

Spawning behavior of *Chaetodon multicinctus* (Chaetodontidae); pairs and intruders

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Received 25.3.1988

Accepted 12.8.1988

Key words: Butterflyfish, Fish social behavior, Mating strategy, Hawaii

Synopsis

Spawning by the banded butterflyfish, *Chaetodon multicinctus* (Chaetodontidae) was observed on coral reefs off Kona, Hawaii. These fish occurred in male-female pairs during normal daytime activities, a behavior which is typical for the family. Courtship is also a paired male-female activity. During spawning, however, other individuals (males?) may intrude on the spawning pair. Spawning typically takes place at least a meter or two above the bottom. The spawning position consists of the male below and behind the female with his snout against the female's ventral flank or anal fin area. Intruding individuals may join in when the pair is in position and about to spawn. Intruders line-up against the male in the same position as he is against his female. Underwater photographs are included to illustrate these behaviors.

Introduction

A long-term pair-bond is believed to exist in most species of chaetodontid fishes. The general pattern is that most individuals of many species are found in pairs (Reese 1975). This behavior has been a focus for discussions about the behavioral ecology of chaetodontids (Reese 1975, Neudecker & Lobel 1982, Driscoll & Driscoll 1988).

The spawning behaviors of several *Chaetodon* species, including *C. multicinctus*, have been described with the fishes in a particular spawning posture when positioned to release gametes (Lobel 1978, Susuki et al. 1980, Neudecker & Lobel 1982, Thresher 1984). Although potential spawning intruders have been seen nearby mating pairs in the field (Lobel 1978, Neudecker & Lobel 1982), intruders actually co-spawning with a pair have been seen only in a large aquarium (Susuki et al. 1980). Other aspects of the aquarium fishes behavior appeared normal for wild chaetodontids (Susuki et al.

1980). The question remained as to whether intruder co-spawning was an aquarium artifact or a natural behavior. This is a field report of spawning *Chaetodon multicinctus*, Garret 1863, and the occurrence of 'spawning intruders' in the wild.

Chaetodon multicinctus, is endemic to the Hawaiian Islands and Johnston Atoll (Randall et al. 1985). Reese (1975) classified it as a strongly paired species (see also Driscoll & Driscoll 1988). It is one of the most numerous of the chaetodontids on Kona reefs, feeding mostly on scleractinian corals during the day and inactive at night (Hobson 1974, Tricas 1985). The primary spawning period is during March to July with occasional spawning at other times (Lobel 1989, Tricas & Hiramoto 1989). Recruitment of *C. multicinctus* larvae from the open sea to the reef habitat is greatest during summer months (Walsh 1987).

Materials and methods

Study site and schedule

The dive site was Kamoia reef, situated about mid-way between Kailua-Kona Bay and Keahou Bay, Kona Coast of the Island of Hawaii. The reef ranged in depth from 8 to 20 m. Between September 1980 and October 1982, about 400 scuba dives were done by the author during all times of day and night; 52 of these dives during dusk (1730 to 1915 h).

Fish sex ratio

Collections were taken by spear from an adjacent reef. Specimens were caught prior to dusk throughout the year for gonadosomatic index measurement (see Lobel 1989). This provided some consistency in ovary status, wherein the eggs become hydrated a few hours before mating. Squash mounts of gonads were examined using a light microscope.

Results

Sex ratio

A total of 467 specimens were collected for study of the fish's spawning season (Lobel 1989). The sex ratio of mature fish collected in pairs was 1 : 1 (N = 400); 14% (N = 67) of individuals collected were immature and not sexually identifiable using a light microscope.

Chaetodon multicinctus was found in pairs during the daytime throughout the year. Selected pairs of fish (N = 36 pairs) were carefully watched for about 10 min to determine if the individuals maintained a pair-bond or were just temporarily associated. This was a reasonable observation duration to determine pairing given the behavior of this species (see Reese 1975, Driscoll & Driscoll 1988). The pair was collected after observation. Pairs were observed during November (N = 8), December (N = 5), March (N = 7) and May (N = 18).

Pairs were composed of a male and a female in all cases where sex could be determined (N = 24 pairs). Twelve pairs of *C. multicinctus* possessed sexually immature gonads. The mean size (\pm SD) of sexually mature paired fish was 67.5 ± 4.4 mm SL (N = 48 individuals). The mean size (\pm SD) of the paired immature fish was 50.4 ± 6.7 mm SL (N = 24 individuals).

Courtship and spawning behavior

Mating behavior of *C. multicinctus* was observed in the evening period (1730 to 1915 h) during 7 of a total of 52 dives in the same reef area. Thirteen spawning events were seen on 7 dates (Table 1). Courtship activity was seen once during the months of October, November, December and the first spawning for a year was seen 5 January. The greatest degree of courtship activity and all other spawning occurred from March until mid July.

