

(1928)d

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THE BIOLOGY OF TAPINOMA SESSILE SAY, AN IMPORTANT HOUSE-INFESTING ANT.*†

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INTRODUCTION.

The ant, *Tapinoma sessile* Say, a common and widely distributed North American species, has been known to entomologists since 1836, yet it has not been mentioned in literature as an economic species until within comparatively recent years.

The writer first became aware of the ant as a house pest in 1921. Its importance as such was scarcely recognized by him until 1924 and 1925 when he found this species to be the most important of all house infesting ants at Urbana, Illinois. The ant was found in houses in nearly every block investigated and in some blocks as high as 80 to 90 percent of the homes were infested. Inquiries concerning the relative importance, the biology, and the control of this ant were then sent to entomologists in all sections of North America. Replies received in response to the questionnaires showed the ant to be a house infesting species in the following localities: California, Nevada, District of Columbia, Maryland, Tennessee, and Mississippi. The ant is very probably a pest in a number of localities from which no reports are available. In California this ant appears to be an especially serious house pest. Essig in a letter stated that 50 percent of the trouble from house infesting ants in the western section of that state was due to this one species.

COMMON NAME.

This ant passed for many years without a common name until Essig named it, the odorous ant, because of the unpleasant,

*An abstract of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Entomology in the Graduate School of the University of Illinois, 1927.

†Contributions from the Entomological Laboratories of the University of Illinois, No. 122.

nauseating, Tapinoma-like smell which it produces. This rather descriptive name is objectionable in that there are other Dolichoderinid ants having a similar odor, which might be confused with this species. The writer would further restrict the name, and call the species, the odorous house ant. In the New England and North Central States, so far as the writer is aware, there are no other Dolichoderinid house infesting ants. In the Southern States east of the Mississippi River species related to *Tapinoma sessile* Say are not common house pests, excepting the Argentine ant, *Iridomyrmex humilis* Mayr, an imported species. The writer fully realizes the name is still open to objection in that there are a number of Dolichoderinid ants which are bad house pests in the Southwestern States; however, for want of a better name the ant will be referred to throughout this paper as the odorous house ant.

SYNONYMY AND DESCRIPTION.

The odorous house ant was described by Thomas Say as *Formica sessilis* in the Boston Journal of Natural History, Volume 1, page 287 for May, 1836, the description being based on Indiana specimens. Say's specimens are now non-existent. His descriptions, although possessing some very salient characters is too brief and inadequate for an ant which is so highly variable in color, size, and pubescence as is the odorous house ant. The writer has redescribed the species from specimens taken at Urbana, Illinois. He believes that the specimens from which he has drawn his descriptions are very similar to those of Say's since Indiana and Illinois are contiguous.

Below is the synonymy of this species, followed by the author's description of the ant.

Formica sessilis Say, Boston Jour. Nat. Hist., Vol. 1, p. 287 (1836) female and worker.

Tapinoma sessilis Fred Smith, Cat. Hym. Brit. Mus., Vol. 6, p. 57 (1858).

Tapinoma sessile Mayr, Verh. Zool.—bot. Ges. Wien., Vol. 36, p. 434 (1886); Emery, Zool. Jahrb. Syst., Vol. 8, p. 332 (1895), female and male.

Tapinoma boreale Roger, Berl. Ent. Zeitschr., Vol. 7, p. 165 (1863), female and worker; Mayr, Sitz. Akad. Wiss. Wien., Vol. 53, p. 397 (1866), worker.

Formica gracilis Buckley, Proc. Ent. Soc. Phila., Vol. 6, p. 158 (1866) worker, female.

Formica parva Buckley, ibidem, Vol. 6, p. 159 (1866) worker.

Worker. Length, 2.39–3.19 mm. (Plate XVIII, Fig. 1).

Head oval, broader behind than in front, with faintly emarginate posterior border, rounded posterior angles and convex sides. Mandibles with the teeth almost gradually and uniformly diminishing in size from the apex to the superior border, the 3 or 4 apical teeth larger and more distinct than the others. Eyes moderately convex, placed at a distance from the mandibles equivalent to their greatest diameter. Clypeus convex, the anterior border distinctly excised medianly, the posterior border broadly rounded and extending for some distance between the bases of the frontal carinæ. Frontal area obsolete. Antennal scapes surpassing the posterior angles of the head by almost one-fourth their length. Thorax short and robust, anteriorly narrower than the head. Pro-mesonotal and meso-epinotal sutures very distinct. Viewed laterally, the pro- and mesonotum together form a rather long, gentle arch, which terminates at the meso-epinotal constriction; from the latter arises a short but gentle arch, which gradually fuses into the straight, oblique, declivous surface of the epinotum. Petiole not strongly developed, inclined forward and usually concealed by the basal surface of the abdomen which is superimposed upon it. Gaster subelliptical, broadest at the base and tapering apically; with four distinct segments, the remaining segments concealed; basal surface of the gaster with a wedge-shaped impression for the reception of the petiole.

Body minutely shagreened, subopaque and slightly glossy. Mandibles and anterior border of head more shining, the former with distinct scattered punctures.

Hairs sparse, light yellowish, erect, confined to the mandibles, clypeus, prosternum, coxæ, and the ventral surface of the gaster and dorsal surface of the fourth segment. Pubescence grayish, fine, yet distinct, and closely appressed to the body, giving the body a general pruinose tinge.

Body deep brown to black; mandibles and appendages lighter, especially the tibiæ and tarsi of the legs.

Dealated Female. Length, 3.75–4.29 mm. (Plate XVIII, Fig. 2).

Head, excluding the mandibles, subquadrate, about as broad as long, widest posteriorly, with rounded posterior angles, faintly excised posterior border and subparallel sides. Eyes large, rather convex, placed at a distance from the mandibles equivalent to less than their greatest diameter. Mandibles and clypeus similar to that of the worker. Antennæ proportionally stouter than in the worker, the scapes surpassing the posterior corners of the head by almost one-fourth their length. Thorax short and robust; through its greatest breadth about as broad as the posterior region of the head. Mesonotum, mesoparaptera and scutellum distinctly flattened dorsally, mesonotum laterally with a distinct parapsidal furrow on each side. Basal surface of the epinotum short, gently convex, not over one-half as long as the oblique, declivous surface, into which it gradually merges. (Wings, when present, of the same character as in the male). Scale of petiole not highly developed, inclined forward and hidden beneath the basal

surface of the gaster, which is somewhat superimposed upon it. Legs of moderate size, distal ends of each tibia with a spur, that of the prolegs clearly pectinate. Gaster subelliptical, broadest basally and tapering apically, with four distinct segments dorsally, the others concealed; base of gaster with a wedge-shaped depression for the reception of the petiole.

