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Two species of *Caligus* (Copepoda: Siphonostomatoida) parasitic on fishes from southern Africa

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Two species of the siphonostomatoid copepod genus *Caligus* are described. *Caligus mortis* Kensley, 1970, collected from the super klipfish *Clinus superciliosus* (Linnaeus, 1758), rocksucker *Chorisochismus dentex* (Pallas, 1769), horned blenny *Parablennius cornutus* (Linnaeus, 1758) from Namibia and South Africa, is redescribed from the holotype and other specimens. In addition, a new species, *Caligus saucius*, is reported from the blenny *Cirripectes castaneus* (Valenciennes) collected at Kwazulu Reef, South Africa. It is distinguished from all its congeners by a 1-segmented exopod of leg 4 with only two spines at the tip.

KEYWORDS: Siphonostomatoida, Caligidae, *Caligus*, Parasitic copepod, Tidepool fishes, Southern Africa.

Introduction

Eighteen species of *Caligus*, a genus of parasitic copepods belonging to the family Caligidae, have been reported from several marine fishes of South Africa by various investigators (Barnard, 1948, 1955 a, b, 1957; Kensley and Grindley, 1973; Cressey and Cressey, 1980). The species are (in alphabetical order): *C. aesopus* Wilson, 1920; *C.* cf. *affinis* Heller, 1866; *C. arii* Bassett-Smith, 1898; *C. bonito* Wilson, 1905; *C. brevicaudatus* Scott, 1901; *C. confusus* Pillai, 1961; *C. coryphaenae* Steenstrup and Lütken, 1861; *C. engraulidis* Barnard, 1948; *C. hottentotus* Barnard, 1957; *C. labracis* Scott, 1902; *C. lalandei* Barnard, 1948; *C. lunatus* Wilson, 1928; *C. mauritanicus* Brian, 1924; *C. mortis* Kensley, 1970; *C. pelamydis* Krøyer, 1863; *C. rapax* Edwards, 1840 (now *C. elongatus* Nordmann, 1832); *C. tetrodontis* Barnard, 1948; and *C. zei* Norman and Scott, 1906. In addition, Kensley and Grindley (1973) described *C. penrithi* from *Cheilodactylus fasciatus* Lacépède from Möwe Bay, in nearby Namibia. *Caligus mortis* is redescribed from the holotype and other specimens on loan from the South African Museum to Dr Brian Kensley. In addition, *Caligus saucius* n. sp., collected from the blenny *Cirripectes castaneus* (Valenciennes) at Kwazulu Reef, South Africa by Dr Jeffrey T. Williams, is described below.

Specimens were cleared in 85% lactic acid for at least 24 hours before measurements were taken; they were then dissected according to the wooden slide procedure of Humes and Gooding (1964). Drawings were made with the aid of a drawing tube. Type specimens have been deposited in the Division of Crustacea, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

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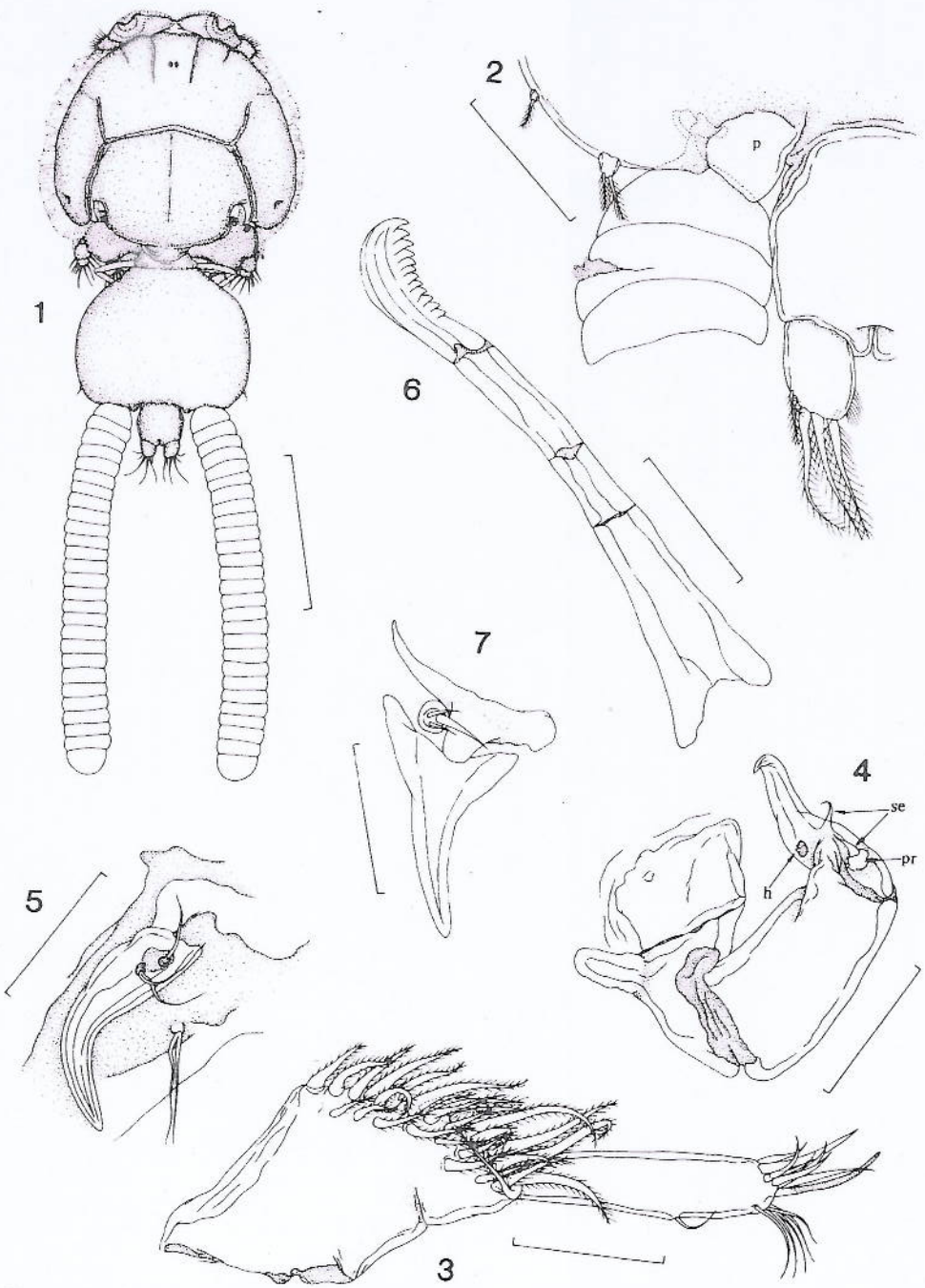


