Two Species of Chondracanthid Copepods (Poecilostomatoida) Parasitic on Commercial Fishes in the Pacific

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With Text-figures 1–5

Several years ago Prof. R.L.C. Pilgrim of the University of Canterbury in Christchurch, New Zealand, sent me some specimens of parastic copepods for identification. Among them were four specimens of *Chondracanthus* taken from the buccal cavity of the Hoki, *Macruronus novaezelandiae*. Hoki is the most abundant deep water commerical fish in New Zealand and it is marketed chiefly as an ingredient for making surimi. According to FAO Yearbook (1988), 104, 403 tons of hoki were landed in 1986 (the most recent available statistics).

Recently, Dr. J. B. Jones of the Fisheries Research Center in Wellington, New Zealand, informed me of the discovery of "*Chondracanthus palpifer* Wilson?" in the buccal carity of hoki. A close examination of his collection together with those collected by Prof. Pilgrim revealed that they are close to, but not identifialbe with *C. palpifer*, which is known essentially from the Pacific hake (*Merluccius productus*) (Kabata and Ho, 1981; Sankurathri et al., 1983). Pacific hake is one of the major commercial fishes from the eastern North Pacific, with a landing of 186, 302 tons in 1986 (FAO Yearbook, 1988).

The specimens of *Chondracanthus* taken from New Zealand hoki is identical with "*Chondracanthus palpifer* Wilson, 1912" reported by Villalba and Fernandez (1985) from another hoki, *Macruronus magellanicus*, off the southern coast of Chile. But, nevertheless, they are not identifiable with the genuine *C. palpifer*. They represent a new species and will be called *Chondracanthus australis*. It should be pointed out that *C. palpifer* reported form the Argentine hake (*Merluccius hubbsi*) by Brain (1944) and Szidat (1961) are also misidentification. In other words, *C. palpifer* is confined to the North Pacific.

In this paper I shall give a redescription of *C. palpifer* in addition to description of the new species. The redescription is prepared based on the examinations of the holotype (deposited in the National Museum of Natural History, Smithsonian Institution in Washigton, D.C.), and the specimens newly collected off the coast of southern California. In the following, a complete description is given of the female and for the male, only those features showing sexual dimorphism are mentioned. Since *C. palpifer* was claimed by Szidat (1961) and Kabata and Ho (1981), and

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disclaimed by Ho (1990) as an auxillary indicator to the evolution and biogeography of hakes (*Merluccius*), a discussion on this matter will be made in light of the clarification of the true identity of "*C. palpifer*" from the South American waters.

Chondracanthus palpifer Wilson, 1912

(Figs 1-2)

Chondracanthus palpifer Wilson 1912: 93-94, pl. vi, figs. 36-46; 1920: 12.—Fraser 1920: 61.—Kabata and Ho 1981: 385, fig. 2G.—Sankurathri et al. 1983: 19.

Acanthochondria palpifer (Wilson).—Oakley 1930: 182.

Acanthochondria palpifera (Wilson).—Markewitsch 1956: 97-98, fig. 47.—Yamaguti 1963: 278, pl. 240, fig. 7.

Material examined. Holotype (USNM 38635), female, from gill cavity of *Gadus macrocephalus* collected by G.W. Taylor on 18 January, 1909, from Nanaimo, British Columbia. Two females each carrying a male from wall of gill cavity of *Merluccius productus* collected by M. Moore on 6 May, 1974, off southern California.

Female. The body (Fig. 1A-B) bears one pair of long ventrolateral processes and another pair of long posterior processes. The head lacks process or protrusion of any kind, with its anterior margin narrower than the rounded posterior margin. The neck region is formed by the small first pedigerous somite. The second pedigerous somite is slightly samller than the third and bears a pair of large, bilobate modified legs. The third pedigerous somite carries the ventrolateral processes and the fourth pedigerous somite, the posterior processes. As in *Chondracanthus merluccii*, there is a swelling on the ventral surface of the fourth pedigerous somite just in front of the genital complex (see Fig. 1C, covered by leg 2 and ventrolateral process). In the genito-abdomen (Fig. 1A-B), the abdominal part is shorter than the genital part. The caudal ramus is as usual attached ventrally to the abdomen in the anterior area and bears the usual armature of 3 setae in the basal enlarged portion. The egg sac (see Fig. 1A) is large, containing many rows of small eggs (about 203 μm). It may reach 1.7 times as long as the body.

