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# A new species of *Anuretes* Heller, 1865 (Copepoda: Caligidae) from the yellowbanded sweetlips *Plectorhinchus lineatus* (Haemulidae) off New Caledonia

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**Abstract** A new species of caligid copepod, *Anuretes justinei* n. sp., is described from off New Caledonia. It is parasitic on the gill filaments of a haemulid fish, the yellowbanded sweetlips *Plectorhinchus lineatus* (Linnaeus). The new species is distinguished from its congeners by the combination of the following character states: (1) the fourth pedigerous somite is covered dorsally by the expanded free posterior margin of the cephalothorax; (2) a maxillary whip is present; (3) the relatively small genital complex is less than half the length of the cephalothorax; (4) leg 3 is armed with nine setae on the terminal exopodal segment and six setae on the terminal endopodal segment; and (5) leg 4 is long and slender with a setal armature of I, III twisted spines. The new species is an addition to the possibly monophyletic group of seven species that is characterised by the possession of a maxillary whip, all of which are found on haemulid hosts. The host-specificity of *Anuretes* is relatively high, its species being largely parasitic on reef-associated fishes, such as

the families Haemulidae (eight species), Ehippidae (four species), Acanthuridae (four species) and Pomacanthidae (one species).

## Introduction

*Anuretes* Heller, 1865 was established by Heller (1865) to accommodate species in the family Caligidae Burmeister, 1835 that lack a well-defined abdomen, within the group of genera without lunules on the paired frontal plates. One difficulty with the generic concept has been that the degree of reduction of the abdomen is variable; in some species a small but distinct abdomen is present, whereas in others the abdomen is fully incorporated into the genital complex and the caudal rami appear to originate directly from its surface. Shiino (1954) discussed the status of *Anuretes* and concluded that it had been used as a waste basket for those species which could not be placed in *Lepeophtheirus* von Nordmann, 1832. Yamaguti (1963) retained *Anuretes* as a distinct genus and erected a new subfamily to accommodate it together with *Pseudanuretes* Yamaguti, 1936. Ho & Dojiri (1977) further discussed the overlap between these two genera and recommended treating the species of *Anuretes* as members of *Lepeophtheirus*. However, it was Dojiri (1983) who resurrected *Anuretes* and distinguished it from *Lepeophtheirus* by a combination of six different characteristic features:

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(1) a vestigial abdomen; (2) a 2-segmented exopod of leg 3; (3) the absence of a basal swelling or fusion of it with the basal spine on the exopod of leg 3; (4) the absence of an inner plumose seta on the first endopodal segment of leg 3; and (5) a 2-segmented exopod on leg 4, in addition to the character state noted by Pillai (1967) that a pinnate seta is located on the surface between the two bifurcate distal spines on the terminal exopodal segment of leg 1. Finally, *Anuretes* was re-instated as a valid genus by Ho & Lin (2000), who provided a key to the 19 species recognised at that time, and this proposal was followed by Boxshall & Halsey (2004).

The new species of *Anuretes* described here was collected from the yellowbanded sweetlips *Plectorhinchus lineatus* (Linnaeus) that belongs to the family Haemulidae (grunts), by Prof. Jean-Lou Justine (IRD, Nouméa) as a part of a large survey of the metazoan parasites of the fishes of the New Caledonia region. Only a single species of *Anuretes* is described here, but numerous other caligids occur, including the newly described genus *Avitocaligus* Boxshall & Justine, 2005 (Boxshall & Justine, 2005). The host, *P. lineatus*, is widely distributed in the Indo-West Pacific: from the Ryukyu Islands to Micronesia, including the Philippines and Indonesia. It is a reef-associated fish that can be found in a depth range of 1–35 m, occurring singly or in aggregations along coral slopes of lagoons and seaward reefs (Froese & Pauly, 2006). The host-parasite relationships for *Anuretes* are discussed below.

## Materials and methods

The host fish, *Plectorhinchus lineatus*, was collected from a site close to Nouméa on the southern coast of New Caledonia. The copepods were removed from the gills of a single host and preserved in 70% ethanol. Specimens were later cleared in 85% lactic acid for 1–2 h before dissection in a drop of lactophenol on a slide. The dissected body parts and appendages were examined using differential interference contrast optics on an Olympus BX50 microscope at magnifications of up to  $\times 1,000$ . All drawings were made with the aid of a camera lucida. Measurements given are the mean followed by the range in parentheses (based on the holotype and four paratypes).