FIGS 1–7. *Caligus mortis* Kensley, female: 1, body, dorsal; 2, posterolateral corner of genital complex, anal segment, and caudal ramus, ventral; 3, first antenna, ventral; 4, second antenna, ventral; 5, postantennal process, ventral; 6, mandible, ventral; 7, first maxilla, ventral. Scales: 1·0 mm in 1; 0·2 mm in 2; 0·1 mm in 3–7. Symbols: p = posterior process; h = hyaline papillae; se = setae; pr = protrusion.

Description

Caligus mortis Kensley, 1970

(Figs 1–17)

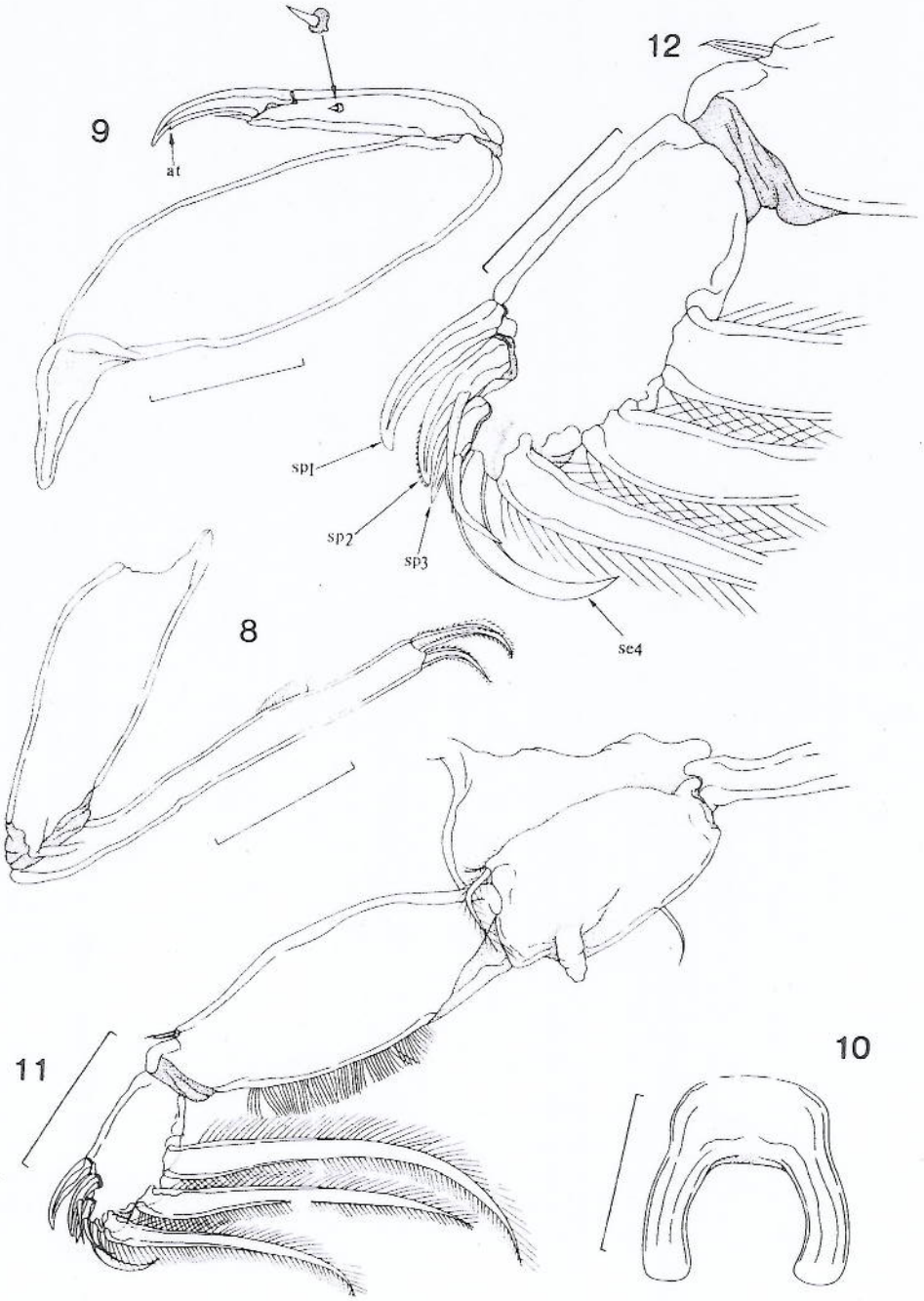
Material examined. 1 female holotype (SAM A12708) caught in intertidal rock pools at Rocky Point, Namibia, 18°59′S 12°29′E, October 1968; 2 females (SAM A11814) from super klipfish *Clinus superciliosus* (Linnaeus, 1758) at Schaapen Island, Saldanha, South Africa; 1 female (SAM A12990) from horned blenny *Blennius cornutus*, now *Parablennius cornutus*, (Linnaeus, 1758) at Swakopmund, Namibia; 1 female (SAM A12991) from rocksucker *Chorisochismus dentex* (Pallas, 1769) at Möwe Point, Namibia; 2 females (SAM A12993) from *Clinus superciliosus* at Möwe Point, Namibia. All specimens on loan from South African Museum to Dr Brian F. Kensley, Smithsonian Institution.

