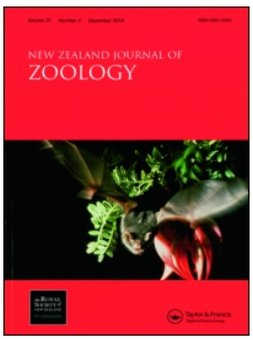

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New Zealand parasitic Copepoda; genus *Caligus* Müller, 1785 (Siphonostomatoida: Caligidae)

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Abstract This paper provides: a key to the species of New Zealand *Caligus*; a description of the male and female of *Caligus kahawai* n. sp., the female of *C. longicaudatus* Brady, 1899, and a redescription of female *C. lalandei* Barnard, 1948; the first records from New Zealand of *C. bonito* Wilson, 1905, and *C. elongatus* Nordmann, 1832; and further records of *C. aesopus* Wilson, 1921, *C. brevis* Shiino, 1954, *C. buechlerae* Hewitt, 1964, *C. coryphaenae* Steenstrup & Lütken, 1861, and *C. pelamydis* Krøyer, 1863.

Keywords Caligidae; Copepoda; description; *Caligus kahawai* n. sp.

INTRODUCTION

Caligus is the most abundant genus of parasitic copepods, with over 200 recognised species spread throughout all the oceans and occasionally in freshwater, utilising as hosts either elasmobranchs or teleosts. Some species, detached from their host, are commonly encountered swimming among plankton.

Caligid copepods have not been extensively collected in New Zealand, probably because they are easily dislodged from the host during collecting. Identification, given the large number of species, can be difficult.

Hewitt & Hine (1972) listed only six species of *Caligus* in their checklist of New Zealand fish parasites, of which one (*Caligus longicaudatus* Brady, 1899) was known from a single planktonic male, and another (*C. productus* Dana, 1852) was known only as a record of the name in Hutton (1904). The remaining four species were all described or recorded by Hewitt (1963, 1964). Kazachenko et al. (1972) provided additional New Zealand host records for *C. pelamydis* Krøyer, 1863. Following the establishment of commercial marine salmon farms in New Zealand, and the subsequent need to identify species of *Caligus* attaching to the stock, this review and key was prepared. It is probable that further species remain to be discovered in New Zealand waters.

Specimens were preserved in neutral buffered formalin and later transferred to 70% isopropyl alcohol for storage. For illustration, copepods were mounted in Berlese fluid and drawn with the aid of a camera lucida. Measurements were made with an ocular micrometer as follows: total length = distance along midline from anterior end of frontal plate to level of most posterior part of abdomen; cephalothorax length = distance along midline from anterior to posterior of shield at midline; cephalothorax width = width at widest point; genital complex length = length along midline from junction with thoracic segment 5 to posterior edge at midline; genital complex width = width at widest point; abdomen length = length along midline from junction with genital complex to the level of the posteriormost part of the abdomen; abdomen width = width at widest point.

Abbreviations of institutions. BMNH—British Museum (Natural History); NZNM—New Zealand National Museum, Wellington; SAM—South African Museum, Cape Town; UCNZ—University of Canterbury Christchurch, New Zealand.

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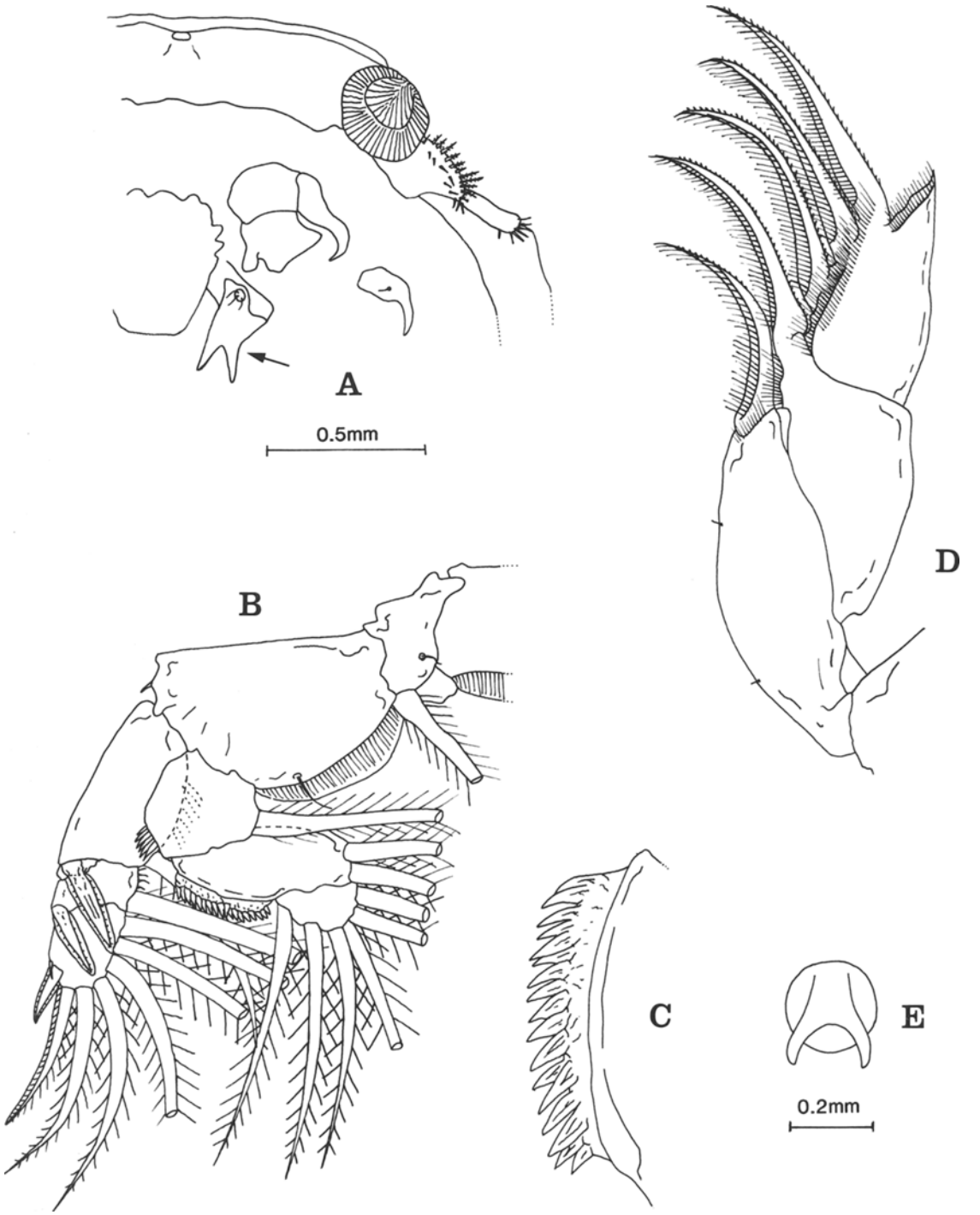

Fig. 1 A, *Caligus buechlerae* anteroventral surface showing bifurcate maxillule (arrowed) (after Hewitt 1964); B and C, *C. bonito* leg 2, and detail, endopodite leg 2 (both after Cressey & Cressey 1980); D, *C. pelamydis* leg 4 (after Cressey & Cressey 1980); E, *C. aesopus* sternal furca (after Hewitt 1963). No scale given for B–D on originals.

