Paternal care has been observed in most species of polygynous gobies; that is, males that care for the eggs spawned by their mates, and *Bathygobius fuscus* is no exception. In teleosts, it is known that during paternal care guardian males may feed on their own broods (filial cannibalism). The present investigation gives new evidence on the egg consumption behavior of *B. fuscus* maternal parents.

*Bathygobius fuscus* breeds during the months June to September on the coast of Kyushu, south Japan. Parental care behavior involves the males occupying nests in tide pools, guarding and aerating the brood by fanning.

The present investigation was carried out using a series of observations, throughout which artificial nests were used. The body of each nest was composed of a concrete block penetrated by a hole into which a polyvinyl chloride (PVC) cylindrical tube (56 mm internal diameter, 100 mm length) was inserted. The PVC tube was closed at one end by a removable cap made of PVC board, which had a central opening measuring 20 mm in diameter so that the fish could be accessed freely. The cap was sealed at the other end by a fixed board of PVC. The tube’s inside was lined with a transparent plastic sheet. Close observations of the laid eggs was facilitated by opening the cap and removing the plastic sheet. Preliminary observations indicated that the artificial nest was readily used by *B. fuscus* in its habitat.

Field observations were conducted during the months of July and August 1999, when four artificial nests were placed in a tide pool (water volume 1300 L, maximum depth 250 mm) on the rocky shore of Nobeoka Bay, Miyazaki prefecture. Three types of observations were conducted.

In the first type of observation, the brood size (number of eggs in the nest) for each brood cycle was monitored. The configuration of the area occupied by the eggs deposited on the nest's lining sheet was traced once a day onto another plastic transparent sheet. The total number of eggs laid in each tube was estimated from the number of eggs per square centimeter. Close observation enabled us to distinguish freshly deposited eggs from those already recognized because the developmental stage of eggs changed visibly each day. In addition, individual males which occupied the nests were marked by the injection of a suspension of blue pigment under the skin.

The second and third types of observations were aimed at analysing the mechanism responsible for the disappearance of eggs from the nest, a phenomenon that was recognized during the first type of observation (discussed later).

In the second type of observation, the nest was monitored once a day and all individuals present in the nests were collected and fixed in 10% formalin for alimentary canal content analysis. Although only two males were tested, a third type of observation was conducted. In this observation, the brood size was monitored for two days from when the eggs were originally deposited. Thereafter, the guarding males were captured, and the alimentary canal contents were examined.

Figure 1 shows that in the first type of observation (*N* = 7) the number of eggs in the nests in the brood cycle (●) was 72,467 ± 16,510 (mean ± SD) and that egg loss from the nests (▲, ■) occurred each day. On the first day's observation after initial egg laying, additional deposition of eggs occurred in five of seven cases. On the second and third days, additional egg deposition occurred in one of seven cases.
The number of eggs that disappeared, particularly in cases in which the nests received additional egg deposits (Fig. 1; ▲), was markedly more than in non-additional cases (Fig. 1; ■). Egg disappearance did not arise from hatching because observations were terminated before initial hatching occurred. On the fourth day, hatching was found to occur in six of seven cases. During the brood cycle, the guardian males were observed not to desert their nests or to be driven out of their nests by other individuals.

In the second type of observation, nest composition was as follows: (i) a male and eggs existed in the nest; (N=9); (ii) a male, a female and eggs (N=11); and (iii) a male and no eggs (N=7). In the first and second cases, 18 of the 20 males and 10 of the 11 females were found to have preyed on eggs. The number of eggs consumed by males ranged between one and 646, and ranged between three and 339 for females. In the third case, one of the seven males was found to have consumed four eggs. In all the cases analysed, all the eggs in the alimentary canal were at the early developmental stages; that is, the cleavage, the blastula or the gastrula stage. These developmental stages were reached within 24 h, which was the maximum period that the nest was used, as observed in the present study.3

Not including eggs, the alimentary canal contents consisted mainly of isopods, amphipods, crustacean decapods, gastropods, polychaetes, and scales. Scales were similar to those of adult B. fuscus in shape and size. The alimentary canals of all males from the first and second cases and six of the seven males from the third case contained scales. In six of 11 females, scales were also found in the alimentary canal. Males from the first case were found to have preyed on 1.67±0.71 species (mean ± SD) of food organisms (eggs excepted), on 1.82±0.87 species in the second case, and on 3.14±1.07 species in the third case. Females preyed on 1.36±0.92 species of food organisms.

For the third type of observation, egg losses from the nests occurred each day (Fig. 2; ···), and both of the two males studied were found to have consumed eggs at the developing stage; that is, embryos had pigmented eyes and had chromatophores present in the caudal regions. Other eggs at the same developmental stage were present in their respective nests.

These results indicate that the daily disappearance of eggs from the nests (Fig. 1; ■) is due to consumption by the guarding males and that the considerable egg losses (Fig. 1; ▲) that occurred when the nests received additional eggs results from consumption by the guardian males and females.

Filial egg cannibalism is a common phenomenon in fishes with paternal care.2,4–8 It has been proposed that one of the benefits of partial clutch cannibalism is that the guardian male is able to sustain himself by eating some of his eggs in order to fulfill the continuous task of rearing the remaining eggs because the foraging opportunities of the male are restricted by the need to remain near the eggs.2,5,6

Data on the alimentary canal contents of B. fuscus support this hypothesis.2,5,6 The number of species of food organisms consumed by males which had eggs in their nests (the first and second cases in the second type of observation) was less than that of males which had no eggs (the third case). As well as by consuming eggs, the consump-
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tion of scales as food may not require the B. fuscus guardian male to make foraging trips, as all males with eggs in their nests had preyed on the scales. Further research is needed to elucidate the reason and the motive for egg consumption by females of male brooding fish species. In many fish species with paternal care of eggs, females are reported to prefer to deposit their eggs with a male which already has eggs.\(^2,6,9,10\) At least four reasons for such a preference have been proposed: (i) reduced risk per egg of predation or cannibalism with increasing brood size;\(^2,7\) (ii) increased paternal care with larger broods;\(^11,12\) (iii) increased chance of choosing a male with good parental qualities;\(^1\) and (iv) increased chance of choosing a male which has been attractive to other females.\(^1\) In fish species with this preference by females, females must come into contact with eggs that have already been deposited, with the exception of those females which lay their eggs in empty nests. However, some studies, have not mentioned the consumption of eggs by females,\(^1,2,6,7,9–12\) which was observed in the present study. Whether or not egg consumption by females is a characteristic unique to B. fuscus among male brooding fish species is unknown and studies of female behavior in other male brooding species is needed.

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