

Ryukyua globosa n. gen., n. sp., and *R. circularis* n. comb., Parasitic in the Opercular Chambers of Pacific and Indian Ocean Clupeid Fishes

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Abstract.—*Ryukyua* is characterized by a compact and hunched body, head immersed in pleon, large eyes, coxae shorter than pleonites, subequal antennae with separated bases and a short third article of mandibular palp, a maxilliped that is not expanded in gravid females, pereopods gradually increasing in length, pleon narrower than and deeply immersed in pereon, uniform pleopods, and uropods not reaching posterior margin of pleotelson. *Ryukyua globosa* n. sp. differs from *Ryukyua circularis* n. comb. (pro *Livoneca circularis* Pillai) by having a rectangular instead of triangular pleotelson, a lobe of the head between bases of antennae 1, and antennae not reaching the posterior border of the head instead of extending beyond it. Mature females of *R. globosa* are wider than long; this unusual shape has not been confirmed in *R. circularis*. Two sardinellas, *Amblygaster sirm* and *Amblygaster leiogaster*, are parasitized by *R. globosa* in Japan and by *R. circularis* in India and Thailand. The duplex male–female arrangement of female in one gill chamber and male in the other is similar to that of *Mothocya bohlkeorum* and some other Cymothoidae. The growth from male to female involves increase in the width of the body but not in the total length.

Bruce (1990) revised the genus *Livoneca* or *Livoneca* (spelling dispute—see Williams and Bowman, in press) and noted that the species *Livoneca circularis* Pillai, 1954, did not belong in this genus and that the generic position of this species was entirely uncertain. Pillai (1954) described *L. circularis* from Trivandrum, (southern) India, and added more details and illustrations 10 years later (Pillai 1964). We obtained fish infected with this isopod from Thailand (Williams and Williams 1986). Fishes infected with a second, heretofore undescribed, isopod species were obtained from a small-boat, indigenous net fishery in Motobu-cho, Okinawa, and other areas in the Ryukyu Islands of Japan. Females of these isopods have a very short third segment of the mandibular palp, and coxae much shorter than the pleonites, and thus do not belong to any known genus of Cymothoidae. Hence, we describe a new genus and species and revise the classification of *L. circularis* here.

Methods

Fishes examined for isopods were collected by commercial fishermen and were kept in holding containers on ice. Other fish were from ichthyological fish collections and had been preserved in formalin. Hosts were measured for fork length to the nearest millimeter. Isopods were measured for total length and maximum width to the nearest 0.1 mm and preserved in 70% ethanol. Eggs and embryos were removed from the brood pouch of

female isopods and counted, and 10 individuals from each brood pouch were measured for total length and maximum width to the nearest 0.01 mm. Mouthparts and appendages were mounted in glycerine jelly and drawn with the aid of a Nikon projection microscope. Whole specimens were drawn with a camera lucida. Pleotelsons of the illustrated specimens were drawn in the natural, depressed position; therefore, the lengths of pleotelsons in illustrated dorsal views do not represent the actual total lengths. Means of measurements, given in millimeters, are in parentheses. Some isopod specimens were taken from fishes in the Ichthyology Collection of the University of the Ryukyu (URM-P). Isopod specimens are deposited in the Crustacean Collection of the National Museum of Natural History (USNM).

Diagnosis of *Ryukyua* n. gen.

(Figures 1–32)

Unique characteristics: Coxae shorter than respective pleonites. Third article of mandibular palp very short relative to other 2 articles, apex rounded.

Other characters: Body compacted and hunched anterior to posterior. Antennae subequal, bases well separated. Eyes large relative to head size. Proximal part of maxilliped not expanded in gravid females. Pereonite 1 produced into lobes along lateral margins of head (head immersed in pleon). Pereopods gradually increasing in length from an-

