BIOLOGY AND HOST–PARASITE RELATIONSHIPS OF *CYMOTHOA EXCISA* (ISOPODA, CYMOTHOIDAE) WITH THREE SPECIES OF SNAPPERS (LUTJANIDAE) ON THE CARIBBEAN COAST OF PANAMA

Although parasitic isopods of the family Cymothoidae have been described from both freshwater and marine fishes, relatively little is known of their biology and host–parasite relationships (Morton 1974). Probably all species of cymothoids are protandrous hermaphrodites, with the male larvae settling out of the plankton onto the mouth, body surface, body cavity, or gills of their host. After a period of maturation, males of some species become associated with the buccal cavity where they undergo a sex change. Both broad and limited host specificities have been described for members of the Cymothoidae (Trilles 1964).

Here we comment on the biology and occurrence of *Cymothoa excisa* Perty on three sympatric species of Caribbean snappers: *Lutjanus synagris* (Linnaeus), *L. analis* (Cuvier), and *Ocyurus chrysurus* (Bloch). Host–parasite relationships and infestation rates are discussed and evidence is provided suggesting that this parasite does little, if any, damage.

Methods and Materials

All specimens were collected along the Caribbean coast of the Republic of Panama and the Canal Zone, near the Smithsonian Tropical Research Institute's Galeta Marine Laboratory. Samples were taken in sea grass habitats consisting primarily of *Thalassia testudinum*, using a 4.9-m otter trawl with 1.3-cm bar mesh. Details of the trawling program and site descriptions are given in Heck (in press). All material was sorted in the laboratory and subsequently preserved in 10% Formalin.[1]

Fishes from which parasites had been removed were wet weighed after blotting. Standard lengths of fishes were measured to the nearest 0.5 mm, and total lengths and widths of isopods were measured to the nearest 0.01 mm, using dial calipers. Individual isopods were sexed according to the presence of an appendix masculina on the second pleopod (males) or from the development of oostegites and presence of larvae (females). The Montalenti femininity index [F.I. = $W/L \times 100$, where W = width and L = length (Montalenti 1941)] was used for the isopods as a measure of the degree of transformation from male to female.

Fulton's coefficient of condition [$K = W/L^3$, where W = wet weight and L = standard length (Ricker 1971)] was used to assess the well-being of fish in relation to the presence or absence of isopods. Values of K were computed for 30 infested and 30 isopod-free individuals in each of the three species of snappers, *L. synagris*, *L. analis*, and *O. chrysurus*. An arc–sin transformation was performed on K values before statistical analyses were carried out.

Results and Discussion

Cymothoa excisa was found to occur on 4.7% (32/681) of the *L. synagris*, 10.5% (16/152) of the *L. analis*, and 2.1% (11/527) of the *O. chrysurus* collected. Adults of the two snapper genera exhibit different habitat preferences: members of the genus *Lutjanus* prefer near-bottom habitats with ample cover, while *O. chrysurus* inhabits the open-water column above coral reefs. Juveniles of all three species are commonly associated with sea grass beds, and it may be during this stage of their life cycle that infestation occurs. This is suggested by the occurrence of metamorphosed parasites in very small fish (20–30 mm SL). In addition, a linear relationship exists between lengths of the isopod and those of its host (Figure 1), which further suggests that fishes are infested early in life with subsequent growth by both host and parasite. Six male parasites differed significantly from this relationship, however, and each of these occurred jointly (or in triplicate) with a much larger female. Previously, Bowman (1960) reported that pairs of isopods (*Lironeca puhi* Bowman) were nearly always present in the gill cavity of the moray eel *Gymnothorax eurotus* (Abbott). In our specimens, pairs (or triplicates) were found in only 6.8% of the parasitized fishes and during sorting no free isopods were found which might have escaped from the mouth cavity. Unless male isopods were differentially lost during the trawling operations, it appears that the population biology of cymothoid genera can be quite different.

