

## Reproductive Behavior and Social Organization of Some Pacific Hawkfishes (Cirrhitidae)

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**Abstract** Ten species of Pacific hawkfishes occur in small social groups consisting of a single male and one or more females. Facultative monogamy occurred regularly in two obligate coral dwelling species while the remaining species were largely harem. Males had larger body sizes than females within groups but not necessarily between groups. Males defended territories in which females had home areas. Females defended courtship sites within a male's territory against neighboring females of the same social group. Courtship was paired and sequential within groups, commencing just prior to or after sunset and concluding at dusk. Spawning, when observed, was pelagic.

Studies of hawkfish reproductive behavior have been largely limited to brief accounts based upon aquarium observations of a few species (see review in Donaldson, 1987). Field studies of reproductive behavior and social organization have appeared recently. These new studies have dealt primarily with members of the genus *Cirrhitichthys*, including *C. oxycephalus* (Thresher, 1984), *C. falco* (Donaldson, 1986a, 1987) and *C. aureus* (Y. Yogo, pers. comm.), and a monotypic species, *Oxycirrhites typus* (Donaldson and Colin, 1989).

All species examined thus far are similar behaviorally and socially in a number of features. They are organized into social groups or harems consisting of a single dominant male and one or more females of various body sizes; in some instances, the harem mating system is replaced by one of facultative monogamy (Donaldson, 1989). Courtship is paired and sequential; it commences just prior to or after sunset and concludes before dusk with pelagic spawning. This information has been derived from studies of a single obligate-coral dwelling species, *Oxycirrhites typus*, and two congeners, *Cirrhitichthys falco* and *C. oxycephalus*. Of these two, the former does not live in close association with corals, and may be classified as a non-coral dwelling hawkfish, while the latter may be either a non-coral dwelling hawkfish or a non-obligate coral dwelling species depending upon geographic locality (Donaldson and Myers, 1988; Donaldson, unpubl. ms.).

This study was undertaken to describe the social organization, mating system and spawning mode of this family of reef fishes, and state the possible influence of microhabitat preferences upon hawkfish reproductive and social behavior. The data reported represent intensive studies of certain species and relatively limited observations of infrequently encountered species or those found in reef habitats which are often hostile to divers. However, these descriptions likely provide a general insight into the organization of reproductive and social systems for all hawkfish species.

### Methods

Between August, 1985 and January, 1988, observations of reproductive behavior and social organization of 10 species of hawkfishes were made at several Pacific Ocean localities, including: the Mariana Islands (Guam, Saipan and Tinian), Japan (Miyake-jima, Izu Islands), Caroline Islands (Ponape, Ant and Pakein), Nauru Island, Solomon Islands (Guadalcanal), Papua New Guinea (Motupore Island and the Papuan Barrier Reef), Great Barrier Reef of Australia (Lizard Island and Yonge Reef), Fiji (Suva, Viti Levu), and the Society Islands (Moorea). Observations were made by SCUBA diving or snorkeling in shallow (1–30 m) depths. Data were recorded on plastic slates and by underwater still photography. Sunset times were determined from meteorological tables. Hawkfish were sexed by behavioral ob-

servations during courtship periods or by gentle extrusion of gametes from fishes collected temporarily prior to sunset (those fishes sexed by the latter method were not observed for reproductive behavior on the same day of capture and release). Fishes were also collected for body size measurement, and, at some localities, tagging, with handnets, monofilament barrier nets and quinaldine-alcohol solution. Measurements (mm TL, to better relate the physical relationships between fishes and corals) were made with calipers; tagging was accomplished by suturing small color-coded glass beads through the dorsal musculature of anesthetized fishes. Fishes were then returned to their original collection sites and released.

