From *Insect Neurochemistry and Neurophysiology • 1989* Edited by A. B. Borkovec and E. P. Masler

PATTERNS OF CORPORA ALLATA ACTIVITY IN OVARIECTOMIZED BLATTELLA GERMANICA

Michal Gadot, Ann-Shyn Chiang,
Edina Burns and Coby Schal

Dept. of Entomology, Rutgers Univ.
New Brunswick, New Jersey 08903

The corpora allata (CA) of adult female cockroaches, including Blattella germanica (Gadot et al., 1989a,b), synthesize juvenile hormone-III (JH-III) in a precisely regulated cycle which corresponds to the ovarian cycle. The brain, the ovary and the ootheca have been implicated as the main sources of regulatory factors which modulate the activity of the CA (Tobe and Stay, 1985). In Nauphoeta cinerea and Diploptera punctata, the maturing ovary activates the CA at the beginning of the first ovarian cycle, while the mature ovary (just before ovulation) has an inhibitory effect on JH-III synthesis (Lanzrein et al., 1981; Rankin, 1989). Herein we examine the role of the ovary in modulating CA activity in B. germanica.

Insect rearing, the radiochemical in vitro assay of JH-III synthesis and the chemicals used are described elsewhere (Gadot et al., 1989b). Ovariectomy was performed on early last instar nymphs. Newly-emerged ovariectomized females were placed daily with mature males until mating was observed; thereafter, each mated female was housed with two males.

The onset of receptivity in ovariectomized females, determined by their readiness to mate, was less synchronized than in intact grouped females: only 53.7% of 162 ovariectomized females mated by day 7, as compared with more than 95% of intact grouped females; most females in both groups mated between days 5-7. The rest of the ovariectomized females became receptive and mated at different ages. Because sexual receptivity in intact B. germanica females is related to CA activity, and mating has no effect on oocyte development and JH-III synthesis (Gadot et al., 1989a), these results suggest that the population of ovariectomized females may be more asynchronous with regard to CA activity.

The activity of the CA of ovariectomized females that refused to mate was compared to that of females that mated on day 6-7 (Fig. 1A). While the CA of unmated (non-receptive) females exhibited low activity at all ages, the CA of mated females exhibited a cyclic pattern of activity. The rates of JH-III synthesis of active CA from ovariectomized females are similar to those of active CA from intact females (compare Fig. 1 and data in Gadot et al., 1989a,b). However, the cyclic pattern is different in the two cases, since in intact grouped females peak activity of the CA is on days 5-8 (when basal oocyte length is 1.5-2.2 mm); by day 9 (ovulation) the CA are inactivated and they resume activity after the ootheca is dropped (Gadot et al., 1989a).

The cyclicity of JH-III synthesis by CA of ovariectomized females was confirmed by comparing the rates of JH-III synthesis between females which mated normally (on day 6-7) and females which mated later (on day 11 to 19, Fig. 1B). The onset of sexual receptivity proved to be a better predictor of CA activity than chronological age. The CA of individual ovariectomized females were activated at different ages, but once activated, the activity of CA in different females increased and decreased in a similar pattern.

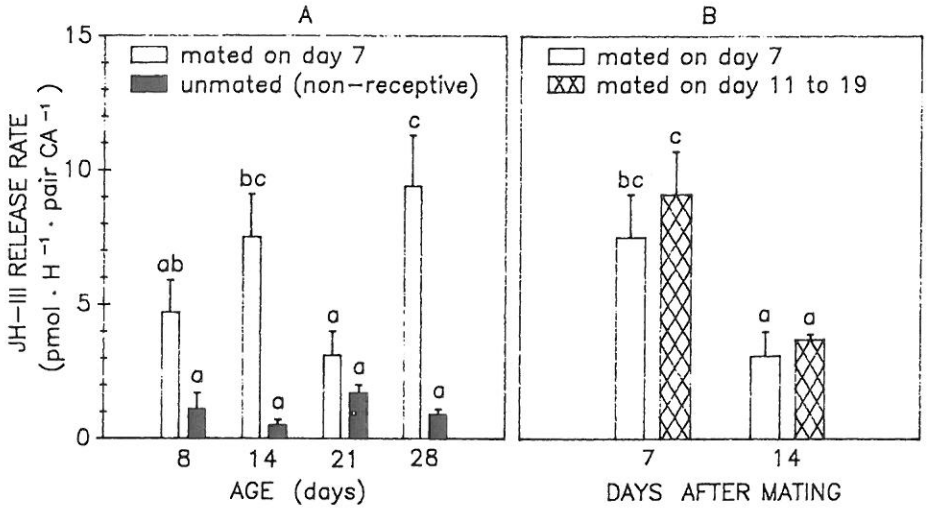

Fig. 1: Juvenile hormone-III synthesis rate, assayed by the in vitro release rate of radiolabeled JH-III (Gadot et al., 1989b) in CA of ovariectomized females: (A) in relation to chronological age in mated and non-receptive females that refused mating; and (B) in relation to onset of sexual receptivity, assayed by days after mating. Each bar represents the mean ± SEM of 4-9 females. Means with different letters differ significantly from each other (Duncan's Multiple Range Test, $p<0.05$).