Female. Body short, as in Fig. 1. Total length (excluding setae on caudal ramus) 2·62 mm (2·23–2·88 mm) based on 6 specimens. Cephalothorax suborbicular, narrower at anterior end, and 1·41 mm (1·23–1·50 mm) × 1·38 mm (1·20–1·53 mm); tip of first antenna not extending to lateral margin of cephalothorax; posterolateral corner of lateral zone with conspicuous sensory pit; free margin of thoracic zone extending well beyond posterior limit of lateral zone; thoracic zone larger than cephalic. Frontal plate well developed with moderate size lunules. Fourth pedigerous segment about 2 × wider than long, 0·10 mm (0·09–0·11 mm) × 0·28 mm (0·23–0·31 mm). Genital complex, tapered anteriorly, wider than long, 0·69 mm (0·63–0·77 mm) × 0·85 mm (0·77–0·88 mm), and bearing a small, triangular, posteroventral process (Fig. 2) between abdomen and egg sac attachment area. Abdomen 1-segmented, slightly wider than long, 0·19 mm (0·15–0·22 mm) × 0·21 mm (0·19–0·24 mm). Caudal ramus (Fig. 2) longer than wide, 132 μm (118–149 μm) × 93 μm (87–99 μm), and equipped with 6 pinnate setae.

First antenna (Fig. 3) 2-segmented; first segment stout, carrying 27 anteroventral and 2 anterodorsal pilose setae; second segment slender, cylindrical, with 13 setae + 1 aesthete (2 posterior setae sharing common base). Second antenna (Fig. 4) 4-segmented; first segment unarmed; second segment with spatulate posteriorly-directed spiniform process; third segment large, quadrangular, and without usual dorsal adhesion pad; terminal segment a curved claw with 2 setae (proximal one borne on protrusion) and circular pit carrying 2 minute hyaline papillae. Postantennal process (Fig. 5) a curved tine, gradually tapered, with 3 groups of setules.

Mouth tube longer than wide, 217 × 186 μm, and similar to that of *Caligus saucius* (see Fig. 25). Mandible (Fig. 6) with third and fourth parts noticeably separated; terminal part bearing transparent membrane on lateral surface and 12 teeth on medial margin. Dentiform process of first maxilla (Fig. 7) with wide base and slightly curved tapering process. Second maxilla (Fig. 8) brachiform as in congeners; serrated flabellum at midlength of brachium; calamus with 4 serrated membranes; canna with only 2. Maxilliped (Fig. 9) with corpus naked; shaft and claw clearly separate on ventral surface; former with small, hyaline, setiform process in small pit and 1 naked seta on inner distal corner; latter with minute accessory tooth near inner distal end. Sternal furca (Fig. 10) with relatively small base; tines not tapered, curving inward, slightly flared, and truncate at tip.

Leg 1 (Figs 11, 12) biramous; sympod with 1 lateral pinnate and 1 medial naked setae; usual lateral setule on basal portion of sympod not seen in specimen, possibly broken off during collection or dissection. Exopod 2-segmented; first segment with



FIGS 8–12. *Caligus mortis* Kensley, female: 8, second maxilla, dorsal; 9, maxilliped, ventral; 10, sternal furca, ventral; 11, leg 1, ventral; 12, tip of leg 1 exopod, ventral. Scales: 0·1 mm in 8–11; 0·05 mm in 12. Symbols: at = accessory tooth; sp1–3 = spines 1–3; se4 = seta 4.

