PARASITISM OF SLEEPING FISH BY GASTROPOD MOLLUSKS IN THE COLUBRARIIDAE AND MARGINELLIDAE AT KWAJALEIN, MARSHALL ISLANDS

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Abstract

Six species of the family Colubrariidae and two species of Marginellidae in the Marshall Islands feed by parasitizing sleeping fish, especially species of Scaridae. Feeding in colubrariids is similar to that described for *Cancellaria cooperi* by O'Sullivan *et al.* (1987), and feeding in marginellids matches that of Bouchet (1989) reported from New Caledonia.

Introduction

This study was undertaken after we noticed that *Colubraria tortuosa* (Reeve, 1844) could often be observed at night in the vicinity of sleeping parrotfish (family Scaridae). Further examination revealed that six of seven species in the caenogastropod molluscan family Colubrariidae known from Kwajalein and at least two species of Marginellidae parasitize scarids and, occasionally, other fish sleeping on the steep oceanside dropoff of Kwajalein Atoll, Marshall Islands.

Parasitism of fish by gastropod mollusks has been reported twice in the past few years. O'Sullivan *et al.* (1987) reported *Cancellaria cooperi* Gabb sucking blood from the ray *Torpedo californica* Ayres in California. More recently, Bouchet (1989) reported two species of Marginellidae from New Caledonia feeding on body fluids of sleeping fish at night.

Methods

Initial observations of gastropods parasitizing sleeping fish were made at night on the steep leeward oceanside dropoff on the west side of the southern portion of Kwajalein Atoll. In this area, the water gradually deepens from the island or inter-island intertidal reef to a depth of 3 to 6 meters at the seaward edge of the reef front. At this point, the reef abruptly drops off in a wall that ranges in slope from 60 to 90 degrees, and is even undercut in places. The reef face on the dropoff and in occasional "surge channels" - 3 to 10 meter wide, 10 to 20 meter deep, 5 to 30 meter long cuts in the reef perpendicular to the reef front that usually intersect the dropoff - is pocketed with numerous caves and holes that provide convenient sleeping sites for scarids and other fish at night.

Over six years, scarid/parasite relationships were monitored during regular night dives. Several dives were made specifically to count scarids with and without parasitic gastropods.

Colubrariid and marginellid species found parasitizing sleeping fish at night were sought out during the day to determine diurnal habits.

Buccal anatomy of colubrariids was examined in an attempt to determine how feeding occurs.

Results and Observations

Colubrariids

Specimens of six colubrariid species found at night are strongly associated with sleeping fish (Table 1). Nearly all of the host fish are several species of Scaridae. The six distinctly parasitic colubrariids are *Colubraria tortuosa*, *C. nitidula* (Sowerby, 1833), *Colubraria muricata* (Lightfoot, 1786), *C. obscura* (Reeve, 1844), *C. aff. obscura*[3] and *C. castanea* Kuroda *in* Habe, 1961. Actual feeding on sleeping fish (described below) has been observed in all six. Furthermore, all or nearly all specimens of five species, when observed at night, are either feeding on or within a meter of a sleeping scarid. *Colubraria muricata* (Lightfoot, 1786) was found under sleeping scarids on five out of thirteen occasions.

One other colubrariid at Kwajalein, *Colubraria clathratus* (Sowerby, 1833) is never found associated

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[3]This unidentified species is similar to, but distinct from, our other *Colubraria obscura*.

with sleeping fish. This nocturnal species is commonly found at night crawling along the walls or ceilings of small dropoff or surge channel caves. Feeding habits of *C. clathratus* are unknown.

A parasitic colubrariid feeds by first approaching a sleeping fish. (See Figures 1-5.) If the fish is a scarid encased in a mucus bag, the colubrariid can either squeeze through the bag or remain outside; small colubrariids have even been observed crawling on the mucus bag itself.. (Most mollusk parasitism has been observed on adult scarids, which, as noted by Hobson (1965), usually do not form complete mucus sleeping bags.) The colubrariid extends its long proboscis, which can stretch three or more times as long as the mollusk's shell. (The maximum shell size for *C. tortuosa* is about 66 mm; for *C. nitidula* about 35 mm.) The proboscis often enters the scarid through the anal opening, the mouth, the gill opening or the eye socket, but it also can be simply slid beneath a body scale. Presumably, the mollusk has a means of breaking through the scarid's flesh, and blood or other body fluids are sucked up through the elongated proboscis. Searches for radulae in *C. tortuosa* and *C. nitidula* were unsuccessful.

