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SEM Observations of Rice Weevil Larvae, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae)[1]

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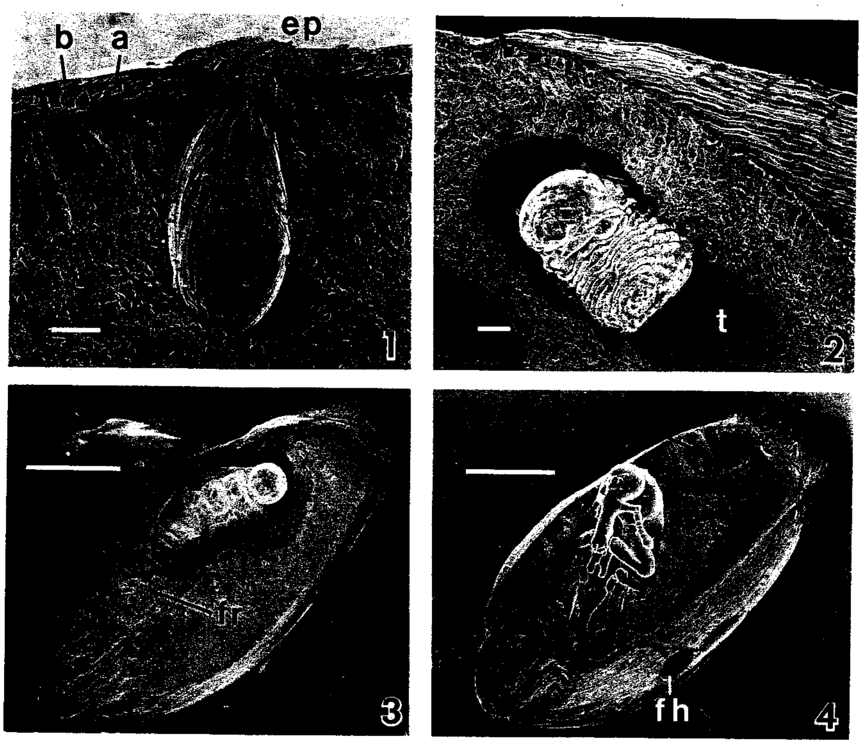
Abstract: The antennae and mouthparts of the rice weevil larva possess a number of very interesting sensilla. At least some of these appear similar in external structure to those of wireworms. The antenna has one large sensillum (probably olfactory) and 10 smaller sensilla of 4 distinct types. The maxillary mala has 6 long curved hairs surrounding 2 smaller pegs. The palpus has one large sensillum and 11 smaller pegs on the apex and a digitiform sensillum on the lateral surface. The labium has 4 long hairs between the palpi (probably mechanoreceptors) and on each palpus one large sensillum surrounded by 6 smaller pegs. These sensors are undoubtedly important to the survival of the larva inside the grain kernel and therefore further research is needed.

The rice weevil *Sitophilus oryzae* (L.) is one of the most important cosmopolitan pests of stored grain. Most of its life cycle takes place inside the grain kernel with an abundance of food and protection



Figs. 1–4. Immature stages of *Sitophilus oryzae* in wheat kernels. 1. Egg (eg), scale = 100 μm. a—aleurone layer, b—outer bran coats, en—endosperm, ep—egg plug. 2. Larva (2nd instar), scale = 100 μm. t—tunnel. 3. Prepupa, scale = 1 mm. fr—frass. 4. Pupa, scale = 1 mm. ch—egg and early larval chamber, fh—adult feeding hole.