KEY TO FEMALES OF *CALIGUS* SPP. FROM NEW ZEALAND WATERS

1a 4th leg three-segmented (sympod + 2 segments) 2
b 4th leg four-segmented (sympod + 3 segments) 8
2a Maxillule clearly bifurcate (Fig. 1A) ..... *C. buechlerae*
b Maxillule not bifurcate 3
3a 2nd leg endopodite with group of prominent stout denticles along outer edge of first 2 segments (Fig. 1B,C) ..... *C. bonito*
b 2nd leg endopodite without denticles along edge (Fig. 3D) 4
4a Pair of conical spiniform processes on ventral surface posterior to maxillules (Fig. 4E), in approximately same position as adhesion pads on male. ..... *C. longicaudatus*
b Not as above 5
5a 4th leg terminal segment with lateral spine at mid-segment, 3 terminal spines ..... *C. elongatus*
b 4th leg terminal segment as for 5a but lacking spine at midcentre, 4 spines about apex ... 6
c 4th leg terminal segment as for 5b but with 3 spines about apex 7
6a 1st leg with 3 long medial plumose setae. Terminal 4 spines subequal in length, central 2 bifurcate, abdomen and uropods very short (abdomen 6% of total length) ..... *C. brevis*
b 1st leg without 3 long medial plumose setae ..... *C. productus*
7a 1st leg with 3 long lateral plumose setae, terminal 4 spines subequal in length, central 2 bifurcate. Abdomen and uropods long (>13% and 9% of total length, respectively) ..... *C. lalandei*
b Terminal 4 spines of 1st leg not bifurcate ..... *C. kahawai*
8a Post-antennal spine absent ..... *C. coryphaenae*
b Post-antennal spine present 10
9a 4th leg terminal segment very short, produced distally to give segment a triangular shape (Fig. 1D) ..... *C. pelamydis*
b Final 3 segments of 4th leg all of similar length, sternal furca on circular base, the branches of the furca forming a semi-circle (Fig. 1E) ..... *C. aesopus*

The host parasite list, by family, is appended.

Caligus aesopus Wilson, 1921

New Zealand hosts. *Seriola grandis* (Kingfish).

New Zealand distribution. ?Wellington.

Location on host. Unrecorded.

New Zealand records. Recorded by Hewitt (1963) from specimens collected by Manter in 1958, but not reported since then.

Records from other areas. Wilson (1921) described this species from the Juan Fernandez Islands (off Chile) "probably from *Seriola peruana*".

Best description. Hewitt (1963).

Caligus bonito Wilson, 1905

New Zealand host. *Katsuwonus pelamis* (Skipjack, bonito).

New Zealand distribution. East Cape.

Location on host. Mouth, gills, inside of operculum, skin.

New record. Two female specimens from one *K. pelamis*, East Cape, 6 Apr 1985.

Records from other areas. This species has been recorded from all but polar oceans. It is primarily a parasite of tunas but has also been recorded from Mugiloidei and Percoidei.

Best descriptions. Kabata (1979), Cressey & Cressey (1980).

Measurements (mm) of both New Zealand specimens. Total length 5.4, 7.0; cephalothorax length × width = 2.35 × 2.25, 3.30 × 3.15; genital complex length × width = 1.45 × 1.45, 1.70 × 1.65; abdomen length × width = 1.10 × 0.47, 1.15 × 0.65.

Cressey & Cressey (1980) found the length range (pooled from several collections) of 37 specimens to be 5.10–8.10 mm, and state "No significant differences could be seen between *C. bonito* from different host species or geographic areas, except that specimens from warmer water tend to be smaller than those from colder." (p 26). Kabata (1979) gives a length of "about 8 mm".

Caligus brevis Shiino, 1954

New Zealand hosts. *Odax cyanoallix* (blue-finned butterfish); *O. pullus* (common butterfish); *Pseudolabrus fucicola* (bearded wrasse); *P. miles* (scarlet wrasse); *P. celidotus* (spotty).

New Zealand distribution. New Zealand wide?

Location on host. Skin, fins.

New records. 14♀♀ specimens, 8 with eggstrings, were collected from *O. cyanoallix*, South-east Bay, Three Kings Islands, 13 Feb. 1986 by M. Francis; 2♂♂, 1 ♀ from *P. fucicola*, Kaikoura, 3 Jun 1983 (UCNZ); 1 ♂ , 1 ♀ from *O. pullus*, Kaikoura, 23 Nov 1986 (UCNZ); 2♀ ♀ , 2♂♂ from *P. celidotus*, Taylors Mistake, Banks Peninsula 30 Jun 1985 (UCNZ).

Previous New Zealand records. From *O. pullus* by Ritchie (1969); he noted that *C. brevis* from this host was 2–5 mm long and occurred over the entire body surface and fins. More than six specimens occurred on individual butterfish without any preference for host size or sex. Ritchie sampled from Leigh, Wellington, Marlborough Sounds, Kaikoura, Dusky Sound, and Stewart Island. The copepod probably occurs throughout this range.

Records on *Pseudolabrus* are given by Hewitt (1963) from the Wellington region.

Records from other areas. The species is also known from Labridae in Japanese coastal waters.

Best description. Hewitt (1963).

Measurements are provided in Table 1.

Caligus buechlerae Hewitt, 1964

New Zealand hosts. *Tripterygion* sp. (triplefins); *Scorpaena papillosus* (red rock cod); *Parapercis colias* (blue cod).

New Zealand distribution. Wellington; Banks Peninsula.

Location on host. Skin.

New records. 1 ♂ , 1 ♀ on *Scorpaena papillosus* body surface, Ocean Beach, Palliser Bay, 24 Feb 1985 (UCNZ).

Table 1 Measurements (mm) of *Caligus brevis* Shiino, 1954.

	Three Kings (mean ± SD $n = 8$)	Hewitt (1963) range	Shiino (1954) range
Total length:	2.38±0.06	2.26–2.69	2.68–3.08
Cephalothorax length:	1.55±0.14	1.68–1.95	—
width:	1.40±0.14	1.53–1.92	1.08–1.86
Genital complex length:	0.67±0.06	0.52–0.72	—
width:	0.80±0.04	0.85–1.10	—
Abdomen length:	0.15±0.04	0.15–0.22	—
width:	0.10±0.02	—	—

Previous records. Described by Hewitt (1964) from *Tripterygion* sp. caught at Wellington and Banks Peninsula. Type material in NZNM. This copepod closely resembles *Caligus* sp. 1 of Byrnes (1987) which also possesses a bifurcate maxillule and has the same relative lengths of the apical spines on the leg 1 exopodite.

Caligus coryphaenae Steenstrup & Lütken, 1861

New Zealand host. *Katsuwonus pelamis* (skipjack, bonito).

New Zealand distribution. Northland.

Location on host. Skin.

New record. 2♀♀ from one *K. pelamis*, north of Three Kings Islands 22 Oct 1985 by A. Ross.

Records from other areas. This species has been recorded from all but polar oceans. It is common on scombrids of the tribe Thunnini, and on species of *Coryphaena*, but has also been recorded on a wide range of other hosts (see Kabata 1979).

Heegaard (1972) stated that, in the material collected by the Dana expedition of 1928–30, this species and *C. productus* were the most common free-swimming caligids.

Best descriptions. Kabata (1979), Cressey & Cressey (1980).

Measurements of two females from *K. pelamis* from New Zealand and a comparison with those from the Atlantic and Indian Oceans are given in Table 2.

Although the New Zealand specimens are larger than is usual for *C. coryphaenae*, Wilson (1935) did record one of 7.6 mm length from the Gulf of Mexico (under the name *C. aliuncus*).

Table 2 A comparison of measurements (mm) of *Caligus coryphaenae* Steenstrup & Lütken, 1861 from different oceans.

	N.Z.		Atlantic*	Indian Ocean#
Total length:	7.2	6.9	5.8–6.5	5.49±0.04
Cephalothorax length:	3.3	3.7	—	2.60±0.04
width:	2.9	2.9	—	2.21±0.03
Genital complex length:	1.8	1.7	1.5	1.42±0.06
width:	1.8	1.7	1.4	1.32±0.05
Abdomen length:	1.7	1.5	—	1.34±0.07
width:	0.9	0.7	—	—
n:	1	1	—	16

* = range from Cressey & Cressey (1980).
\# = mean ± standard deviation from Lewis et al. (1969).

Caligus elongatus Nordmann, 1832

New Zealand host. "flounder".

New Zealand distribution. Heathcote estuary.

Location on host. "gill chamber".

New record. 1 ♂ on slide, from "flounder", Heathcote estuary, Christchurch, New Zealand, 21 Jun 1959 (UCNZ).

Records from other areas. This species has been recorded from at least 60 host species in both northern and southern temperate seas.

Best description. Parker (1969).

Caligus lalandei Barnard, 1948

New Zealand host. *Seriola grandis*, (Kingfish); *S. hippos* (Samson fish).

New Zealand distribution. Northland, East Cape.

Location on host. Skin.

New records. 1 ♀ from *S. grandis*, East Cape, 5 Apr 1985. 1 ♀ from *S. hippos*, Russell, date unknown, host submitted to G. James for identification and specimen collected by him.

Records from other areas. Described from *S. lalandei* (= *S. grandis*) from Kalk Bay (Cape Peninsula), South Africa, by Barnard (1948), also described and illustrated by Barnard (1955). Type specimens at SAM (Curator, pers. comm.).

