

## METAZOAN PARASITES OF SOME OKINAWAN CORAL REEF FISHES WITH A GENERAL COMPARISON TO THE PARASITES OF CARIBBEAN CORAL REEF FISHES

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**ABSTRACT**- The parasite fauna of Okinawan coral reef fishes was surprisingly depauperate. Our results differ from the generally accepted greater diversity of Pacific vs. Atlantic parasite faunas. Previous comparisons have not been based on identical-direct examinations of fishes. The rarity of casual parasites (leeches and ageid isopods) suggested that this life strategy may be relatively unsuccessful on Okinawan reefs. Nudibranch and tongue worm associations may be unique to this coral reef system. Most parasites either occurred at levels approximately equivalent to that seen on Caribbean reefs (cymothoid isopods, gnathiid isopods, copepods, barnacles, nematodes, tapeworms), or at lower levels (thorny-headed worms, flukes, gill worms). Only turbellarians were more abundant on Okinawan than Caribbean fishes. Overall the parasites in Okinawan coral reef fishes seem less diverse and less numerous than those in the Caribbean. Tumors, lymphocystis lesions and abnormalities were much more rare in Okinawan fishes.

### INTRODUCTION

As Foreign Visiting Researchers at the Sesoko Marine Science Center we (EHW & LBW) examined coral reef fishes for metazoan parasites from May 1985 through March 1986. We completely examined 289 specimens of 186 species of fishes; and grossly examined 1,013 specimens of 184 species for parasites occurring on the body, gills and mouths; for a total of 1,302 examinations of 293 fish species (Fig. 1). We will generally compare the diversity and abundance of parasites found on those fishes with our 20 years of Caribbean examinations below.

### MATERIALS AND METHODS

Host collection techniques were described by Williams & Williams (1986g). Standard methods were employed in examining hosts for parasites and in preparing specimens of parasites as described in the papers cited for each parasite group below. WGD stained and mounted the digenean and monogenean specimens. All specimens were deposited in the U. S. National Museum Helminthological Collection,

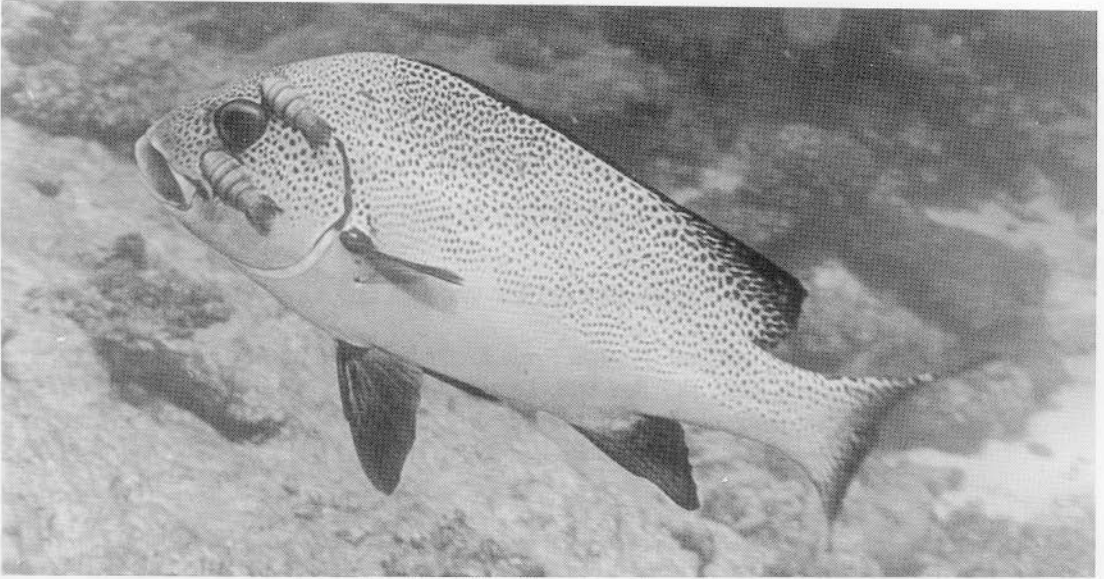


Fig. 1. Large female cymothoid isopods, probably *Anilocra longus* or a new species of *Anilocra*, attached above and below the left eye of a sweetlips, *Plectorhynchus pictus* (Val.), off Okinawa. This parasitic isopod occurs on other species of sweetlips (Pomadasyidae) around the Ryukyu Islands. This association has appeared in photographs published in local newspapers, diving magazines, and books of underwater photographs. Unfortunately, we have not been able to obtain specimens of this isopod for study. We would greatly appreciate receiving specimens.