## Family Caligidae Burmeister, 1835

### Genus *Anuretes* Heller, 1865

#### *Anuretes justinei* n. sp.

*Type-host*: *Plectorhinchus lineatus* (Linnaeus) (family Haemulidae).

*Site*: Gill filaments.

*Type-locality*: Baie de Sainte Marie, off Nouméa, 22°31'40"S, 166°26'00"E, New Caledonia.

*Etymology*: The species is named for Prof. Jean-Lou Justine, (IRD, Nouméa, New Caledonia), who collected the material.

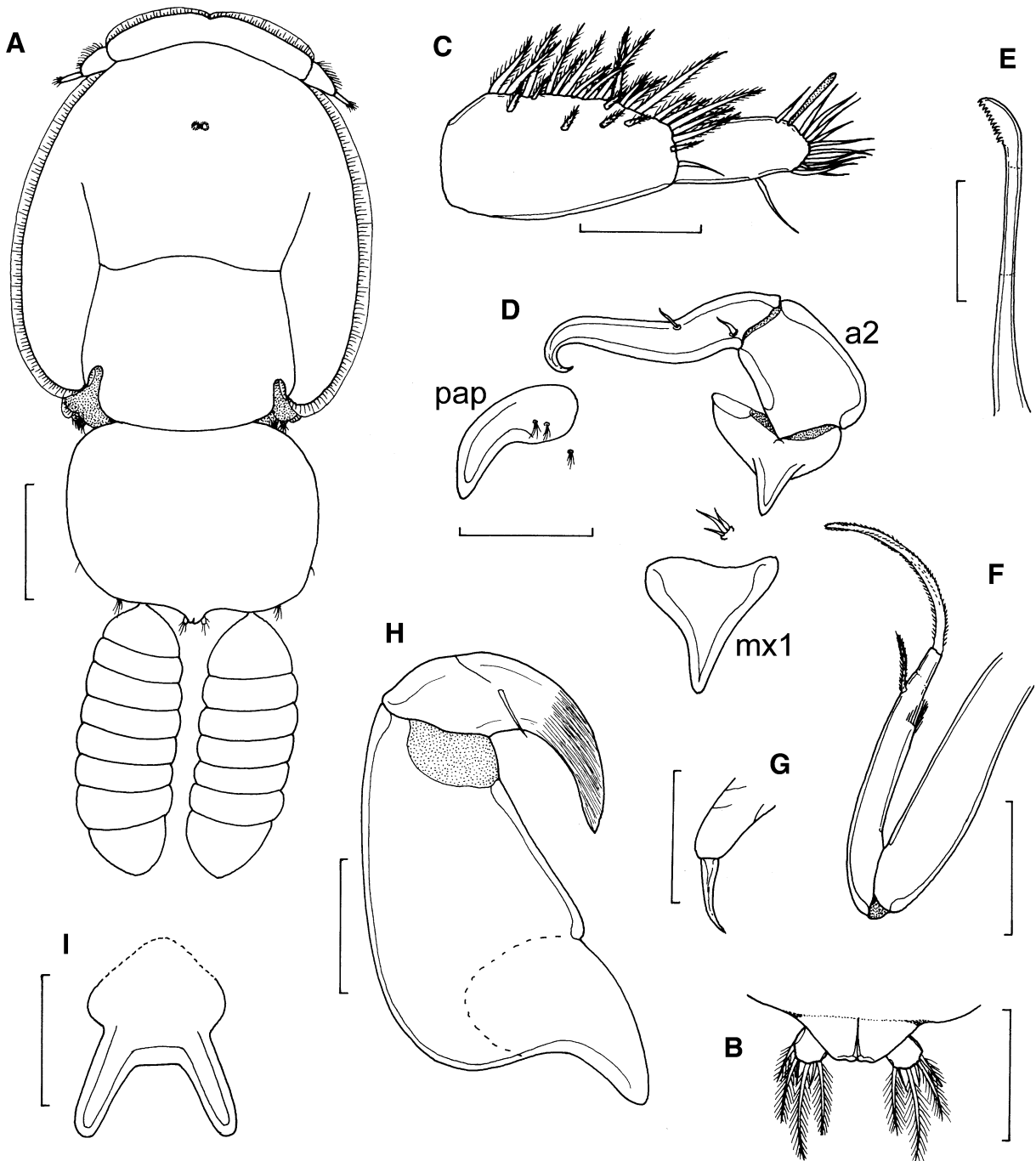
*Type-material*: Holotype female and 2 paratype females deposited in the collections of the Museum National d'Histoire Naturelle in Paris, registration numbers, MNHN Cp.2423 (Parasitological record JNC796B) and Cp.2424 (paratypes); 2 paratype females deposited in the collections of the Natural History Museum, London, registration numbers BMNH 2007.175–176. Females from *P. lineatus* caught in the Baie de Sainte Marie (7 August, 2003).