### Pacific hawkfishes

The Cirrhitidae includes at least 35–36 species in 9–10 genera. Hawkfishes are distributed worldwide on coral and rocky reefs in tropical and subtropical waters (Randall, 1963; Springer, 1982; Donaldson, 1986b). As many as 26 species in all genera occur in the central and western Pacific. Those species considered here include (approximate number of hours of observation are given in parentheses): *Cirrhitichthys aprinus* (64), *C. falco* (>100), *C. oxycephalus* (>22), *Cirrhitus pinnulatus* (>60), *Neocirrhites armatus* (>125), *Oxycirrhites typus* (>20), *Paracirrhites arcatus* (>110), *P. forsteri* (>100) and *P. hemistictus* (>30). Brief notes on *Amblycirrhites bimacula* (6) are also included. Studies of the reproductive behavior and social organization of *C. oxycephalus*, *C. falco*, and *O. typus* have been published (Thresher, 1984; Donaldson, 1986a, 1987) or described (Donaldson and Colin, 1989), and additional information is included here. Many of these species, with the exception of *C. aprinus*, *C. falco*, and *N. armatus* and, to a lesser extent, *P. hemistictus*, are widely distributed in both the western Pacific and Indian Oceans (Donaldson, 1986b).

### Courtship and spawning motor patterns

Twenty-eight cirrhitid courtship and spawning motor patterns were recognized from descriptions by Thresher (1984), Donaldson (1986a, 1987), Donaldson and Colin (1989) and those included here. Motor patterns were identified as being of

one of the following types: Assessment and Synchronization, Stimulation, and Spawning (Table 1; see also, Figs. 1–3, 5–8). Species repertoires for these patterns appear in Table 2. Analyses of pattern use during courtship and spawning bouts, and temporal patterning of courtship and spawning, will appear elsewhere (Donaldson, in prep.).

### Species accounts

*Cirrhitichthys aprinus*. This species was observed on coral reefs and encrusted shipwrecks in Papua New Guinea and Guadalcanal, and on rocky reefs at Miyake-jima. This species occurred in male-dominated harems consisting of 2–6 individuals. Males defended territories of up to 25 m<sup>2</sup> against neighboring males. Females and juveniles had individual home areas within male territories, and each female had its own courtship site or shared one with a neighboring female.

Social interactions were usually confined to female-female aggressive encounters within harems at shared or bordering courtship sites. Male-female aggressive encounters were rare and limited to a time just prior to the onset of courtship. Males usually did not interact with juveniles except when the latter interfered with the courtship of adults. Male-male interactions were uncommon and depended upon the relative proximity of neighboring territories. For example, on encrusted shipwrecks territorial boundaries tended to rather close, sometimes less than 1.5 m apart, because of the limited amount of habitable space compared with a natural substratum; male-male interactions tended to be more frequent. Males and females usually remained separate during daylight hours, but, as sunset approached, males made multiple brief visits to females by moving from one to the next in succession.

Sexual dimorphism in body sizes (Table 3) was evident, with males having larger body sizes than adult females within harems, but not necessarily between harems. This size difference may be indicative of protogynous hermaphroditism, but not necessarily so (see Sadovy and Shapiro, 1987); this possibility is currently under investigation.

Occasionally, *C. aprinus* harems included congeners or vice versa. Harems occurring on small shipwrecks at Bootless Inlet, Papua New Guinea

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Table 1. Courtship and spawning motor patterns of Pacific Cirrhitidae. References: 1, Thresher (1984); 2, Donaldson (1986a); 3, Donaldson (1987); 4, Donaldson and Colin (1989); 5, this paper.