Courtship activity became apparent about 45 to 30 min before spawning occurred. In the early stages, a pair of fish swam along a track of reef at moderate speed with the female followed closely by the male. The male would periodically rush upon the female, approaching her from behind and placing his snout to her anal fin area. This behavior progressed and later appeared as false starts before actual spawning. If intruding fish were present at this time, they followed several body lengths behind the pair (see photo in Lobel 1978). Courtship usually involved a single male and a female (N = 14), but on five occasions several other *C. multicinctus* were seen closely following a mating pair. On one occasion a group of 8 intruders were seen a few minutes earlier as members of a group of about 20 *C. multicinctus* which was aggregated in one section of the reef. These intrusions took place once in January, twice in March and twice in May. Further description of the courtship and spawning behavior of *C. multicinctus* is in Lobel (1978).

Release of gametes occurs with the fish assuming a stereotyped spawning position. In this position, the fish are a meter or more above the bottom, the male is below and behind the female with his snout against her anal fin area (Fig. 1). Once a pair is in

spawning position, intruders may rush in line. Intruders follow behind the first male and mimic the spawning position of the pair (Fig. 2). A pair was frequently disturbed by the intruders and sometimes broke away. In such cases, the pair swam to a nearby location and were followed by the intruders. Although I cannot be absolutely certain, it appeared in most cases that the intruders released gametes at the same instant the leading pair spawned. At the time of gamete release the fish made a quick sharp body movement and then darted back to the bottom.

Time of spawning

The time of spawning relative to sunset was calculated for spawning events consisting of pairs alone ($N = 7$) and pairs plus intruders ($N = 5$). In all cases, spawning occurred after the time of sunset and before nautical twilight (Table 1). The limited data obtained to date suggests that intruders are more likely to spawn with a pair earlier in the evening. The mean (\pm SD) time of spawning by pairs plus intruders was 24 ± 6 (range 15 to 29) min after sunset. The mean time of spawning of pairs alone was 34 ± 4 (range 29 to 39) min after sunset.

Discussion

The behavior of intruder fish rushing upon a breeding pair and releasing gametes simultaneously is not unusual among fishes. The behavior has been described as 'streaking' among labroid fishes and as 'sneakers' among salmonid and centrarchid fishes. Labroid fishes (Labridae and Scaridae) are broadcast spawning species. Pair spawning occurs between a terminal phase male and a single female and as the spawning pair peaks in its ascent to spawn, initial phase males rush in (i.e., 'streaking') and release sperm at the same instant (Warner et al. 1975, Robertson & Warner 1978, Warner & Robertson 1978, Warner & Hoffman 1980). Pair and group spawning has also been seen among acanthurid species (Robertson 1983). Salmonid and centrarchid freshwater fishes lay eggs in nests on cleared space on the bottom. Intruder or 'sneaker' males rush upon the spawners and release sperm simultaneously with the spawning pair (Keenleyside 1979, Gross 1984). Fertilization stealing has also been described for several other groups of freshwater fishes. The possible evolutionary implications of this spawning strategy have been recently reviewed by Gross (1984).

The pair spawning position described for *C. multicinctus* (Lobel 1978) has since been referenced for its similarity to the pair spawning position in other chaetodontids (Susuki et al. 1980, Neudecker &

Table 1. Dates and times of spawning *Chaetodon multicinctus*.

Date	Pair only	Pair & intruder(s)	Time of spawning	Sunset	Nautical twilight
1. 3 Mar 81	x		1835	1806	1853
2. 10 Apr 81	x		1852	1817	1906
3. 10 Apr 81	x		1855		
4. 10 Apr 81	x		1856		
5. 17 Jul 81	x		not recorded		
6. 5 Jan 82		x + 1	1750	1735	1826
7. 6 Mar 82		x + 2	1828	1807	1854
8. 21 Mar 82		x + 3	1840	1811	1859
9. 5 May 82		x + 8	1850	1825	1915
10. 5 May 82	x		1853		
11. 5 May 82		x + 2	1853		
12. 5 May 82	x		1859		
13. 5 May 82	x		1900		

