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OBSERVATIONS ON THE BIOLOGY *OF ECTOBIUS PALLIDUS* (OLIVIER) (BLATTARIA, BLATTIDAE)

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Ectobius pallidus,[1] the spotted Mediterranean roach, was first collected in the United States in East Falmouth, Massachusetts, in 1948 (Flint, 1951); it has since been reported from other coastal localities in Massachusetts: Falmouth, Manomet, and Plymouth (Gurney, 1953), and Cotuit where two specimens were taken in a house (Gurney, personal communication). In 1955 we collected several male specimens in Natick and one male in Sherborn, Massachusetts, which would indicate that this species is spreading inland. The establishment of this cockroach in Massachusetts probably resulted from an accidental introduction from Western Europe or the Mediterranean area (Gurney, 1953). *E. pallidus* is a nondomiciliary species that occasionally invades houses.

On November 8, 1954, Mr. Paul Rolander collected some oöthecae of *E. pallidus* for us in Plymouth. On this date adults had apparently already died, and he found only a few small nymphs in addition to the egg cases. Rolander (unpublished data) had obtained hatching of eggs from oöthecae only after they had swelled on absorbing water. Following his suggestion, we placed the oöthecae on moist filter paper in our laboratory. On November 24, 1954, some of the oöthecae began to increase in size and to change color. The original color of the hardened egg case was dark brown; this gradually changed to a milk-chocolate

[1] This species has been referred to as *Ectobius lividus* (Fab.) by Flint (1951), and *Ectobius livens* (Turton) by Ramme (1951), Gurney (1953), and Roth and Willis (1955). However, Dr. Ashley B. Gurney, after correspondence with Dr. K. Princis, has informed us that it seems advisable to call this introduced species *Ectobius pallidus* (Olivier).

color after the oötheca had absorbed water and swelled (figs. 1-3). These eggs began to hatch on December 3, 1954. We were unable to establish a laboratory colony from this material.

The following summer we collected large numbers of *Ectobius pallidus* on several trips to Plymouth. On July 12, 1955, adult males and females were numerous under leaf litter in shaded woods. Small nymphs and a few large ones were present but no oöthecae, other than empty egg cases, were found. No females carrying oöthecae were collected on this day, but the following day the females that had been brought into the laboratory began to form oöthecae. On July 19, 1955, we made another collecting trip to Plymouth, and of 157 adult females obtained, 19 were found to be carrying oöthecae. Ovipositing females usually deposited their oöthecae in the laboratory the day following oöthecal formation. The oötheca is formed with the keel upwards and is then rotated so that the seam is directed to the right side of the insect (fig. 13). In the laboratory, complete formation of the oötheca took about one day and rotation occurred about two hours later. Although Rolander (in Roth and Willis, 1955) had claimed that *E. pallidus* carries her oötheca up to 16 days or longer before she deposits it, we found in the laboratory that the females formed and deposited their oöthecae in one to two days; most of the oöthecae were deposited on the moist cotton stoppers of the drinking water vials. Since it was obvious that the eggs had to absorb water before hatching, we kept many of the oöthecae on moist cotton for several weeks. However, these oöthecae did not swell and none of the eggs hatched.

Very few eggs of *Ectobius pallidus* that were deposited in the laboratory hatched. The only ones that did hatch were in oöthecae that had been removed from the moist cotton stoppers, stored dry for about six months, and then allowed to absorb moisture. Oöthecae that were deposited from August 19 to 22, 1955, were stored dry at 23° C. and 50 to 60% R.H. until February 14, 1956, when they were placed on wet filter paper. After they had been kept moist for one to two weeks, some of the oöthecae began to swell. Between March 21 and 26, eggs from six oöthecae hatched; the mean number of offspring per oötheca was 14 (range 13 to 15, N = 5).

When the eggs hatched, the oötheca split along the keel and practically all embryos emerged simultaneously (figs. 4-6). Immediately after wriggling free from the oötheca, the young pronymphs were still enveloped by their embryonic membranes (figs. 7-8), but these were quickly shed (figs. 9-10). Brown (1952) reported similar hatching behavior in *Ectobius panzeri* Stephens.

