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Sensilla on the larval antennae and mouthparts of cotton leaf-roller, Haritalodes derogatus Fabricius (Lepidoptera:Pyralidae)【Research report】

棉捲葉野螟幼蟲觸角及口器之感覺毛【研究報告】

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Abstract

Sensilla on the larval antennae and mouthparts of Haritalodes derogatus (Lepidotpera:Pyralidae) wer examined with scanning electron microscope and transmission electron microscope. The characterization and distribution of sensilla on antennae and mouthparts were described in this paper.

摘要

利用掃瞄電子顯微鏡及穿透式電子顯微鏡檢視棉捲葉野螟幼蟲觸角及口器感覺毛之結構。觸角及口器上的感覺毛之特性和分佈在本文中有詳細的描述。

Key words: Sensilla, labium, maxilla, SEM, TEM.

關鍵詞: 感覺毛、上唇、小顎、掃瞄電子顯微鏡、穿透式電子顯微鏡。

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Sensilla on the Larval Antennae and Mouthparts of Cotton Leaf-roller, *Haritalodes derogatus* Fabricius (Lepidoptera: Pyralidae)

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ABSTRACT

Sensilla on the larval antennae and mouthparts of *Haritalodes derogatus* (Lepidoptera: Pyralidae) were examined with scanning electron microscope and transmission electron microscope. The characterization and distribution of sensilla on antennae and mouthparts were described in this paper.
Key words: Sensilla, labium, maxilla, SEM, TEM

Introduction

The cotton leaf-roller, *Haritalodes derogatus* Fabricius, 1775 is a serious pest of cotton. The host plants of this insect include most of member family of Malvaceae, such as *Hibiscus taiwanensis*, *Hibiscus rosa-sinensis* L., *Hibiscus indicus*, *Sida rhomhifolia* L., *Urena lobata* L., and Euphorbiaceae such as *Jatropha curvas* L. in Taiwan. The adults oviposit usually inside the old, rolled leaf which formed by the last instar larvae. The feeding behavior of the mature larvae is very interesting, they cut and trench the leaf about 1/3 of the leaf and roll the leaf as a trumpet-like form (Lin, 1994). Until now, most observations concerning the cotton leaf-rollers have been conducted under field conditions (Wang, 1980). The mechanism of the larval feeding behavior still remains unknown, due to the lack of morphological description.

Numerous reports on the types of sensilla found on the cephalic appendages of various lepidopterous larvae have been published, especially focused on the olfactory sensilla on the antennae, the maxillary palps and galeae (Morita and Yamashita, 1961; Schoonhoven and Dethier, 1966; Stadler and Hansan, 1975; Devitt and Smith, 1982), the gustatory sensilla on the galeae and palps of the maxillae and on epipharynx (Dethier, 1937; Ishikawa,

1963; Schoonhoven and Dethier, 1966; Ma, 1972; Stadler and Hanson, 1975; De Boer *et al.*, 1977). In addition. The mechanosensory sensilla were found on the antennae as well as on all mouthparts (Faucheux, 1995).

So far, no available information about the sensory organs of the larva of *H. derogatus* was reported. Thus, the present study was undertaken to observe and localize the sensilla on the antennae and mouthparts of the cotton leaf-roller with an attempt to understand the sensory basis of feeding behavior of this insects.

Materials and Methods

The larvae of cotton leaf-roller, *H. derogatus* (Lepidoptera: Pyralidae, Pyraustinae) were collected in the field and reared in the laboratory with their host plants (*Hibicus rosa-sinensis* L.). The last instar larvae were for SEM observation and adults were for identifications. The larvae were killed in hot water (70-80 ℃) and immediately fixed and stored in Kahle's solution (120 ml 95% ethanol, 48 ml formaldehyde, 16 ml acetic acid, 240 ml water). The mandibles were removed and superficially cleaned by gentle stroking with a soft brush. The tissues were then sonicated briefly in 50% ethanol solution.

The mouthparts of the insects were dehydrated in a series of ethanolic gradient. Drying was accomplished with a CO_2 critical point dryer (Hitachi CPD HCP-2). Dried tissues were then dissected and coated with gold. The coated mouthparts were then examined and photographed in a scanning electron microscope (Hitachi S-570) at accelerating voltages of 20 kV.

