Sensitive Stage for the Diapause-Averting
Effect of High Temperature in the Blowfly,
Calliphora vicina ROBINEAU-DESVOIDY
(Diptera: Calliphoridae)¹

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The blowfly, *Calliphora vicina* is widely distributed in temperate and subarctic zones of the Holarctic. Diapause in postfeeding third-instar larvae is important for winter survival in this species, especially under the cool climate which prevails in the northern areas of its distribution (VINOGRADOVA, 1984, 1991). Diapause is primarily determined by the short-day conditions experienced by the female parent, although high temperatures in the larval period can prevent the induction of diapause programmed by the short-day conditions in the maternal generation (VINOGRADOVA and ZINOVJEVA, 1972; SAUNDERS et al., 1986). The upper threshold temperature for the induction of diapause is between 12 and 17°C in various geographic populations (VINOGRADOVA and ZINOVJEVA, 1972; SAUNDERS et al., 1986; VINOGRADOVA, 1991). Larvae of this species develop promptly even at low temperatures. The period from egg hatching to maximum weight is only 5.66 d at 15°C (DAVIES and RATCLIFFE, 1994). Thus, *C. vicina* may produce an additional generation in a relatively warm autumn. Furthermore, in the natural habitat of larvae, i.e., carcasses or feces of animals, heat is produced as a result of the digestive activity of microorganisms and the activity of enzymes secreted by the larvae themselves. The temperature in the natural habitat of larvae is likely to be much higher than ambient temperature, especially in carcasses of large animals. It is, therefore, interesting to observe how temperature influences the onset of

diapause in this species. Such information is important for understanding how larvae of this species enter diapause in the appropriate seasons in natural conditions. In the present study, we examine the sensitive stage for the diapause-averting effect of high temperatures.

MATERIALS AND METHODS

A laboratory culture of *C. vicina* originating from the Murmansk suburbs (68°57'N, 33°10'E), North Russia, was maintained as described by NESIN et al. (1995). For experiments, adults were kept under short-day conditions (12L–12D) at 20 ± 1°C. In this species, not only photoperiodic conditions but also adult age of the maternal generation affects the incidence of diapause in the progeny (SAUNDERS, 1987; NESIN et al., 1995). Eggs laid 2–3 weeks after adult emergence were used, because eggs obtained under such conditions invariably become diapause larvae under 12L–12D at 12°C (NESIN et al., 1995). Small pieces (7–10 g) of fresh beef with eggs were placed in 250 or 500 ml glass jars on slightly moistened sawdust covered by filter paper. The eggs were divided into six groups under 12L–12D. Group A was kept continuously at 10 ± 1°C. Groups B, C, D and E were placed at 20°C for 4, 5, 6 or 7 d respectively, and then transferred to 10°C. In groups B, C and D, larvae were in the third instar and feeding at the time of transfer. In group E, however, most larvae had already ceased feeding and were wandering at the time of transfer, whereas a few individuals had not. The latter larvae were removed from this group at the transfer to 10°C. Group F was kept continuously at 20°C. Fresh meat was added when the initial ration was consumed before the end of the feeding period. Mature larvae migrated into sawdust where they pupariated. In this experiment, larvae were fed on small pieces of meat, and, therefore, the temperature inside the meat became only 2–3°C higher than the ambient temperature. To determine the duration of larval development, larvae were checked for pupariation and all puparia were removed from the containers every few days, in accordance with the dynamics of pupariation.

RESULTS AND DISCUSSION

Larvae continuously maintained at 10°C stopped feeding 24 d after oviposition. None of them had pupariated by 10 d after the cessation of feeding, but

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Fig. 1. Effect of temperature on the time of pupariation in *Calliphora vicina*. Eggs laid by adults grown under 12L-12D at 20°C were kept continuously at 10°C (A), transferred from 20°C to 10°C after 4, 5, 6 or 7 d after oviposition (B, C, D, E), or kept continuously at 20°C (F) under 12L-12D. $n = 195-330$.

pupariation started thereafter (Fig. 1A). From previous findings (NESIN et al., 1995), we expected all larvae to enter diapause under these conditions. However, some larvae developed rapidly and pupariated much earlier than the diapause larvae observed at 12°C (NESIN et al., 1995), although the rest took longer to pupariate. As a result, this group showed a bimodal pupariation pattern; the two peaks probably corresponded to nondiapause and diapause individuals, respectively, although the pattern was rather continuous (Fig. 1A). At 20°C, the larvae stopped feeding six d after oviposition, and all larvae pupariated within 10 d after the cessation of feeding (Fig. 1F). This species is known to develop without diapause at this temperature (VINOGRADOVA and ZINOVJEVA, 1972; SAUNDERS et al., 1986). The period from the cessation of feeding to the pupariation was 2.2 ± 0.9 d (mean $\pm$ S.D., $n = 259$). When larvae were kept at

20°C for the first 4-6 d and then transferred to 10°C, the pupariation profile was similar to that of the larvae kept continuously at 10°C for both nondiapause and diapause individuals (Fig. 1B-D). However, when transferred to 10°C within one day after the cessation of feeding, all larvae pupariated within 10 d (Fig. 1E). The period from the cessation of feeding to pupariation was 3.2 ± 1.0 d ($n = 229$), and, therefore, was longer by only one day than in the larvae kept continuously at 20°C.

Thus, it appears that high temperatures during the wandering period completely averted diapause in the progeny of short-day parents, and the temperatures experienced during the earlier stages had little or no effect on the induction of diapause. The larvae are extremely sensitive to temperature after the cessation of feeding when they have already left the larval habitat. In *C. vicina*, therefore, it is likely that the progeny of short-day parents can either enter or avert larval diapause under natural conditions, depending on the ambient temperature during the wandering period, even though they may have experienced relatively high temperatures during the feeding period.

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REFERENCES

- DAVIES, L. and G.G. RATCLIFFE (1994) *Med. Vet. Entomol.* **8**: 245-254.
- NESIN, A.P., N.P. SIMONENKO, H. NUMATA and S.I. CHERNYSH (1995) *Appl. Entomol. Zool.* **30**: 351-356.
- SAUNDERS, D.S. (1987) *Physiol. Entomol.* **12**: 331-338.
- SAUNDERS, D.S., J.N. MACPHERSON and K.D. CAIRNCROSS (1986) *Exp. Biol.* **46**: 51-58.
- VINOGRADOVA, E.B. (1984) *Blow Fly Calliphora vicina as a Model Object for Physiological and Ecological Investigations*. Nauka, Leningrad, 272 pp. (in Russian).
- VINOGRADOVA, E.B. (1991) *Diapause of Flies and Its Regulation*. Nauka, St. Petersburg, 256 pp. (in Russian).
- VINOGRADOVA, E.B. and K.B. ZINOVJEVA (1972) *J. Insect Physiol.* **18**: 2401-2409.