

to be found in large colonies of highly eusocial species<sup>11–13</sup>. According to our hypothesis, *R. marginata* is unusual in that the transition from physical inhibition to chemical regulation occurs in the same species. It follows therefore that *R. marginata* is an attractive model system to investigate the evolutionary transition from physical inhibition to chemical control (of worker reproduction) in particular and the transition from the primitively eusocial state to the highly eusocial state in general.

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**ACKNOWLEDGEMENTS.** This work was supported by grants from the Department of Science and Technology, and the Ministry of Environment and Forests, Government of India. We thank an anonymous referee for helpful comments. RG was at the the Wissenschaftskolleg Zu Berlin when this paper was written.

Received 21 August 2002; revised accepted 17 March 2003

## Studies on the reproductive behaviour of the common catopra, *Pristolepis marginata* Jerdon (Nandidae–Perciformes) under captive conditions

T. V. Anna Mercy\*, Eapen Jacob and Raju K. Thomas

College of Fisheries, Kerala Agricultural University, Panangad, Cochin 682 506, India

***Pristolepis marginata*, popularly known as common catopra, is an endemic, ornamental fish of the Western Ghats of India. Even though there are quite a lot of indigenous fishes that can be utilized as ornamental varieties, they have not received sufficient attention and popularity among traders of ornamental fish. This paper deals with the studies made on captive breeding of *Pristolepis marginata*. To study the spawning of *Pristolepis marginata*, it is essential to understand the entire behavioural cycle of reproduction such as courtship, mating and spawning. This paper describes the behaviour associated with reproduction in common catopra. There is no demarcated sexual dimorphism except for a small genital papilla and a pot belly for the females. The male fish builds a nest in the pebbly bottom, guards the site and shows strong territoriality. It guards the embryo and larvae until they become free-swimming.**

INDIA is blessed with a rich biodiversity with a high degree of endemism in ‘hotspot’ areas like Western Ghats and North Eastern Ghats. Presently only a very small fraction of the endemic fish biodiversity is being utilized as ornamental fishes. Mercy *et al.*<sup>1</sup> collected 57 species of freshwater fishes from the Western Ghats and studied their behaviour and feeding in captive conditions of forty-seven of them and they were recommended as ideal for ornamental fish industry. One of them is *Pristolepis marginata* Jerdon, popularly known as common catopra.

This is an endemic fish to the Western Ghats and has not so far been exposed to the ornamental fish industry. Even though not brightly coloured, it is quite attractive in aquarium tanks due to its behaviour. It is slow moving and stands still most of the time moving its pectoral fins. It is a very compatible fish in the aquarium except for its breeding time. It readily takes any food, both artificial and natural. Breeding in captive conditions is one of the desirable qualities for an ideal ornamental fish. Hence, this paper deals with attempts made to breed *Pristolepis marginata* in captivity. It describes its behaviour associated with reproduction.

The main objective of this experiment was to test whether it is possible to make common catopra spawn natu-

\*For correspondence. (e-mail: kaufish@vsnl.com)

rally in captive condition. The breeding behaviour of 12 pairs of common catopra (size ranging from 10–14.5 g in weight for females and 10.5–15 g weight for males) was studied to standardize its breeding behaviour and spawning in captive conditions.

Fishes for the present study were collected from Bharathapuzha river (about 150 km away from the hatchery site) and were brought to the hatchery in the College of Fisheries, Panangad in oxygen-filled polythene bags. They were acclimatized to captive conditions by gradual exchange of water. Different feeds were tried and they were seen relishing mosquito larvae. Since no information was available on the reproductive behaviour, at the start of the studies, various facilities were provided in order to test whether it was possible to make common catopra spawn in captivity. Majority of the fishes collected were large, ranging in size from 7 to 15 cm in total length and 70 to 88 g in weight. They were kept in different types of containers like glass aquaria ( $3\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2}$  m) and in rounded cement tanks (one metre in height and diameter), with and without biological filter. All the fishes in these containers were kept under close observations. Water quality parameters were also noted every day. Oxygen was never a limiting factor in the tanks fitted with biological filters. However, in the other tanks without biological filters, water was exchanged everyday. pH ranged from 7 to 7.5. All these studies were made in ambient temperatures (26 to 29°C). Twelve fishes of total length ranging from 10–15 cm were kept in a glass tank with biological filter and they were kept under close daily observation. After a few weeks one of the fishes was found chasing another. On close observation it was found that the belly of the chased fish bulged a little and it was considered as female. Both the male and female fishes were separated and kept in another tank fitted with a biological filter and gravel bottom where the spawning behaviour of individual male–female couples was studied. All activities related to spawning were recorded on a videotape.

