ABILITY OF PEDERSON CLEANER SHRIMP TO REMOVE JUVENILES OF THE PARASITIC CYMOTHOID ISOPOD, *ANILOCRA HAEMULI*, FROM THE HOST

BY

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ABSTRACT

Eight species of prospective cleaners, four fishes (sharknosed goby *Gobiosoma evelynae*, and juveniles of bluehead (wrasse) *Thalassoma bifasciatum*, Spanish hogfish *Bodianus rufus* and gray angelfish *Pomacanthus arcuatus*) and four shrimps (cleaner shrimp *Lysmata grabhami*, Pederson cleaner shrimp *Periclimenes pedersoni*, banded coral shrimp *Stenopus hispidus* and golden coral shrimp *Stenopus scutellatus*) were evaluated in aquaria for their ability to remove newly settled juveniles of the fish-parasitic cymothoid isopod *Anilocra haemuli* from French grunts *Haemulon flavolineatum*. *Periclimenes pedersoni* removed all isopods almost immediately. No other cleaners removed any isopods over a 24 hr challenge period. This study is the first evidence that cleaner shrimps can remove juvenile cymothoid isopods.

RÉSUMÉ

Huit espèces de nettoyeurs présumés, quatre poissons (*Gobiosoma evelynae*, juvéniles de *Thalassoma bifasciatum, Bodianus rufus* et *Pomacanthus arcuatus*) et quatre crevettes (*Lysmata grabhami, Periclimenes pedersoni, Stenopus hispidus* et *S. scutellatus*) ont été examinées en aquarium pour évaluer leur capacité d'enlever les juvéniles d'*Anilocra haemuli*, isopode cymothoïde parasite de poissons, nouvellement fixés sur *Haemulon flavolineatum*. *Periclimenes pedersoni* a enlevé tous les isopodes presque immédiatement. Aucun autre nettoyeur n'a enlevé d'isopode pendant une période de 24 heures. Cette étude prouve pour la première fois que des crevettes nettoyeuses peuvent enlever des isopodes cymothoïdes juvéniles.

INTRODUCTION

Ten species of large, conspicuous isopods of the genus *Anilocra* parasitize 25 species of West Indian coral reef fishes (Williams & Williams, 1981; Bunkley-Williams & Williams, unpubl. data). We previously described the natural release (and predator-triggered burst release) of juvenile cymothoid isopods from the brood pouch of the female (Williams & Williams, 1985). It is known that these juveniles are photopositive in daylight and rise to the surface plankton (Williams & Williams, 1985); otherwise, nothing is known about the free-living or planktonic part of the cymothoid life cycle or about their initial attachment to the hosts.

Cleaner fishes and shrimps are generally thought to remove and eat fish-parasitic copepods and gnathiid isopods. They are also assumed to remove cymothoid isopod juveniles from fishes (Bunkley-Williams, unpubl.; Williams & Williams, 1978), but no published physical or experimental evidence supports this hypothesis. Cleaner removal of juvenile cymothoids has been suggested as limiting the transmission of *Anilocra* spp. among coral reef fishes (Bunkley-Williams, unpubl.). The demonstration of cleaner removal is the first step in establishing the importance of cleaner organisms in the ecology of isopod parasites.

Coral reef fish infected with juvenile *Anilocra haemuli* Williams & Williams, 1981, were challenged with common Caribbean cleaner shrimps and cleaner fishes in saltwater aquaria to evaluate the hypothesis of cleaner removal.

METHODS

Specimens of cleaner shrimp *Lysmata grabhami* (Gordon, 1935); Pederson cleaner shrimp *Periclimenes pedersoni* Chace, 1958; banded coral shrimp *Stenopus hispidus* (Olivier, 1811); golden coral shrimp *Stenopus scutellatus* Rankin, 1898; ringed anemone *Bartholomea annulata* (Lesueur, 1817); and sharknosed gobies *Gobiosoma evelynae* Böhlke & Robins, 1968, were collected in plastic bags. Specimens of bluehead (wrasse) *Thalassoma bifasciatum* (Bloch, 1791) juveniles were collected in glass jars baited with crushed sea urchins. Juvenile Spanish hogfish *Bodianus rufus* (Linnaeus, 1758) and gray angelfish *Pomacanthus arcuatus* (Linnaeus, 1758) were collected with quinaldine. French grunts *Haemulon flavolineatum* (Desmarest, 1823) were collected at night with hand nets (Williams et al., 1991).