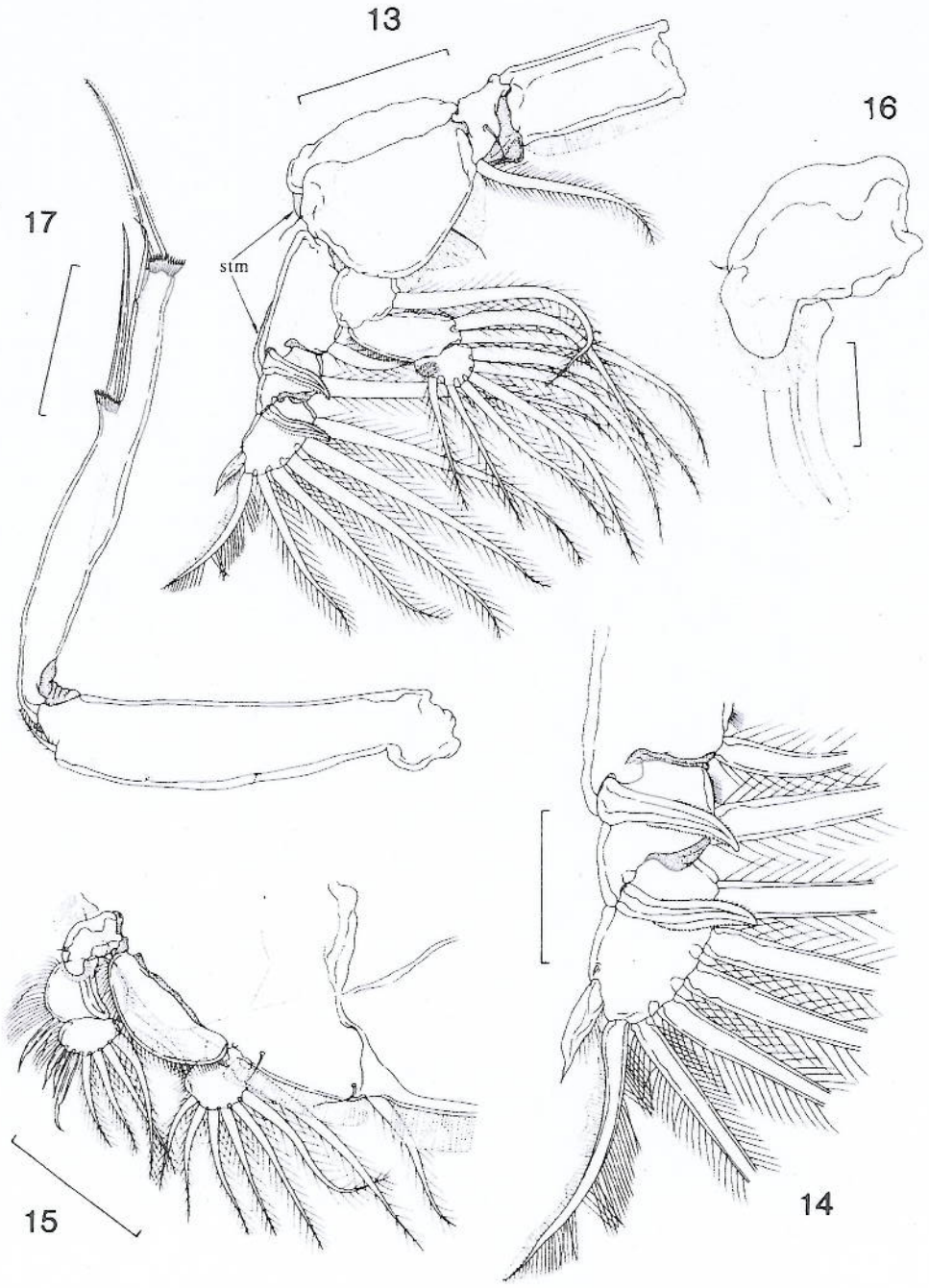
lateral distal spine and medial row of setules; second segment (Fig. 12) with 3 spines (2 with hyaline, setiform accessory processes; process of spine 3 extending to about midlength of seta 4), a naked seta 4, and 3 large pinnate medial setae. Endopod a reduced lobe. Leg 2 (Figs 13, 14) with coxa bearing 1 medial pinnate seta and 1 setule near intercoxal plate; basis with 1 small, naked lateral seta, 1 long medial setule, and a striated membrane along medial margin. Exopod (Fig. 14) 3-segmented with formula I-1, I-1, II,I,5; first exopodal spine curved, without row of minute spinules at base; second exopodal spine sigmoid; both spines with serrated membranes along 2/3 length of outer and inner margins; terminal exopodal segment (Fig. 14) with 1 minute outer spine, 1 hyaline element, 1 terminal seta with striated membrane along outer margin and pinnae on inner margin, and 5 inner pinnate setae. Endopod (Fig. 13) with formula 0-1, 0-2, 6; second endopodal segment with outer and inner rows of setules; third segment with prominent ventrolateral patch of spinules. Leg 3 (Fig, 15) with sympod bearing 2 small, dorsal, corrugated adhesion pads (see leg 3 of *C. saucius*, Fig. 36), striated marginal membranes, 1 lateral (dorsal to insertion of exopod) and 1 medial pinnate setae. Exopod 3-segmented; large exopodal spine (Fig. 16), without lateral flange, subterminally situated on basal swelling which bears terminal striated membrane and lateral setule; second and third segments with formula I-1, III,4, and having rows of setules on lateral margins. Endopod (Fig. 15) 2-segmented; first segment expanded laterally into velum on outer margin and bearing 1 pinnate seta on medial margin; velum subovoid, flat, and setulated along free margin; second segment with 6 pinnate setae and outer row of setules. Leg 4 (Fig. 17) with sympod bearing 2 setules and 1 distal pinnate seta; exopod indistinctly 2-segmented with formula I, II; first spine, almost as long as terminal spine, naked and bearing pectinate membrane at base; second spine relatively short, naked, not highly sclerotized, without pectinate membrane; terminal spine with 2 rows of serrated membranes and equipped with pectinate membrane at base. Leg 5 (Fig. 2) represented by 2 setiferous lobes; anterior lobe with 1 pinnate seta; posterior one with 2 pinnate setae.

Remarks. Caligus mortis was first described by Kensley (1970) from intertidal rock pools at Rocky Point and Torra Bay, Namibia. The specimens were not collected from any hosts, but from the water. However, Kensley noted that four species of fish, *Chorisochismus dentex*, *Clinus superciliosus*, *Blennius cristatus*, and *Parablennius cornutus*, were possible hosts. Additional collections of *C. mortis* indicate that three of the four are indeed hosts for this parasite. *Blennius cristatus* has not yet been confirmed as a host for *C. mortis*.

The majority of the species of *Caligus* possess three terminal spines on the exopod of leg 4. Only nine species of the over 200 known species of this genus have been described as bearing two spines at the tip of leg 4. They are (in alphabetical order): *C. atromaculatus* Wilson, 1913; *C. centrodonti*; *C. distortus* Pillai and Natarajan, 1977; *C. engraulidis* Barnard, 1948; *C. labracis*; *C. mortis*; *C. pageti* Russell, 1925; *C. saucius* n. sp. (described below), and *C. sensorius* Heegaard, 1962.