Crustacean Collection, or Division of Worms Collection. USNM Collection Numbers were published in the papers cited for each parasite group below. Only general comparisons are presented, exact statistical comparisons will be made in a subsequent publication.

## RESULTS AND DISCUSSION

The parasites we collected in Okinawa are subdivided into categories arbitrarily arranged in the order of most pertinent information available from our studies.

### ISOPODS[CRUSTACEA: ISOPODA]

One new genus and 8 new species of cymothoid isopods were described: (1) The new genus contains a new species from *Amblygaster sirm* and *Amblygaster leiogaster*, herrings, in Okinawa (Fig. 2), and a second species (new combination) from the same herrings in the Indian Ocean (Williams & Bunkley-Williams, 1994, Williams &



Fig. 2. Large female of marui-tokiyaku-ruui, a new genus and species of cymothoid we are describing, from the upper gill chamber of a herring, *Amblygaster sirm*. The isopod attaches to the opercular flap of this clupeid, thus the underside of the female with the brood pouch filled with embryos is shown in the photograph. This is an unusual attachment position. We named the new genus of isopods for the Ryukyu Islands (Williams & Bunkley-Williams, 1994).

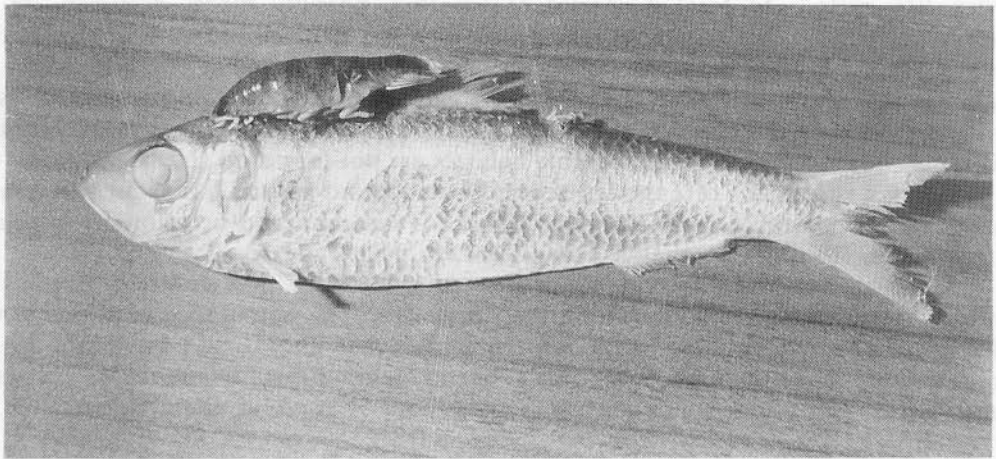


Fig. 3. A large female of sappa-yadori-mushi (shin-sho), *Anilocra clupei*, on the left side of the head of a herring, *Sardinella zunasi* (Bleeker). This is the first published photograph of the association between this clupeid and isopod (Williams & Williams, 1986a).