Description of male. Barnard (1948).

Description of New Zealand specimens.

Adult female (Fig. 2A–3J). Measurements given in Table 3. Dorsal shield with deep posterior sinuses; posterior tips of lateral zones do not reach level of posterior margin of thoracic zone; longer than wide but less than half total length. Posterior margin of cephalothorax articulating with 4th pedigerous somite. Genital complex clearly delimited, curves out to maximum width at posterior margin with prominent posterolateral lobes on either side of abdomen. Abdomen elongate, one-segmented but indentation on margin suggests fused 2nd segment 2.5× length of first (Fig. 2A). Abdomen length:width ratio 2.2:1. Deep sinus at posterior midline. Abdomen length:genital complex length = 1.8:1. Uropods as long as abdomen, bear 3 relatively long and 3 short setae about apex (Fig. 3I, J).

Antenna 1 (Fig. 2B,C). Two-segmented. Basal segment with 27 setae along anterior margin (25 ventral, 2 dorsal); all but 2 setae pilose. Terminal segment bears usual 13 setae in two groups about apex and 14th seta midlength along segment. Terminal segment length 5.5× width.

Antenna 2 (Fig. 2E). Three-segmented. Basal segment with elongate spatulate tine directed posteriorly; 2nd segment squat, unarmed; 3rd segment a terminal claw which has 2 fine naked setae, one on inner margin near base, one half distance along claw; Terminal ¼ of claw sharply recurved.

Postantennal process (Fig. 2D). Strongly developed, curved and pointed, bears 2 setiferous papillae, both with small seta; third seta on papilla near base of process.

Mandible. Distal segment bears 13 teeth on medial edge.

Maxillule (Fig. 2F). Largely incorporated into ventral integument. Anteriorly, papilla bearing 3 setae of various lengths; posteriorly formed into curved pointed tine.

Maxilla (Fig. 2G). Two-segmented; basal segment length 4.5× width; distal segment length 10× width. Flabellum present. Small fringed lappet extending from level of flabellum to canna.

Maxilliped (Fig. 3A). Corpus maxillipedis unarmed but with sclerotised swelling (myxa) where tip of claw opposes. Shaft extending into stout claw with small auxilliary spine below base of claw and small spinule just above base.

Sternal furca (Fig. 2H). Rather characteristic, widening distally with oval sinus between apically truncated prongs.

Leg 1 (Fig. 3B,C). Protopodite two-segmented: coxa unarmed; basis with pinnate seta on lateral

Table 3 Measurements (mm) of *Caligus lalandei* Barnard, 1948.

	Barnard (1955)	New Zealand *S. grandis*	New Zealand *S. hippos*
Total length to uropods:	10.5	9.3	8.6
to abdomen:	9.0	7.9	7.4
Cephalothorax width:		3.4	3.1
length:		3.7	3.4
Genital complex width:		1.6	2.0
length:		2.8	2.6
Abdomen width:		0.7	0.9
length:		1.2	1.4
lunule diameter:		0.4	0.4
Dist. between lunules:		1.1	1.1

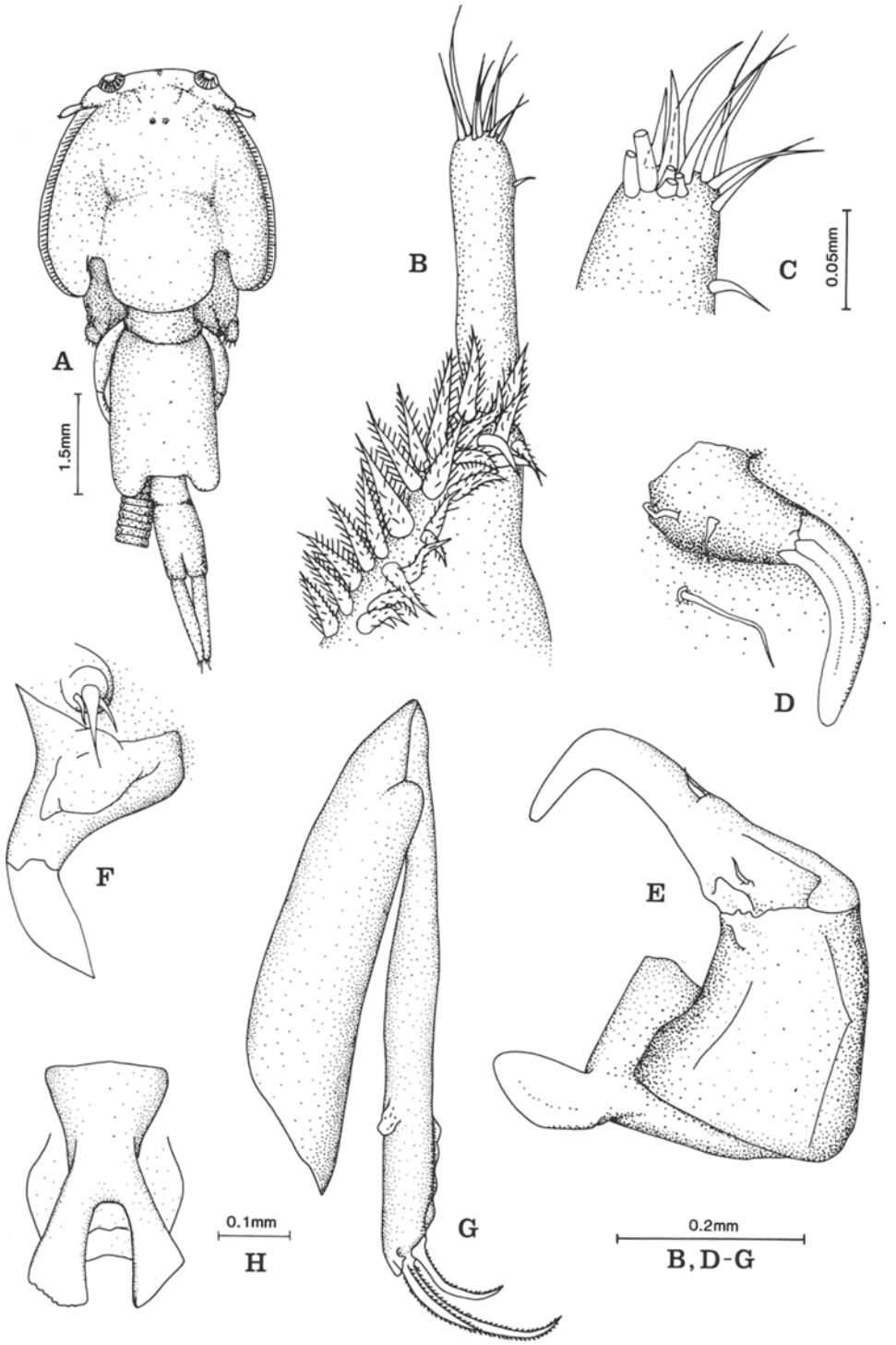

Fig. 2 *Caligus lalandei* female. **A**, dorsal view; **B**, antenna 1; **C**, detail, tip of antenna 1; **D**, postantennal process; **E**, antenna 2; **F**, maxillule; **G**, maxilla; **H**, sternal furca.

