J. Helminthol. Soc. Wash.
59(2), 1992, 153–158

Gonapodasmius williamsoni sp. n. (Digenea: Didymozoidae) from the Pink Snapper, *Pagrus auratus* (Teleostei: Sparidae) in Western Australia

T. H. CRIBB[1] AND A. WILLIAMS[2,3]

[1] Queensland Museum, P.O. Box 300, South Brisbane 4101, Australia and
[2] Department of Biological and Environmental Sciences, Murdoch University, Murdoch 6150, Australia

ABSTRACT: *Gonapodasmius williamsoni* sp. n. (Digenea: Didymozoidae: Gonapodasmiinae) is described from the muscle of the pink snapper, *Pagrus auratus* (Teleostei: Sparidae) from Shark Bay, Western Australia. The species is separable from the 15 described *Gonapodasmius* species most notably by the presence of a well-developed glandular "stomach" (Drüsenmagen), and by its site and host-specificity.

KEY WORDS: *Gonapodasmius williamsoni* sp. n., Digenea, Didymozoidae, Sparidae, *Pagrus auratus,* economic significance, Australia.

The developing export market of Western Australian pink snapper, *Pagrus auratus,* met some resistance in 1988 when complaints were received about bright yellow parasites in the flesh of the snapper. The parasite concerned was identified as a didymozoid trematode. The species does not agree with any described species and so is here described as new.

Materials and Methods

Parasites were dissected from either the flesh of the fish or in situ and fixed in hot or cold 5% or 10% formalin. Whole mounts were stained with Mayer's hematoxylin, cleared in methyl salicylate, and mounted in Canada balsam. Specimens for sectioning were embedded in paraffin wax, cut at 7–10 μm, and stained with Mayer's hematoxylin and eosin. Measurements are given in micrometers; figures in brackets are means. Drawings were made with the aid of a camera lucida.

Didymozoidae Poche, 1907

Gonapodasmiinae Ishii, 1935

Gonapodasmius williamsoni sp. n. (Figs. 1–9)

DESCRIPTION: Female observed from several more or less complete collections of fragments; measurements of suckers and pharynx from single individual. Body slender, slightly flattened dorsoventrally, 2 individuals (sums of fragments) 122 and 153 cm long, maximum width about 530. Tegument smooth. Mouth terminal (Fig. 2). Oral sucker 60 long and 55 wide. Prepharynx absent. Pharynx 33 long and 25 wide. Esophagus muscular, unstraightened length 347 long. Glandular "stomach" (=Drüsenmagen) prominent. Ceca simple, posterior extent not determined. Ventral sucker 57 wide and 37 long, 887 from anterior end of body. Ovary a single tube, extending anteriorly from egg-forming complex, distance of termination from anterior end not determined. Vitellarium a single narrow tube extending posteriorly to near posterior end of body (Fig. 3). Seminal receptacle, Mehlis' gland and Laurer's canal not observed. Uterus issues from egg-forming complex and passes posteriorly, without convolutions, to near posterior end of body then loops (Fig. 3) and passes anteriorly to ventral genital pore at level of posterior margin of pharynx. Testes and associated male reproductive system never observed, presumed absent. Eggs oval, tanned, operculate, 27–31 (30) by 10–13 (12) ($N = 10$). Excretory vesicle a single, simple tube opening subterminally at posterior end of body, divides near cecal bifurcation to form 2 irregular arms reaching midway between cecal bifurcation and oral sucker. Female system sometimes represented in males by single duct developed to greater or lesser extent; sometimes with malformed eggs.

Male observed only from incomplete fragments; measurements of suckers and pharynx from single individual. Body slender, approximately $\frac{1}{10}$ length of female, somewhat flattened dorsoventrally, 2 individuals (sums of fragments) 9 and 13 cm long, respectively, maximum width about 284. Tegument smooth. Mouth terminal (Fig. 4). Oral sucker 81 long and 47 wide. Prepharynx not distinguishable. Pharynx 37 long and 40 wide. Esophagus and "stomach" not observed. Ventral sucker 43 long and 53 wide. Testes paired, parallel, winding through most of body, posterior extent not determined.

