a thermal effect from the tissue[2]. It is possible that the histamine released from the mastcells granula might be responsible for the thermal effects measured. Histamine content per gram tissue in solitary mastocytoma has been reported to vary between 0.95-2 mg, whereas 0.08 mg is normal[3,4]. In the Batch Microcalorimeter we have achieved small heat effects when healthy skin biopsies are exposed to compound 48/80 and histamine, and the Warburg studies that we have run parallel indicates that there is an increased metabolism in the tissue caused by these potent substances[5]. Heparin is also bound in the mastcells granulae[6] maybe in relatively weak bound with the amines, for example histamine. Also other of the many substances in mastcells granula may, of course, be responsible for the thermic effects and in further studies we intend to investigate this.

In many allergic conditions affecting the skin, i.e. urticaria, degranulation of the tissue mastcells and the blood basophilics are central processes in the pathogenesis, and this indicates that the present finding that thermic effects can be measured by Sorption microcalorimetry when mastcells in mastocytoma and normal skin are degranulated by compound 48/80, might be of clinical importance in the future.

[2] L. HELLGREN and K. LARSSON, Techniques of Microcalorimetric Investigations on Cellular Systems with Special Reference to the Clinical Field. Chemical Center, Lund University, Lund, Sweden, July 9–11, 1973.
[3] G. B. EST and J. F. RILEY, J. Physiol., Lond. *119*, 44 (1952).
[4] H. ZACHARIAE, Acta derm.-vener., Stockh. *43*, 125 (1963).
[5] L. HELLGREN and J. VINCENT, Personal communication (1975).
[6] J. E. JORPES, H. HOLMGREN and O. WILANDER, Z. mikrosk.-anat. Forsch. *42*, 279 (1937).

## Effect of sectioning the prothoracic gland nerves in the larva of the lemon-butterfly, Papilio demoleus L.

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*Summary.* Sectioning the nerves innervating the prothoracic glands of the larva of the lemon-butterfly has no effect on the development and metamorphosis of the insect. The results are discussed in the light of the known facts.

*Introduction.* Innervation of the prothoracic glands is known in at least five insect orders[2]. While the function of this innervation has been variously suggested by different authors[2–7], no attempt was made to get a direct clue by denervating the glands themselves. In this paper we present a preliminary report on such an experiment carried out in the larva of the lemon-butterfly, Papilio demoleus.

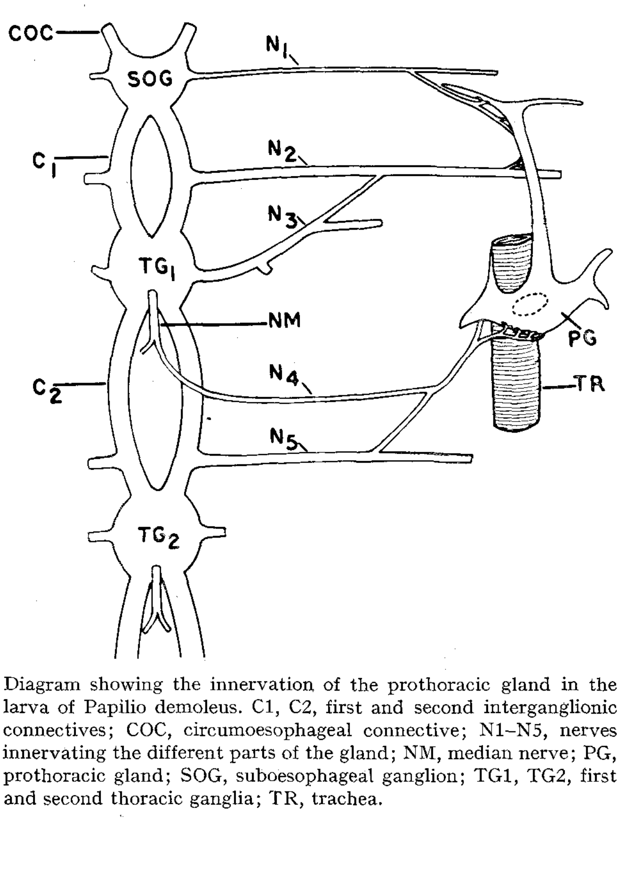


Diagram showing the innervation of the prothoracic gland in the larva of Papilio demoleus. C1, C2, first and second interganglionic connectives; COC, circumoesophageal connective; N1–N5, nerves innervating the different parts of the gland; NM, median nerve; PG, prothoracic gland; SOG, suboesophageal ganglion; TG1, TG2, first and second thoracic ganglia; TR, trachea.

