Mating behaviour and breeding of the grey bamboo shark, *Chiloscyllium griseum* Müller & Henle, 1838 in captivity

C. ANANDHAKUMAR, G. DHINAKAR RAJ*, A. UMA1, K. G. TIRUMURUGAAN, A. RAJA AND K. KUMANAN

Department of Animal Biotechnology, Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University, Chennai - 600 007, Tamil Nadu, India

1Vaccine Research Centre, Centre for Animal Health Studies, Tamil Nadu Veterinary and Animal Sciences University, Madhavaram Milk Colony, Chennai - 600 051, Tamil Nadu, India

*e-mail : dhinakarraj@yahoo.com

ABSTRACT

In the present study, the mating behaviour and breeding of the grey bamboo shark (*Chiloscyllium griseum*), in captivity was documented. During mating, two male sharks grasped the pectoral fins of one female, with the dominant male succeeding in copulation in a vertical position. Subsequently, 22 eggs cases were laid in pairs of which 7 eggs hatched after a period of 114-125 days with 85.7% survival. The male to female sex ratio in shark pups was 1:0.75. In India, this is the first report of complete documentation of the mating behaviour and breeding of sharks in captivity.

Keywords: Captive breeding, *Chiloscyllium griseum*, Mating behaviour, Mermaid pouch, Shark

The two genera of sharks *viz.*, *Chiloscyllium* and *Hemiscyllium* represent the group of oviparous sharks under the Hemiscyllids which are often caught in nets operated in the inshore waters (Compagno, 2002). Among the six species recorded from the Western Indian Ocean, *Chiloscyllium indicum* and *Chiloscyllium griseum* are the two major species found in Indian waters (Jagadis and Ignatius, 2003). Sharks are the focus of much attention because of their real and perceived relationships with man and increasingly, for their role in marine ecosystems (Lent, 1999). Reproductive behaviours in Chondrichthys are known to be complex and only very few studies on their reproductive behaviour have been published (Henningsen *et al.*, 2001; Pratt and Carrier, 2001). In India, there is paucity of information on captive shark breeding other than selected reports on morphological features and reproductive physiology (Devados, 1988) and on rearing of sharks in tanks to study the development of eggs and their hatching (Jagadis and Ignatius, 2003; Manoj Kumar and Asokan, 2011). The captive mating behaviour has not been documented so far, which would aid in better survival rate of the pups under captivity. As a part of our ongoing study on the role of innate immunity in sharks, four individuals (two males and two females) of *Chiloscyllium griseum* were maintained in a marine aquarium created for this purpose. These animals were caught using gillnets from Kanyakumari-Kolachal coast of Tamil Nadu, India. The *Chiloscyllium* sp. is known to adapt well in captivity in contrast to most other elasmobranch species (Harahush *et al.*, 2007).

At the time of introduction into 3 t capacity marine aquarium facility (6 ft*6 ft*6 ft) on 10th July 2010, the sharks were light brown in colour with 12 or 13 saddle marks. With advancing time, these marks faded and were absent after about 5 weeks. The sharks had a moderately stout body without lateral ridges, broad round snout with 5 small gill slits, large spiracles below the eye, nostrils with short barbels and had small and transverse mouth well in front of eyes. The dorsal fin was slightly smaller than the pelvic fins. These features were similar to the ones reported for the species (Fisher and Bianchi, 1984). The water quality in the aquarium was maintained at optimum levels by providing water exchange and good aeration. The water temperature was maintained at around 28.5°C, salinity in the range 32.0 to 34.5 ppt and pH 8.0 to 8.2.

The bottom of the tank was provided with sea sand, boulders and dead corals to facilitate hiding place for sharks. The sharks got acclimatised to this experimental captive condition very well from the day they were introduced into the aquarium and they were fed daily with fresh shrimps at scheduled times (Table 1). The males were always active and had a typical and different swimming track in the tank. The females were found to be less active. Both males and females had preferential resting points. One of the females was found to be mostly a bottom dweller.
with less frequent vertical bouts to the top of the tank. The other female was observed to swim around the tank at the midlevel. Both the males and females competed well and were very much active during feeding time. Sometimes, they were also aggressive to the extent of dislodging rocks placed at the bottom of the tank.

During the maintenance, their mating behaviour could be documented along with the details pertaining to eggs laid and hatching of the pups. During courtship and copulation, around mid-afternoon on 20th December 2010, the smaller male was found biting the dorsal fin of a female. After a few minutes the other male in the tank moved towards the female and was nosing the female from its ventral side (Fig. 1A). The two males were observed to chase the female for a few minutes. Following this, the slightly bigger male grasped on to the female shark’s right pectoral fin tightly, while the slightly smaller male was grasping to the left. It has been reported that biting or holding appeared to be universal and in larger species, co-operation on the part of the female also has been shown to be necessary (Pratt and Carrier, 2001). Despite the strong grasp, no lacerations or wounds were seen in the fins of the female after copulation. Even though two males tried to restrain the female, it could swim through small distances with both the males grasping on to her. During this time, the movement was mostly guided by the female (Fig. 1B) and almost after 5 min the female settled down at its preferential resting point (Fig. 1C). At this point of time the bigger male was successful in turning the female to its ventral side and the male was almost in a vertical position with snout towards the bottom of the tank (Fig. 1D). The slightly smaller male released the pectoral fin of the female for a very short period when the other male turned the female ventrally, but returned back to grasp the female’s fin. Reports indicate the existence of such social hierarchies and interactions preceding or following mating in species that remain together like the nurse shark (Carrier et al., 1994). The bigger male by grasping the left pectoral fin maneuvered its ventral surface to the female followed by insertion of its claspers into the female’s cloaca (Fig. 1D). The female showed little resistance during the entire act and was in the dorso-ventral posture. After about a couple of minutes the mating was over with the release of female by the copulating male. Partial sperm release into the water was also observed (Fig. 1E). The non-copulating male continued to grasp the female for a few more minutes and finally the female managed to escape from the grasping male. During this period, the behaviour of the other female shark (not involved in mating) in the tank was normal and found moving around the tank.