The antennule (Fig. 1D) is fleshy, consisting of a swollen basal portion and two poorly defined terminal segments. There is only 1 seta on the basal inflated portion. Armature on the two terminal segments are 2 and 10, with 8 setae on the terminal segment clustering at its tip. The antenna is 2-segmented, with terminal segment forming a strong recurved hook (see Fig. 1A). There is no vestigial tip of antenna at the base of this recurved hook.

The labrum (Fig. 1E) bears a small protrusion on the lateral surface and several rows of denticles on the ventral surface. The mandible is 2-segmented. The terminal segment (Fig. 1F) bears on the concave (lateral) side a row of 27 teeth and on the convex (medial side), another row of 34 teeth. The paragnath is a small fleshy lobe bearing denticles. The maxillule (Fig. 1H) is a stout sac bearing 2 unequal elements at the tip and a spinous lobe at the base. Its anterior surface bears denticles

(Fig. 1G). The maxilla (Fig. 1I) is 2-segmented; the basal segment is robust and unarmed, but the distal segment protrudes out into a process bearing 4 teeth on the shaft, and an anterior large seta and a posterior slender seta in the swollen basal region. The maxilliped is 3-segmented; the longest first segment is unarmed, the

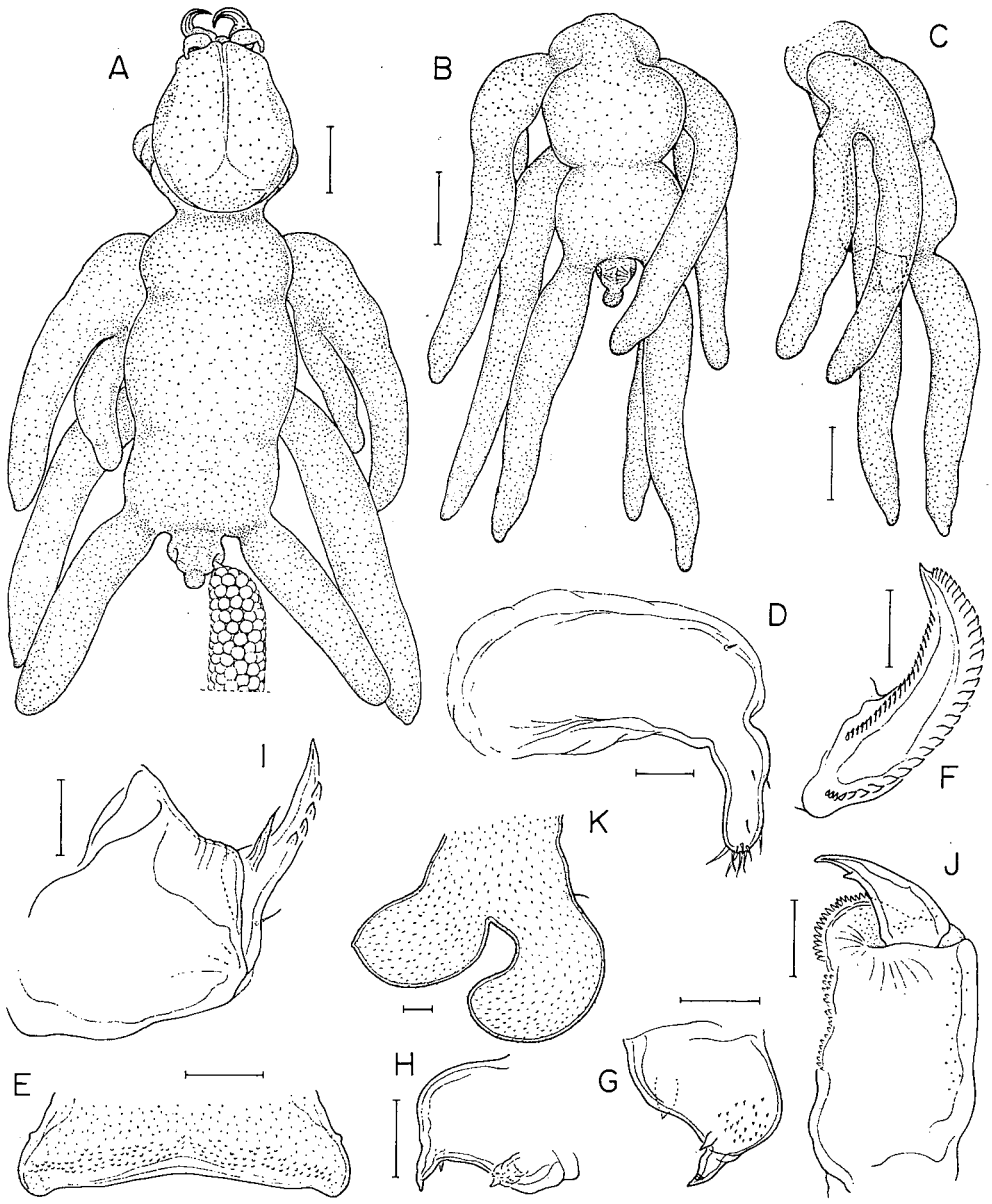

Fig. 1. *Chondracanthus palpifer* Wilson, 1912, female. A. Holotype, dorsal; B. A decapitated body, dorsal; C. Same, lateral; D. Antennule, dorsal; E. Labrum, ventral; F. Termianl segeent of mandible; G. Maxillule, vantral; H. Same, dorsal; I. Maxilla; J. Terminal two segments of maxilliped; K. Leg 1, anterior. Scales: 1 mm in A, B, C; 0.05 mm in D. F. G, H, I, J; 0.1 mm in E, K.