Williams, 1986f). (2) *Anilocra clupei* from *Sardinella zunasi*, a herring (Fig. 3). Immatures of this isopod also occur on other herrings and anchovies (Williams & Williams, 1986a). (3) *Anilocra prionuri* from *Prionurus scalprus*, a surgeonfish; *Girella punctata*, a nibbler; and *Stephanolepis cirrhifer*, a filefish; but seems to occur most commonly on the surgeonfish (Williams & Williams, 1986a). (4) *Cterissa sakaii* from *Sargocentron spiniferum*, a squirrelfish, was found at the Yaeyama Islands in the

southern Ryukyu Islands, but not in Okinawa (Williams & Williams, 1986e). (5) *Pleopodias superatus* from unknown deepsea fishes (Williams & Williams, 1986a). (6) *Renocila bollandi* is a spectacularly tiger-striped isopod from *Scorpaenopsis cirrhosa* and *Scorpaena bynoensis*, juvenile scorpionfish. This parasite has only been found on a short section of the west coast of Okinawa (Williams & Williams, 1987). This or possibly a similar isopod occurs on the lionfish. We hope to obtain specimens of this association. With the new material we have obtained of this isopod, we will be able to determine if it represents a new genus. (7) *Renocila kohnoi*, occurred on *Centropyge heraldi* and *C. vrolicki*, cherubfishes. This parasite is only known from Iriomote and Ishigaki Islands in the southern Ryukyu Islands. The variation in female-male attachment positions suggests how male-female pair, duplex pairs, and double females developed in other cymothoid isopods (Williams & Williams, 1987). (8) *Renocila yamazatoi* was collected from *Chromis ovatiformis*, a damselfish. This parasite is only known from Irimote Island in the southern Ryukyu Islands (Williams & Williams, 1987). *Anilocra longus*, or possibly a new species, occurs commonly on the head of sweetlips around Okinawa (Fig. 1). Dr. Bolland (pers. comm.) has observed this association and hopes to collect these isopods for our examination. The diversity and numbers of cymothoid isopod parasites seems to be comparable with those found in Caribbean fishes.

Gnathiid isopods occur as immature forms on marine fishes. The only way to identify them to species with any certainty is to study the entire parasitic and free-living life cycle. At least 2 species of *Gnathia*, possibly more, occurred on the Okinawan fishes. On Okinawan reef fishes, *Gnathia* sp. occurred commonly, but not abundantly, at much the same levels found on Caribbean reefs. In tide pools and shallows near shore in Okinawa, *Gnathia* sp. were very abundant on parasitized fishes, perhaps related to the absence of cleaner species in this habitat (Bunkley-Williams & Williams, in preparation). Comparable habitats are not found on Caribbean reefs.

Only 4 specimens of 2 species of aegids were found on an Okinawan fish. In the Caribbean a comparable aegid, *Rocinela signata*, is common and occasionally abundant on reef fishes (Bunkley-Williams & Williams, in preparation).

The species diversity and abundance of cymothoid and gnathiid isopods are approximately equal in Okinawa and the Caribbean. The abundance of aegids is very different in the two regions. It is surprising that cymothoids and gnathiids are not more abundant in Okinawa with little or no competition from aegids. Possibly competition with aegids is not a factor in cymothoid or gnathiid abundances.

## COPEPODS[CRUSTACEA: COPEPODA]

Our examinations of the copepods from Okinawa are not completed, but 503 specimens of approximately 50 species of copepods were collected (Williams, Bunkley-Williams & Ortiz-Corps, in preparation). This abundance and diversity approximates the levels found on Caribbean fishes. Dr. Roger Cressey was kind enough to name a new species of copepod, *Orbitacolax williamsi* from this collection, for us. It occurred in the orbit around the eye of a number of okinawan fishes (Cressey & Cressey, 1989).

## BARNACLES [CRUSTACEA: CIRRIPIEDIA: THORACICA]

We reported the first association of *Conchoderma virgatum* on a non-permanently attached copepod on a fish host. It occurred on the outside of a Caribbean shark (Williams, 1978). Its occurrence on a copepod in the mouth of a whale shark in Okinawa represented a new location in a fish host, a new fish host, and a new copepod host (*Dysgamus atlanticus*) for this barnacle (Williams & Williams, 1986b). This barnacle occurs so rarely on crustacean parasites of fishes that comparison between Okinawa and Caribbean faunas is not possible.

