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MOTHOCYA BOHLKEORUM, NEW SPECIES (ISOPODA: CYMOTHOIDAE) FROM WEST INDIAN CARDINALFISHES (APOGONIDAE)

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ABSTRACT

Mothocya bohlkeorum, new species, is described from the gill chambers of the whitestar cardinalfish *Apogon lachneri* Bohlke from Puerto Rico; and the dusky cardinalfish *Phaeoptyx pigmentaria* (Poey) and the freckled cardinalfish *P. conklini* (Silvester) from the Bahamas. It may be distinguished from *Mothocya nana* (Schioedte and Meinert) by the shape of the frons and telson; and by having a cephalon which is slightly instead of deeply immersed in pereonite 1. Larger female *M. bohlkeorum* occur on the larger hosts. Female isopods may undergo vegetative growth stages between reproductive brood stages. Male and female isopods occur in opposing gill chambers of a host. This duplex male-female association may explain how relatively large cymothoid isopods colonize small host species.

Bohlke and Chaplin (1968) and Tyler and Bohlke (1972) reported unidentified isopods in the gill chambers of the dusky cardinalfish *Phaeoptyx pigmentaria* (Poey) and the freckled cardinalfish *P. conklini* (Silvester) from the Bahamas. Williams and Williams (1977) reported a new species of *Mothocya* from the whitestar cardinalfish *Apogon lachneri* Bohlke from Puerto Rico. We were able to examine the specimens of Bohlke and Chaplin (1968) and found them to be identical with specimens on the whitestar cardinalfish from Puerto Rico. This isopod, *Mothocya bohlkeorum*, new species, is described herein.

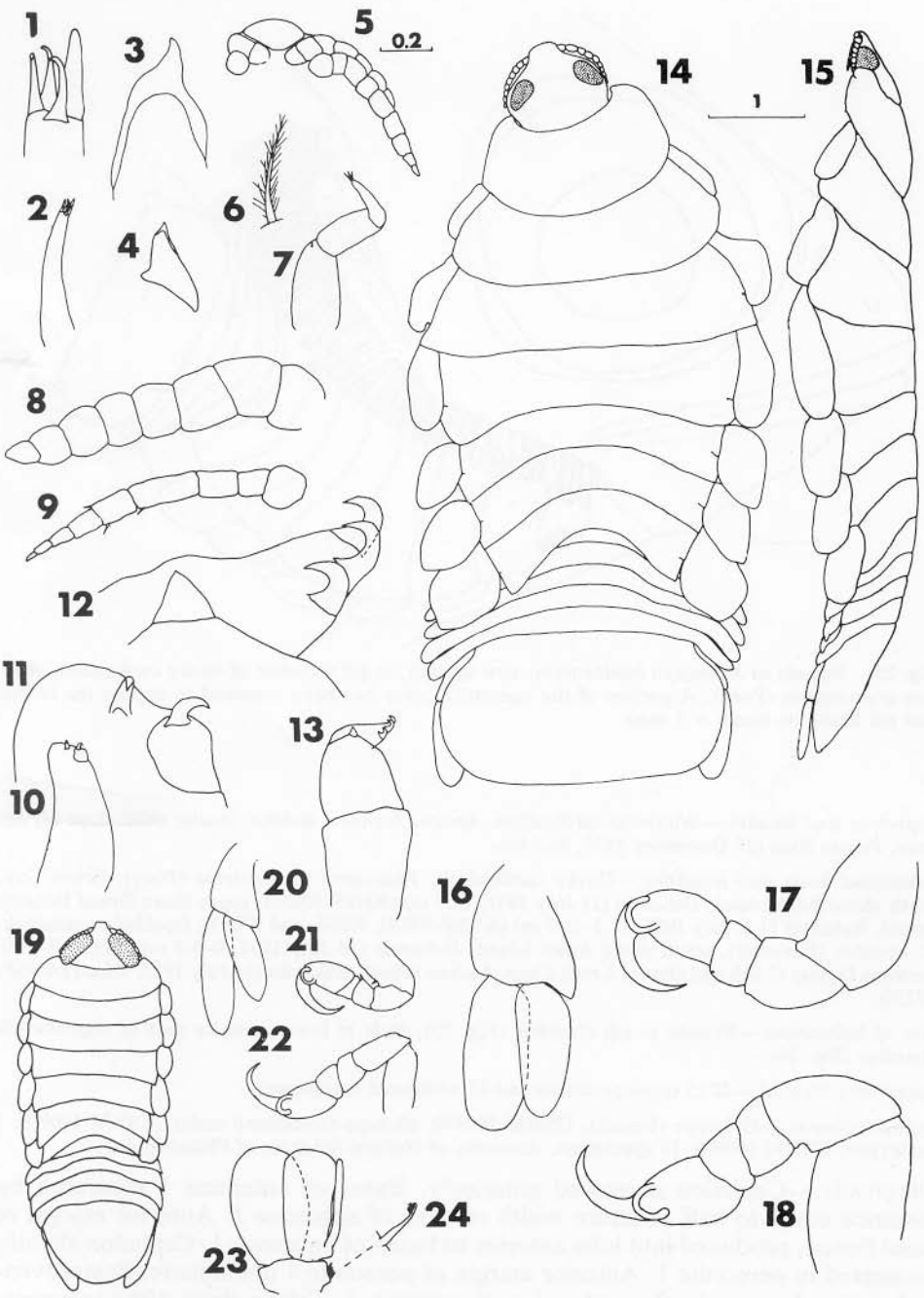
Three other isopods have been reported from West Indian cardinalfishes. Dale (1975) observed an unidentified isopod on a barred cardinalfish, *Apogon binotatus* (Poey), from the Bahamas. Williams and Williams (1977) reported *Excorallana oculata* (Hansen, 1880) from the dusky cardinalfish and the flamefish *A. maculatus* (Poey). Williams and Williams (1980) described *Renocila colini* on the flamefish and the belted cardinalfish *A. townsendi* (Breder) from Puerto Rico. Beebe and Tee-Van (1928), Bohlke and Randall (1968), and Tyler and Bohlke (1972) noted what was possibly the same isopod on the sponge cardinalfish *Phaeoptyx xenus* (Bohlke and Randall) from Haiti.