second segment bears rows of denticles in the inner-distal region, and the terminal segment forms a claw with a small, blunt subterminal tooth.

Leg 1 (Fig. 1K) is bilobate and covered with spinules. The exopod (outer lobe) turns strongly inward, with rounded tip. The endopod (inner lobe) differs in being straight and bluntly pointed at the tip. Leg 2 (see Fig. 1C) much longer than leg 1, with both rami protruded into a long process.

Measurements. Body length 9.75 to 11.18 mm (from head to the tip of posterior process), 9.77 mm for the holotype; width (accross the third pedigerous somite) 2.21 to 2.43 mm, 2.29 mm for the holotype; longest egg sac 18.12 mm.

Male. The body (Fig. 2A) is as usual in the Chondracanthidae with a greatly enlarged cephalothorax. The fifth pedigerous somite is indistinguishably fused with the genital complex (Fig. 2B), which bears a pair of prominent ventral ridges. The abdomen is also indistinguishably coalesced with the genital complex. The caudal ramus (Fig. 2B) is a slender spinulose process carrying in its basal ragion 1 dorsal and 2 ventral setae.

The antennule (Fig. 2C) is filiform, bearing the usual armature of 1–1–2–2–8. The 2-segmented antenna (Fig. 2C) differs slightly from that of the female in having a relatively shorter uncinate terminal part. The mandible bears fewer teeth in the terminal segment: 16 or 17 on the concave margin and 19 to 24 on the convex mragin. The anterior surface of the maxillule (Fig. 2D) is without denticles and the basal element is smooth without spinules. The terminal process of the maxilla is without teeth.

Leg 1 (Fig. 2E) is larger than leg 2 (Fig. 2F). Both bear a long outer seta on the protopod, a bifurcate process representing the exopod, and a simple, bluntly pointed process representing the endopod. Other legs are missing.