Pattern	Description	Reference
<b>ASSESSMENT AND SYNCHRONIZATION</b>		
Approach	male approaches female at onset of courtship, stops just in front of her, and faces her	1, 2
Parallel Rest	male and female align parallel to one another	2, 4, 5
Anti-parallel Rest	male and female align parallel to one another but facing opposite directions (see Fig. 6)	3-5
Perpendicular Rest	male aligns perpendicular to female	3, 5
Parallel-swim	male and female swim parallel to one another around courtship site	4, 5
Parallel-hover	male and female hover parallel to one another above substratum	4
Tail Stand	male and female align parallel to one another, vertically, balancing upon substratum with their caudal fins	4
Tilt	male tilts body toward female	5
Head-to-Head	male and female aligned 180 apart, facing each other	5
Tail-to-Tail	male and female align 180 apart, facing away with caudal fins touching	5
Curl	male curls his body so that the flank is exposed to an approaching female	5
Color Change	head of male or female pales upon approach of partner	5
Jump	male or female jump quickly in place upon approach of partner	5
Circling	male and female circle one another, often touching one another's caudal fins with their snouts	2, 4, 5
Lead-and-Follow	Female leads male around courtship site on substratum (see Fig. 7)	3-5
Hopping	male and female swim parallel to one another by hopping along substratum at courtship site	1, 2, 5
Passing	male swims from one side of female at parallel rest, passes in front of the female, and comes to rest at her opposite side	3, 5
Looping	male swims out from parallel rest in a wide loop, up to 3 m away from female, and comes to rest on her opposite side (see Fig. 5)	4, 5
Figure 8	male performs double looping pattern, either clockwise or counter-clockwise relative to the female	5
Chase Male	female chases after passing or retreating male just prior to onset of courtship or during a lapse in courtship, respectively	5
Chase Female	male aggressively chases female around courtship site at onset of courtship	5
<b>STIMULATION</b>		
Nudging	male nudges female's flank or operculum with his snout (see Fig. 1a)	1, 2, 4
Mounting	male positions his body across dorsal fin and upper flank of female (see Fig. 1b)	3, 4
Tail Beating	male beats caudal fin vigorously against water while mounting female	3, 4
Quivering	male quivers his body, usually while nudging or mounting	3, 4
<b>SPAWNING</b>		
Head Up	male and female, in parallel rest, raise their heads upwards towards the vertical and wait, just prior to the spawning ascent (see Fig. 3)	4, 5
Lifting	male and female, in parallel rest and head up, lift their bodies by flexing their pectoral fins	5
Ascent	male and female rise in parallel, the male often pushing his body or snout against the female, into the water column; at the apex of ascent the pair turn downward and release gametes; after gamete release the pair return to the substratum together (see Fig. 2a-e)	1-5

included single *C. falco* or *C. oxycephalus* females in addition to female *C. aprinus*. Female *C. aprinus* were present in harems of *C. falco* at Miyake-jima, and a male *C. aprinus* regularly attempted courtship with a female *C. falco* when conspecific females were absent (Donaldson, 1986a). Interspecific courtship was infrequent at Papua New Guinea however, and encounters between species of different sexes were marked by female-directed aggression by *C. aprinus* males.

Daily courtship has been observed at both Papua New Guinea and Miyake-jima localities. Courtship commenced just prior to or after sunset and concluded at dusk. Courtship was paired and sequential, with males making multiple brief visits to each female at individual courtship

sites (1–11;  $\bar{x}=4.24 \pm 2.78$  SD; n=46 females, 197 total visits). During these visits or bouts, the male approached the female, circled her and came to Parallel Rest, Antiparallel Rest, or Perpendicular Rest. The male then either left the female for another or continued courtship with the same by Circling and Nudging. The female responded with Lead and Follow, and then joined the male in Parallel Swim, Parallel Rest or Perpendicular Rest, followed by Nudging. Gradually, courtship intensified as the number of bouts with each female increased. Males engaged in Passing, Nudging, Mounting, and Tail Beating prior to assuming the Head-up pattern (Fig. 3) from that of Parallel Rest. From this position, the pair rapidly rose 0.25–1.0 m above the sub-

Table 2. Courtship and spawning motor patterns observed in ten species of Pacific hawkfishes. CA, *Cirrhitichthys aprinus*; CF, *C. falco*; CO, *C. oxycephalus*; PF, *Paracirrhites forsteri*; PA, *P. arcatus*; PHP, *P. hemistictus* "polystictus"; CP, *Cirrhites pinnulatus*; OT, *Oxycirrhites typus*; NA, *Neocirrhites armatus*; AB, *Amblycirrhites bimaculata*. n.o.=not observed; %=percent of total species where pattern was observed.

Pattern	CA	CF	CO	PF	PA	PHP	CP	OT	NA	AB	%
Approach	x	x	x	x	x	x	x	x	x	x	100
Parallel Rest		x	x	x	x	x	x	x	x		80
Anti-Parallel Rest	x	x		x	x		x	x	x		70
Perpendicular Rest	x	x		x		x	x		x		60
Parallel Swim	x	x	x	x				x			50
Parallel Hover	x				x			x			30
Tail Stand								x			10
Tilt							x				10
Head-to-Head		x		x							20
Tail-to-Tail	x			x				x			30
Curl	x										10
Color Change				x							10
Jump			x	x	x						30
Circling	x	x	x	x	x		x	x	x	x	90
Lead-and-Follow	x	x	x	x	x	x	x	x	x		90
Hopping		x	x	x							30
Passing	x				x			x			30
Looping				x	x			x			30
Figure 8				x							10
Chase Male	x	x	x								30
Chase Female									x		10
Nudging	x	x	x	x	x			x			60
Mounting	x	x		x	x			x			50
Tail Beating	x	x	x	x				x			50
Quivering		x		x	x			x	x		50
Lifting		x		x	x		x				40
Head Up	x	x	x	x	x	x		x	x		80
Ascent	x	x	x	x	x	n.o.	x	x	n.o.	n.o.	70
Total	16	17	12	21	15	5	9	17	9	2	