After shaking in 50% ethanolic solution, the dissected antennae and mandible of the larvae were fixed in 2.5% glutaraldehyde in 0.1M cacodylate buffer, pH 7.2 for 6 hrs at 6 ℃ , and post-fixed in 1% osmium tetroxide in 0.05 M cacodylate buffer at 6 ℃ for 2 hrs. After dehydration in a series of ethanol gradient from 70% to absolute alcohol. The specimens were embedded in spur's epon resin. The ultra thin sections (ca. 800 Å) were made with a diamond knife and picked up on copper grids with 0.3% formvar supporting membrane, then stained with uranyl acetate and lead citrate. These stained sections were observed with a Hitachi H-7000 transmission electron microscope at an accelerating voltage of 75 kV.

Results

Antennae

The antennae of the last instar larvae of *H. derogatus* are short and consisted of 3 segments (Fig. 1): basal segment (I), medial segment (II) and distal segment (III). Except the basal segment, the other segments bear sensilla (Figs. 1 and 2). The medial segment bears distally 3 sensilla chaetica, C1, C2, and C4 according to the length of sensilla and laterally 1 sensillum C3 (Figs. 1 and 2). These sensilla chaetica (C1, C2, C3, and C4) are aporous with a socket at base and vary in different length. The wall of the hairs is thick, about 1.08 μm (Fig. 3). The distal segment possesses 2 aporous sensilla styloconica (Fig. 2, S1 and S2), both located ventrally and 1 sensillum basiconicum (B) located dorsally (Fig. 2).

Labrum

Twelve of aporous socketed sensilla chaetica (K1-K12) distribute over the dorsal surface of the labrum (Fig. 4, L).

Maxillary galeae

Fig. 1. Ventral view of larval antenna showing 3 segments(I-III) of the antenna of *Haritalodes derogatus* and the elongated sensillum chaeticum (C1). Bar: 200 μm.

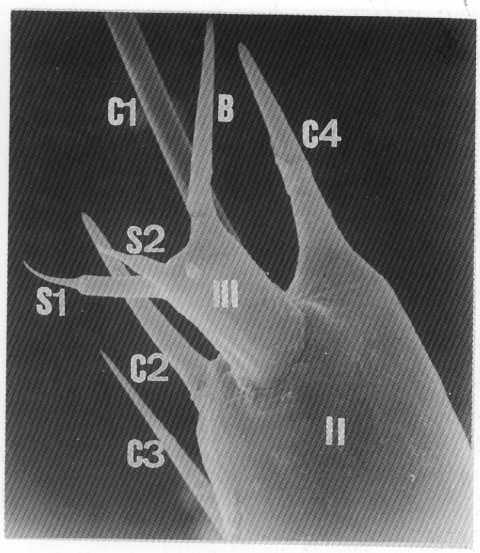

Fig. 2. Ventral view of segments II & III showing sensillum chaeticua (C1, C2, C3, and C4); sensilla styloconica (S1, and S2); and sensillum basiconicum (B); Bar: 43 μm.

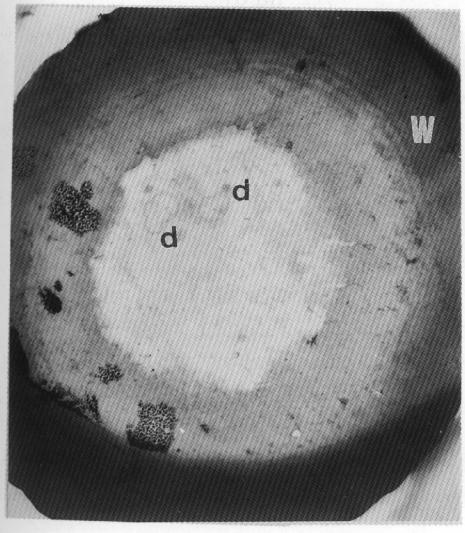

Fig. 3. Cross section of C1 sensillum chaeticum, w = cuticular wall, d = dendrite. Bar: 1 μm.

Fig. 4. Ventroanterior view of *H. derogatus* head; L:labrum, K1-K12:sensilla chaetica. M:mandible, C1-C2:sensilla chaetica. ML:mesal lobe of maxilla, MP: maxillary palpus segment, 1,2,3. Bar: 30 μm.