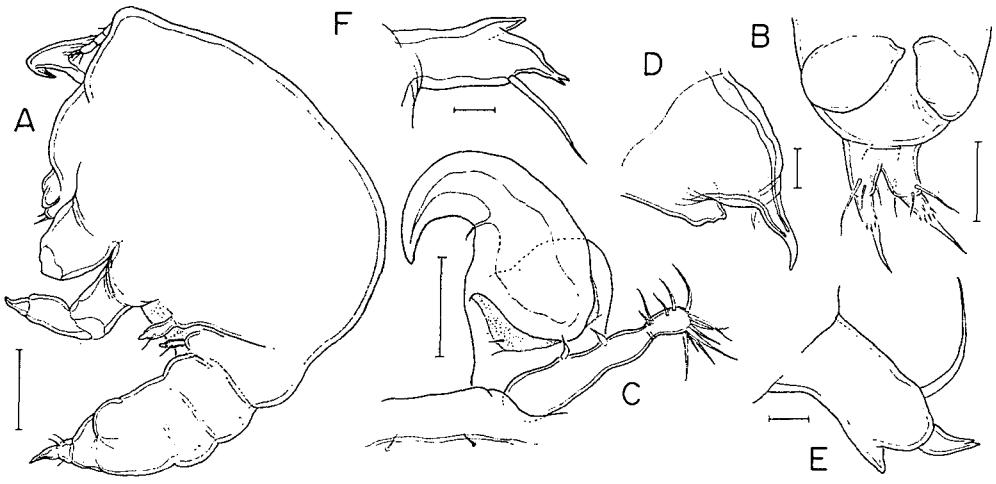

Fig. 2. *Chondracanthus palpifer* Wilson, 1912, male. A. Habitus, lateral; B. Urosome, ventral; C. Antennule and antenna, dorsal; D. Maxillule; E. Leg 1; F. Leg 2. Scales: 0.1 mm in A; 0.05 mm in B, C; 0.01 mm in D, E, F.

Chondracanthus australis, new species

(Figs 3–5)

Chondracanthus (*Acanthochondria*) *palpifer* (Wilson).—Brian 1944: 195–197, pl. I, figs. 1–8, pl. VII, figs. 55, 56, 62–64.

Chondracanthus palpifer Wilson.—Szidat 1961: 14, 16, 18, fig. 1a.—Atria 1980: 307.—Villalba and Fernandez 1985: 37–39, figs. 81–105.—Fernandez 1985: 31, 34, 35.

Material examined. Prof. Pilgrim's collection from Kaikoura, Nea Zealand: 6 females (each carrying a male) attached to the roof of mouth of *Macruronus novaezelan-*