Sculpturing similar to that of the worker.

Pilosity similar to that of the worker; the anterior border of the clypeus with a long distinct hair on each side of the median excision. Pubescence yellowish or grayish, according to the light, and longer and more distinct over all parts of the body than on the worker, thus giving the body a more subopaque, pruinose tinge.

Body varying from brown to almost black; thorax and appendages lighter, especially the latter.

Alate Male. Length, 3.60–4.44 mm. (Plate XVIII, Fig. 3).

Head, excluding the mandibles, subquadrate, broader behind than in front of the eyes, the posterior border faintly convex, the posterior corners subangular. Mandibles with one large apical and several subequal denticulae. Maxillary palpi 6-segmented, labial palpi 4-segmented, as in the worker and female. Clypeus moderately convex, the anterior border with a faint central excision, the posterior border broadly rounded and extending some distance between the frontal carinae. Eyes elliptical, very large and strongly convex. Vertex with 3 prominent ocelli, the distance between the two ocelli approximately twice as great as that between one of the lateral and the median ocellus. Antennae 13-segmented, the scapes surpassing the posterior corners of the head by about one-fourth their length. Mesonotum large, flattened dorsally, and with a parapsidal furrow on each side, but without Mayrian furrows. Wings sordid gray, thickly pilose, and with ciliated margins, the veins yellowish-brown. Anterior pair of wings each with a single closed discoidal cell, cubital cell, and radial cell, the discoidal cell subquadrate. Epinotum with the base and declivity so completely fusing that the limits of each are not definitely discernible, the two forming a rather gentle, convex surface. Legs moderate in size, the distal ends of each tibia with a spur. Petiole inclined forward, but concealed for the most part by the base of the gaster which is superimposed upon it. Gaster elongate elliptical, with a wedge-shaped impression at the base for the reception of the petiole. Genitalia rather large and prominent, stipites large and subtriangular, the cerci each with a tuft of hairs or cilia at their distal ends.

Pilosity resembling that of the worker and female, but different in lacking hairs on the dorsum of the fourth segment, which are here confined for the most part to the stipites of the genitalia and the cerci. Body covered with dense, grayish pubescence, which is most discernible on the appendages. In certain lights the pubescence of the body has a slight, somewhat subopaque luster. The petiole is free of pubescence and is therefore smooth and glabrous.

Body uniform deep brown to almost black; the mandibles and appendages scarcely or not at all paler in color.

CLASSIFICATION.

The odorous house ant is a member of the subfamily *Dolichoderinæ*, which in North America embraces seven genera. The ants of this subfamily are characterized (1) by the presence of a ventral, slit-shaped, cloacal orifice; (2) by the presence of anal glands which produce a secretion having a rotten cocoanut or nauseating *Tapinoma*-like odor; (3) by the presence of a single-segmented abdominal pedicel, and (4) by the fact that the pupæ are not enclosed in cocoons.

The food of the ants of this family is small organisms, supplemented by honeydew, and the floral, extrafloral and glandular excretions of plants. A number of species are important house pests: among these being, the Argentine ant, *Iridomyrmex humilis* Mayr; the odorous house ant, *Tapinoma sessile* Say; and the species, *Tapinoma melanocephalum* Fabricius. The Argentine ant is without doubt, one of the worst house infesting ants in the world.

Worker ants of the genus *Tapinoma* can be distinguished from the workers of closely related genera in that the abdominal pedicel bears a vestigial scale or petiole, which is overshadowed by the base of the abdomen.

Only three species of *Tapinoma* are definitely known to occur in North America, and all of these except one are native species. The following key will suffice for the determination of the workers.

KEY TO WORKERS OF THE NORTH AMERICAN SPECIES OF TAPINOMA.

1. Workers small, never measuring more than 1.5 mm. in length. 2
Workers larger, measuring at least 2 mm. or more in length; color varying from brown to black, appendages lighter; antennal scapes surpassing the posterior corners of the head; most common species. *sessile* Say
2. Antennal scapes surpassing the posterior corners of the head; head and thorax very distinctly brown, mandibles, antennæ and legs very pale yellowish; imported species. *melanocephalum* Fabr.
Antennal scapes not attaining the posterior corners of the head; general color pale yellow, sometimes, however, with the dorsal surfaces of the body brownish; native species, at present only recorded from the coast of Florida. *litorale* Wheeler

A species which has been passing in literature for sometime as *Tapinoma pruinosus* Roger was described by Roger in 1866 from Cuban specimens (*Tapinoma pruinosum*, Roger, Berl. Ent. Zeitschr. Vol. 7, p. 165 (1866)). Wheeler in his bulletin on the ants of Cuba (Bull. Mus. Comp. Zool. Harvard, Vol. 54, p. 497 1913) has shown that the ants which have been passing

as *Tapinoma pruinosus* Roger are really *Iridomyrmex pruinosus* (Roger), a species common to the United States as well as to Cuba. The name *Tapinoma pruinosus* Roger is therefore relegated to synonymy and the name *Iridomyrmex pruinosus* (Roger) succeeds it.

On page 16 of this paper, the writer mentions a species of ant which Wheeler described from Massachusetts as *Bothriomyrmex dimmocki*. Wheeler in remarking about the ant mentions the fact that he was very much surprised to find a species of *Bothriomyrmex* occurring in North America as no species had been previously recorded for this country.

According to the opinion of Emery the ant should be transferred to the genus *Tapinoma* (Emery, Bull. Soc. vaud. Sci. Nat. Vol. 56, p. 19, 1925). Since the writer does not possess Emery's paper he does not know what reasons the author gives for such a change. To the writer it would appear that Wheeler was correct in placing this species in the genus *Bothriomyrmex* as the workers which he described had 4 segmented maxillary palpi and not 6 segmented as do the species of *Tapinoma*. Wheeler does not mention whether the scale of the abdominal pedicel of the workers was distinct or not; if it was distinct, then the workers of this species would appear unquestionably to belong to *Bothriomyrmex*, since the scale of *Tapinoma* is vestigial. The writer has followed Wheeler for the reasons stated and has therefore not considered *dimmocki* a species of *Tapinoma* as Emery does.