No sexual dimorphism was observed prior to reproductive maturation in common catopra. However, a few days before spawning, the mature female developed a small genital papilla and a pot belly. A ripe male could be distinguished by its characteristic behavioural patterns at the onset of gonad maturity. It started nest building by selecting a portion in the tank and displaying territorial behaviour (Figure 2). The male showed greater aggressiveness and territoriality, and was busily engaged in preparing a nest out of pebbles, while the female kept herself away from the male, visiting the nest area at frequent intervals and was being chased by the alert male.

The nest of the common catopra, is nothing but a small depression-like structure made of pebbles. For the preparation of the pebble nest, the male fish carried 1 to 3 cm sized pebbles to the proposed site of the nest and at the same time took away smaller ones and sand particles (Figures 3–5). Their thick lips are the sole organs used as

tools for all these acts. The male tried very hard to pull bigger pebbles towards the site. Every time a new stone was laid in the pit the fish fanned the stone with its pectoral fin as if to make it clean. The completed nest was in the form of a pit with little thick risen border (Figure 6). The nest was very clearly distinguishable from other parts of the tank, as it was little deeper and was formed of comparatively bigger pebbles.

In this experiment, the male was co-habitated with a mature female. The presence of a ripe female seemed to intensify the nest-building activities of the male which showed aggressive chasings and erected its fins frequently, along with its nest building work (Figure 7). This behaviour could be reckoned as a possible indication of the fish being alert. Whenever the female tried to visit the nest, because of the aggressive approach of the male, it swiftly moved back to safer points. The females spent most of the time somewhere away from the male hiding behind plants or other big structures available in the tank. All these activities such as making of the nest, chasing the female, nuptial display of the males and frequent visit of the female to the nest lasted for 1–2 days (Figure 8).

After 1–2 days of pre-spawning activities, the female was invited to the nest. Male and female stood sidewise to each other. Male slightly beat and pushed the female



Figure 1. *Pristolepis marginata* in captive conditions.



Figure 2. Male *Pristolepis* selecting a site in the tank.

with its caudal region (Figure 9). The courtship rituals also included the sidewise lying inside the pit, along with shivering of the fins and body. They both slowly circled inside the pit, and keeping the same position, vigorously shook the body and fins (Figures 10–12). They inclined slightly to one side, keeping the anal regions close to each other, the female with a more enlarged genital papilla released a few eggs and the milt from the male simultaneously fertilized the eggs (Figures 13, 14). Release of the eggs could be observed at times but release of the milt could not be observed. Soon after this, the female

left the pit. The eggs fell into the voids of the stones and became attached to the stones. After a short while, the female returned to the pit and repeated the same act several times. This lasted for 2–3 h until the female released all the eggs, batch by batch, and they were being fertilized simultaneously. Whenever the female tried to devour some of the eggs the male always prevented her. The collapsed belly gave the sure sign of complete laying of eggs. It could also be observed that there was no specific time for breeding. They were found breeding during the early morning, evening and also during night hours. The size at first maturity was found to be 6.8 cm for male and 6.2 cm for female.

When the spawning activities were completed, the male started guarding the site by fanning it with its fins and defending any intruders. The male parent continued to rearrange the pebbles until the pit was changed into a heap of stones. The female was seen slightly injured after spawning activities and was seen resting in a corner away from the male and the eggs. Male was found aggressive before and after the spawning. During this time the female was removed from the tank.

The observations made on the breeding behaviour of *Pristolepis marginata* indicated that it exhibited parental care and the male took care of the eggs and young ones till they became free-swimming. The phenomenon of male



Figure 3. Male *Pristolepis* collecting pebbles from the bottom.



Figure 4. Male *Pristolepis* picking pebble.



Figure 6. Arranging pebbles in the pit.



Figure 5. *Pristolepis* spitting out unwanted pebbles from the pit.



Figure 7. Male chasing the female.

parental care in fishes has been recognized and described since the origins of scientific thought – Aristotle cited by Agassiz 1856 (ref. 2). In the case of *Pristolepis marginata*, male fish worked continuously for  $30 \pm 5$  h to build the nest. Ridley<sup>3</sup> has classified male caring fishes into two types of mating systems. First, those in which male remains with the eggs (male site-attached with or without territoriality), and second in which the male carries the eggs with him. *Pristolepis marginata* can be included in the first group in which the males remain with the eggs (site-attached) with territoriality. While considering 39 families of fishes having site-attachment, he suggested that site attachment has been important in the evolution of parental care along several evolutionary lineages. He suggested that a male builds a nest or defends a site in order to attract or control mates. Blumer<sup>4</sup> has defined parental care as a non-gametic contribution that directly or indirectly contribute to the survival, reproduction, and reproductive success of the offspring. According to Trivers<sup>5</sup> the amount of care invested by territorial males varies. In families such as Cyprinidae, Galaxidae and Percidae, the eggs are incidentally defended as a by-product of territorial defense. In the present study the trend observed was of increased territoriality of males that can

be correlated with increased tendency of the males to take care of the eggs and young ones as suggested by Winn<sup>6</sup> in the case of 14 species of darters.