#### Description (Figs. 1–2)

##### *Adult female*

Mean body length (Fig. 1A) 1.15 (range 1.06–1.22) mm long, excluding caudal setae. Cephalothoracic shield longer than wide,  $0.76 (0.71–0.81) \times 0.61 (0.54–0.66)$  mm, excluding marginal hyaline membranes; cephalothorax more than twice as long as genital complex. Fourth pediger completely covered by long cephalothorax. Genital complex, rectangular, wider than long,  $0.37 (0.33–0.40) \times 0.48 (0.45–0.54)$  mm. Abdomen (Fig. 1B) reduced, bilobed, largely incorporated into posterior surface of genital complex. Caudal ramus (Fig. 1B) small, longer than wide, with 3 long and 3 short plumose setae. Egg-sac  $c.0.77 (0.76–0.78)$  mm in length, containing 7–10 eggs per sac.

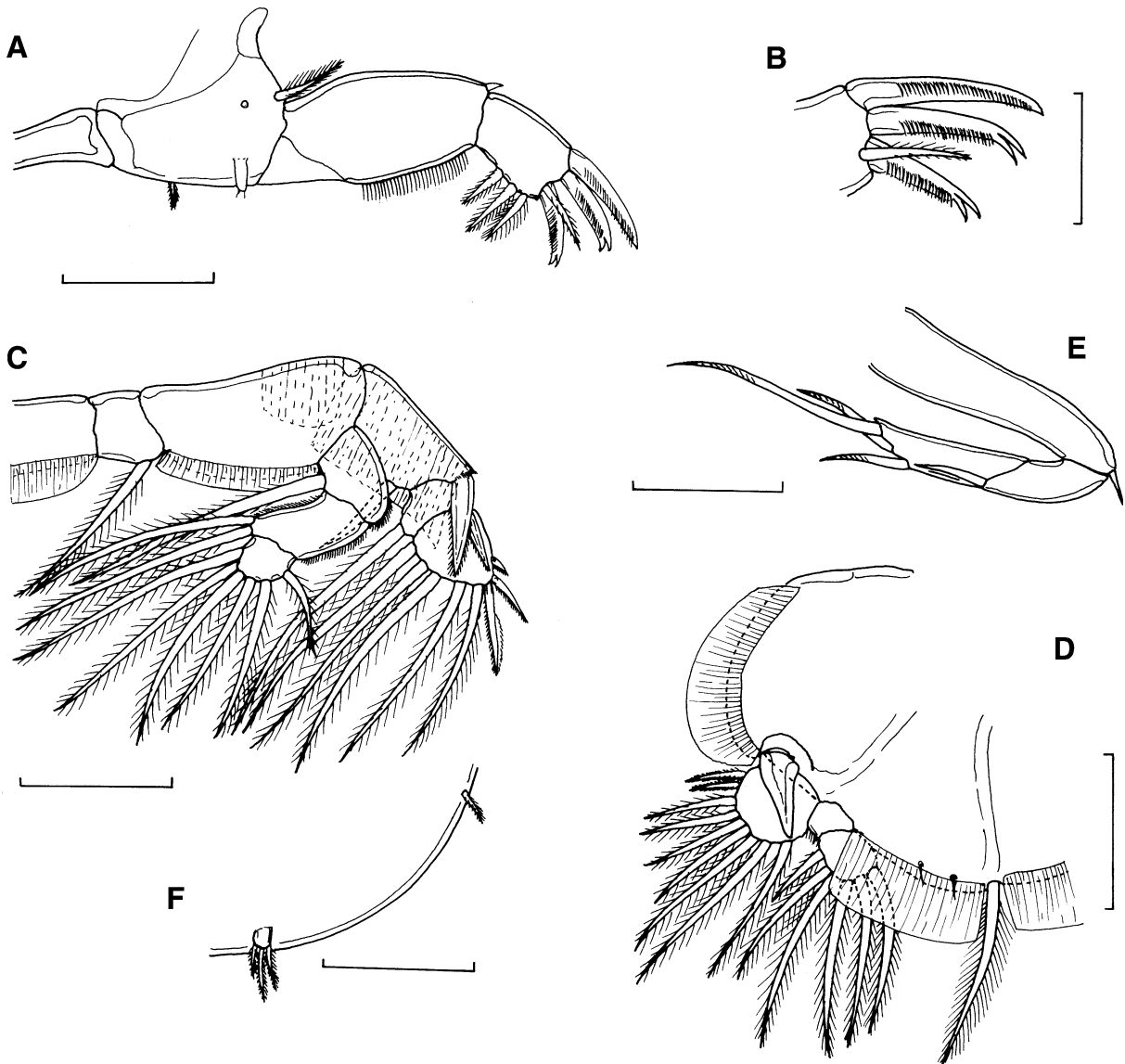
Antennule (Fig. 1C) 2-segmented; proximal segment with 27 setae; distal segment with 12 setae plus 1 aesthetasc subterminally. Antenna (Fig. 1D) 3-segmented; proximal segment small with acute, posteriorly-directed process; middle segment broad, unarmed; endopod forming curved distal claw bearing 1 seta proximally and another at mid-length. Postantennal process (Fig. 1D) curved, blunt, bearing 2 4-setulate papillae, with another small