Only four congeners of *C. mortis* (*C. centrodonti*, *C. labracis*, *C. pageti*, and *C. sensorius*) have a 2-segmented exopod of leg 4 with the formula I, II. *Caligus mortis* can be distinguished from these species by the shape of the sternal furca, and the morphology and relative lengths of the exopodal spines of leg 4, particularly the setiform nature of spine 2, and spine 1 almost equal in length to the terminal spine.

Since the small, naked, subterminal spine ('second spine') of the terminal exopodal segment of leg 4 is so far removed from the tip of the ramus, the homology of this spine is not known. In many species of *Caligus* the exopod is 3-segmented with the armature



FIGS 13–17. *Caligus mortis* Kensley, female: 13, leg 2 and intercoxal plate, ventral; 14, leg 2 exopod, ventral; 15, leg 3, ventral; 16, leg 3 exopod spine, ventral; 17, leg 4, ventral. Scales: 0·2 mm in 13, 15; 0·1 mm in 14, 17; 0·03 mm in 16. Symbol: stm = striated membrane.

formula I-I-III. From this character state two evolutionary scenarios are likely. The second exopodal segment and associated spine may have been suppressed during development, and, consequently, absent in the adult along with the absence of the middle spine of the terminal segment. Therefore, in the first scenario, the 'second spine' is homologous to the outermost (proximal-most) spine of the apical elements of leg 4. This spine, however, is located in a subterminal position rather than at the tip. This explanation requires a displacement of the spine to a more proximal position.

In the second possible scenario, the second exopodal segment became indistinguishably fused to the terminal segment but retained its spine. In addition, the terminal segment lost both the outermost and middle spines and retained only the innermost spine. In this case, the 'second spine' represents the spine associated with the second, now obsolete, exopodal segment rather than one of the apical spines. However, since the spine of the second exopodal segment is always located in a much more proximal position than the present location of the 'second spine', this scenario requires a migration of the spine distally. Both explanations require a displacement of the spine from its location in the plesiomorphic state to its present subterminal location. An examination of the developmental stages of this species may help elucidate the homology of this spine.

Caligus saucius n. sp.

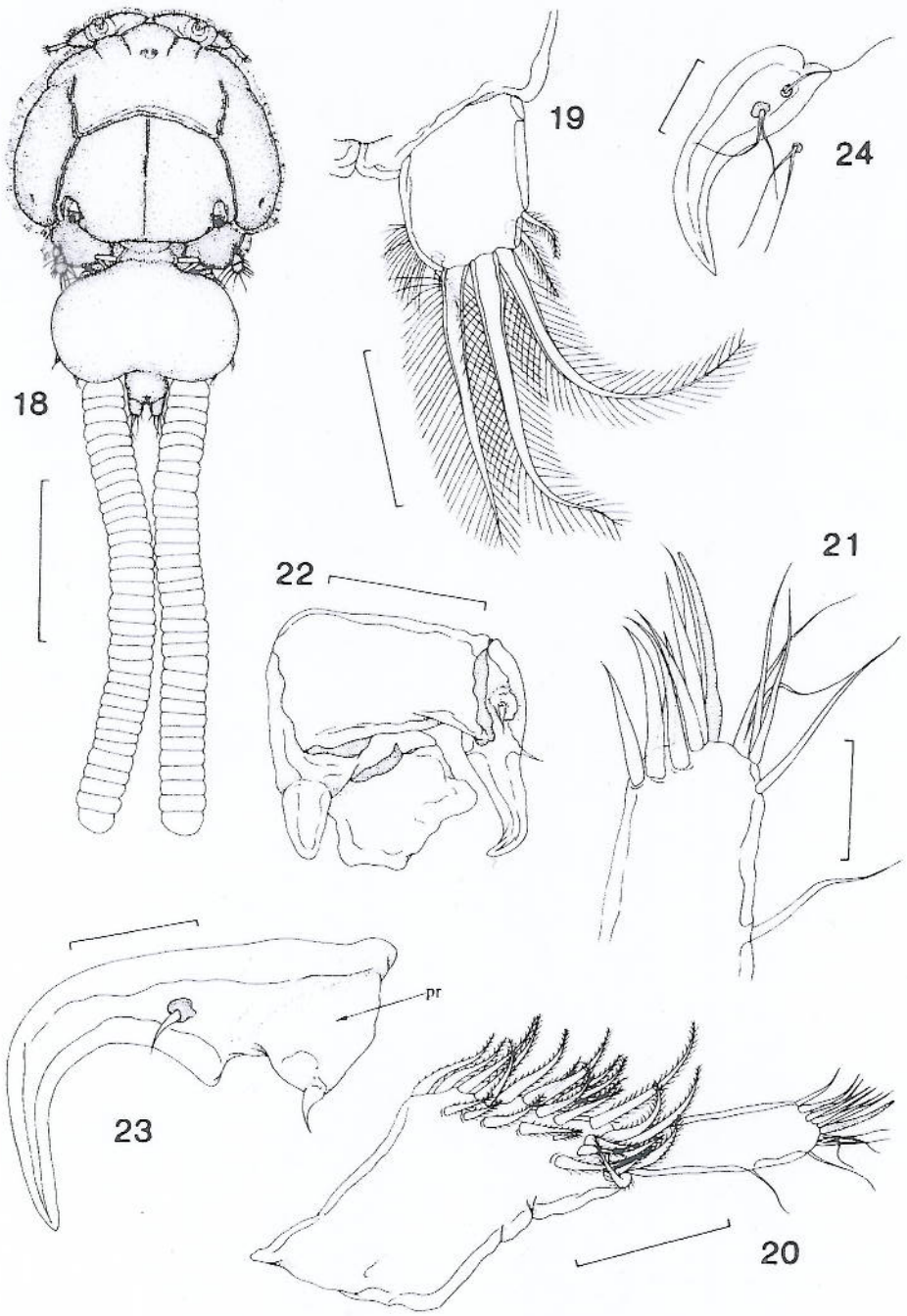
(Figs 18–39)

Material examined. 1 female holotype (USNM 229988) and 2 female paratypes (USNM 229989) (1 female dissected; slide in collection of author) from *Cirripectes castaneus* (Valenciennes) collected at Kwazulu Reef, 6·5 km north of Island Rock, South Africa on 28 July 1976; copepods removed from host by Dr J. T. Williams.

