The Canadian Entomologist

LXVI ORILLIA, SEPTEMBER, 1934 No. 9

A BRIEF ACCOUNT OF AESTIVATION AND OVERWINTERING OF THE OCCIDENT ANT, POGONOMYRMEX OCCIDENTALIS CRESSON, IN IDAHO.

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INTRODUCTION.

The phenomena of aestivation and overwintering of ants present a most interesting study. The similarities between the two as well as their many differences offer excellent comparisons. Little work has actually been accomplished with ants in this field in spite of the studies of arthropod hibernation instigated by Holmquist (1)[1] and others. The purpose of this paper is to present some of the more important physical and biotic factors involved in the aestivation and overwintering periods of the Occident ant, *Pogonomyrmex occidentalis* Cresson, in a portion of the Northern Desert Shrub region, near Twin Falls, Idaho.

THE AESTIVATION PERIOD.

In southern Idaho, on a typical summer day, that is, one without rain, heavy clouds or excessively low temperatures, *P. occidentalis* aestivates within its nests from approximately 11 a. m. until 2 p. m. During this period no activity of the ants occurs on or away from the mounds. Externally the nests appear to be deserted. Activity, however slight, presides within the nests, especially in the chambers of lowest depth, as the writer has observed on many occasions. The nest entrances remain open.[2]

The influence of temperature upon aestivation. The highest temperatures during the summer day normally occur during the period from 11 a. m. to 3 p. m., the maximum usually being near the latter hour. At this time July atmospheric temperatures of 95° to 100°F. are not uncommon and the soil surface temperatures range between 120° and 140°F. In so far as the writer has been able to determine from repeated observations of large samples of mounds near Twin Falls, aestivation of *P. occidentalis* begins when the soil surface temperature reaches a level of approximately 118°F. Activity gradually ceases from a temperature of 110°F. to the threshhold of total aestivation.

If mounds are opened at soil surface temperatures above 118°F, and the ants placed either on the mounds or in the denuded areas, they hastily enter their nests and retreat to the deeper subterranean chambers where much cooler temperatures prevail. There they remain until the soil surface temperature falls to the activity level, at which time they desert the nests in ever increasing numbers to begin harvesting.

The writer believes that while temperature alone may not explain the phenomenon of aestivation, it is, however, the most important of a relatively

[1]Numbers in parenthesis refer to the literature cited.
[2]Apparently this observation is contrary to that of McCook (2).

small group of interrelated factors.

On a cool and cloudy summer day, with a maximum soil surface temperature of about 105°F., *P. occidentalis* does not enter a state of aestivation. Often, harvesting activity is greatest from 1 p. m. to 3 p. m., but this is true only when the day is abnormally cool and soil surface temperatures are correspondingly lower. On days with high maximum temperatures, greatest harvesting activity is between 5 a. m. and 10 a. m., with its peak at about 8 a. m., although at times another period, that from 3 p. m. to 9 p. m., predominates, its peak being at about 7 p. m.

In general, harvesting activity of the ant continues from daylight to dusk or after, except for the relatively short period of aestivation.

THE OVERWINTERING PERIOD.

The overwintering period of *P. occidentalis*, which does not represent true hibernation because of constant feeding activity within the nests throughout the winter, lasts, on the average, from the middle or end of October to the middle of the following March. During this entire period the ants are in a semi-comatose state and they do not leave their nests.

External aspects of the nest. At the beginning of the overwintering period the entrances to the nest are closed by the worker ants with small pebbles, sand or bits of earth. During severe winters many mounds are partially levelled or completely destroyed by the forces of Nature, especially where there is likely to be a wash of water over the mounds. Therefore, those nests on relatively level areas are more adaptable to severe weather conditions of this nature than those on hillslopes or in canyons. At times the mounds may be covered with snow to a depth of from a fraction of an inch to several feet.

Storage of seeds. During late summer and early autumn and continuing until the overwintering state is fully in progress, the workers harvest and store large quantities of seeds from various annuals and perennials. In the Twin Falls area stored seeds are chiefly those of *Bromus tectorum* L. (Downey Bromegrass). These are placed in rather specialized nest chambers either in or below the mound. Table 1 lists the weights of seeds removed from chambers of a series of ten fully-developed mounds at the end of the harvesting period, together with the weights of seeds from chambers in ten similar mounds at the same locality in March, at the termination of the overwintering period.

