

Interspecific Spawning of the Pygmy Angelfishes *Centropyge shepardi* and *Centropyge bispinosus* at Guam¹

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Abstract—Interspecific spawning involving a male *Centropyge shepardi* and a female *C. bispinosus* was observed at Guam, where *C. bispinosus* is rare and *C. shepardi* is ubiquitous. The female *C. bispinosus* was a member of a harem that included a male and a female of *C. shepardi*. It has been noted by various authors that hybridization may occur in situations where one species is rare and a closely related species is common. In this paper it is hypothesized that interspecific spawnings usually involve females of the rare species and males of the common species, resulting from constraints imposed by energy expenditure in the production of eggs versus sperm. Females will engage in interspecific spawnings only when conspecific mates are unavailable. Males are less discriminating in their choice of mates.

Introduction

Hybridization in angelfishes (Pomacanthidae) and in the related butterflyfishes (Chaetodontidae) has occasionally been reported (Feddern, 1968; Moe, 1976; Randall et al., 1977; Steene, 1977; Allen, 1979; Myers and Shepard, 1981). All of these authors have discussed hybrids observed in their natural habitat or reared in aquaria, and some have speculated about the conditions under which hybridization might occur in nature (e.g., Randall, et al., 1977; Allen, 1979). To my knowledge, no material is available on interspecific spawnings in nature or social interactions that might make such spawnings and subsequent hybridization possible.

In April, 1981, during a study of pygmy angelfishes at Tanguisson, Guam, I discovered a harem that consisted of two *Centropyge shepardi* Randall and Yasuda and a single *C. bispinosus* (Günther). Observations on the interactions within this harem, including courtship behavior and spawning, are reported below. The harem social structure of *C. shepardi* was first noted by Moyer and Nakazono (1978) as *Centropyge* sp., and later substantiated by Randall and Yasuda (1979).

Methods

Four observations of 40 min each were made using scuba. A dive in midmorning and another in midafternoon gave limited data on territory size and foraging

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A



B



C



behavior. Two sunset dives were for the purpose of observing spawning. Photographs were taken by the author with a Nikonos III camera.

Results

Centropyge shepardi was abundant on the reef slope at the study site at depths below 20 m, where it replaced *C. flavissimus* (Cuvier), the most common pygmy angelfish on the reef flat at that location. The two species cooccurred between 20–24 m. By contrast, *C. bispinosus* is extremely rare at Guam (Randall and Yasuda, 1979). With John Eads, I collected a single specimen at a depth of 45 m at the study site in 1978 (see Randall and Yasuda, 1979), and we had observed another there in 1977.

Of four harems of *C. shepardi* under observation in my 1981 study, the harem with the *C. bispinosus* had the fewest females and was located in the shallowest water (20 m). The harem consisted of a relatively small male *C. shepardi* of about 75 mm T.L., a slightly smaller female *C. shepardi*, and a female *C. bispinosus* approximately 70 mm in T.L. Both the male and female *C. shepardi* aggressively attacked and chased the female *C. bispinosus* whenever they observed her, both in midday and as the spawning time approached. During daylight hours, the *C. bispinosus* eluded her pursuers and took shelter, always within the small 4 m × 3 m territory of the male *C. shepardi*. However, the *C. bispinosus* did not attempt to leave the territory of the male even when being aggressively attacked. By contrast, interactions between the male and female *C. shepardi* were rare during midday, with typical *Centropyge* rushing and circling of the female by the male beginning in late afternoon (see Moyer and Nakazono, 1978, for this and the following action patterns related to spawning).

As sunset approached, the female *C. bispinosus* avoided attacks by the male and female *C. shepardi*, but took shelter only when the female attacked. After dodging the male's chases, she frequently moved up into the water column about 10–20 cm, fins outstretched in the manner of females of *C. interruptus* during "mutual soaring." Occasionally the male moved under her in the "nuzzling" position. They spawned at 18:20 h, 14 min before sunset, 12 Apr. 1981. Although the male regularly courted the female *C. shepardi* with a typical "soaring" display, he never initiated courtship with the female *C. bispinosus*. The female *C. shepardi* interrupted three potential interspecific spawnings by attacking the *C. bispinosus* during "nuzzling." *C. bispinosus* did not interfere with the female *C. shepardi* during "nuzzling" nor at any other time.

Fig. 1A. Male *Centropyge shepardi* (above) and female *C. bispinosus*, members of the same harem at Tanguisson, Guam.

B. Male *C. shepardi* moves under female *C. bispinosus* to take prespawning "nuzzling" position.

C. Male *C. shepardi* (below) and conspecific female in prespawning "nuzzling" position. Note temporary prespawning pink coloration around vent of female, and her egg-swollen abdomen.

Discussion

Hubbs (1961), Reese (1975), Meyer (1977), Randall, et al. (1977) and others have shown the relationship between hybridization and scarcity of mates. When a particular species is scarce at a given location, it seems that failure to find a conspecific mate leads to interspecific breeding with the opposite sex of a closely related species. My observations suggest that such interspecific breedings probably most often consist of a female of the rare species and a male of the common species. The opposite probably rarely, if ever, occurs. With my colleague, Dr. A. Nakazono, I repeatedly observed a male of the labrid fish *Thalassoma lunare* (Linnaeus) attempting to spawn with females of *T. cupido* (Temminck and Schlegel) at Miyake-jima, Japan, where *T. cupido* is ubiquitous and *T. lunare* is rare. Motor patterns associated with spawning are very similar between species of *Thalassoma* (Meyer, 1977). Yet, although females showed a passive interest in the "fluttering" display of the male *T. lunare*, often rising 5–10 cm above the substrate under him, no spawnings were observed over a three-day period. However, frequent pair spawnings have been observed at Miyake-jima involving females of *T. lunare* (the rare species) and males of *T. cupido* (the common species) (Meyer, 1977; personal observations).