Female *Anilocra haemuli* on *H. flavolineatum* (fig. 1) were examined underwater with scuba. Those with darkly pigmented and slightly bulging brood pouches (indicating juveniles in an advance stage of development) were collected with quinaldine, transported to the laboratory, and held in 40-l aquaria until the juveniles developed and escaped in 2-8 days (Williams & Williams, 1985). Free-swimming juveniles from the aquarium were used to infect *H. flavolineatum* for no more than 3 days.

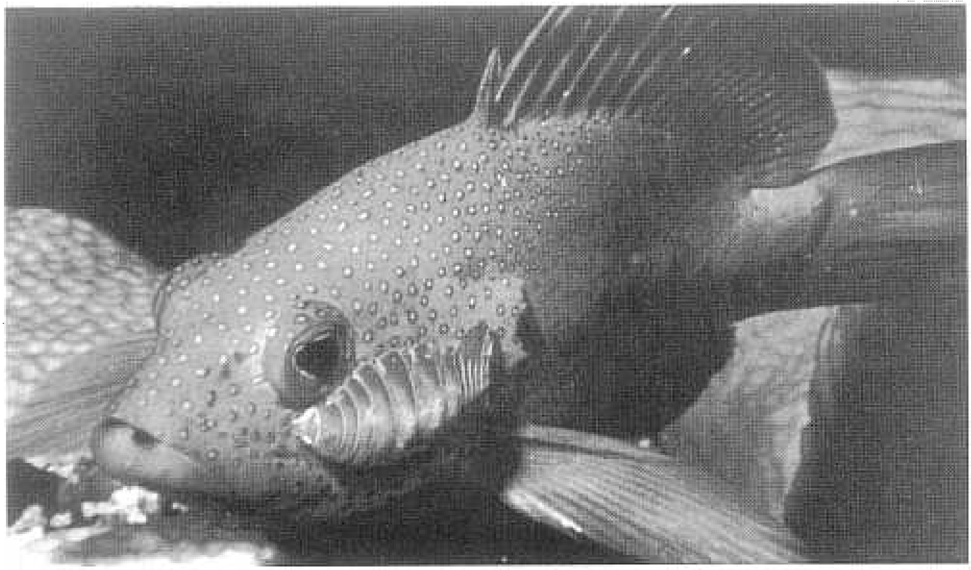

Fig. 1. Coney, *Epinephelus fulvus* (Linnaeus, 1758), parasitized by a female cymothoid isopod *Anilocra haemuli* Williams & Williams, 1981, from La Parguera, Puerto Rico.

Standard 40-l glass aquaria were used for each cleaner species, with the exception of *Thalassoma bifasciatum*. For these a 220-l aquarium was used. Each aquarium was filled with seawater and aerated. Aquaria were subjected to natural light conditions. The ringed anemone from which each *Periclimenes pedersoni* was collected, the same species of coral [boulder star coral, *Montastraea annularis* (Ellis & Solander, 1786)] from which *Gobiosoma evelynae* were collected, and dead coral heads for the other cleaner species, were placed in the aquaria, and the corresponding shrimps and fishes were introduced. The number of associated cleaners and sizes of cleaners that we collected were typical of what we routinely observed in the field (Bartels et al., 1996).