METHODS OF CONDUCTING THE BIOLOGICAL STUDY.

Ants collected in the field, were brought to the laboratory where they were etherized, counted, and placed in the cages for observations. These plaster of Paris cages consisted of two small, rectangular, intercommunicating chambers which were covered by a small pane of glass upon which was a heavy piece of carboard. The glass and cardboard not only prevented the ants from escaping, but held in the moisture and made the cages dark. Food, consisting of nuts, meats, cooked eggs, honey, and sugar, was placed in one of the compartments of the cage as needed. Since the food would quickly mold it was necessary to change it every other day. Observations on the number of eggs laid from day to day and on the develop-

ment of the ants were recorded and compared with field observations.

In computing the development of the brood, it was necessary to assume that the first eggs laid were the first to hatch, and that the first to hatch, were the first to pupate, etc. This method, though open to some objections, is the only practical means of ascertaining the life history of so complex a social insect, inasmuch as it is constantly moving its eggs and brood or even at times devouring them.

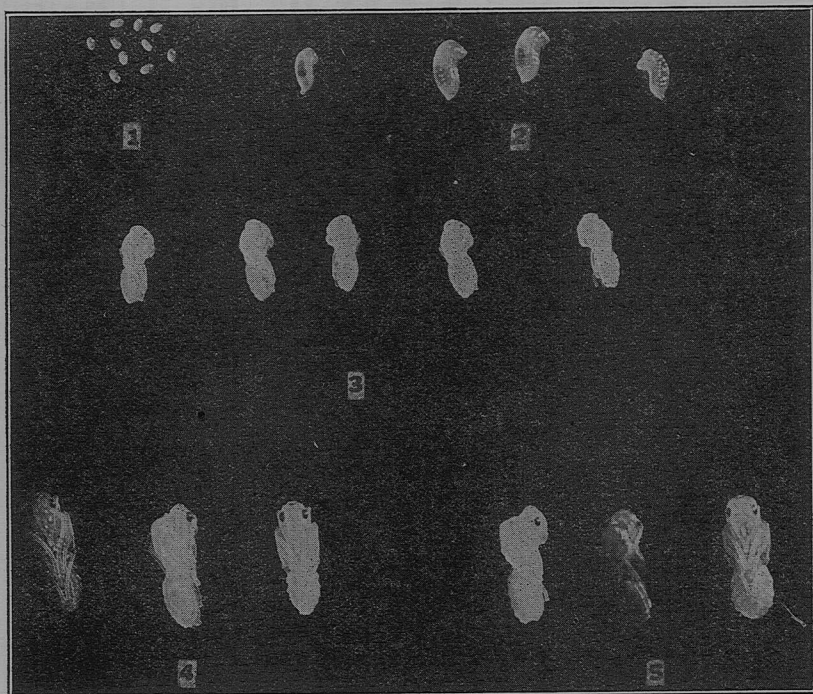
SEASONAL HISTORY.

Indoors in apartment houses, single residences, green-houses, and other places where the temperature is optimum, the workers are active the year around, and very probably breeding operations also take place continuously. Due to the inaccessibility of such nests, no examinations could be made to determine whether development of the brood was taking place or not. Dealated females that were brought to the laboratory in late fall and kept at a temperature of 70 degrees Fahrenheit, or above, laid a few eggs, which took from twenty-two to twenty-six days to hatch, and the larvæ developing from these eggs made no satisfactory growth until spring. •

Outdoors, on the other hand, the odorous house ant passes the winter as workers, dealate females, and partly grown larvæ. Workers began foraging as early as March 7th. Egg laying and uniform development of the brood were continuous processes from late April till cold weather, approximately November 1st. After a dormant period from November till April, the partly grown larvæ appeared as workers during April, thus requiring six to seven months for their complete life history. For eggs laid from April to June, development of the workers took place in from five to nine weeks. For eggs laid from June to September development proceeded even faster than this, requiring only six to seven weeks. No observations were made on the development of the males and females.

Alate females have been observed by the writer and others to appear at various dates ranging from June 17th to early July, and males have been noted from June 10th to July 9th. From the data available it appears that the males emerge a short time before the females. Mating is believed to take place both inside the nest and outside of it. That mating may

take place in the nest is indicated by the finding of partly and wholly dealated females there as well as freshly discarded wings. If mating takes place in the nest it is very probable that there is considerable inbreeding in this species. Such may account for the large number of dealated females to be found in the nest. Young colonies are apparently not capable of producing sexed forms, for of the many colonies examined only two large,



Tapinoma sessile Say.

Fig. 1—Eggs, $\times 4$. Fig. 2—Worker larvæ, $\times 4$. Fig. 3—Male pupæ, $\times 4$.
Figs. 4 and 5—Female pupæ, $\times 4$.

(Photographs by the Department of Photography, University of Illinois)

populous ones contained sexed forms. The males are very short-lived and have never been found in the nest except for the period during which they are attaining sexual maturity. Many winged males and females have been captured outside the nest, where some of these no doubt mated. Wheeler states that he has seen females of *Tapinoma** establishing their

*Very probably *sessile* Say.—AUTHOR.

nests independently, but the writer has not been so fortunate as to observe this. That young females of the current season begin egg laying soon after fertilization has been proven by the writer who kept such females in artificial nests and has obtained eggs from them.

Since the breeding season lasts from April to November and since the average time required for the development of the worker in summer is seven weeks, four to five generations a year is postulated.

DEVELOPMENT OF THE WORKER FROM EGG TO ADULT.

The egg of the odorous house ant is subelliptical in form, pearly white in color, lustrous, and without markings. It measures .24 by .39 mm. The egg membrane is thin and easily ruptured. It is also of such a sticky nature that one egg easily adheres to another. In the process of incubation the egg gradually loses its luster, becomes more opaque, and eventually the form of the developing embryo can be distinguished. Incubation requires from eleven to twenty-six days according to the season of the year (Fig. 1).

