the woodlot was observed. The collecting period for this survey extended from June, 1955, through January, 1957. When the collection was examined at the end of the 1955 season, it was noticed that the web-weaving species predominated. During the following spring and first weeks of summer, the non-web weaving spiders including the Lycosidae, Pisauridae, and others, were the dominant types. There were very few mature web-weaving species present at this time. Again, during the latter portion of the summer and throughout the fall, it was the web-weaving varieties that predominated. The underlying basis for such a phenomenon is the fact that most of the web-weaving spiders mature during one season, mate, lay their eggs and die; and the majority of non-web weavers do not mature until very late in the fall or in the spring of the following year, then mate, lay their eggs and die. The web weavers overwinter as eggs and the non-web weavers as mature spiders or immatures in the penultimate or earlier instars.

Included in the collection of the woodlot is a mature female Agelenidae belonging to the genus *Wadotes*. At present, this specimen appears to be a new species. Dr. M. H. Muma who confirmed the determinations of species for this family, recognized the specimen as being closely related to *Wadotes calcaratus* (Keyserling). It is hoped that mature male specimens of this species will be found during the present growing season (1957). These would enable the author to describe the species.

LIFE HISTORY STUDIES

Purpose and Objectives

The life history facet of Araneology has not received as much attention from investigators as the taxonomic phase. No doubt, the primary reason for this is the amount of time involved in the rearing of spiders. According to Deevey (1949), life history studies for 21 species of spiders have been completed. The present study contains the life histories of three species which have not been previously recorded. These are *Philodromus pernix*, *Dictyna sublata*, and *Theridion frondeum*.

The purpose of this part of the investigation was to study the developmental sequence of the spider from egg to maturity. The primary objectives were to observe and record the number of moults from the egg to the sexually mature adult and the duration of the stadia. Secondary objectives were to record the characteristics of the egg cases, their contents, and the measurement of body length of the spiders at various instars.

Methods

Treatment of egg cases. When collected, the egg case and its substrate were placed in a suitable bottle containing a strip of tissue paper. The bottle was loosely capped. Each bottle and its contents were assigned a letter for recording purposes. The bottle was then placed in a position to receive indirect natural light. Every two days, a few drops of water were placed on the tissue paper in an attempt to keep the humidity somewhat constant.

Isolation of spiderlings. The spiderlings were isolated and put into separate vials not later than two days after they had emerged from the egg sac. Separation made observation of the individual spider possible and it also eliminated cannibalism.

Each spider was given a number which in conjunction with the letter of its egg case served as its label throughout the study. This label was printed in permanent ink on the cork of the vial in which the spider was housed. A three-by-five file card was kept for each specimen.

After the separation of the entire brood was completed, measurements and descriptive notes were taken. The first live food was then introduced into each vial.

Materials and their use. Two sizes of glass, shell vials were used in the study. The small vial measured 50 mm. x 15 mm. (1½ dram capacity), and a larger vial 70 mm. x 31 mm. (4 dram capacity). Initially, the smaller vial was used and as the spiderling grew, a larger vial was substituted. In the early stages, the smaller vial limited the area in which the flies, used as food, could move making them easier prey for the young spiderling.

Appropriate sized corks used as stoppers were not forced into the vial. Rather, they were loosely placed insuring an air supply for the spiderlings.

Each vial contained a strip of two-ply tissue paper which was narrower than the diameter and shorter than the length of the vial. The purpose of the tissue was to absorb any excess moisture from the bottom of the vial, thus preventing mold.

Care of the spiderlings. The factors of temperature, humidity and light were neither rigidly controlled nor were they allowed to fluctuate from one extreme to the other. The temperature did not exceed 85°F. nor did it fall below 68°F. The relative humidity of the vials was different than the outside atmosphere due to the fact that water was introduced every three or four days for drinking purposes. The vials were so placed as to avoid direct sunlight. Artificial light was not shielded from the specimens as no effort was made to control the period of time light reached the vials.

Vestigial-winged *Drosophila melanogaster* Meigen were used as the food source in these studies. Other investigators (Crane, 1948 and Deevey, 1949) have used this species and secured favorable results. In the present studies, the flies were not anesthetized before being placed in the vials; nor was the amount consumed rigidly controlled. Every three days, several live flies were placed in the vials. The number of flies depended upon the size and condition of the spider. If the spider was in the process of moulting or appeared swollen in readiness to do so, no flies were introduced. For in the former case, they may have caused the spider to injure itself and in the latter case, the flies would have been wasted.