Two free-swimming juvenile isopods and water from the brood aquarium were removed in a plastic scoop and transferred to a 40-l aquarium with a *Haemulon flavolineatum* 12 to 17 cm. This method was used, instead of placing uninfected hosts in the brood tank, because we found exposure to many (50-100) juveniles allowed multiple infections that impaired or killed the host. Super-infection (Williams & Bunkley-Williams, 1996) with juveniles can also occur in impaired hosts in nature (Williams & Bunkley-Williams, 1994). The fish was left undisturbed overnight, because we found that juveniles only attach at night. Those *H. flavolineatum* with one or two juvenile isopods attached the next morning were used for cleaner challenges. At 0900 hrs, experimentally infected hosts were surrounded in the aquaria with 2-l plastic containers, transferred to aquaria with the previously described cleaner organisms, and released. They were allowed to remain for 24 hrs. Aquaria were monitored continuously for isopod removal for the first hour, hourly until 1700 hrs, and thereafter at 2200, 0400, and 0800 hrs. At 0800 hrs the host fish was removed and a newly infected fish was introduced at 0900 daily for a total of five replications. Two replicate cleaner units of each cleaner species were treated as described above (table I).

The observation times were designed to determine when and if cleaners would remove isopods. Cleaning behavior observations were not taken because the study was attempting to examine isopod removal, not cleaning behavior. No fishes, shrimp, anemones, corals or adult *Anilocra haemuli* died during the experiments and all were released in their original sites of collection.

TABLE I

The ability of Caribbean cleaner fishes and shrimp to remove juveniles of *Anilocra haemuli* Williams & Williams, 1981, from the natural host, the French grunt, *Haemulon flavolineatum* (Desmarest, 1823), in 24 hr challenges

Cleaner	Number of:			Percentage
species	Challenges	Isopods	Removals	removed
Bodianus rufus (Linnaeus, 1758); Spanish hogfish	10	12	0	0%
Gobiosoma evelynae Böhlke & Robins, 1968; sharknosed goby	10	11	0	0%
Pomacanthus arcuatus (Linnaeus, 1758); gray angelfish	10	11	0	0%
Thalassoma bifasciatum (Bloch, 1791); bluehead (wrasse) juveniles	10	11	0	0%
Lysmata grabhami (Gordon, 1935); cleaner shrimp	10	11	0	0%
Periclimenes pedersoni Chace, 1958; Pederson cleaner shrimp	10	11	11	100%
Stenopus hispidus (Olivier, 1811); banded coral shrimp	10	12	0	0%
Stenopus scutellatus Rankin, 1898; golden coral shrimp	10	11	0	0%
Totals	80	90	11	–

RESULTS

One hundred twenty-three *Haemulon flavolineatum* were experimentally exposed to *Anilocra haemuli* juveniles. The number infected with no juveniles was 36 (29%), with one juvenile attached 81 (66% of total or 85% of infected) and with two juveniles attached 14 (11% of total or 15% of infected).

In the experimental challenges, *Periclimenes pedersoni* responded immediately to the introduction of an *H. flavolineatum* with juvenile *A. haemuli* by moving directly to the isopod and removing it (table 1). In each trial, a *P. pedersoni* removed each isopod from the fish, and returned to the substratum to eat it. No other species of cleaner shrimps or fishes removed isopods from infected fish during the 24 hr observations periods.

DISCUSSION

Each isopod was removed by *Periclimenes pedersoni* in a similar cleaning action as described by Corredor (1978). The exact action of detachment could not be determined. The shrimp may have removed the isopod from its legs (pereopods) or may have just unhooked the pereopods from the host. Turnbull (unpubl.) suggested that the morphology of the chelae of *P. pedersoni* (examined by SEM) would not be suited for cutting off or removing parasites. Although the exact method of removal was not observed, the isopods were removed.

Turnbull (unpubl.) found *P. pedersoni* did not remove adult caligid copepods nor aegid, corallanid, and cymothoid isopods from the external surfaces of Bahamian serranids. The large size of these adult parasites probably prevents their removal by western Atlantic coral reef cleaners. The bulk of the diet of Caribbean cleaner gobies *Gobiosoma* spp. are relatively small juvenile gnathiid isopods *Gnathia* spp. These are too small to be seen by human observers in the field, but they are much more abundant on fishes than the larger copepods and isopods. Gnathiid isopods would logically be the most likely crustacean food source of *P. pedersoni*.