Both *C. tortuosa* and *C. nitidula* are usually found in groups of two or more individuals. The most *C. tortuosa* individuals ever found on a single host scarid is five. Nine *C. nitidula* have been observed on a single host, and the maximum numbers of individuals of *C. aff. obscura*, *C. obscura*, *C. castanea* and *C. muricata* found with one host are two, one, one, and one respectively. In several instances, both *C. tortuosa* and *C. nitidula* were found parasitizing a single fish at the same time.

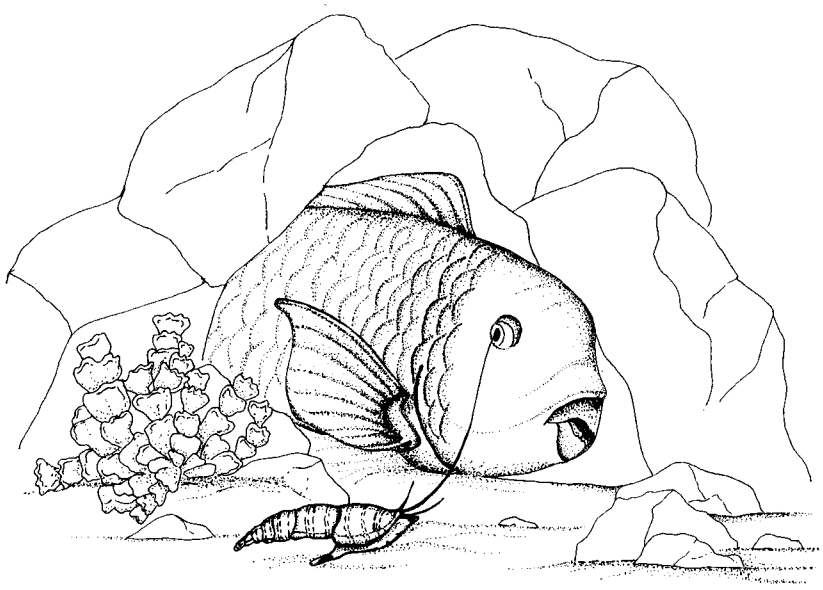


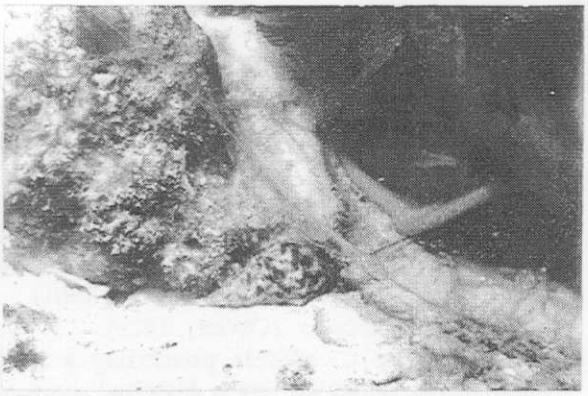
Figure 1. *Colubraria tortuosa* with feeding proboscis extended into the eye socket of a sleeping scarid.

During the day, all colubrariid species are usually inactive and remain secreted beneath rocks or in piles of dead coral rubble that collect on the dropoff wherever it is flat enough (often on floors of or in front of the small caves and ledges where scarids sleep at night). Some, such as *C. muricata*, *C. obscura* and *C. nitidula*, also bury in sand within the caves. Groups of three or more *Colubraria nitidula* are frequently found under rocks that rest on sand or sandy rubble.

We have observed two cases of colubrariids actively feeding during the day. In one instance, a group of nine *C. nitidula* was actively parasitizing a sleeping nocturnal fish, *Priacanthus* sp., at midday. The fish was resting in a relatively narrow sandy-bottom ledge. The *C. nitidula* had emerged from the sand (in most specimens, only the anterior whorl of the shell protruded from the sand), and each had extended its proboscis 8 to 10 cm upward into the ventral surface of the sleeping fish. In the other case, a single *C. castanea* was observed partly buried next to what appeared to be a rubble pile in a small sandy hole in the reef. When pulled from the sand, the snail retracted its long brown proboscis, which extends only when the animal is feeding. A close examination of the hole revealed that the "rubble pile" the snail was nestled up against was in fact its prey: a stonefish, *Synanceja verrucosa* Bloch & Schneider, 1801, buried up to its eyeballs in the sand.