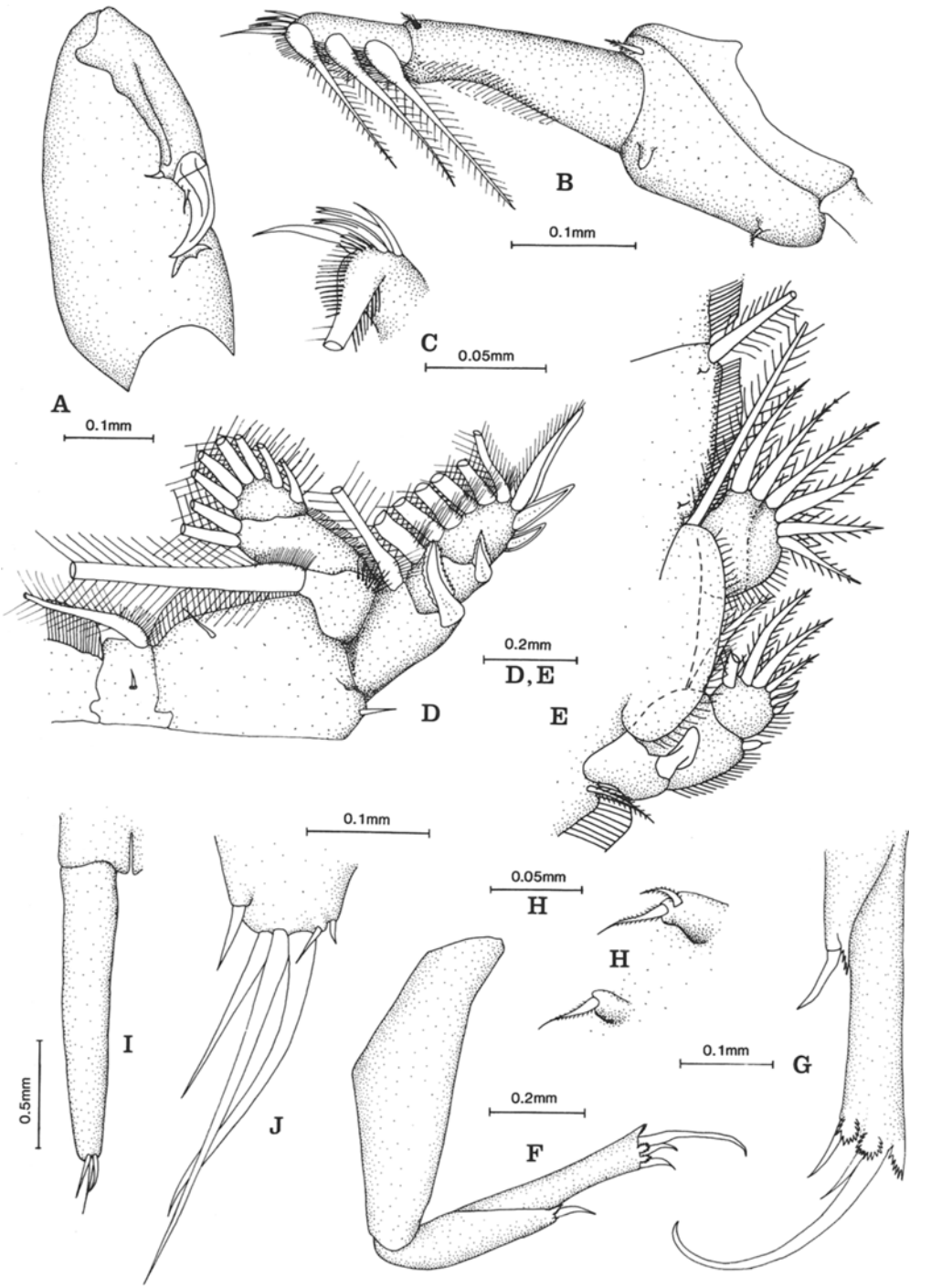

Fig. 3 *Caligus lalandei* female. **A**, maxilliped, **B**, leg 1; **C**, detail, tip of exopodite leg 1; **D**, leg 2; **E**, leg 3; **F**, leg 4; **G**, detail, leg 4; **H**, leg 5; **I**, uropod; **J**, detail, tip of uropod.

margin, and one on medial margin. Endopodite a small unsegmented papilla. Exopodite two-segmented: proximal segment with fringe of setules along posterior margin, small seta on distolateral corner; distal segment half length of proximal, with 4 terminal spines, inner 2 bifurcate at tips, 3 medial setae each bearing prominent spinules on swollen base.

Leg 2 (Fig. 3D). Protopodite two-segmented: basal segment (coxa) extending dorsally over distal (basis), with large pinnate seta on posterior medial margin near interpodal bar and fine setule on ventral surface; distal segment with 2 small setae, one at medial third near posterior margin, other on margin lateral to insertion of exopodite. Exopodite three-segmented: basal segment and 2nd segment both with long pinnate seta on inner margin, stout pectinate spine on outer margin; terminal segment with 2 spines, 6 pinnate setae. Endopodite basal segment with seta on inner margin, tuft of fine setules on outer margin; 2nd segment with two setae on inner margin; 3rd segment with 6 terminal setae.

Leg 3 (Fig. 3E). Protopodite segments fused, bearing pinnate seta lateral to interpodal bar, 2 small setules on either end of marginal membrane, and short pinnate seta on ventral surface near base of exopodite. Exopodite three-segmented: basal segment small bearing stout terminal spine; 2nd segment largest, bearing fringe of setules on lateral margin, small spine on distolateral margin, long pinnate seta on distomedial margin; terminal segment with 4 pinnate setae, 3 short spines on lateral margin. Endopodite three-segmented: basal segment forms base for long pinnate seta, lateral margin forms long oval velum fringed with setules; 2nd segment platelike, bears 2 pinnate setae on lateral margin; 3rd segment armed with 4 long pinnate setae. Suture between 2nd and 3rd segments indistinct on some specimens.

Leg 4 (Fig. 3F,G). Uniramous, three-segmented: segment 1 (sympod) unarmed; 2nd segment bears short spine on laterodistal tip; distal segment bears 2 very short and one long curved spines. All spines have pectinate lamella at base.

Leg 5 (Fig. 3H). Reduced to 2 papillae, with 1 and 2 pilose setules respectively.

Notes. The New Zealand specimens were identified from the descriptions given by Barnard (1948, 1955) from specimens taken from *S. grandis* in South African waters. The copepod is easily recognised by the long abdomen and uropods, especially in the male; the relative lengths of the terminal spines on the 4th leg, and the flat spatulate tines on the sternal furca.

Caligus longicaudatus Brady, 1899

New Zealand hosts. *Oncorhynchus nerka* (Sockeye salmon) in plankton (male).

New Zealand distribution. Marlborough Sounds; Dunedin.

Location on host. Skin.

New record. 10♀♀ (2 damaged), 2♂♂ taken from a sockeye salmon reared in commercial sea-cages, Hallay Cove, Marlborough Sounds, Jan 1986. 4♀♀, 1 ♂ deposited with NZNM, (Cr.4564); 4♀♀ at BMNH (1987. 7–10).

Previous record. Described by Brady (1899) from single planktonic male, Port Chalmers, Dunedin, New Zealand.

Description of male. Parker (1968).

Description. *Adult female* (Fig. 4A–5E). Measurements given in Table 4. Dorsal shield with deep posterior sinuses; posterior tips of lateral zones not quite reaching level of posterior margin of thoracic zone. Posterior margin of cephalothorax articulating with short, broad, 4th pedigerous somite. Genital complex clearly delimited, subrectangular, length to width ratio 1:0.72. Posterior margin indented slightly forming posterolateral lobes which bear vestigial 5th legs. Eight of 10 females bearing eggstrings.

Abdomen one-segmented, length:width ratio = 1:0.79, ratio abdomen length:genital complex length = 1:1.37. Uropods subrectangular, bear 3 small and 3 large pinnate setae about apex. Posteromedial edge of each uropod with fringe of setules.

Table 4 Measurements (mm) of *Caligus longicaudatus* Brady, 1899.

	Male	Female	
		range	mean
Total length:	3.7	4.6–5.4	5.1
Cephalothorax length:	1.7	2.0–2.4	2.2
width:	1.6	1.5–1.9	1.7
Length to posterior of apron:	2.0	2.1–2.7	2.5
Genital complex length:	0.7	0.8–1.6	1.3
width:	0.5	0.7–1.2	0.9
Abdomen length:	0.7	0.9–1.0	0.9
width:	0.3	0.3–0.4	0.3
n:	1	5	