*Pristolepis marginata* exhibited strong territorial behaviour during breeding time. According to Keenleyside<sup>7</sup> territoriality stabilizes the evolutionarily stable strategy of parental care. In 1972, the importance of territoriality in the evolution of parental investment was pointed out by Trivers<sup>5</sup>. The present study indicated that as the male remained with the eggs until the hatchlings became free-swimming, territoriality is to improve the probability of an individual offspring's survival to ensure reproductive success. This has also been suggested by Perrone *et al.*<sup>8</sup>. The presence of a ripe female apparently induces the male brooder to intensify its nest building and pre-spawning activities. This may be due to the influence of the pheromones the females possess. According to Chen and Martinich<sup>9</sup>, the presence of the opposite sex has a potential role in the reproductive activities. Spawning occurred when a sexually mature female entered the male's territory and the two fish circled slowly in the nest with the male on the outside. The female periodically tilted sideways about  $90^\circ$  with her vent near that of the male and released eggs, which he fertilized. These eggs were



**Figure 8.** Female occasionally visits the site for breeding.



**Figure 10.** Male and female breeding together in the constructed nest.



**Figure 9.** Male and female together in the breeding site.



**Figure 11.** Courtship behaviour.

guarded by the male until they hatched and became free-swimming hatchlings. Several occasions of spawning have been observed in the aquaria but the release of milt by the male could never be seen. Similarly, Miller<sup>10</sup> and Keenleyside<sup>11</sup> were also unable to see the sperm release from male of *L. gibbous* at the moment of spawning, where it was also observed that after spawning the female tried to devour some of the eggs, but was usually chased away by the male. This can be a test of the male's ability to defend the eggs.

There seemed to be several points of resemblance between the spawning behaviour of the common catopra and other members of the family Nandidae. Barlow<sup>12</sup> described the spawning of *Badis badis* (Nandidae) in aquaria. The male defended the nest site and spawned with two or three females. Fertilization was external, gamete release being synchronous. In *Badis badis* also, the male guarded the eggs, which hatched out after 24 h and then cared for the young until they could swim (after 3–4 days). The male spawned again with another female within two days or so. Females could spawn after at least one week. Similar behaviour was found in *Pristolepis marginata* also except for the fact that the female bred only after a month or so after gaining full breeding condition. It seemed that

as the female laid eggs batch by batch, if the female is disturbed in between the breeding times, the egg laying will not be completed. In such a condition, the female will be able to breed again after one or two days with another male. In the present study the female was allowed to complete her egg laying with the first male itself. If two or more females are put together, they became aggressive.

Male *Pristolepis marginata* was found to breed with another female in another tank when it was removed after the hatching of the eggs but the reproductive success was poor. However, it was never seen breeding with another female in the same tank soon after the first female was removed. A care-giving male may refuse to further spawning after a certain length of time or after a given number of eggs are deposited for him as reported by Fishelson<sup>13</sup> and Sale<sup>14</sup>.

Physical parameters like water quality, flow rate, nature of substratum, and rain, have great importance in the spawning of the fish<sup>15</sup>. As a tropical fish, the common catopra was little influenced by slight changes in temperature since the fish was found to breed throughout the year. However, the nature of substrata is of great importance in the captive breeding of the fish. The fishes that



Figure 12. Breeding behaviour.



Figure 14. Eggs being laid (another view).



Figure 13. Eggs being laid can be seen (arrow mark is given).



Figure 15. Hatched out larva when they became free-swimming.

**Table 1.** Details of the size of breeders, time taken to spawn and time of spawning observed of *Pristolepis marginata* under captive conditions

Length		Time taken to spawn (h)	Time of spawning
Male	Female		
10.5	10.2	18	Early morning
12.5	11.5	24	Night
13.5	12.8	48	Evening
15.0	14.5	36	Afternoon
13.2	12.7	24	Morning
11.5	10.7	30	Early morning
12.8	11.9	23	Night
14.8	13.8	24	Early morning
12.5	12.0	20	Night
11.5	10.5	24	Early morning
13.4	12.8	48	Evening
14.5	12.8	36	Early morning

Early morning, 46.6%; Night, 26.6%; Evening and afternoon, 20%.

were kept in tanks without a gravel bottom did not breed in captive conditions.

According to the ecomorphological system of classification of Balon *Pristolepis marginata* can be included in the ethological class of Guardians, ecological group of nest builders and morphotype of lithophils. Further studies are

being carried out regarding the reproduction of this valuable fish.

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ACKNOWLEDGEMENTS. We thank the Director, NBFGR, Lucknow and ICAR for financial assistance. We also thank Dr A. G. Ponniah, Mission Leader, ICLARM, Indonesia for his constant encouragement and support.

Received 9 December 2002; revised accepted 28 March 2003