Captive behaviour of cephalopods

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Introduction

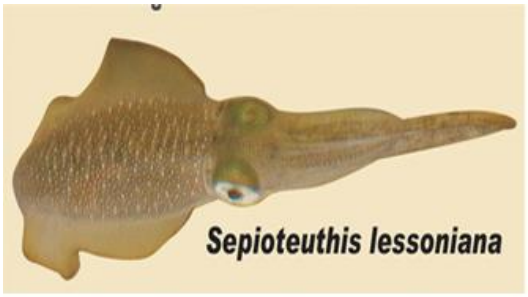
Cephalopods are the largest and most active invertebrates. India exports frozen cuttlefish and frozen squid to countries such as Japan, USA and the European Union. Cephalopods are unique because they have 85% protein by dry weight (16-21% by wet weight) and are considered a delicacy in seafood restaurants. Recent years have witnessed a significant amount of research interest in cephalopod culture and behaviour, in order to develop technology for commercial farming as well as to produce multiple laboratory generations for research in neurobiology and also to gather information for fishery management. In India, first major success in captive rearing studies of Cephalopod was achieved in 1999 with the cuttlefish *Sepiella inermis* at Tuticiorin Research Centre of CMFRI. Since then CMFRI has been working on squids, *Uroteuthis (Photololigo) duvaucelii*, *Sepioteuthis lessoniana*; cuttlefish, *Sepia pharaonis*, and octopus *Octopus dollfusi*. However, research was mainly focused on the cuttlefish *S. pharaonis* and squid, *S. lessoniana*.

Egg Collection

Normally egg mass of *S. pharaonis* is deposited in offshore waters from 15 to 35 m depth along the Vizhinjam coast. Egg deposition of this species is only rarely noticed in near shore waters. For egg collection, coconut spadix is submerged in deeper waters 15-30m. Egg deposition peaks during post monsoon months from September to January and extends till April. These egg collectors are recovered using GPS.

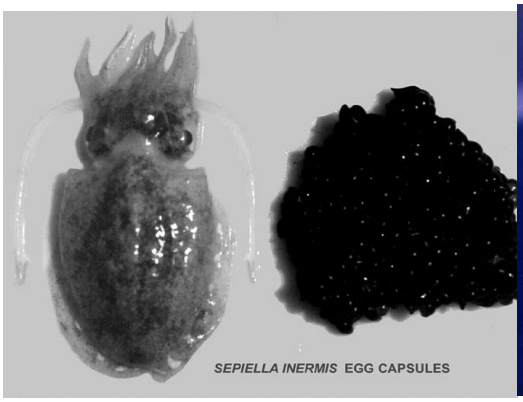
Egg mass of *S. pharaonis*

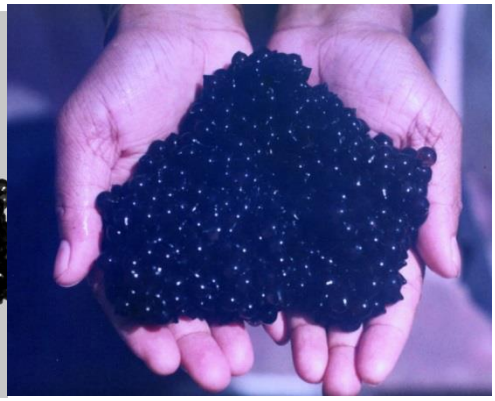
In the case of *S. lessoniana* spawning congregations are found in inshore waters also. For the collection of egg capsules different collectors such as old net, coconut spadix and nylon ropes are used from a raft or coconut spadix tied together are submerged at selected areas during the breeding season. Squids attached up to 40 clusters of egg capsules in a single spadix with each cluster consisted of 17-19 finger shaped egg capsules containing 6 to 8 embryos. Egg deposition was observed during the months from March to September with peak in August.



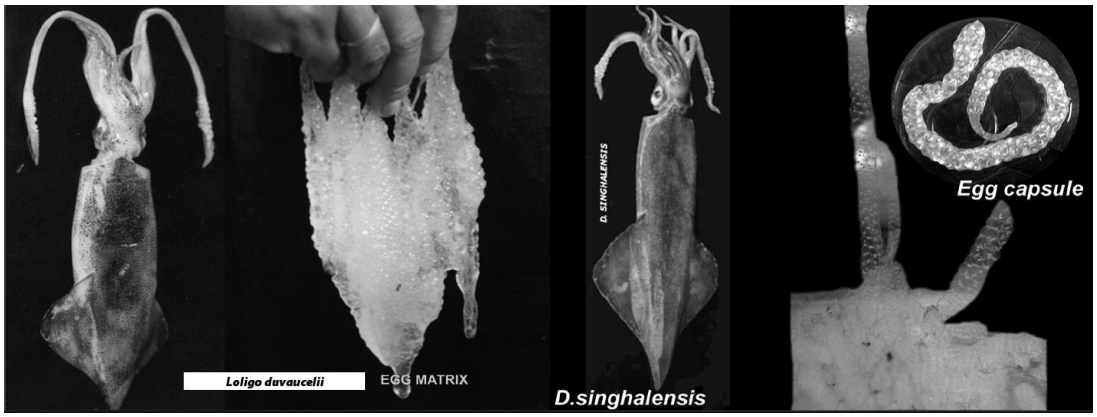
Sepioteuthis lessoniana eggs on coconut spadix