Marginellids

One of the marginellid species found on sleeping fish has been tentatively identified as *Kogomea ovata* Habe, 1951; the other resembles the parasitic *Hydroginella caledonica* (Jousseaume, 1876) reported by Bouchet (1989) but is only about one third its size. At least four other small



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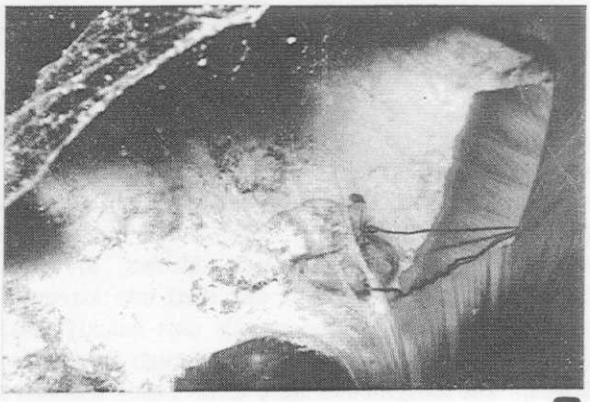

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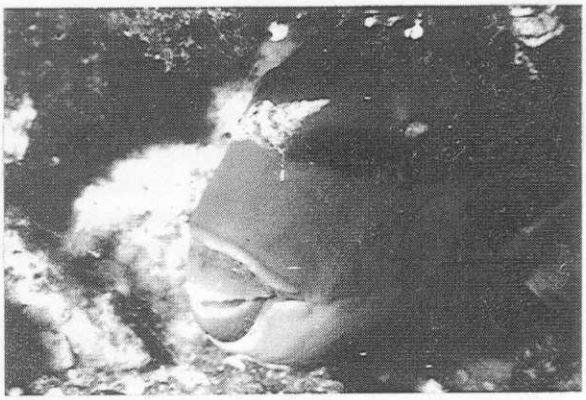

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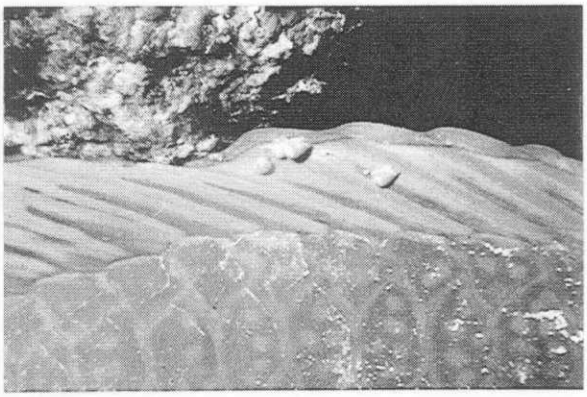

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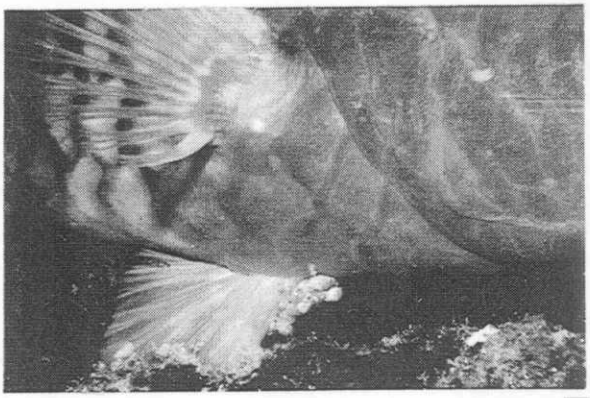

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Figures 2-7. (2) *Colubraria tortuosa* with feeding proboscis extended into the underside of a sleeping scarid.
(3) Pair of *Colubraria tortuosa* with probosces extended into the anus of a sleeping scarid through its mucus bag (the mollusks are under and outside of the bag).
(4) Small *Colubraria tortuosa* crawling on the outside of an invisible mucus bag.
(5) *Colubraria nitidula* with white proboscis extended into the mouth of a sleeping scarid.
(6) Several *Kogomea ovata* on the dorsal fin of a sleeping scarid.
(7) Cluster of *Kogomea ovata* just in front of the pelvic fin of a sleeping scarid.

marginellids from Kwajalein appear not to parasitize sleeping fish.