*Materials and methods.* Young (1-day-old) fifth (ultimate) instar larvae of the lemon-butterfly were water-narcotised[8] and fixed in position with their ventral surface up between 2 crossed pins in a wax dissecting dish. All the nerves (N1 through N5, see below) innervating each gland were sectioned with a pair of microscissors on either side of the ventral nerve cord through incisions made in the intersegmental membranes. An antibiotic-phenyl-thiourea (1:1 by weight) mixture was applied on the wounds and the insects were cooled at 5 °C in a refrigerator for 4–5 h to reduce bleeding[9]. The insects were then transferred to room temperature and kept starved for 24 h to minimize bleeding due to feeding movements. The controls were treated in a similar manner but their nerves were only slightly pulled and not severed.

*Results.* There are 5 nerves designated as N1 through N5 that contribute to the innervation of each prothoracic gland in this insect (figure). The N1 arises from the suboesophageal ganglion and sends a small branch to innervate the terminal part of the gland. The N2 arising from the first interganglionic connective (C1) lying between the suboesophageal and prothoracic ganglia joins the N3 from the prothoracic ganglion to form a common nerve that sends a branch to innervate the middle part of the gland. Likeweise, the N4 arising from the median nerve of the prothoracic ganglion joins the N5 from the second interganglionic connective (C2) lying between the pro-

1 We wish to acknowledge the financial support from the Atomic Energy Commission, Bombay, and the working facilities provided by Prof. M. S. Kanungo, Head of the Department.
2 W. S. Herman and L. I. Gilbert, Gen. Comp. Endocrin. *7*, 275 (1966).
3 B. Possompes, Arch. Zool. exp. gen. *89*, 203 (1953).
4 K. P. Srivastava and H. H. Singh, Experientia *24*, 838 (1968).
5 Ch. Hintze-Podufal, Experientia *26*, 1269 (1970).
6 N. J. Alexander, J. Insect. Physiol. *16*, 271 (1970).
7 T. H. Hsiao and C. Hsiao, 14th Int. Cong. Ent. Abstr. 176 (1972).
8 K. Sláma, J. Insect Physiol. *10*, 283 (1964).

and mesothoracic ganglia to form another common nerve that innervates the posterior part of the gland. However, the main trunks of all these nerves (except possibly of the N4) proceed past the prothoracic glands to innervate the body wall and musculature of the first 2 thoracic segments. Bilateral sectioning of the nerves had no effect on the development and metamorphosis of the insect except for a delay of a day or two in pupation which could be due to the shock of the operation. The results of the experiment are summarized in the table.

*Discussion.* Different authors have suggested different roles for the nerves innervating the prothoracic glands in insects. Possompes[3], for example, concluded that the nerves are involved in the regulation of the moulting process while Herman and Gilbert[2] believed that they stimulate degeneration of the glands during the pupal-adult moult. Srivastava and Singh[4] and later Hintze-Podufal[5], on the other hand, suggested that the nerves transport a neurosecretory type of granules to the gland cells. None of these suggestions, however, have experimental support. On the basis of the experimentally known facts, it can be assumed that the nerves innervating the prothoracic glands are either involved in feeding sensory/proprioceptive inputs to the central nervous system, or exert a nervous inhibition on the activity (synthesis or release of ecdysone) of the prothoracic glands. In regard to the first alternative, there is now an increasing evidence to suggest that proprioception plays an important role in the activation of the neurosecretory system (NSS) and/or release of the brain hormone[9–12].