Turnbull (unpubl.) and Spotte (in press) suggested that cleaner shrimp do not clean parasites, and that our study (Williams & Williams, 1978) constituted the only physical, non-inferential evidence of parasite cleaning by shrimp ever described. Shrimp probably cannot remove all parasites. No cleaner organisms on western Atlantic coral reefs can remove specimens of adult female *Anilocra* spp., for example, which are often larger than the cleaners. Nonetheless, our experiments demonstrate that *P. pedersoni* remove parasites.

De Lisle (unpubl.) found "*Gobiosoma genie*" (probably *Gobiosoma evelynae*) and juvenile foureye butterflyfish *Chaetodon capistratus* Linnaeus, 1758, French angelfish *Pomacanthus paru* (Bloch, 1787), *Pomacanthus arcuatus*, and queen angelfish *Holacanthus ciliaris* (Linnaeus, 1758) "cleaned" fishes in 95 to 190-l aquaria, but juvenile *Thalassoma bifasciatum* did not. Darcy et al. (1974) reported limited cleaning by *T. bifasciatum* in 300-l aquaria. In our 220-l aquaria, *T. bifasciatum* did not remove isopods. Losey (1974) found cymothoid juveniles in the stomach contents of *T. bifasciatum*, but they could have been obtained from the plankton. *Thalassoma bifasciatum* are carnivorous and opportunistic feeders.

Burnett-Herkes (unpubl.) suggested that cleaner gobies could not remove *Anilocra* spp. juveniles. He speculated that their mouths are too small. However, shrimp cut these isopods apart and ate them, and Pacific cleaner wrasses *Labroides dimidiatus* (Valenciennes, 1839) bite gnathiid isopods, smaller than juvenile *Anilocra* spp., into pieces to swallow them (Williams & Williams, 1986), although judging from the size of the mouths of these cleaners, they could easily have swallowed them intact. Cleaner gobies *Gobiosoma* spp. could do the same with juvenile *Anilocra* spp. Losey (1974) found cymothoids in the gut contents of *T. bifasciatum* but not in *Gobiosoma* spp. Randall (1967) found only gnathiid isopods in *Gobiosoma* sp. Our *Gobiosoma evelynae* did not remove any juvenile *A. haemuli*. This suggests that they do not remove cymothoid juveniles.

Stenopus hispidus are routinely listed in a variety of publications as cleaners, although little evidence exists to support this behavior (Spotte, in press). Maynard (1976) found this shrimp to be more active at night, but noted that it also cleaned during the day. Corredor (1978) suggested that this shrimp is nocturnal, and Collette & Talbot (1972) suggested that it cleaned fishes at night, although their assumption was based on casual observations made with scuba. In our experiments, this species did not remove isopods during the day or night.

Aquaria are limited approximations of the conditions on coral reefs and might have repressed isopod removal. Greater numbers of challenges with experimentally infected hosts, particularly with additional sets of cleaners, would have been desirable. The captive *Haemulon flavolineatum* were agitated. Small groupers [coney *Epinephalus fulvus* (Linnaeus, 1758), graysby *Epinephalus cruentatus* (Lacépède, 1802), red hind *Epinephalus guttatus* (Linnaeus, 1758) and rock hind *Epinephalus adscensionis* (Osbeck, 1771)] also harbor *Anilocra haemuli* and may be better experimental hosts because they are calmer in captivity and occur alone in nature. Other cleaners, especially juveniles of *Holacanthus ciliaris*, *Pomacanthus paru*, and spotfin hogfish *Bodianus pulchellus* (Poey, 1860), should be evaluated for any ability to remove juvenile cymothoid isopods. We could not find enough specimens to evaluate because of the rarity of *H. ciliaris* and *P. paru* juveniles and depths (>37 m) where *B. pulchellus* occurs in our area. In conclusion, these experiments demonstrate that cleaners can remove and probably control juvenile *Anilocra* spp. and possibly other cymothoid isopods.

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