stratum (or perpendicularly away from the substratum if it was the deck of a sunken ship), turned, and spawned by releasing a small cloud of visible gametes, which rapidly dispersed. Twenty-three spawns have been observed. After spawning was completed, the pair quickly dashed back to the substratum. Once there, the female quickly moved into shelter; the male, after pausing a few seconds, either moved on to the next female or, if all courtship within the harem was completed, acquired shelter as well.

When spawning did not occur, females chased after departing or passing males, occasionally drove them back toward their individual courtship sites, and resumed courtship. Alternately, females refused courtship from males, despite intense aggressive courtship behavior, if potential predators were near. Similar behavior has been observed in social groups of the congeners *C. falco* and *C. oxycephalus* (pers. obs.). Courtship behavior patterns were similar (Table 2) to those of *C. falco* (Donaldson, 1986a, 1987), although fewer numbers of patterns were used in any given courtship bout. Courtship bouts were shorter in duration but more numerous compared with *C. falco* and *C. oxycephalus* (Donaldson, unpubl. data). Occasionally, a male continued to court the same female after spawning with her before moving on to another female.

Spawning began 24 minutes before to 34 minutes past sunset for first spawns, and ended 11 before to 34 minutes past sunset for the last. Pelagic spawning ascents tended to be both higher and faster than those observed of *C. falco* (pers. obs.).

Predation attempts on courting males by scorpaenids and serranids occasionally occurred as males moved past ambush sites located between female courtship sites or during courtship at those sites. Observed predation attempts were unsuccessful, although courtship was usually interrupted. Males avoided predation attempts by rapidly erecting their dorsal spines, and then quickly withdrawing from the immediate area. Males also moved along different "paths" between courtship sites if predators were near. At Bootless Inlet, Papua New Guinea, female congeners, resident in a male's territory, usually elicited courtship from the male when he passed. Males did not respond to this behavior, although male *C. aprinus* have been observed in courtship with

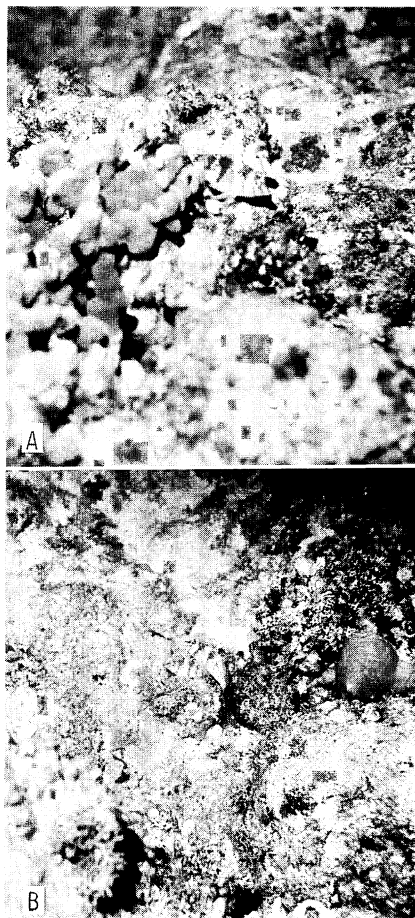


Fig. 1. Nudging (A) and mounting (B) behavior by a male during courtship of *Cirrhitichthys falco* at Tanguisson Reef, Guam, Mariana Islands.

female *C. falco* at Miyake-jima (Donaldson, 1986a). Interspecific spawnings yielded viable offspring; eggs of *C. aprinus* and *C. falco* cross-fertilized in the laboratory resulted in 30% fertility (P.L. Colin, pers. comm.).