Eggs of *Ectobius pallidus* apparently must pass through a dormant period or diapause before they will absorb water and complete development. This is indicated by (1) the failure of eggs to hatch when the oöthecae were kept continuously moist from the time they were dropped by the female, (2) the swelling and hatching of field-collected eggs after the oöthecae had been placed on moist filter paper in the laboratory, and (3) similar swelling and hatching of eggs that had been subjected to dry storage conditions for six months before being allowed to absorb moisture. Brown (1952) reported that oöthecae of *Ectobius panzeri* that were produced in the laboratory, as well as those collected on the dunes in the fall, did not hatch until the following spring.

We have similarly observed that the oöthecae of *Cariblatta lutea minima* Hebard also increase in size and change color after being kept on moist filter paper. The eggs of this species do not hatch unless they are kept moist (Roth and Willis, 1954), but, unlike the eggs of *Ectobius pallidus*, the eggs of *Cariblatta* do not undergo a dormant period. The average time for development of *Cariblatta* eggs, when the oöthecae were kept on moist cotton at 27° C., was 26 days (range 23 to 27 days, N = 8).

Apparently in Massachusetts, *Ectobius pallidus* overwinters as eggs in the oöthecae, the adults dying after reproducing, although it is possible that some nymphs also may overwinter. Lucas (1928) stated that *Ectobius lapponicus* (L.) overwinters as nymphs producing adults in spring or early summer. Brown (1952) found overwintering oöthecae of *Ectobius panzeri* in sand dunes in February, but no hibernating nymphs or adults. We suggest that *E. pallidus* may overwinter as nymphs because nymphs have been collected as late as November. These either die or hibernate. In addition, adults appear in early July which

seems to indicate too short a developmental period for progeny hatched from eggs in the spring of the same year. The adults are relatively short-lived. Adult females reared from nymphs collected in the field and kept with males in the laboratory lived an average of 23 days (range 6 to 61 days, N = 14); virgin females lived an average of 35 days (range 19 to 42 days, N = 14). Females lived longer than males. Very few individuals were reared to adulthood from eggs which hatched in the laboratory; we have been unable to establish a laboratory colony of this species using Purina dog chow checkers as food.

Ramme (1923) stated that it was not known whether the secretion of the tergal glands of males of species of *Ectobius* served to attract females or acted as a defensive organ to discourage enemies. In describing the mating behavior of *Ectobius*, he stated that the male runs backwards, with its elytra and wings raised vertically, toward the end of the abdomen of the female and accurately places its genitalia into those of the female. He further stated that one might assume that the male raised his wings to expose the tergal gland in order to excite the female with his glandular secretion; but Ramme believed that this was not so and that the wings were raised because in the resting position they cover the abdomen and would obstruct or even prevent union. Copulation often lasted as long as 24 hours and, according to Ramme, no spermatophore was formed. Konček (1924) stated that the tergal glands of males of *Ectobius lapponicus* and *E. sylvester* (Poda) were biologically important as a secondary sex character and mentions Sikora's (1918) observations on *Blattella germanica* as confirmation for this view.

Our observations of the mating of *Ectobius pallidus* show that Ramme's interpretation of the reproductive behavior of *Ectobius* is incorrect. The males which we observed were isolated from females for three days before being paired. When the male comes in contact with a female, he turns about, raises his wings and tegmina, extends his abdomen toward the female, brings his cerci together, and moves backwards. Even when the female has moved out of range, the male remains in a characteristic position with his head down, abdomen raised and strongly convex, and wings raised slightly away from the abdomen. If a female

passes close by, or even if touched by another male, the courting male raises and flutters his wings at about a 90° angle and pushes his abdomen backwards. A receptive female feeds on the secretion of the male tergal gland (fig. 11), and the male pushes backwards beneath the female and grasps her with his hooked phallomere. Once this is accomplished, the pair assume the characteristic opposed position (fig. 12). Contrary to Ramme's belief, a spermatophore is formed in *Ectobius*. The tergal gland of *Ectobius* functions in mating behavior just as it does in other species of cockroaches in which the males possess this structure (Roth, 1952; Roth and Willis, 1952, 1954).

In the field at Plymouth, we observed two species of ants, *Aphaenogaster picea* Emery and *Lasius alienus* (Förster) carrying off specimens of *Ectobius pallidus*.

