6th or 7th day. In contrast, the vapour affected ovarioles exhibited several structural abnormalities. The damage starts from the distal end of the ovariole where the first egg is almost reabsorbed (Figure B). As the severity of the damage increases, either 1 or 2 oocytes with yolk are observed and the rest are very small, if at all present, but their arrangement continues to be linear (Figure C, D and E). Such a linear arrangement is lost in ovarioles with the 0.1 ml dose (Figure F and G). An extreme case was observed where a mature egg hangs on the side of the germarium (Figure G). At the higher dose of 0.15 ml, previtellarium and vitellarium are reduced to a small tube with one chorionized egg (Figure H and I) or tubes with remanents of ova. At this stage, the fat reserves of the body are almost exhausted. The fat reserves decrease day by day in treated insects, though their stomachs are always full of food.

Ovarioles of *Dysdercus koenigii* F. A. Normal B to J affected by *Acorus calamus* oil vapours. A, normal with 8 identical ova in vitellarium and 5–6 oocytes in previtellarium; B, 0.05 ml dose, 2 basal ova reduced, on 7th day of exposure; C, 0.05 ml dose, only 2 ova with yolk after 15 days; D, 0.05 ml dose after 17 days; E, 0.1 ml after 10 days; F and G, 0.1 ml after 7 days, eggs with yellow eggshell could be seen. H, I and J, 0.15 ml dose, egg with yellow eggshell in common oviduct and in vitellarium; H, single or many ova with or without yolk (F, J). Double line shows the eggs with yellow egg shell.

Discussion. The effect of *A. calamus* oil vapours on *D. koenigii* and *T. domestica* are almost similar. In addition, some more observations have been made in the case of bugs, such as loss of linear arrangement, occurring in chorionized eggs in the vitellarium and on the side of the germarium, and stucking of eggs in the common oviduct. In both cases, the degeneration process begins from the distal end. Similarly prefollicular cells in this case appear to be affected. These cells receive a wrong code and perform wrong functions at wrong place and time[3]. Besides, the preceding case can be compared with *D. cingulatus* ovaries affected by tepa[5]. However, to mention calamus oil as a chemosterilant is a subject for debate. Usually antimetabolic chemosterilants affect females only, particularly when administered to adults. But when they are administered in the larval stage (that is at the initiation of vigorous synthesis of nucleic acids in many different tissues), basic effects with general characteristics are usually produced rather than the specific ones[6]. In one of our experiments, treated 5th instar nymphs moulted into normal adults, but their ovaries failed to develop[7]. In other words, the effect is specific rather than general.

The consumption of fat reserves could be due to inhibition of digestion, thus indirectly affecting oogenesis, as in the case of the antimetabolite 5-fluorouracil[8]. The validity of this assumption has to be investigated in the case of *Acorus* oil. It is known that oogenesis is not an autonomous process; it is possible that the sterility is achieved due to interference with regulatory functions rather than the function of the ovarian tissue. We found the corpora allata is greatly reduced (almost $^1/_3$ in comparison to normal individuals) in *Pyrrhocoris apterus* nymphs treated with *A. calamus* oil vapours[9]. However, the possibility cannot be ruled out that this vital organ, acting as messenger for triggering vitellogenesis in insect ovaries, is the cause of sterility.

The *A. calamus* oil vapours also effectively derail the normal functioning of ovaries of *Callosobruchus chinensis* L.; *Trogoderma granarium* Evarts; *Tribolium castaneum* Herbst and *Sitophilus oryzae* L. which are important pests of food products, and *Anthrenus vorax* Waterhouse pest of woolen cloth. The oil of *A. calamus* is accordingly a versatile, non-toxic pest-controlling agent[10] for stored grain.

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Structure of the Foregut Cuticle of *Periplaneta americana*

R. C. MURTHY[1]

Zoology Department, University of Lucknow, Lucknow (U.P., India), 12 August 1975.

Summary. The cuticular lining of the foregut of *Periplaneta americana* did not contain either pore canals or the openings of dermal glands, and the length of the cuticular spines decreased posteriorwards.

Cuticle of arthropods, specially that of insects, has been studied by many workers and the studies have been reviewed by WIGGLESWORTH[2] and RICHARDS[3]. However, the structure of the foregut cuticle of insects is not well known. The present study gives an account of the structure of the cuticle of the foregut of *Periplaneta americana*.

