

SEASONAL CHANGES IN THE INSECT POPULATION OF AN ILLINOIS FOREST

(Abstract)

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The observations on which this paper is based were made in a tract of woodland some sixty acres in extent, located about five miles from the main campus of the University of Illinois, at Urbana, known as the University Woods. The higher parts of the area are well wooded, the trees being almost entirely maple (*Acer saccharum*), while a mixed stand, composed chiefly of maple and elm (*Ulmus americana*), occupies the lower parts. In the more open situations there is a considerable growth of underbrush, largely *Benzion* and *Asimina*. This area is one of the very few remaining bits of the woodland originally extending into the prairie of Central Illinois along the Vermillion River and its tributaries, and has of course undergone considerable modification accompanying the development of adjacent lands for agricultural purposes.

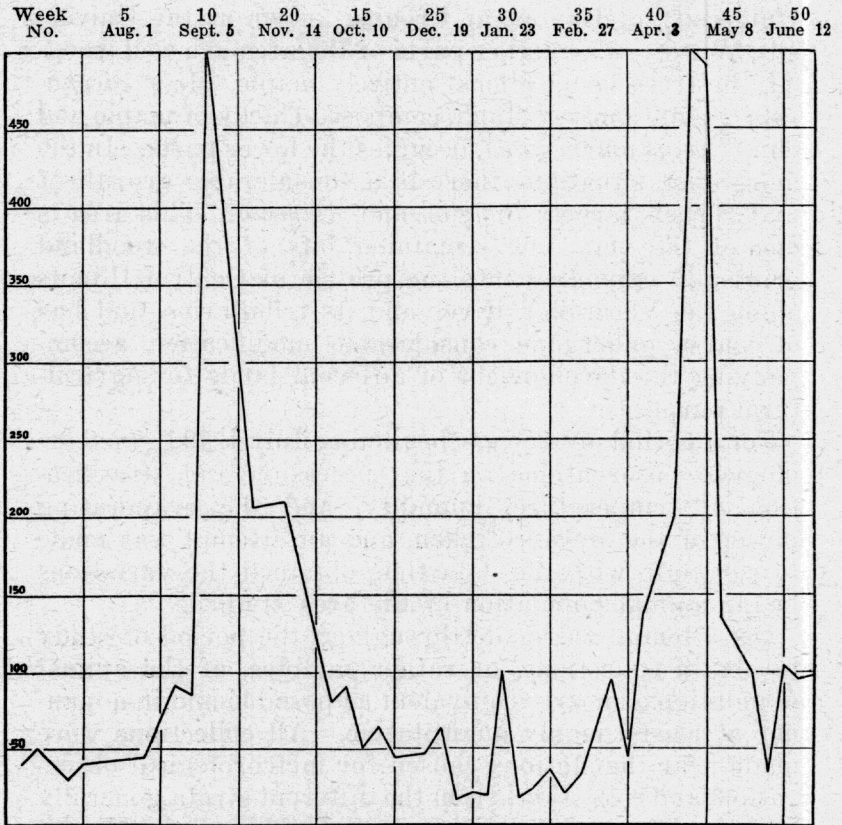
For a period of one year beginning July 1, 1921, meteorological observations on the succession and stratification of temperature, humidity, and the evaporating power of the air were taken, and an attempt was made to correlate with the data thus obtained the variations in the animal population of the area studied.

An attempt was made throughout the period of study to obtain collections, or rather samples, of the animal population as nearly equivalent as possible and in a manner at least roughly quantitative. All collections were made near the stations chosen for meteorological observation, and collections from the different strata generally were made on the same day. In the table and the text all collections are dated according to the last day of the week in which they were made, reckoning from Monday to Monday. This day was chosen for convenience because the thermograph and hygograph sheets were arranged to be changed at this time.

Because of the difficulties attendant upon quantitative collection from the tree stratum no systematic samples

were taken from this level. The remaining strata considered were the shrub, herb, and ground strata. Because of the constant presence in the forest of a blanket of leaves on the surface of the soil, the ground stratum was divided, for the purpose of this study, into two parts which will be referred to as the leaf and soil strata. Of the latter only the upper ten centimeters were considered.