Egg mass of *S. lessoniana*



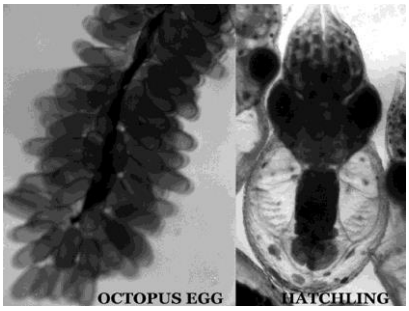


Egg mass of *S. inermis*



Egg mass of *U. (P.) duvaucelii* Egg mass of *D. singhalensis*

Egg matrices of *U. (P.) duvaucelii* and *D. singhalensis* are found attached to the sandy sea bottom even in near shore waters and can be obtained from shore seines. Octopus keep and incubate eggs among sea bottom structures and rocky areas and guards the eggs till hatching and the incubating female usually dies after hatching due to the starvation during incubation period.



Egg mass of *O. dollfusi*

Captive behaviour of pharaoh cuttlefish (*S. pharaonis*), spineless cuttlefish (*S. inermis)* and palk bay squid *(Sepioteuthis lessoniana)*

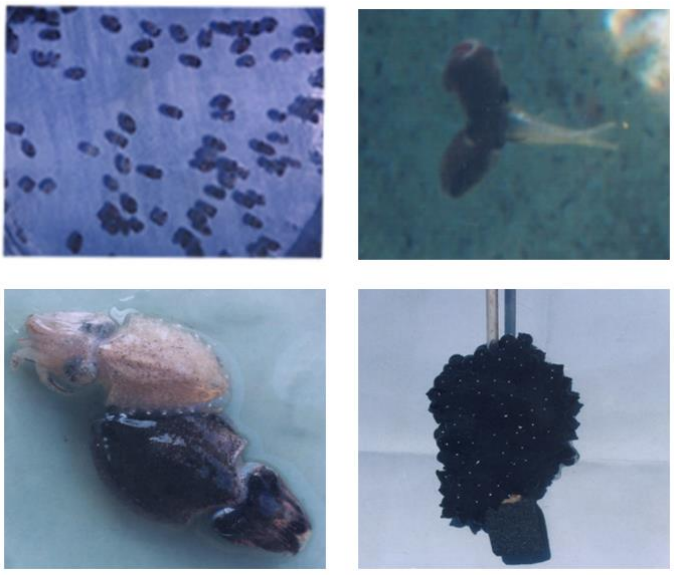
For hatching, the egg masses are placed in an incubation tank and aeration is provided through air stones. The eggs are kept suspended above the aeration point in a smooth nylon net bag of 10 mm mesh size. Development of embryo is clearly visible through the egg membrane. The fully formed embryo with arms clinging to the spherical yolk material and the ink sac of the animal are visible. They showed jerking movements inside the capsule and even released ink inside the egg capsule when mechanical shocks were given.

Food and feeding behaviour

The limitation in cephalopods rearing is that they are carnivorous and selective feeders; they require live feed with a specific size, shape and movement. Feed without these characteristics will be ignored and the cephalopods will starve to death. The degree of selectivity is higher in the early stages compared to the adults. After a stage they can be trained to accept dead fish.

They were observed not feeding on mysids during day time in the first 2 days of rearing but there was noticeable reduction in the live feed available in the rearing containers when observed in the morning. From the third day onwards they were found actively feeding on mysids by striking them with ejection of tentacles even during day time.

From the third day onwards they were found actively feeding on mysids by striking them with ejection of tentacles during day time. Other feed items such as meat suspension, brine shrimp (*Artemia salina)* nauplii and rotifer *Brachionus plicatilis* did not attract the attention of hatchlings. During second week they can be fed with mysids of all sizes and shrimp post larvae and *Artemia*. They readily accepted *Artemia* (6-10 mm size). Shrimp post larvae (*Penaeus indicus* and *Metapenaeus dobsoni*) though accepted by the squid, could not be given in any significant amount due to their non-availability in sufficient quantities. From the 4th week onwards they were fed mostly with small fishes and caridian shrimps.

