

### Control of Oöcyte Development in Cockroaches

**Abstract.** Development of ovarian eggs and secretory activity of colleterial glands are inhibited by the oötheca in the oöthecal chamber of *Blattella germanica* (L.) and by the oötheca in the uterus of *Pycnoscelus surinamensis* (L.). The inhibition is due to nervous stimuli from pressure of the oötheca. Removing the oötheca or severing the ventral nerve cord eliminates inhibition of the *corpora allata* and results in premature development of the oöcytes and resumption of activity of the colleterial glands.

Oöthecal eggs in the uterus of the cockroach *Leucophaea maderae* (Fab.) are said to release a substance which causes the brain to inhibit secretion of the *corpora allata* and, thus, maturation of oöcytes (1). Differences in ovipositing behavior among various species of cockroaches (2) indicate that this mechanism would operate only in species carrying their oöthecae internally throughout embryogenesis.

*Blattella germanica* carries its oötheca externally during embryogenesis, and the oötheca inhibits development of the oöcytes and secretion of the colleterial glands. Removal of the egg case from the female results in an increase in the rate of oötheca production (3). The

oötheca is carried an average of 30 days (4). During this time the oöcytes increase in length only slightly, from 0.34 to 0.52 mm. Ten days after the first oötheca is dropped the oöcytes have grown to an average length of 2.55 mm, and a second oötheca is formed. The *corpora allata* were shown to be necessary for development of the oöcytes of *B. germanica*; allatectomized adult females did not oviposit. Implantation of *corpora allata* into allatectomized females resulted in oviposition within 2 weeks. An allatectomized female with four implanted *corpora allata* produced three oöthecae in 61 days; another produced four in 58 days. When imitation wax "oöthecae" were inserted into the oöthecal chamber of adult females 1 day old or less, the oöcytes remained undeveloped. When the ventral nerve cord was severed in a female carrying an oötheca, the oöcytes grew rapidly and colleterial glands accumulated secretion in spite of the presence of an attached oötheca [Fig. 1 (1 and 2)]. Nineteen females from which oöthecae were removed 3 to 5 days after oviposition formed new oöthecae in  $19.8 \pm 0.5$  days (5). Similarly, 11 females whose nerve cords were cut 3 to 5 days after oviposition formed new oöthecae in  $19.5 \pm 0.5$  days. The original oötheca may adhere to the new

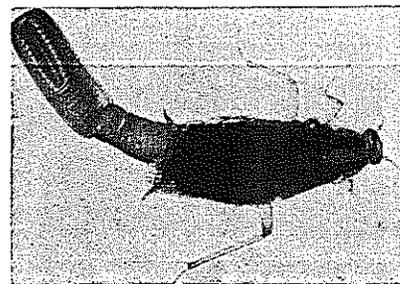


Fig. 2. *Blattella germanica* whose ventral nerve cord was severed 4 days after oviposition; 19 days after the operation it had formed a second oötheca, to which the first adhered. ( $\times 2.4$ ). [E. R. Willis]

one, as shown in Fig. 2. One female with a severed nerve cord formed four oöthecae over a period of 82 days, essentially doubling the rate of oöthecal production.

*Pycnoscelus surinamensis* incubates its eggs in a uterus, like *Leucophaea maderae* (2). During gestation, which averaged 55.5 days in our parthenogenetic strain of *Pycnoscelus* (4), the oöcytes increased slightly in length, from 0.56 to 0.75 mm. About 2 weeks after parturition, oviposition again occurs, when the oöcytes average 3.2 mm in length. Usually about 70 days elapse between the formation of the first and second oöthecae. Allatectomized adult females failed to oviposit, but when *corpora allata* were implanted, these females oviposited 2 or more weeks later. The presence of an oötheca in the uterus inhibited ovarian development; the interval between the production of successive oöthecae was decreased from about 70 to 27 days when oöthecae were removed between 1 and 7 days after oviposition. The presence of parts of oöthecae implanted into the body cavity of adult females 1 day old or less failed to inhibit development of the oöcytes. Parts of young oöthecae were implanted into the body cavities of six females 1 day old or less; after 11 days the oöcytes of these six females were  $2.91 \pm 0.06$  mm long—a length similar to that ( $2.93 \pm 0.06$  mm) of oöcytes of normal 11-day-old females.

