Breeding and rearing of the sea cucumber *Holothuria scabra* in Iran

Abdul-Reza Dabbagh[1] and Mohammad Reza Sedaghat[1]*

Abstract

Induced spawning of *Holothuria scabra* was achieved for the first time in Iran in September 2011. Broodstock spawned when induced through combined stimulation. Larvae were kept at 26ºC and fed with unicellular algae. Early juveniles were first observed on day 24. Juveniles grew better under partial shade with natural sunlight than indoors. However, after one year, juveniles averaged only 22 g in weight.

Introduction

Because A-grade beche-de-mer produced from sandfish (*Holothuria scabra*) fetches a high price on the international market, this can lead to overexploitation (Agudo 2006). Dr James was the pioneer of artificial production of juvenile *H. scabra* (Pitt and Duy 2004; Laxminarayana 2005). Subsequently, several researchers have also worked on this species (Battaglene et al. 1999; Bell et al. 2007; Dabbagh et al 2011a, b; Hair et al. 2011; James et al. 1994; Lavitra et al. 2009; Mercier et al. 2000; Pitt and Duy 2004; Purcell et al. 2006). As an approach to commercial aquaculture production of sandfish, and sometimes to attempt to restock overexploited populations, this species has been bred and reared in Australia, Indonesia, New Caledonia, Maldives, Solomon Islands and Vietnam in recent years (James 2004). Sea cucumber culture in Iran started when, for the first time, juvenile *H. leucospilota* were produced by Dabbagh et al (2011a) at the research station in Bandar-e Lengeh. This paper outlines methods that have since been applied to breed and rear *H. scabra* in Iran.

Materials and methods

Broodstock

In June 2011, 25 *H. scabra* were bought for broodstock from dealers in Qeshm Island, and maintained in the hatchery in a bare 1-tonne (t) polyethylene tank. The water in the broodstock tank was changed daily. Animals were fed with an extract of *Sargassum* sp. and unicellular algae (*Chaetoceros* sp. and *Isochrysis* sp.).

Spawning and larval rearing

The methods used for inducing the spawning of broodstock were based on those developed by Dabbagh et al (2011b), which involve water pressure jetting followed by thermal stimulation. Normal temperature in the broodstock tank was 24°C, but this was raised by 5°C by a heater when carrying out thermal stimulation.

After females spawned, eggs were left for one hour to be fertilised. The collected eggs were washed in fresh seawater to remove excess spermatozoa. Eggs were then transferred to three larval rearing tanks that were stocked at a density of 0.7 eggs ml^{-1}. The temperature in the larval tanks was maintained at 26°C.

The eggs and early larvae were held in darkness by covering the larval tanks with opaque plastic covers. Larvae were fed with phytoplankton, including *Isochrysis* sp., *Chaetoceros muelleri, C. calcitrans* and *Pavlova lutheri*. The algae were given twice daily, at gradually increasing concentrations of 20,000 cells ml^{-1} to 40,000 cells ml^{-1}. Complete water changes (100%) were carried out every second day until the late auricularia stage was reached. At the start of the metamorphosis from late auricularia to doliolaria (Fig. 1), preconditioned polyethylene plastic sheeting, rough-surfaced tiles and 500-m planktonic netting were added to the tanks. During this stage, water was drained from the floor while fresh seawater was added at the top of the tanks. When settlement plates were placed into the tanks, the pentactula larvae were fed with spirulina powder and Algamac Protein Plus at a concentration of 0.25 g m^{-3}.

Rearing juveniles

Newly metamorphosed juveniles were fed with Spirulina powder and Algamac Protein Plus. When juveniles reached 2 cm, they were fed with *Sargassum* and *Padina* extract. The water in juvenile tanks was changed daily. A fine layer of sand was added to tanks as soon as juveniles reached 4 cm.

[1] Young Researchers Club, Bandar-e Lengeh Branch, Islamic Azad University, Bandar-e Lengeh, Iran
* Corresponding author: A.R Dabbagh: rezadabbagh@yahoo.com