Fig 1.



The unit of sample from the soil and leaf strata was taken from an area two feet square. The unit sample from the herb and shrub strata was that obtained by ten short sweeps through the vegetation with an insect net whose subcircular opening averaged thirty centimeters in diameter. It is not claimed that there is an exact correspondence in the numerical data as obtained from the

different strata by these methods, although the ratios so obtained are probably in the right direction and of the right order of magnitude. The method of collection was probably most efficient with respect to the leaf stratum, the soil stratum and the herb and shrub strata following in the order named. The numerical data obtained from samples taken in the manner described above are given in the accompanying table and illustrated graphically in Figure 1.

Examining the curve representing the total population in all strata we find a fall in the fourth week (the week of July 25), corresponding to an increase in the evaporating power of the air at that time. At the beginning of the period of study the woods were rather dry and the animal population was small. With the increase in moisture content of the air (and of the soil-leaf strata) during the week of August 1, there was a marked increase in the size of the collections. The increased humidity, however, does not account for the high maximum during the fourteenth week (ending Oct. 3). A gradual decline in temperature had been going on with a considerable increase in mean variability due to lower temperatures at night, so that while the initial increase was due certainly to a return to moisture conditions nearer the *optimum* for the species concerned, the sudden and great increase in the number of organisms taken in the samples was due almost entirely to the great autumnal migration toward places of hibernation. An analysis of the samples taken at this time showed that the great maximum was caused mainly by a few species of beetles and leaf-hoppers, all hibernating forms in course of migration from the forest margin to the leaf stratum of the more protected portions of the woods. Following this maximum the fall was again rapid as temperatures continued to fall (the first heavy frost was the night of Oct. 4). The peaks in the total curve after November 12, the date of the first ice formation, were caused by samples taken on warm days when insects partially emerged from hibernation or at least approached near enough to the surface to be collected. The spring maxima may be explained largely as the result of the reverse movement.

This phenomenon will be discussed more fully in a later paper.

The most striking phenomenon of the entire period covered by the collections was the autumn hibernating reaction evidenced by migration inward from the forest margin and downward to the forest floor. In most of the species observed the stimulus initiating migration seems to be gradual increase in daily range of temperature and lower night temperature. Some species evidently require the additional stimulus of frost of greater or less intensity, while others which appear in the forest very early seem not to require this. The disappearance or maturation of food-plants may be a factor in some cases. In the forest the insects appear first in large numbers in the stratum corresponding to that in which the summer portion of their life history is spent. If the principal summer food plant is found in the high forest margin, the first appearance is in the shrub stratum. If the summer habitat is the low forest margin or meadow the insects first appear in the herb stratum. A downward migration follows under the stimulus of an additional fall in temperature or additional frosts. Insects from the shrub stratum seem in most cases to spend a short period of time in the intermediate herb stratum before seeking the final place of hibernation in the leaf or soil strata. Warm days may reverse the course of migration at any point. The fact that a large number of species react alike and at the same time to the same stimulus or combination of stimuli shows a large degree of similar adjustment of the climatic rhythm of the temperate savanna region on the part of the characteristic insects of the local area.

TABLE 1.

Animal Population of the Lower Strata of University Woods, Urbana, Ill.

July, 1921, to June, 1922.

Week Ending	Soil Str.		Leaf Str.		Herb Str.		Shrub Str.		Total	Per Acre (Thousands)	Per Hectare
	No.	Ave.	Coll.	Ave.	Coll.	Ave.	Coll.	Ave.			
July 4.....	1	11	2	24.5	3	9	3	.6	45.1	496	1217
July 11.....	2	16	1	20	6	13.5	....	2	51.5	566	1390
July 18.....	3	10	1	14	3	15	3	4.8	43.8	481	1182
July 25.....	4	15	2	5	3	8.4	....	4.2	32.6	359	980
Aug. 1.....	5	14.7	1	11	....	11.5	....	3.9	41.1	452	1109
Aug. 8.....	6	14.5	1	12	3	14	3	3.6	44.1	485	1190
Aug. 15.....	7										
Aug. 22.....	8	18	1	15	3	8	2	4.5	44.5	490	1101