TYPE HOST: *Pagrus auratus* (Bloch and Schneider) (Sparidae).

[3] Present address: CSIRO Division of Fisheries, Marmion, P.O. Box 20, North Beach 6020, Australia.

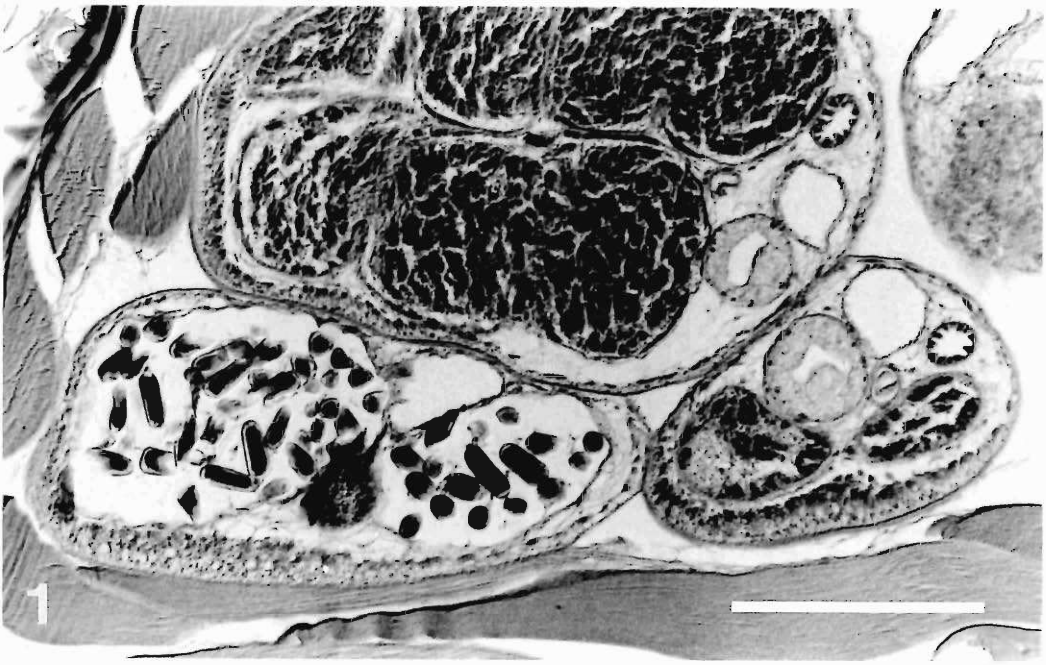


Figure 1. ***Gonapodasmius williamsoni*** **sp. n. in section in situ in fillet of** ***Pagrus auratus*****; 2 sections through male, 1 section through female. Scale bar = 200 μm.**

PREVALENCE OF INFECTION: 5.6% in 4,100 fish.

SITE IN HOST: Deep in lateral musculature, never observed in fins or head.

LOCALITIES: Vicinity Shark Bay, Western Australian coast, 23°–27°S.