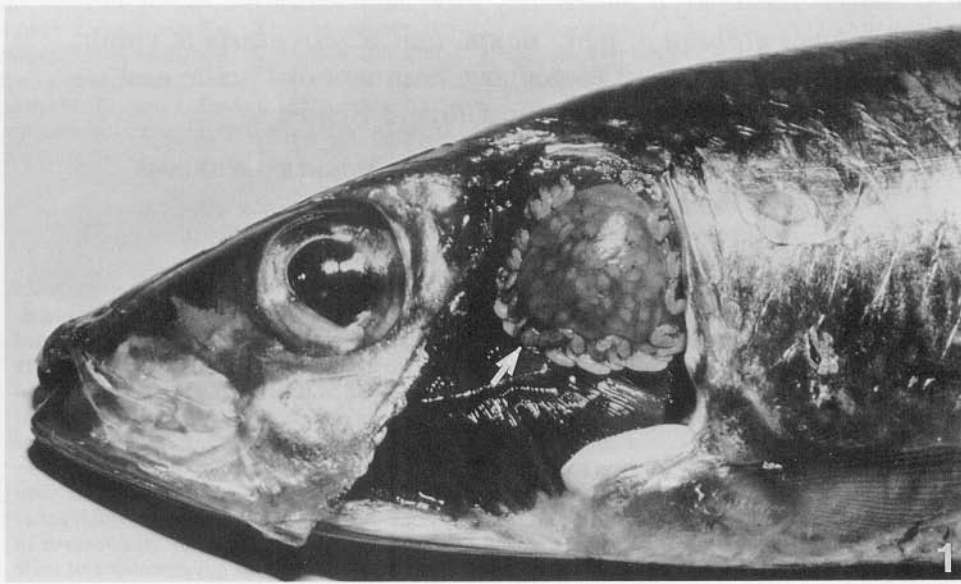


FIGURE 1.—Holotype (female) of *Ryukyua globosa* n. sp. in the posterior dorsal corner of the gill chamber of *Amblygaster sirm*. Arrow indicates head of the 17-mm-long isopod.

terior to posterior. Lateral part of pereonite 7 produced posteriorly and overlapping lateral parts of first 3–5 pleonites (pleon deeply immersed in pereon). Pleon narrower than pereon. Pleopods uniform, lacking folds, pockets, or digitiform processes. Uropods not reaching posterior apex of pleotelson.

Type species: *Ryukyua globosa* n. sp.

Etymology: The name (gender feminine) is in honor of the Ryukyu Islands and the Ryukyu people of Japan.

Remarks: The new genus differs from all known cymothoid genera in that mature *Ryukyua* females have bodies that range from being almost as wide as long to being wider than long, a very short third article of the mandibular palp, and coxae that are much shorter than pleonites. Similar broadening of the body is found in the genera *Agarna* Schioedte and Meinert and *Cterissa* Schioedte and Meinert, but these genera have very asymmetrical expansions, while the expansion of *Ryukyua* is approximately equal on both sides of the body. The genus *Joryma* Bowman and Tareen is similarly hunched, but not as expanded in width. Various other characters separate *Ryukyua* from these genera, and thus their resemblance is only superficial. No other described cymothoid genus is similar to *Ryukyua*.

The Ryukyu Islands or Ryukyu Archipelago stretches from just south of Kyushu (in the “main”

Japanese islands) to near Taiwan off the southern Chinese coast in a gently curving arc of more than 1,300 km. The geographic range of isopods in the genus *Ryukyua* is far wider. We know they occur in southern India in the Indian Ocean, Thailand in the South China Sea, and the Ryukyus in the Pacific. Naming a genus in honor of a people or a locality does not mean that the species in the genus is geographically restricted to the region (for example, *Kuna* [Cymothoidae], so named in honor of the Kuna Indians off the Caribbean coast of Central America). Since ancient times, the Ryukyuan have been famous seafarers who traded from Japan to India. These routes also correspond to the known ranges of the species in *Ryukyua*.