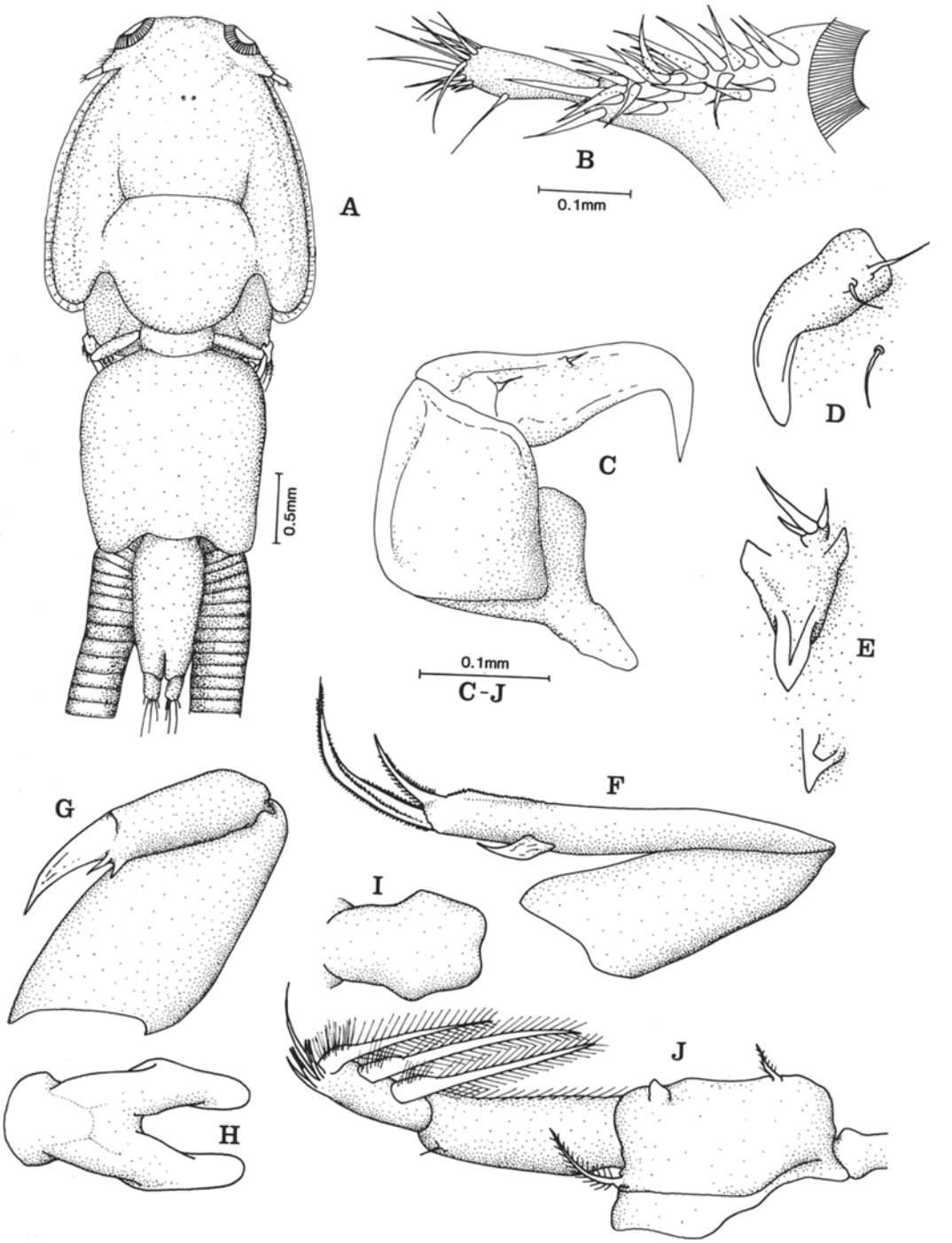

Fig. 4 *Caligus longicaudatus* female. **A**, dorsal view; **B**, antenna 1; **C**, antenna 2; **D**, postantennal process; **E**, maxillule and post maxillular spiniform process; **F**, maxilla; **G**, maxilliped; **H**, sternal furca; **I**, abnormal sternal furca; **J**, leg 1.

Antenna 1 (Fig. 4B). Basal segment with 27 setae along anterior margin; 25 ventral, 2 dorsal, all but 2 setae pilose. Distal segment bears usual 13 terminal setae and 14th seta at mid-length along segment. Distal segment length:width ratio = 3.3:1.

Antenna 2 (Fig. 4C). Three-segmented. Basal segment short, armed with sharp-pointed spatulate process directed posteriorly. 2nd segment stout, bears terminal claw with 2 fine naked setae, one on inner margin near base, one ½ distance from base to tip of claw.

Postantennal process (Fig. 4D). Strongly developed, slightly curved, pointed. Bears 2 setiferous papillae, both with seta, additional papilla near base of process bears seta.

Mandible with 12 teeth on edge of distal segment.

Maxillule (Fig. 4E). Largely incorporated into ventral integument. Anteriorly papilla bears 3 flattened setae of various lengths, posteriorly maxillule formed into prominent heavy spiniform process bearing faint striations along ventrolateral edge. Sharp-pointed conical projection situated posterior to dentiform process of maxillule in approximately same position as adhesion pad in male (Fig. 4E).

Maxilla (Fig. 4F). Two-segmented; basal segment elongate, length 3× width; terminal segment length 10× width. Flabellum present. Fringed lappet extending from point opposite flabellum to base of canna.

Maxilliped (Fig. 4G). Strongly developed, subchelate. Corpus maxillipedis unarmed, shaft bearing stout claw with well developed barb and small seta on suture line.

Sternal furca (Fig. 4H). Tines slightly spatulate. One specimen had malformed furca without tines (Fig. 4I).

Leg 1 (Fig. 4J,5A). Protopodite two-segmented: Coxa unarmed; basis with small pinnate seta on lateral and one on medial margin. Endopodite on unsegmented papilla. Exopodite two-segmented: proximal segment armed with fringe of setules along posterior margin and small seta in disto-lateral corner; distal segment ½ length of proximal with 4 terminal spines, inner 2 bifid from midpoint to apex (Fig. 5A), 3 medial pinnate setae each with swollen base bearing prominent spinules.

Leg 2 (Fig. 5B). Two-segmented protopodite, three-segmented exopodite and endopodite. Protopodite: coxa extending dorsally over basis, with large pinnate seta on posterior medial margin, fine setule on ventral surface; distal segment with one setule at medial third near posterior margin and one seta on anterior margin lateral to insertion of exopodite. Exopodite: first two segments each with one spine, one large seta; terminal segment with 2 spines, 6 pinnate setae. Endopodite basal segment with seta on inner margin, and tuft of short setules on outer-distal margin; 2nd segment with 2 setae; terminal segment with 6 setae.

Leg 3 (Fig. 5C). Protopodite segments fused, bearing pinnate seta lateral to interpodal bar, 2 small setules at either end of marginal membrane, short pinnate seta on ventral surface near base of exopodite. Exopodite three-segmented: basal segment small bearing stout terminal spine; 2nd segment lateral margin with fringe, spine in lateral corner, long pinnate seta on medial margin; terminal segment with fringe of setules, 3 lateral spines and 4 pinnate setae about apex. Spines on 2nd and 3rd segments have flattened bases with sclerotised tips. Endopodite two-segmented: basal segment with long pinnate seta, lateral margin expanded into oval velum, posterior margin of velum fringed with setules, anterior margin fused with protopodite; 2nd segment bearing 6 setae about apex.

Leg 4 (Fig. 5D). Three-segmented: basal segment (sympod) with small subterminal seta; 2nd segment with terminal denticulate spine; third segment with 3 denticulate spines of different lengths, outer spine ⅓ length of inner. All spines with pectinate lamellae at bases.

Leg 5 reduced to 2 papillae, with 1 and 2 pilose setae respectively.

Notes. The males of this species were identifiable from Parker's (1968) redescription of the type. This is the first description of the females, which are unusual in having spiniform processes posterior to the maxillules. Most female caligids have no such projections.

Sockeye salmon were introduced into New Zealand from Canada in 1901–02 as ova subsequently reared at a freshwater hatchery (McDowall 1978) and so cannot be the only host utilised by this copepod. The endemic hosts remain unknown, and in this *C. longicaudatus* joins another endemic copepod; *Paeonodes nemaformis* Hewitt, 1969, also known only from introduced salmonids.

Caligus pelamydis Krøyer, 1863

New Zealand hosts. *Arripis trutta* (Kahawai); *Seriolella maculata*?, *S. brama* (blue warehou); *Scomber* sp. (? blue mackerel); *Leionura* (*Thyrsites*) *atun* (barracouta).