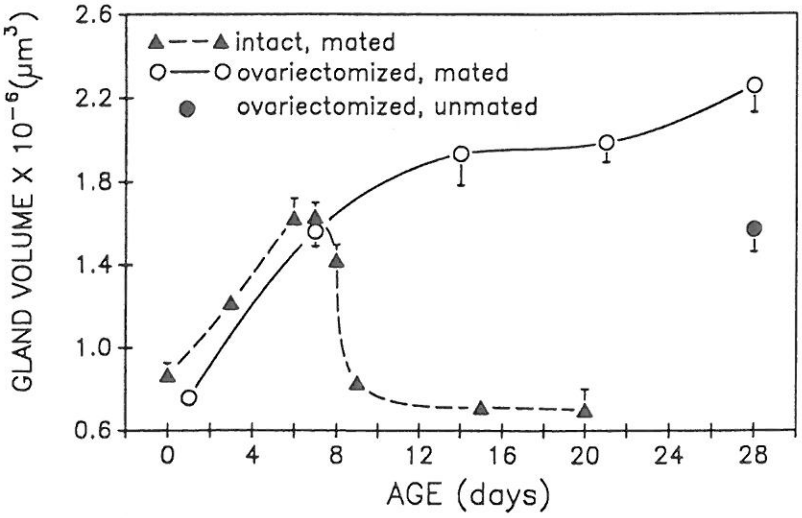

Fig. 2: Corpus allatum volume of intact and ovariectomized females in relation to age. Intact females were mated on day 6, and ovariectomized females as described in Fig. 1. Each point is the mean ± SEM of 8 individual glands.

The effects of ovariectomy in B. germanica are similar to those reported in two other cockroach species, Leucophaea maderae and Periplaneta americana, in which the CA of ovariectomized females exhibit varying levels of activity (Scharrer and von Harnack, 1961; Weaver, 1981). However, while in L. maderae histological and ultrastructural evidence suggests hypertrophy, accompanied by transient hyperactivity of the CA (Scharrer, 1978), in P. americana only low to moderate rates of JH-III synthesis in vitro are exhibited by CA of ovariectomized females (Weaver, 1981). In both cases, no cyclicity of CA activity in ovariectomized females was apparent. Our combined data from all B. germanica females would show a similar pattern, except that high-activity CA from ovariectomized females have the same rates of JH-III synthesis as active CA of intact females. However, by using mating as an indicator of physiological stage, we support the hypothesis of lack of population synchrony among ovariectomized females.

These data suggest that the ovaries are not required in B. germanica for full activation of the CA or for their subsequent inhibition, although they clearly accelerate CA activation and synchronize cyclicity in the population. This is in contrast to the effects of ovariectomy in N. cinerea and D. punctata, which prevents the activation of the CA (Lanzrein et al., 1981; Stay et al., 1983). In these two species, the inactive CA of ovariectomized females, nevertheless increase in volume with age (Lanzrein et al., 1981; Tobe et al., 1984). Similarly, the CA of ovariectomized B. germanica continued to increase in volume

through day 28 and did not exhibit the normal cycle of volume changes (Fig. 2). Low-activity CA of ovariectomized unmated females also increased in size and on day 28 were as large as high-activity CA of intact females. Thus, the ovary may modulate developmental changes independently of its effects on overt CA activity, and may have different effects on each process even in closely related species.

Acknowledgments - Supported by PHS-NIH grant HD21891 (to CS) and the Headlee Fellowship (to AC). New Jersey Agricultural Experiment Station publication no. J-08170-02-89 supported by State Funds and by the U.S. Hatch Act.

REFERENCES

Gadot M., Burns E. and Schal C. (1989a) Juvenile hormone biosynthesis and oocyte development in adult female Blattella germanica: Effects of grouping and mating. Arch. Insect Biochem. Physiol. (in press).

Gadot M., Chiang A. and Schal C. (1989b) Farnesoic acid-stimulated rates of juvenile hormone biosynthesis during the gonotrophic cycle in Blattella germanica. J. Insect Physiol. (in press).

Lanzrein B., Wilhelm R. and Buschor J. (1981) On the regulation of the corpora allata activity in adult females of the ovoviviparous cockroach Nauphoeta cinerea. In Juvenile Hormone Biochemistry, Action, Agonism and Antagonism (Edited by Pratt G.E. and Brooks G.T.), 1st Edn, pp. 147-160, Elsevier, Amsterdam.

Rankin S. M. (1989) Regulation of corpus allatum activity in adult females of the viviparous cockroach, Diploptera punctata. In Cockroaches as Models for Neurobiology: Applications in Biomedical Research. (Edited by Huber I., Rao B.R. and Masler E.P.) 1st Edn, CRC Press, Boca Raton. (in press).

Scharrer B. (1978) Histophysiological studies on the corpus allatum of Leucophaea maderae. VI. Ultrastructural characteristics in gonadectomized females. Cell. Tiss. Res. **194**, 533-545.

Scharrer B. and Harnack von, M. (1961) Histophysiological studies on the corpus allatum of Leucophaea maderae. III. The effect of castration. Biol. Bull. **121**, 193-208.

Stay B., Tobe S.S., Mundall E.C. and Rankin S. (1983) Ovarian stimulation of juvenile hormone biosynthesis in the viviparous cockroach, Diploptera punctata. Gen. Comp. Endocrinol. **52**, 341-349.

Tobe S.S. and Stay B. (1985) Structure and regulation of the corpus allatum. Adv. Insect Physiol. **18**, 305-432.

Tobe S.S., Clarke N., Stay B. and Ruegg R.P. (1984) Changes in cell number and activity of the corpora allata of the cockroach Diploptera punctata: a role for mating and the ovary. Can. J. Zool. **62**, 2178-2182.

Weaver R.J. (1981) Radiochemical assays of corpus allatum activity in adult female cockroaches following ovariectomy in the last nymphal instar. Experientia **37**, 435-436.