Many of the adult cockroaches that were collected were parasitized by an undetermined species of Mermithidae. This mermithid (fig. 16) lies coiled in the body cavity of the host, and one end of the worm may extend into the thorax. The worms have been seen to leave the cockroach between the thorax and abdomen (fig. 14) or thorax and head (fig. 15). Inasmuch as the adult cockroaches are relatively short-lived, we are undecided whether the host was killed by the parasite or whether the worms left the insects after they died or became moribund from other causes. However, it is obvious that these parasites are detrimental to their hosts because some of the internal organs of the cockroaches were destroyed; the abdomens of the parasitized cockroaches from which worms emerged were essentially hollow shells. Hyman (1951) states that mermithids destroy the viscera and fat body, ". . . killing the host or rendering it incapable of metamorphosis and reproduction."

Although a large number of nematode species have been described from cockroaches, there are practically no records of mermithids parasitizing these insects. Bode (1936) stated that he found a few instances of *Periplaneta americana* being parasitized by such nematodes as "*Mermis* or *Gordius*." The only record we have found of a nematode parasitizing *E. pallidus* is *Blatticola blattae* (Graeffe, 1860) Chitwood, 1932 which is found in the intestinal tract (Chitwood, 1932).

Summary

Some field and laboratory observations on the biology of *Ectobius pallidus* are described. In Massachusetts, this cockroach apparently overwinters as eggs in the oötheca; however, possibly some nymphs may also overwinter. Adults die shortly after reproducing. The eggs apparently pass through a dormant period before absorbing water and completing development. As a result of water uptake, the oötheca increases markedly in size and changes color, becoming lighter brown, prior to the hatching of the eggs.

The mating behavior of *Ectobius pallidus* is similar to that of other species in which the males possess tergal glands; the female *Ectobius* feeds on the male's tergal gland secretion prior to copulation.

Two species of ants were found to prey on *E. pallidus*, and an undetermined mermithid parasitizes this cockroach.

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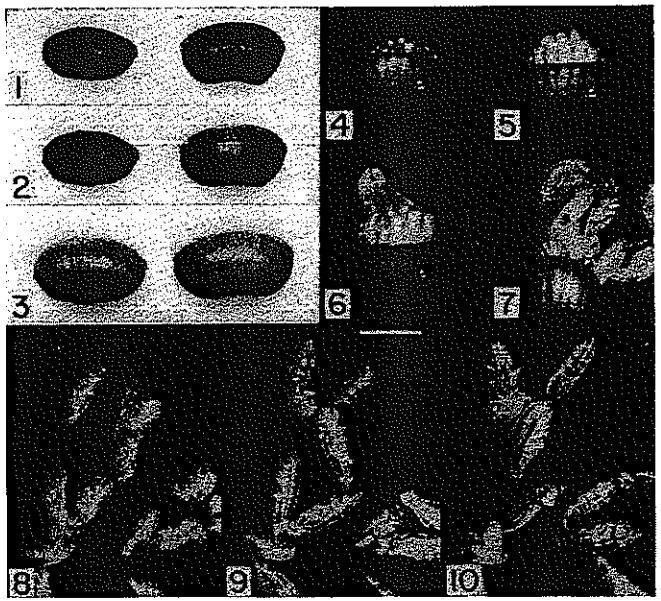
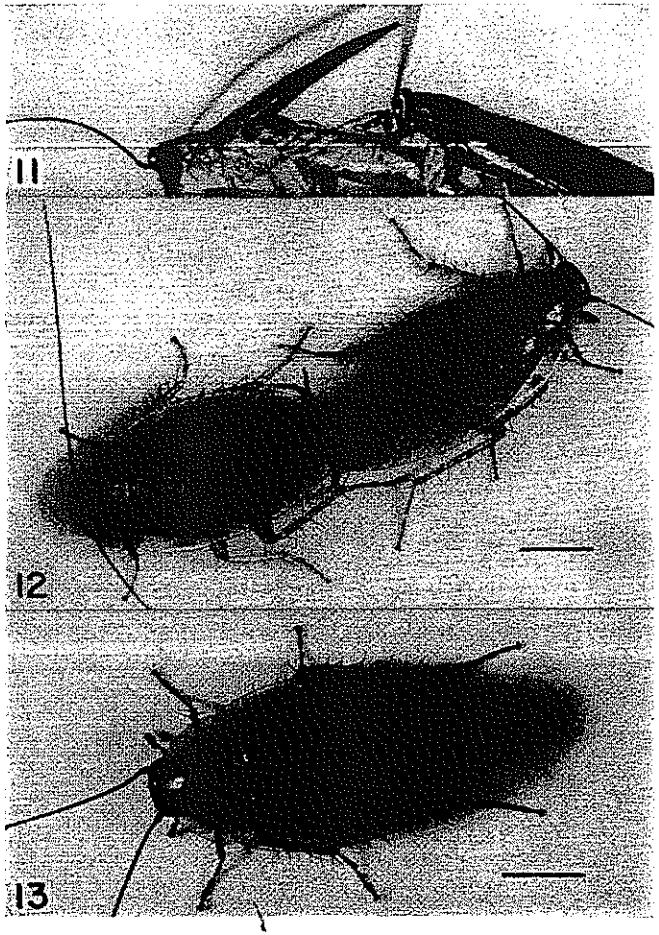


