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Sensilla on antenna and maxillary palp of predaceous fly, *Lispe neimongola* Tian *et* Ma (Diptera: Muscidae)

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ABSTRACT

This study describes aspects of sensilla on the antennae and maxillary palps of an aquatic predator, *Lispe neimongola* Tian *et* Ma. Types, distribution and density of sensilla were studied by stereoscopic microscope and scanning electron microscopy. The antennal scape has one type of sensilla, the sharp-tipped chaetic sensilla; whereas, the antennal pedicel possesses two subtypes of these sensilla. Three types of sensilla are found on antennal funiculus: trichoid sensilla, basiconic sensilla (two subtypes) and clavate sensilla. Sensilla found on palpal surface include the third subtype of basiconic sensilla and chaetic sensilla. Two unique sensillar characters of *L. neimongola* detected are the absence of coeloconic sensilla on antennal funiculus and the greater number of basiconic sensilla on spoon-like palps. These results are compared with equivalent findings in several other Calyptratae fly species of different ecotypes to provide evidence of adaptation to their environment.

1. Introduction

In the history of fly evolution, the paradigm of adaptive radiation has been applied to every level of biological classification with a number of life history transitions to saprophagy, phytophagy, parasitism and predation (Wiegmanna et al., 2011). Despite extremely varied natural history, the antennae and maxillary palps of adult insects are important sensory receptors implicated in various behaviors during adult life and sensilla on these sensory organs perform specific functions to adapt to their habitat (Chapman, 1982). Distinctive features of olfactory sensilla have already been addressed in flies belonging to various ecological niches, according to previous literature (Ross, 1992; Sukontason et al., 2004; Zhang et al., 2012a, 2012b). Therefore, it is particularly intriguing to characterize the features of these sensory organs that reflect evolutionary adaptations of predaceous flies to ecological niches, and to link these phenomena to progress of evolution.

Adult flies of the genus *Lispe* are predaceous flies, closely bound to aquatic and subaquatic habitats (Xue and Zhang, 2005; Werner and Pont, 2006), and several species are reported as useful insects for monitoring water quality (Morse et al., 1994). Consequently, as a predaceous species living in the Gobi desert, *L. neimongola* Tian *et* Ma, 2000 is taken for a commendable model of sensillar examination on flies from a special ecological niche among multifarious ones. Besides, most of the current knowledge of the olfactory sensory system on muscid flies is mainly obtained from saprophagous and phytophagous species (Ross, 1992; Smallegange et al., 2008; Setzu et al., 2011), and relatively little information involves aquatically predatory fly species. Due to this deficiency, type, size, density and distribution of the sensilla on the antennae and maxillary palps of *L. neimongola* Tian *et* Ma, 2000 are provided in this study. The purposes of our investigation are to compare the sensilla in *L. neimongola* with those in other muscoid flies of various ecotypes, seek unique characteristics of this predator and elucidate their adaptive relationship to the environment and life history.

2. Materials and methods

The adult *L. neimongola* were obtained from Kalamaili Ungulate Nature Reserve, Xinjiang, Northwest China, in August 2009. Then the specimens were identified, pinned as museum samples and air dried on site (Xue and Zhao, 1996).

10 specimens of each sex were processed for preparation of scanning electron microscope. Surface debris that could obscure cuticular details was removed by rinsing in phosphate buffered saline buffer (pH 7.4). For further cleaning, the antennae and palps were dissected from the head, cleaned with detergent and ultrasonic wave. Then, specimens were dehydrated in a graded ethanol series (2 times 15 min each with 60%, 70%, 80%, 90%, 95%, 100% ethanol). The specimens were mounted on aluminum stubs with double-sided adhesive tape, and left in a desiccator overnight to dry thoroughly, then, they were coated with gold and viewed with a