MATERIALS AND METHODS

Parasitized cardinalfishes were paralyzed with rotenone, and collected with hand nets using scuba. Hosts were measured for standard and total lengths to the nearest millimeter, and examined for damage associated with the isopods under 10× power of a dissecting microscope. Isopods were measured for total length and maximum width to the nearest 0.1 mm. They were preserved in 70% ethanol or in 10% formalin and transferred to 40% isopropanol. Eggs and larvae were removed from female isopods, counted, and a random sample of 10 measured for total length and maximum width to the nearest 0.01 mm. Mouthparts and appendages were mounted in glycerine jelly. Drawings of appendages were made with the aid of a Bausch and Lomb Trisymplex microprojector. Whole specimens were drawn from projections of 35 mm photographic slides. All measurements are in millimeters. Other material included specimens from the Academy of Natural Sciences of Philadelphia (ANSP).

Mothocya bohlkeorum, new species
Figs. 1–26

Synonyms.—"Isopod" of Bohlke and Chaplin, 1968, pp. 246, 248; Tyler and Bohlke, 1972, p. 608, in part. *Mothocya* sp. of Williams and Williams, 1977, p. 14.



Figs. 1–24. *Mothocya bohlkeorum*, new species. 1–18, Gravid female holotype. 1, Apex of maxilla 1; 2, Maxilla 1; 3, Apex of mandible; 4, Mandible; 5, Antennae and anterior margin of head; 6, Seta of mandibular palp; 7, Mandibular palp; 8, Antennae 1; 9, Antennae 2; 10, Maxilla 2; 11, Apex of maxilla 2; 12, Apex of palp, maxilliped; 13, Maxilliped; 14, Dorsal view; 15, Lateral view; 16, Uropod; 17, Pereopod 1; 18, Pereopod 7. (Antennae, pereopods, and uropod, 32×; mouthparts, 65×; enlargements of mouthparts, 320×). 19–24, Male allotype. 19, Dorsal view; 20, Uropod; 21, Pereopod 1; 22, Pereopod 7; 23, Pleopod 2; 24, Seta of pleopod 2. (Appendages, 32×; seta, 320×).