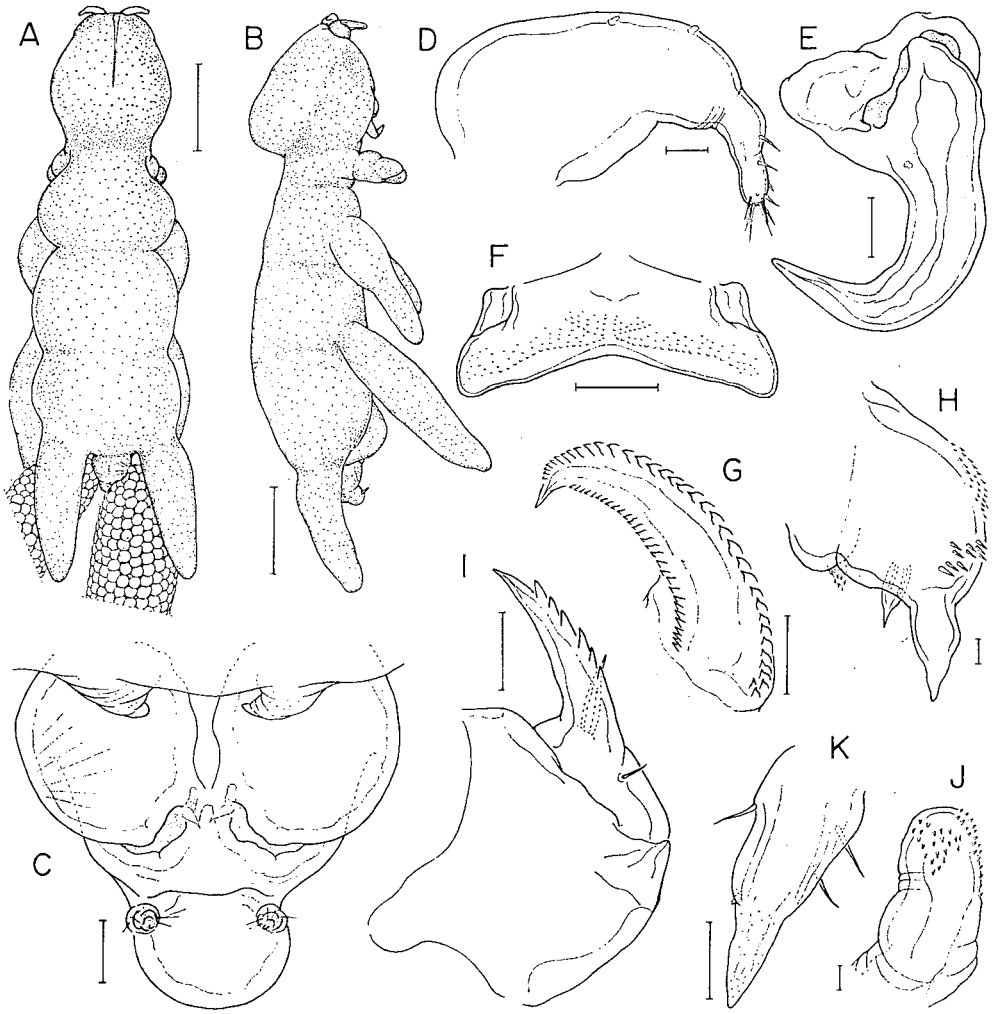

Fig. 3. *Chondracanthus australis*, new species, female. A. Holotype, habitus, dorsal; B. Same, lateral; C. Genito-abdomen, ventral; D. Antennule; E. Antenna; F. Labrum, ventral; G. Terminal segment of mandible; H. Maxillule; I. Maxilla; J. paragnath; K. Caudal ramus. Scales: 1 mm in A, B; 0.1 mm in C, E, F; 0.5 mm in D, G, I, K; 0.01 mm in H, J.

diae collected on 4 June, 1982; 1 female found loose on the floor of mouth of *Thyrsites atun* collected on 4 June, 1982; and 1 female in the oral cavity of *Arripis trutta* collected on 3 June, 1983. Dr. Jones's collection from 51°41.7'S 166°50.14'E: 5 females (each carrying a male) attached to the roof of mouth or tongue of *M. novaezelandiae* collected on 25 October, 1989. One female specimen in the latter collection was selected for the holotype and deposited, together with four paratypes, in the U.S. National Museum of Natural History, Smithsonian Institution in Washington, D.C.

Female. The body (Figs 3A-B) is inflated, with one pair of ventrolateral processes and another pair of posterior processes. The head has no process. The small neck consists of the first pedigerous somite. The second pedigerous somite well marked off from the remainder of the trunk (see Fig. 3A). The third pedigerous somite bears a pair of large ventrolateral processes and the fourth pedigerous somite, a pair of large posterior processes. There is a swelling on the ventral surface of the fourth pedigerous somite (see Fig. 3B) and a pair of vermiform processes at the posterior margin of this swelling (see Fig. 3C). The genito-abdomen(Fig. 3C) is wider than long, carrying a pair of setae on the midventral surface. The abdominal part is much smaller than the genital part in this complex. The stout caudal ramus (Fig. 3K) bears 3 setae and 1 short knob on the proximal swollen portion and denticles on the distal slender portion. The egg sac (see Fig. 3A) is large, containing many rows of small eggs (about $2 \times 6\ \mu m$).