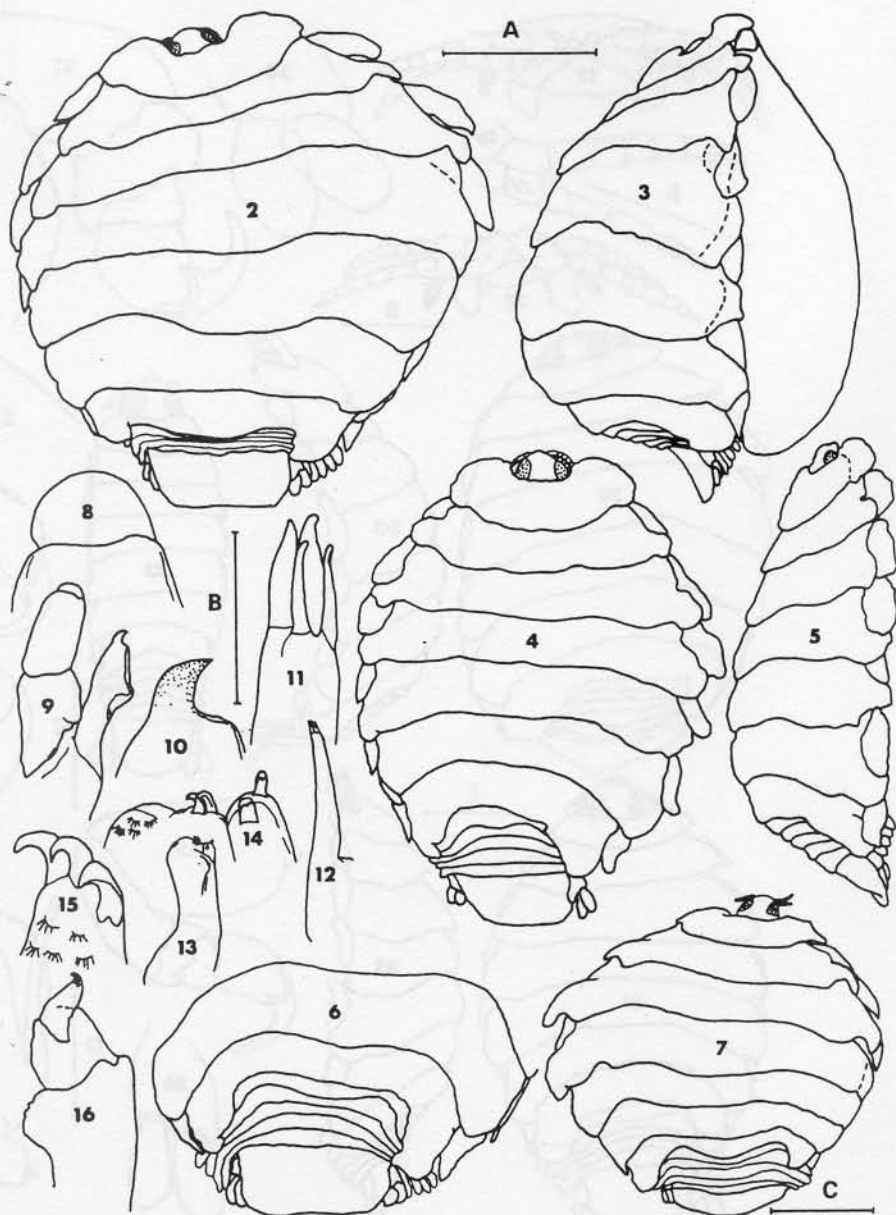
Description of *Ryukyua globosa* n. sp.

(Figures 1–27; Table 1)

Type material: Holotype (USNM 231038), associated male paratype (USNM 231042), 17 paratypes (USNM 231039–231041, 231043, 231045–231047).

Type host and locality: *Amblygaster sirm*,¹ hoshi-yamato-mizum (Clupeiformes: Clupeidae),

¹ Common names given here follow Masuda et al. (1984). The common names preferred by AFS—spotted sardinella *Amblygaster sirm* and smoothbelly sardinella *A. leiogaster*—are given in Robins et al. (1991).



