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# DISCOVERY OF ELYTRAL THERMO-RECEPTOR SENSILLA IN THREE SPECIES OF COLEOPTERANS- A COMPARATIVE MORPHOLOGY STUDY

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**A B S T R A C T**

Coleopterans are all hard in physic and are tougher to withstand fatalities due to random or blind flight. This unusually thick chitinous cuticle is definitely an evolutionary gift in the foresaid sense while this doesn't correlate with the extraordinary olfactory and thermo-reception properties, the family execute in general. Current study gain its base in this quest and to understand the mechanism, examination of the distribution and function of the receptive sensilla in the body surface of three coleopteran insects viz. *Odoiporus longicollis* Oliver, *Cosmopolitus sordidus* Germer and *Pollitus mellerborgi* Bough was carried out. The sensilla discovered on the surface of the elytral cuticle were observed using light and scanning electron microscopy. The thermal sensitivity of the elytral-sensilla was proven by providing various temperature exposures. Though these sensilla are observed in common they exhibit slight morphological variations that fine tune the niche boundary between the three closely related species.

**Keywords**: Elytral-Sensilla, Sensilla modification, Coleopteran morphology, Thermo receptors, Elytra-Electron microscopic study, Micro niche.

## INTRODUCTION

The coleopteran weevils *Odoiporus longicollis* Oliver, *Cosmopolitus sordidus* Germer and *Pollitus mellerborgi* Bough are pests of banana. Banana being a fruit as well as a staple food is of prime importance to human kind. Ravage of pests is the prime constraint in the production and productivity. Of the three weevil pests reported, *O. longicollis*, commonly known as banana pseudostem weevil (BPW), is the most noxious monophagous pest than the other two *viz*. *C. sordidus* (banana rhizome weevil-BRW) and *P. mellerborgi* (small banana weevil-SBW), infesting banana in the field at its multiple stages. Banana pseudostem weevil bears superficial resemblance with rhizome weevil, but the former is slightly larger and its elytra do not cover the abdomen completely. Sing (1966) observed distinctive sexual dimorphism in BPW and categorised black and smaller weevils are males, whereas reddish brown and bigger ones are females [1]; however Shukla and Kumar (1969) contradicted the observations in just opposite way [2]. Small banana weevil is quite unique from the rest due to its very small size while it exhibit very similar taxonomical features with both the weevils apart from dimension. The colour difference of weevil has a controversy. Dutt and Maiti (1972) reported that colour of the adult BPW varies from reddish brown to black with respect to its age [3], whereas Gailce *et al.* (2008) opined that colour variation cannot be linked with sexual dimorphism [4], but only a phenomenon of non-sex limited variation and of sympatry. SBW shows similar colour ranges from reddish brown to black while BRW was observed majorly in black/ash shade. Based on the thickness of rostrum and its punctures, sex determination was described by Dutt and Maiti (1972), and they reported rostrum was thicker and punctures were more in male than in female, this feature is common for all the three weevils [3]. As the number of punctures per linear unit is more in male than in female, the rostral surface of male feels rough [4,5]. Though the status of pest is globally enjoyed by BRW, vigorous infestation is executed by BPW. Small banana weevil is

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not up to the status of a major pest due to its unusually small size and being least abundant, studies are demanded for them regarding their possible status as a vector for banana viral diseases. All the three weevils are very sensitive to external changes in the environment and this is possibly a key character that distinguishes the very minute niche boundaries among them. Apart from physical contact inhibitions in sharing the habitat the foresaid coleopterans possibly specifies their permitted microhabitat using unusual percipience about their surrounding with the aid of receptors. In the current study Scanning electron microscopic studies on the elytra was carried out to find such receptors.