The antennule (Fig. 3D) is shaped and armed as in *C. palpifer*, and so is the antenna (Fig. 3E). However, the labrum (Fig. 3F) differs in having smooth lateral margins. The terminal segment of the mandible (Fig. 3G) bears on the concave (lateral) side a row of 22 to 29 teeth and on the convex (medial) side, another row of 31 to 34 teeth. The paragnath (Fig. 3J) is a small spinous lobe. The maxillule

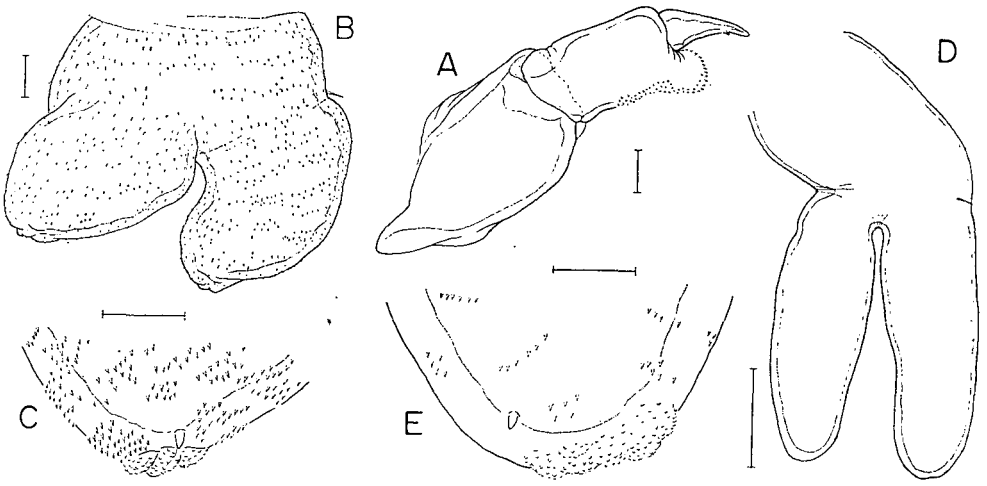

Fig. 4. *Chondracanthus australis*, new species, female. A. Maxilliped; B. Leg 1, anterior; C. Tip of leg 1 exopod; D. Leg 2, anterior; E. Tip of leg 2 exopod. Scales: 0.05 mm in A, C, E; 0.1 mm in B; 0.5 mm in D.

(Fig. 3H) is as in *C. palpifer*, except for the details of the ornamentation on the anterodistal surface. The maxilla (Fig. 3I) is essentially like the one in the previous species. The maxilliped (Fig. 4A) is 3-segmented; the first segment is unarmed, the senond segment has its disto-inner corner protruded into a lobe with spinules, and the third segment forms a claw with a small subterminal tooth.

Leg 1 (Fig. 4B) is robust and covered with spinules. The exopod (outer lobe) is not as strongly bent as in *C. palpifer*. Both rami (inner and outer lobes) are tipped with nodules (see Fig. 4C), but only the exopod carries a small, blunt seta in this region. Leg 2 is much larger than leg 1 (see Fig. 3B), with both rami (lobes) distinctly longer than the protopod and only sparsely covered with spinules (too small to be shown in Fig. 4D). The tips of both rami are armed with nodules as in leg 1, and, similarly, only the exopod carries a small, blunt seata in this region (Fig. 4E).

