

A first report on the morphology of the postantennal process in *Lernanthropus* (Lernanthropidae: Copepoda) and its possible significance as a taxonomic feature

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Received 3 December 1996; accepted 17 April 1997

Notes on the postantennal process as a category of cuticular spines of parasitic Copepoda are given. Arguments on the status of the postantennal process as an appendage are briefly compared. It is concluded that these structures are cuticular outgrowths and not appendages. The morphology of this structure is concisely compared in the Caligidae, Taeniacanthidae and Lernanthropidae. The structure of postantennal processes, based on light microscopy and scanning electron microscopy (SEM) studies, of five species of *Lernanthropus* (*L. capistroides* Olivier & Van Niekerk, *L. sarbae* Kensley & Grindley, *L. gisleri* Van Beneden, *L. sp.A* and *L. sp.B*) is discussed and illustrated. Morphological differences of possible taxonomic value are highlighted.

Keywords: Postantennal process, Lernanthropidae, *Lernanthropus*, parasitic Copepoda, St. Lucia

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Apart from the normal complement of segmental cephalic appendages, antennules to maxillipeds (Figure 1), parasitic copepods (or at least some forms of parasitic copepods) have additional structures that appear to have arisen as adaptations to a parasitic mode of life. Different categories, such as cuticular spines, rostral spines, sternal furca, adhesion pads, buccal stylets and lunules (Kabata 1979), are known. Because these structures are additional to normal appendages, it is usually very difficult to interpret their homology and functional purpose. In most instances, however, these are cuticular outgrowths of various kinds, presumably useful in attachment to the host.

Cuticular spines are the most common category of these structures and probably the best known and most controversial is the postantennal process. The latter is defined by Huys & Boxshall (1991) as a tapering, spinous process located on the ventral surface of the cephalothorax. To date, this process is known to appear in members of the families Caligidae (Siphonostomatoida) and Taeniacanthidae (Poecilostomatoida). However, not all members of these families have postantennal processes. In the Taeniacanthidae, the genera *Taeniacanthodes* and *Pseudotaeniacanthus* and the caligid genera *Abasia*, *Echetus*, *Haeniochophilus*, *Mappates*, *Pseudanuretes* and females of *Alicalgus* are devoid of postantennal processes (Kabata 1979). In the caligid genera *Caligus*, *Hermilius* and *Pseudocaligus*, a postantennal process may be present or absent, while it is only vestigial in species of *Dartevellia* (Kabata 1979). Pillai (1985) discusses 13 species of taeniacanthid parasites, but illustrates (with no text reference) postantennal processes for three species only. Members of Bomolochidae, close relatives of Taeniacanthidae, lack postantennal processes, but small paired spines are present medially on the rostrum.

In the description of *L. capistroides* (Olivier & Van Niekerk 1995a) a pair of papilla-like cuticular outgrowths posterolateral to the bases of the antennae was noted. Cuticular outgrowths in a similar position were also observed for *L. sarbae* (Olivier & Van Niekerk 1995b). They were at first

simply referred to as a pair of papillae (Olivier & Van Niekerk 1995a) and later postulated to be postantennal processes (Olivier & Van Niekerk 1995b). The latter was supported by Dr. G.A. Boxshall of the British Museum (Natural History) in a personal communication.

Lernanthropus, with more than 100 nominate species, is the largest genus of the family Lernanthropidae and is considered a common genus of parasitic copepods (Kabata 1993). Nevertheless, postantennal processes have never been reported for any of these species. This, and the fact that the postantennal processes of *L. capistroides* and *L. sarbae* show distinct morphological differences, prompted a study to investigate postantennal processes in other species of the genus. In this study the postantennal processes of *L. capistroides*, *L. sarbae*, *L. gisleri*, *L. sp.A* and *L. sp.B* are morphologically compared. The main objective is to determine whether the postantennal process can be used as an additional and/or secondary distinguishing taxonomic feature within the genus.