## NUDIBRANCH [MOLLUSCA: GASTROPODA: OPISTHOBRANCHIATA]

We found the dorid nudibranch, *Gymnodoris nigricolor*, attached on the dorsal spine of gobies, *Amblyeleotris japonica* (Williams & Williams, 1986d). This association seems to be unique to the Ryukyu Islands. Our report marked the first attachment of an adult mollusk on a fish. Dr. Robert Bolland (pers. comm.) has been working on the biology of this association and has collected hundreds of additional specimens.

## LEECHES [ANNELIDA: HIRUDINEA]

The 1 specimen of leech which we collected was *Trachelobdella lubrica* from *Oplegnathus punctatus*, a knifejaw (Williams, Bunkley-Williams & Burreson, 1994). This species occurs on the gills of coral reef fishes worldwide. More specimens of *T. lubrica* would have been found in a comparable sample of Caribbean fishes. Also several other species of leeches commonly occur on Caribbean fishes (Williams, 1982, Williams, Bunkley-Williams & Burreson, 1994). Leeches seem to be unusually rare on Okinawan fishes.

## THORNY-HEADED WORMS [ACANTHOCEPHALA]

We found very few thorny-headed worms in Okinawan fishes. All were larval or immature forms (Nagasawa, Williams, Bunkley-Williams, in preparation). Adult thorny-headed worms are not very abundant in Caribbean fishes, but they occur much more commonly than the levels we found in Okinawa. Larval thorny-headed worms are almost unknown in Caribbean fishes. The apparent contrast between Okinawan coral reef fishes serving largely as intermediate host for thorny-headed worms, and Caribbean reef fishes serving as final hosts, is interesting.

## NEMATODES [NEMATODA]

We cooperated with Dr. Hideo Hasegawa is describing 2 new species of nematodes, *Cucullanus okinawanus*, from *Echidna delicatula*, a moray eel; and *Paracapillaria sesokensis* from *Fistularia petimba*, a coronetfish; and redescribing

*Dichelyne laticeps* from *Arothron mappa*, a puffer. *Dichelyne laticeps* and 4 other nematodes are reported from Okinawa for the first time, and this suggests an Indo-Polynesian Province type nematode fauna (Hasegawa, Williams & Bunkley-Williams, 1991). The 115 specimens of 9 species is roughly comparable with what we find in Caribbean fishes. Nematodes are not very abundant parasites in coral reef fishes.