The method used to introduce live flies into the vials was devised by the author during the course of this study. In methods described in the literature (Brown 1946, Crane 1948, Deevey 1949), either the flies were allowed to crawl into the vial containing the spider or the flies were anesthetized. In the present studies, the flies were transferred from the culture bottle to an empty half-pint milk bottle. This bottle was stopped with a plug as shown in Figure 4. The corks were removed from the vial and spout of

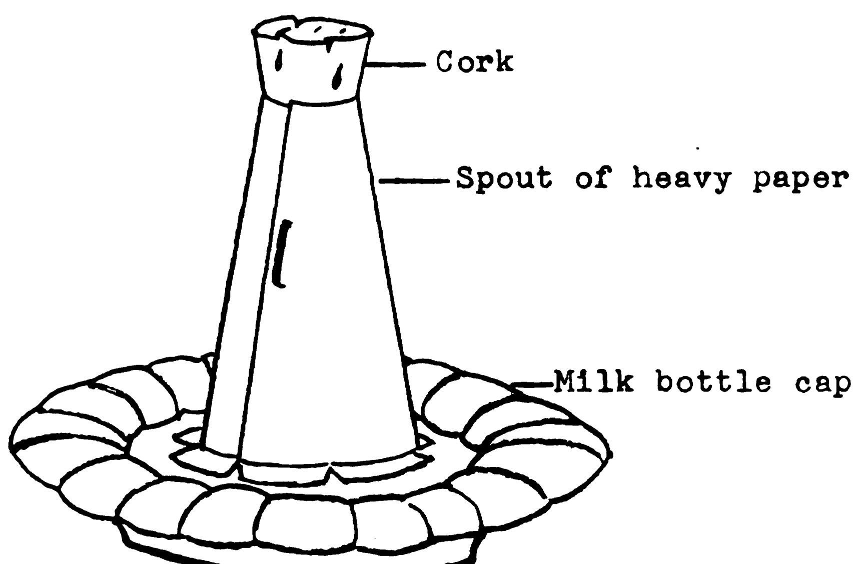

Figure 4. Plug of the "feeder bottle"

the "feeder bottle," the spout was fitted into the mouth of the vial, the bottle was tapped lightly until a sufficient number of flies were in the vial and then both the vial and spout were again corked.

Water was supplied by placing a drop on the bottom of the cork that had been removed for feeding. When the cork was replaced, the drop was pendant inside the vial and accessible to the spider by means of the tissue paper strip used as a walking surface.

The specimens were fed and watered frequently so that any change in their condition was easily observed. The cast skins or exuviae were of major importance and were the basis of the treatment given a spider. That is, the size of the vial was changed or more food was added. Each time an exuvium was removed, an entry for that date was made on the file card of this particular specimen. The data recorded included the measurement of body length taken as accurately as possible with a millimeter scale while the spider was next to the inside surface of the vial. Two days after the spider had shed, it was again examined and notes on its coloration were taken. The lapse of time allowed the colors to deepen. At maturity, the spider was preserved in 95% alcohol, labeled and placed in the collection.

Control groups. In an attempt to check the effectiveness of the methods used in this study, *Achaearanae tepidariorum* (C. L. Koch) and *Latrodectus mactans* (Fabricus) whose life histories had previously been investigated by others were reared as control groups. Because external environmental factors such as humidity, temperature and food can cause variation in the number of moults (Browning 1941, Jones 1941, Deevey 1949), and because such factors were not rigidly controlled in the present studies, control groups were necessary for comparison of results.

Results

Philodromus pernix Blackwall. A total of four egg sacs of this species were collected. Of these, two were left undisturbed and two were dissected. All four sacs of white silk, collected in October, 1955, were located in forked twigs of trees. The outer coverings were oval, taut, and measured 13 mm. x 10 mm., 13 mm. x 9 mm., 11 mm. x 9 mm., and 10 mm. x 8 mm. respectively. The two sacs which were examined had a layer of loose white silk beneath the outer cover and contained 12 and 17 eggs which measured less than 1 mm. each. These were yellowish-white and non-agglutinate.