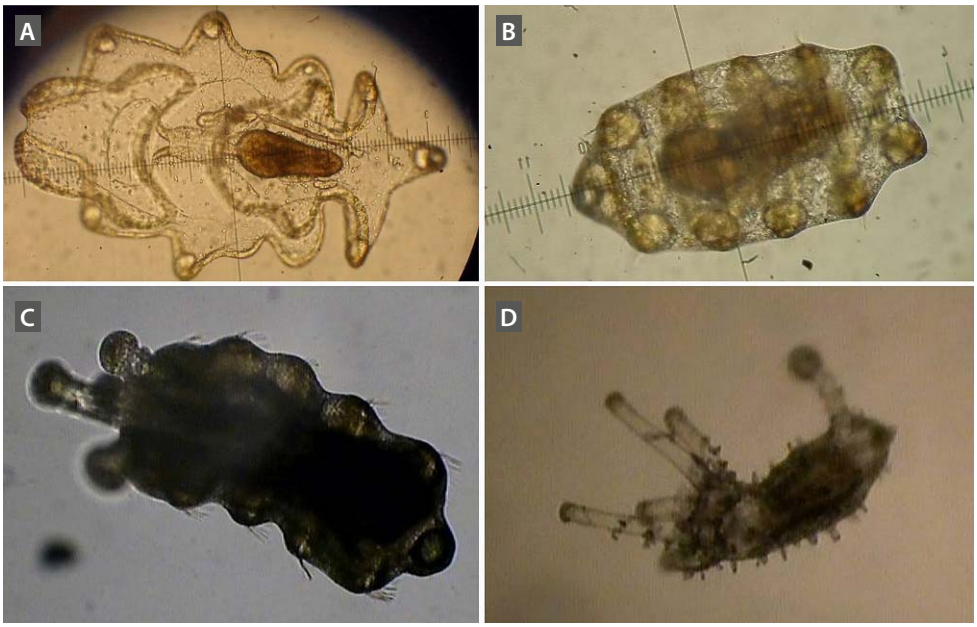

Figure 1. Developmental stages of *Holothuria scabra*:
A - auricularia; B - doliolaria; C - pentactula; D - early juvenile.

Results

Two days after broodstock were obtained they were exposed to several stresses but no spawning occurred. After further rearing, spawning occurred in September (Fig. 2). Attempts at spawning induction started at 11:00. By 15:05, 11 males had released sperm by raising their anterior ends. At 16:15, two females had spawned a total of 4 million eggs.

Figure 2. *Holothuria scabra* specimen standing erect and ready to spawn.

After 48 hours, embryos had developed to early auricularia (350–450 μ). On day 15, first non-feeding doliolaria (420–620 μ) were observed. On day 24, juveniles were easy to see on settlement plates (Fig. 3). After one year, juveniles were 22 g (Fig. 4). Juveniles reared in a large tank with natural sunlight reached larger sizes than juveniles under artificial light. Likewise, juveniles fed on extracts of *Sargassum* and *Padina* reached larger sizes than those fed with other feeds.

The timing for each developmental stage is shown in Table 1. Details of results according to the type of settlement plates and feed used for pentactula larvae and juveniles have

Figure 3. Early *Holothuria scabra* juveniles on settlement plates.

Figure 4. One year-old juvenile *Holothuria scabra*.

been described previously in Dabbagh et al. (2011a, b) and Dabbagh and Sedaghat (in press).

Table 1. Time after hatching for the different developmental stages of *Holothuria scabra*.

Stage	Time after fertilisation
Early auricularia	2 d
Mid auricularia	4 d
Late auricularia	8 d
Doliolaria	14 d
Pentactula	20 d
Juvenile 1 mm	30 d
Juvenile 22 g	1 yr

Discussion

Several species of sea cucumbers are processed to produce high value beche-de-mer (e.g. *Apostichopus japonicus*, *Holothuria spinifera, H. scabra, H. lessoni*, *Isostichopus fuscus*). The very highg demand for beche-de-mer from Asian markets has led to the overexploitation of many wild populations and has induced farmers to culture sea cucumbers (Ivy and Giraspy 2006; Agudo 2006). Attempts at breeding and rearing *H. scabra* in captivity have been conducted in several countries, including Australia, Fiji, India, Madagascar, New Caledonia, Solomon Islands and Vietnam (Bell et al. 2007; Battaglene et al. 1999; Hair et al. 2011; James, 2004; Lavitra et al. 2009; Morgan 2001; Pitt and Duy 2004).

The most common method for inducing *H. scabra* to spawn is thermal stimulation (James et al 1988; Morgan 2000; Battaglene et al. 1999; Giraspy and Ivy 2005). However, in this project, *H. scabra* was induced to spawn by applying combined stresses. Spawning may be seasonally limited in some countries. In Vietnam, for example, broodstock could be induced to spawn year round, but egg yields have been shown to be best from December to April (Pitt and Duy 2004). Spawning was obtained from October to March in the Gulf of Mannar in India and from March to October (James 2004). There seem to be spawning peaks in Iran in early and late summer. Induced spawning has also occurred in the middle of summer and in fall in Bandar-e Lengeh in the case of broodstock maintained under ideal conditions. Most aspidochirote holothurians go through the same larval stages, although development times may vary from species to species, or be related to latitude (Agudo 2006). *H. scabra* larvae in India took less than 15 days to reach the non-feeding doliolaria stage. Our larvae reached this stage on day 15.