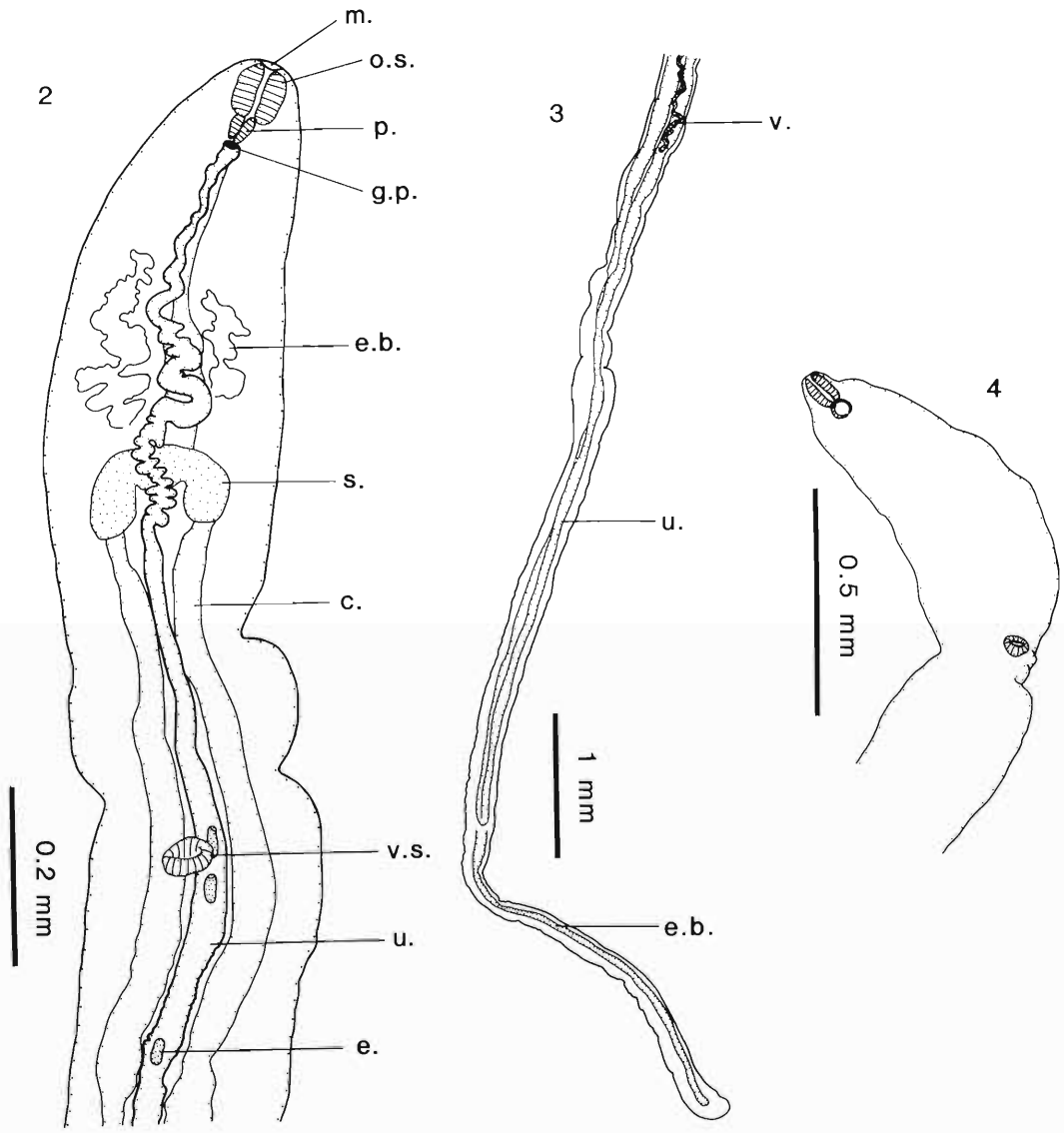
DEPOSITED MATERIAL: Holotype, coll. A. Williams, 6 Oct. 1988, Queensland Museum GL 1297. Four paratypes, coll. T. Cribb, Mar. 1989, QM GL 1298–1301. Sectioned nontype material: QM 12736–12745.

ETYMOLOGY: This species is named in honor of Messrs. Rodney and Mark Williamson upon whose boat this species was collected, and who facilitated this study.

Results and Discussion

This species presented considerable difficulties because the worms are long (over 1 m for females) and wind through the tissues of the host. Thus, specimens were difficult to recover. No specimens were recovered intact, and despite rapid fixation of specimens following collection, the preservation of the parasites was not ideal. The trematode was found in patches in the lateral musculature of the fish (Fig. 1), and though no further localization within the musculature was noted, the parasite was never found in any part of the head, the fins, or the viscera. As far as could be ascertained, the patches always consisted of 1 male and 1 female individual, i.e., no more than 2 anterior ends were ever recovered from a single patch. However, because the masses were so entangled in the flesh and the worms were never recovered intact, the possibility that more than 1 of each sex might be present on occasions cannot be discounted. The patches of worms were not encapsulated by a structure of parasite or host origin. Live trematodes tended to loop back and forth in the muscle of the fish, each loop separated from the next by host tissue. In what appeared to be older, perhaps moribund infections, the trematodes were less freely intertwined with host tissue. Dead parasites appeared as patches of dark, fragmented, granular material or formed discrete lumps.