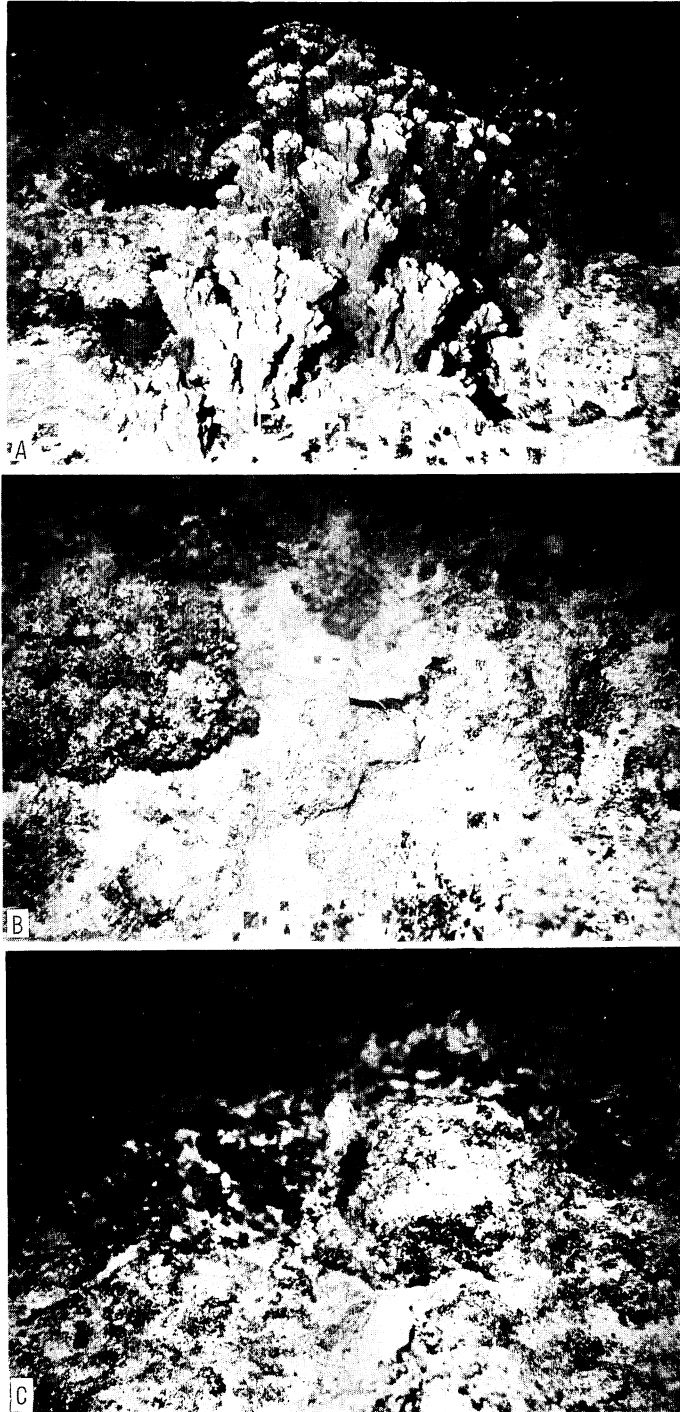
***Cirrhitichthys falco* and *C. oxycephalus*.** Social organization and reproductive behavior of both *C. falco* and *C. oxycephalus* have been described (Thresher, 1984; Donaldson, 1986a, 1987). The former species was observed at Miyake-jima, Guam, Guadalcanal, Papua New Guinea and the Great Barrier Reef. The latter species was observed at Nauru, Guadalcanal, Papua New Guinea and the Great Barrier Reef.

Both species were sexually dimorphic for body size (Table 3), with males being larger within

groups rather than between groups.

*Cirrhitichthys falco* occurred in social groups of 2-8 individuals (Donaldson, 1987). Observa-

tions of *C. oxycephalus* at Nauru and Lizard Island revealed a social organization which differed from that described for this species in the