Several other species of lutjanids collected showed no indication of isopod infestation. For example, none of the 53 *Lutjanus griseus* (Linnaeus) nor any of the 19 *L. apodus* (Walbaum) contained *C. excisa*. Differences in habitat prefer-

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

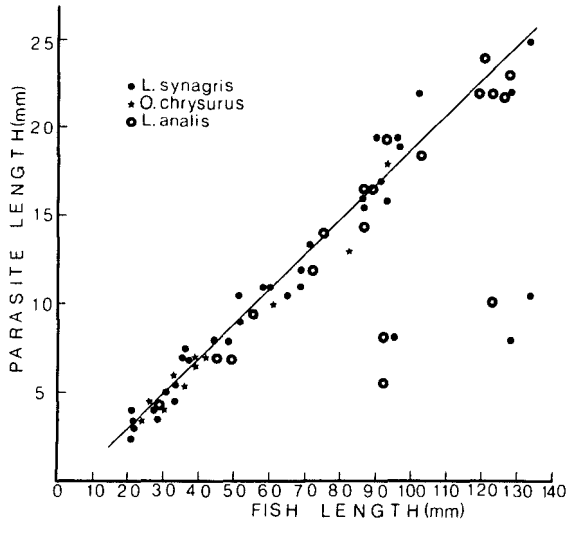

FIGURE 1.—Relationship between *Cymothoa excisa* and lutjanid lengths. Least squares line was fit excluding the six points which fall far below the cluster of other points. These six points represent males which occurred jointly with females.

ences may be responsible for the absence of cymothoids on these species. It is also possible that nonparasitized snapper species are cleaned of parasites by cleaner fishes and decapod crustaceans on nearby reefs.

All isopods were attached to the tongue and oriented anteriorly with smaller males positioned behind females. Some degeneration and possibly some scar tissue were evident at the base of the tongue, but not elsewhere in the mouth. The mouth parts of *C. excisa* seem adapted for piercing and sucking and Morton (1974) has postulated that cymothoids are hemophages. As expected, females of *C. excisa* are proportionately wider than males, and the transition from male to female appears to occur in the 13- to 19-mm size range (Figure 2).

Bowman (1960) presented evidence that the presence of a female suppresses feminity in cooccurring males, as expressed by the Montalenti index. We found just the opposite result: males occurring jointly with females displayed a significantly higher average femininity index than males which occurred alone (Figure 2); (t-test, $P<0.01$). The reason for this difference is unknown.

Because *C. excisa* filled so much of the mouth cavity of infested snappers, it seemed, a priori, that the presence of isopod parasites must interfere with feeding. However, several crustacean families, including Xanthidae (*Micropanope* sp., *Pilumnus* sp., *Panopeus* sp.), Porcellanidae (*Petrolisthes* sp.), Squillidae (*Squilla* sp.), Penaeidae (*Penaeus* sp.), and Alpheidae (*Alpheus* sp.), were represented in the gut contents of the infested snappers. Moreover, there were no significant differences between coefficients of condition calculated for parasitized and unparasitized fish in any of the three lutjanids (t-test, $P = 0.01$). Thus it appears that any harmful effects due to the presence of parasites are not reflected in either the ability to capture prey or in overall health, as measured by K. It is possible, however, that the presence of isopod parasites may lower fitness by causing increased mortality during periods of stress (Keys 1928), by reducing the reproductive output of infested fish, or by decreasing the ability of parasitized individuals to avoid predators. Although the requisite data are lacking to test the first two premises, we were able to test the latter possibility indirectly using the following reasoning: If predation is not selective for parasitized individuals, then a similar distribution would be expected for each group. This was tested by assigning both parasitized and nonparasitized individuals of all three species to 20-mm (SL) size classes for all but the largest fish (excluded because of small sample size). There was no significant difference between the two groups ($\chi^2 = 6.69$, $P = 0.05$).

