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Stock enhancement of sea cucumbers - a solution for the depletion of natural stocks of *Holothuria scabra* along Gulf of Mannar

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As in many countries of the Indo-Pacific areas, sea cucumbers form a valuable source of income for the poor fisherfolk along Gulf of Mannar and Palk Bay areas of South-east-coast of India. The dried product from sea cucumbers (families Stichopodidae and Holothuridae) called beche-de-mer (trepang or hai-som) has very high export value in the South East Asian countries as a protein rich food. Recent findings indicated their potential in the biomedical research, as they are rich in chondrotin sulphate and glucosamine and other bioactive substances with anti-inflammatory and anti-tumor activities as well as fungicidal properties. Several commercial products formulated from sea cucumber extract, like ArthiSea and SeaCuMax (arthritis medicines, nutritional supplements and Sea Jerky) have been introduced in the market recently.

Owing to the high demand in international market and inadequate fishery management practice, the commercial sea cucumber species have been over-exploited leading to the extinction of sea

cucumber populations in several habitats. The "Convention on International Trade in Endangered species of Wild Fauna and Flora" (CITES) has recommended inclusion of sea cucumbers in the list of endangered animals and cited the reasons as limited mobility, late sexual maturity, density depended reproduction, low rates of recruitment and ease of collections for their overexploitation and subsequent resource depletion. The workshop held by FAO on "Advances in sea cucumber Aquaculture and Management" in China in 2003 had stressed the challenges in the sustainable management of sea cucumber fisheries. The releasing of hatchery produced juveniles of commercial sea cucumber species to their natural habitat, a process called restoration, restocking or reseeding is gaining momentum world wide, as the only way for replenishing the depleted stock of sea cucumbers.

The Indian beche-de-mer industry is an age old practice introduced to India by Chinese more than 1000 years back along the South-east-coast of India, which is mainly dependent on species like *Holothuria scabra*, *H. spinifera* and to a minor extent on *Bohadschia marmorata*. Though they are distributed in Lakshadweep and Andaman and Nicobar Island, processing is banned in these areas. Like in other countries, commercial sea cucumber populations are overexploited along Indian waters too. Considering the decreased export trend of beche-de-mers from India, as well as reduction in catch per unit effort of sea cucumbers fished, the Ministry of Environment, Government of India has banned both fishery and export of sea cucumbers from India since July 2001 by listing them under Wild life Protection Act, which caused severe impact on the livelihood of several thousands of fishermen populations along Gulf of Mannar and Palk Bay, who subsist on the fishery of this species.

Holothuria scabra commonly called 'sand fish' is one of the most commercially valuable tropical species of sea cucumber with a wide distribution throughout Indo-Pacific areas. The 'A' grade beche-de-mer processed from 'sand fish' commands one of the highest price in the international market. Since the mass production of juvenile *H. scabra* through hatchery system has been proved, it is being considered as an ideal candidate for stock enhancement programme in many countries. An Institute project has been carried out for a period of five years (2002-2007) to develop conservation

Table 1. Trials carried out on larval and juvenile rearing of *Holothuria scabra*

Spawning attempt	Induction technique	Auricularia larvae produced	% settlement	No. of sea ranched juveniles and mean size	Constraints
Feb '02	Feed	7,00,000	10%	10000 No. (3mm)	–
Mar '03	Feed	4,00,000	0.5%	145 No. (40mm)	–
Apr '04	Several agents	No spawning	–	–	Spent population
Nov '04	Salinity changes	3,21,600	8%	1190 (25mm)	–
May '05	Feed	50,000	5%	–	Ciliate infestation
Dec '05	Egg suspension	4,40,000	5%	–	among juveniles
Mar-May 06	Several agents	No spawning	–	–	Skin ulceration among broodstock
Nov '06	Heat and cold shock (±5°C)	800,000	–	–	Fresh water influx and associated salinity reduction

strategies of this species along Gulf of Mannar. Under this project, several trials were carried out to refine the current hatchery techniques of the same at TRC of CMFRI, Tuticorin (Table 1). The technology advancement in various hatchery steps was achieved during the said periods, which are briefed here under.

Brood stock collections and management

In the Gulf of Mannar area, sea cucumber fishery is mainly carried out by trawling and skin diving. Trawling is done either by non-mechanized country crafts operated for short distance called Thallumadi or by mechanized bottom trawlers. Local fishermen do the diving fishery, depending on water clarity, which is highly seasonal and fluctuating.

The specimens collected from trawlers are of inferior quality as they are stressed during the trawling process. But the specimens from thallumadi were better. They often developed skin lesion disease outbreak, which is highly contagious and end up in mass mortalities. The quality and liveliness of the specimens collected by skin diving are excellent for broodstock requirements and never developed any disease and hence are highly recommended for hatchery operations.

The brood stock is to be collected prior to the breeding season. The breeding induction is to be conducted during the two spawning peaks ie, the major spawning peak (March-May) and the minor breeding peak (October - December). The various trials conducted indicated the significance of a steady salinity for effective broodstock management, larval and juvenile rearing during the minor breeding peaks, because of the north east monsoon season and associated fresh water influx.