The freshly hatched larva is scarcely larger than the egg. As the larva grows its head becomes recurved ventrally, and a peculiar protuberance can be noted on the superior surface of the caudal end of the body. The body of the larva is distinctly segmented and also somewhat yellowish in color. Beneath the integument are small, scattered, white particles, probably excretory products. When full grown the larva is rather plump, being less distinctly segmented dorsally. The meconium is now quite apparent. The head of the larva appears even more recurved than formerly, and the caudal protuberance is very clearly evident. The larva now measures .72 by 1.74 mm. The larval stage occupies from thirteen to twenty-nine days (Fig. 2).

The prepupa is an almost exact replica of the full grown larva except that the meconium is not evident, it having been cast out just before the larva went into this stage. The body is robust and very plump. The integument soon acquires a much wrinkled, dry appearance. The prepupa measures about 1.8 mm. in length. The prepupal stage requires from two to three days.

The worker pupa when first formed is naked, white, and destitute of any color markings. It measures from 1.82 to 2.29 mm. in length. The head is directed ventrad, and the appendages are borne very close to the ventral surface of the body as in the usual manner. The eyes of the pupa begin to show a faint brown in color in from two to three days, and in from six to nine days not only are the eyes black but the mandibles are brown and the body has acquired a sordid yellowish tinge, the gaster being more infuscated and the head less so. The pupal stage lasts from eight to twenty-five days, averaging in midsummer about fourteen days (Fig. 3).

TABLE I.

The Maximum, Average, and Minimum Time Required for the Workers to Develop from Egg to Adult at Various Seasons of the Year.

| Season | Maximum Number Days | Average Number Days | Minimum Number Days | Number Specimens Observed |
|-------------------------------|---------------------------|---------------------------|---------------------------|---------------------------------|
| April-June Egg Stage..... | 20 | 15 | 12 | 15 |
| *Larval Stage..... | 29 | 22 | 13 | 8 |
| Prepupal Stage..... | | | | |
| Pupal Stage..... | 18 | 13 | 6 | 35 |
| Total—Egg to Adult.... | 67 | 50 | 31 | |
| July-September Egg Stage..... | 16 | 12 | 11 | 28 |
| Larval Stage..... | 16 | 15 | 14 | 3 |
| Prepupal Stage..... | 3 | 2 | 2 | 7 |
| Pupal Stage..... | 25 | 13 | 8 | |
| Total—Egg to Adult.... | 60 | 42 | 35 | |

Three days after emergence the gaster of the callow is deeply infuscated, the head less so, and the thorax least of all. The time required for the callow to attain full color in the life history cages has ranged over wide limits, usually averaging from less than a week to more than three weeks.

LENGTH OF LIFE OF THE VARIOUS CASTES.

Very little information was obtained on the length of adult life of the various castes. One female was kept eight months, the longest period observed, and was then accidentally

*This is the time required for the combined larval and prepupal stages.

killed by crushing. Many of the females brought in from the field died in a period of a few weeks to several months. Death in many cases was due to unsatisfactory cage conditions, such as the development of mold, etc. Workers appear to be as hardy as females and lived equally long. In cages the males on the other hand, are very short-lived, perishing within a week or ten days. During confinement they seemed to have exhausted themselves by running nervously about. Under natural conditions the females probably live a number of years, as do the workers, whereas the males perish within a few days after emergence.

HARDINESS OF THE ANTS.

The hardiness of the ants is most remarkable. On a number of occasions the writer has accidentally broken off appendages, or even crushed the bodies of the female and workers, yet these specimens lived and appeared to be little affected by the injuries. Some females with considerably crushed abdomens have laid eggs in spite of their injuries. In one case, two dealated females without food or water, survived confinement in a jar for a period of over two months.

THE EGG LAYING CAPACITY OF THE FEMALE.

Tapinoma sessile Say is remarkable in that there are so many dealated females in each colony, in some nests as many as two hundred, all apparently taking part in brood production. The females, although considerably larger than the workers, are not so much so as in other species. Females kept in life history cages over a considerable period of time have laid only a very small number of eggs. Sometimes an individual has laid as many as twenty to thirty eggs a day, but when an egg count was kept over a long period of time it was found that the total number of eggs produced by each female was comparatively small; some averaged not over .03 eggs a day, whereas the most prolific layers averaged only 1.78 eggs a day. Assuming that a female begins egg laying in April and lays 1.78 eggs per day up to the first of October, she will have laid only 350 eggs, a very small number. Although the records mentioned above were obtained under artificial conditions, the writer believes they closely approximate those in nature. The small size of the females and the great number in each nest very clearly

indicate that the females are individually not large egg layers, and that the flourishing condition of the colony is due to the combined output of many females (Table 2).

REPRODUCTIVE ABILITY OF THE WORKERS.

Egg laying by the workers has been observed on three different occasions, indicating a not uncommon habit of this caste. A number of workers without a female, which were confined in a cage on May 7th, laid twenty-one eggs by the

TABLE II.

The Total Number of Eggs Laid by Each Female, the Number of Days Each Female Was Kept in Confinement, and the Estimated Number of Eggs Produced a Day by Each.

| Specimen Number | Date Installed in Cage | Date Cage Discontinued | Total Number of Eggs | Average No. Eggs per Day |
|-----------------|------------------------|------------------------|----------------------|--------------------------|
| A | April 9. | April 30. | 22 | 1.04 |
| B | April 13. | April 29. | 15 | .19 |
| C | April 13. | May 25. | 44 | 1.04 |
| D | April 26. | May 26. | 40 | 1.30 |
| E | June 11. | December 31.. | 40 | .20 |
| F | June 22. | July 23. | 35 | 1.60 |
| G | August 22. | February 6. | 42 | .22 |
| H | September 5. | September 19.. | 24 | 1.78 |
| I | November 28. | July 8. | 10 | .04 |
| J | November 28. | May 1. | 5 | .03 |
| K | December 11.. | April 17. | 16 | 1.12 |
| L | December 11.. | July 28. | 19 | .08 |

14th of May. These eggs failed to hatch since the workers died before the eggs had an opportunity to develop. Whether more than one worker was laying is not known.

The most complete record is that of Cage 9 in which seventeen workers were confined on May 6th. Between this date and May 19th they laid a total of forty-five eggs. On May 31st small larvæ were observed for the first time and on July 10th a prepupa appeared, which was almost immediately destroyed by the ants before it had a chance to pupate. July 13th another prepupa appeared which met a similar fate. Judging from the size of the prepupæ the writer feels that if these had been allowed to pass into the pupal and adult stages they would have formed workers. Although this is somewhat contrary to general expectation it is by no means impossible or

improbable, for Tanner and Reichenbach, experimenting with other species of ants, have succeeded in rearing worker ants from worker eggs. The writer believes that the workers of *Tapinoma sessile* Say and other ants lay eggs more frequently than is usually supposed and that the eggs may at times develop into castes other than males.