Initially, we thought that the marginellids could be simply feeding on body mucus. However, when we attempted to carefully remove specimens from a sleeping scarid's body, we noticed the proboscis extended into the host's flesh. The marginellids sometimes adhere well enough, in fact, to remain attached to a scarid that is disturbed into leaving its sleeping spot. Disturbed scarids dart quickly away, often running into coralheads with enough force to lose scales. The marginellids need to be firmly attached to remain on the fish when this happens.

Kogomea ovata are often found in groups. Up to 28 individuals have been found on a single host scarid (Figures 6-7). Frequently, they cluster into small "balls" of 10 to 15 shells, especially on or around a host's fins. In one case, about 18 individuals were seen crawling on a scarid's face, leaving criss-crossing mucus trails to which fine sand was sticking.

During the day, *K. ovata* lives, also usually in groups, under rocks and in piles of dead coral rubble, and is apparently inactive. In one case, over 50 individuals were found clustered together under a large rock; once exposed to sunlight, they began to crawl rapidly away. The second parasitic marginellid is rare and has not been found during the day.

Hosts

Colubrariids and marginellids parasitize most of the large species of scarids on the reef, including *Scarus rubroviolaceus* (Bleeker, 1849), *S. altipinnis* (Steindachner, 1879), *S. festivus* Valenciennes, 1840, *S. gibbus* Rüppell, 1828, and others. *Cetoscarus bicolor* (Rüppell, 1829), although very common on the reef, seems to be parasitized less often. Whether this species' protection is due to tougher skin, more sensitivity to disturbances by the parasites, or simply gastropod choice is unknown.

The percentage of the adult scarids on the leeward reef that appear to have parasites varies from night to night or site to site (Table 2). (The numbers are under-reported since few sleeping scarids could be examined on all sides for the often small mollusks.)

Observations of sleeping fish on lagoon reefs have so far yielded no parasitism by *Colubraria* spp., although living and dead shells of *C. muricata, C. nitidula*, and *C. tortuosa* are occasionally found on those reefs during the day. Parasitism on sleeping scarids by *Kogomea ovata* has been observed at night on lagoon pinnacles.

Other fish occasionally subject to parasitism on seaward reefs include species in the families Acanthuridae, Serranidae, Balistidae, Scorpaenidae and Priacanthidae. Parasitism within these families is rare. On one occasion each, *Colubraria tortuosa* was observed parasitizing *Acanthurus pyroferus* Kittlitz, 1834, *Naso lituratus* (Bloch & Schneider, 1801), *Cephalopholis argus* (Schneider, 1801), *Balistoides viridescens* (Bloch & Schneider, 1801) and *Scorpaenopsis diabolus* (Cuvier, 1829). A single instance of nine *C. nitidula* parasitizing a sleeping *Priacanthus* sp. during the day is described above, as is an observation of one *C. castanea* on a *Synanceja verrucosa*.

Discussion

Feeding habits of species of *Colubraria* have not previously been reported. Taylor (1987) found no identifiable remains in the stomach of *C. reticulata* (Blainville, 1826), which might indicate it is also parasitic. An individual that feeds on blood and body fluids would not be expected to have anything readily identifiable in its stomach.

Parasitism by *Colubraria* and marginellids typically occurs at night. However, the observation of two instances of parasitism in the middle of the day indicates that the mollusks' nocturnal activity is probably due more to the limited availability of motionless fish within reach during the day.

O'Sullivan *et al.* (1987) showed that *Cancellaria cooperi* locates host fish by chemosensory means. It is likely the same holds true for *Colubraria* and marginellids. Sleeping scarids are abundant in small holes and on ledges on the oceanside reefs of Kwajalein. Most *Colubraria* and marginellid individuals live either in those same holes or in piles of dead coral rubble on the floor of or just outside the holes. Since virtually all active parasitic *Colubraria* and marginellids observed at night are on or adjacent to sleeping fish, the parasites might remain inactive and hidden unless a host is within sensing distance. Even colubrariids buried in sand appear to be able to detect the presence of sleeping fish. The nine *C. nitidula* feeding on the sleeping *Priacanthus* during the day were still mostly buried in sand when observed. They apparently detected the fish above them, and emerged just enough to extend their probosces into the host.