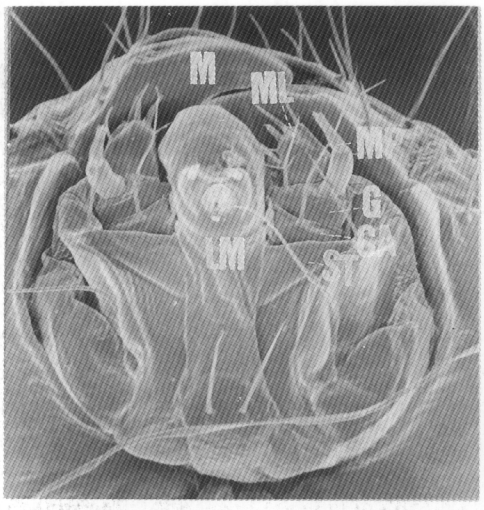

Fig. 5. Part of the ventroanterial aspect of *H. derogatus*. M:Mandible; LM: Labrum; ST: stipe; MP: maxillary palpus; ML: mesal lobes of maxilla; G: galea; CA: Cardo. Bar:.43mm.

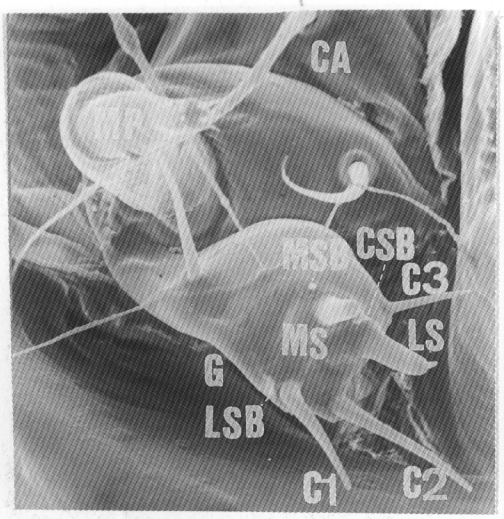

Fig. 6. Ventral view of right maxilla. ML: mesal lobe of maxilla; MP: maxillary palp; LS: lateral sensillum styloconium; MS: medial sensillum styloconium; C: sensillum chaeticum; LSB:lateral sensillum basiconicum; MSB:medial sensillum basiconicum; CSB:central sensillum basiconicum. Bar: 100 μm.

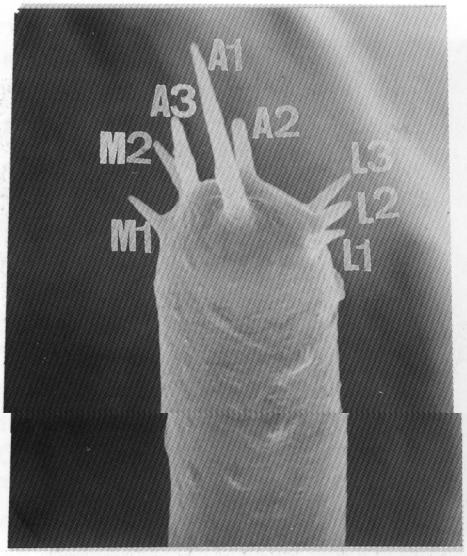

Fig.7. Dorsoposterior view of the 3th segment of a maxillary palpus; A1-3: apical sensilla basiconica, M1-2: medial sensilla basiconica, L1-3: lateral sensilla basiconica. Bar: 20 μm.

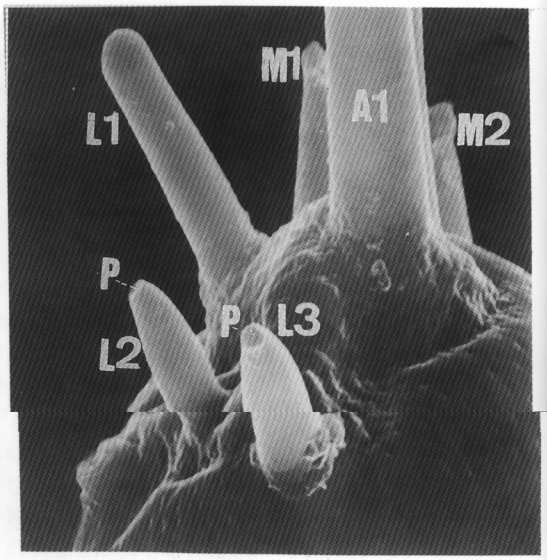

Fig. 8. Dorsoposterior view of the 3rd segment of a maxillary palpus showing pore (P) at the distal end. Bar: 5 μm.