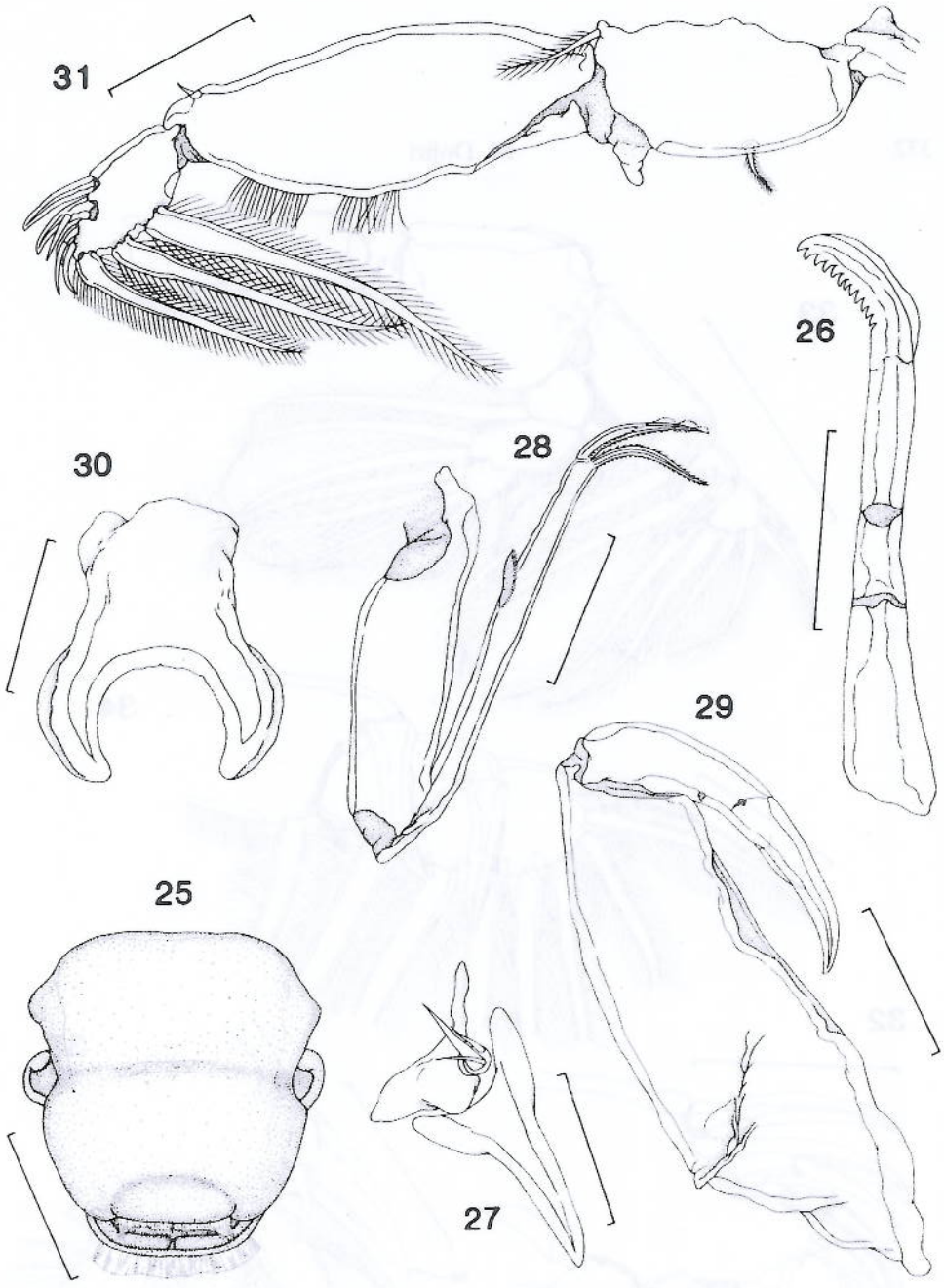
Female. Body short and stout as in Fig. 18. Total length (excluding setae on caudal ramus) 2·54 mm (2·49–2·63 mm) based on 3 specimens. Cephalothorax suborbicular, broader than in *C. mortis*, and 1·51 mm (1·48–1·53 mm) × 1·67 mm. Frontal plate well developed with moderate size lunules. Fourth pedigerous segment almost 4 × wider than long, 0·11 mm (0·09–0·11 mm) × 0·41 mm (0·38–0·43 mm). Genital complex suborbicular, wider than long, 0·70 mm (0·67–0·77 mm) × 1·12 mm (1·01–1·19 mm). Abdomen 1-segmented, slightly wider than long, 0·22 mm × 0·30 mm (0·29–0·31 mm). Caudal ramus (Fig. 19) longer than wide, 112 × 81 μm, with medial row of setules, and bearing 6 pinnate setae.

