Reproductive aspects, larval and juvenile rearing of Holothuria (Theelothuria) spinifera Theel
P.S. Asha
Tuticorin Research Centre of CMFRI, South Beach Road Extension, Karapad, Tuticorin, Tamil Nadu, India, 628 001.
Email: ashasanil@yahoo.com
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As in many Indo-Pacific countries, sea cucumbers form an important part of a multispecies fishery in India. Beche-de-mer exported from India during the period 1992-2000, varied from 10.5 to 140 tonnes (t) and ranked first among the dried marine products. The beche-de-mer industry mainly depends on two species of Holothuria: H. scabra and H. spinifera. Beche-de-mer exports have declined from 70 t in 1996-1997 to 3.8 t in 2001. Due to overexploitation, the Ministry of Environment, Government of India, has banned both the fishing and export of sea cucumbers since June 2001.

Considering the role of H. spinifera in the commercial fishery, and the fact that it has been indiscriminately exploited, knowledge on reproductive aspects and seed production through a hatchery system is essential for enriching the natural population of this species. Therefore, a study of H. spinifera was undertaken and the salient results are summarized below.

Of the 294 mature H. spinifera studied, 52.1% were females and 49.3% were males; the sex ratio was 1:1. The occurrence of 90% mature animals during September-October and 60% in April indicated the biannual reproductive activity. The mean gonadal index of males and females was 1.4 and 2.0, respectively. The peak gonadal index during September-November and the minor peak in February-March indicated biannual gametogenic activity. Gonochoric gonad consisted of 17-490 tubules of varying lengths from 9-51 mm, with uniform development. The tubule length in males (33-51 mm) was significantly (t = 2.537 p<0.05) greater than that of females (24-47 mm). The white colour of the tubules in the indeterminate and spent stages changed to creamy white in mature males and dark yellow in mature females. The tubule diameter of 1-1.2 mm in the females was significantly higher (t = 3.921; p<0.01) than that of the males. The mean oocyte diameter was 148 μm and the number of oocyte per tubule varied from 2233 and 29,667 with a mean value of 7938. The number of oocytes per tubule was significantly related to the tubule length (r = 0.2903; p<0.01) and also to the oocyte diameter (r = 0.923; p<0.01). The absolute fecundity ranged from 36.1 to 5195 x 10³, with a mean of 1739 x 10³. Out of this, the actual reproductive output is 1660 x 10³, which is equivalent to 5.4 g ovary weight. The mean fecundity index was 1770. The relative fecundity to eviscerated weight was 10.8 x 10³ and that of gonad weight was 307 x 10³.

The mean value of oxygen consumption in H. spinifera was 0.012 ml g⁻¹ (dry wt) h⁻¹ and the ammonia excretion was 12.45 μg g⁻¹ (dry wt) h⁻¹. The rate of oxygen consumption and ammonia excretion did not vary during the maturity stages but varied with length and dry weight of the animals. The mean values of protein, carbohydrate and lipid content in the body wall of H. spinifera were 17.8, 2.8 and 1.3%, respectively. The highest concentration of these organic constituents was during the maturity stages, and their decline during the post-spawning periods indicated their role as the source of energy during gametogenesis.