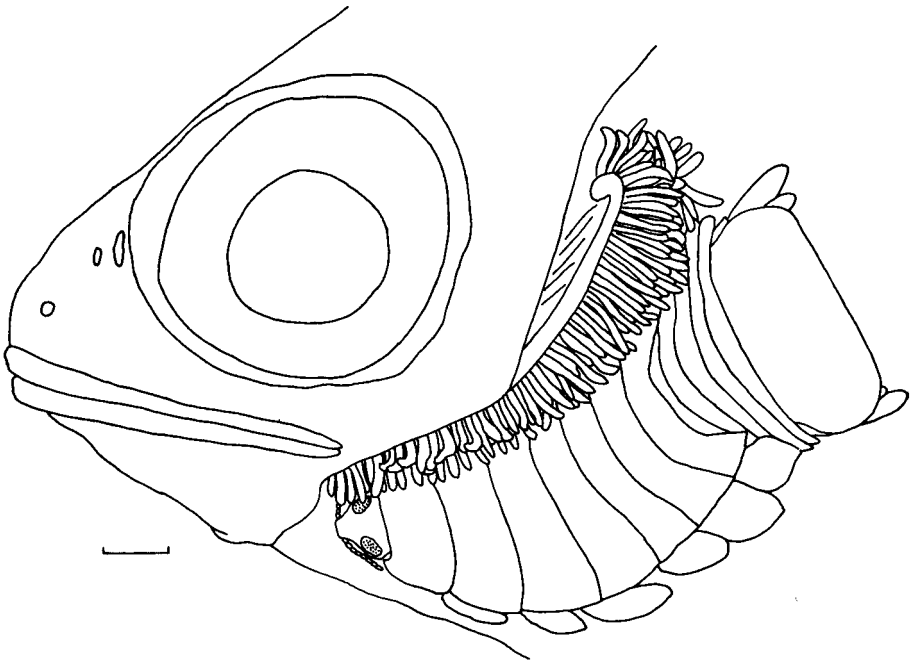


Fig. 25. Female of *Mothocya bohlkeorum*, new species, in gill chamber of dusky cardinalfish, *Apogon pigmentaria* (Poey). A portion of the opercular cover has been removed to expose the isopod and gill filaments (scale = 1 mm).

Type-host and locality.—Whitestar cardinalfish, *Apogon lachneri* Bohlke, insular shelf slope off Salinas, Puerto Rico (25 December 1976, 36.6 m).

Additional hosts and localities.—Dusky cardinalfish, *Phaeoptyx pigmentaria* (Poey), Green Cay, north shore Rose Island, Bahamas (21 July 1957, 13.7 m) (ANSP-97052); south shore Grand Bahama Island, Bahamas (1–2 July 1959, 12.2–13.7 m) (ANSP-97030, 97053, and 97055); freckled cardinalfish, *P. conklini* (Silvester), south shore Athol Island, Bahamas (14 July 1955, 0–6.1 m) (ANSP-97218); between Grassy Creek and Grassy Creek Cays, Andros Island, Bahamas (14 July 1957, 4.6 m) (ANSP-97230).

Site of Infestation.—Female in gill chamber (Fig. 25); male in lower anterior part of opposite gill chamber (Fig. 26).

Specimens Studied.—22 (5 type-specimens and 17 additional specimens).

Type-specimens.—Holotype (female), USNM 190978; allotype (associated male), USNM 190979; 3 paratypes, USNM 190980; 17 specimens, Academy of Natural Sciences of Philadelphia.

Diagnosis.—Cephalon narrowed anteriorly. Bases of antennae 1 separated by distance equal to half of entire width of base of antennae 1. Anterior margin of head flexed, produced into lobe anterior to bases of antennae 1. Cephalon slightly immersed in pereonite 1. Anterior margin of pereonite 1 not sinuate. Posteroventral angle of pereonite 7 overlapping pleonites 1–3. Telson three-fifths to seven-eighths wider than long, subrectangular. Uropod extending slightly beyond posterior margin of telson; outer ramus longer than inner ramus.

Further Details.—Antennae 1 of 8 articles. Antennae 2 of 9 articles. First segment of mandibular palp expanded, third segment with 3 setae at apex. Incisor process of mandible acute. Maxilla 1 with 1 large straight spine and 3 smaller recurved