Effect of sectioning the prothoracic gland nerves in the larva of Papilio demoleus

| Nerves sectioned | No. operated | No. survived | Pupation after | | |
|---|---|---|---|---|---|
| | | | 6–7 days | 12–14 days | none |
| N1 through N5 | 110 | 65 | 61 | 3 | 1 |
| Controls | 35 | 30 | 30 | 0 | 0 |

Edwards[9] has shown that this effect is more pronounced when the sensory input of a larger number of body segments is blocked by severing the ventral nerve cord anteriorly than when the input of only a few segments is blocked by severing the cord more posteriorly. Similar results were also obtained by Alexander[6]. From these findings it could follow that there exists an effective sensory/proprioceptive input produced by the peripheral nervous system of a larger number of body segments, to which alone the NSS responds. Since N1 through N5 in the present insect innervate only 2 of the body (thoracic) segments, their sectioning would not be adequate to dilute the effective sensory/proprioceptive input to the extent that it could inhibit the NSS. And therefore, despite the denervation of the prothoracic glands, the development of the insect would not be hampered, as observed in our studies. The evidence for the second alternative comes from the works of Alexander[6] and Hsiao and Hsiao[7]. While their evidence is largely indirect, the difficulty in confirming their findings lies in 2 facts: a) that the ecdysone is capable of activating its own prothoracic glands[13], and b) that tissues other than prothoracic glands may also produce ecdysone in some cases[14, 15]. These possibilities are likely to neutralize any effect that the nerve section may produce. The whole issue of the significance of the prothoracic gland innervation is, therefore, a complex one and needs a more thorough investigation.

One of the side effects of the above experiment was the failure of the C2 (figure) to condense in the adults that developed from the nerve sectioned larvae. Preliminary observations implicate N5 for this effect. Further work is in progress to confirm and explain this possibility.


9 J. S. Edwards, J. Insect. Physiol. *12*, 1423 (1966).
10 V. B. Wigglesworth, Q. J. microsc. Sci. *77*, 191 (1934).
11 K. U. Clark and P. A. Langley, J. Insect. Physiol. *9*, 411 (1963).
12 F. Sehnal and J. S. Edwards, Biol. Bull. *137*, 352 (1969).
13 C. M. Williams, Biol. Bull. *103*, 120 (1952).
14 T. H. Hsiao, C. Hsiao and J. de Wilde, Nature *255*, 727 (1975).
15 F. Romer, Naturwiss. *58*, 324 (1971).


## Influence of corpora allata and brain extract on the lipid release from the fat body of termite queen Odontotermes assmuthi


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*Summary.* Short term in vitro experiments on the influence of the extracts of corpora allata and brain from the termite queen *Odontotermes assmuthi* on the lipid release from the fat body into the haemolymph indicated that the extract of corpora allata does not influence the lipid mobilization, whereas the brain extract increases the free fatty acid level in the haemolymph. It is believed that the brain extract stimulates triglyceride hydrolysis in the fat body.


It is well recognized now that the corpora allata control aspects of lipid metabolism in the various tissues of insects[1–3]. Allatectomy increases the total lipid content[4] and also stimulates turn-over of phospholipids and triglyceride fractions[5]. In the allatectomized *Schistocerca gregaria*, Walker and Bailey[6] have demonstrated considerable increase in triglyceride content of the fat body, but no appreciable effect on the haemolymph lipid level. The role of cerebral neurosecretary material on carbohydrate, as well as on the lipid metabolism in the fat body of some insects, has also been suggested[7–8]. While working with *Hyalophora cecropia* moth Gilbert and his associates[1] have shown that corpora allata stimulate incorporation of (1-$C^{14}$) palmitate into ovarian glycerides. It is well understood now that the glycerides provide some of the energy for embryogenesis. In vitro studies on the female *Leucophaea maderae*[1] have suggested that the corpora allata act on both the fat body and ovary by making more lipid available for storage in the maturing


1 L. I. Gilbert, in *Advances in Insect Physiology*, vol. 4 (Eds J. W. L. Beament, J. E. Treherne and V. B. Wigglesworth; Academic Press, New York 1967).
2 M. Lafon, J. P. Cazal and C. R. Roussel, Acad. Sci. Paris, Ser. D 273, 2613 (1971).
3 G. J. Goldsworthy, J. Endocr. *50*, 237 (1971).
4 R. Millis, F. C. Greenslade and E. F. Couch, J. Insect. Physiol. *12*, 767 (1966).
5 H. E. Vroman, J. N. Kaplanis and W. E. Robbins, J. Insect. Physiol. *11*, 899 (1971).
6 P. R. Walker and E. Bailey, J. Insect. Physiol. *17*, 1125 (1971).
7 E. van Handel and A. O. Lea, Science, N. Y. *149*, 298 (1965).
8 G. J. Goldsworthy, R. A. Johnson and W. Mordue, J. Comp. Physiol. *79*, 85 (1972).