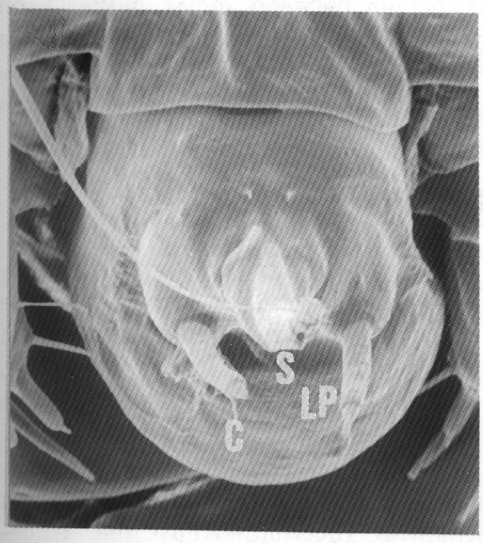

Fig. 9. Dorsal view of spinneret (S), and labial palpus (LP) of labium (LM). Bar: 120 μm.

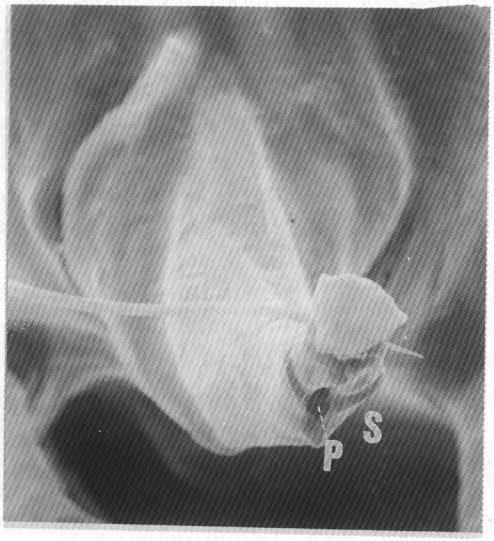

Fig.10. High magnification of apical part of spinneret (S) showing the triangular shape of the spinneret opening. Bar: 38 μm.

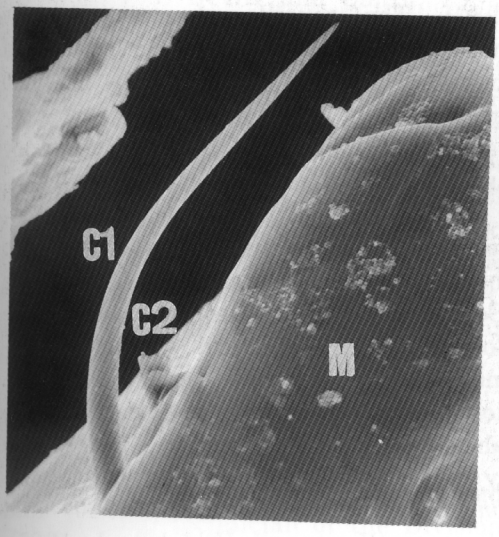

Fig. 11. Inner surface of left mandible (M) showing the mandibular sensilla chaetica (C1 & C2)(C2 broken).Bar: 50μm.

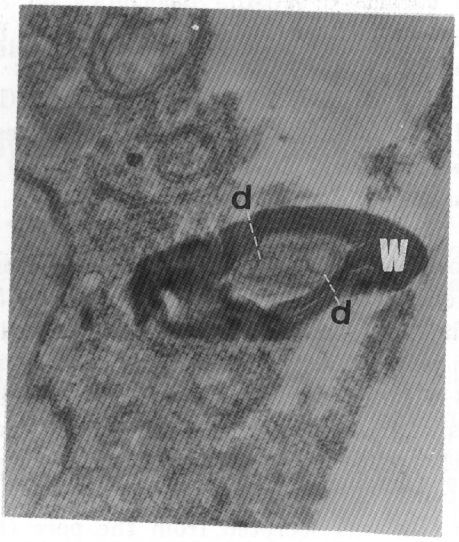

Fig. 12. Cross section of left mandibular sensilla chaetica (C1) showing a pair of dendrites inside the sensillum, w: cuticular wall; d: dendrite. Bar: 1 μm.