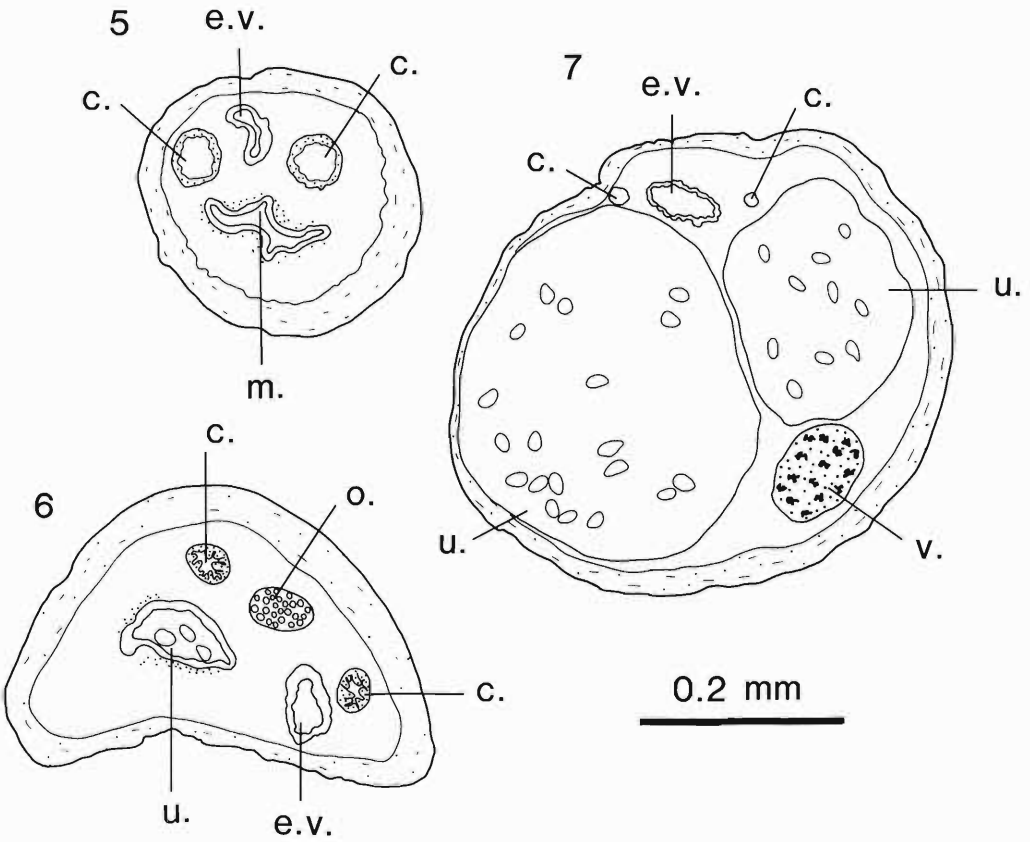
The skeletal musculature of 4 other commercial fish species taken by the snapper fishery in Shark Bay at the same time were also examined for *Gonapodasmius williamsoni.* It was not found in 185 *Lutjanus sebae* (Lutjanidae), 79 *Epinephelus multinotatus* (Serranidae), 429 *Lethrinus nebulosus,* or 184 *L. miniatus* (Lethrinidae), al-



Figures 2–4. ***Gonapodasmius williamsoni*** **sp. n. 2. Holotype, female, anterior end, ventral view. 3. Female, posterior end, orientation unknown. 4. Male, anterior end, ventral view (digestive and reproductive tracts not distinguished). c., cecum; e., egg; e.b., excretory bladder; g.p., genital pore; m., mouth; o.s., oral sucker; p., pharynx; s., stomach; u., uterus; v., vitellarium; v.s., ventral sucker.**

though *L. miniatus* was found to be host to another (undescribed) species of *Gonapodasmius*.