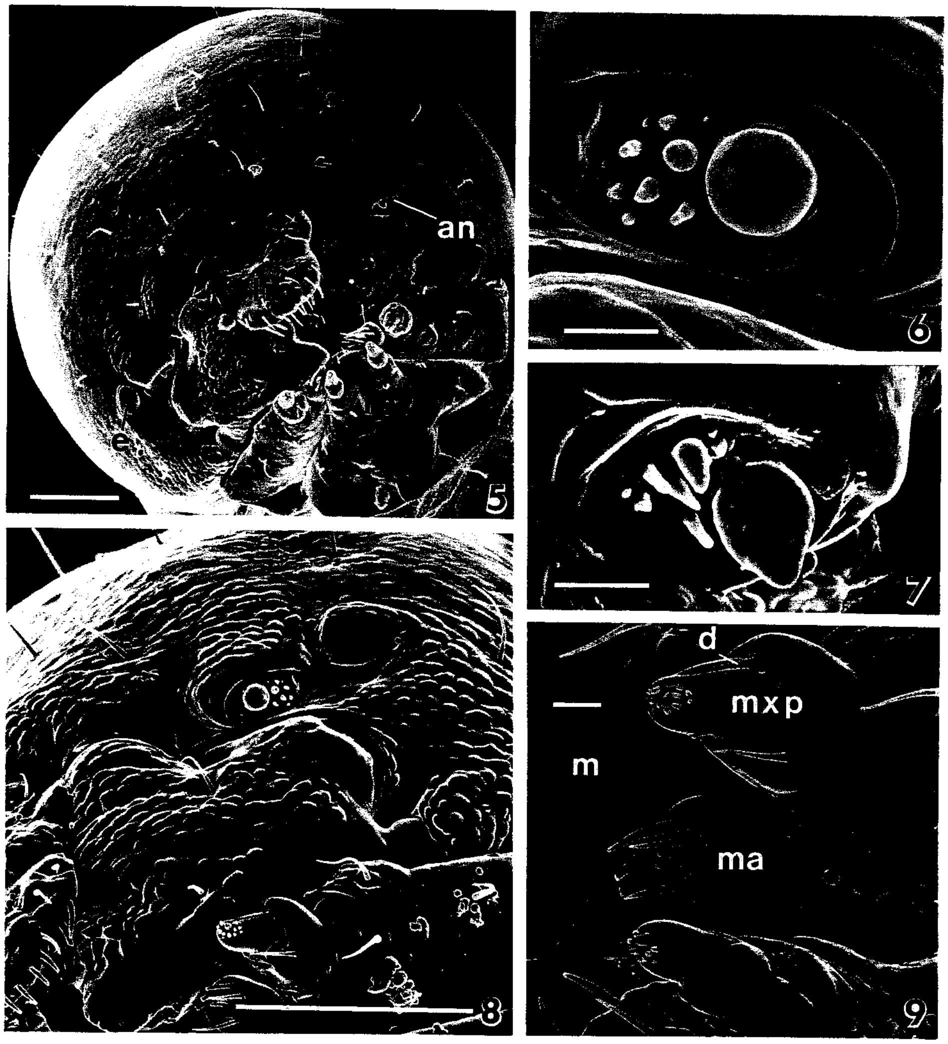
from most enemies. The immediate environment and need for sensing it are thus restricted. More complete knowledge of the requirements of the insect and the means by which it functions to survive and multiply may be useful in improving control measures.

The life cycle, development, and behavior of *S. oryzae* have been reported on by many authors (e.g., Hinds and Turner, 1911; Cotton, 1920; Soderstrom, 1960). Structures of the species observed by light microscopy have been well illustrated by Kurtz and Harris (1962). The larval mandibles have been photographed using light microscopy and scanning electron microscopy (SEM) by Kvenberg (1981).

We present here our SEM observations of the sensilla located on the antennae and mouth parts of the rice weevil larva.

MATERIALS AND METHODS: For the SEM observations we selected infested kernels of hard winter wheat taken from laboratory cultures and dissected the kernels to expose the insect in various stages of development. The egg, young larva (2nd instar), prepupa, and pupa were used in situ in the kernel. Last instar larvae were used for closer observation of the sensilla. Larvae removed from the kernels were cleaned by washing them in an ethanol water series by gently rinsing or agitating in an ultrasonic bath. Morphological structures for observation were mounted on circular (13 mm diam) specimen-holder studs with an adhesive. The specimens on the studs were coated in vacuo with gold-palladium alloy. We examined the specimens placed in an Etec Autoscan® SEM and photographed them with Polaroid® type 55 PN film.