Material and methods

Host species of fish were sampled from Lake St. Lucia (Kwa-Zulu-Natal, South Africa) and included *Elops machnata* (Forsskål), *Acanthopagrus berda* Forsskål, *Rhabdosargus holubi* Steindachner, *Rhabdosargus sarba* Forsskål, *Johnius dussumieri* (Cuvier), *Otolithes ruber* (Schneider) and *Caranx sexfasciatus* Quoy & Gaimard. All hosts were collected using gill nets. Species of *Lernanthropus* were collected from gill filaments of the hosts and fixed in 70% ethanol. Cleaning the specimens of mucus and other debris was facilitated with the aid of a BRANSON 3200 ultrasonic cleaner after which the material was postfixed for 24 h in unbuffered 2% osmium tetroxide (OsO₄). After OsO₄-treatment, the specimens were washed several times in distilled water and left in distilled water overnight. Specimens were then dehydrated in graded ethanol (30%–100% at 5–10 min intervals), critical point dried (CPD) and sputter-coated for SEM-studies. For light microscopy, precleaned specimens, not treated in osmium

tetroxide, were cleared in lactophenol for 4–6 h. Temporary mounts were made using cavity slides and lactophenol as mounting medium.

Material examined

L. capistroides, 20 females and 5 males; *L. gisleri*, 3 females and 1 male; *L. sarbae*, 12 females and 9 males; *L. spA*, 5 females and 2 males; *L. spB*, 7 females and 2 males.

Results and Discussion

A number of arguments (relating to Caligidae and Taeniacanthidae) have been put forward on the status of the postantennal process as an appendage. Wilson (1905, 1911) and Heegaard (1945, 1947) postulated that the postantennal process is the maxillule. This contention was mainly based on two considerations, firstly the similarity in appearance and secondly the superficial similarity in nerve supply from the suboesophageal ganglion. Wilson (1911) also suggested the postantennal process to be the exopod of the maxillule. Counter arguments for the homology of the postantennal process with the maxillule were put forward by Lang (1946, 1948), principally taking ontogenetic sequences into account. However, in all of the parasitic copepods with a postantennal process (Caligidae, Taeniacanthidae and Lernanthropidae), a complete set of cephalic appendages (antennules to maxillipeds) are present as illustrated in Figure 1.



Figure 1 *Lernanthropus capistroides*, female, ventral view, cephalic region, an = antennule; at = antenna; cs = cephalic shield; mb = mandibular base; mc = mouth cone; mu = maxillule; mx = maxilla; mxp = maxilliped; pa = papilla of postantennal process; scale = 500 μ m.

The authors, therefore, accept the views of Kabata (1979) and Huys & Boxshall (1991) regarding the postantennal process as a cuticular outgrowth (representing an elaboration of a sclerite forming part of the ventral cephalosomic wall), and not a true appendage.

In Caligidae the postantennal process is posterolateral to the antenna, much in line with the maxillule. It is in the form of a simple, somewhat hooked spine-like sclerite with an inflated base. Occasionally a second, smaller spine may be present on the anterior margin of the base. Sensory setae, different in numbers and form for different species, are always associated with the postantennal process (Kabata 1979).

In Taeniacanthidae the postantennal process may resemble the caligid spine, but is never associated with sensory setae. It usually also lacks the prominently inflated base of the caligid postantennal process. Positioned in closer proximity to the antennule, the postantennal process may be seen in association with the armature of the ventral rostral area. In *Taeniastrotos* this involves the presence of a shield-like sclerotized plaque; in *Scolecicara* three prominent rostral spines are present posteriorly on an ill-defined medial cuticular ridge; other genera with postantennal processes bear a medial cuticular ridge, varying in shape. In genera devoid of postantennal processes, the rostral area contains spike-like rostral spines (*Taeniacanthodes*) or rostral spines associated with a denticulated diverging cuticular ridge as in *Pseudotaeniacanthus* (Kabata 1979).



Figure 2 *Lernanthropus sp.A*, male, general structure of postantennal process, cr = cuticular ridge; mr = medial ridge; pa = papilla; sp = posterolateral spine; scale = 100 μ m.

In Lernanthropidae the postantennal process is situated just posterior to the antenna, towards the lateral margin of the anteroventral cephalic region. It consists, in general, of the following (Figure 2): (1) a pair of relatively large, usually anteriorly-directed pommel-shaped papillae (pa), interconnected by a medial cuticular ridge (mr); (2) cuticular ridges (cr) anterior to the papillae and close to the base of the antennae, medially converging between the antennae and laterally blunt-ending; the inner posterior medial margin of cuticular ridges sometimes has small patches of ornamented integument (oi) (Figure 3); (3) in some species an additional, relatively small or large, erect spine (sp) is found lateral to posterolateral of the papillae (Figure 2).



Figure 3 *Lernanthropus gisleri*, male, detail of ornamented integument, oi = ornamented integument; scale = 10 μ m.



Figure 4 *Lernanthropus capistroides*, female, papilla of postantennal process, scale = 100 μ m.