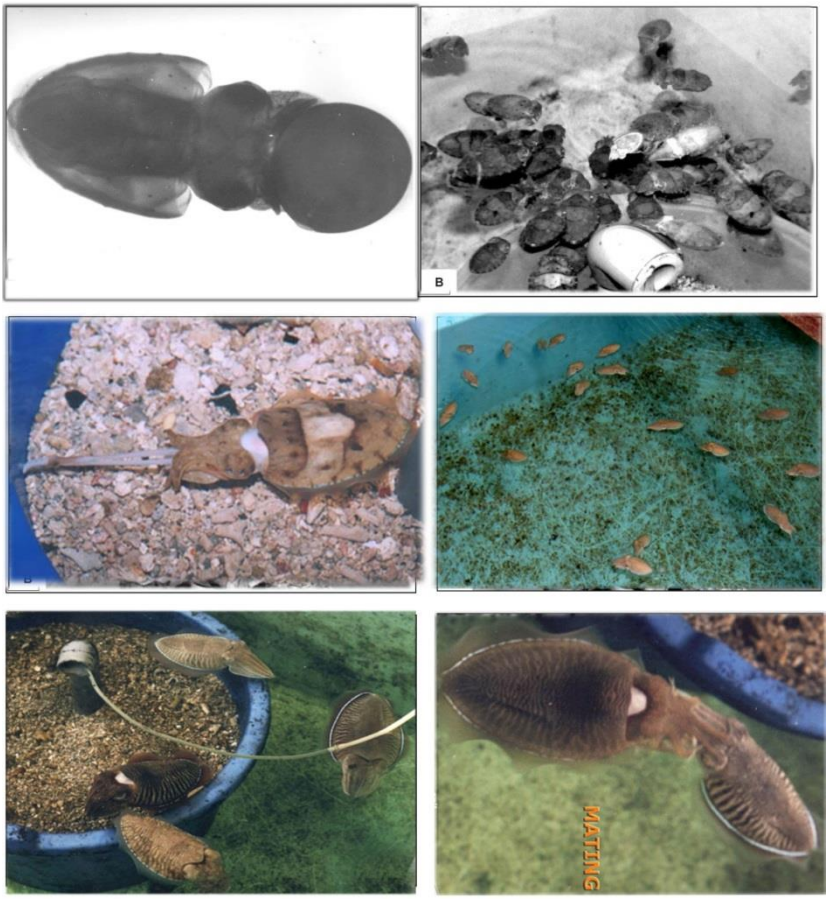


Captive development of spineless cuttlefish *Sepiella inermis*

The young squid were seen capturing animals more than its size. During feeding, even the small squid showed the three stage attack sequence of fixating the prey, positioning itself in attacking position and striking the prey with ejection of tentacles. From 8th week onwards they were slowly acquainted with dead fish (anchovies) and *Acetes* procured from locally and the quantity of live feed given was slowly reduced. Squid *S. lessoniana* acquired most of adult behaviour such as locomotion, capture of prey , ejection of ink and sudden changes of colour associated with excitement and escape bid even in the hatchling size of

5mm ML. These animals frequently changed colour from pale yellowish brown to dark brown and back. During the first two months they showed aggregation behaviour. For training the animals to feed on dead fishes, anchovies of the size 45-50 mm were taken in sticks with pointed ends and presented to the animals. Within 2-3 days most of them started taking the feed. Fish pieces were accepted even from the hand or taken from the bottom after one week training. At Karwar Research Centre of CMFRI, spineless cuttlefish *S. inermis* was successfully reared from the egg mass collected from wild. They mated under captivity and spawned on 86th day at a size of 60 mm mantle length producing 214 viable eggs. Only live food organisms, consisting of mysids, shrimp post larvae and juvenile fishes formed the diet of these animals in different stages. The initial average size of hatchling was 4mm ML (0.02g) that increased to on 110th days respectively. Average survival was 43, 37 and 28% at the end of first, second and third months.

At Vizhinjam Research Centre of CMFRI, Pharaoh cuttlefish (*S. pharaonis*) was successfully reared from egg to an average size of 168 mm mantle length (ML) and weight of 521 g in 226 days in the laboratory, using simple biological filtration systems. The period of egg incubation was 15 days at a temperature range of 27-31˚ C. Food items given were live mysids, *Artemia salina*, juveniles of fishes and prawns. Subsequently, the juveniles were slowly acquainted with food items such as dead caridian prawns and small fishes. Hatchlings were reared at a stocking density of one animal/l during the first month, and subsequently stocking density was reduced as the growth proceeded. The study shows that the pharaoh cuttlefish can be reared under captivity with a survival rate of 40% with the use of live feed limited to the initial phase of 50 days.



Sepia pharaonis: embryo, juveniles**,** feeding behavior, subadults, mating behaviour, mating

At Vizhinjam, the PalkBay squid *Sepioteuthis lessoniana* was also successfully bred under captivity.

Captive development of *S. lessoniana*

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