

## Reproductive Behavior of the Wrasse, *Cheilinus bimaculatus* at Makurazaki in Kagoshima, Japan

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**Reproductive behavior of wrasse, *Cheilinus bimaculatus*, was studied in a shallow waters at Makurazaki in Kagoshima, southern Japan. Mating system of *C. bimaculatus* was harem. Males established mating territory around the prominent rocks or a thicket of soft corals. Within the territory, there were two or three females. And pair-spawned with a female between 15:00 h~15:30. One spawning was performed within six seconds. The streaking, sneaking and group spawning were not observed in our observation.**

**Key words : *Cheilinus bimaculatus*, reproductive behavior, harem, pair-spawning**

### Introduction

The wrasse (Labridae) is a remarkably large and diverse group of tropical and temperate marine fishes distributed on coral, rocky reefs and sand flats throughout the world. Currently, 57 genera and approximately 500 species are recognized (Nelson, 1994). In the last thirty years, the reproductive ecology of many labrid fishes has been clarified by underwater observation using SCUBA (Thresher, 1984; Yogo, 1987).

The structure of social and mating systems of many labrids can be broadly distinguished between lek-like and harem. In lek-like species, males occupy temporarily territorial sites only during the spawning period, and mate with females which come to the sites to spawn. In harem species, males are permanently territorial and mate almost exclusively with females included within their territories. Generally, two types of spawning behaviors can be distinguished. One is pair spawning, in which a single male mating with a single female at a time, and the other is group spawning, in which a number of males fertilize the eggs of one female.

The small labrid fish, *Cheilinus bimaculatus* Valenciennes was chosen for our study. This species has rounded caudal fin when young, but some of fin rays become filamentous in adults. This species is the smallest member of the genus *Cheilinus*, and is found further north than others. A maximum total length reaches 15 cm (Masuda, Araga and Yoshino, 1975). We observed the reproductive behavior of *C. bimaculatus* in a shallow waters at Makurazaki in Kagoshima, Japan. Its mating system and mating behavior were described. The present study also aimed to clarify time-series reproductive behavior in detail by using underwater video camera, because reproductive behavior expressed sequentially in exact time had seldom attempted. We consider that sequential analysis is important for understanding the reproductive behavior of pelagic egg spawners.

### Methods

Our observation was made at the two points at Makurazaki in Kagoshima, called Urajiri and Bohnotsu (Fig. 1). The station at Urajiri was 12 to 15 m deep, and the substrate at the spawning

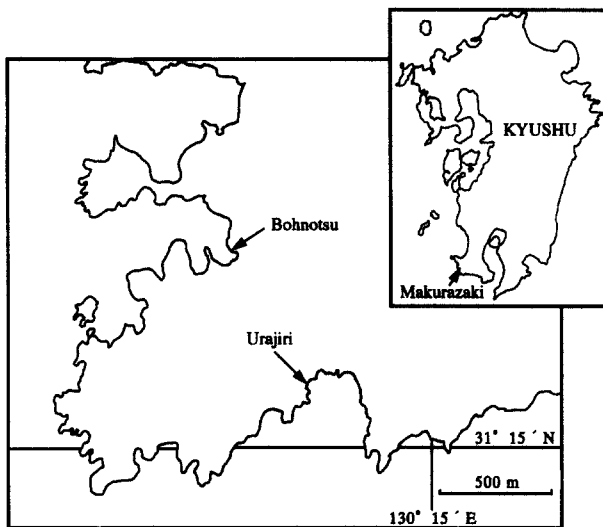


Fig. 1. Map of study site (Bohnotsu and Urajiri) at Makurazaki in Kagoshima, Japan.

site consisted of rocks and boulders about 10 to 15 m offshore. The station at Bohnotsu was 3 to 4 m deep, and the substrate at the spawning site consisted of rocks, corals and sand about 15 to 20 m offshore. At Urajiri, two harems and at Bohnotsu, one harem were monitored. Sampling and observations were made using SCUBA.

Observation were made between July and August in 1997. During the observation period, each territorial male was observed continuously from 14:00 h to 16:00 h. Reproductive behavior was observed and recorded by underwater video camera. The sequence of reproductive behavior was analyzed by slow-motion of video cassette recorder (30 frame/sec), frame by frame.