Each maxilla comprises 2 appendages, the maxillary palp (MP) and galea (G) are which arise from the basal segment- cardo (CA). The base of the cardo connectes to the stipes (ST) (Figs. 5 and 6). The galea possesses 8 sensilla on its distal surface: 2 sensilla styloconica (the lateral sensillum styloconicum (LS) and the medial sensillum styloconicum (MS)), 3 sensilla basiconica(the lateral sensillum basiconicum (LSB), the central senisllum basiconicum (CSB), and the medial sensillum basiconicum(MSB)), and 3 sensilla chaetica C (Fig. 6). The lateral and medial sensilla styloconica (LS & MS) consist of a small uniporous unsocketed peg on top of bulbous base. The aporous sensilla basiconica are short, and locates laterally, mesally, and centrally. The sensilla chaetica (C) are long, sharply pointed, and locates dorsally.

Maxillary palps (MP)

The maxillary palps are 2-segmented. The apical segment is long and carries 8 sensilla basiconica on its distal end (Figs. 7 and 8). They can be divided into 3 morphological groups: 3 apical sensilla (A), 3 lateral sensilla (L) and 2 medial sensilla (M). All these sensilla possess an apical pore (Fig. 7)

Labium

The labial region (LM) consists of 2 palps and a long spinneret (S) from which silk is secreted by larvae (Fig. 5) . The palp bears 2 sensilla. The sensillum styloconicum has a bulbous base and a blunt apical portion (Fig. 9). The sensillum is located on the dorsal face of the palp. At the base of the labium contains 2 aporous sensilla chaetica. The silk was secreted from the pore (P) of spinneret (S) and was controlled by the distal, triangular lobe (Fig. 10).

Mandibles

Each mandible (M) contains 2 aporous sensilla chaetica (Figs. 4 & 11, C1, C2). These sensilla are present at the tips or between molar cusps. Each sensillum consists of a pair of dendrites (d) extending through a canal in sensillum (Fig. 12) and ending close beneath the surface.

Discussion

The types, numbers, and distribution of sensilla on the larval antennae of *H. derogatus* are similar to those of other lepidopterous larvae (Dethier, 1941; Baker, 1990). The aporous sensilla chaetica on the larval antennae of *Manduca sexta* are innervated by one mechanosensory cell and implied an mechanical fucction (Kent and Hildebrand, 1987). Electrophysiological evidences and behavioral observations had showed that the antennal sensilla basiconica of antenanae of lepidopterous larvae are olfactory receptors (Schoonhoven and Dethier, 1966; Hanson and Dethier, 1973; Dethier, 1980). The sensilla chaetica on the antennae of *H. derogatus* are believed to be mechanical sencilla, whether the large sensilla basiconica on the antennae of *H. derogatus* have a olfactory function or not needs further studies.

The sensilla on the larval mouthparts of *H. derogatus* are also similar to those of other lepidopterous larvae (Schoonhoven and Dethier, 1966; De Boer *et al.*, 1977), with several differences in the external appearance, location, and number of these sensilla. The labral sensilla chaetica are innervated by a single bipolar neuron in *Choristoneura fumiferana* (Albert, 1980) and *M. sexta* (Kent and Hildebrand, 1987). They are tactile but they have no electrophysiological evidence. In *H. derogatus*, the labral sensilla chaetica are tactile but further morphological and electrophysiological studies are needed.

Maxillary sensilla styloconia has an important function in food recognition (Ishikawa *et al.*, 1969). Each sensillum is innervated by 4 contact chemoreceptors (Ishikawa, 1963; Schoonhoven and Dethier, 1966; Dethier, 1973). According to Stadler and Hanson (1975), contact chemoreceptors within the lateral sensillum styloconicum of *M. sexta* have an olfactory capacity too. The aporous, lateral sensillum basiconicum (LSB) (Fig. 6) on the maxillary galea of *H. derogatus* corresponds to the medial sensillum basiconicum (MSB) (Grimes and Neunzig, 1986b). These aporous sensilla possess a single bipolar neuron (Albert, 1980; Devitt and Smith, 1982) and are probably mechanosensilla. The aporous, central sensillum basiconicum (CSB) (Fig.6) of *H. derogatus* resembles the central basiconic sensillum of Ditrysian species (Grimes and Neunzig, 1986b). These sensilla are innervated by one to 3 neurons, suggested as mechanoreceptor (Albert, 1980; Devitt and Smith, 1982; Schoonhoven and Dethier, 1966).

Mandibular sensilla chaetica are mechanoreceptors (Albert, 1980; Kent and Hildebrand, 1987). These sensilla are present at the tips of incisor cusps or between molar cusps. These receptors help to monitor the hardness of food and modulate the power output of the adductor muscles (Zacharuk and Albert, 1978). In *H. derogatus*, the mandibular sensilla chaetica are mechanoreceptors.