First antenna (Fig. 20) 2-segmented; first segment robust, carrying 29 pilose setae (only 28 figured; 1 broken off in specimen illustrated); second segment (Fig. 21) cylindrical, not as slender as in *C. mortis*, bearing 13 setae and 1 aesthete (2 posterior setae sharing common base). Second antenna (Fig. 22) 4-segmented; second segment with stout, tapered, posteriorly-directed spiniform process with bluntly rounded tip; third segment quadrangular and without usual dorsal adhesion process; terminal segment a curved claw (Fig. 23) bearing 2 setae (proximal one arising from globular protrusion). Postantennal process (Fig. 24) a curved tine, abruptly tapered, with 3 groups of setules.

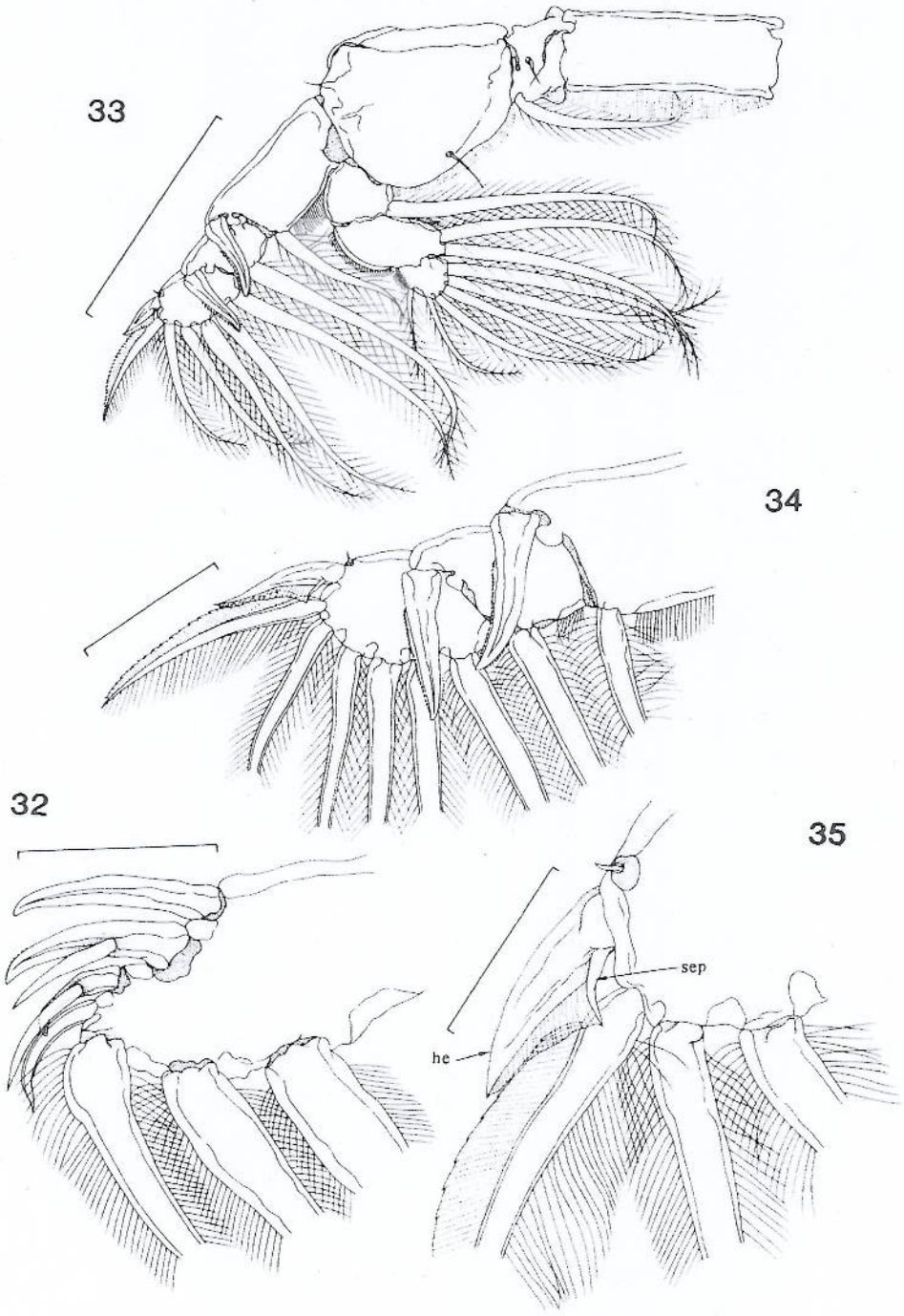
Mouth tube (Fig. 25) longer than wide, 202 × 187 μm. Mandible (Fig. 26) with third and fourth parts indistinctly separated. First maxilla (Fig. 27) with relatively straight tapering process. Second maxilla (Fig. 28) with calamus and canna longer and more slender than in *C. mortis*. Maxilliped (Fig. 29) with corpus bearing cuticular fold on ventral surface; shaft and claw partially fused; former with small, hyaline, setiform