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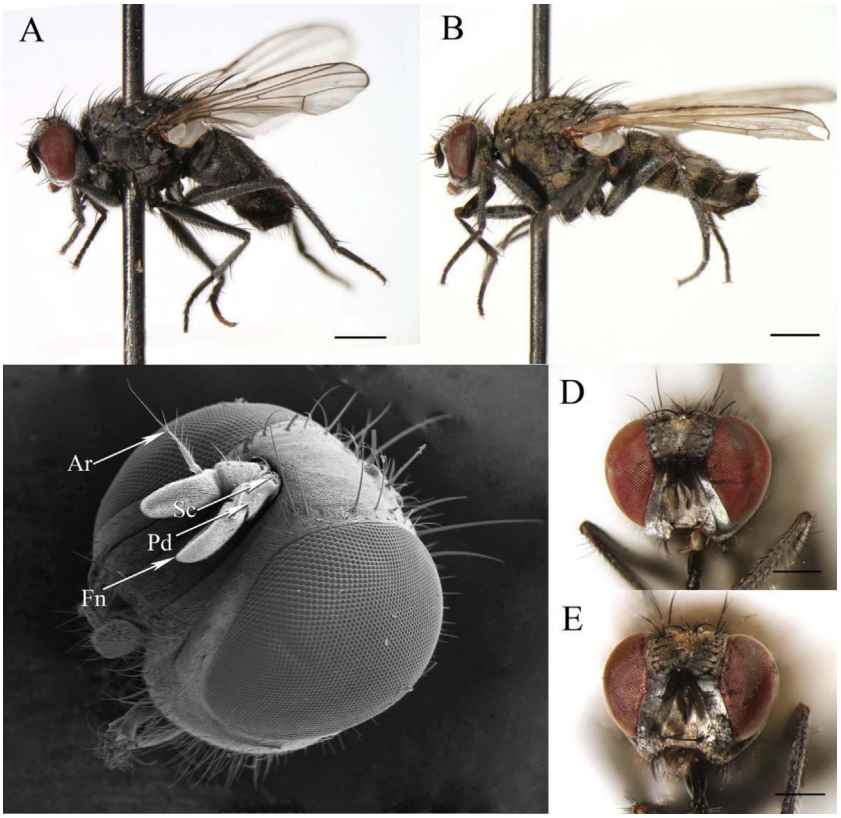

Fig. 1. Features on the head of adult male and female *Lispe neimongola* Tian *et* Ma, 2000. (A) Lateral view of male *L. neimongola*. (B) Lateral view of female *L. neimongola*. (C) Features of the head. (D) Frontal view of male *L. neimongola*. (E) Frontal view of female *L. neimongola*. Ar (arista); Fn (funiculus); Pa (palp); Pd (pedicel); Sc (scape). Scale bars: (A and B) 1 mm; (C) 0.4 mm; (D and E) 0.5 mm.

HITACHI S34Q scanning electron microscope (Hitachi Corp., Tokyo, Japan) at the Microscopy Core Facility, Biological Technology Center, Beijing Forestry University (Beijing, China). The distribution and density of various types of sensilla were determined using the grid technique described by Kelling-Johannes (2001), all results were scaled to 1000 μm^2.

The terminology and nomenclatures used to describe antennal morphology and classification of sensilla types in this study follow the ones used by Hunter and Adserballe (1996), Shanbhag et al. (1999) and Setzu et al. (2011).

3. Results

3.1. General description of the antenna and maxillary palp of *Lispe neimongola*

In common with other dipterans, the antenna of *L. neimongola* is composed of a basal scape (Sc), pedicel (Pd), and an elongated funiculus (Fn) with a large pectinate arista (Ar) (Figs. 1C and 2A).

3.1.1. Scape

Scape is the most proximal segment of the antenna, on which the only sensilla is chaetic sensilla (Ch). Ch is a long, curved bristle inserted into a socket with longitudinal grooved wall (Fig. 2C). These are found in groups of 3–4 in a single row. The cuticular surface of antennal scape is densely covered by small spinules of microtrichiae, which are small hair-like structures with acuminate apex.

3.1.2. Pedicel

Pedicel is the second segment of antenna, whose surface is also covered with microtrichiae (Fig. 2D). Interspersed amongst the microtrichiae, are chaetic sensilla. Two subtypes of Ch (Ch I and Ch II) can be distinguished by their shape and size. The Ch I are morphologically similar to those found on antennal scape, but they are straight, more numerous and variable in length (Fig. 2D and F). The Ch II is surmounted by a seta and contain a tuft of microsetae (Fig. 2D and G).

3.1.3. Funiculus

The antennal funiculus, which measures approximately 531.34 ± 8.97 μm along its longest axis, is the most important segment of the antenna (Fig. 2A and B) and numerous sensilla are attached to it. For orientation, antennal funiculus has been divided into 2 regions: anterior surface and posterior surface. A total of three morphological types of sensilla are distributed on the entire funicular surface, including trichoid sensilla (Fig. 4), basiconic sensilla (two subtypes) (Fig. 5) and clavate sensilla (Fig. 6). The length and basal diameter of these antennal sensilla for both male and female species are summarized in Table 1 and the density of them is also examined, shown in Table 2.

3.1.4. Maxillary palp

Unlike flies of other genera with club-like palp, the extremely enlarged spoon-like maxillary palp (310.08 ± 6.82 μm in length and 223.13 ± 5.87 μm in width in females, and 208.60 ± 5.34 μm in length and 148.74 ± 4.59 μm in width in males) of *L. neimongola* (Figs. 1C, 3A and B) is a genus specific character in the family Muscidae. A relatively greater number of basiconic sensilla are attached for the larger surface area. Female *L. neimongola* bear moderately larger maxillary palp than males. Two morphological types of sensilla are distributed on the entire maxillary palp, namely chaetic sensilla (Fig. 3B–D) and subtype III basiconic sensilla (Fig. 3E and F). On maxillary palp, chaetic sensilla resemble those on antenna,