**MATERIAL AND METHODS**

Adults of *Odoiporus longicollis*, *Cosmopolitus sordidus* and *Pollitus mellerborgi* collected from the banana fields of Thiruvananthapuram district (8.5488 °N, 76.9173 °E), were maintained in the laboratory at 26±3 °C, 60 ± 10% RH and L:D 12:12. Weevils used for the study were identified using taxonomic key for Curculionoidea super family. It was further confirmed through the identification service rendered by the Division of Entomology, Indian Agricultural Research Institute, New Delhi. Morphological features of BPW, BRW and BSW were studied using stereo microscope- Zeiss EV 018 (Spl. edition) under 10, 20 and 40X magnifications and by scanning electron microscope (JEOL Model JSM-6390LV; Resolution- 3 nm ACC V 30Kv, WD 8 mm, SEI; Mag- 5X to 300000X both in high and low vacuum mode). Elytrum of the respective weevils were mounted onto copper stubs and coated with gold (12.6 nm thickness) using ion sputter coater (Emitech sputter coater SC 7620, Quorum Technologies, U.K). Images were scanned using scanning electron microscope at 20 kV. Images of various magnifications were captured and the morphological features were studied.

Elytra that were dissected out from a live insect accordingly were taken and the axial root of the wing was just dipped in insect saline keeping major portion of the elytrum dry. Elytra of all the three weevil *sp*. are then exposed respectively at different temperature (-20 ºC, 4 ºC and 32 ºC) for 2 minute accordingly. Thermal response is estimated by Cyanide fixation, ie; 1000ppm of Hydrogen Cyanide fumes are exposed over the treated elytra just to temperature treatment.

**RESULTS AND DISCUSSIONS**

**General morphology of the study insects:** Adult BPW is oily black, tough and measuring 11.5±0.4 mm long in male and 13.5±0.9 mm in female, and both the sexes were significantly different in size (P=0.923). BRW male and female are 9.12±0.4 mm and 10.24 ±0.2 mm respectively (P=0.864). SBW male and female are 1.98±0.6 mm and 2.02±0.3 mm respectively which are statistically insignificant (P=0.314). Rostrum measures 2.84±0.25 mm in male and 4.16±0.15 mm in female BPW. Rostrum of BRW is 2.82±0.34 mm and 2.94±0.11 mm respectively while the rostrum of SBW is 0.42±0.03mm and 0.43±0.02mm respectively for male and female. It is long, curved and smooth in female, whereas short, stout and rough in male for all the three weevils (Fig. 1). Antenna composed of 11 segments with basal scape, seven funicles and three club shaped terminal segments. Scorbes are clear but faded away towards the tip for all the three weevils. Labrum and clypeo-labral sutures are indistinct for BPW and SBW while it is distinct for BRW. Prementum is pedunculate, maxillary palps are compact and reduced. Mandibles are relatively larger (574±17 μm, 592±32 μm, 51±08 μm respectively for BPW, BRW and SBW) than other mouthparts. Inner margin of mandible is dentate and attached laterally favouring horizontal movement.