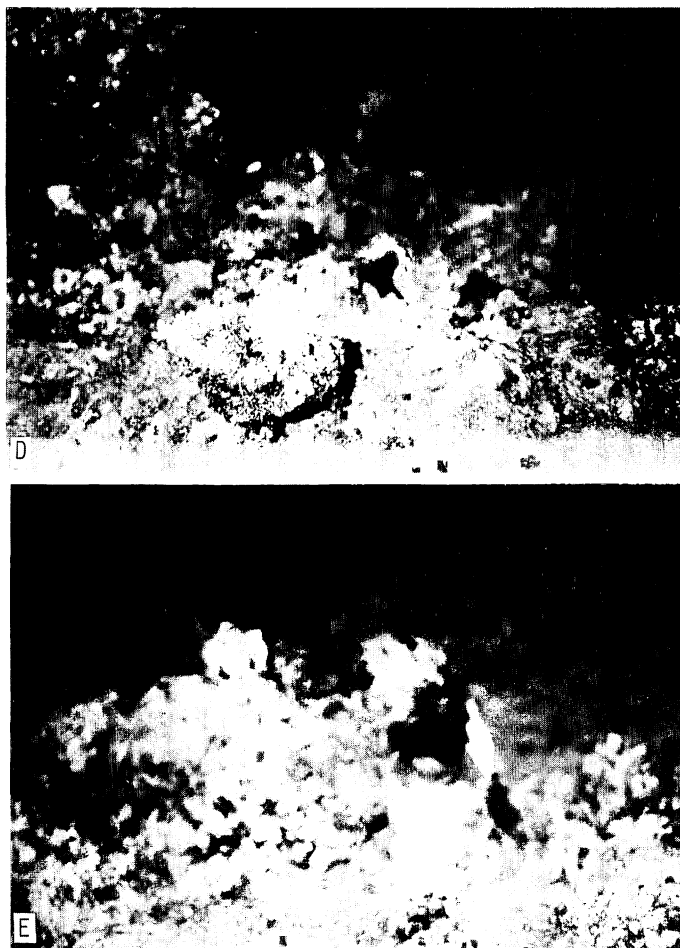


Fig. 2. Spawning ascent in a pair of *Cirrhitichthys falco* at Tanguisson Reef, Guam, Mariana Islands. A, beginning of ascent from the Head-up pattern; B, half-circle above the substratum; C, vertical rise, with the male pushing against the female; D, turn and release of gametes; E, descent towards the substratum.

Gulf of California (Thresher, 1984). At the latter locality, social groups consisted of a male and up to seven females; courtship occurred at one or more corals within the male's territory. At Nauru and Lizard Island social groups consisted of a male and two females; a male and one female shared a single coral while a second female lived in a coral up to 3 m away. During courtship periods, particularly at Lizard Island (Fig. 4), the male first made his way to the second female and courted her before returning to court the first female. Courtship with the second female occurred either at her coral or at a point halfway between the two corals; courtship with the first

female always occurred at her coral. Usually the male completed courtship and spawning with the second female before doing so with the first; occasionally, courtship attempts with the second female were rejected and the male switched back and forth between both females until courtship with either one was completed or he moved into refuge with the first female as darkness fell. In addition, the first female occasionally followed the male out of her coral in apparent attempts to "lure" the male back to her courtship site.

*Paracirrhites forsteri*. This wide-ranging species occurs from the Red Sea to Hawaii (Randall, 1963, 1985). Social groups of this species were



Fig. 3. Head-up behavior prior to a spawning ascent by a pair of *Cirrhitichthys aprinus* at Igaya Bay, Miyake-jima, Izu Islands, Japan. The female's body is hidden by the male's (forefront).

observed at Guam, Saipan, Nauru, Guadalcanal, Papua New Guinea, Great Barrier Reef, Fiji and Moorea; a single adult individual was observed at Miyake-jima and was probably a stray recruit carried north from southern Japan as a larva by the Kuroshio Current. Courtship and spawning were observed at Tanguisson Reef and Pago Bay,

Guam; Aiwo Reef; Nauru; and North Point Reef, Lizard Island. These hawkfishes were sexually dimorphic for body size (Table 3), with males larger than females within harems. Social groups were male-dominated and consisted of a single male and 1-3 females within the male's territory. Males held relatively large territories

Table 3. Mean ( $\pm$ SD) body sizes (mm TL) of male and female hawkfishes (Cirrhitidae). \* Data from Donaldson and Colin (1989). \*\* Data from Donaldson (1989).

