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EXTERNAL MORPHOLOGY OF SENSORY STRUCTURES ON THE TARSI OF THE RICE BROWN PLANTHOPPER

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ABSTRACT

The gross external morphology of sensory structures on the tarsal segments of the rice brown planthopper, Nilaparvata lugens (Stal), is examined and related to the insect's behaviour. Both chemoreceptor and mechanoreceptor sensilla appear to be present, and may play a role in the feeding site and ovipositing site location behaviour of this insect.

KEY WORDS

Nilaparvata lugens, tarsal receptors,

INTRODUCTION

The feeding behaviour of the brown planthopper has normally been seen as consisting of four distinct phases, (Sogawa, 1982): (i) Orientation to the rice plant, (ii) leaf surface exploration, (iii) stylet probing, (iv) ingestion.

Various sensory fields on the insect are involved in detecting chemical and mechanical cues which trigger the above behavioural responses. Comparing host location in the dark between brown planthoppers where the antennae had been removed with ones which were left intact, Sogawa (1982) has shown these to be essential to the planthopper in locating rice plants. Scanning electon microscopical (SEM) and electrophysiological investigations of the 'Plaque Organs' on the antennal pedicel of the Brown Planthoppper, by Aljunid and Anderson (1983), suggest that these may be the sites of olfactory chemoreception involved in host location. The presence of contact chemoreceptors and mechanoreceptors on the labium of the Brown Planthopper, involved in phase (ii) of its feeding behaviour, has been inferred by Foster et al. (1983a), based on SEM and ultrastructural evidence. The same authors have also shown the presence of receptors in the stylet and cibarium (1983b) which could be involved in phase (iii), leading on to response (iv).

SEM investigation of tarsi in dipteran species has shown the presence of, mechanoreceptors (McIver and Siemicki, 1978), chemoreceptors (Slifer, 1970) or sensillae with a dual chemo- and mechanoreceptive function (McIver, 1980). The presence of sensory structures on the tarsi of the brown planthopper is investigated here, using scanning electron microscopy.

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METHODS AND MATERIALS

Selected carbon-dioxide anaethetised animals were killed by placing them in the first step of an alcohol dehydration-series (10, 30, 50, 70, 90 and 100% ethanol). Insects were kept in each alcohol concentration for a period of 15 minutes, but were stored in 70% alcohol until required. Specimens held in alcohol were placed in an ultra-sound bath to remove debris. As prolonged exposure to the ultra-sound damaged fine structures, this had to be restricted to two periods of 30 seconds, separated by a change of alcohol. Adult and fifth instar nymphs were then allowed to air dry, before being mounted on a copper stub with silver conducting paint. For the earlier instars, air-drying tended to distort the cuticle and so critical point drying had to be used.

Specimens were sputter-coated with gold-palladium for 4 minutes with a p.d. of 1.1kV and a current of around 40mA. Coated specimens were then viewed under either a Jeol 35 SM microscope at an electron accelerating voltage of 25kV or a Philips scanning microscope at 5-15kV.

RESULTS

Figure 1 shows the gross structure of an adult brown planthopper fore limb tarsus. The rough cuticular sculpturing of the three main tarsal segments, is broken by longitudinal rows of single hair-like projections (a) arising from slightly raised sockets. The two most distal