A number of writers contend that when workers lay eggs, the brood developing from these eggs take longer to reach maturity than the brood reared from female eggs. From the present data it would appear that their contention is correct. With some of the eggs just mentioned the incubation period was twenty-three days, and the larval stage forty-one to forty-two days. If three days be allowed the brood for the prepupal, and fourteen days for the pupal stage (the time required by the brood reared from female eggs) then it would have taken the workers from eighty-one to eighty-two days to attain maturity, or a period of eleven to twelve weeks as compared with five to nine weeks for workers produced from female eggs.

Superficially the eggs of the workers appeared larger and more elongate than those laid by the females, but the writer cannot be sure of this statement for he did not measure or otherwise carefully study the eggs, due to their scarcity and the fact that he was anxious to have them incubate successfully.

NESTING SITES.

Probably no ant surpasses the odorous house ant in the diversity of its nesting sites. These ants nest in the soil beneath stones, boards, leaves, or other rubbish; under the bark of rotten logs and stumps; and also in cavities in the stems of elder (probably those made by the caterpillar, *Achatodes zea* Harris). Sturtevant found the odorous house ant nesting in the galls made by the wasp, *Amphibolips confluens* Harris that were lying on the ground beneath an oak tree. Essig stated in a letter that the ants nest in bird's nests, rubbish, and trees. In addition the writer has found them nesting in houses in Urbana, Illinois. The type of soil or the altitude has apparently little to do with the choice of their nesting sites. The ants have been found to nest all the way from sea level to heights of over 10,000 feet, and from nests located in boggy or swampy localities to sandy areas along the sea coast or to higher and drier locations inland. A study of the nesting sites

of this species has revealed two facts: (1) their lack of permanency; and (2) their shallowness. Some of the nests are located at the surface of the soil or only slightly beneath it. The nests are most commonly found in the soil beneath stones, rubbish, boards or any such refuse.

RELATION TO CLIMATIC CONDITIONS.

The odorous house ant is evidently acclimated to a wide range of temperature and humidity, since it is distributed from Canada to Mexico. At Urbana, Illinois, the workers have not been noted foraging outdoors at a temperature below 50 degrees Fahrenheit. At this temperature the ants appeared as if numbed by the cold and moved at a slow gait, as compared with their usually quick method of scurrying along. Workers however, have been observed to enter refrigerators and get into the ice compartments where the temperature must certainly have been below 50 degrees Fahrenheit. The ants do not like to cross water and if possible avoid doing so; but once in the water, due to the lightness of their bodies, they can float on the surface film, and in their violent struggles usually manage to propel themselves to one side and crawl out. Many colonies have escaped from the writer by crossing a slow stream of water which surrounded their nest. Rain, by washing their favorite food, honey-dew, from the foliage of plants, often causes the ants to invade homes; in fact, many housekeepers state that the ants are worst immediately after a rain. The writer has seen workers foraging in his yard when a wind storm was in progress, which was so violent as to blow aphids from trees. The aphids referred to were the box elder louse, *Periphyllus negundinis* Thos. That the ants can stand considerable heat is shown by the fact that they often construct nests under small piles of leaves or in compost heaps where the temperature is undoubtedly very high.

RELATION TO OTHER ORGANISMS.

RELATION TO HONEY-DEW EXCRETING FORMS.

Few ants excel the odorous house ant in its honey-dew loving habits. It is an aphidicolous and coccidicolous species par excellence and deserves to be ranked with such ants as the corn field ant, *Lasius niger*. var. *americanus* Emery, the honey

ant, *Prenolepis imparis* Say, and other such honey-dew loving species.

The writer has very commonly witnessed the workers of this species stroking with their antennæ, the box elder louse and obtaining from them the much sought honey-dew. The ants also showed a keen interest in mealy-bugs, especially individuals of the species *Pseudococcus maritimus* Ehrh. which they attempted to pick up and carry away when the writer sought to take specimens of the mealy bugs from the trunk of box elder trees. The workers of the odorous house ant may also distribute plant lice and other honey-dew excreting forms. On two occasions they have been seen carrying live box elder lice in their mouths and also a species of *Macrosiphum*, common on raspberry. A list of some of the insects with which this ant has been found associated is given below:

Aphididæ: *Periphyllus negundinis* Thos. on box elder; *Chaitophorus viminalis* Monell on American aspen and quaking aspen trees; *Aphis viburnicola* Gill. on *Viburnum opulus* L.; *Aphis* sp. on Englemanns Ivy; *Anuraphis cardui* Linn. on plum; *Aphis* sp. on burdock; *Aphis rumicis* Linn. on *Viburnum opulus* L.; *Aphis helianthi* Monell on sunflower; *Neothomasia populicola* (Thos.) on cottonwood; *Myzus cerasi* on cherry; *Macrosiphum solanifolia* Ashm. on rose and raspberry; *Aphis pseudobrassicæ* Davis on turnips and *Chaitophorus delicata* Walker on an undetermined host.

Coccidæ:—*Lecanium* sp. on box elder; *Kermes* sp. on water oak; *Chionaspis furfura* (Fitch) on apple; *Saissetia hemisphærica* (Targ.) on lemon and olive; *Coccus hesperidum* Linn. on orange; *Pseudococcus citri* (Risso) on Dracæna plant, the rice paper plant, lemon and coleus; and *Pseudococcus maritimus* (Ehrh.) on box elder.

Membracidæ:—*Entylia sinuata* Fabr. on sunflower.

RELATION TO OTHER ANTS.

During the period of two years devoted to the study of this ant, the writer failed to observe any fight or animosity on the part of *Tapinoma sessile* Say toward any other native species which it encountered. The odorous house ant is extremely common at Urbana, Illinois, and its nests are situated near those of other species, yet the ants do not seem to fight. When the odorous house ant encounters another species, each

seems to sense the other's presence and they therefore avoid one another. On one occasion the odorous house ant and the corn field ant, *Lasius niger* var. *americanus* Emery, were found foraging in a kitchen at the same time, yet the two species did not intermingle. The tiny thief ant, *Solenopsis molesta* Say, and the ant, *Strumigenys pulchella* Emery, have been found to live with this ant in what appeared to be compound nests. The tiny thief ant is known to feed on the brood of other species of ants and the species of *Strumigenys* are suspected of the same habit.