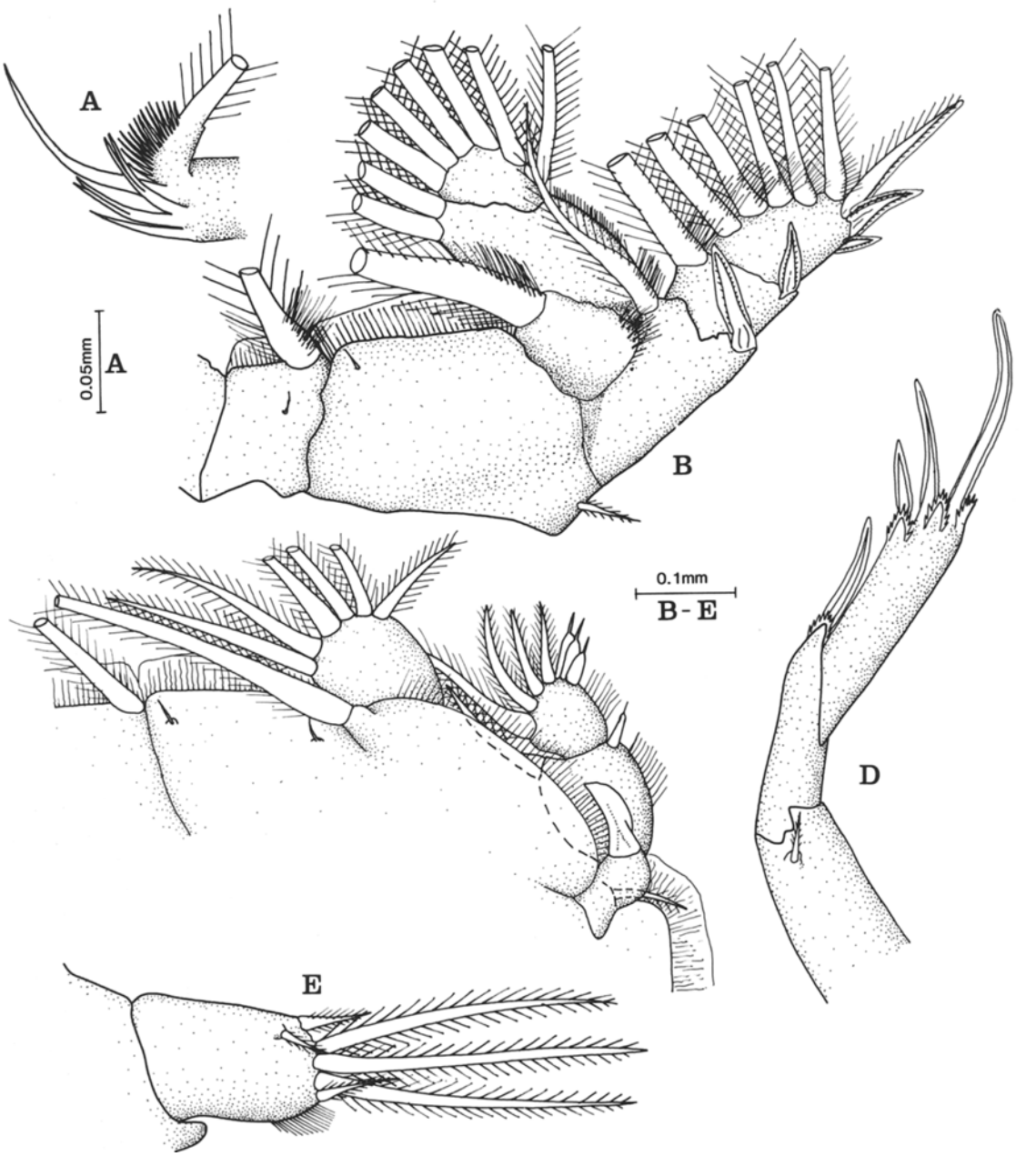

Fig. 5 *Caligus longicaudatus* female. A, detail, tip of exopodite leg 1; B, leg 2; C, leg 3; D, leg 4; E, uropod.

New Zealand distribution. North Island, "West coast of New Zealand", Kaikoura, Christchurch.

Location on Host. Operculum, gills, buccal cavity, body surface.

New Records. 1 ♀ on *A. trutta*, Te Kaha, East Cape, 3 Jan 1980. 1 ♀ on *S. brama*, Kaikoura, Jun 1982 (UCNZ). 1 ♀ on *A. trutta*, Kaikoura, 12 May 1977 (UCNZ). 1 ♀ on *A. trutta*, South Brighton, Christchurch, New Zealand, 24 Jun 1979 (UCNZ).

Previous New Zealand records. Hewitt (1963) recorded two specimens of this species from *Thyrsites atun* caught off Cape Turakirae near

Wellington, and Kazachenko et al. (1972) recorded it on *Scomber, Thyrsites*, and "*Seriolella maculata*" (not a recognised New Zealand species of *Seriolella*) on the "West coast of New Zealand".

Best descriptions. Kabata (1979), Cressey & Cressey (1980).

Measurements (mm) of the Te Kaha specimen are as follows. Measurements from Hewitt (1963) are in brackets. Total length: = 4.6 (4.42–4.48); cephalothorax length × width = 1.6 × 1.7 (1.40–1.42 × 1.50–1.46); genital complex length × width = 1.3 × 1.2 (1.25 × 1.27); abdomen length × width = 1.5 × 0.5 (1.3 × 0.5); lunule diameter = 1.2 (–); distance between lunules = 0.4 (–).

Records from other areas. This species is common in latitudes greater than 20°N or S.

Caligus productus Dana, 1852

There are no positive records of this species in New Zealand (see Hewitt, 1963).

It is common on scombrid fishes throughout the circumtropical and subtropical areas (Cressey & Cressey 1980); it also occurs on *Coryphaena* spp., Sciaenidae, Sparidae, Centropomidae, Carangidae, Serranidae, Lutjanidae, Polynemidae, Sphyraenidae, Elopiformes, and Balistoidei (Kabata 1979).

This copepod might be found in northern New Zealand waters or on fish moving down from subtropical waters.

Descriptions. Kabata (1979), Cressey & Cressey (1980).

Caligus kahawai n. sp.

New Zealand host. *Arripis trutta.*

New Zealand distribution. Palliser Bay; Lyttelton Harbour.

Location on host. body surface.

New records. 1 ♀ on *A. trutta*, Palliser Bay, 20 Sep 1982 **Holotype** slide NZNM (Cr.4563). 1 ♀ on *A. trutta*, Palliser Bay, 22 Jul 1985. 1 ♂, 1 ♀, on *A. trutta* juvenile, Lyttelton Harbour, 14 Apr 1985 (UCNZ). (♂ on slide NZNM Cr.4901).

Descriptions. *Adult female* (Fig. 6A–7E). Measurements given in Table 5. Dorsal shield with deep posterior sinuses; posterior tips of lateral zones do not reach level of posterior margin of thoracic zone; shield longer than wide, about half total length. Posterior margin of cephalothorax articulating with 4th pedigerous somite. Genital complex elongate, expanding in width posteriorly. No posterolateral lobes. Abdomen small, one-segmented, length:width ratio 1.3:1. Uropods small, 0.24× length of abdomen, bear 3 relatively long, 3 short setae about apex Fig. 6A).

Antenna 1 (Fig. 6B). Two-segmented. Basal segment with 27 long setae (25 ventral, 2 dorsal) along anterior margin, setae reaching almost to tip of terminal segment, all but 2 setae pilose. Terminal segment bears seta at midlength along segment and 13 setae about apex.

Antenna 2 (Fig. 6C). Three-segmented. Basal segment with elongate spatulate posterior tine; second segment squat, unarmed; third segment forms terminal claw with distal third bent at acute angle and fine seta at proximal third.

Postantennal process (Fig. 6D). Strongly curved tine with 2 setiferous papillae, both with small setule; 3rd papilla near base has 2 setules of unequal lengths.

Mandible with 12 teeth on distal segment.

Maxillule (Fig. 6E). Anterior papilla bearing 3 setae; posterior spine has blunt spatulate tip.

Maxilla (Fig. 6F). Two-segmented, basal segment length 3.4× width; distal segment length 12.5× width.

Maxilliped (Fig. 6G,H). Corpus maxillipedis unarmed, distal segment extending into stout claw with small seta and larger barb at base of claw.

Sternal furca (Fig. 7A). Tines spatulate, diverging so that length equals width at posterior extremity.

Leg 1 (Fig. 7B). Two-segmented protopodite: coxa unarmed; basis with small pinnate seta on margin and seta on lateral margin below exopodite.

Table 5 Measurements (mm) of four specimens of *Caligus kahawai* n. sp. (mounted on glass slides).