Figure 5 *Lernanthropus capistroides*, male, postantennal process, cr = cuticular ridge; oi = ornamented integument; pa = papilla of postantennal process; scale = 50 μ m.

Postantennal process of *Lernanthropus capistroides*

Papillae (pa) pommel-shaped, posterolateral to the base of the antennae, setule-covered and sometimes partly obscured by the cephalic shield in the female (Figures 1&4), but smooth and unobscured in the male (Figure 5). Cuticular ridges (cr), in both sexes, slightly arched, laterally blunt-ending, attenuating anteriorly between the bases of the antennae. In the male, round patches of ornamented integument (oi) are present midway on the inner surface of the cuticular ridge. The additional spine (sp) is lacking in both sexes.

Postantennal process of *Lernanthropus sarbae*

Similar in both sexes. Papillae (pa) similar to that of *L. capistroides*, but covered with scattered spinules (Figure 6). Lateral to each papilla a second, very large, branched spine (sp), pedastalled on a rounded base, is present. The latter has only a few spinules.

Postantennal process of *Lernanthropus gisleri*

In the female (Figure 7) the papillae (pa) are sausage-like, elongated structures, with a conspicuously swollen tip, orientated much more laterally than anteriorly. In the male (Figure 8) the papillae are pommel-shaped with an elongated proximal section, distal section curved anteriorly. The cuticular ridges (cr) in both sexes are relatively large, peculiarly shaped with diverging anterior tips and medially separated by a prominent furrow (f). Two conspicuous ornamented patches

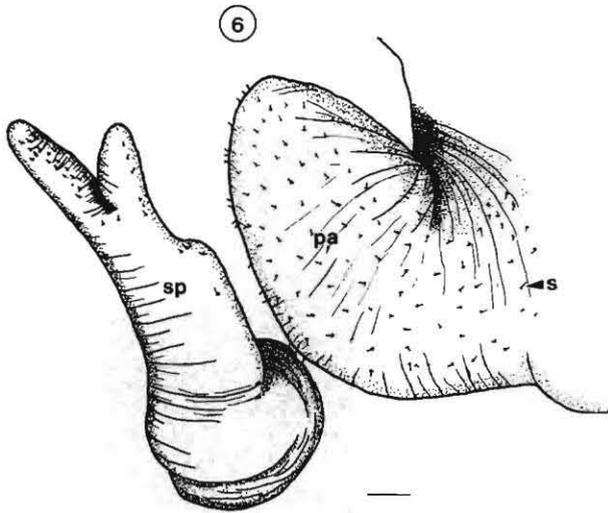


Figure 6 *Lernanthropus sarbae*, male, papilla and posterolateral spine of postantennal process, pa = papilla; s = spinule; sp = posterolateral spine; scale = 10 μ m.

(oi) are present on the inner posterior margin of the cuticular ridges (not observed in the female).

Postantennal process of *Lernanthropus* sp.A

In both sexes the papillae are noticeably smaller than in the other species. In the female (Figure 9) the papillae (pa) appear wrinkled. In the male (Figure 10) the papillae are smooth, curved more anteriorly than in the female and a small spine (sp) is present posterolateral to the papillae. The cuticular ridge (cr) is lunar-shaped in the male with a prominent medial division and two ornamented patches (oi) on the posterior inner margin. In the female the cuticular ridges are less prominently lunar-shaped, appearing more flattened and the ornamented patches are vastly reduced in size.



Figure 7 *Lernanthropus gisleri*, female, papilla of postantennal process, ant = anterior; at = antenna; pa = papilla of postantennal process; scale = 10 μ m.

Postantennal process of *Lernanthropus* sp.B

The papillae (pa) are smooth in the male (Figure 11), but scattered with few inconspicuous spinules in the female (Figure 12). In both sexes a small spine (sp) is present posterolateral to the papillae. In both male and female the cuticular ridges (cr) are club-shaped with relatively well developed lateral projections. In the female the cuticular ridges bear spinules similar to those of the papillae and the lateral tips of the cuticular ridges may sometimes be covered by the papillae (Figure 12).

