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THE MORPHOLOGY OF *LAEMOBOTHRION* (*LAEMOBOTHRION*) *MAXIMUM* (PHTHIRAPTERA: LAEMOBOTHRIIDAE)

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Abstract. Adult specimens of *Laemobothrion* (*L.*) *maximum* (Scopoli, 1763), a buzzard louse species, were studied using scanning electron microscopy and paying special attention to sensitive structures, mainly those located on the head, mouthparts, abdomen and legs. Data on shape and size of palpal and antennal sensilla, as well as post-spiracular ones, were obtained. Some modifications of the mouthparts were observed.

Key words: *Laemobothrion* (*L.*) *maximum*, SEM, morphology.

The family Laemobothriidae comprises a number of monogeneric species characterized by their large size and parasitizing several bird orders: Podicipediformes, Ciconiiformes, Falconiformes, Galliformes and Gruiformes (Hopkins and Clay, 1952; Nelson and Price, 1965; Clay, 1970). On the basis of their morphological characters only a few *Laemobothrion* species can be distinguished as ectoparasites of Falconiformes birds (Nelson and Price, 1965). *Laemobothrion* (*L.*) *maximum* (Scopoli, 1763) has been considered as a cosmopolitan species, being cited on 32 raptor species belonging to 18 genera (Clay, 1976).

Scanning electron microscopy (SEM) has been used for taxonomic purposes in the study of several lice species (Clay, 1966; 1969; 1970; Clayton and Price, 1984; Zlotorzycka and Kassner, 1986; Kassner and Zlotorzycka, 1987). Cephalic organs like the antennae, mouthparts and palpi have been the phthirapteran structures studied most by means of SEM techniques in order to improve our knowledge of the morphology and receptor function of these organs (Miller, 1971; Eicher and Sixl, 1974; Stendel and Holm, 1975; Eichler *et al.*, 1976; Slifer, 1976; Szczesna, 1984; Clarke, 1990; Zlotorzycka, 1990) as well as the function of mouthparts (Smith and Titchener, 1980).

This paper supplements the existing description of the buzzard louse, *Laemobothrion* (*L.*) *maximum*, and pays special attention to cephalic and legs structures.

MATERIALS AND METHODS

Adult *Laemobothrion* (*L.*) *maximum* were collected from several infested buzzards, *Buteo buteo*, kept in captivity in the Acebuche Recuperation Center, Doñana National Park, Spain and in CREA Las Mimbres: Agencia de Medio Ambiente, Granada, Spain. For this study 45 specimens (20 males and 25 females) were used.

Lice removed from the host plumage were fixed in a filtered 10% formaldehyde solution. Preparation routines for SEM started with cleaning the material. Specimens were washed consecutively in 65% ethanol, bidistilled water, 5% aqueous Triton X^R and again in bidistilled water. In each step (5-10 minutes) manual cleaning was improved with a thin brush under a stereoscopic microscope. After this process lice were sonicated for 5 minutes in 65% ethanol.

After cleaning, lice were pre-dehydrated for 15 minutes in each 70%, 90% and 100% ethanol solution. Then, material was introduced in amyl acetate (15 minutes) and finally dehydrated by means of critical point at $-31°C$ and 90 bars in the presence of CO_2 as the transition fluid. Lice were mounted posteriorly on standard pin type SEM mounts using double-sided tape.

After mounting, specimens were sputter-coated with gold in a Polaron E 5000 machine and viewed in a Zeiss DSM 950.

Scales included in the photographs represent micrometres.