	Palliser Bay		Lyttelton Harbour	
	female	female	female	male
Total length:	5.25	4.45	4.2	5.5
Cephalothorax width:	2.05	2.00	1.88	2.45
length:	2.65	2.55	2.62	1.75
Genital complex width:	1.55	1.07	1.25	0.75
length:	1.88	1.30	1.37	0.90
Abdomen width:	0.40	0.37	0.40	*0.42 0.43
length:	0.55	0.53	0.57	*0.22 0.5
lunule diameter:	0.25	0.25	0.22	0.27
Distance between lunules:	0.67	0.6	0.65	0.75

* male with two-segmented abdomen.

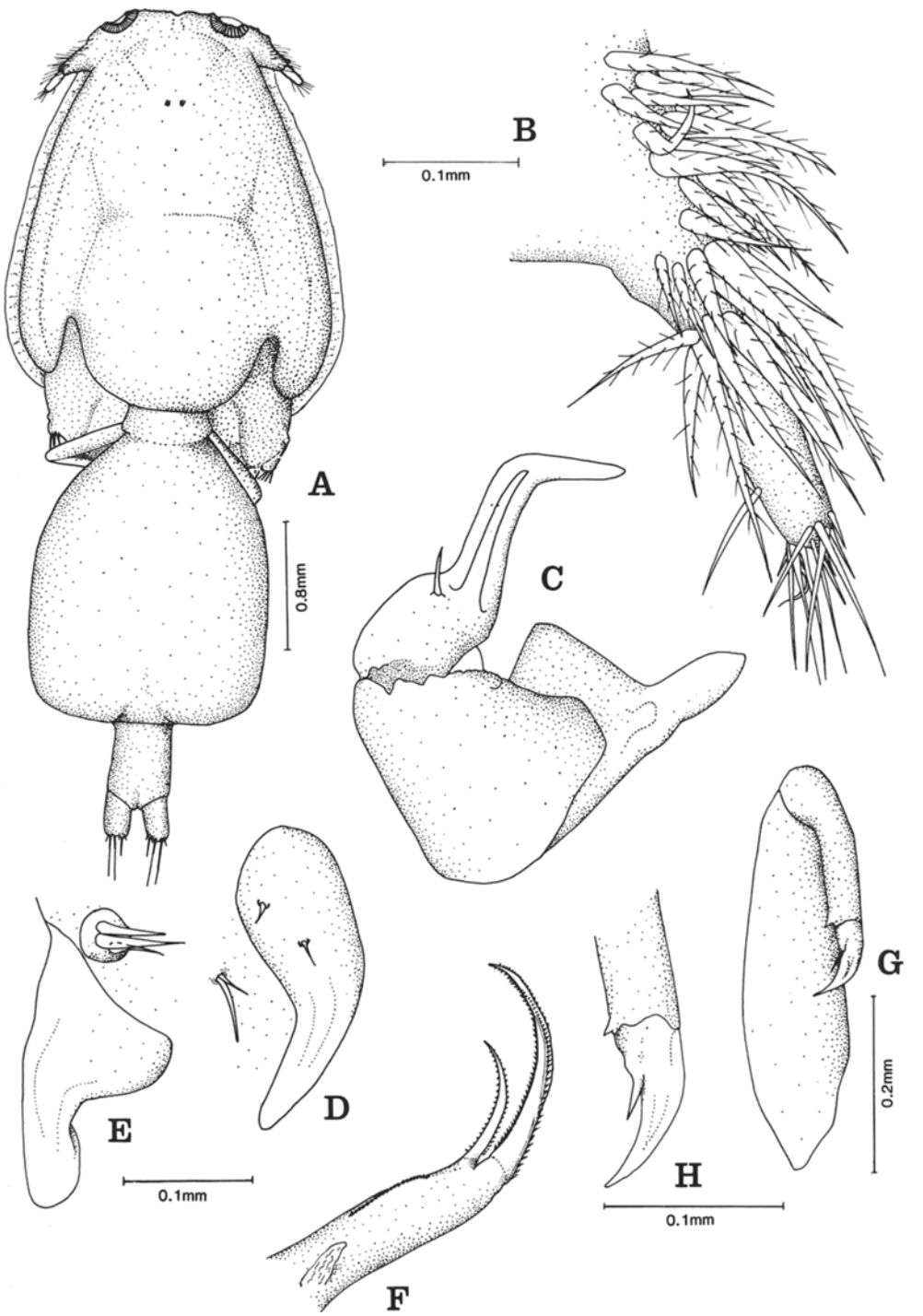

Fig. 6 *Caligus kahawai* n. sp. female. **A**, dorsal view; **B**, antenna 1; **C**, antenna 2; **D**, postantennal process; **E**, maxillule; **F**, detail, tip of maxilla; **G**, maxilliped; **H**, detail, tip of maxilliped.

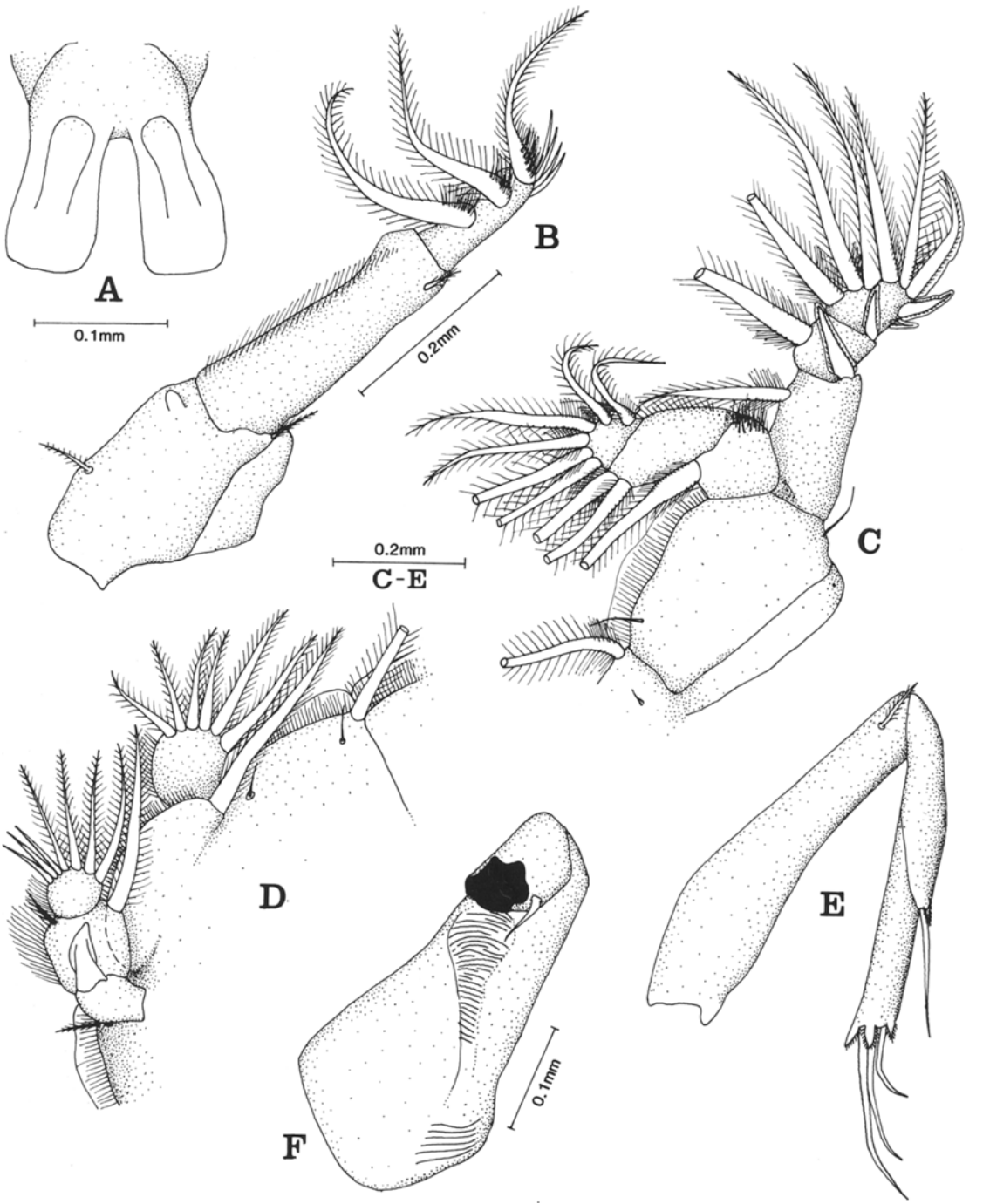

Fig. 7 *Caligus kahawai* n. sp. female. **A**, sternal furca; **B**, leg 1; **C**, leg 2; **D**, leg 3; **E**, leg 4; **F**, *Caligus kawawai* n. sp. male antenna 2 (terminal claw missing).