Conclusion

From our study it is clear that there are morphological differences in the postantennal processes of different species of *Lernanthropus*. Although only five species have been studied, the shape of the cuticular ridges varies amongst species, e.g. *L. gisleri*, *L. spA* and *L. spB*. Prominent differences are

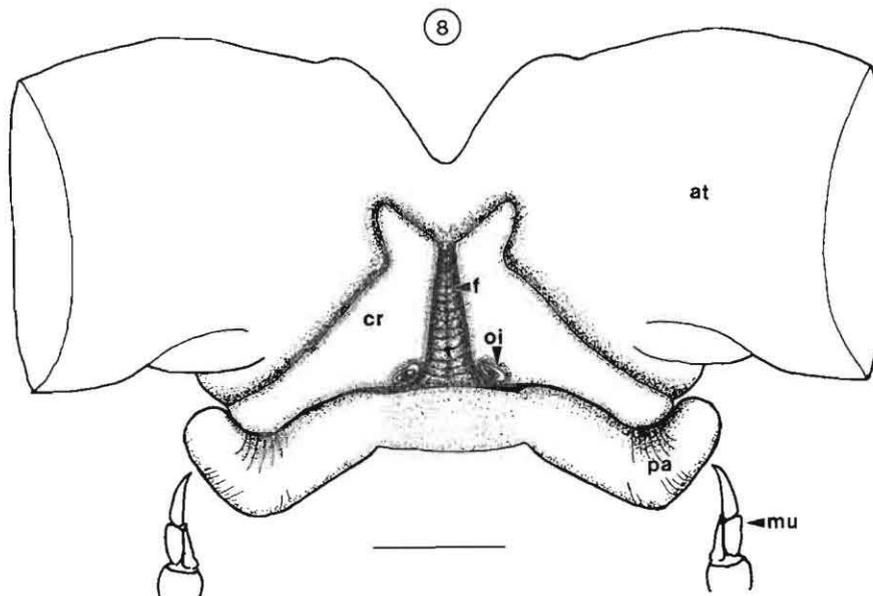


Figure 8 *Lernanthropus gisleri*, male, postantennal process, at = antenna; cr = cuticular ridge; f = furrow; mu = maxillule; oi = ornamented integument; pa = papilla; scale = 100 μ m.

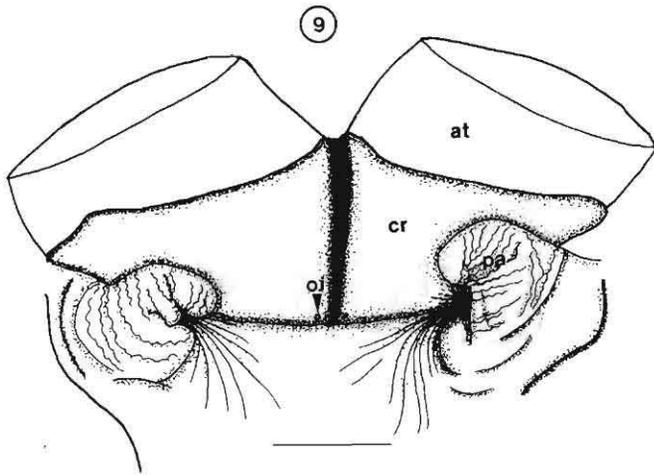


Figure 9 *Lernanthropus* sp.A, female, postantennal process, at = antenna; cr = cuticular ridge; oi = ornamented integument; pa = papilla; scale = 100 μ m.

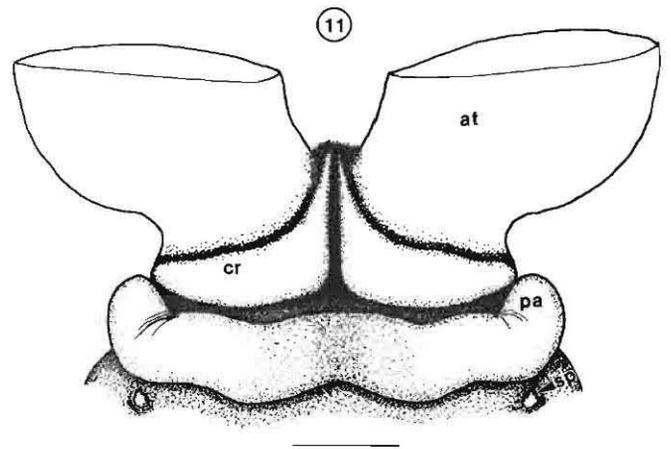


Figure 11 *Lernanthropus* sp.B, male, postantennal process, at = antenna; cr = cuticular ridge; pa = papilla; sp = posterolateral spine; scale = 100 μ m.