The ants feed during the winter on the stored seeds. They do not, therefore, enter true hibernation, although activity is very slight, even on the warmer winter days, and consists chiefly of feeding. Because of this normal feeding the stock of stored seeds gradually diminishes, and by the time the workers venture from their nests in the spring only a relatively small proportion of the original supply remains. It is of interest that the writer has on no occasion observed a nest which did not possess at least a small quantity of seeds at the end of the overwintering period. Apparently the ants rarely, if ever, utilize their entire supply of stored food. The quantity is evidently ample and the remaining seeds, except those which sprout, are consumed by early spring feeding, from the end of the overwintering period to the time early annuals reach maturity.

After normal spring activity has begun the workers often carry many of the seeds to the mound surface where germination may begin. Occasionally some of the seeds germinate within the mound. The workers cut and remove the short plant growth so that the mounds and cleared areas surrounding them are completely denuded, in which condition they normally remain.

TABLE 1.

Weights of seeds in two series of ten representative mounds* of *Pogonomyrmex occidentalis* Cresson at Twin Falls, Idaho, October 29, 1932, and March 13, 1933.

Mound Number	Weights of Seeds, grams October 29, 1932						Weights of Seeds, grams March 13, 1933					
	Chamber 1	Chamber 2	Chamber 3	Chamber 4	Chamber 5	Totals	Chamber 1	Chamber 2	Chamber 3	Chamber 4	Chamber 5	Totals
1	42.3	12.8	1.2	14.5	1.3	72.1	0.0	2.1	0.0	4.8	0.0	6.9
2	5.6	2.0	3.4	1.8	2.4	15.2	1.4	3.6	1.2	5.1	0.0	11.3
3	7.4	6.3	1.3	0.2	2.5	17.7	0.0	0.0	8.5	0.0	0.0	8.5
4	9.8	1.0	0.5	2.4	4.6	18.3	5.0	0.0	0.0	0.8	0.0	5.8
5	36.9	24.3	13.6	6.9	2.6	84.3	0.3	1.2	0.0	4.0	0.2	5.7
6	1.4	0.0	9.2	16.8	8.7	36.1	0.6	0.8	1.2	3.1	0.4	6.1
7	21.1	11.7	1.9	5.5	3.0	43.2	2.6	8.6	5.1	2.0	0.0	18.3
8	14.3	9.6	2.8	1.8	3.5	32.0	0.0	2.3	0.0	1.8	0.0	4.1
9	6.9	1.4	2.9	12.6	8.3	32.1	2.2	0.0	1.9	0.0	1.0	5.1
10	5.2	7.1	19.1	10.2	4.7	46.3	5.8	0.1	0.6	0.0	0.1	6.6

*All mounds possessed five seed chambers and were selected for this reason.

Depth of colony. The bulk of the ants usually resides in a pocket about two feet beneath the base of the mound, although several greater and a few more shallow depths have been noted. The workers and the queen are massed together.

Nest temperatures. Table 2 lists temperatures at different levels in a series of five nests and their surrounding cleared areas during the overwintering period. There are decided differences between nest temperatures and those of the denuded areas. As in the case of soil moisture, which is discussed later, these differences may be produced by the relative porosity of the mounds and the denuded areas. The writer is unable to account for the rise in temperature from the eighteen to the twenty-one inch levels of the nests unless this represents an indication of the amount of heat produced by the ant cluster. This might be substantiated somewhat by the fact that the temperatures of the twenty-one and twenty-four inch depths in the nests were invariably higher than those at the same depths in the adjoining cleared areas.

Brood rearing. Brood rearing generally ceases about one month before the initial date of entrance of the ants into their winter quarters. The normal length of a single brood of workers of *P. occidentalis* averages about thirty days.[3] It is clear, therefore, that only in exceptional cases does a colony enter the overwintering state with brood yet in the nest chambers. In the insignificantly small number of cases when the overwintering colony includes brood which is not near the point of maturation, this brood usually dies in the early winter before any possibility of emergence. This may be caused by an insufficient

[3]Unpublished notes of the author.

supply of prepared food, to inadequate moisture conditions or to rather severe subsoil temperatures.

TABLE 2.