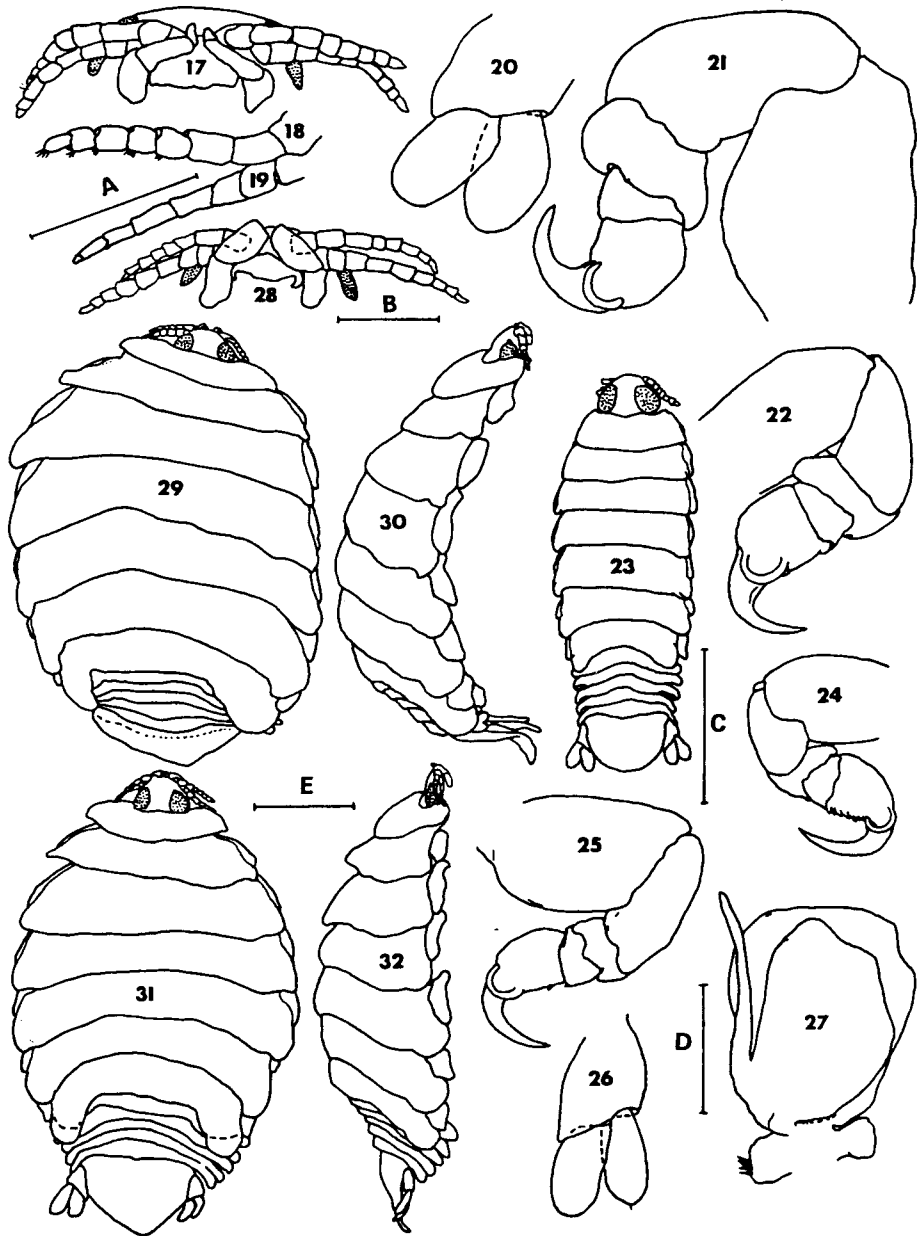
FIGURES 2-16.—*Ryukyua globosa* n. gen., n. sp., from *Amblygaster sirm*. **Figures 2-3, 6 (and 17).** Gravid female holotype: (2) dorsal view; (3) lateral view; (6) oblique view of posterior end, for detail of pleon and pleotelson. **Figures 4-5, 7-16.** Female paratypes: (4) dorsal view; (5) lateral view; (7) dorsal view; (8) distal segment of mandibular palp; (9) mandible; (10) incisor process of mandible; (11) apex of maxilla; (12) maxilla 1; (13) maxilla 2; (14) apex of maxilla; (15) apex of maxillipedal palp; (16) maxilliped. Scale bars: **A** (=5 mm) applies to Figures 2-6 (and 23); **B** (=1 mm) applies to Figures 9, 12, 13, 16 (and 18, 19); **C** applies to Figure 7. Figures 8, 10, 11, 14, and 15 are enlargements of associated mouthparts (no scale bar).

northern Okinawa, Toguchi Market, Motobu-cho, Okinawa, Japan, 14 September 1985.