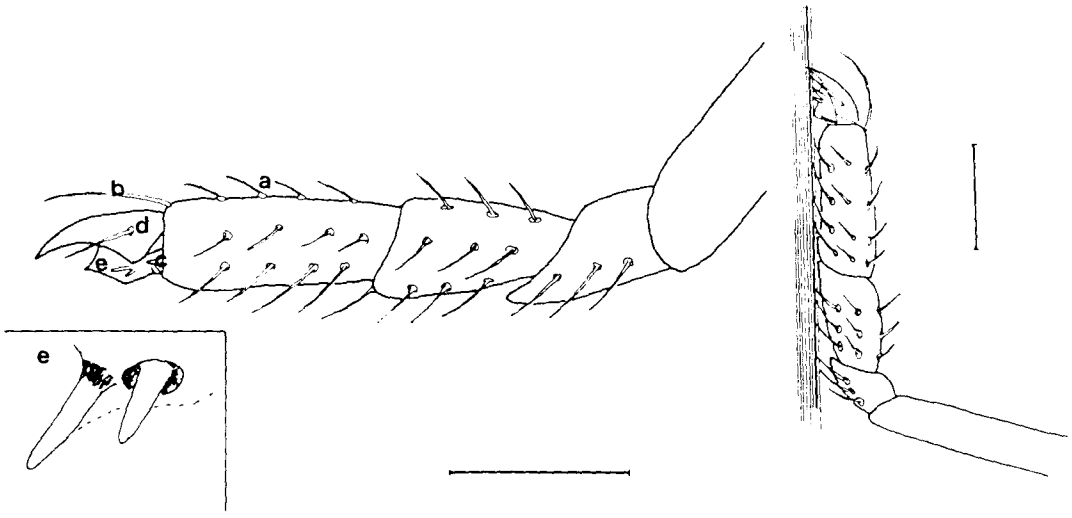

Figure 1. (A) Diagram of the tarsal segments to show the position of various types of sensory hair. a, socketed hairs of the tarsal segment, b and c, hairs at the edge of the distal tarsal segment, d single hairs arising from the claw ventral surface, e finger-like projections on the lower surface of the arolium. Scale bar = 100μm (insert, = 1μm).
(B) Position of the tarus and tarsal hairs on the feeding substrate.

segments, bear five such rows which are separated radially by approximately equal distances. The number of hairs in each row is equal within a segment, but differs between segments, thus tarsal segments 2 and 3 have three and four hairs per row respectively. At the distal margin of the segment 3, there are two further types of hair structure. Situated on the dorsal mid-line of the segment, there is a long, single hair, (b) located in a socket, while present laterally, on both sides of the segment, are two unsocketed, shorter projections (c).

The appendages of the most distal tarsal segment, the claw and the arolium, also have various surface structures. There is a single unsocketed hair on both sides of the claw (d) which forms a sharp angle with the ventral surface of the structure. On the ventral surface of the arolium, there are two symmetrical pairs of short, finger-like projections (e, insert of Fig. 1), which form a shallow angle with the rest of the aroliar surface. Figure 1b shows diagramatically the position of these various structures, for the living insect, in relation to its feeding substrate. At least two rows of hairs on the tarsal segments would be in constant contact with the leaf surface, as would all the hairs on the ventral surfaces of the claw and arolium.

DISCUSSION

McIver (1978) reviews external morphological and ultrastructural characteristics which may be used to identify cuticular structures which have a mechanosensory function. The long, pointed tip, and the articulating socket from which the hairs on the main tarsal segments arise, are typical features of the trichoid sensillum and point to a mechanoreceptor function. The shape of the single hair at the dorsal edge of the third tarsal segment again suggests a tactile function. The shape of the finger-like sensilla of the arolium, would correspond to the descriptions of chemosensors given in the review by Slifer (1970). It has however, so far been impossible to locate any pores in the structure which would allow a chemoreceptive function to be attributed to these sensilla with considerably greater certainty. Similarly, for the hairs of the claw and the lateral edge of the distal tarsal segment, while the general shape would suggest a chemosensory function, no pores could be resolved with the SEM used.

For all the above receptor types we hope to be able to identify their function more closely by ultrastructural investigation. The very obvious tapping or scrapping of the substrate by the brown planthopper and noted for various leafhopper species by Waloff (1980) provides behavioural evidence for the significance of these receptors. In the light of descriptions of tarsal chemoreceptors (McIver *et al.*, 1980) and mechanoreceptors, (McIver and Siemicki, 1978) for dipteran species, and chemoreceptors which have been implicated with a role in ovipositioning site-determination in the lepidopteran *Pieris brassicae* by Ma and Schoonhoven (1973), it seems probable that planthopper tarsi too may be involved in site location for feeding and egg-laying.

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