## Results

### Male mating territories and mating system

The male of *Cheilinus bimaculatus* established mating territories around prominent rocks (3~4 m in diameter, 1.5~2.5 m high) or a thicket of soft corals (*Goniopora planulata*, etc.).

The circumference of male territory was about 10~15 m. Within the territory, there were two or three females.

The territorial male patrolled slowly about 0.5~1 m above the rocks or thickets of soft corals, in wide irregular circles before spawning. The intruding males from outside were not observed.

The females in the territory of the male had

small territories around a thicket of soft corals or small rocks. The circumference of female territory was about 1 m.

From the above results, it was shown that the mating system of *C. bimaculatus* was harem.

### Spawning acts

Females often swam along crevices or in the thicket of soft corals. About 15:00 h, the patrolling male, being or becoming aware of female, circled above the female clockwise or counter-clockwise. While the female looked upward and swam slowly under the male (Fig. 2A). After the male descended to the female, both fish ascended slowly in a spiral movement but both fish were still apart some distance (Fig. 2B). At the end of the spiral movement, both fish came close each other with their body bent. Both fish, the female below the male, swam upward and straight forward (Fig. 2C). They may touch each other momentarily, but usually the female was a little ahead of the male. Finally the male caught up the female which started to move in a more vertical direction very quickly (Fig. 2D). After this, both fish separated and swam rapidly downwards in different directions - the female usually more quickly. A tiny cloud of sex products (egg and sperm) marked the place where the fish released their gametes.

In the present study, the spawning behavior of *C. bimaculatus* were observed seven times and three times of that were recorded with UW video

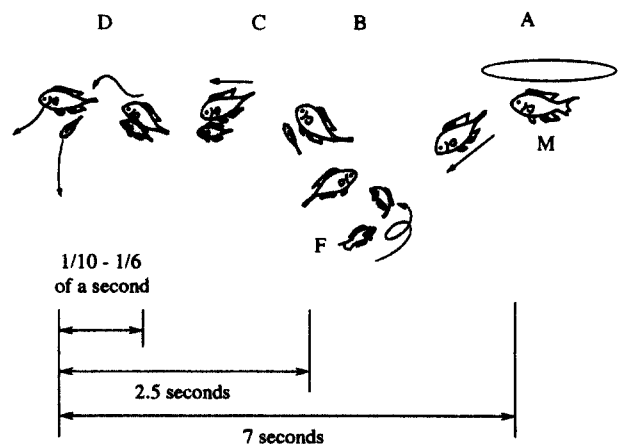


Fig. 2. Schematic representation of pair spawning of *Cheilinus bimaculatus* with spending time. Reproduced by under water video recording. (M: male, F: female, A, B, C, D: see the text)

camera. According to an analysis of video camera records, in the whole process of spawning, male descending to their releasing gametes were performed within seven seconds. Coming close each other to releasing gametes were performed within 2.5 seconds. Moving in more vertical direction and releasing gametes were completed for hardly more than 1/6 to 1/10 of a second (Fig. 2). This means gametes of the pair are released within a very short period of time and not recorded observation also showed basically the same sequence of behavior and duration of each behavioral pattern. Sneaking, streaking and group spawning were not observed.

### Discussion

Colin and Bell (1991) reported the spawning behavior of *C. bimaculatus* at Enewetak Atoll. This species at Enewetak Atoll was common in the *Halimeda* meadows at 20 m depth, but was seldom seen elsewhere. At Makurazaki, *C. bimaculatus* was seen on the beds of soft corals. During the observation periods, this species was frequently seen in or under the thicket of soft corals, especially around the thicket of *Goniopora planulata*. The shape of *G. planulata* is similar to algae. *C. bimaculatus* may use algal beds or thickets of soft corals as hiding places.