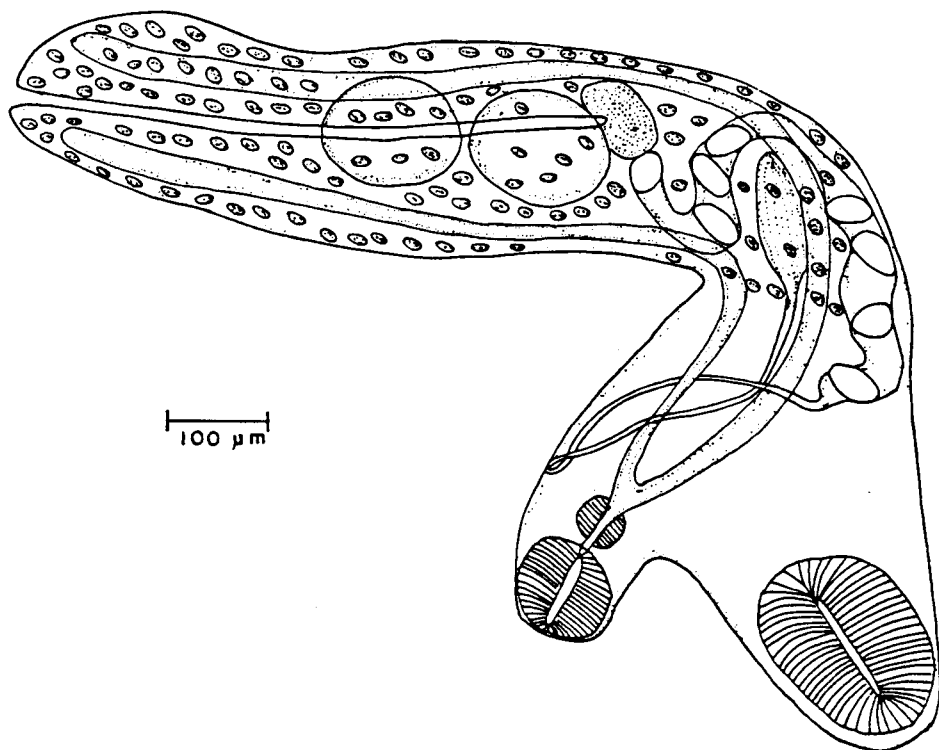


Fig. 4. A drawing of a new species of fluke that we recently named from the intestine of a sweetlips, *Plectorhynchus pictus* (Val.), we collected off Okinawa (Dyer, Williams & Bunkley-Williams, 1988a).

#### FLUKES [PLATYHELMINTHES: DIGENEA]

We described 1 new species of digenean or fluke, *Pseudopecoelus sesokoensis*, from *Plectorhynchus pictus*, a sweetlips (Dyer, Williams & Bunkley-Williams, 1988b). Twenty-five new host records and 7 new locality records were noted (Dyer, Williams & Bunkley-Williams, 1988a). We have also examined a number of Caribbean fishes for flukes (Dyer, Williams & Bunkley-Williams, 1985, 1986, 1991, 1992). The 34 species recovered in Okinawa is only slightly less than would be expected in Caribbean fishes, but the 56 specimens is many fewer than would be expected.

## GILL WORMS [PLATYHELMINTHES: MONOGENEA]

The 2,697 specimens of gill worms looks impressive, but most of these were on a few severely infested fishes we examined as disease cases from the local aquarium and a mariculture project. Very few individuals occurred on the wild fishes examined. Half of the monogenean species had not previously been reported from Okinawa, and 15 new host records were noted (Dyer, Williams & Bunkley-Williams, 1989). Both the abundance, the 12 species of worms, and 21 specimens of hosts were lower than what occurs in Caribbean fishes.

## TURBELLARIANS [PLATYHELMINTHES: TURBELLARIA]

A single species of turbellarian occurred on Okinawan fishes. This could represent the same species that we find in Caribbean fishes, but this is not certain as they have not been adequately studied. The 121 specimens found in Okinawan fishes is much higher than what would be found in the Caribbean.

## TAPEWORMS [PLATHYHELMINTHES: CESTOIDEA]

Larval tapeworms commonly occur in coral reef fishes. These forms usually mature in sharks and rays. The 502 specimens of possibly 3 species of metacestodes (larval cestodes) we found roughly compares to levels in Caribbean fishes. Very few coral reef bony fishes are hosts for adult tapeworms.

## TONGUE WORMS [PENTASTOMATIDA]

Two encysted larval tongue worms were found on the gill arches of 2 groupers. These parasites are occasionally found encysted in freshwater fishes, but rarely in marine fishes. The adult of this worm may possibly parasitize a sea snake (Williams, Dyer & Bunkley-Williams, in preparation). We know of no comparable cases in the Caribbean.

## MISCELLANEOUS GROUPS

Sole-worms (Aspidobothria), fish lice (Branchiura), and rosette-worms (Cestodaria) have relatively few species and are seldom occur anywhere in any abundance (Table 1). Fish lice and rosette-worms are not found in Caribbean coral reef fishes and their absence in Okinawa is not surprising. We have found several species of sole-worms in Caribbean fishes. We would have expected to see a few in the Okinawan collections.

Table 1. Parasites of Coral Reef Fishes Collected in Okinawa.