The classification of the Didymozoidae is based largely on that of Yamaguti (1971) who recognized 23 subfamilies of which 3, the Gonapodasmiinae, the Nematobothriinae, and the Glomeritrematinae, include threadlike forms such as the present species. Of these 3 subfamilies, only the Gonapodasmiinae includes forms with separate sexes, and it may be separated from the other 2 on that basis. Within the Gonapodasmiinae, 3 genera have been recognized—*Gonapodasmius* Ishii, 1935, *Paragonapodasmius* Yamaguti, 1938, and *Neogonapodasmius* Radhakrishnan and Nair, 1981. Yamaguti (1938, 1971) differentiated *Paragonapodasmius* from *Gonapodasmius* by the relative positioning of the



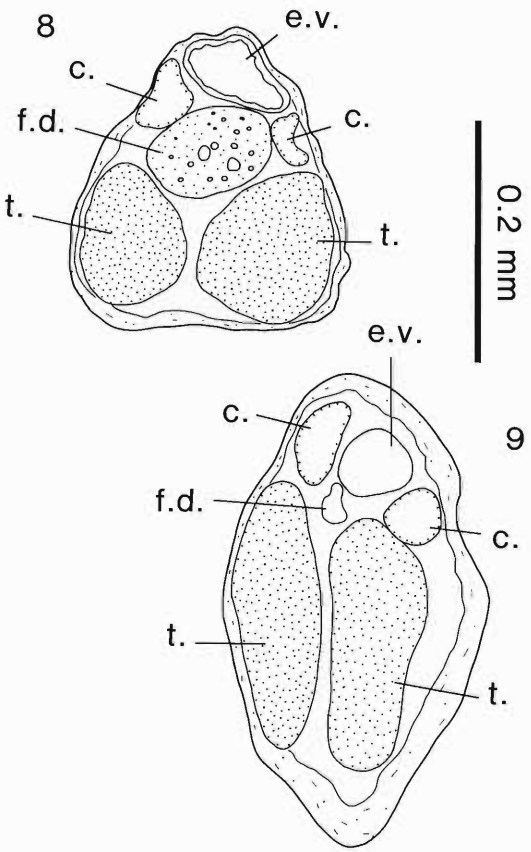
Figures 5–7. ***Gonapodasmius williamsoni*** **sp. n. in transverse section. 5. Female, level of metraterm. 6. Female, level of ovary and single loop of uterus. 7. Female, level of vitellarium and 2 loops of uterus. c., cecum; e.v., excretory vesicle; m., metraterm; o., ovary; u., uterus; v., vitellarium.**

testes, which are tandem in the former and parallel in the latter. Radhakrishnan and Nair (1981) distinguished *Neogonapodasmius* from the other 2 genera because the female has a distinct fore- and hindbody and the ovary and vitellaria are branched. Based on these criteria, the present species should therefore be placed in *Gonapodasmius*.

Fifteen *Gonapodasmius* species have been described and recorded (generally only in the original description): *G. branchialis* Yamaguti, 1970, from Hawaii, encysted in pairs or singly in "sea bass" and on or in the olfactory organ of *Epinephelus quernus* (Serranidae) (Shen, 1990) and in *Cephalopholis platycentron* (also Serranidae); *G. cypseluri* Yamaguti, 1940, from Japan, in the submucosa of the buccal cavity of *Cypselurus agoo* (Exocoetidae); *G. epinepheli* Abdul-Salam, Sreeltha, and Farah, 1990, from the Arabian Gulf, encysted on the gills of *Epinephelus tauvina* (Serranidae); *G. haemuli* (MacCallum and MacCallum, 1916) Ishii, 1935, from the New York Aquarium (presumed origin North Atlantic), in the pseudobranchs of *Haemulon flavolineatum* (Haemulidae); *G. hainanensis* Gu and Shen, 1983, from the China Sea, encysted on the gills of *Trisotropis dermopterus* (Serranidae) (see also Shen, 1990); *G. kovaljovae* Nikolaeva and Gaevskaya, 1985, from the Atlantic Ocean, encysted on the gills of *Cubiceps capensis* (Nomeidae); *G. menpachi* Yamaguti, 1970, from Hawaii, in the body cavity of *Myripristis berndti* (Holocentridae); *G. microovatus* Reimer, 1980, from the Gulf of Aden, in the body cavity of *Megalaspis cordyla* (Carangidae); *G. okushimai* Ishii, 1935, from Japan, in the muscle of *Pagrus auratus* (as *Pagrosomus major*) (Sparidae); *G. oxyporhamphii* Nikolaeva and Gichenock, 1981, from the Indian and Pacific oceans, from the fins of *Oxyporhamphus convexus* and *O. micropterus* (Hemirham-