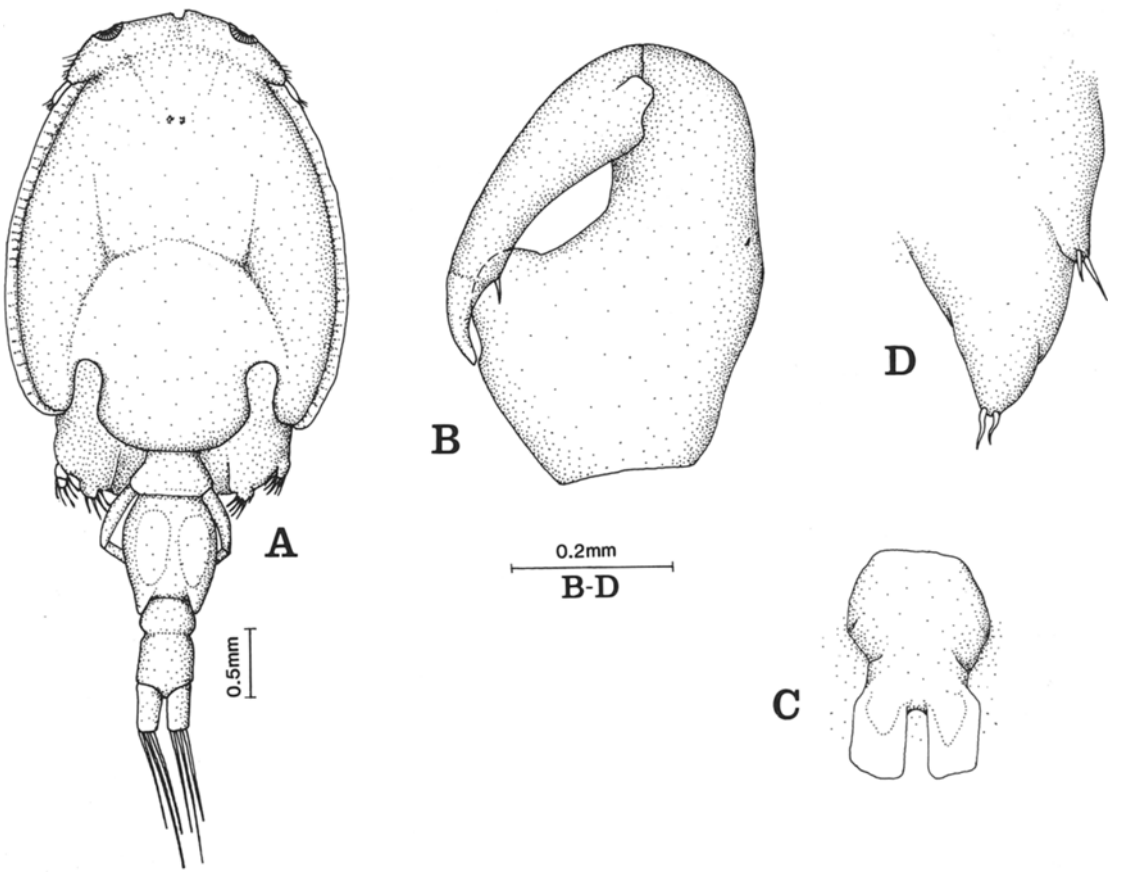

Fig. 8 *Caligus kahawai* n. sp. male. **A**, dorsal view; **B**, maxilliped; **C**, sternal furca; **D**, legs 5 and 6.

Endopodite small unsegmented papilla. Exopodite two-segmented: proximal segment with fringe of setules along posterior margin, small seta on distolateral corner; distal segment ½ length of proximal, with 4 terminal spines (none bifid), and 3 medial setae bearing prominent spinules on swollen bases.

Leg 2 (Fig. 7C). Protopodite two-segmented: coxa with large pinnate seta on posterior medial margin near interpodal bar, fine setule on ventral surface; basis with 2 small setae, one at medial third near posterior margin, one on lateral margin below exopodite. Exopodite three-segmented: first two segments both with long pinnate seta on inner margin, stout pectinate spine on outer margin; terminal segment with 2 spines, 6 pinnate setae. Endopodite basal segment with seta on inner margin, tuft of fine setules on outer margin; 2nd segment with 2 setae on inner margin; terminal segment with 6 apical setae.

Leg 3 (Fig. 7D). Protopodite segments fused, bearing pinnate seta lateral to interpodal bar, 2 small setules on either end of marginal membrane, short pinnate seta on ventral surface near base of exopodite. Exopodite three-segmented: basal segment small, bearing stout terminal spine; 2nd segment largest, bearing fringe of setules on lateral margin, small spine on distolateral margin, long pinnate seta on distomedial margin; terminal segment with 4 pinnate seta 3 lateral spines. Endopodite obscurely three-segmented, basal segment with long pinnate seta, lateral margin forms long velum. 2nd segment platelike, bearing 2 pinnate setae on lateral margin. Segment 3 armed with 4 long pinnate setae. Suture between segments 2 and 3 indistinct.

Leg 4 (Fig. 7E). Uniramous, three-segmented. Basal segment (sympod) with terminal seta; 2nd segment with terminal pectinate spine; 3rd segment with 3

denticulate spines all with pectinate lamellae at bases.

Leg 5 reduced to 2 setose papillae.

Male (Fig. 7F–8D). Differs from female as follows: Genital complex ovoid, posterior margin deeply indented so that posterolateral lobes bearing legs 5 and 6 overlie abdomen. Abdomen two-segmented, ratio of lengths 1:2. Antenna 2: basal segment stout, unarmed except for extensive adhesion pad; terminal claw broken off, seta below base of claw. Maxilliped corpus maxillipedis very stout, with sclerotised myxa against which terminal claw closes; shaft with barb, claw with seta on inner surface. Sternal furca (Fig. 8C) do not diverge as much as those of female. Leg 5 (Fig. 8D) a basal seta and papilla bearing 2 setae, leg 6 at posterior tip of genital complex consists of 2 setae only.

Notes. This species of *Caligus* has been found only on *Arripis trutta*. A combination of features serve to distinguish this species from all other (c. 200) congeners of *Caligus*: (a) truncate tip of dentiform process of maxillule; (b) spatulate tines and truncated tips of sternal furca; (c) exopodal spines of leg 1; and (d) two-segmented edxopodite of leg 4 with armature formula I–III.

Etymology. The species name is derived from the Maori name for the host fish (Kahawai) meaning "strong water" a reference to the fighting qualities of the fish and its habit of forming foaming surface schools.

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APPENDIX

Host parasite list arranged in alphabetical order by family of host.

Arripidae	
Arripis trutta	*Caligus pelamydis*
	C. kahawai
Carangidae	
S. grandis	*C. aesopus*
	C. lalandei
Seriola hippos	*C. lalandei*
Centrolophidae	
Seriolella brama	*C. pelamydis*
"*S. maculata*"	*C. pelamydis*
Gempylidae	
Leionura (=*Thyrsites*) *atun*	*C. pelamydis*
Labridae	
Pseudolabrus celidotus	*C. brevis*
P. fucicola	*C. brevis*
P. miles	*C. brevis*
Mugiloididae	
Parapercis colias	*C. buechlerae*
Odacidae	
Odax cyanoallis	*C. brevis*
O. pullus	*C. brevis*
Pleuronectidae	
?*Rhombosolea* sp. (recorded as 'flounder')	*C. elongatus*
Salmonidae	
Onchorhynchus nerka	*C. longicaudatus*
Scombridae	
Katsuwonus pelamis	*C. bonito*
	C. coryphaenae
Scomber australasicus	*C. pelamydis*
Scorpaenidae	
Helicolenus papillosus	*C. buechlerae*
Tripterygiidae	
Tripterygion sp.	*C. buechlerae*