RESULTS

The base of the maxillary palpi and labium, and the region between these structures, bear numerous small prolongations as shown in Figure 1. Figure 2 shows another cuticular
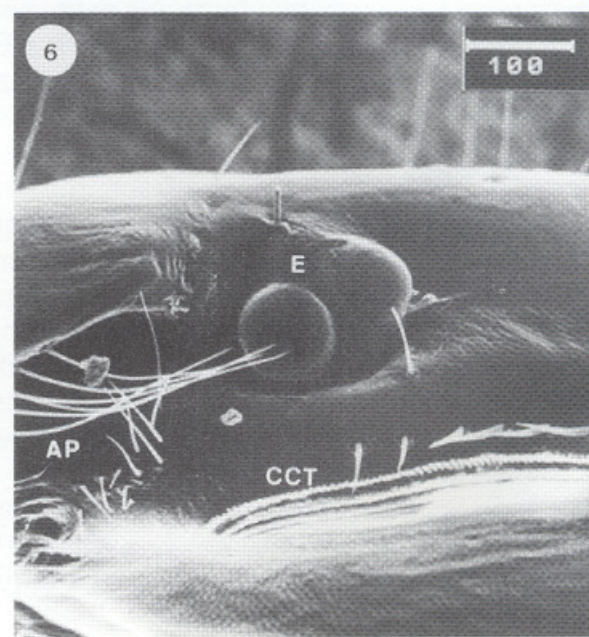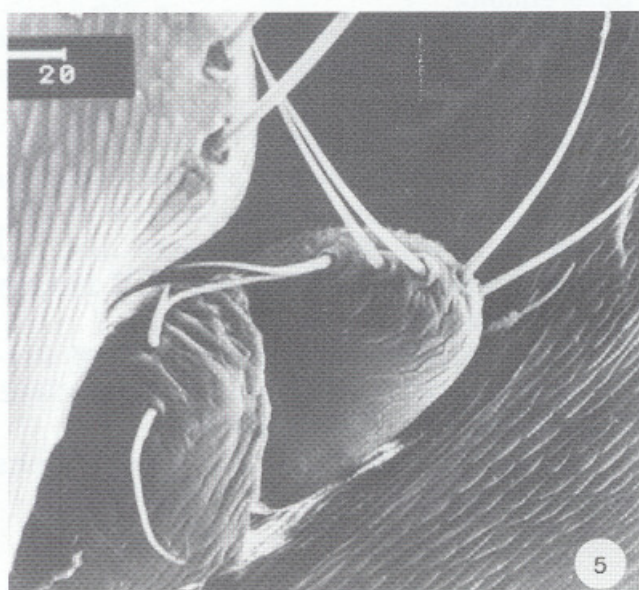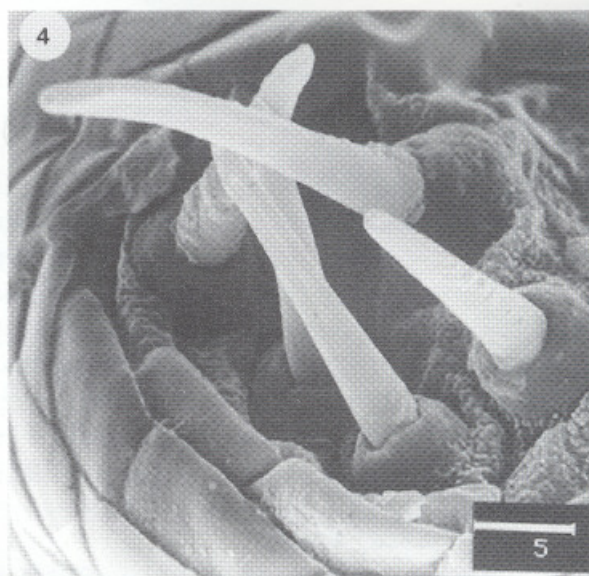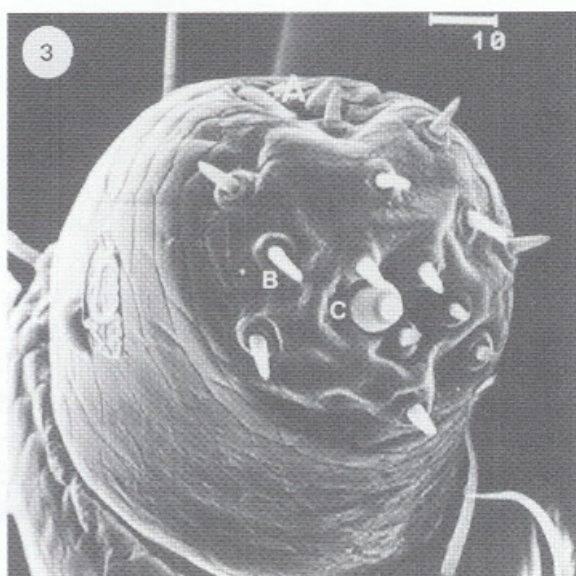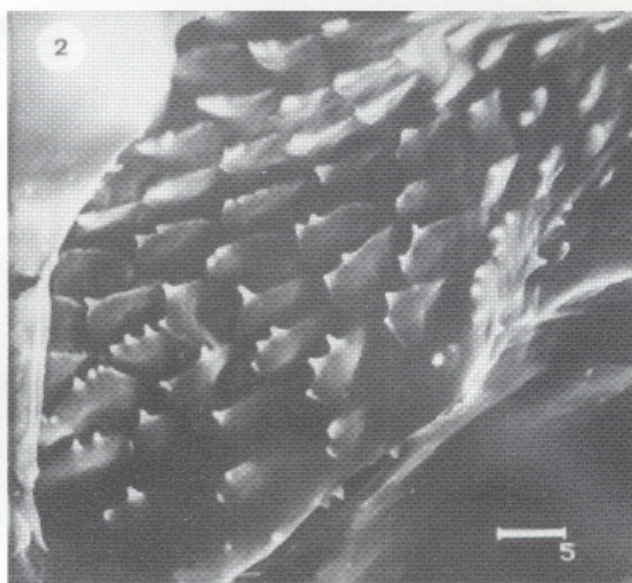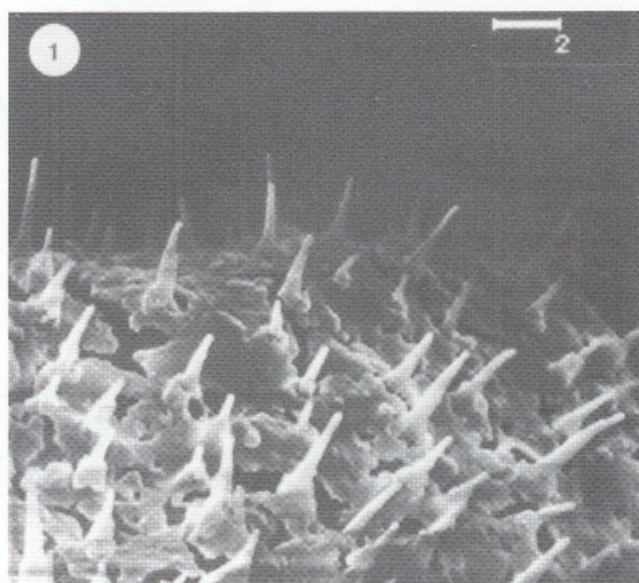