phidae); *G. pacificus* Yamaguti, 1938, from Japan, in the gills of an "epinephelid" (presumably Serranidae); *G. pristipomatis* (Yamaguti, 1934) Yamaguti, 1938, from Japan, in the gills of *Pristipoma trilineatum* (Haemulidae) and the pharyngo-branchial region of *Epinephelus akaara* (Serranidae); *G. ryjikovi* Nikolaeva and Parukhin, 1971, from the Atlantic Ocean, in the pelvic and pectoral fins of *Cypselurus furcatus, Exocoetus volitans, E. monocirrhus* (all Exocoetidae), *Euleptorhamphus viridis,* and *Oxyporhamphus convexus* (both Hemirhamphidae); *G. spilonotopteri* Yamaguti, 1970, from Hawaii, free beneath the inner surface of the operculum and gill opening of *Cypselurus spilonotopterus* and *C. spilopterus,* and from the Bay of Bengal by Madhavi (1982) in connective tissue overlying the swim bladder of *C. comatus* (all Exocoetidae); *G. tomex* (Linton, 1907) Yamaguti, 1971, from Bermuda, in an unrecorded site in *Epinephelus striatus* (Serranidae).

We compared our specimens with the descriptions of these species and noted the following distinctions: *Gonapodasmius williamsoni* is the only species in the genus with a well-defined glandular stomach (=Drüsenmagen) at the cecal bifurcation. Although some of the other species have gland cells surrounding the beginning of the ceca, only *G. williamsoni* has a clearly demarcated "stomach." *Gonapodasmius pristipomatis* is distinct from *G. williamsoni* (and evidently all other species) in having 2 loops in the uterus. *Gonapodasmius haemuli* lacks a pharynx (it possesses only 1 muscular structure at the anterior end, which was interpreted as the pharynx by MacCallum and MacCallum [1916] but as the oral sucker by us). *Gonapodasmius okushimai* lacks a ventral sucker and has the genital pore much closer to the anterior end than does *G. williamsoni.* We found differences in the dimensions of the oral sucker, ventral sucker, and pharynx between *G. williamsoni* and some species, but because considerable ranges have been quoted for these features, and because they are often based on small sample sizes (in our description as well as in those of others), we find it difficult to draw useful conclusions from the differences noted. However, the ventral suckers of female *G. pacificus* and *G. menpachi* are recorded as being 125–150 and 120–180 μm in diameter, respectively—in each case more than twice the maximum diameter recorded for *G. williamsoni.* In *G. williamsoni* the ventral and oral suckers are of similar size, whereas in *G. microovatus* the



Figures 8, 9. ***Gonapodasmius williamsoni*** **sp. n. in transverse section. 8. Male, showing testes, gut, excretory vesicle, and "female duct" with malformed eggs. 9. Male, as previous with "female duct" weakly developed. c., cecum; e.v., excretory vesicle; f.d., female duct; t., testis.**

ventral sucker is much larger than the oral sucker, and in *G. ryjikovi* the oral sucker is much larger than the ventral sucker. The single described specimen of *G. tomex* is only 12 mm long as opposed to over 1 m for the specimens of *G. williamsoni. Gonapodasmius oxyporhamphii* and *G. kovaljovae* are far more robust than *G. williamsoni,* which is threadlike.

Gonapodasmius williamsoni appears to be distinct from other *Gonapodasmius* species, except *G. okushimai,* in the combination of the site of infection in the host and the identity of the host. These are the only 2 species recorded from muscle and also the only 2 known from sparids. This information can generally be used only with caution in the identification of helminths, and in the case of the Didymozoidae, the degree of site and host specificity has not been examined critically.