King (1897) has found mixed colonies of the odorous house ant and the following species: *Formica fusca* var. *subsericea* Say, *Lasius flavus* subsp. *nearcticus* Wheeler, and *Lasius niger* var. *americanus* Emery.

Woodworth (1910) appears to be the only observer who has seen the odorous house ant in conflict with another species; namely, the ubiquitous Argentine ant, *Iridomyrmex humilis* Mayr. The latter species is noted for its pugnacity toward all ants it encounters except a few small species such as the tiny black ant, *Monomorium minimum* Buckley, and Pharaoh's ant, *Monomorium pharaonis* Linn. Woodworth has the following to say concerning the conflicts between the Argentine ant and the odorous house ant: "This odor is produced by a liquid secretion (speaking of the ejections from the anal glands) which can be ejected from the abdomen as an appreciable drop, and which is used in its contest with the Argentine species. As long as the supply of the secretion lasts the *Tapinoma* has no difficulty in keeping the Argentine ant off, but after having put four or five Argentines out of the combat in this way finally the *Tapinoma* is put to rout and the Argentines are invariably victorious, because they always attack in sufficient numbers. We have observed many battles between these species and the *Tapinoma* is always driven away from its feeding ground and its home despoiled."

If there is any animosity exhibited by individuals of one colony of *Tapinoma sessile* Say towards those of another colony, the writer has not witnessed it. He has mixed colonies artificially in the laboratory and has also seen alien colonies combine of their own accord.

Wheeler (1916) described a species of ant, *Bothriomyrmex dimmocki*, from Massachusetts, which he states may be a

temporary parasite on the odorous house ant, like its cogener, *B. atlantis* Forel, of Tunis is on *Tapinoma nigerrimum* Nyl. The female of *B. atlantis* Forel after descending from her nuptial flight is pulled into the nest of *T. nigerrimum* Nyl., by the workers of that species. She soon crawls on the back of the *nigerrimum* female and decapitates her. After the death of the *nigerrimum* female, the workers of that species accept the *B. atlantis* female and rear the brood she produces. Eventually all the *nigerrimum* workers die and the colony then becomes a pure one of *B. atlantis*.

RELATION TO MYRMECOPHILES AND OTHER NEST INMATES.

In the nests of the odorous house ant, Mann (1911) has found the little cricket, *Myrmecophila oregonensis* Bruner, and also a little wingless wasp, *Isobrachium myrmecophilum* Ashm. "Ashmead states that the genus (*Isobrachium*) is parasitic upon the ants or other myrmecophilous *Coleoptera*," according to Mann who writes further, "the latter being so rare in the nests of *Tapinoma*, it is probable that *Isobrachium* is a parasite on the ant itself." The crickets, *M. manni* Schimmer and *nebracensis* Lugger, have also been taken in the nests of this ant.

The following species of *Coleoptera*, most of which are rove beetles (*Staphylinidae*), have also been taken from the nests of the odorous house ant by Mann, Wheeler, and others: *Zyras tapinomatis* Mann, *Myrmoecia lugubris* Casey, *Nototaphra lauta* Casey, *Connophron longipenne* Casey, and *Myrmedonia* sp.

The writer has found in the nests of the odorous house ant an unidentified species of spring tail (*Collembola*), termites (*Isoptera*), and sow bugs, *Armadillidium vulgare* (Latr.). In the laboratory a species of book lice thought to be *Troctes divinatoria* (Muller) appeared in the cages and fed on the dead bodies of the ants and other refuse. Neither were the ants observed to attack the lice nor the lice to trouble the ants.

RELATION TO PREDATORS.

The only animals known to feed on the odorous house ants are birds and toads. A winged male of this ant was taken from the stomach of a toad, *Bufo* sp., at Anna, Illinois, by a member of the Illinois State Natural History Survey. The following list of the species of birds known to feed on the

odorous house ant was sent to the writer by the United States Bureau of Biological Survey: the pigeon hawk, *Falco columbarius* Linn; the American magpie, *Pica pica hudsonia* (Sabine); the Bartramian sandpiper, *Bartramia longicauda* Bechet; the chimney swift, *Chaetura pelagica* Linn.; the crow, *Corvus brachyrhynchos brachyrhynchos* Brehm; and the red shafted flicker, *Colaptes cafer collaris* (Vigors). Bryant (1914) mentions that the western meadowlark, *Sturnella neglecta neglecta* Audubon, feeds on this species of ant and the writer has observed the English sparrow, *Passus domesticus* Linn. doing the same thing.

RELATION TO PLANTS.

The odorous house ant not only visits plants for the purpose of attending insects but for the purpose of visiting also the floral and extrafloral nectaries and other glandular excretions. The workers have very commonly been seen lapping up exudates on the buds of peonies. This habit apparently causes the buds to dry out to such an extent that the flowers developing therefrom are smaller and in many cases malformed. Dietz (1926) states that the black lawn ant, *Formica fusca* var. *subsericea* Say, can spread peony bud wilt by means of the workers crawling from infected to non-infected buds, while visiting the buds for the much sought exudates. If this be true in case of the lawn ant, it should also apply for the odorous house ant, for it, like the lawn ant, is a persistent visitor of peony buds. Davis of New York (1922) states that he has seen workers of this species visiting the glands at the base of the leaves of *Populus grandidentata* Michx. The writer has seen this ant in attendance on the glands of castor bean plants.

During 1926 the writer found a fungus, *Laboulbenia formicarium* Thaxter, infecting several species of ants in Urbana, Illinois, namely: *Formica fusca* var. *argentea* Wheeler, *F. neogagates* Emery; *Lasius niger* var. *neoniger* Emery, and *F. pallide fulva schaufussi* var. *incerta* Emery. Although the odorous house ant was present on the same blocks as the species mentioned above, this ant was not found to be infested with the fungus.

In the laboratory, colonies of the odorous house ant were often choked out by luxuriant growths of the bread mold, *Rhizopus nigricans* Ehrh., and a species of *Aspergillus*. These molds arose from foods that were allowed to remain in the

cages too long, thriving best where there was considerable excess moisture. The writer did not find the ants outdoors to be affected by any sort of fungus and he doubts if they ever are.