Like *Thalassoma*, members of the genus *Centropyge* exhibit similar action patterns during courtship (Aldenhoven and Moyer, in prep.). Close phylogenetic relationships make hybridization probable. Yet, my observations of *C. shepardi*/*C. bispinosus* demonstrate that, unlike normal behavior between conspecifics, the "intruding" female of the scarce species initiates spawning and is resisted to a certain degree by the male. Why the male eventually accepts the "intruder," but females in similar situations probably rarely do, can be explained by a cost/benefit analysis of energy expenditure in production of eggs vs. sperm (see Trivers, 1972). Males, with a comparatively low energy investment in zygote production and the ability to spawn repeatedly every day, suffer no serious decrease in reproductive fitness from occasional interspecific spawnings. However, females, being able to spawn far less frequently, avoid malfunctions by being more discriminating in choice of mates.

Among labrids and scarids, where roving nonterritorial males commonly attempt to steal spawnings from territorial males (Warner, et al., 1975), it may sometimes be possible for a male of the scarce species to fertilize eggs of a female of the common species. L. Bell (personal communication) reported seeing a male of the labrid *Cirrhilabrus cyanopleura* (Bleeker) rush in to release gametes simultaneously with a spawning pair of *C. temminckii* Bleeker at Miyake-jima, where *C. temminckii* is common and *C. cyanopleura* is scarce. In this case, the male *C. temminckii* initiated spawning with a lengthy courtship display, and the "intruding" male *C. cyanopleura* merely dashed in to join in the spawning rush. Stolen spawnings seem unlikely in the rigidly-structured, harem system of pygmy angelfishes, and hybrids in this genus probably result mainly from situations such as that described for *Centropyge bispinosus* and *C. shepardi*. Indeed, a female *C. bispinosus* was part of a harem that included a male and two females of *C. tibicen* (Cuvier) that I frequently observed



Fig. 2. Females of *Centropyge tibicen* and *C. bispinosus* (arrow), members of the same harem at Miyake-jima, Japan, where *C. bispinosus* is rare.

during my study of the latter species at Miyake-jima in 1978–1979 (Fig. 2). No attempts were made to observe spawning at this harem. Similarly, P. Colin (pers. comm.) reported a single *C. bicolor* in a harem of *C. heraldi* at Enewetak.

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References Cited

- Allen, G. R. 1979. *Butterfly and Angelfishes of the World*. Vol. 2. Wiley-Interscience, New York. 352 p.
- Feddern, H. A. 1968. Hybridization between the western Atlantic angelfishes, *Holacanthus isabelita* and *H. ciliaris*. *Bull. Mar. Sci.* 18: 351–382.
- Hubbs, C. L. 1961. Isolating mechanisms in the speciation of fishes. *Univ. Texas Symp. Vertebrate Speciation*: 5–23.
- Meyer, K. A. 1977. Reproductive behavior and patterns of sexuality in the Japanese labrid fish *Thalassoma cupido*. *Japan. J. Ichthyol.* 24(2): 101–112.

- Moyer, J. T., and A. Nakazono. 1978. Population structure, reproductive behavior, and protogynous hermaphroditism in the angelfish *Centropyge interruptus* at Miyake-jima, Japan. *Japan. J. Ichthyol.* 25(1): 25-39.
- Moe, M. A., Jr. 1976. Rearing Atlantic angelfish. *Marine Aquarist (U.S.)*, 7(7): 17-26.
- Myers, R. F., and J. W. Shepard. 1981. New records of fishes from Guam with notes on the ichthyofauna of the southern Marianas. *Micronesica* 16(2): 305-347.
- Randall, J. E., and F. Yasuda. 1979. *Centropyge shepardi*, a new angelfish from the Mariana and Ogasawara Islands. *Japan. J. Ichthyol.* 26(1): 55-61.
- Randall, J. E., G. R. Allen, and R. C. Steene. 1977. Five probable hybrid butterflyfishes of the genus *Chaetodon* from the central and western Pacific. *Rec. West. Aust. Mus.* 6(1): 3-26.
- Reese, E. S. 1975. A comparative field study of the social behavior and related ecology of reef fishes of the family Chaetodontidae. *Z. Tierpsychol.* 37: 37-61.
- Steene, R. C. 1977. *Butterfly and Angelfishes of the World*. Vol. 1. Wiley-Interscience, New York. 144 p.
- Trivers, R. L. 1972. Parental investment and sexual selection. p. 136-179. *In* B. Campbell (ed.), *Sexual Selection and the Descent of Man, 1871-1971*. Chicago, Aldine-Atherton. x+378 p.
- Warner, R. R., D. R. Robertson, and E. G. Leigh. 1975. Sex change and sexual selection. *Science* 190: 633-638.