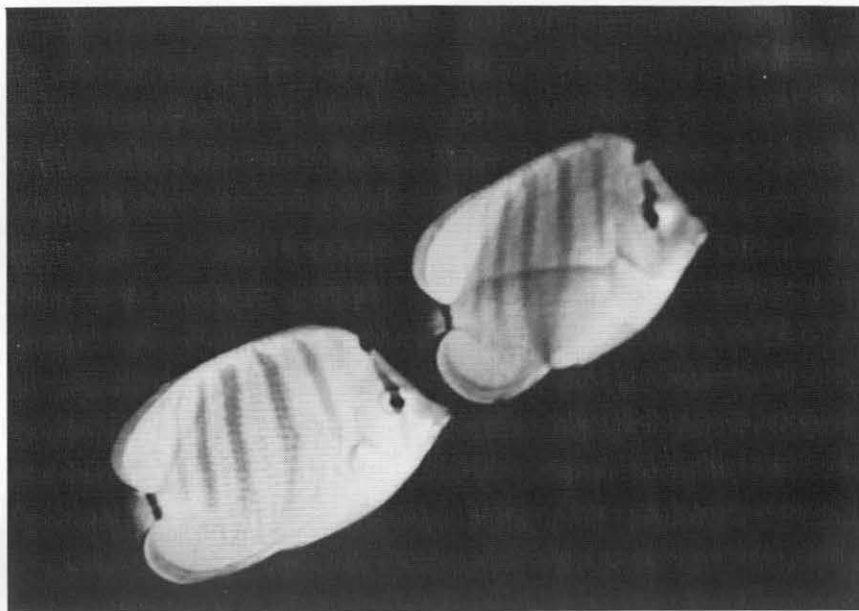


Fig. 1. A spawning pair of *Chaetodon multicinctus*, a moment before gamete release (1835 h, 3 March 1981). The male approaches the female from below and places his snout against her anal fin area immediately prior to spawning. Notice the swollen belly of the female bearing eggs.

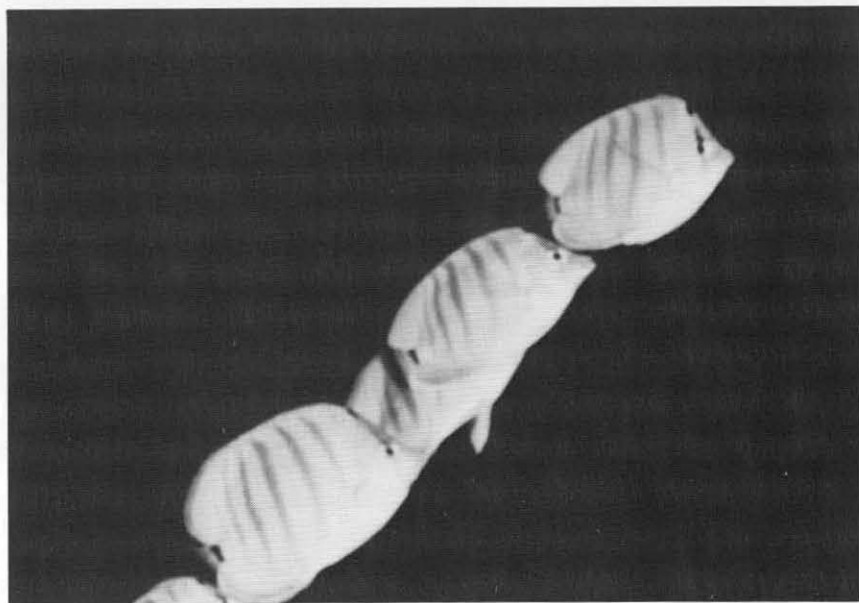


Fig. 2. A spawning pair of *Chaetodon multicinctus* accompanied by 3 intruders (1840 h, 21 March 1982). The intruders rushed into line behind the primary male at the time when the original pair were about to spawn.

Lobel 1982, Thresher 1984). The exception to the pair spawning behavior was seen among *C. nippon* in an aquarium by Susuki et al. (1980). They described co-spawning by intruding males. These males joined a pair about to spawn. The intruder males released sperm simultaneously when the leading pair spawned (Susuki et al. 1980). The same intruder behavior has now been observed among *C. multinctus* in the field (this study). The intruder fish I saw were also possibly males; females would have been noticeably swollen with eggs and females have not been observed assuming a male's position during courtship. The limited observations reported herein indicate that intruder co-spawning was more common earlier than later during the dusk period.

These observations suggest an added complexity to the social relationships of chaetodontids on coral reefs. The question is, are these spawning intruders unattached marauding males or are they males who have temporarily abandoned their mates? At this point, both possibilities are plausible. First, every individual *C. multinctus* on a reef is not necessarily associated in a pair; $83 \pm 10\%$ of individuals on a reef were confirmed in pair association leaving about 17% unattended (Reese 1975). Second, sexual selection theory can argue for mate desertion after spawning planktonic offspring (Trivers 1972). So far, female chaetodontids have been observed to spawn only once per evening (Lobel 1978, Susuki et al. 1980, Neudecker & Lobel 1982, Thresher 1984). It may be that male chaetodontids could benefit by temporarily deserting their female mates after spawning to seek additional matings. One constraint on this behavior is the temporal synchronization of spawning throughout a local population. There is a narrow time window which closes shortly after sunset during which a male is required to court and mate his partner, desert her and then locate and co-spawn with another pair. This time constraint may be one factor favoring pair-bonding among fish with spawning restricted to the dusk crepuscular period (Neudecker & Lobel 1982).

Acknowledgements

This research was supported by the NSF (OCE-8009554 and OCE-8117891) while the author was a postdoctoral fellow in Oceanography, Center for Earth and Planetary Physics, Harvard University. Further support provided by grants from the U.S. Department of Energy's program for O.T.E.C. (DE-A503-83CE89302), administered by the Marine Science Group, University of California at Berkeley, the U.S. Army (DACA83-83-C0049) and Sea Grant (NA86AA-D-SG090 WHOI No. R/A-26-PD). Contribution No. 6774 from the Woods Hole Oceanographic Institution.

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