Figures 1-10. *Ectobius pallidus.* 1-3. Uptake of water through the oötheca; egg cases collected in the field 8 November 1954 and placed on moist filter paper.

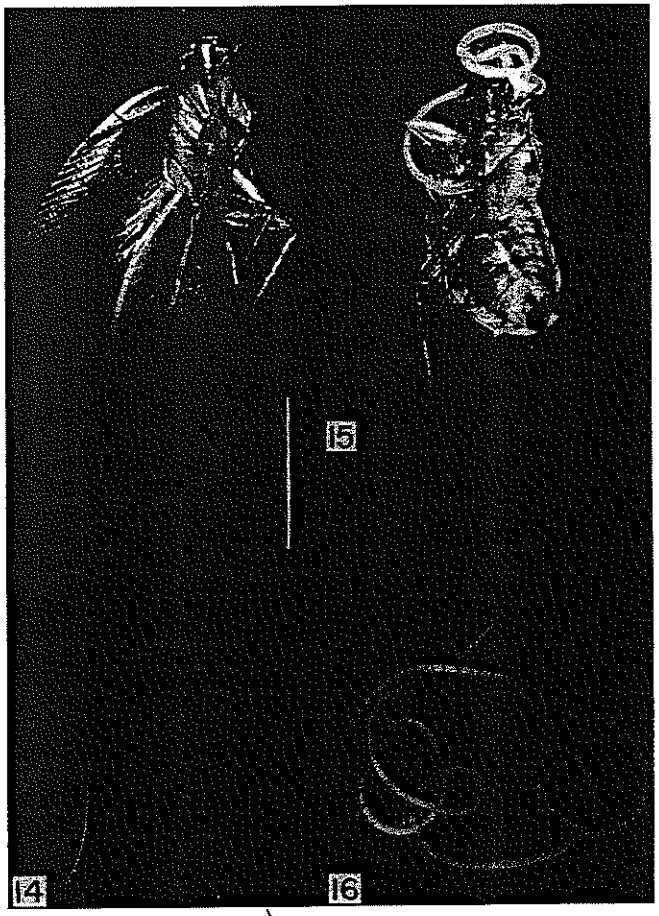
1. 23 November: essentially no visible external change during the first 15 days the oöthecae were kept moist. 2. 24 November: note the increase in size of both oöthecae and the change in color down the middle of the egg case on the right where the oötheca is being stretched by the growing embryos. 3. 26 November: note the marked increase in size of the oöthecae and the complete change in color (cf. fig. 1). This was the extent to which the oöthecae swelled before the eggs hatched.

4-10. Hatching of eggs, initiated by slitting the crista of the oötheca with a scalpel. The entire sequence required 12 minutes; note in figure 8 that the pronymphs are still enveloped by their embryonic membranes which are being shed and can be seen at the tips of the abdomens of several nymphs in figure 10.

(Horizontal bar = 2 mm.)



Figures 11-13. Reproductive behavior of *Ectobius pallidus*.
11. Female (right) feeding on the secretion from the male's tergal gland. 12. Pair in copula. (Horizontal bar = 2 mm.) 13. Female carrying an oötheca; note that the oötheca was rotated so that the keel was toward the right. (Horizontal bar = 2 mm.)



Figures 14-16. Undetermined mermithid that parasitizes *Ectobius pallidus*. (Vertical bar = 5 mm.)

14. Mermithid which has emerged from between the abdomen and thorax of an adult male *Ectobius*. 15. Mermithid which has emerged from between the head and thorax of an adult female *Ectobius*. 16. Mermithid free from the host.