One of the two sacs which were not dissected was collected on October 21, 1955, and 12 spiderlings emerged from it on November 4, 1955. The other sac was collected on October 23, 1955, and 15 spiderlings emerged on November 14, 1955. Cast skins found in the remains of the two egg sacs were evidence that when the spiders emerged they were in their second instar. According to Gertsch (1949), all spiders undergo their first moult in the egg sac.

The changes that occurred in this species from the second instar spiderling to the mature adult were primarily in size. The emergent spiderlings measured approximately 0.8 mm. and the adults averaged 4.53 mm. in body length. The coloration of the legs darkened from a faint yellow to amber and the brown spots on this ground color remained more or less concentrated at the distal ends of the metatarsal and tarsal segments. The coloration on the dorsal surface of the emergent spiderlings was predominately a dull gray with numerous brown speckles. The coloration in the adult was essentially the same except for a chevron pattern on the posterior abdomen. The ventral surface was gray at all stages of growth but the demarcation between the dorsal and ventral abdominal coloration became sharply defined as the spider moulted. The ratio of leg lengths of the emergent spiderlings was 2-1-4-3. This was also the ratio of the adult leg lengths.

Of the 27 spiderlings, three reached sexual maturity, two females and one male. Table IV contains the developmental data on Philodromus pernix Blackwall.

Dictyna sublata (Hentz). A female of this species was found in the rolled edge of a dead shrub leaf early in July, 1956. She was put in a vial and placed in the laboratory where she produced the two egg sacs used in this study.

Both of the egg sacs were white and lens-shaped. The female placed the first egg sac directly on the tissue paper

TABLE IV

THE DURATION OF STADIA AND NUMBER OF MOULTS FOR PHILODROMUS PERNIX

Sex and label	Duration of stadia in days						No. of moults	Measurement of adult[1]
	3rd	4th	5th	6th	7th	8th		
Male S 13	23	23	20	20	57		7	4.3 mm.
Female S 1	28	19	23	20	28		7	4.8 mm.
Female P 1	27	33	24	44	22	29	8	4.5 mm.

[1]Measurement was taken at last ecdysis.

in the vial and the next partially overlapping the first egg sac. When separated from one another, the egg sacs measured 4.8 mm. x 4 mm. and 4.3 mm. x 3 mm. Each was about 1.5 mm. high.

The examined sac contained 20 agglutinated, grayish-white eggs which measured about 0.7 mm. in diameter. The other egg sac produced 11 spiderlings. When the remains of the sac were examined, seven apparently infertile eggs were found. This brought the total of eggs in this sac to 18.

At emergence the spiders measured approximately 1.3 mm. and were a uniform dull yellow. The adult spiders averaged 3.52 mm. in body length. In coloration the legs and ventral surfaces of the body segments of the adult were uniformally gray. The cephalothorax was yellow to brown in front, darker brown on the sides and thoracic portion. The dorsal surface of the abdomen had a mottled appearance of brown on gray.

Of the 11 spiderlings, six reached maturity. The three males matured on the average of 208 days after the second moult whereas the females averaged 186 days. Table V contains the developmental data of the study on Dictyna sublata (Hentz).

TABLE V

THE DURATION OF STADIA AND NUMBER OF MOULTS FOR DICTYNA SUBLATA

Sex and label	Duration of stadia in days					No. of moults	Measurement of adult[1]
	3rd	4th	5th	6th	7th		
Male H 1	15	11	19	98	42	7	3.3 mm.
Male H 3	11	15	31	151		6	3.5 mm.
Male H 4	10	11	19	92	92	7	4.0 mm.
Female H 2	11	15	27	143		6	3.0 mm.
Female H 7	17	55	14	106		6	3.3 mm.
Female H 9	24	58	73	17		6	4.0 mm.

[1]Measurement taken at last ecdysis.

Theridion frondeum Hentz. A mature female of this species and her single egg sac were taken from the lower surface of a shrub leaf. The female produced three more sacs later in the laboratory. These were white, circular, and measured 3.9 mm., 3.8 mm., and 3.5 mm. in diameter. The eggs measured approximately 0.6 mm. in diameter, were gray white, non-agglutinated, and totaled 54, 43, and 41 in the three sacs.