Figs 1-6. *Laemobothrion (L.) maximum*.
Fig. 1. Base of the maxillary palpi, labium and region between these structures. Fig. 2. Cuticular modification at the base of the mandibles. Fig. 3. End of a maxillary palpus. A, B, C: basiconic sensilla. Fig. 4. Apex of a labial palpus. Fig. 5. Third antennal segment. Fig. 6. Head, lateral view. E: eyes; AP: antennal pit; CCT: cephalic ctenidia. Scales represent micrometres.
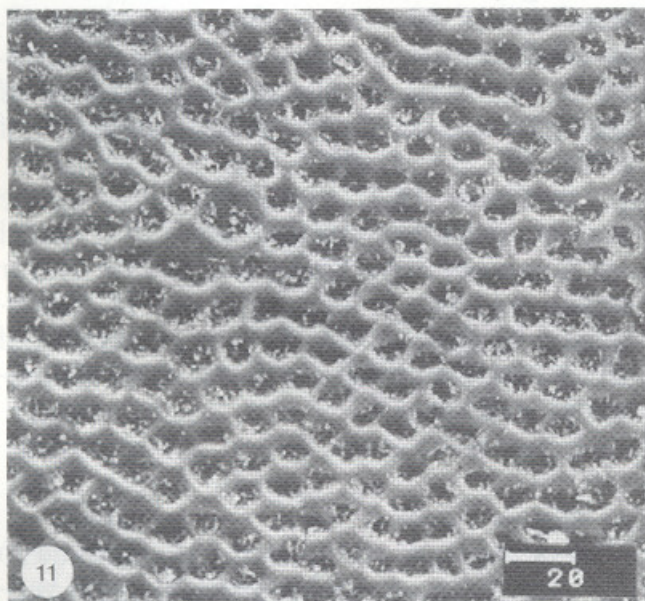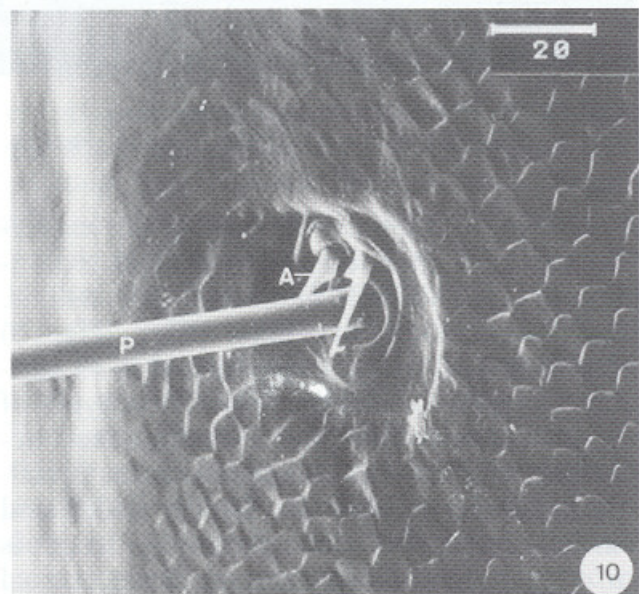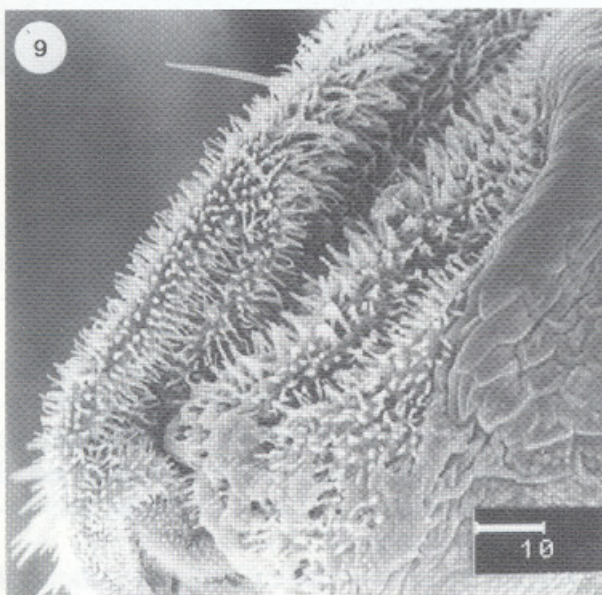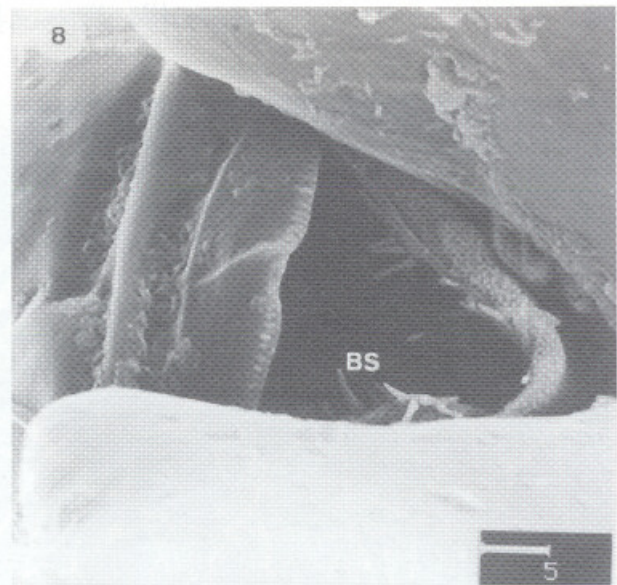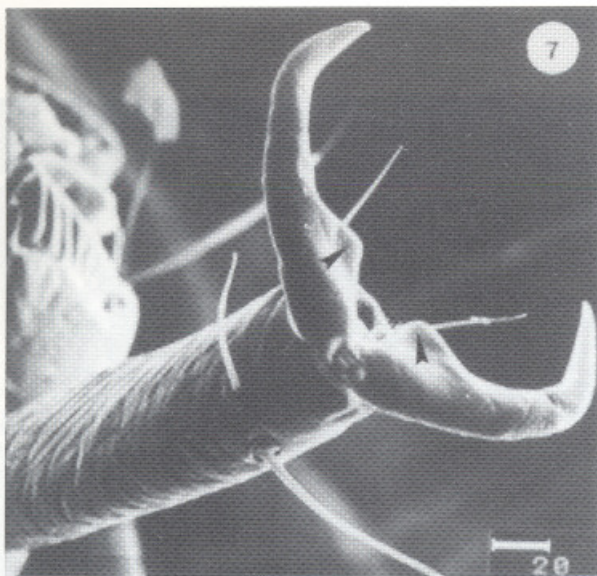
Figs 7-12. *Laemobothrion (L.) maximum.*
Fig. 7. Tarsal claws. Arrows show the inner protuberances. Fig. 8. Basiconic sensilla (BS) surrounding the tarsal orifice located between the tarsal claws. Fig. 9. Tibial extreme. Climbing