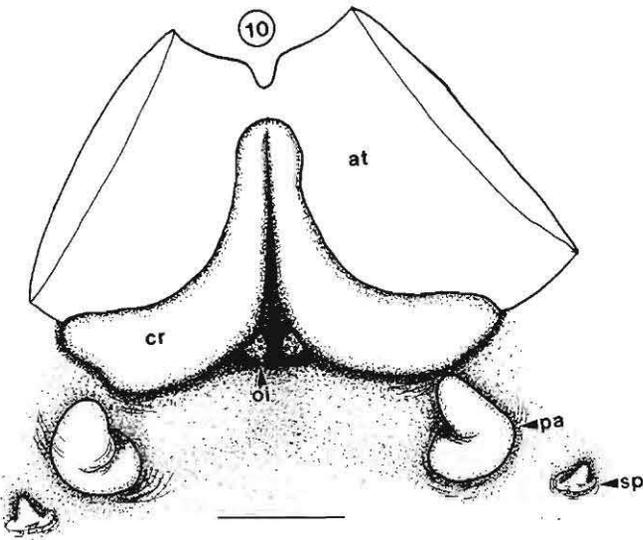


Figure 10 *Lernanthropus* sp.A, male, postantennal process, at = antenna; cr = cuticular ridge; oi = ornamented integument; pa = papilla; sp = posterolateral spine; scale = 100 μ m.

also observed concerning the papillae. The most outstanding difference is, however, to be found in the additional spine posterolateral to the papillae. The latter may be absent (*L. capistroides* and *L. gisleri*) or present (*L. sarbae*, *L. spA* and *L. spB*). If present it is either small (*L. spA* and *L. spB*) or very large and much more complex as in *L. sarbae*. The presence or absence of patches of ornamented integument on the cuticular ridges needs further investigation. Minor differences in the morphology of the postantennal processes between males and females of the same species were also observed.

Although not well documented or widely used, morphological differences of the postantennal processes are also present amongst members of the Caligidae and Taeniacanthidae. In Caligidae, for example, such differences are incorporated in identification keys to some species of *Caligus*, *Lepeophtheirus* (Kabata 1979; Pillai 1985) and *Heniochophilus* (Pillai 1985). It may, therefore, be possible to use morphological differences of the postantennal processes as

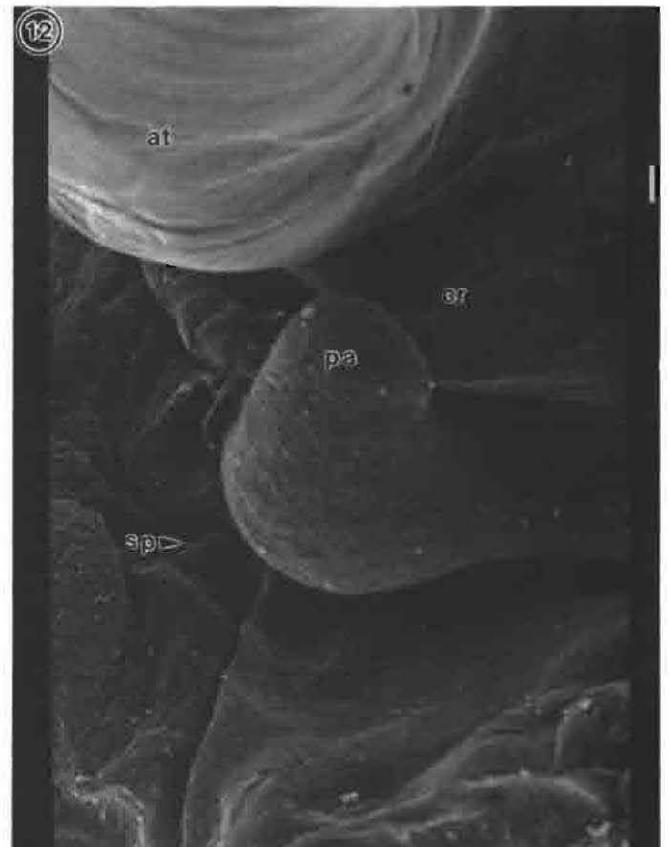


Figure 12 *Lernanthropus* sp.B, female, left papilla covering lateral projection of cuticular ridge, at = antenna; cr = cuticular ridge; pa = papilla of postantennal process; sp = posterolateral spine; scale = 10 μ m.

secondary taxonomic features. It is, however, strongly suggested that more data is required before this feature can be seen as one of key importance in distinguishing species of *Lernanthropus*.

Acknowledgements

The authors wish to thank the Natal Parks Board for support-

ing the study at Lake St Lucia, the Research Committee of the University of the North for financial assistance, the Department of Zoology and Biology and the EM-unit of the University of the North for technical assistance and the use of SEM-facilities.

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