**Fig. 1A–I** *Anuretes justinei* n. sp., holotype female: A, habitus dorsal view; B, abdomen and caudal rami, dorsal view; C, antennule, anteroventral view; D, antenna, postantennal process and maxillule *in situ*, ventral view; E, mandible; F, maxilla, ventral view; G, maxillary whip, ventral view; H, maxilliped, anterior view; I, sternal furca, ventral view. *Abbreviations*: a2, antenna; mx1, maxillule; pap, postantennal process. *Scale-bars*: A, 300  $\mu$ m; C, E, 60  $\mu$ m; B, D, F–I, 100  $\mu$ m

4-setulate papilla located on ventral cephalothoracic surface nearby. Maxillary whip (Fig. 1G) present as curved, pointed process located near maxilla.

Mandible (Fig. 1E) stylet-like, with 12 small, lateral teeth near apex. Maxillule (Fig. 1D) bearing 3 setae (1 long and 2 short) on anterior papilla; posterior



**Fig. 2A–F** *Anuretes justinei* n. sp., holotype female: A, leg 1, ventral view; B, distal armature of leg 1 exopod; C, leg 2, ventral view; D, leg 3, ventral view; E, leg 4, ventral view; F, leg 5, ventral view *in situ*. Scale-bars: A, C–F, 100 µm; B, 60 µm

process pointed. Maxilla (Fig. 1F) 2-segmented; syncoxa large, unarmed; basis slender, bearing short subapical process and long, curved subchela, ornamented with irregular strips of hyaline membrane. Maxilliped (Fig. 1H) incompletely 3-segmented; proximal segment large, unarmed; middle segment small, fused, with terminal segment forming acutely-pointed claw with medial seta. Sternal furca (Fig. 1I) present; tines slightly divergent, with rounded tips extending posteriorly beyond intercoxal sclerite of leg 1.

Spine and setal formula of legs 1–4 (Fig. 2A–E) as follows: (Roman and Arabic numerals indicate spines and setae, respectively)

	Coxa	Basis	Exopod	Endopod
Leg 1	(1–1)*		I-0; III + 1,3	vestigial
Leg 2	0–1	0–0	I-1; I-1; II,I,5	0–1; 0–2; 6
Leg 3	(0–1)*		I-0; 9	0; 6
Leg 4	(1–0)*		I-0; III	

\* Single protopodal segment defined.

Leg 1 (Fig. 2A) with outer and inner plumose setae on protopod; vestigial endopod with distal setal vestiges. Plumose setae on posterior margin of distal exopodal segment small; distal margin spines gradually decreasing in length from outer to inner, each ornamented with row of dense spinules along inner margin; second and third spines with bifurcate tips; distal margin seta offset, originating on ventral surface of segment between second and third spines (Fig. 2B). Leg 2 (Fig. 2C) with outer margin of first and second endopodal segments ornamented with fine setules. Leg 3 (Fig. 2D) fused medially to broad intercoxal sclerite, forming wide apron. Leg 4 (Fig. 2E) comprising 3 segments; protopodal segment with outer distal seta; second and third segments (= exopod) subequal in length, armed with 1 and 3 long, twisted, slender (aserrate) spines, respectively. Leg 5 (Fig. 2F) represented by isolated seta and by exopodal lobe bearing 3 plumose setae on margin of genital complex. Leg 6 represented by unarmed operculum closing off genital aperture on each side.