The oötheca was removed from the uterus of each of ten females 1 to 16 days after oviposition, and one half of each oötheca was implanted into the body cavity of the donor female. Twenty-three days after the operation the oöcytes averaged  $2.70 \pm 0.10$  mm in length. However, substitution of a wax oötheca for a

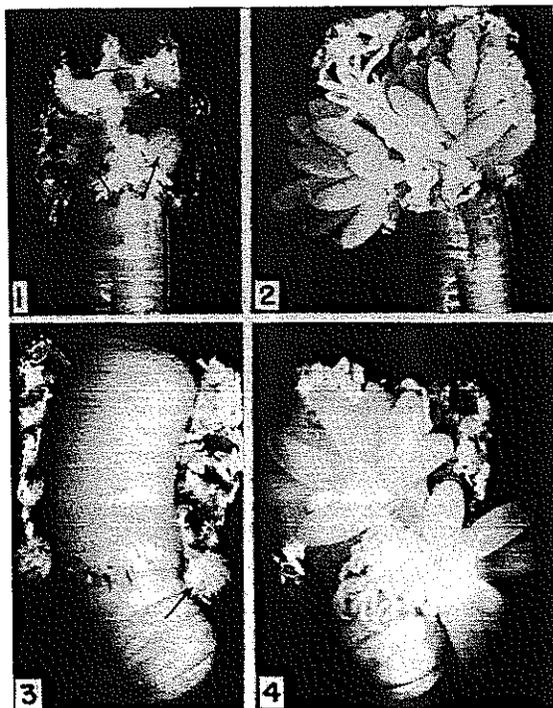


Fig. 1. (1, 2) Reproductive tracts of *B. germanica* females that carried oöthecae for 26 days. (about  $\times 4.8$ ). (1) Unoperated female; the ovaries (arrows) are undeveloped and the colleterial glands lack secretion; (2) female whose ventral nerve cord was severed 6 days after oviposition; the basal oöcytes are almost mature, and the colleterial glands are full of secretion. (3, 4) Reproductive tracts of *P. surinamensis* females that have oöthecae in their brood sacs. (about  $\times 4.1$ ). (3) Unoperated female 37 days after oviposition; the ovaries (arrows) are small, and the colleterial glands lack secretion; (4) female whose ventral nerve cord was severed just after oviposition; 29 days later the basal oöcytes have matured and the colleterial glands are full of secretion.

real oötheca in the uterus inhibited oöcyte development. Ten females whose nerve cords were cut either 0, < 1, or 4 days after oviposition had well-developed oöcytes  $2.74 \pm 0.18$  mm long and full colleterial glands 24 to 31 days after the operation [Fig. 1 (3 and 4)]. When real or wax oöthecae were present in the uterus, oöcytes developed only after the nerve cord was severed.

In both *Blattella germanica* and *Pycnoscelus surinamensis*, inhibition of oöcyte development during pregnancy appears to be due to nervous stimuli resulting

from pressure of the oötheca—on the uterus in *P. surinamensis* and on the oöthecal chamber in *B. germanica*. There was no indication that any substance released by the eggs in the oötheca acted through the brain to inhibit secretion of the *corpora allata*, as has been reported for *Leucophaea maderae* (1).

LOUIS M. ROTH\*

BARBARA STAY†

Pioneering Research Laboratories,  
U.S. Army Quartermaster Research and  
Engineering Center,  
Natick, Massachusetts

#### References and Notes

1. M. Lüscher and F. Engelmann, *Rev. suisse zool.* 62, 649 (1955); F. Engelmann, *J. Insect. Physiol.* 1, 257 (1957).
  2. L. M. Roth and E. R. Willis, *Smithsonian Misc. Collections* 122, 1 (1954); *Trans. Am. Entomol. Soc.* 83, 221 (1958).
  3. B. M. Parker and F. L. Campbell, *J. Econ. Entomol.* 33, 610 (1940).
  4. Insects were kept at 24° to 25°C and at about 50 to 70 percent relative humidity.
  5. The numbers following  $\pm$  represent standard errors.
- \* Present address: Central Research Laboratories, United Fruit Co., Upland Road, Norwood, Mass.
- † Present address: Biological Laboratories, Harvard University, Cambridge, Mass.
- 11 March 1959