Additional localities: Motobu-cho, Okinawa, Japan, July 1973 (URM-P 1247); Chinen Fish Market, Chinen Village, Okinawa, Japan, 26 May

1984 (URM-P 9405-9418, 9420-9422, 9424, 9426, 9428-9432, 9434); Naha Fish Market, Naha, Okinawa, Japan, 19 June 1984 (URM-P 10011-10012).

Additional host and locality: *Amblygaster leio-*



FIGURES 17-27.—*Ryukyua globosa* n. gen., n. sp., from *Amblygaster sirm*. Figure 17. Head, ventral view (holotype). Figures 18-22. Gravid female paratype: (18) antenna 1; (19) antenna 2; (20) uropod; (21) pereopod 7; (22) pereopod 1. Figure 23. Dorsal view (male associated with holotype). Figures 24-27. Male paratype: (24) pereopod 1; (25) pereopod 7; (26) uropod; (27) pleopod 2. Scale bars: A (=1 mm) applies to Figures 18, 19; B (=1 mm) applies to Figures 17, 28; C (=5 mm) applies to Figure 23; D (=1 mm) applies to Figures 20-22, 24-27.

FIGURES 28-32.—*Ryukyua circularis* n. comb. from *Amblygaster sirm*. Figure 28. Head, ventral view. Figures 29, 31. Dorsal view. Figures 30, 32. Lateral view. Scale bar E (=3 mm) applies to all of Figures 28-32.

gaster,¹ yamato-mizun (identity of fish not confirmed by us), Ishigaki City, Ishigaki Island, Japan, 1 December 1985.

General description (female): Body round, almost spherical in gravid females, usually slightly

curved to one side or the other (related to side of branchial chamber the individual inhabits). Anterior margin of head ventrally flexed, forming a broad lobe between bases of antennae 1. Antennae 1, 8 segments; antennae 2, 8-9 segments. Anten-

TABLE 1.—Description of embryos and larvae in the brood pouches of 11 *Ryukyua globosa*.

Number per pouch	Description	Range (mean), mm	
		Length	Width
459–644 ^a	Subspherical embryos	1.10–1.50 (1.21)	0.90–1.11 (0.98)
188	Oblong embryos, a few with cephalic end formed	1.50–1.65 (1.60)	0.90–1.02 (0.96)
432	Oblong embryos with cephalic end, without eyes, small eye-pigment spots in some	1.65–1.75 (1.69)	0.80–0.95 (0.86)
428	Embryos with eyes and leg buds	1.60–1.80 (1.71)	0.85–1.00 (0.92)
529	Manca larvae with eyes, antennae and 6 pereopods, no pigment spots, compressed	2.55–2.81 (2.68)	0.69–0.85 (0.76)
431	Manca larvae with small pigment spots on body, body flattened and curled	3.10–3.35 (3.23)	0.90–1.10 (0.96)
60,115 ^b	Manca larvae with large pigment spots on body, body flattened not curled	3.70–4.20 (4.04)	0.88–1.05 (0.98)

^a Specifically 459, 504, 526, and 644.

^b Released in gill chamber of the host; some larvae probably lost.

nae not reaching posterior border of head. Mandible with recurved incisor process, palp with second or middle segment slightly inflated. Maxilla 1 with 2 stout and 2 slender slightly recurved apical spines. Maxilla 2 with 2 recurved spines on each lobe. Maxilliped article 3 with 3 recurved apical spines. Lateral part of pereonites dilated. Posterolateral angles of pereonites 2–4 produced posteriorly and those of pereonites 2, 3, and sometimes 4 also produced laterally on longer side of isopod. Coxae of pereonites 2–4 laterally produced in larger and more hunched specimens, rather variable in size and shape. Pleotelson 2.5–3 times wider than long, rectangular, posterior border straight to broadly rounded or slightly emarginate (Figure 6). Uropods small relative to body size, rami elongate-oval, subequal in length. Pereopods stout, propodus as wide as long, merus of pereopods 6 and 7 expanded, more so in pereopod 7. Body white in life and in alcohol. A few chromatophores scattered on head and lateral part of pereon, more concentrated on pleon and pleotelson. Pleotelson with 2 patches of concentrated chromatophores.