Two weeks after it had been collected, the egg case that was taken with the female produced 65 spiderlings. The emergent spiderlings measured approximately 0.7 mm. in body length and in profile the cephalothorax was of the same proportion as the abdomen. The coloration was a nearly uniform gray white with the anterior portion of the cephalothorax being somewhat darker. After the second moult, the abdomen became globular in outline with the spinnerets in a mid-ventral position, and the color of this body region became pale orange-tan which was darker than the cephalothorax. The adults averaged 3.20 mm. in body length and were white with nearly black markings on the abdomen. The cephalothorax had a mid-dorsal dark stripe and dark spots on tarsal and metatarsal segments. Males and females each took an average of 43 days to reach maturity after the second moult.

Of the original number of 65 spiderlings, ten reached sexual maturity. Table VI contains the data for these.

Discussion

The studies of Browning (1941), Jones (1941) and Deevey (1949) have demonstrated the fact that certain external environmental factors can influence the number of instars or

TABLE VI

THE DURATION OF STADIA AND NUMBER OF

MOULTS FOR THERIDION FRONDEUM

Sex and label	Duration of stadia in days					No. of moults	Measurement of adult[1]
	3rd	4th	5th	6th	7th		
Male L 2	11	8	8	14		6	3.0 mm.
Male L 4	17	17	8			5	3.5 mm.
Male L 8	34	3	10			5	3.0 mm.
Male L 10	21	8	13			5	3.0 mm.
Female L 1	2	9	8	8	14	7	3.5 mm.
Female L 5	8	7	35			5	3.0 mm.
Female L 7	11	8	28			5	3.0 mm.
Female L 11	14	7	21			5	3.5 mm.
Female L 13	17	8	18			5	3.0 mm.
Female L 14	14	8	13			5	3.0 mm.

[1]Measurement taken at last ecdysis.

stadia and moults. Jones (1941) found that temperature affects the rate of growth and the duration of the stadia; also that humidity influences the rate of growth as well as the rate of mortality with a greater effect on mortality. Deevey (1949) investigated the effect of different rates of feeding on Latrodectus mactans. Her results showed a relationship between the rate of feeding and the number of moults and length of instars. Browning (1941) studied the effect of the factors mentioned above and included light in an attempt to explain the variation in numbers of moults and length of instars. It is evident then that the life history of a spider is influenced by the external environment. In conjunction with this are the inherited factors (Browning, 1941 and Deevey, 1949) which enable some spiders to withstand a greater degree of variation in external environment.

If the number of moults and stadia can fluctuate under laboratory conditions, it is probable that spiders do not have a constant number but rather a range in number of moults and stadia.

The results obtained by this author for the two control species closely paralleled and often duplicated the results of other investigators. In the investigations of Latrodectus mactans, Thorp and Woodson (1945) gave the number of moults as from three to six for males and six to nine for females, and Deevey (1949) reported three to eight for males and six to nine for females. The results obtained on this species in the present study were five to six for males and eight moults for females. For Achaeranea tepidariorum, the second control species, Kaston (1948) recorded six or seven moults for males and seven for females. Ewing (1919) found that males moulted five times and females four, six, seven, and eight times. The results of the present study were that males matured in five to six moults and females in seven to eight moults. Using these favorable comparisons, it was apparent that the rearing methods used in this study were effective in obtaining reasonable data on life histories of spiders.

Throughout the course of the rearing investigations, the author observed spiders drinking from the drop of water that had been placed on the cork of the vial. This behavior was not limited to any particular species of spider.

SUMMARY

1. Twenty of the 25 families of spiders known to occur in Michigan were collected in the Horticultural Experimental Plots and Baker Woodlot located on the property of Michigan State University, East Lansing, Ingham County, Michigan.

2. Seventy-eight species belonging to 52 genera of the 20 families were represented in the collection.

3. Stratification of the spider fauna was observed in the 50 acres comprising the Baker Woodlot. This area supported over 25% more spiders than the 200 acre experimental plot area.

4. Seasonal variation of the woodlot spider fauna was observed over the 18 month collecting period.

5. A mature female Agelenidae belonging to the genus _Wadotes_ is new. This specimen is closely related to _Wadotes calcaratus_ (Keyserling).

6. The females of _Philodromus pernix_ Blackwall moult seven to eight times. The males moult seven times before becoming sexually mature.

7. In _Dictyna sublata_ (Hentz), maturity is reached by males after six to seven moults and in females after six moults.

8. The males of _Theridion frondeum_ Hentz moult five to six times and the females five to seven times before becoming sexually mature.

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