Measurements. Body length 4.82 to 7.56 mm (from head to the tip of posterior

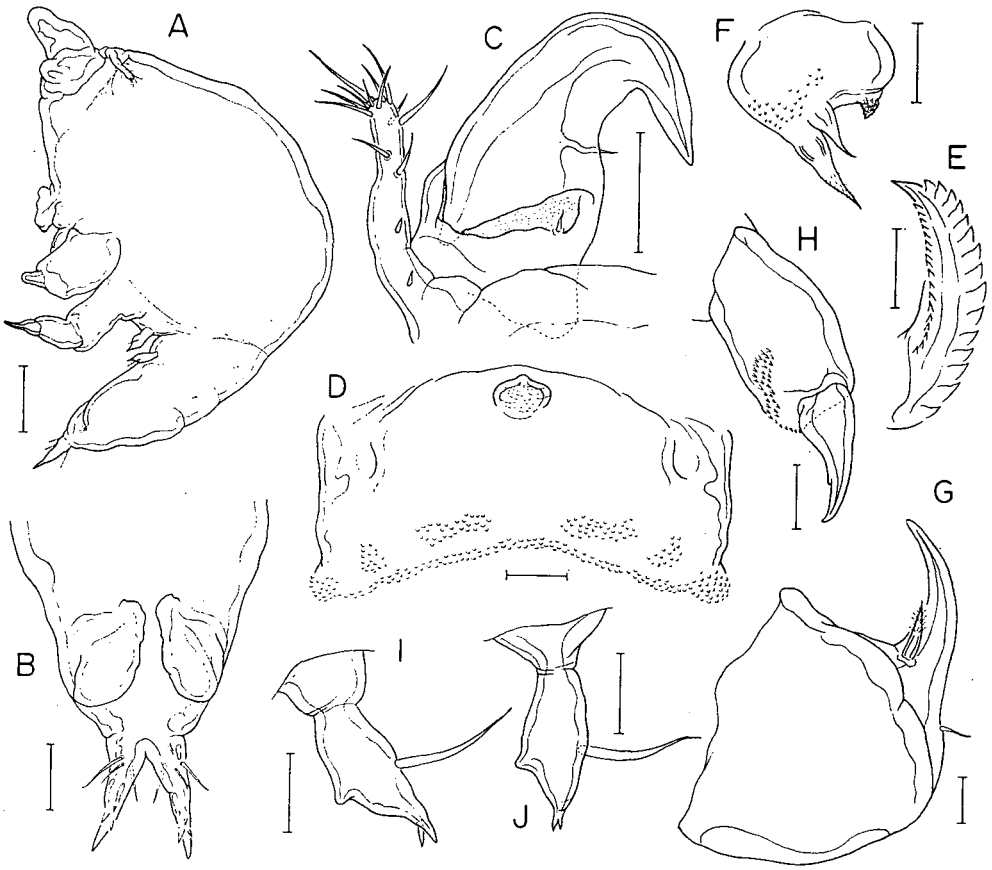

Fig. 5. *Chondracanthus australis*, new species, mele. A. Habitus, lateral; B. Urosome, ventral; C. Antennule and antenna, dorsal; D. Labrum, ventral; E. Terminal segment of mandible; F. Maxillule; G. Maxilla; H. Terminal two segments of maxilliped; I. Leg 1; J. Leg 2. Scales: 0.1 mm in A; 0.05 mm in B, C, H; 0.02 mm in D, E, F, G, I, J.

process), 7.56 mm for the holotype; width (across the third pedigerous somite) 1.26 to 1.78 mm, 1.78 mm for the holotype; longest egg sac 6.25 mm.

Male. The body (Fig. 5A) is shaped as in the previous species with a greatly enlarged cephalothorax. The urosome (Fig. 5B) is slender than that in *C. palpifer* and the caudal ramus seems to be thicker.

The antennule (Fig. 5C) is filiform and armed as in the previous species. The 2-segmented antenna (Fig. 5C) is not different from that in *C. palpifer* either. The labrum (Fig. 5D) is rather rectangular and bears a smooth knob on the anteromiddle surface and a denticulate protrusion on each posterolateral corner. The posterior surface of the labrum between the two protruded corners is fringed with rows of denticles. There are also patches of denticles on the subterminal surface of labrum. The mandible bears fewer teeth in the terminal segment (Fig. 5E): 16 to 19 on the concave margin and 14 or 15 on the convex margin. The paragnath resembles that in the female. The maxillule (Fig. 5F) is slightly different from the female in the ornamentation. The maxilla (Fig. 5G) shows the usual sexual dimorphism in lacking teeth on the terminal process. The maxilliped differs from female in lacking an inner-distal protrusion in the second segment (Fig. 5H).

Both leg 1 (Fig. 5I) and leg 2 (Fig. 5J) resemble those in the previous species, except for having a smaller medial protrusion, the reduced endopod. Other legs are missing.