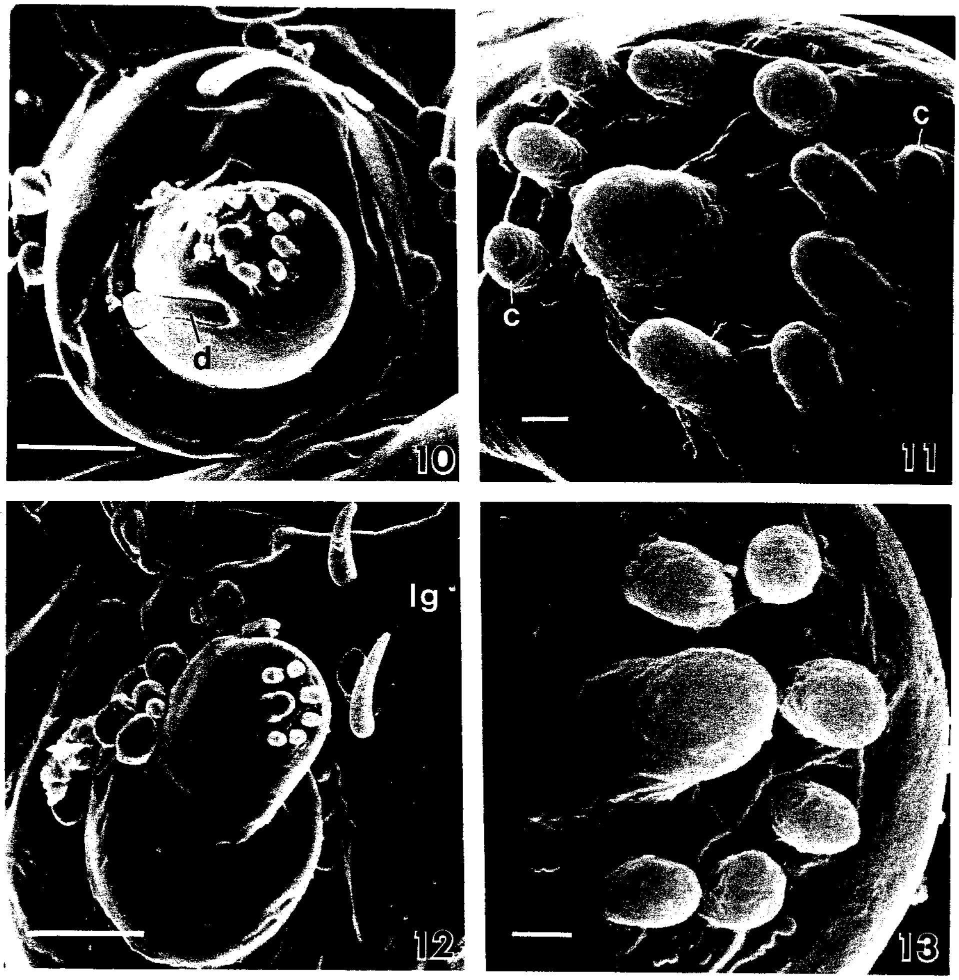
RESULTS AND DISCUSSION: The adult female weevil excavates a cell for the egg and deposits it within the endosperm of the wheat kernel. She then seals off the cell with a gelatinous material from the ovipositor that hardens to form a solid plug. The egg, larva and pupa (Figs. 1–4) and the newly eclosed adult are thus confined within the kernel until the adult emerges.



Figs. 5–9. Head of last instar *Sitophilus oryzae* larva. 5. Head, scale = 100 μm. an—antenna, e—eye (ocellus), lb—labium, lm—labrum, m—mandible, mx—maxilla. 6. Antenna, scale = 10 μm. 7. Antenna (lateral), scale = 10 μm. 8. Left side of head enlarged, scale = 100 μm. 9. Maxilla, scale = 10 μm. d—digitiform sensillum, m—mandible, ma—mala, mxp—maxillary palpus.