Week Ending	Week Soil Str.		Leaf Str.		Herb Str.		Shrub Str.		Total	Per Acre (Thousands)	Per Hec-tare (Thousands)	
	No.	Coll. Ave.	Coll.	Ave.	Coll.	Ave.	Coll.	Ave.				
Aug. 29.....	9	1	19	1	21	5	5.8	1	1	46.8	515	1263
Sept. 5.....	10	..	14.5	..	32	5	18.2	5	3.4	68.1	749	1838
Sept. 12.....	11	1	10	1	43	1	22	1	15	90	990	2437
Sept. 19.....	12	1	17	1	24	1	30	1	15	86	946	2322
Sept. 26.....	13	1	15	..	60	2	54	2	78.5	207.5	2283	5602
Oct. 3.....	14	1	13	1	133	1	283	1	69	498	5480	13446
Oct. 10.....	15											
Oct. 17.....	16	1	7	1	49	1	128	1	24	208	2288	5616
Oct. 24.....	17											
Oct. 31.....	18	1	27	1	146	1	25	1	14	212	2352	5734
Nov. 7.....	19	1	16	1	125	1	23	1	5	169	1859	4773
Nov. 14.....	20	..	12	1	85	....	20	....	4.5	121.5	1337	3280
Nov. 21.....	21	1	8	1	54	1	16	1	4	82	902	2214
Nov. 28.....	22	1	14	1	33	1	37	1	9	93	1023	2511
Dec. 5.....	23	1	1	1	36	1	11	1	0	48	528	1296
Dec. 12.....	24	1	13	1	51	1	2	1	0	66	726	1782
Dec. 19.....	25	1	5	1	22	1	16	1	0	43	473	1161
Dec. 26.....	26											
Jan. 2.....	27	1	3	1	34	1	8	1	0	45	495	1215
Jan. 9.....	28	2	5.5	1	58	1	4	1	0	67.5	743	1822
Jan. 16.....	29	1	3	1	15	1	0	1	0	18	198	486
Jan. 23.....	30			1	22							
Jan. 30.....	31			1	22							
Feb. 6.....	32	1	7	1	90	1	3	1	0	100	1100	2700
Feb. 13.....	33	1	7	1	10	1	0	1	0	17	187	459
Feb. 20.....	34	1	6	1	16	1	10	1	0	23	258	621
Feb. 27.....	35	1	7	1	29	1	0	1	0	36	396	972
Mar. 6.....	36	1	10	1	7	1	4	1	0	21	231	567
Mar. 13.....	37	1	4	1	13	1	12	1	3	32	352	864
Mar. 20.....	38			1	23							
Mar. 29.....	39	1	14	1	74	1	6	1	1	95	1045	2565
Apr. 3.....	40	1	5	1	28	1	11	1	2	46	506	1242
Apr. 10.....	41	1	6	1	68	1	39	1	23	136	1496	3772
Apr. 17.....	42											
Apr. 24.....	43	1	0	1	34	1	3	1	163	200	2200	5400
May 1.....	44	1	13	1	39	1	51	1	398	501	5511	13527
May 8.....	45	1	1	1	26	1	400	1	64	491	5501	13257
May 15.....	46	1	22	1	9	1	52	1	51	134	1474	3618
May 22.....	47			1	9	1	4	1	63			
May 29.....	48	1	8	1	7	1	34	1	42	91	1001	2457
June 5.....	49	1	1	1	2	1.5	24	1.5	8	35	385	955
June 12.....	50	1	10	1	6	1	54	1	25	95	1045	2565
June 19.....	51	1	10	1	5	1	40	1	31	86	946	2322
June 26.....	52	1	0	1	0	1	55	1	32	87	957	2349
July 3.....	53	1	14	1	5	1	55	1	20	94	1034	2538

FIG. 1. Graph of the Animal Population of an Area of Four Square Feet in an Illinois Elm-Maple Forest, July, 1921-June, 1922, inclusive.