Parasite Group	Number of			Reference
	Specimens	Species	New Species	
gill worms	2,697	21	0	1
flukes	56	34	1	2, 3
turbellarians	121	1	?	4
sole-worm	0	0	0	4
tapeworm	502	3	0	4
rosette-worms	0	0	0	4
nematodes	115	9	2	5
thorny-headed worms	17	4	0	6
leeches	1	1	0	7
cymothoids	197	12	9	8 to 14
gnathiids	167	2	?	8, 13
aegids	4	2	?	8
corallanids	1	1	?	8
fish lice	0	0	0	4
copepods	3,503	50	1	14 to 17
barnacles	1	1	0	11
tongue worms	2	1	?	4
sea slugs	4	1	0	18
<b>TOTALS</b>	<b>7,387</b>	<b>143</b>	<b>13</b>	

**PARASITES:** gill worms = Monogenea, flukes = Digenea, turbellarians = Turbellaria, sole-worm = Asphidogastrea, tapeworm = Cestoidea, rosette-worms = Cestodaria, nematodes = Nematoda, thorny-headed worms = Acanthocephala, leeches = Hirudinea, cymothoids = Cymothoidae, gnathiids = Gnathiidae, aegids = Aegidae, corallanids = Corallanidae, fish lice = Branchiura, copepods = Copepoda, barnacles = Cirripedia, tongue worms = Pentastomatida, sea slug = Nudibranchia.

**REFERENCES:** 1 = Dyer, Williams & Bunkley-Williams, 1989; 2 = Dyer, Williams & Bunkley-Williams, 1988a; 3 = Dyer, Williams & Bunkley-Williams, 1988b; 4 = this paper; 5 = Hasegawa, Williams & Bunkley-Williams, 1991; 6 = Nagasawa, Williams & Bunkley-Williams, in preparation; 7 = Williams, Bunkley-Williams & Bureson, 1994; 8 = Bunkley-Williams & Williams, in preparation; 9 = Williams & Bunkley-Williams, 1994; 10 = Williams & Bunkley-Williams, 1996; 11 = Williams & Williams, 1987; 12 = Williams & Williams, 1986a; 13 = Williams & Williams, 1986e; 14 = Williams & Williams, 1986g; 15 = Williams & Williams, 1986b; 16 = Williams, Bunkley-Williams & Ortiz, in preparation; 17 = Cressey & Cressey, 1989; 18 = Williams & Williams, 1986d.



## SIGNS OF DISEASES AND ABNORMALITIES

We did not find tumors, lymphocystis lesions, or any overt signs of microbial diseases in any of the wild coral reef fishes which we examined. Lymphocystis (Williams, Williams & Grizzle, 1984) and various tumors (Grizzle & Williams, 1983, 1985) occasionally occur in Caribbean coral reef fishes. If a similar-sized sample and variety of Caribbean coral reef fishes had been examined, we would expect to see a few cases of lymphocystis and at least 1 tumor.

We routinely record abnormalities of the gill filaments, gill arches and internal organs of the fishes we examine. We found very few abnormalities in Okinawan fishes. A few abnormalities frequently occur on Caribbean fishes, their absence in Okinawa seems unusual.

## HEALTH ASSESSMENT OF OKINAWAN FISHES

We reported stomach contents, size and occurrence records, both for Sesoko Island and for Okinawa, for many of the hosts examined (Williams & Williams, 1986g). The "Necropsy Based Fish Health Assessment" has recently become fashionable. This technique employs the appearance of organs and tissues in the host as well as levels of parasites and diseases to estimate the well being of a fish. If this could be applied to our Okinawan examinations, the appearance of the hosts would have suggested a high level of health.

## CONCLUSIONS

The mean density of parasites was 20.6, and the mean number of species per host was 0.3. The parasite fauna of Okinawa was surprisingly depauperate compared to other tropical and temperate areas (Table 1). The great diversity in fish fauna of this region does not seem to be matched in the parasites which associate with these fishes. Our results are quite different from the generally accepted greater diversity of Pacific vs. Atlantic parasite faunas as summarized in Rohde (1982). Former comparisons have not been based on direct examinations of fishes using the same personnel and techniques in different oceans, and thus may not have been entirely accurate. The possibly also exists that the fauna of Okinawa is aberrant from the rest of the Indo-Pacific, but we have no reason to believe so. Certainly, additional studies in other Indo-Pacific areas would be of interest.

Most parasites of Okinawan fishes seem to be less abundant to as abundant as those found in Caribbean fishes. Casual parasites (may change hosts), such as leeches and aegid isopods, occur at drastically low levels in Okinawa compared to the Caribbean. The circumstances opposing the casual parasite life strategy on Okinawan reefs would be very interesting to ascertain.