organ. Fig. 10. Postspiracular seta (P) and adjacent sensilla (A). Fig. 11. Detail of the cuticular surface of the abdominal terguites. Fig. 12. Microtrichia located laterally on abdominal sternites IV and V. Scales represent micrometres.
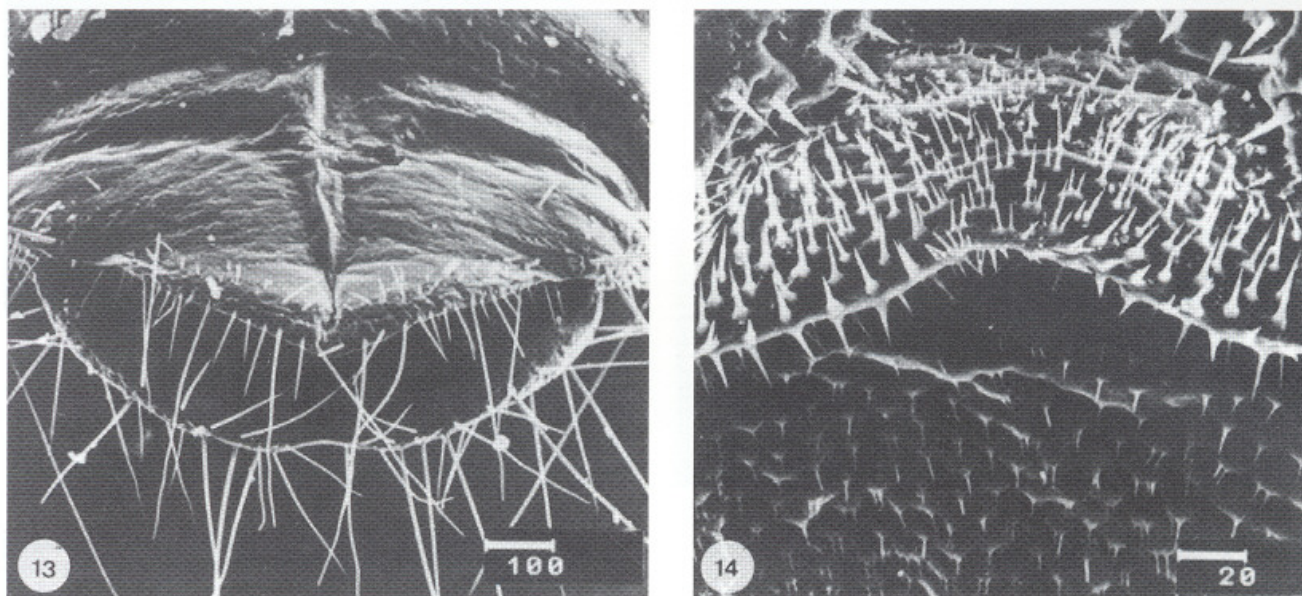
Figs 13, 14. *Laemobothrion (L.) maximum.*
Fig. 13. Male. Tip of the abdomen. Fig. 14. Female. Vulvar region. Scales represent micrometres.