Indeed, it is salutary to note that only 4 of 15 *Gonapodasmius* species have been recorded in the literature more than once. Because of this, we use this information only as a posteriori support for further distinction of *G. williamsoni.* We believe that, in the present case, the evidence suggests that the site of infection and the host are valuable characters for use in association with the analysis of morphology. In support of this, we note that *G. williamsoni* always looked the same in the musculature (Figs. 1, 5–9) and that it was never seen other than in the lateral muscle. Furthermore, other fish species caught at the same sites as the infected snapper were not infected with this parasite.

In its host and site of infection *G. williamsoni* agrees entirely with *G. okushimai.* This special circumstance needs further consideration. *Gonapodasmius okushimai* was described from Japan from *Pagrosomus major,* a species now considered by Paulin (1990) to be a synonym of *Pagrus auratus,* the host of the present species. *Pagrus auratus* has a wide Indo-Pacific distribution from New Zealand and Australia to China and Japan, although northern and southern hemisphere populations of this species are "independent and reproductively isolated" (Paulin, 1990). This relationship between the 2 host populations sharpens the need for morphological separation of the 2 parasite species. We believe the differences we outlined earlier (presence/absence of Drüsenmagen and ventral sucker, position of genital pore) are strong characters. However, we recognize that should *G. okushimai* be found to possess a ventral sucker (which may have been overlooked in the original study), the case for recognition of 2 species would be weakened. Unfortunately, we were unable to examine specimens of *G. okushimai*; according to Dr. Shunya Kamegai of the Meguro Parasitological Museum, Japan, the location of the type specimens of this species is unknown. The infection of a single host species by more than 1 species of the same genus is a common occurrence within the Didymozoidae. For example, *Thunnus albacares* (yellowfin tuna) is reported to harbor 6 species of *Didymocystis* and 4 species of *Koellikeria.* Presence of 2 species within the 1 host therefore provides no special grounds for doubting the validity of the species.

Acknowledgments

Thanks are extended to the Williamson family of Carnarvon, Western Australia, who assisted in many ways with this research, including carrying us aboard their fishing vessel. Funding was provided by the Western Australian Fisheries Department (WAFD). We thank Dr. S. Kamegai of the Meguro Parasitological Museum for information on type specimens. Useful comments on the manuscript were given by Dr. Mike Moran (WAFD) and Dr. S. C. Barker and Miss S. C. Pichelin (Department of Parasitology, University of Queensland).

Literature Cited

MacCallum, G. A., and W. G. MacCallum. 1916. The family Koellikeriadae (sic) (Didymozoidae Mont.). Zoologische Jahrbücher, Abteilung für Systematik, Ökologie und Geographie der Tiere 39:161–166.

Madhavi, R. 1982. Didymozoid trematodes (including new genera and species) from marine fishes of the Waltair coast, Bay of Bengal. Systematic Parasitology 4:99–124.

Paulin, C. D. 1990. *Pagrus auratus,* a new combination for the species known as "snapper" in Australasian waters (Pisces: Sparidae). New Zealand Journal of Marine and Freshwater Research 24: 259–265.

Radhakrishnan, S., and N. B. Nair. 1981. *Neogonapodasmius hemiramphi* n. gen., n. sp. from the fin of *Hemirhamphus xanthopterus* (Val.). Acta Ichthyologica et Piscatoria 11:19–25.

Shen, J. 1990. [Digenetic Trematodes of Marine Fishes from Hainan Island.] Institute of Oceanology, Academia Sinica, Qingdao. 228 pp. (Chinese with English summary of a new species.)

Yamaguti, S. 1938. 2. Studies on the helminth fauna of Japan. Part 24. Trematodes of fishes, V. Japanese Journal of Zoology 8:15–74.

———. 1971. Synopsis of Digenetic Trematodes of Vertebrates. Vols. 1 and 2. Keigaku Publishing Co., Tokyo, Japan. 1,074 pp.