Species	Body size		t-value	Significance
	male	female		
<i>Cirrhitichthys aprinus</i>	72.4 $\pm$ 13.5 n=7	50.9 $\pm$ 12.2 n=21	3.93	P<.01
<i>Cirrhitichthys falco</i>	65.7 $\pm$ 9.5 n=18	52.8 $\pm$ 10.1 n=36	14.20	P<.01
<i>Cirrhitichthys oxycephalus</i>	47.8 $\pm$ 2.6 n=9	42.5 $\pm$ 5.3 n=15	2.77	P<.02
<i>Cirrhites pinnulatus</i>	190.7 $\pm$ 25.9 n=14	104.3 $\pm$ 32.7 n=64	31.37	P<.01
<i>Paracirrhites arcatus</i>	64.7 $\pm$ 12.5 n=38	49.6 $\pm$ 11.7 n=57	6.01	P<.01
<i>Paracirrhites forsteri</i>	140.8 $\pm$ 25.6 n=20	98.4 $\pm$ 31.2 n=44	5.30	P<.01
<i>Paracirrhites hemistictus</i> ( <i>polystictus</i> -morph)	207.5 $\pm$ 18.9 n=4	152.5 $\pm$ 32.4 n=8	3.09	P<.02
<i>Oxycirrhites typus</i> *	78.3 $\pm$ 18.2 n=3	61.5 $\pm$ 7.9 n=4	(no test)	
<i>Neocirrhites armatus</i> **	53.8 $\pm$ 15.9 n=51	49.6 $\pm$ 6.4 n=77	2.08	P<.05
<i>Amblycirrhites bimacula</i>	55.0 n=1	48.0 n=1	(no test)	



which included one or more large, prominent coral heads (*Pocillopora eydouxi* or *Acropora palifera*). Males moved between these coral heads, and used them for feeding sites, refuge, and courtship sites with resident females. Large males (<150 mm TL) usually had two or more females; pairs were defined with caution since some males had second females in coral heads up to 15 m away. Juveniles, recognized by their distinctive coloration, were present within male territories but rarely interacted with adults. Juvenile coloration was maintained by unattached individuals to 80 mm TL; adult coloration was assumed when juveniles joined social groups.

Male-male interactions occurred along territorial borders more often compared with most other cirrhitids. Male-female interactions were limited to brief, non-aggressive encounters when individuals entered a coral inhabited by another. Female-female interactions were infrequent and limited to encounters at commonly shared courtship sites at sunset whether the male was present or not. Such interactions were often intense, however. For example, at North Point, Lizard Island, a melanistic female (130 mm TL) frequently interacted aggressively with a larger (145 mm TL) female when the latter approached the coral used as a courtship site by both and as a residence for the former, as well as the male. The larger female often chased the melanistic female off the coral prior to courting with the male. The melanistic female responded by interrupting courtship between the larger female and the male, and then attempted courtship with the male. When this occurred, both the larger female and the male chased the melanistic female from the larger coral head, and then continued courtship while the melanistic female waited on a coral boulder 2.5 m away. After spawning, the larger female immediately returned to her home area, some 15 m away. The male remained in the coral and was joined by the melanistic female. However, by this time it was usually dark and no further courtship attempts were observed. The male always showed a preference for the larger female over the melanistic female. Occasionally, he was observed swimming towards her home area if she had not yet arrived to commence courtship, and even if the melanistic female was present and attempting courtship with the male.