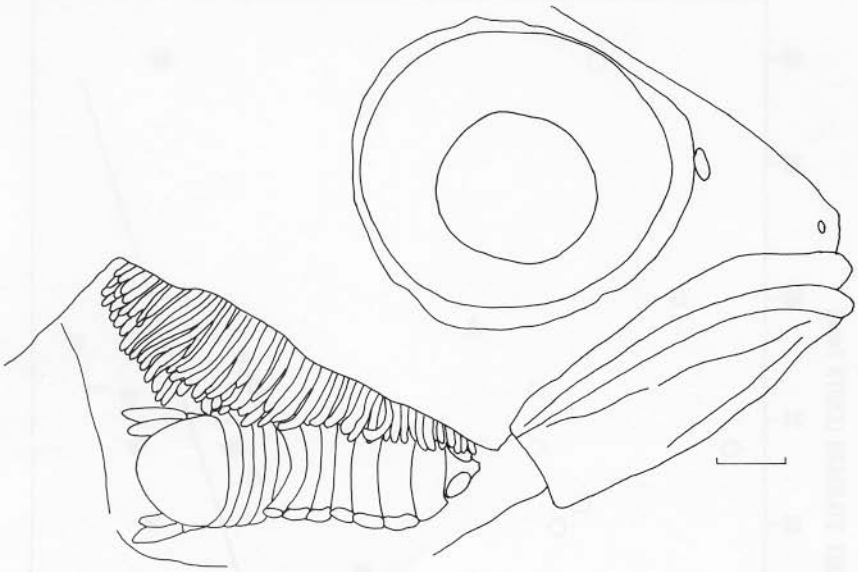


Fig. 26. Male of *Mothocya bohlkeorum*, new species, in gill chamber of dusky cardinalfish, *Apogon pigmentaria* (Poey). A portion of the opercular cover has been removed to expose the isopod and gill filaments (scale = 1 mm).

apical spines. Distal lobes of maxilla 2 each with 1 recurved spine, occasionally 2 spines on smaller lobe. Distal segment of maxillipedal palp with 3 stout recurved spines, apex of second segment with stout triangular spine. Penis lobes of male separate. Appendix masculina of male pleopod 2 linear, with unmodified apex. Color light brown.

Remarks.—Costa (1851) described the genus *Mothocya*. Schioedte and Meinert (1884) described a similar genus, *Irona*, without considering the genus *Mothocya*. *Mothocya* and *Irona* represent the same genus (Monod, 1971). This genus is being revised by Dr. T. E. Bowman (personal communication) and therefore will not be considered in detail in the present paper. *Mothocya bohlkeorum* differs from all the known species of *Irona* and *Mothocya*. Members of these genera possess

Table 1. Brood of *Mothocya bohlkeorum*, new species, from six gravid specimens listed in order of development.

Number	Description	Length* (mean)	Width* (mean)
170	Spherical to subspherical embryos	0.65–0.68 (0.66)	0.59–0.63 (0.61)
102	Oblong embryos	0.68–0.76 (0.72)	0.57–0.61 (0.59)
56	Oblong embryos with cephalic end formed, but not possessing eyes	1.01–1.04 (1.03)	0.53–0.61 (0.57)
85–95**	Embryos with eyes	0.87–1.06 (0.99)	0.46–0.59 (0.55)
49	Juveniles with eyes, antennae, and six pereopods formed	1.44–1.52 (1.48)	0.46–0.53 (0.49)

* In mm.
** Embryos in the brood numbering 95 were apparently ready to molt, and larvae in the process of forming pereopods were visible under the cuticle.