In H. spinifera, spawning was induced by powdered feed. The larval cycle lasted for about 10-15 days; with a pelagic larval stage: auricularia (809 μm) up to 10 days; non-feeding floating doliolaria (468 μm) on 10-12th day; and the settling pentactula (330 μm) on 13-15th day. On day 20, 200 juveniles attained 1 mm, and on the day 80 day, 55 juveniles attained 30 mm for the first time in the hatchery. The larval growth rate was 49-58 μm day⁻¹. Algamac, at a concentration of 0.5g 500 L⁻¹, was observed to be the best inducing agent for larval settlement. A sharp increase in the growth rate of juveniles (1.5 mm day⁻¹) was observed when they were fed with Spirulina. A survival rate of 73.3%, 16 μm day⁻¹ growth of stomach and 80% of late auricularia development with normal symmetrical shape suggested that 2 x 10⁴ cells ml⁻¹ was the optimum algal...
feed concentration for larvae. Among the single algal diet, a high larval growth rate of 59 μm day⁻¹ was observed in the larvae that were fed with Chaetoceros calcitrans, whereas greater survival (68%) occurred in the larvae that were fed with Isochrysis galbana. Among the combination of algal feed, I. galbana and C. calcitrans yielded better growth rates (43 μm day⁻¹) and survival rates (73%). Highest survival rates (90.8% and 72.3%), growth rates (62.6 μm day⁻¹ and 33.6 μm day⁻¹) and development of doliolaria (100%) indicated that suitable rearing conditions for H. spinifera larvae consisted of water temperatures of 28–32°C, salinity 35 ppt and pH 7.8. The maximum growth rate for length (0.52 mm day⁻¹) and weight (0.08 g day⁻¹) with Spirulina, as supplemented in the feed, indicated that 4% Spirulina could be supplemented as an additional protein source along with fine sand and Sargassum powder. Gonochoric gonad, bimannual reproductive cycle, high fecundity and amenable for production of juveniles through hatchery techniques, show the suitability of H. spinifera as a candidate species for farming.

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Population biology of shallow water holothuroids and ophiuroids from Raine Island and Moulter Cay, Northern Great Barrier Reef

M. Byrne¹, A. Smoothery¹, A. Hoggert² and S. Uthicke³
1. One Tree Island Research Station and Department of Anatomy and Histology, University of Sydney, NSW, Australia
2. Lizard Island Research Station, Cairns, QLD, Australia
3. Australian Institute of Marine Science, Townsville, QLD, Australia

Echinoderms are a conspicuous component of the invertebrate fauna of Raine Island and Moulter Cay, Northern Great Barrier Reef (GBR). Reefs around these islands support high densities of the commercially important holothuroid, black teatfish Holothuria whitmaei. The densities of H. whitmaei recorded were on the higher end of those measured for the Northern GBR, supporting previous findings that no-take (green) zones are effective in protecting stocks of commercial holothuroids. The seagrass habitat at Raine Island had the highest densities recorded for H. whitmaei and the specimens from this habitat were smaller than those in the lagoon. It is suggested that the seagrass habitat may be an important settlement and nursery area for these holothuroids. A survey of ophiuroids in the rubble zone on the Raine Island reef flat revealed an assemblage of at least 8 species. Ophiuroids were more abundant under the largest boulders. Ophiocanella scolopendrina and O. dentata were the most common ophiuroids with O. scolopendrina being more abundant near shore and O. dentata being more abundant further from shore. The lack of co-occurrence of these ophiuroids under the same boulder might suggest the presence of antagonistic interactions, but a coefficient of interspecific association indicated a random distribution for these species.

Diversity of echinoderms at Raine Island, Great Barrier Reef

M. Byrne¹, P. Cisternas¹, A. Hoggert², T. O’Hara³ and S. Uthicke⁴
1. Department of Anatomy and Histology, F13, University of Sydney, NSW 2006 Australia
2. Lizard Island Research Station, Cairns, QLD, Australia
3. Museum Victoria, Melbourne, Australia
4. Australian Institute of Marine Science, Townsville, QLD, Australia

Echinoderms are a conspicuous and diverse component of the invertebrate fauna of the waters around Raine Island, in the Far Northern Great Barrier Reef (GBR). Detailed surveys of the shallow waters around the island revealed the presence of 111 echinoderm species: 11 asteroids, 24 cirrhidoids, 8 echinoids, 27 holothuroids and 41 ophiuroids. In general, the echinoderm fauna of Raine Island is typical of the outer Great Barrier Reef, although aspects of the fauna differed from other areas of the Far Northern GBR. Several species were recorded for the region for the first time. These included an asteroid of the genus Ophidiaster that appears most similar to O. perrieri, a species known only from the western Indian Ocean, and Microcystis macroclusus, an echinod previously only known in Australia from Heron Island in the far south of the GBR. Several potentially new species were also found. These included two Ophiocoma species, a new fissiparous Ophiacantha, an Ophiacanthella species and an unusual colour morph of the crinoid Comanthus.