Generally, courtship of *P. forsteri* commenced

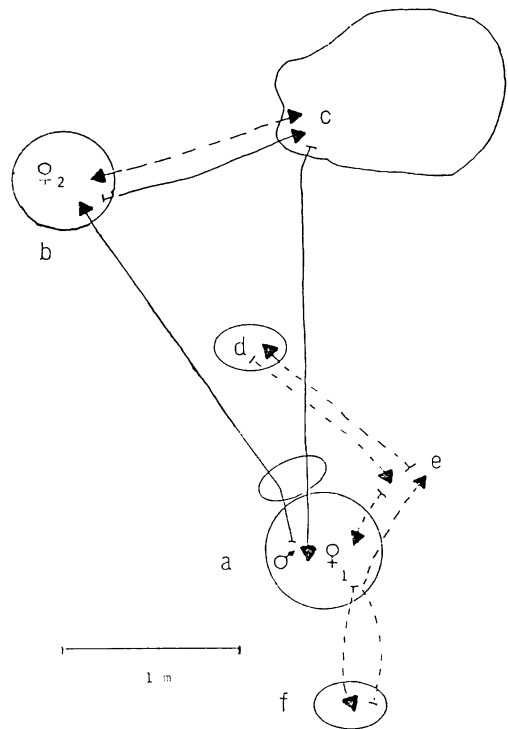


Fig. 4. Spatial pattern and movements of male and female *Cirrhitichthys oxycephalus* prior to and during courtship at North Point Reef, Lizard Island, Great Barrier Reef, Australia. a, *Pocillopora* coral inhabited by the male and female-1; b, *Acropora* coral inhabited by female-2 and visited by the male prior to courtship; c, coral rock which served as a courtship site for the male and female-2; d-f, coral rocks where female-1 waited for the return of the male prior to courtship (after courtship and spawning had been completed with female-2). Solid lines indicate the paths taken by the male; dashed lines indicate the paths taken by both females (summarized from 10 hours of observation).

16 minutes before to 58 minutes after sunset and was not always successful. Courtship consisted of one or more bouts, each 4–800 seconds, with each female. Bouts leading to successful spawning ranged from 152–758 seconds ( $\bar{x}=482.5 \pm 278.2$  SD,  $N=8$ ). Spawning occurred 1–47 minutes past sunset.

Most courtship patterns in *P. forsteri* were also used by other species (Table 2). Patterns that appeared unique to *P. forsteri* included an ex-



Fig. 5. Looping behavior by a pair of *Paracirrhites forsteri* during courtship at Pago Bay, Guam, Mariana Islands. The male is on the left of the coral, the female is on the right.

aggerated form of Looping, and Figure-8 passing. The former (Fig. 5) consisted of swimming in a single loop outside of a coral in which both male and female rested, exiting the coral from the front, relative to the direction in which both fish were facing, and returning from the back. Males executed this pattern from the Parallel Rest position in the presence of the female; females usually executed this pattern immediately after the arrival of the male in her coral head. Figure-8 passing, performed by males only, consisted of two loops, one each on either side of the coral, made so that the male passed directly in front of the resting female before executing the second loop.

Courtship commenced when the male approached the waiting female and settled into her coral head, or when the female arrived in a male's coral. Occasionally, the male's color would pale. Both male and female would then line up parallel to one another, and rest for a few to several seconds. The male and female often shifted position in the coral head, usually by jumping or hopping between the coral branches or on the surface of the coral, before coming to rest parallel, anti-parallel (Fig. 6) or perpendicular to one another. Courtship continued with Looping, Figure-8 passing, or Lead and Follow (Fig. 7), interspersed with periods of rest or waiting. Just prior to spawning, the male and female assumed Parallel Rest, raised themselves into the Head-up pattern, and began Lifting by raising and lowering their bodies, in synchrony, by flexing of the pectoral fins. After a few lifts, the pair executed a spawning ascent and quickly rose 1.5–2.5 m into the water column. At the top of the ascent, both turned, heads down, released a cloud of gametes, and, quickly swam for the coral. Once in the coral,

the pair rested for a few minutes. The male then either left to court additional females or remained with the female and settled between the branches of the coral for the night; in some instances, such as at Lizard Island, the female left the male and returned to her own home area.

*Paracirrhites arcatus*. This species was common at Guam, Saipan, Nauru, the Papuan Barrier Reef off Motupore Island, the outer Great Barrier Reef (Yonge Reef), and Moorea; it was less commonly observed at Guadalcanal. Courtship and spawning was observed only at Guam and Nauru.

Social organization at all localities consisted of male-dominated harems of one or more females, with each female living in a coral and having a home area within the male's territory. The male moved freely between female-occupied corals in this territory and usually shared a coral with one of the females. Favored corals included *Pocillopora eydouxi*, *P. elegans*, or *Stylophora mordax*. Juveniles within the boundaries of a territory were usually found in smaller *P. verrucosa* or *Acropora* spp. corals, which were not utilized by adults.

Aggressive interactions were few and usually limited to border encounters between neighboring males. Males and females were never observed in aggressive interactions with one another. Females rarely ever interacted aggressively with one another, even just prior to or during courtship periods. Generally, each female's coral, her courtship site, was far enough away from the next to avoid interaction. Aggressive interactions did occur when more than one female shared a coral as a shelter or as a site for courtship with the male.

Sexual dimorphism in body size was pronounced (Table 3), with males being larger than females