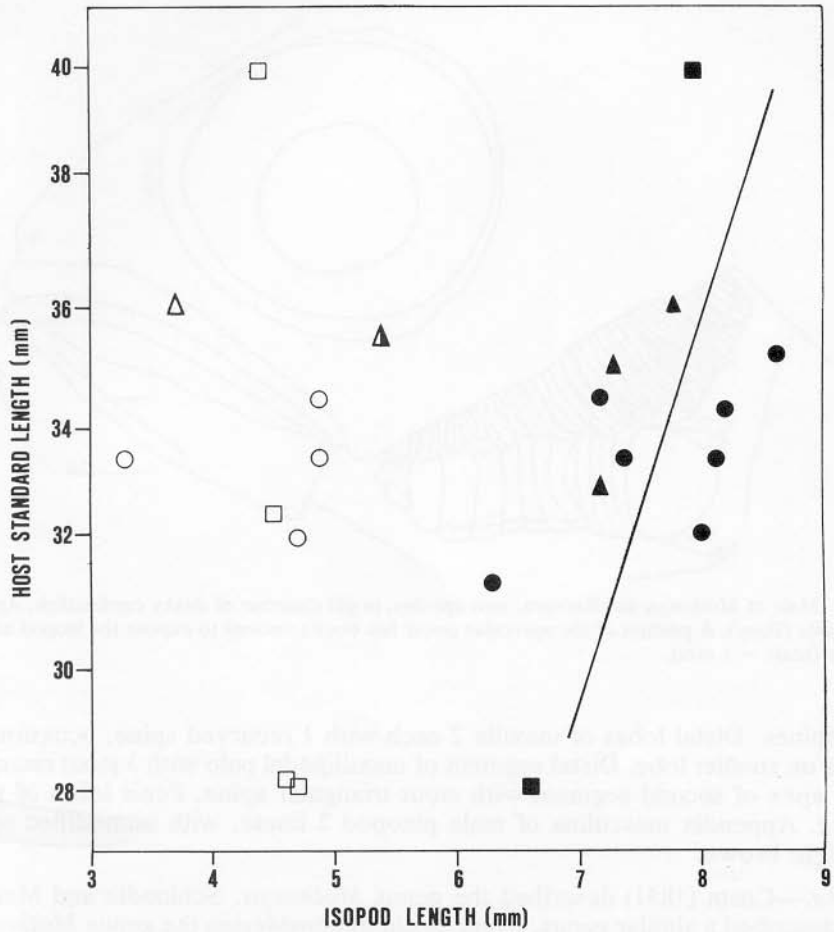


Fig. 27. Host-isopod length relationships of *Mothocya bohlkeorum*, new species, and *Apogon lachneri* (triangles), *Phaeoptyx pigmentaria* (circles) and *P. conklini* (squares) (nonshaded symbols indicating males, half-shaded transitionals, and solid-shaded females), with a regression of body length of female isopods on standard length of hosts (n = 12, r = 0.562347).

cephalons which are deeply immersed in pereonite 1 and bases of antennae 1 which are widely separated. Although the cephalon of *M. bohlkeorum* is only slightly immersed in pereonite 1, and the bases of its antennae are only slightly separated, this species is otherwise in agreement with the characters shared by these species, and separation into a new genus is not justified. *Mothocya bohlkeorum* most closely resembles *M. nana* (Schioedte and Meinert). It varies from *M. nana* by having a cephalon which is narrowed instead of broad anteriorly, a slightly immersed instead of a deeply immersed cephalon, a nonsinuate anterior margin of pereonite 1, and a subrectangular instead of a subtriangular telson.

Most of the life-cycle stages of *M. bohlkeorum* are represented in Table 1 and Fig. 28; juveniles, however, were not collected. *Mothocya bohlkeorum* is known from the northern Bahamas and Puerto Rico, but probably occurs in other areas of the West Indies. It has been collected from very shallow waters down to a depth of over 36 m on the insular slope. Species of the genus *Mothocya* (and

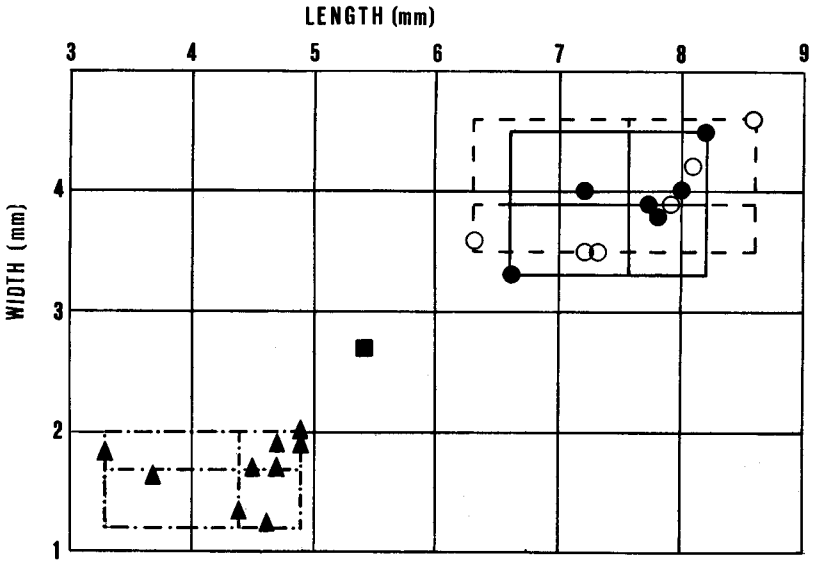


Fig. 28. Length-width relationship of 22 specimens of *Mothocya bohlkeorum*, new species, collected from 15 hosts; male (solid triangles), transitional (solid square), female without oostegites (open circles), and female with oostegites (solid circles). Length-width ranges represented by boxes and divided by mean lines; male (dash-dot line), female without oostegites (dashed line), female with oostegites (solid line).