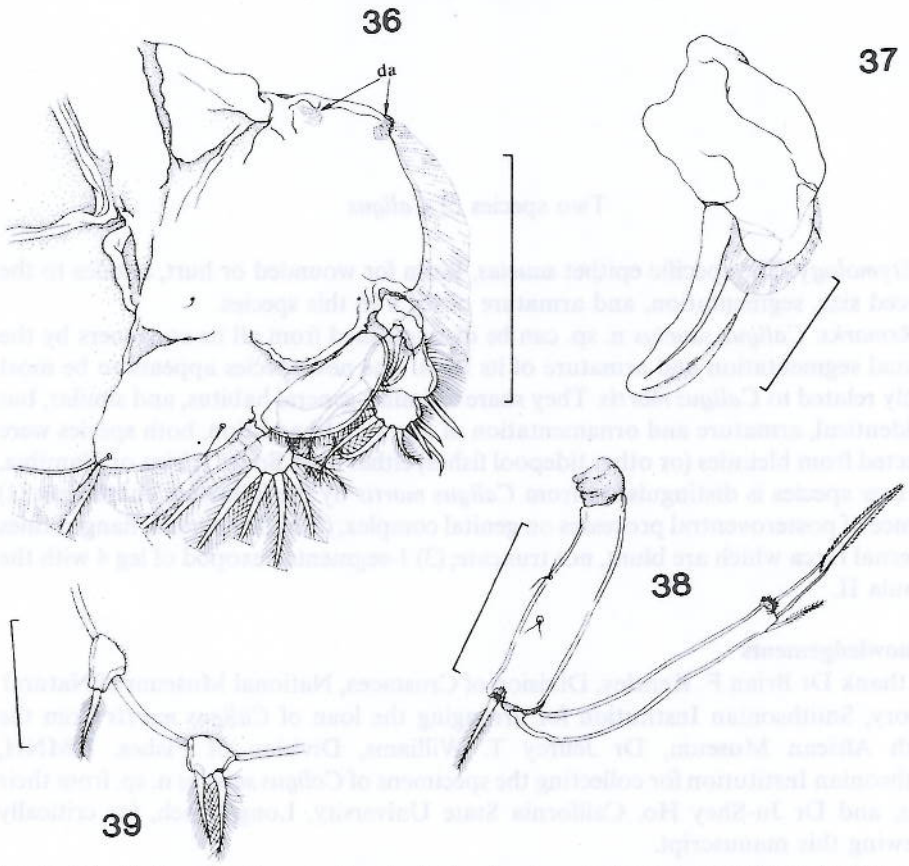
FIGS 18–24. *Caligus saucius* n. sp., female: 18, body, dorsal; 19, caudal ramus, ventral; 20, first antenna, ventral; 21, tip of first antenna, ventral; 22, second antenna, ventral; 23, claw of second antenna, anteroventral; 24, postantennal process, ventral. Scales: 1·0 mm in 18; 0·1 mm in 19, 20, 22; 0·03 mm in 21; 0·05 mm in 23, 24. Symbol: pr = protrusion.



FIGS 25–31. *Caligus saucius* n. sp., female: 25, mouth tube, ventral; 26, mandible, ventral; 27, first maxilla, ventral; 28, second maxilla, dorsal; 29, maxilliped, ventral; 30, sternal furca, ventral; 31, leg 1, ventral. Scales: 0·1 mm in 25, 27–31; 0·05 mm in 26.



FIGS 32–35. *Caligus saucius* n. sp., female: 32, tip of leg 1 exopod, ventral; 33, leg 2 and intercoxal plate, ventral; 34, leg 2 exopod, ventral; 35, tip of leg 2 exopod, ventral. Scales: 0·05 mm in 32, 35; 0·3 mm in 33; 0·1 mm in 34. Symbols: he = hyaline element; sep = setiform process.



FIGS 36–39. *Caligus saucius* n. sp., female: 36, leg 3 and ventral apron, ventral; 37, leg 3 exopod spine, ventral; 38, leg 4, ventral; 39, leg 5, ventral. Scales: 0·3 mm in 36; 0·05 mm in 37; 0·1 mm in 38, 39. Symbol: da = dorsal adhesion pads.

process in small pit; latter with conspicuous inner seta. Sternal furca (Fig. 30) horseshoe shaped; each tine tapered and flanked with lateral flange.

Leg 1 (Figs 31, 32) biramous; sympod with coxal portion broken off in specimen figured. Exopod 2-segmented; second segment (Fig. 32) with hyaline accessory process of spine 3 extending almost to tip of seta 4. Endopod a reduced lobe. Leg 2 (Figs 33–35) similar to that of *C. mortis*. Exopod (Fig. 34) 3-segmented with formula I-1, I-1, II-I-5; first exopodal spine with row of minute spinules at base; second exopodal spine relatively straight; both spines with serrated membranes along 3/4 length of outer margin, but only at distal end on inner margin; terminal exopodal segment (Fig. 35) with hyaline element carrying membrane along inner margin; proximal portion of this membrane rolled-up on itself to form a setiform process at base of element. Endopod (Fig. 33) with second and third endopodal segments with outer rows of setules; second segment with inner row of setules. Leg 3 (Fig. 36) with sympod bearing 2 small, dorsal, corrugated adhesion pads. Exopod 3-segmented; large exopodal spine (Fig. 37) with conspicuous flange on lateral margin; basal swelling as in *C. mortis*. Endopod (Fig. 36) as in *C. mortis*. Leg 4 (Fig. 38) with sympod carrying 2 groups of setules near midlength, and a small patch of spinules and 1 pinnate seta distally; exopod 1-segmented, with a pectinate membrane, 1 small barbed spine, and 1 large terminal spine fringed with 2 rows of serrated membranes. Leg 5 (Fig. 39) similar to that in *C. mortis*.

Etymology. The specific epithet *saucius*, Latin for wounded or hurt, alludes to the reduced size, segmentation, and armature of leg 4 in this species.

Remarks. Caligus saucius n. sp. can be distinguished from all its congeners by the unusual segmentation and armature of its leg 4. The new species appears to be most closely related to *Caligus mortis*. They share a similar general habitus, and similar, but not identical, armature and ornamentation of legs 1–3. In addition, both species were collected from blennies (or other tidepool fishes) either from South Africa or Namibia. The new species is distinguished from *Caligus mortis* by the following characters: (1) absence of posteroventral processes on genital complex; (2) highly curved, flanged tines of sternal furca which are blunt, not truncate; (3) 1-segmented exopod of leg 4 with the formula II.

Acknowledgements

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