modification found on the base of the mandibles and near them consisting of rigid prolongations with a variable number of indentations. The 4-segmented maxillary palpi (Fig. 3) present several trichoid sensilla and >15 basiconic sensilla located apically. Three types of these structures have been distinguished according to their size and appearance. Sensillum type A is a single one basally folded and partially imbedded in the cuticle. Its length is *ca.* 10 µm. Sensilla named type B are normal basiconic sensilla with variable size. Finally there is a very globular sensillum (type C). On the extreme of the labial palpi (Fig. 4) usually five sensilla are inserted, with a mean length >15 µm. Their surface is grooved and they might be considered as basiconic sensilla.

The four-segmented antennae are located in the antennal pits. The third segment shows several long hairs (Fig. 5). Figure 6 shows a pleural view of the head at the level of the two eyes (E). Just in front of them the antennal pit (AP) is surrounded by long hairs and trichoid sensilla. Near the eyes there is a row of trichoid sensilla measuring about 50 µm in length and, below them, several rows of rigid spines, the cephalic ctenidia.

Tarsal claws are perpendicularly articulated to the tarsus (Fig. 7) and there is a terminal orifice bordered by basiconic sensilla (BS) (Fig. 8). Claw movements seem to be limited by two cuticular protuberances. The structure represented in Figure 9 is the climbing organ (according to the terminology given by Richards and Davies, 1977), located at the apex of the tibia. An abundant pilosity with some interspersed trichoid sensilla can be observed.

In each side of the pleural region of some abdominal segments (II to VIII) a postspiracular seta (P) is inserted (Fig. 10). This structure is a very long hair associated with two small adjacent sensilla (A). Each of them are independently inserted.

Figure 11 shows the reticulated cuticle of the tergal abdominal surface. A detail of the small combs, or microtrichia, located laterally on abdominal sternites IV and V is depicted in Figure 12. In this species, this kind of structure also occurs on the ventral surface of femur III.

In Figure 13 the terminal region of the male abdomen shows a wide opening bordered by numerous long hairs; the female vulvar region is shown in Figure 14, and is characterized by the insertion of a large number of chaetic sensilla, both on the external and internal surfaces.

DISCUSSION

One of the most common receptors found in *L. maximum* were trichoid sensilla, with variable size, type of insertion and thickness. Many of these structures operate as mechanical or tactile receptors (Slifer, 1960). We have obtained no evidence of the existence of pores on the surface of these structures. Nevertheless, in

some cases (in legs) superficial longitudinal grooves were observed in trichoid sensilla. This type of trichoid sensilla has been also found in other lice species, e.g. antennal apices of *Degeeriella fulva* (Giebel, 1874) and *Craspedorrhynchus platystomus* (Burmeister, 1838) and abdominal terguites of *Colpocephalum meridionale* Pérez *et al.*, 1988 (Perez, 1990), as well as in other insect orders: Diptera (McIver, 1971; Mercer and McIver, 1973), Hymenoptera (Cave and Gaylor, 1987) or Coleoptera (Bland, 1984) among others. These grooved trichoid sensilla might operate as olfactory receptors, since the grooves would replace the characteristic pore-tubule system of chemoreceptors found in various other insects (Bay and Pitts, 1976; Slifer, 1976; Altner, 1977).