Because this activity is new to Iran, various problems were encountered. One, for which a solution is yet to be found, is the high water temperature in Bandar-e Lengeh — over 30ºC year round. In addition, there is limited space for rearing juveniles at sufficiently low densities for good growth. Sea cucumbers have still only reached an average weight of 22 g one year after spawning. That is a very low growth rate. However, we think that if a special hatchery and nursery for sandfish were established in Bandar-e Lengeh, we would be able to overcome these problems.

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References

Agudo N. 2006. Sandfish hatchery techniques. New Caledonia: ACIAR, SPC and the WorldFish Center. 45 p.

Battaglene S.C., Seymour J.E. and Ramofafia C. 1999. Survival and growth of cultured juvenile sea cucumbers, *Holothuria scabra*. Aquaculture 178:293–322.

Bell J., Agudo N., Purcell S., Blazer P., Simutoga M., Phamb D. and Della Patron L. 2007. Grow-out of sandfish *Holothuria scabra* in ponds shows that co-culture with shrimp *Litopenaeus stylirostris* is not viable. Aquaculture 273:509–519.

Dabbagh A.R., Sedaghat M.R., Rameshi H. and Kamrani E. 2011a. Breeding and larval rearing of the sea cucumber *Holothuria leucospilota* Brandt (Holothuria vegabunda Selenka) from the northern Persian Gulf, Iran. SPC Beche-de-mer Information Bulletin 31:35–38.

Dabbagh A.R., Sedaghat M.R., Rameshi H., Arganji G.R. and Keshavarz M. 2011b. The effect of different substrates on larvae settlement in the sea cucumber, *Holothuria scabra*, Jaeger 1833. World Journal of Fish and Marine Sciences 3(3):263–264.

Dabbagh A.R. and Sedaghat M.R. in press. Feeding some commercial feeds in the captive breeding of the sea cucumber, *Holothuria scabra* in Iran. World Aquaculture.

Giraspy D.A.B. and Ivy G. 2005. The influence of commercial diets on growth and survival in the commercially important sea cucumber *Holothuria scabra* var. *versicolor* (Conand, 1986) (Echinodermata: Holothuroidea). SPC Beche-de-mer Information Bulletin 28:46–52.

Hair C., Pickering T., Meo S., Vereivalu T., Hunter J. and Cavakiqali L. 2011. Sandfish culture in Fiji Islands. SPC Beche-de-mer Information Bulletin 31:3–11.

Ivy G. and Giraspy D.A.B. 2006. Development of large-scale hatchery production techniques for the commercially important sea cucumber *Holothuria scabra var. versicolor* (Conand, 1986) in Queensland, Australia. SPC Beche-de-mer Information Bulletin 24:28–34.

James D.B. 2004. Captive breeding of the sea cucumber, *Holothuria scabra*, from India. Advances in sea cucumber aquaculture and management. FAO Fisheries Technical Paper 463:385–395.

James D.B., Rajapandian M.E., Baskar B.K. and Gopinathan C.P. 1988. Successful induced spawning and rearing of holothurian, *Holothuria (Metriatyla) scabra,* Jaegar at Tuticorin. Marine Fisheries Information Service, Technical and Extension Service 87:30–33.

James D.B., Gandhi A.D., Palaniswamy N. and Rodrigo J.X. 1994. Hatchery techniques and culture of the sea cucumber *Holothuria scabra*. Central Marine Fisheries Research Institute Special Publication No. 57.

Lavitra T., Rasolofonirina R., Jangoux M. and Eeckhaut I. 2009. Problems related to the farming of *Holothuria scabra* (Jaeger, 1833). SPC Beche-de-mer Information Bulletin 29:20–29.

Laxminarayana A. 2005. Induced spawning and larval rearing of the sea cucumbers, *Bohadschiamarmorata* and *Holothuria atra* in Mauritius. SPC Beche-de-mer Information Bulletin 22:48–52.

Mercier A., Battaglene S.C. and Hamel J.-F. 2000. Periodic movement, recruitment and size-related distribution of the sea cucumber *Holothuria scabra* in Solomon Islands. Hydrobiologia 440:81–100.

Morgan A.D. 2000. Induction of spawning in the sea cucumber Holothuria scabra (Echinodermata: Holothuroidea). Journal of the World Aquaculture Society 31(2):186–194.

Morgan A.D. 2001. The effect of food availability on early growth, development and survival of the sea cucumber *Holothuria scabra* (Echinodermata: Holothuroidea). SPC Beche-de-mer Information Bulletin 14:6–12.

Pitt R. and Duy N.D.Q. 2004. Breeding and rearing of the sea cucumber *Holothuria scabra* in Viet Nam. Advances in sea cucumber aquaculture and management. FAO Fisheries Technical Paper 463:333–346.

Purcell S.W., Blockmans B.F. and Agudo N.N.S. 2006. Transportation methods for restocking of juvenile sea cucumber, *Holothuria scabra*. Aquaculture 251:238–244.