FOOD.

The food of the odorous house ant under normal conditions is largely honey-dew, supplemented by the flesh of organisms and the juices of fruits. The ants are also very fond of the floral and extrafloral secretions of plants. In the laboratory cages the ants occasionally fed on their brood. It is presumed that under outdoor conditions this seldom, if ever, happens.

When the ants enter houses they are almost omnivorous but seem to show a slight preference for sweets. In a number of homes in Urbana, Illinois, the ants have been known to cut through paraffine in order to reach jelly and preserves in containers. They have been noted to infest the following foods: honey, sugar, preserves, pies, custards, marmalades, cooked and uncooked beef, fish, raw and fried liver, boiled and mashed potatoes, stewed prunes, cheese, milk, ice cream, and ripe fruits.

SIZE OF COLONIES.

The colonies of this ant show a wide variation in size, perhaps due to their age. The smallest colony observed contained only four dealated females and about one hundred workers. The largest colony noted was estimated to contain about ten thousand individuals, including brood and adults. An average colony may be expected to contain between two thousand and five thousand specimens.

One of the most striking characteristics of the colonies of this ant is the unusually large number of dealate females, all of which no doubt take part in reproduction. The females, unlike those of the honey bee, are most amiable toward one another.

From observations that have been made it is believed that the sexed-forms are not produced in any but the older and stronger colonies. Although many nests have been examined sexed-forms have been found only in the larger and more flourishing colonies, which were very probably from four to five years of age (Table 3).

GENERAL HABITS OF THE WORKERS.

The workers of the odorous house ant are strikingly slender and graceful in appearance. When alarmed they run with a rapid, erratic, jerky sort of pace and oftentimes with the caudal end of their abdomen slightly elevated. When a nest is disturbed it is only a few seconds until the ants are running everywhere in a somewhat helter-skelter manner.

The workers are splendid foragers, who seek food by night as well as by day. Very seldom are they seen foraging singly but are ordinarily observed trailing along in a file from their

TABLE III.

The Size of the Colonies and the Types of Castes and Immature Stages in the Nest at Various Periods During the Year.

| Date | Total No. Individuals | Males | Dealate Females | Male Pupæ | Female Pupæ | Worker | | |
|------------|-----------------------|-------|-----------------|-----------|-------------|--------|-------|------|
| | | | | | | Pupæ | Larvæ | Eggs |
| Apr. 1-25 | 104 | 0 | 4 | 0— | 0 | 0 | x | 0 |
| Apr. 8-26 | ? | 0 | x | 0 | 0 | 0 | x | 0 |
| Apr. 12-26 | ? | 0 | x | 0 | 0 | 0 | x | 0 |
| Apr. 25-26 | ? | 0 | x | 0 | 0 | 0 | x | x |
| June 11-25 | ? | 0 | 15 | 0 | 0 | x | x | x |
| June 6-26 | ? | x | x | x | x | x | x | x |
| June 27-25 | 6,000-8,000 | x | *x | x | x | x | x | x |
| Aug. 22-25 | 3,000-4,000 | 0 | x | 0 | 0 | x | x | x |
| Sept. 5-25 | 10,000 | 0 | 240 | 0 | 0 | x | x | x |
| Nov. 10-25 | ? | 0 | x | 0 | 0 | x | x | x |

x—Form present.

* Alate and Dealate Females.

NOTE.—Workers are not mentioned in Table because they are present all the year and comprise the largest percentage of individuals in the nest.

nest to the source of food supply. The ants seldom have to travel over thirty to fifty feet to find food, and for this reason their trails are generally not long. Their foraging activities take them into every conceivable sort of place, such as garbage cans, commodes, dirty linens, pantries, sinks, refrigerators, and other places too numerous to mention. Like their cogeners, the Argentine ants, the odorous house ants are prying little busybodies, eternally poking their antennæ into everything.

FEEDING HABITS OF THE WORKERS.

When hungry the ants eat very greedily. The writer found that a worker will feed from three to five minutes before she seems satisfied. During this time her gaster gradually enlarged until the chitinous segments stood out like small islands between the intersegmental membranes.

Workers have often been observed regurgitating food to the female or to other workers. They also feed their larvæ in this manner but never with solid particles as do some of the primitive ants.

NURSING DUTIES OF THE WORKERS.

The workers are good nurses as well as foragers. Whether there is any particular division of labor among them, the writer does not know, since the individuals are practically all the same size (monomorphic) and indistinguishable. Recently emerged individuals (callows) show considerable interest in the brood and will attempt to pick up the brood and carry it away when the nest is disturbed. The dealated females seem to show little interest in the brood, leaving their care to the workers, when these are present in sufficient numbers. The workers show considerable attention to the female and to the brood, around which they cluster. Since the pupæ of this ant has no cocoon covering it, the assistance of the worker for its removal at emergence is not necessary. The writer has, however, noted a worker removing the meconium from a larva which was preparing to enter the prepupal stage. Workers are continually seen licking the brood, the females, or other workers.

ACKNOWLEDGMENTS.

The writer wishes to express his gratitude to Dr. C. L. Metcalf for his unfailing interest and guidance in the work and in the preparation of this paper. He is also grateful to Dr. W. P. Hayes, Dr. R. D. Glasgow, and Dr. W. V. Balduf for their valuable aid and many helpful suggestions. The writer is also indebted to the United States Bureau of Biological Survey and the Illinois State Natural History Survey for furnishing valuable data, and to Dr. W. E. Britton, Mr. J. R. Horton, and Mr. S. A. Rohwer for the loan of specimens. Mr. P. W. Mason kindly determined the plant lice for the author.

SUMMARY.

1. *Tapinoma sessile* Say, a native North American ant, is of considerable economic importance as a house pest not only in Urbana, Illinois, but in localities in California, Nevada, District of Columbia, Maryland, and Mississippi.

2. The synonymy and a redescription of the species is given in this paper. The immature stages of the ant are also described.