Apart from the taxonomic importance of the presence/absence, shape and size of the post-spiracular seta and adjacent sensilla (Clay, 1954) we believe that these structures might act as amplifying the mechanical stimuli, in that when the seta is bent it stimulates the adjacent sensilla.

Basiconic sensilla can be distinguished from trichoid ones by the thicker aspect of their projected portion. Thickness of their cuticular wall is variable, and the surface of these sensilla can be grooved, sculptured or porous. These structures usually respond to diverse chemical stimuli (Richards and Davies, 1977). This type of sensilla is also widely distributed in phthirapteran species, mainly in cephalic organs, such as the maxillary palpi (Clay, 1966; 1969; Perez, 1990), antennal ends (Clay, 1969; 1970; Miller, 1971; Ubelaker *et al.*, 1973; Slifer, 1976; Szczesna, 1984; Kassner and Zlotorzycka, 1987; Clarke, 1990), or the gular area of several amblyceran species (Clay, 1969). Basiconic sensilla have also been commonly reported from cephalic organs of other insect orders: Plecoptera (Kapoor, 1989), Orthoptera (Bland, 1982), Diptera (Mercer and McIver, 1973), or Coleoptera (Arbogast *et al.*, 1972) among others.

As in the case of the trichoid sensilla we have found no pores on the basiconic sensilla surface, but in the species studied short and grooved basiconic sensilla have been observed at the antennal apices. This type of sensilla was also found in the antennal end of *Laemobothrion (L.) vulturis* (Fabricius, 1775) (Clay, 1970). Longer grooved basiconic sensilla were also ob-

served on the apex of the labial palpi (Fig. 4). Depending on the location, ultrastructure, wall thickness and innervation of the non-porous basiconic sensilla they may acquire several functions, such as termoreceptors, hygroreceptors or mechanoreceptors (Slifer, 1970; Altner, 1977). However, complementary ultrastructural and electrophysiological studies are needed in order to know the exact function of each sensillum.

Neither placoid sensilla, also named "circular areas" (Clay, 1970), nor "porous organs" (Agren, 1975; Szczesna, 1984; Zlotorzycla and Kassner, 1986), nor coeloconic, nor campaniform sensilla were found in *L. maximum*. Such sensilla are typical for ischnoceran Phthiraptera (Kim and Ludwig, 1982).

With regards to the mouthparts, the most conspicuous modification observed, apart from the sharp mandibles, were the indented rigid prolongations located close to these organs (Fig. 2). In our opinion, these structures, as well as the mandibles, might be involved in obtaining host blood. Haematophagy has been reported in this species (Perez *et al.*, 1994), as well as in *Laemobothrion (L.) vulturis* (Zlotorzycka and Danecki, 1969; Srivastava, 1974). The arrangement, articulation, size and development of the legs of *L. maximum* might be associated with the species very fast locomotion in practically any direction: lateral, posterior-anterior and anterior-posterior, movements we have actually seen in live specimens during sampling. Moreover, the climbing organ makes the locomotion of this louse on very smooth surfaces like glass, metal or plastic very easy. This behaviour might compensate for its poor resistance to adverse conditions.

There is evidence that combs (both cephalic, femoral and sterno-abdominal) provide additional methods by which the lice attach to host feathers. The mechanism of combs might also be regarded as an adaptation that resists dislodgement, or capture, by the host, as in the case of fleas (Humphries, 1967; Kim, 1985) and other ectoparasitic insect groups. However, Marshall (1980) argued that combs in all ectoparasites, merely protect mobile joints and the membrane beneath.

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