Irona) have been reported in hosts from three families, Exocoetidae (halfbeaks), Belonidae (needlefishes), and Atherinidae (silversides), in the Order Atheriniformes. Lanzing and O'Connor (1975) found an isopod provisionally identified as *Mothocya renardii* (Bleeker) to be "occasionally" present in luderick, *Girella tricuspidata* Quoy and Gaimard (Kyphosidae, Perciformes), in Australia. Hale (1926) reported this isopod only from needlefishes in Australia. Isopods from the genus *Mothocya* have not previously been reported on members of the family Apogonidae. *Mothocya bohlkeorum* is the second species of this genus known to occur on members of the order Perciformes, but probably the only species of *Mothocya* which parasitizes perciformids only.

The four infested *Apogon lachneri* were 33.0–36.0 mm in standard length (mean 34.3 mm); seven *Phaeoptyx pigmentaria* 31.4–35.2 mm (mean 33.5 mm); and four *P. conklini* 28.1–39.9 mm (mean 32.2 mm). In the seven collections of hosts with *M. bohlkeorum* used in this study, the isopod infested 6.7–66.7% (mean 36.6%) of the hosts. Bohlke and Chaplan (1968) reported this isopod from 27 of 83 dusky cardinalfish and 6 of 247 freckled cardinalfish from the Bahamas.

Female *M. bohlkeorum* cause extensive erosion and distortion of host gill filaments (Fig. 25); males cause moderate erosion of gill filaments (Fig. 26).

The specific name is in honor of the discoverers of this isopod, Dr. James E. and Eugenia B. Bohlke.

Discussion

The size of *Mothocya bohlkeorum* does not seem to differ among the three species of host (Fig. 27). The larger female isopods seem to occur on larger hosts, but there is no increase in the size of the males corresponding to an increase in

host size (Fig. 27). Some of the females without oostegites are longer and wider than the females with oostegites (Fig. 28). In fact, a rectangle representing the measurements of length-width of females without oostegites practically encloses a rectangle for females with oostegites (Fig. 28). Females without oostegites probably do not represent a simple virgin-female stage which is intermediate in size and development between transitionals and mature or gravid females. Rather, some of these females without oostegites seem to be in intermolt growth and recovery periods between reproductive cycles in which they possess oostegites. This vegetative growth stage between reproduction and brooding could allow the isopod to produce multiple broods, live for a longer period of time with the host, and grow as the host grows. The positive correlation between female isopod and host lengths (Fig. 27) may be another indicator that this is occurring.

Many cymothoid isopods occurring on the skin or fins of fishes do not form long-term, male-female associations; however, most gill-dwelling cymothoids form long-term pairs with the members in physical contact in the gill chamber. *Mothocya bohlkeorum* seems to be unique among the known gill-dwelling cymothoids in having members of the male-female pairs separated into different gill chambers of a host (Figs. 25, 26). Physically this "duplex" situation is easily explained. A gravid female *M. bohlkeorum* occupies too much of the available space in a gill chamber of the host to allow room for a male (Fig. 25). Origin of this situation is less clear. One measure of the age of a parasite-host relationship is found in the amount of damage the parasite does to the host. Generally, the more damage, the newer the relationship is assumed to be. This isopod does extensive damage to the cardinalfish host in two principle ways: (1) the extremely large size of the female isopod in relation to the gill chamber volume of the host, and (2) isopods occurring in both gill chambers instead of only in one chamber. Assuming that, due to the damage, this is a relatively new relationship, then the causes of the damage must gradually be moderated over time. The female *M. bohlkeorum* may gradually decrease in size relative to the size of the gill chamber of the host and eventually enough space may be available in one gill chamber to accommodate both the female and the male. The duplex arrangement, as seen in *M. bohlkeorum,* may permit an isopod, having an adult male-female pair that would be too large to fit into one gill chamber of a host, to parasitize successfully the host. Thus an isopod species associated with a relatively large host species could colonize a much smaller host species. Subsequent host environmental and behavioral differences and isopod size-adaptation to the host (as discussed previously) might produce sufficient isolation between the isopod populations on different hosts to allow eventual speciation.

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