Discussion

About twenty years ago when Ho (1970) reviewed the genera of the Chondracanthidae, 23 species of *Chondracanthus* were recognized. But this genus has since expanded to embrace 37 species (Ho, in press). As pointed out in the introduction, the new species is most closely related to *C. palpifer*. The most outstanding characteristics shared between the females of these two species are: (1) the lack of processes or protrusions of any kind in the head region, (2) the short neck region consisting of only the first pedigerous somite, (3) one pair of large processes in the trunk region (in additin to the posterior processes) arising from the ventrolateral surface of the third pedigerous somite, (4) a midventral swelling at the posterior extremity of the trunk just in front of the genito-abdomen, and (5) the fleshy, modified antenna clearly divided into two portions: the large, swollen base and the short, 2-parted, cylindrical terminal. With the combination of these five characteristics, these two species are separated from the remaining 35 species of the *Chondracanthus*.

The major morphological differences between the two species of *Chondracanthus* parasitic on Pacific commercial fishes are: (1) *palpifer* has longer leg 2 in female (reaching or passing the posterior end of the trunk, cf. Fig. 1C and Fig. 3B), (2) *australis* has nodules at the tip of the modified rami of female legs 1 and 2 (see Fig. 4C, E; cf. Fig. 1K and Fig. 4B), and (3) the male labrum in *australis* is more elaborate in having a central protrusion and a denticulate lobe in both posterolateral corners (see Fig. 5D). As far as the hosts are concerned, it seems that *palpifer* is chiefly a

parasite of hakes (*Merluccius*) and *australis*, a parasite of hoki (*Macruronus*). However, it should be pointed out that in South American waters *australis* is occasionally found on the hakes (Brain, 1944; Szidat, 1961; Villalba and Fernandex, 1985) but such host shifting is yet to be found in New Zealand waters (J.B. Jones, personal communication).

The misidentification of *C. australis* for *C. palpifer* by Brain (1944) has led Szidat (1961) to propose an erroneous concept that the "Urheimat" (original center of development) of hakes was situated in the present-day Bering Sea. In defeating Szidat's hypothesis on the origin and dispersal of hakes, Kabata and Ho (1981) encountered difficulty in explaining the evolution of *C. palpifer* from *C. meruccii* when their ancestral hosts migrated separately from the Caribbean into the Pacific and the South Atlantic. Of course, it is clear now that the difficulty experienced by them at the time was due to their unawareness of the fact that the so-called *C. palpifer* parasitic on the Argentine hake was actually a different species.

In his recent work on the historical biogeography of hakes, Ho (1990) discarded *C. palpifer* as an indicator parasite of hakes because it is not host specific to this genus (*Merluccius*) of fish. However, with the present clarification of the true identity of the so-called *C. palpifer* of South America, it should be rectified that *C. palpifer* on the Pacific hake is a good indicator parasite, signifying that Pacific hake evolved from the ancestral hakes in the western North Atlantic that carried *C. merluccii*. Combining the present clarification together with information provided by Ho (1971) and Kabata and Ho (1981), we understand now that *C. merluccii* is host specific to hakes occurring in both North and South Atlantic Oceans.

C. merluccii is very closely related to *C. palpifer* and *C. australis*. Based on Ho's (1971) redescription, *merluccii* differs from *palpifer* and *australis* in only item one of the five items enumerated in the beginning of this section. Inada (1989) recognized four genera in the family Merlucciidae; *Merluccius*, *Macruronus*, *Lyconus*, and *Steindachneria*. Ho's (1990) cladistic analysis of these four genera indicated that *Steindachneria*, *Macruronus*, and *Lyconus* are monophyletic and occur as the sistergroup of *Merluccius*. If coevolution has occurred between *Chondracanthus* and merlucciids, Ho's (1990) phylogenetic hypothesis would predict that *C. australis*, but neither *C. palpifer* nor *C. merluccii*, is to be found on *Lyconus* and *Steindachneria*.

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