Territory size of *C. bimaculatus* were estimated as about 15 m × 6 m and 15 m × 7 m (90 ~ 105 m<sup>2</sup>) at Enewetak Atoll (Colin and Bell, 1991). At Makurazaki, territory size of *C. bimaculatus* was smaller than that of at Enewetak Atoll. The circumference of male territory at Makurazaki was 10 ~ 15 m (8 ~ 12 m<sup>2</sup>). Geographical variation in the mating system has been documented in *Halichoeres maculipinna* (Thresher, 1979; Robertson, 1981). Territorial sizes and sites may vary geographically between different areas.

The present study indicated that the mating system of *C. bimaculatus* was harem. The mating system of *C. bimaculatus* at Enewetak Atoll (11° 40' N) was also harem (Colin and Bell, 1991). In general, when females live in areas from which eggs can be rapidly carried off the reef, females apt to spawn with the territorial male in whose territory they live. In locations offering an abundant suitable spawning site, a harem mating system can be established. The present study site, abundant spawning sites must have existed because the low density of *C.*

*bimaculatus* and the flow of a current.

According to an analysis of video camera recording, the spawning acts were accomplished quickly. Especially, gametes were released in a very short period of time (1/6 ~ 1/10 of a second). For higher fertilization rate, synchronization of releasing of eggs and sperms is very important. And to spawn within a very short period of time enables sperms and eggs to be packed in a small volume of water. Packing of sperms and eggs can attain higher possibility of fertilization. In spawning of *Thalassoma bifasciatum*, a few or no eggs were collected outside the spawned region or one minute after spawning (Reinboth, 1973). It is supposed that a ceremony of spawning is necessary for synchronization and a rapid releasing of gametes can promote fertilization.

Eggs and mating fish are vulnerable to predation. Egg predation by five species of pomacentrid fishes were described by Moyer (1975) and Nakazono (1979). And conspicuous sexual displays of these species probably attracted an attention of predators. But to avoid danger of predation, fishes would rather not perform spawning acts or would spawn in dark evening. Though *Parapercis snyderi* (Nakazono, Nakatani and Tsukahara, 1985), *Franzia squamipinnis* (Yogo, 1985), *Novaculichthys taeniourus*, *Pseudocheilinus hexataenia* (Colin and Bell, 1991) spawned at dusk, almost of labrids spawned while surrounding sea water is lighter (Colin and Bell, 1991; Nakazono, 1979; Yogo, 1985). The reason why labrids spawn at an earlier time than above species is not known. Though the ceremony is dangerous, it may be important for synchronization to release gametes.

Colonially nesting males of the longer sunfish, *Lepomis megalotis megalotis*, are often cuckooed by neighbors, but solitarily nesting males are not (Jennings and Philipp, 1992). In the three-spine stickleback, *Gasterosteus aculeatus*, sneaking occurs more frequently when inter-nest distance is shorter (Goldschmidt *et al.*, 1992). In *C. bimaculatus*, a large territorial male was monopolizing two to three females. Sneaking, streaking and group spawning by initial phase male and non-territorial terminal phase male are common among labrid fishes (Warner *et al.*, 1975; Warner and Robertson, 1978; Nakazono, 1979; Hoffman *et al.*, 1985). But in the present study, sneaking, streaking and group spawning were not observed.

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Received February 24, 1999

Accepted March 19, 1999

## 日本 鹿兒島の 枕崎産 늘래기과 어류 *Cheilinus bimaculatus*의 산란 행동

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늘래기과 어류 *Cheilinus bimaculatus*의 산란 행동을 조사하기 위해 1997년 7월과 8월 두 달에 걸쳐 日本 鹿兒島の 枕崎에서 수중 관찰 및 video 촬영을 하였다. *C. bimaculatus*의 mating system은 harem적이었다. 본 종의 수컷은 수중의 커다란 바위 또는 연산호의 덩불을 중심으로 짝짓기를 위한 세력권을 형성하였고 자신의 세력권 내에 2~3마리의 암컷을 거느렸다. 암컷은 수컷의 세력권 안에서 작은 바위 또는 연산호의 덩불을 중심으로 작은 세력권을 형성하였다. 오후 3시부터 3시 30분 사이에 수컷은 자기 세력권 내의 암컷과 차례차례 산란하였다. 방란, 방정을 하기 전에 특유의 산란 행동을 하였다. 본 연구에서 streaking, sneaking 및 group spawning은 관찰되지 않았다.