Head measures 1.317±0.41 mm in BPW, 1.122±0.23 mm in BRW and 0.092±0.01 mm in SBW. Eyes are dorsally contiguous. Vista antero- lateral with narrow fronts are feature of all the three weevils. Thorax is distinct with pronotum which is longer and carinate, elytra are abbreviated, leaving pygidium uncovered in BPW and BSW but pygidium covered almost for BRW. Elytral striae are 10 in nos. with the 10$^{th}$ one partially fused with the 9$^{th}$ at its mid-way. An unusual flame like setae was observed with a probable thermo regulatory function. Wings are brown being translucent. Femora are slightly broader and equipped with a tooth in all the three weevil sps. Trochanter is reduced and triangular in BPW. It is attached with femur at its side, and the front coxa is sub-contiguous. Apex of the tibia is end with an apical tooth (mucro) and a hook (uncus), and two sets of spurs at the inner apical margin of the tibia. Combs are at the ventral margin of the tibia, continuously along the femaro-tibial junction and ends with setae. Tarsal segments are five with the fourth one is inconspicuous and concealed between the bilobed third and fifth tarsite. The fifth tarsal segment bears a pair of free moving claws equipped with no tooth in BPW and SBW but poses tooth in BRW. Abdominal segments are 7, but only 5 sternites are visible, as the first two sternites are fused to form a larger plate. The 4th and 5th sternite are act like a hinge for the easy movement of the tip of the abdomen for all the three weevils. Abdominal tip poses many micro setae in female weevil, possibly for the detection of air chamber suitable for egg laying in both BPW and BSW while it is absent in both the sex of BRW. Ovipositor is equipped with spines to pierce pseudostem in all the three female weevil *sps*. Complexion of the same species of insect may have variation in accordance with its food and eco-locations. Present study revealed that body colour of the adult BPW is reddish brown to black as reported by many authors [4, 6, 7, 8]. Size of the adult weevil observed was on par with the findings of [1] Sing (1966) and [7] Tara *et al.* (2010). The taxonomic features of adult BPW reported is corroborates with the findings of [4,6, 7, 8, 9, 10] Galice *et al.* (2008); Azam *et al.* (2010); Tara *et al.* (2010); Thippaiah *et al.* (2011); Priyadarshini *et al.* (2014) and Khairmode *et al.* (2015). According to Zimmerman (1968) mouthparts undergo a retrogressive evolution from the grub stages to adult, and are not proportional to the body size as similar to every member of Dryophthorinae subfamily [11]. The study supports the reports of [12] Gold *et al.* (2002) and [13] Scot *et al.* (2006), confirming BPW comes in the subfamily Dryophthorinae with the taxonomic evaluations and not in Rhynchophorinae as reported by [7] Tara *et al.* (2010).

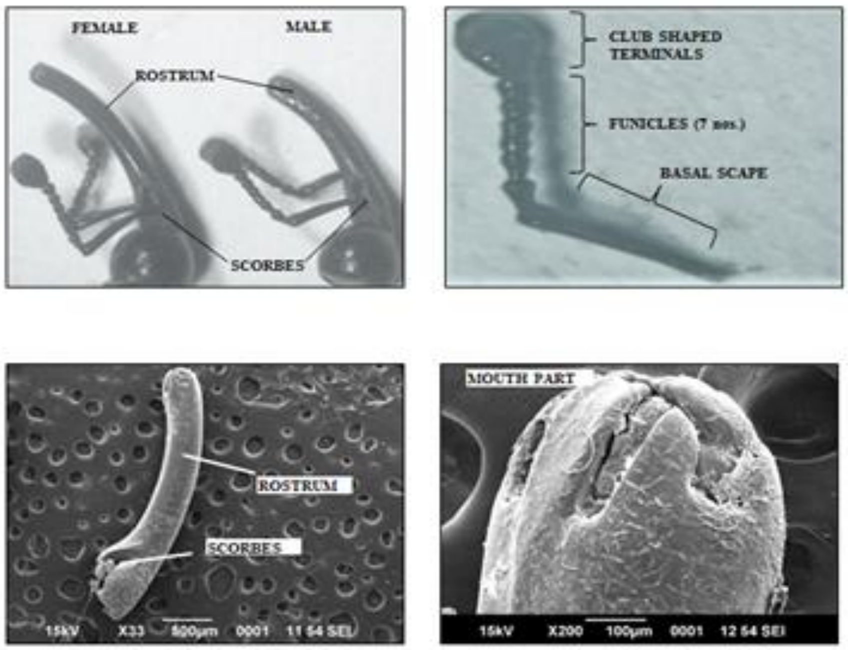


Figure1. Rostrum and Antenna images of *Odoiporus longicollis*. (a). Rostrum of *Odoiporus longicollis*, (b). Antennae of *Odoiporus longicollis*,(c). Scanning electron microscopic image of Rostrum of *Odoiporus longicollis*.