A month following the mating, two oval dark brown eggs with tendrils were found attached to the stone at the bottom of the tank on 24th January 2011 (Fig. 1F). Following this, we could observe that most of the egg deposition had occurred mostly during the night with the eggs mostly laid in pairs as already reported (Harahush et al., 2007). Eggs were around 5 - 7 cm long; the color was light brown to dark brown. When the egg case was first laid, it was soft and pale; the case hardened and darkened in a few hours. The egg cases were observed periodically for the growth of embryo and the decayed egg cases were removed. The eggs were found to be expanded in the centre to form a central pouch where the embryo was found with the marginal ribs of the eggs slightly thick and flexible in some, while stiff in others. Closer observation revealed the presence and movement of larva inside the egg case (Fig. 1G) and attachment to the yolk. The egg cases were observed for the release of shark pups, and the period taken for each release and the size of egg case were recorded. Egg cases collected from different time of release were tagged batch-wise and maintained in the same tank with good aeration. The female laid a total of about 22 eggs till 8th March 2011. The first young shark successfully emerged on 18th May 2011, after an incubation period of 114 days. Initially 2 young sharks that hatched out got entangled in the egg case filaments and died. Hence, later we manually intervened to release the young ones from the egg cases. Newly released young sharks (Fig. I H) were measured and

### Table 1. Feeding schedule of the adult and young Chiloscyllium griseum pups under captivity

<table>
<thead>
<tr>
<th>Stage of the animals</th>
<th>Feed</th>
<th>Feeding schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>• Live feeds which included fresh or frozen shrimps – peeled and deveined</td>
<td>• 5% of the body weight, fed twice a day in the morning (0700 hrs) and evening (1900 hrs)</td>
</tr>
<tr>
<td>Pups after hatching</td>
<td>• Egg custard supplemented with commercial vitamin mix</td>
<td>• Minced fresh shrimp</td>
</tr>
<tr>
<td></td>
<td>• Fed to satiation (1-30 days)</td>
<td>• Fed twice a day in the morning (0700 hrs) and evening (1900 hrs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fed to satiation (30-60 days)</td>
</tr>
</tbody>
</table>
Fig. 1. Mating behavior and breeding of *Chiloscyllium griseum* in captivity. A. Grasping of the dorsal fin by one of the male shark and nosing by other male shark; B. Two male sharks seen grasping the pectoral fin of the female shark; C. Projection of the clasper of the copulating male; D. Copulation; E. Release of semen following copulation; F. A typical egg case with the tendrils; G. Mermaid pouch egg case with a live embryo; H. Shark pup after assisted release from the egg case after 114 days.
maintained separately in small wiremesh cages installed inside the aquarium tank. The young sharks were about 10 cm in length on an average, with 10-12 black bands on their body. The shark pups did not enjoy parental care. Apparently, such protection for them is unnecessary for survival in the wild. The just hatched pups were initially fed with egg custard supplemented with multi-vitamin for about a week. Subsequently, the hatched pups were fed with crushed pieces of cooked shrimps for a month following which the juvenile sharks accepted minced fresh raw shrimp (Table 1).

The initial growth of the pups was slow and slowly the bands on their body started to disappear. Out of the 22 egg cases, 7 pups hatched out naturally (31.8% hatchability) with male to female sex ratio of 1:0.75. Out of the 7 pups that hatched naturally, 6 of them could be successfully maintained until 2 months (survivability of 85.7%), beyond which they were used in expression studies and transcriptome profiling which was a part of our ongoing research programme. To the best of our knowledge, this is the first documentation of the entire mating behavior of Chiloscyllium griseum in India under captivity. These observations on the behaviour, feeding, mating and hatching of the pups enabled us to successfully maintain and breed them in order to have samples for our ongoing research studies. The current observations on the mating and breeding of shark in captivity could augur well for the captive maintenance and breeding of shark species which are extensively subjected to human exploitation.

Acknowledgements

This study is funded by the Indian Council of Agricultural Research, New Delhi under the National Agricultural Innovative Project code C30018. The authors thank the Tamil Nadu Veterinary and Animal Sciences University and the Director, Centre for Animal Health Studies for the support and facilities provided. The Nodal Officer, Integrated Agromet Advisory Services and Professor and Head, Livestock Production and Management, MVC is duly acknowledged for their help in collecting the environmental data during the study period. The efforts of the National Co-ordinator (Component 4) of NAIP is duly acknowledged.

References