Temperatures at different levels in five mounds of *Pogonomyrmex occidentalis* Cresson, near Twin Falls, Idaho, December 27, 1932. One-half inch snow cover.

Depth	Temperatures of Nest, Degrees F.					Depth	Temperatures in Cleared Area, Deg. F.				
	Md. 1	Md. 2	Md. 3	Md. 4	Md. 5		No. 1	No. 2	No. 3	No. 4	No. 5
Apex of mound	40.0	39.5	39.5	39.5	39.0	6 in. above surf.	38.5	38.0	38.0	38.0	38.0
Center of mound	32.0	32.0	32.0	32.0	32.0	3 in. above surf.	38.0	39.0	38.0	38.0	38.0
Inner base of mound	32.0	31.5	32.0	31.5	31.5	Surface	35.0	35.0	35.5	35.0	35.5
3 in. below base	32.5	32.0	32.0	32.0	32.0	3 in. below surf.	33.0	33.0	33.5	33.0	33.0
6 in. below base	33.0	33.0	33.0	33.0	33.0	6 in. below surf.	32.0	32.0	32.0	32.0	32.0
9 in. below base	34.0	33.5	33.5	33.5	33.5	9 in. below surf.	32.0	32.0	32.0	32.0	32.0
12 in. below base	34.5	34.5	34.0	34.0	34.0	12 in. below surf.	33.0	33.0	33.0	33.0	33.0
15 in. below base	34.5	34.5	34.0	34.5	34.0	15 in. below surf.	33.5	33.0	33.0	33.0	33.5
18 in. below base	35.5	35.0	35.5	35.5	35.5	18 in. below surf.	33.5	33.0	33.5	33.5	33.5
21 in. below base	36.5	36.5	36.5	36.5	36.5	21 in. below surf.	33.5	33.5	33.5	33.5	33.5
24 in. below base	36.5	36.5	36.5	36.5	36.5	24 in. below surf.	33.5	33.5	33.5	33.5	33.5

Eggs are deposited by the queen at the time the colony breaks its semi-dormancy, usually in March. This brood matures after an interval of about six weeks, a longer period than is normally required apparently because of low temperatures and possibly because of a high subsoil moisture content.

Soil moisture. Table 3 shows the percentages of soil moisture in a mound of *P. occidentalis* and its denuded area near Twin Falls, Idaho, during the over-wintering period.[4] The differences between the moisture contents of the two areas are rather distinct. The high percentage from the zero to the six-foot levels in the denuded area was induced primarily by a light coating of moist snow which was removed before the samples were taken. It is evident that the moisture content of the nest soil was significantly lower than that of the adjoining area.[5] This may have been caused by a greater degree of soil aeration because of the porosity of the mound material and the presence of the numerous galleries.

CONCLUSIONS.

Aestivation and the overwintering state of *P. occidentalis* are similar in that both are semi-comatose conditions apparently induced by certain seasonal or diurnal changes in weather, but differ because of the lack of feeding during aestivation, the slower approach to normal activity after overwintering and the usual lack of environmental conditions during aestivation which are likely to be toxic during overwintering. In the case of aestivation there is no preluding preparation—not even the nest entrances are closed, while a number of important

[4]These were secured by means of a three-foot soil tube.

[5]Care must be exercised in interpreting the table. The height of the mound was just six inches; therefore, the ground level of the mound area corresponding to the zero level of the cleared area would lie six inches below the mound apex. This accounts for the fact that samples in the cleared area were taken to only as great a depth as two feet.

changes occur before and during overwintering, such as storage of seeds, termination of harvesting and cessation of brood rearing. Entrance to aestivation is abrupt; to overwintering it is gradual. The period of aestivation is of an indefinite length. When *P. occidentalis* enters the overwintering state it remains in that condition until the following spring, changes in weather being relatively unimportant.

TABLE 3.

A comparison of soil moisture in a mound and cleared area of *Pogonomyrmex occidentalis* Cresson. Twin Falls, Idaho, January 2, 1933.

Soil Moisture in and Below Mound*		Soil Moisture in Denuded Area	
Depth of Sample	Percent Water	Depth of Sample	Percent Water
Apex of mound to 6 in. below	7.4	0 to 6 inches	16.9
6 to 12 inches	5.1	6 to 12 inches	6.5
12 to 18 inches	6.0	12 to 18 inches	6.9
18 to 24 inches	6.4	18 to 24 inches	7.6
24 to 30 inches	6.5		

*6 inches in height

SUMMARY.