Male (measured from 2 specimens): Lengths, 11.1 and 12.4 mm; maximum widths, 5.2 and 5.5 mm. Body twisted to right or left, not hunched. Penes bilobed conical process, not reaching bases of pleopod 1. Stout spines on inner margin of propodus of pereopods 1–4. Appendix masculina of pereopod 2 linear, with unmodified apex, extending well beyond exopod apex.

Female (measured from 17 specimens): Lengths, 11.8–17.0 mm (14.4 mm); maximum widths, 9.2–

16.0 mm (13.5 mm). Only 1 female (11.8 × 11.6 mm) without oostegites. Maximum width of females with oostegites varied from 1.12 times wider than long in mature females (Figure 7) through equal to total length of isopod (Figure 2) to 78% of total length (Figure 4). Average width 94% of length. Eight females were as wide as long or wider than long, and 9 were narrower than long. Areas medial to inflated coxae varied from inflated into bosses (Figures 4, 5) to expanded into posteroventral angles (Figures 2, 3).

Brood pouch reproduction: See Table 1. The number and sizes of eggs and embryos in broods are not known for the majority of cymothoid species. This information may have useful taxonomic and biological applications and should be encouraged in any description or redescription of a cymothoid.

Location in host: Female in posterior dorsal corner of gill chamber on top of gill filaments attached to operculum (Figure 1). Male in same position in opposite gill chamber.

Damage to host: The males of *R. globosa* and apparently *R. circularis* displace the filaments in the posterior dorsal corner of the gill chamber of *Amblygaster* sp. Females crypt these filaments (i.e., cause a necrotic eroding reaction of host tissues pressed against the parasite) and form a deep cavity in the gill chamber of the host. Provenzano (1983) suggested that isopods make these cavities by consuming host tissues. We believe cymothoids feed on fluids, not solid tissues.

Host fishes examined: The incidence of this isopod in 3 collections of *Amblygaster sirm* was 60%

(3/5), 8% (1/12), and 83% (25/30). Thirty-two specimens of *A. leiogaster* (collected with the sample of *A. sirm* with 83% infected) were not infected by this isopod. The host for the single record of an infected *A. leiogaster* from Ishigaki Island was not examined by us. Thus, we have not confirmed this fish as a host for *R. globosa*. Twenty to 100 specimens of each of the remaining 13 species of clupeids in Japanese waters (Masuda et al. 1984) were examined by us, but no specimens of *R. globosa* were found.

Etymology: From Latin *globosus*, meaning round like a ball, *globose*, spherical.

Japanese standard common name: Marui-to-yaku-rui (English translation = circular isopod).

Remarks: *Ryukyua globosa* differs from *R. circularis* by having the anterior margin of head flexed and produced into a lobe between bases of antennae 1 (Figure 17) instead of having no lobe (Figure 28), having antennae not reaching posterior border of the head (Figure 7) instead of reaching beyond it (Figures 29–32), and having a rectangular (Figure 6) instead of a triangular pleotelson (Figures 29, 31).

Characteristics of *Ryukyua circularis*

(Pillai, 1954) n. comb.

(Figures 28–32)

Livoneca circularis Pillai, 1954, p. 17; 1964, pp. 218–220, Figures 4L, 5, 7F.

Lironeca circularis Williams and Williams, 1986, pp. 213–215, Figures 1 A–E.

Specimens deposited: Two females (USNM 231048).

Host and locality: *Amblygaster sirm*, Phuket Island Fish Market, Phuket Island, Thailand (URM-P 9099, 9102).