Adult cockroaches were starved for 3–4 days to empty their gut. The foregut was dissected out, slit opened longitudinally, washed thoroughly with water to remove adherring particles and then left in water for 1 h. It was then possible to separate the cuticle lining of the foregut from the epithelium and muscles. Foregut was fixed in

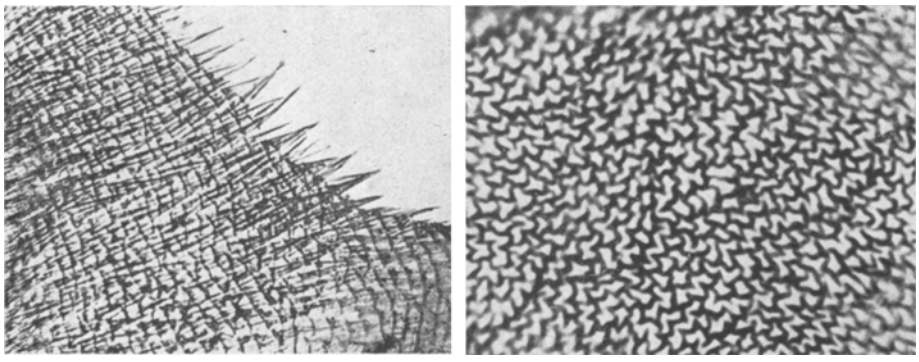

Fig. 1. A) Surface view of the cuticle of pharynx. B) Surface view of the cuticle of crop.

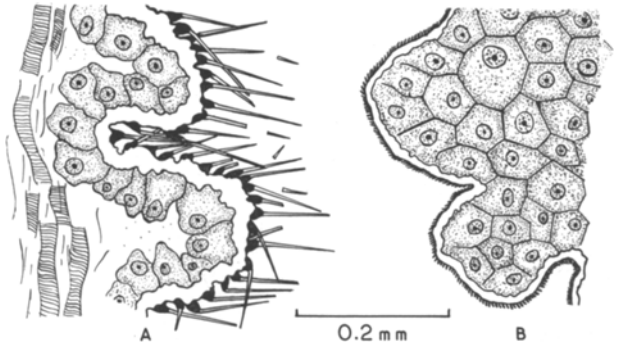

Fig. 2. A) Longitudinal section of pharyngeal region. B) Longitudinal section of crop region.

alcoholic Bouin's fluid for 24 h. Transverse and longitudinal sections were cut at 4 μm and stained with either Mallory's triple stain or iron haematoxylin or Sudan black B.

The surface of the cuticular lining of pharynx and crop shows a pattern, somewhat resembling the arrangement of scales in Cyprinoid fishes. In the region of pharynx, elongated pointed spines arise from the margins of the scale-like areas (Figure 1 A). The length of the spines decreases posteriorwards. Ultimately in the crop region, only very small peg-like projections are seen arizing from the entire surface of the scale-like areas (Figure 1 B).

The cuticle was not stained with ammoniacal silver hydroxide and did not show the openings of the dermal glands. Therefore the pattern of the foregut cuticle is different from that of the cuticle of the body wall. In sections, endocuticle was visible throughout the foregut lining, giving positive chitin test and staining blue with Mallory's stain. Pore canals were not visible in any portion of the foregut cuticle. The spines of the pharyngeal region were not similar to the blunt hard spines of *Sarcophaga falculata*[4] and *Calliphora*[5], since they did not take Sudan black B stain but gave a positive reaction to chitin test[6]. When stained with Mallory's stain, the spines did not take any colour, only their bases stained red showing that their basal part was of untanned exocuticle and upper portion was of tanned exocuticle (Figure 2 A). In the posterior region, the hard exocuticle layer reduced and the entire spine stained red; in the crop region also, the projections did not show the presence of hard exocuticle (Figure 2 B). In the gizzard region, the teeth consisted mainly of tanned exocuticle, and untanned exocuticle and endocuticle layers were thin.

The epicuticle of the foregut cuticle was very thin and was not visible in sections; however, its presence could be shown by chemical treatment of the cuticle. When the cuticle was kept in cold concentrated HCl, a very thin layer remained undigested, the concentrated HCl digests all the layers of the cuticle, except the epicuticle. This shows the presence of epicuticle in the foregut cuticle. Even when this treatment was extended for 3 months, this layer was not digested. Probably the spines of the pharyngeal region are also covered with epicuticle, since they resisted the acid treatment for several days. The thickness of the different layers of the cuticle of the foregut was different from those of the body wall cuticle. It is difficult to attribute filtering or any other mechanical function to the spines of the pharyngeal region, since the size of the food particles in the crop was larger than the gap between the spines.

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