P. occidentalis usually aestivates from about 11 a. m. to 3 p. m., or when the soil surface temperature is about 118°F., or higher. It does not aestivate on a cool summer day with soil surface temperatures of about 100°F. or lower. On abnormally cool days harvesting activity is greatest from 1 p. m. to 3 p. m. Another period, that from 3 p. m. to 9 p. m., often occurs. The nest entrances remain open. If worker ants are removed from the nest chambers during aestivation and are placed on the adjoining soil surface they return swiftly to their subterranean chambers about one foot below the base of the mound.

The overwintering period lasts, on the average, from the middle of October to the middle of March. During this time the ants are clustered in chambers approximately two feet below the base of the mound. Winter nest temperatures are consistently higher than those of the cleared area. Nest soils contain less moisture than those of the denuded area, possibly because of the greater porosity of the soil in the mound and nest. Egg deposition ceases about one month before the ants enter the overwintering state and only rarely does brood mature after the overwintering period is in progress.

Large quantities of seeds are stored by the worker ants for winter food, and a small percentage remains in the nests after the termination of the overwintering period. Some of the seeds which remain are transported to the mound surfaces where often they germinate. The plants are then cut and disseminated by the workers or the wind. The forces of nature, especially the wash of water, often damage or destroy mounds during the winter or in the early spring. The ants do not enter a true hibernating state because feeding activity occurs in the nest chambers. Soil temperatures, where the bulk of the ants overwinter, remain at about 36°F. During the winter mounds are often covered with snow to a depth of from a fraction of an inch to several feet.

LITERATURE CITED.

(1) Holmquist, A. M., "Hibernation of the Ant, Formica ulkei Emery." *Physiol. Zool.*, I, (1928) 325-357.

(2) McCook, H. C. The Honey Ants of the Garden of the Gods, and the Occident Ants of the American Plains. J. B. Lippincott & Co., Philadelphia, 1882.

TINGITOIDEA AFFECTING COTTON

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In May, 1933, my attention was drawn to a peculiar leaf injury to young cotton plants at Presidio, Texas. The leaves showed a striking reddish brown spotting from the upper side that at first glance resembled red-spider injury. The damaged plants were quite localized in one section of a large cotton field. Examination revealed the presence of large numbers of lace bugs present on the lower surface of the leaves. This species was identified as *Gargaphia iridescens* Champion by H. G. Barber of the U. S. National Museum. Gibson, 1919, records the food plants as *Ambrosia, Solanum, Malva,* and sand nettle. According to records in the U. S. National Museum, this species has been collected by McMillan at Brownsville, Texas, on *Solanum,* string beans, and *Ambrosia*; on egg plant at Olmito, Texas, by McMillan; on *Croton texanus* at Tucson, Arizona, by W. D. Pierce. It has also been recorded from Colorado, New Mexico, and Aguascalientes, Mexico. Mr. E. P. Van Duzee writes that this species has been collected by him from several localities in California, one host plant record being mint. So far as I have been able to ascertain, there is no previous record of this species feeding upon cotton.

The record of a lace bug feeding upon and injuring cotton was so unusual that further information of other species of this interesting group attacking cotton was sought. These data have been obtained through the courtesy of Mr. E. P. Van Duzee of San Francisco, California; Mr. H. G. Barber of Washington, D. C.; and Dr. C. J. Drake of Ames, Iowa. It was found that eight other species of *Tingitoidea* have been recorded as feeding on cotton, all in the New World. The following is a list of these species together with their geographical distribution and other host plant records:

FAMILY PIESMIDAE.

Piesma cinerea Say. Collected on cotton near Dallas, Texas. Barber notes that this record is of no particular significance as it is such a general feeder.

FAMILY TINGITIDAE.

Corythucha gossypii (Fab.) This species is recorded from southern United States, Central America, and the West Indies. It breeds on cotton and several other plants. Dr. M. D. Leonard and A. S. Mills have recently published a list of food plants[1] obtained from field records and from data on specimens in the

[1]Leonard, M. D., and Mills, A. S. Observations on the bean lace-bug in Porto Rico. Jr. Dept. Agric. Puerto Rico XV. July 1931.