3. The common name, the odorous house ant, is applied to the species for the first time.

4. The ants overwinter outdoors as dealate females, workers, and larvæ. Workers begin foraging as early as March 7th. Egg laying and the uniform development of the brood begins in late April and continues until cold weather in the fall or approximately November 1st. The overwintering larvæ attain maturity in April, having required from six to seven months to attain maturity. From April through June workers can be produced in from five to nine weeks, whereas during the period July through September they require only six to seven weeks to attain maturity. Four to five generations of workers a year are postulated.

5. Alate females were observed at various dates ranging from June 17th to early July. Males appeared from June 10th to July 9th. Only large and strong colonies seem capable of producing sexed-forms. Mating probably takes place both in and outside of the nest.

6. Colonies range from a hundred to ten thousand individuals. The average colony contains from two thousand to five thousand individuals, many of which are dealated females; one colony contained over two hundred dealated females.

7. Some of the workers lay eggs. The brood reared from such eggs attained the prepupal stage before they were eaten by the workers. It is believed that if they had attained maturity the adults would have been workers. Development of brood from worker eggs apparently takes longer than the development of brood from female eggs.

8. The ants show a wide diversity in their nesting habits. Nests have been found in houses; under the bark of logs and stumps; in galls on plants; in stems of plants; under debris; and in the soil.

9. The species is apparently eurythermal in disposition as it is found throughout most of North America from the sands of the seashore to heights of over ten thousand feet and from boggy locations to perfectly dry inland spots. Workers have been seen foraging at temperatures as low as fifty degrees Fahrenheit.

10. The natural food of the ants is honey-dew, supplemented by the flesh of organisms. In houses they feed on fruits, vegetables, meats and sweets, but seem to show a preference for sweets.

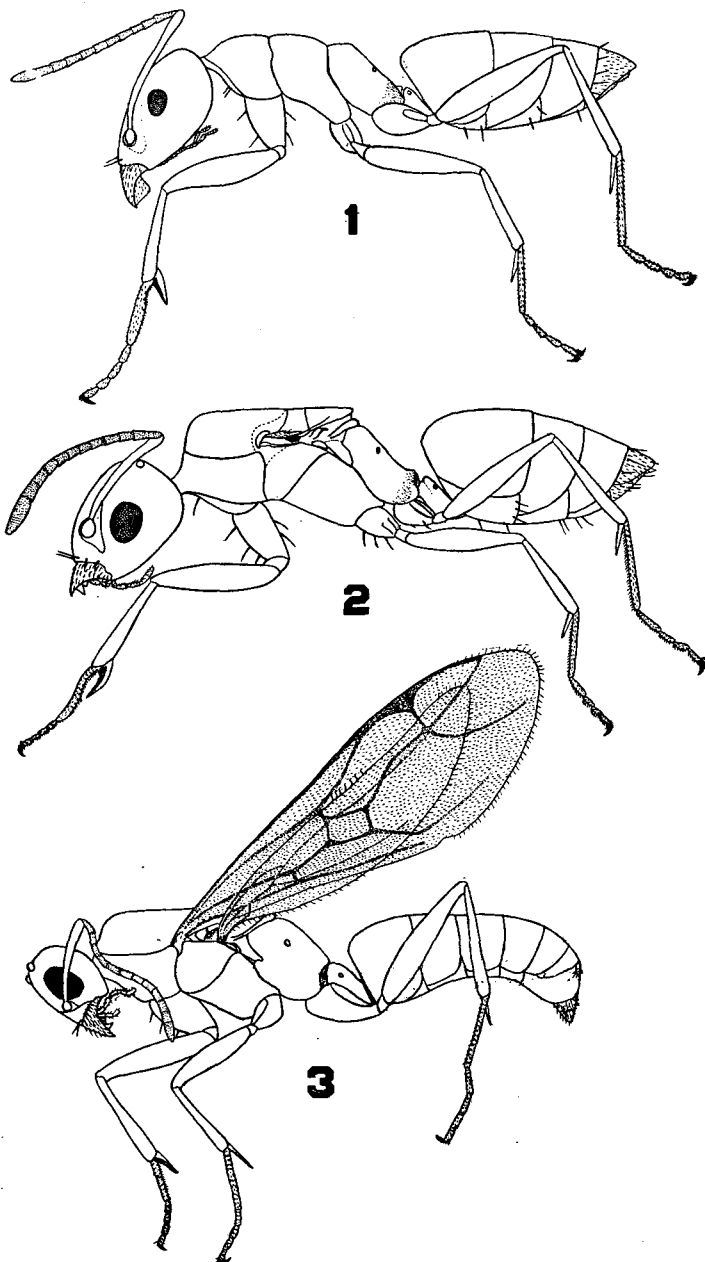
11. A list of the species of plant lice, scale insects, mealybugs, tree hopper, etc., which they are known to attend is given in this paper.

12. A number of beetles, wasps, crickets, spring tails, termites, book lice and other insects have been found living in association with the ants.

13. A species of toad and eight species of birds are known to feed on the ants.

BIBLIOGRAPHY.

- Bryant, H. C. 1914. Univ. of Cal. Pub. Zool., 11: 21-24.
Davis, W. T. 1922. Bull. Bklyn. Ent. Soc., 17:2.
Dietz, H. F. 1926. Insect Pest Survey, 6: 122-123.
Doten, S. B. 1910. Nev. Agr. Expt. Sta. Bull., 73.5: 43-44.
Emery, C. 1912. Genera Insectorum, 137: 40.
Essig, E. O. 1926. Insects of Western North America. McMillan Co., N. Y., pp. 863-864.
King, G. B. 1896. Entomological News, 7: 169.
Mann, W. M. 1911. Psyche, 18: 29.
Reichenbach, H. 1902. Biol. Centrabl., 22: 461-465.
Say, Thos. 1836. Boston Jour. Nat. Hist., 1: 287.
Tanner, J. E. 1892. Trinidad Field Naturalist's Club, 1: 123-127.
Wheeler, W. M. 1910. Ants, Their Structure, Development and Behaviour. Columbia Univ. Press, N. Y., pp. 45.
1913. Bull. Mus. Comp. Zool., Harvard, 54: 497.
1915. Bull. Amer. Mus. Nat. Hist., 34: 417-418.
Woodworth, C. W. 1919. Univ. Cal. Publ., 207: 70-71.



Marion R. Smith

Tapinoma sessile Say.

- Fig. 1. Worker, greatly enlarged.
- Fig. 2. Dealated female, greatly enlarged.
- Fig. 3. Alate male, greatly enlarged.