Parasitic feeding in *Colubraria* spp. is similar to that reported by O'Sullivan *et al.* (1987) for *Cancellaria cooperi* in that the snail's proboscis is often extended into an area of the host with thin, easily penetrated skin

(e.g., mouth, eye, gill opening, anus). When not feeding from such an "internal" part of the prey, *C. cooperi* makes small cuts with a piercing radular tooth on a ray's ventral surface; a species of *Colubraria*, on the other hand, squeezes its proboscis under a parrotfish's large, thick scales and presumably cuts through the skin there.

How *Colubraria* breaks through the skin of a sleeping fish is unknown. We were unable to find radulae in several specimens of *Colubraria nitidula* and *C. tortuosa*. Some publications (e.g., Springsteen & Leobrera, 1986) have stated that members of the Colubrariidae lack a radular ribbon. Ponder (1973), on the other hand, indicates that the radula is vestigial. It is conceivable that a minute, apparently vestigial ribbon of single teeth (which might be difficult to find if present) would be sufficient to cut through thin skin and allow the proboscis access to the fish's blood. The proboscis wall is muscular, indicating that feeding is suctorial.

Ponder (1973) also notes the presence of a glandular esophagus wall in colubrariids. The glands might produce an anesthetic to keep from disturbing the sleeping fish or, if no radula is present, produce substances that chemically break through the skin.

Probably the best defense a scarid has against colubrariid parasites is its tendency to dart away at the least disturbance, leaving behind all colubrariids (which often get buried in a cloud of silt). An anesthetic used by a colubrariid to mask its entry through the fish's skin would almost certainly be advantageous. However, it is uncertain if the sleeping fish are sensitive to disturbances under natural conditions, or if their observed edginess is simply due to the presence of a diver carrying a bright light.

Marginellids are sometimes able to hang on when the fish darts away. However, these parasites are small enough that their feeding probably has little effect on a healthy adult scarid.

Approximately 5-10% of the adult scarids on the Kwajalein reef form mucus bags; for juvenile scarids, the percentage is higher. When present, these bags do not protect the fish from parasitism by *Colubraria*; the mucus is easily penetrated by the snail itself or by its long proboscis. On several occasions, a small *C. tortuosa* or *C. nitidula* was observed to crawl up the side of a mucus bag surrounding a scarid and extend its proboscis through the bag to the fish.

The mucus bags might offer some protection against marginellid parasites; although often seen crawling on the bag, marginellids rarely are on the protected fish inside.

Acknowledgment

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Table 1. Associations of Kwajalein Atoll colubrariids at night.

	On Fish	Not On Fish
C. castanea	3	1
C. clathratus	0	>100
C. muricata	5	8
C. nitidula	>100	9
C. obscura	4	0
C. aff. obscura	5	0
C. tortuosa	>100	13

Table 2. Gastropod parasites observed on selected night dives. The first number in each column is the number of scarids with that column's species of parasite. In parentheses are the numbers of parasitic individuals per fish. Total number of fish with parasites is not always the sum of the fish with different parasites because occasionally more than one species of gastropod parasitizes a single host.

	NUMBER OF SCARIDS					
Date of observation	without parasites	with *Colubraria nitidula*	with *Colubraria tortuosa*	with *Colubraria obscura*	with *Kogomea ovata*	Total with Parasites
01/27/90	17	0	0	0	1 (3)	1
02/24/90	16	0	3 (1/1/1)	1 (1)	7 (8/6/2/1/1/1/1)	11
02/24/90	33	3 (2/2/1)	4 (3/1/1/1)	0	7 (14/9/8/8/4/3/2)	12
03/02/90	9	0	0	0	3 (2/1/1)	3
03/10/90	8	0	0	0	3 (4/3/1)	3
03/16/90	6	0	1 (1)	0	1 (18)	2
03/23/90	16	0	3 (1/1/1)	0	4 (1,1,1,1)	6
03/30/90	9	0	1 (1)	0	2 (1/1)	2
03/31/90	11	0	2 (2)	0	2 (1/1)	4
04/13/90	10	0	0	0	2 (2/1)	2
04/14/90	15	1 (3)	2 (1/1)	0	2 (10/2)	5
04/21/90	14	1 (1)	2 (1/1)	0	3 (9/4/4)	5
10/25/91	22	0	2 (3/1)	0	1 (4)	3
12/27/91	18	0	1 (1)	0	4 (8/3/2/2)	5
01/04/92	24	1 (2)	3 (2/2/2)	0	2 (4/3)	5

Editor's note: An excellent color photograph by Doug Perrine of a colubrariid parasitizing a sleeping scarid appeared in the October 1995 issue of **Sport Diver** magazine.