Figure 5 shows the larval head from a view exposing the mouthparts, antennae, and single faceted eyes (ocelli). Long curved hairs (setae) are sparsely located on the surfaces of the epicranium, frons, gena, labrum, mandibles, basal segments of the maxillae and labium, and on the stipes and first segment of the palpus of the maxillae. These are probably mechanoreceptors. The antenna (Figs. 6 and 7) has one large sensillum (accessory sensory appendage—Ahmad and Burke, 1972) with pores on the sides (sensillum basiconicum) that probably has an olfactory function. There are also 10 smaller sensilla that appear to represent at least 4 distinctly different morphological types. There is one large cone-shaped sensillum, 3 relatively long pegs, 3 shorter conical sensilla, and 3 small pegs. A lateral view of the antenna (Fig. 7) reveals the pear shape of the large sensillum. Figure 8 shows part of the larva's head at higher magnification than in Fig. 5. The stout mandible has 2 rather long curved setae.

The maxilla (Fig. 9) has sensors on the mala (galea—Bland, 1983) and the palpus. The mala (center) has 6 long curved hairs (sensilla trichodea) surrounding 2 small pegs. The long hairs are probably



Figs. 10–13. Maxillary and labial palpi of *Sitophilus oryzae* larva. 10. Maxillary palpus, scale = 10 μm. d—digitiform sensillum. 11. Apex of maxillary palpus, scale = 1 μm. c—coronal sensillum. 12. Labial palpus (right), scale = 10 μm. lg—ligula. 13. Apex of labial palpus, scale = 1 μm.

mechanoreceptors. The function of the 2 pegs is unknown. The maxillary palpus has a group of sensilla (papillae—Ahmad and Burke, 1972) on the apex consisting of one large sensillum and 11 smaller pegs. The lateral surface of the distal lobe bears a digitiform sensillum (sensillum lying in a groove). This type of sensillum on the labial palpus of the wireworm *Ctenicera destructor* (Brown) has been shown to respond to contact and vibratory stimuli (Zacharuk et al., 1977). This sensillum is shown more clearly in Fig. 10. A higher magnification of the apex of the palpus (Fig. 11) indicates that there are different morphological types of pegs. At least 2 appear to be coronal sensilla similar to those on the labial and maxillary palpi of the wireworms (Bellamy, 1973; Doane and Klingler, 1978). In wireworms these are thought to be mechanoreceptors sensing contact or pressure based on external and internal structure. Several others have grooved apexes with a central pore and may correspond to some of the thick-walled pegs of wireworms that Bellamy (1973) interprets as chemosensors and probably also mechanoreceptors.

The labial palpus (Fig. 12) also has one sensillum that is larger than the others and is nearly surrounded by 6 smaller pegs. Note the 2 long curved hairs (sensilla trichodea) on the ligula. These are probably mechanoreceptors. The exact types of the sensilla (enlarged in Fig. 13) and their function are not known but at least some of the pegs are probably involved with taste and the larger sensillum may be olfactory.

In a very detailed report on *Hypera postica* (Gyllenhal) larval sensilla, Bland (1983) included those on the antennae and mouthparts. As might be expected there was much similarity to those of *S. oryzae.* Notable exceptions are two auriculate sensilla on the apex of the antenna, no digitiform sensillum on the maxillary palpus, fewer small sensilla on the antenna (5 or 6 vs. 10), and more small pegs surrounding the central sensillum basiconicum on the labial palpus (9 vs. 6).

Somehow the feeding *S. oryzae* larva avoids chewing through the bran coats to the outside of the kernel thus maintaining its protective cell. It usually turns when reaching the aleurone layer. It would be interesting to know which sensors are involved in this response and whether it is a response to the chemical or physical nature of this part of the kernel.

It is apparent from the findings in this study that there are many sensilla on the antennae and mouthparts of the rice weevil larva that undoubtedly contribute to its survival and well-being in its confined environment. These sensors should provide ample material for much interesting and enlightening research to further clarify their development (embryological and early instars), structure and function in the life cycle of this very serious pest of stored grain.

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[1] Mention of a commercial or proprietary product in this paper does not constitute endorsement by the U.S. Department of Agriculture.

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