**Distribution of the Elytral-Sensilla:** Many hair (trichoid) sensilla of 80 µm or more in length are present on the ventral and lateral surfaces of all the three weevil body (Fig. 2). The bilateral distribution of the long sensilla is almost symmetrical, and most are located on the Dorso-median area of each elytrum. These sensilla are distributed on either side of a suture which is aiding in the airo-dynamics of weevils flight. In addition to the sensilla some setae modifications are also observed in the suture run anterio-posteriorly throughout the elytra. A dozen long such micro hairs (8–15 µm in length) located in the marginal (anterior and lateral) areas of the femur of the foreleg, 15–30 short hairs are present in the posterior area of the femur. A few short hairs are usually seen on the dorsal surface of the tibia and the lateral surface of the tarsus. The pretarsus is devoid of hair sensilla. A similar distribution of the two classes of hair sensilla were observed in the middle and hind legs and the number of hairs was about a quarter that of the forelegs. The short sensilla hairs are also scattered on the surface of other parts of the pupal body, including the forehead (frons), vertex, labrum, labium, pronotum, mesothoracic tergum, and metathoracic tergum, at a density similar to that of the abdominal segments. The elytron is the only region which holds both short hair sensilla and thermo receptor sensillae in all the three species of banana weevils (Fig. 3), while the hind wing has several short sensilla but no thermo sensilla.

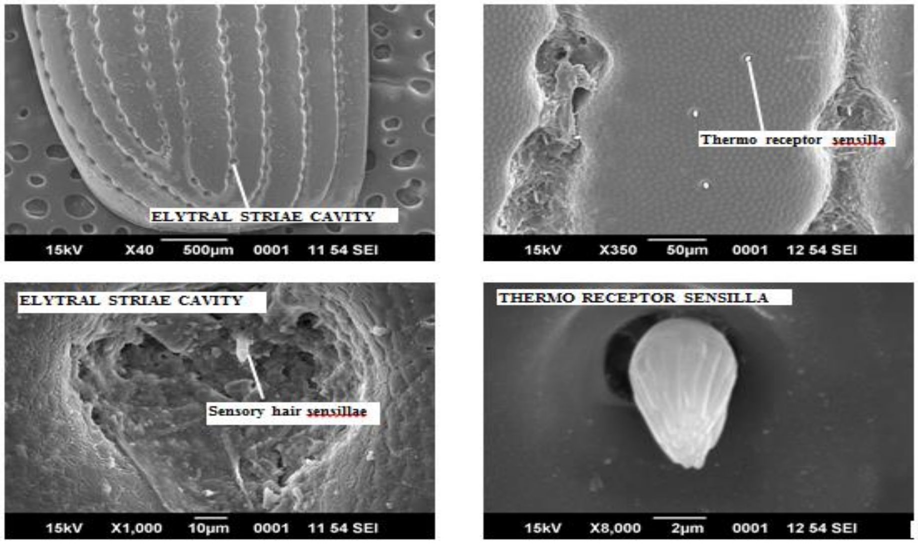


Figure 2. Scanning electron microscopic image of elytra of *Odoiporus longicollis*.