The broodstock collected by skin divers are to be acclimatized in the hatchery for two weeks by maintaining them in a continuous system with a 50% daily exchange of rearing water and feeding them with *Sargassum* spp. powder at 0.5g 500 L^{-1}.

Induced spawning

The brooders are induced to spawn by several techniques. Addition of compound feed made from rice bran, *Sargassum* spp. powder and soya bean powder (2:1:0.5) at 50-100 g 500L^{-1} is found to be very effective. On three occasions, the dried feed induced successful spawning among the brooders (Table. 1). On one occasion, the sudden fluctuation in salinity induced effective spawning. The egg suspension from an eviscerated female also induced spawning successfully on another occasion. Rather than an exclusive thermal shock, a combination of cold shock followed by heat shock (±5°C) is found to be more effective in *H. scabra*. Since it is difficult to determine the sex of *H. scabra* externally, it is advisable to collect 30-40 specimens of the desired length and live weight (ranging from 20-30cm and 300-500g). The optimum broodstock density is observed to be 15 No. 500L^{-1}.

Larval rearing

High sperm density is found to affect fertilization. Various experimental results indicated that stocking densities of 0.5ml^{-1} for the eggs, 1 ml^{-1} for the larvae and salinity ranging from 33-35ppt are the optimum hatching and larval rearing conditions. The fertilized eggs and larvae are to be reared in sterile and filtered sea water with mild aeration. The appropriate concentration of feed is important for the successful larval rearing. The feeding schedule is to be determined by the larval healthiness. The early auricularia are to be fed at 2×10^4 cells ml^{-1} for the first three days which is slowly raised to 3×10^4 cells ml^{-1} in the mid stage to 4×10^4 cells ml^{-1} in the later stage. Though better larval survival is observed when fed with *Isochrysis galbana*, the highest growth rate is noticed when fed with *Chaetoceros calcitrans* and hence a mixture of these two (1:1) is recommended as an ideal feed for the auricularia larvae. The appearance of the lipid sphere in the later stage is an indicator of larval viability. By periodic assessment of larval growth rate, the feeding regime is adjusted so that the auricularia survival rate is improved to 80-90%. However, feeding is not recommended for doliolaria larvae and they are to be maintained at 2 ml^{-1} in a flow through system with 200% of water exchange. The trials indicated that the just hatched doliolaria have more settlement rate than two or three days old.

Settlement

The doliolaria are induced to settle by the daily addition of powdered algae 'Algamc' at a concentration of 0.5g 500L^{-1}, which act both as an inducer for the doliolaria to settle and also serve as a food source for the newly settled pentactulae.

Experiments indicated that freshly added 'Algamc' is good for metamorphosis and settlement compared to preconditioned settlers exposed to 'Algamc'. The newly settled pentactulae can be fed by Algamac for one more month by slowly raising the concentration from 0.5g to 1g 500^{-1}. The periodic thinning out of the pentactulae to reduce the stocking density is found to improve the growth rate.

Juvenile rearing

One month old juveniles are given *Sargassum* spp. extract (<40µm) (10L $500L^{-1}$) for one month. Experiments indicated that juveniles >20mm reared in sand bed registered higher growth rate than those reared with same feed in bare tank. When the juveniles attained an average length of 20mm, a mixture of *Sargassum* spp. powder and fine sand in a proportion of 1:2 was given at 1% of the body weight of the juveniles (initially < 80, < 200µm as the days progressed). Algamac at 2% level was provided along with the above feed. The results indicated that a mixture of *Sargassum* spp. powder with fine sand or *Sargassum* spp. powder with fine coral sand are suitable for rearing the juveniles of >20mm size. The maximum growth rate of the juveniles obtained in another experiment suggested the salinity 30 ppt as the optimum for juvenile rearing. 50% water exchange was made daily and the juveniles were assessed for the growth and survival rate. By maintaining appropriate stocking densities, periodic transferring to new tanks along with size-wise segregation, the juveniles can be reared successfully. The juveniles are to be maintained in the hatchery, till they attained the stockable size.

Stock enhancement

The average size recommended for the release of juveniles to suitable habitat to replenish the wild population is 20-30mm. A total of 11335 numbers of juvenile *H.scabra* having a mean size 23mm, produced during various spawning trials were sea ranched around Van Island and Tuticorin Port Guest House (Table 1).

Conclusion

The continued research effort in the hatchery operation has refined the existing hatchery technology for the mass production of the juveniles of *H. scabra*. Future research need to be focused on the present stock structure of *H. scabra* along Gulf of Mannar, which is essential to assess the effect of sea ranching. The effective ways to release the hatchery produced juvenile sand fish into inshore habitat has to be studied, so as to get a high proportion of survival to repopulate the depleted areas. At the same time, fence enclosures are also to be tried as a method for recapture and survival assessment of the sea ranched juveniles in potential release habitats and also to conduct tank and pond based experiments to examine the conditions for scaling up the production.