Once the copepod (Williams, Bunkley-Williams & Ortiz-Corps, in preparation) and isopod papers (Williams & Bunkley-Williams, in press, in preparation) (Fig. 5), and notes concerning the thorny-headed worms (Nagasawa, Williams & Bunkley-

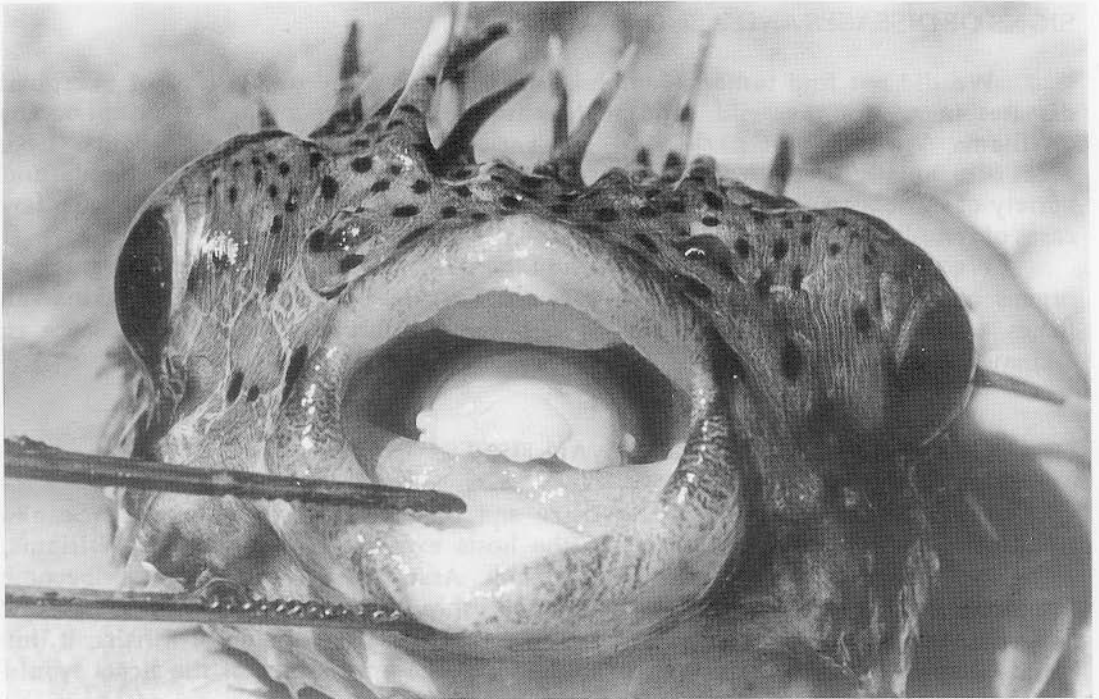


Fig. 5. Large female of *Cymothoa pulchrum* in the mouth of a spiny puffer, *Diodon holacanthus* L. Females of this isopod occurred in the mouths of every spiny puffer or diodontid that we examined in the Ryukyu Islands (*D. holacanthus*, *Diodon hystrix*; and *Diodon liturosus*).

Williams, in preparation) and tongue worms (Williams, Dyer & Bunkley-Williams, in preparation) are published, a complete host-parasite checklist and summary with be submitted for publication in "Galaxea".

The entire work conducted in Okinawa will be combined with our similar but larger-scale studies in the Caribbean and the Gulf of Mexico to obtain a detailed comparison of parasite faunas in three different seas. We are unaware of any other direct comparisons with this important topic.

#### ACKNOWLEDGMENTS

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specimens and information concerning parasites of Okinawan fishes; and Dr. Bolland continues to search for isopods. Travel support to this Symposium allowed EHW to complete a type series for a another new species of fish-parasitic isopod. Support for this study was provided by the Ministry of Education, Science and Culture of the Japanese Government. The 23 publications marked with an astrict are contributions of the Sesoko Marine Science Center resulting from our work in Okinawa, approximately 10 more remain to be written.

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