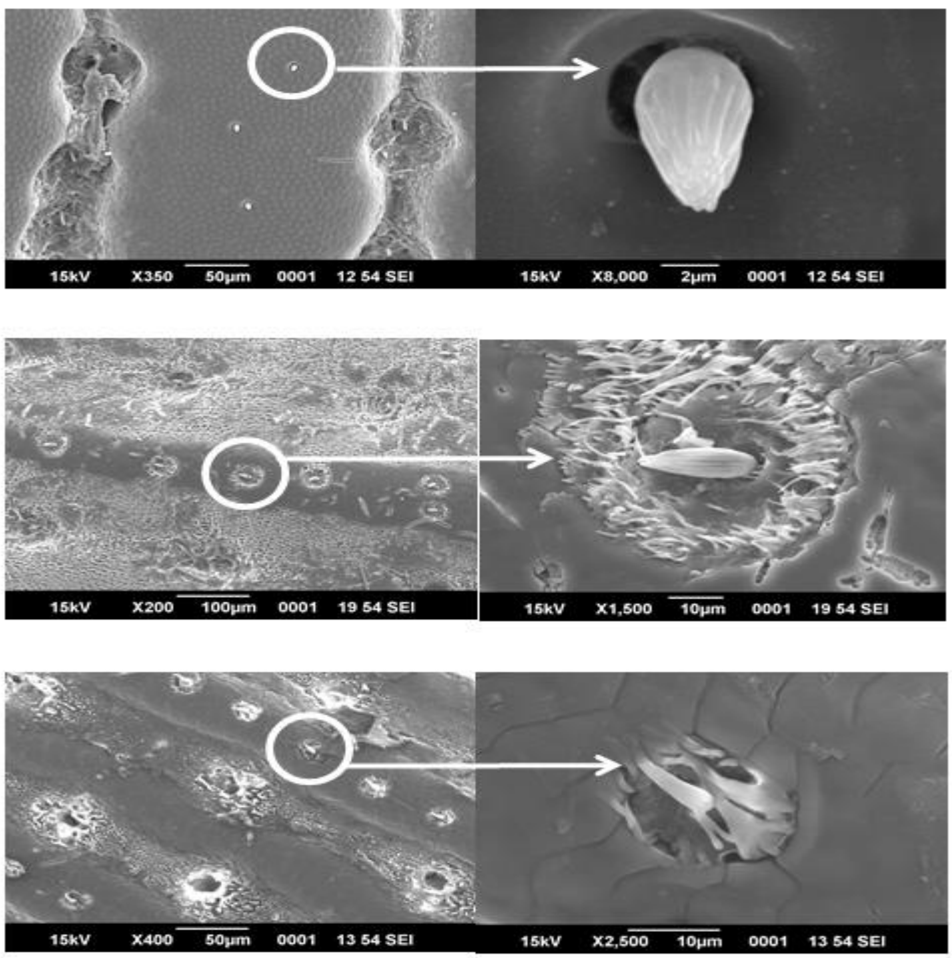


Figure 3. Scanning electron microscopic image of the thermo receptive sensilla found on the elytral surface of banana weevils. (a). *Odoiporus longicollis*. (b). *Cosmopolitus sordidus*, (c). *Pollitus mellerborgi*.

**Response of Thermo Receptor-Sensilla to varying temperature:** It was observed that the thermo receptor sensilla are probably a setae modification with a lotus flower shape that ensures a maximum surface area to a very quick response. The response experiment clearly showcases the reception response of these sensillae to temperature. To colder temperatures as -20 ºC and 4 ºC sensillae are closed while to favourable climatic condition of 32 ºC they are found to be fully open, probably to perceive minute temperature deflections. Adult of the coleopteran weevils *Odoiporus longicollis*, *Cosmopolitus sordidus* and *Pollitus mellerborgi* bear short hair sensilla on almost all parts of their body. The distribution of the sensilla was generally similar to that in another species of tenebrionid beetle, *T. molitor* [14] apple beetle, *A. mali* [15] and ground beetle, *P. dorsalis*[16]. These hair sensillae may perceive mechanical information for the recognition of external environments, including potential enemies, and increasing arousal level for defensive behaviours according to the site of its existence. Thermo receptive sensilla are found only on the dorsal median surface of elytra only and they are found to respond accordingly to change in temperature, this can potentially help the weevil to respond to very slight change in habitat temperature and stimulate niche preference even in a single host plant with definite margins.

**CONCLUSIONS**

It's definitely vital to understand the pest in every perspective to manage them very specifically. Current study effectively finds its success in the discovery of thermo receptive sensilla on the elytra surface of a weevil that is very vital to the existence of pests. Though slight variation in structure of thermo receptive sensilla are observed there function is found to be same that can be considered. Management tools that target on this can be employed for the specific annihilation of coleopteran pest.

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