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References

Albert, P. J. 1980. Morphology and innervation of mouthpart sensilla in larvae of the spruce budworm, *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae). Can. J. Zool. 58:842-51.

Baker, G. T. 1990. Morphology of eyes and sensory receptors of larval and adult stages of *Thyridopteryx sphemeraeformis* Haworth (Lepidoptera: Hyponomeutoidea). Ann. Soc. Entomology. Fr.(N.S.)25:163-70.

De Boer, G., V. G. Dethier, and L. M. Schoonhover. 1977. Chemoreceptors in the peroral cavity of the tobacco hornworm, *Manduca sexta* and their possible function in feeding behavior. Entomol. Exp. Appl. 21:287-298.

Dethier, V. G. 1937. Gustation and olfaction in lepidopterous larvae. Biol. Bull. 72:7-23.

Devitt, B. D., and J. J. B. Smith. 1982. Morphology and fine structure of mouthpart sensilla in the dark-sided cutworm *Euxoa messoria* (Harris) (Lepidoptera: Noctuidae). Int. J. Insect Morphol. Embryol. 11: 255-70.

Dethier, V. G. 1941. The function of the antennal receptors in lepidopterous larvae. Biol. Bull. 80:403-14.

Faucheux, M. M. 1991. Morphology and distribution of sensilla on the cephalic appendages, tarsi, and ovipositor of the European sunflower moth, *Homoeosoma nebulella* Den. and Schiff. (Lepidoptera: Pyralidae). Int. J. Insect Morphol. Embryol. 20:

291-307.

Grimes, L. R., and H. H. Neunzig. 1968a. Morphological survey of the maxillae in last stage larvae of the suborder Ditrysia (Lepidoptera) Palpi. Ann. Entomol. Soc. Amer. 79: 491-509.

Grimes, L. R., and H. H. Neunzig. 1968b. Morphological survey of the maxillae in last stage larvae of the suborder Ditrysia (Lepidoptera) Mesal lobes (Laciniogaleae). Ann. Entomol. Soc. Amer. 79:510-26.

Ishikawa, S. 1963. Response of maxillary chemoreceptors in the larva of the silkworm, *Bombyx mori*, to stimulation of carbohydrates. J. Cell. Comp. Physiol. 61:99-107.

Kent, K. S., and J. G. Hildebrand. 1987. Cephalic sensory pathways in the central nervous system of larval *Manduca sexta* (Lepidoptera: Sphingiddae). Philos. Trans. R. Soc. Lond. B. 315:1-36.

Lin, C. S. 1994. Host plants and feeding behavior of pyraustine larvae in Taiwan. Ann. Taiwan Museum 37:107-136.

Ma, W. C. 1972. Dynamics of feeding responses in *Piereis brassicae* Linn. as a function of chemosensory input: a behavioral, ultrastructural and electrophysiological study. Meded. Landbouwhogesch. Wageningen. 72:1-162.

Morita, H., and S. Yamashita. 1961. Receptor potentials recorded from sensilla basiconica on the antennae of the silkworm larvae, *Bombyx mori*. J. Exp. Biol. 38:851-61.

Schoonhoven, L. M., and V. G. Dethier. 1966. Sensory aspects of host plant discrimination by lepidopterous larvae. Arch. Neerl. Zool. 16:497-530.

Stadler, E., and F. E. Hanson. 1975. Olfactory capabilities of the "gustatory" chemoreceptors of the tobacco hornworm larvae. J. Comp. Physiol. 104:97-102.

Wang, P. Y. 1980. Economic insect fauna of China, Lepidoptera: Pyralidae, Fasc.21, Science Press, Beijing, China.

Zacharuk, R. Y., and P. J. Albert. 1987. Ultrastructure and function of scolopophorous sensilla in the mandible of an elaterid larva (Coleoptera). Can. J. Zool. 56:246-259.

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棉捲葉野螟幼蟲觸角及口器之感覺毛

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摘　要

利用掃瞄電子顯微鏡及穿透式電子顯微鏡檢視棉捲葉野螟幼蟲觸角及口器感覺毛之結構。觸角及口器上的感覺毛之特性和分佈在本文中有詳細的描述。

關鍵詞： 感覺毛、上唇、小顎、掃瞄電子顯微鏡、穿透式電子顯微鏡