#### Remarks

In *Anuretes* only four species from the Indo-West-Pacific (*A. branchialis* Rangneker, 1953, *A. occultus* Ho & Lin, 2000 (see Prabha & Pillai, 1983), *A. plataxi* Prabha & Pillai, 1986 and *A. plectorhynchi* Yamaguti, 1936) have their fourth pedigerous somite totally covered dorsally by the expanded free posterior margin of the cephalothorax. Three of these have a setal armature of leg 4 exopod as I, III, the exception being *A. plataxi* which has an armature of I, IV. The new species from New Caledonia shares this characteristic, and has a leg 4 exopodal armature of the I, III type. Apart from these species, in all other 15 *Anuretes* species the fourth pedigerous somite is not covered by the free margin of the cephalothorax.

The new species closely resembles *A. plectorhynchi* but differs in the following key features: it has nine setae on the exopod of leg 3 (cf. eight in *A. plectorhynchi*) and a maxillary whip is present (absent in *A. plectorhynchi*). The genital complex is box-shaped and of moderate size in the new species but is small and triangular in *A. plectorhynchi*. It differs from *A. branchialis*, which has a relatively larger genital complex and the expanded posterior margin of the cephalothorax covers up to a quarter of

the genital complex as well as the fourth pedigerous somite. *A. occultus* has even a larger genital complex than the other three species (Prabha & Pillai, 1983).

#### Discussion

The so-called maxillary whip is an enigmatic structure. It appears to be a novel structure arising as an outgrowth on the ventral surface of the cephalothorax, rather than representing a modified paired limb, since all members of the limb series are present in their normal caligid configuration in addition to the maxillary whip. The maxillary whip is present in seven species only: *A. anomalus* Pillai 1967, *A. grandis* Ho & Lin, 2000, *A. hoi* Prabha & Pillai, 1986, *A. occultus*, *A. rotundigenitalis* Hameed, 1976, *A. similis* Ho & Lin, 2000 and the new species. These seven species all exhibit the setal formula I, III for leg 4 exopod, rather than either I, II or I, IV, which are the other known states for the ramus, but this is not an exclusive correlation, since some species with the I, III formula lack a maxillary whip.

There is some evidence that the group of species possessing a maxillary whip represents a monophyletic lineage within the genus; all seven of these species are found in the Indo-Pacific and all utilise grunts (family Haemulidae) of the genera *Plectorhynchus* and *Diagramma* as hosts, although in the case of *A. anomalus* only a second host family has been reported (the Ehippidae). We consider it likely that the presence of the maxillary whip is synapomorphic to a small group of Indo-Pacific species, the ancestor of which may have utilised a haemulid as host. The new species belongs to this group.

#### Host-specificity

In total, *Anuretes* has been recorded from 15 families of fishes in tropical and subtropical waters around the world (Ho & Lin, 2004). Seventeen of the 20 species are typically found on reef-associated families, the Haemulidae (eight species), Ehippidae (four species), Acanthuridae (four species) and Pomacanthidae (one species), while the few remaining species utilise non reef-associated host families, such as the Zeidae (one species), Sparidae (one species) and Polynemidae (one species) (Froese & Pauly, 2006). The zoogeographical distribution shows that 16 species of *Anuretes* are

found on hosts from the Indo-West Pacific, two from the Central Pacific and two from the Atlantic.

The closely related *Lepeophtheirus* has about 109 valid species (Boxshall & Halsey, 2004) compared to only 20 species in *Anuretes*. As noted in the introduction, there has been considerable confusion over the differentiation between *Anuretes* and *Lepeophtheirus*. Interestingly, although some species of *Lepeophtheirus* are parasitic on reef-associated fish families such as the Acanthuridae and Chaetodontidae (see Boxshall & Halsey, 2004), they have not yet been reported from the Haemulidae. Similarly, *Pseudanuretes* Yamaguti, 1936 utilises members of the reef-associated families Chaetodontidae, Ehippidae and Pomacanthidae as hosts (Yamaguti, 1936, 1963), but is also unknown from species of the Haemulidae. Whereas *Kabatella* Prabha & Pillai, 1984 is exclusively reported from fishes of the family Haemulidae (see Boxshall & Halsey, 2004).

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