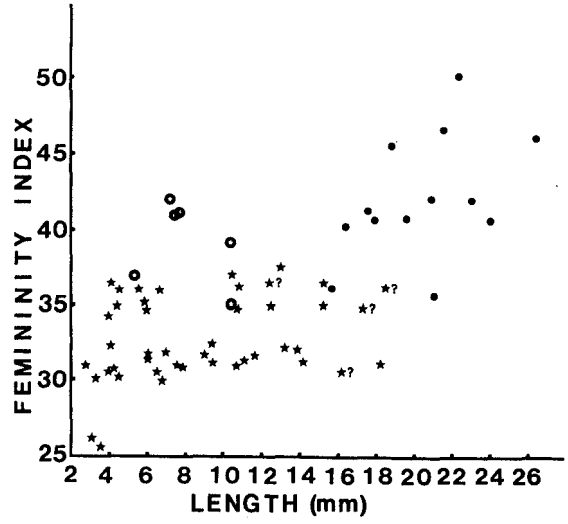

FIGURE 2.—Femininity index in *Cymothoa excisa*. Legend: ⋆ = male, • = female, o = male occurring jointly with female, ⋆? = sex indeterminate.

On the basis of these results and the data previously presented, we consider *C. excisa* to be a relatively benign parasite. This appears to be a general characteristic of host–parasite relationships between cymothoids and fishes, at least in unstressed situations (Keys 1928).

Acknowledgments

Specimens of *C. excisa* were kindly identified by T. Bowman, U.S. National Museum of Natural History (USNM), and have been deposited at the USNM. C. M. Courtney, Marco Ecology Laboratory, Marco Island, Fla., sexed the parasites and analyzed gut contents of parasitized fishes. D. T. Logan and M. H. Baslow provided comments on the manuscript.

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FECUNDITY OF THE SOUTHERN NEW ENGLAND STOCK OF YELLOWTAIL FLOUNDER, *LIMANDA FERRUGINEA*

The yellowtail flounder, *Limanda ferrunginea*, is an important commercial species to both the New England and Canadian fishing industries. According to Royce et al. (1959) there are five relatively distinct stocks of yellowtail flounder with little migration occurring between them: southern New England, Georges Bank, Cape Cod, Nova Scotian, and Grand Bank stocks. Catches have recently been declining. For example in the southern New England and Cape Cod stocks (ICNAF (International Commission for the Northwest Atlantic Fisheries) subarea 5Zw), the number of metric tons landed per standard fishing day has declined from 3.5 in 1970 to 1.5 in 1975; the total catch declining from 24,103 to 5,460 metric tons over the same period (Cain[1]).

Pitt (1971) has estimated the fecundity of the Grand Bank stock (ICNAF Subareas 3L, 3N, 3O) but no other yellowtail flounder fecundity data have been published. Fecundity may vary from one stock of flatfish to another, e.g., plaice (Simpson 1951), so we have analyzed the fecundity of the southern New England stock of yellowtail based on 50 fish, and compared these values with the fecundity estimates of Pitt (1971).

Methods and Materials

Ovaries used for fecundity estimates were collected on 9 and 12 April 1976 from fish landed by commercial vessels at Point Judith, R.I. Fish were randomly sampled from the combined catches of several vessels, and therefore represented a random sample of the southern New England population. Only ripening ovaries, i.e., ovaries swollen but eggs not fully developed in size (Scott 1954), were used thus omitting fish that may have begun to spawn. Fish were measured to the nearest centimeter total length, and the ovary wet weight was determined to the nearest 0.1 g. Ovaries were preserved in Gilson's fluid as modified by Simpson (1951) and allowed to remain in this solution for 3-5 mo to facilitate ovarian tissue breakdown. Otoliths, read independently by each of us, were used to determine ages. The growth rings were recognized according to Scott (1954) who also

[1]Cain, W. L. 1976. Yellowtail flounder tabulations for 1977 assessments. Int. Comm. Northwest Atl. Fish. Working Pap. No. 76/IV/49.