General description (female): Our specimens' characteristics are in agreement with the descriptions and figures of Pillai (1954, 1964), with the exception that our specimens are not simply convex in cross section but are hunched. Pillai (1964: 222) illustrated a female isopod that was only 72% as wide as long, but described *Lironeca circularis* (as *Livoneca circularis*) as "nearly circular" (Pillai 1964:218). Nevertheless, mature females of this species may be as wide as long. Our 2 female isopods were 61 and 69% as wide as long (and the narrowest *R. globosa* was 78% as wide as long). The peduncle and flagellum divisions of the antennae noted by Pillai (1964) are not apparent in our specimens, and the pleotelson is not bilobed at the posterior apex. The mandibular palps of this species extend beyond the anterior margin of the

head and are visible in dorsal view (Figures 29, 31). This condition was not described by Pillai (1954, 1964). A lateral view of the female and ventral view of the head were not illustrated by Pillai (1954, 1964). Williams and Williams (1986) illustrated these views. Similar illustrations are given here (Figures 28, 30, 32) for comparison with the new species.

Female (measured from 2 specimens): Lengths, 14.0 and 14.2 mm, maximum widths, 8.6 and 9.6 mm. Both with oostegites.

Location in host: Same as described for *R. globosa*.

Discussion

Pleopod morphology is used as a taxonomic character to identify certain cymothoid genera. Some genera, such as *Ryukyua*, have rather uniform, unadorned pleopods. For these taxa, illustration of the second pleopod of the male is sufficient in a description. Plates filled with nearly identical pleopods (1–5 of the female and male) are not necessary or desirable.

A taxonomic description cannot be completed without accumulating a good deal of biological information concerning the animal under consideration. Much of the older literature omitted this information, as do some recent descriptions. The biological data can seldom stand alone as a separate publication, and are thus lost if not joined in the discussion of the description. Taxonomists should be urged to include biological information with their descriptions, as we have attempted to do in the present descriptions.

The position of *R. globosa* and *R. circularis* in the posterior dorsal corner of the gill chamber of their hosts, attached to the operculum, is unusual among parasitic isopods of fishes. We are only aware of two other species, *Agarna malayi* Tiwari, 1953, and *Norileca indica* Bruce, 1990, with this orientation in the gill chambers of their hosts. *Joryma engraulides* (Barnard, 1936) may possibly have a similar attachment position (see Barnard 1936).

The separation of female and male in opposite gill chambers in *R. globosa* and *R. circularis* is similar to the duplex arrangement of females and males of *Mothocya bohlkeorum* reported by Williams and Williams (1982). A female *M. bohlkeorum* completely fills the gill chamber so that no space is available for a male. A similar explanation would not apply to the distribution of *R. globosa* or *R. circularis* because the female does not fill the gill chamber (Figure 1); however, these iso-

pods could be restricted to the posterodorsal portion of the gill chamber of their hosts.

Pillai (1964) reported that male and female *R. circularis* are the same total length (12 mm). We assumed that this was a typographical error (as female cymothoids are invariably larger than males) until we examined specimens. The similarity in lengths between males and females is a consequence of the unusual shape of mature females. Although females enlarge in width and slightly in length as they mature, the hunched posture that develops minimizes the increase in length.

Ryukyua globosa seems to be host-specific to *Amblygaster sirm*. In three collections of this host ($N = 46$), 63% of the fish had this isopod. Specimens of the remaining 13 species of Japanese clupeids (Masuda et al. 1984) that we examined were not infested. Pillai (1954) reported *Lironeca circularis* (as *Livoneca circularis*) from the gill chamber of *Amblygaster leiogaster* (as *Clupea leiogaster*), and Williams and Williams (1986) reported this isopod from *A. sirm*.

Males of *R. globosa* and possibly *R. circularis* ($N = 1$) seem to abandon the host during capture. Wounds produced by males of *R. globosa* were abundant on the gills of *A. sirm*, but few males were collected. Females and males seem to be almost always associated in pairs even though they are isolated in opposite gill chambers.

Amblygaster sirm is an important food fish throughout the Ryukyu Islands. It is sold fresh in fish markets and supermarkets without scaling or removing the internal organs. *Ryukyua globosa* must be familiar to the general public as well as to the fishermen in the region. The lack of attention this pest has received is difficult to explain.

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