Preliminary observations on broodstock development and spawning of Indian Halibut *Psettodes erumei* (Bloch & Schneider, 1801) in captivity

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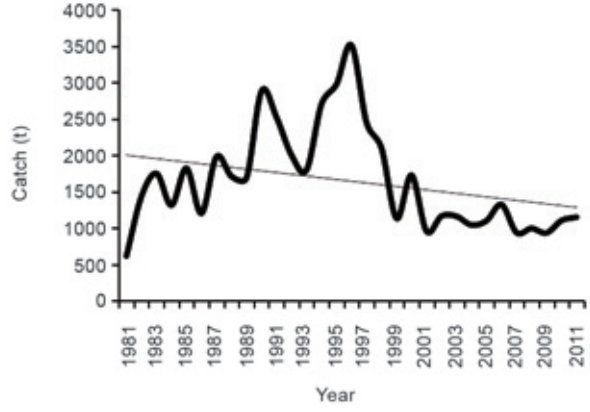
The Indian halibut *Psettodes erumei* (Bloch &Schneider, 1801) is a typical tropical bottom dwelling, piscivorous marine flat fish distributed all along the coastal waters of India (5-50 fathoms). It is a highly valued table-fish with high white meat yield for fillet. The meat yield (%) is known to vary between 42-49%, which is comparable to some of the best white meat fish species cultivated globally. The fish is locally called as *Hario* (Gujarati), *Bhakus/ zipli* (Marathi), *Boxlep* (Konkani), *Ayirampalli* (Malayalam), *Erumeinakku* (Tamil) and *Norunalaka* (Telugu). It is also called the 'Australian Halibut' and 'Pazifischer steinbutt' in international markets. There is a huge demand for flat fish in U.S/ Europe/ Japan. A lot of development has taken place in temperate and Mediterranean countries like Norway, Spain, France and Israel in domestic rearing and large scale aquaculture of temperate halibut and sub-temperate turbots. Attempts to domesticate this species in India are now being made in CMFRI's Kovalam Field Laboratory to establish a viable rearing technology and supplement the falling production of this commodity in the wild.

While domestic consumption in India was initially restricted to the peninsular states of Kerala and Karnataka, increase in trawling/mechanized fishing brought in larger quantities and slowly the fish qualified as a good table fish in the coastal states of northwest and southeast India also. Published literature documents these fishes to be seasonal spawners, spawning once annually, with low fecundity, relatively bigger oocytes at spawning. They are dioecious with external fertilization.

Fishery

Bottom trawling and bottom set gill net operations in coastal waters are the main source of halibut landing along the coast. Halibut production in the country was about 620 t in 1981, which increased to 3516 t in 1996; thereafter it has exhibited a steady declining and the production in 2011 was 1154 t (*Source: National Marine Fishery Resources Data Centre of CMFRI, Kochi*). While it formed 0.05% of the total marine fish landings in 1981, the contribution in 1996 was 0.15% while in 2011 it is only a mere 0.03%. Rapid stock assessment



Annual landing of *Psettodes erumei* in India (1981-2011)

(Mohamed *et al.*, 2010) based on the ratio of the recent 3-year average (2009-2011; 1067 t) over the historic maximum recorded for the species during the period 1981-2011 (3516 t) indicates that the stock is "Declining." At Chennai, the landing of *P. erumei* has averaged around 140 t annually during the period 2007-2012, forming about 0.46% of the total landings. Maximum landing of 206 t was recorded in 2009 and the landing in 2012 was 99 t.

The bottom set gillnet (*naakkuvalai*/*tharavalai*) are predominantly used for flatfish fishing in the coastal waters along the Chennai-Puducherry stretch at a depth of 15-25 m during May-July. It is a well known fact among the fishers that during upwelling and mixing of the turbid waters during July-August (*vandal thanni* - south to north currents) from the deep, these fishes tend to aggregate in the coastal habitats; possibly increased demersal fish assemblage and turbidity provide excellent feeding grounds. This periodic movement of the fishes to a flat sandy terrain every year also makes them vulnerable to targeted fishery.

Broodstock development

Preliminary studies on live collection, quarantine and holding was carried out from 2012. A substantial number of juveniles and maturing specimens were collected live from bottom set gill net landings off Kanathur, Kovalam, Chemmenchery and Cuddalore Chinnakuppam to the south of Chennai. The size range of the fishes was 130-555 mm TL and 40-2500 g weight. The percentage of adult males was very less in fishes obtained from the wild in sizes beyond 400 mm. After several trials, standards were developed for transportation and conditioning of these fishes to laboratory holding. Fishes brought up by the gill nets were sorted without much physical damage and kept in seawater-filled containers on board FRP boats and brought to the shore. The fishes so collected were brought to the lab and shifted to dark coloured quarantine tanks of 1m depth with sand substratum. They were observed for wounds, scale loss, and behavior and treated with 50-250 ppm formalin depending on the intensity and size of the animals, for 3 consecutive days. The healthy ones were shifted to the grow-out and maturation facility developed in the lab. Since these fishes tend to remain buried in the sand, their skin and respiratory surfaces are quite vulnerable to external parasites and trematodes. With periodic treatment with formaldehyde and de-worming agents, the fishes survive exceedingly well.

Behaviour and biology

These fishes are mostly sedentary, nocturnal, photophobic, bury in sand, swim vertically up occasionally and rest of the time moves horizontally with flat white ventral surface beneath. They exhibit high levels of camouflage when live and normally their colour and pattern resembles that of the fine sand bottom. If probed and handled the band pattern turns deeper and brownish and when taken out the dorsal skin color turns dark brown. They are hardy to handle, scale are firm and can remain outside water for several minutes. After repeated trials it was understood that theses fishes prey upon only fishes that inhabit the lower strata of the water column like tilapia, cardinal fishes, eels, silverbellies, threadfin breams, lizardfish, anchovies and milkfish. We therefore conditioned them to feed on tilapia fry which is easily available in the backwaters of Kovalam-Muttukadu area. The fishes have so far not responded to artificial and inert diets or raw fish meat. Cannibalism has not been noticed. They remain buried in the sand and wait for the prey to come within close range, then snap the fish with wide open flexible jaws bearing large number of teeth and swallow it. The fish capture one or two fish at a time depending on the size of the prey and then retreats into the sand. They do not normally feed continuously and these activities are quite restricted. Through the wave like oscillatory movement of dorsal and ventral fins (lateral) the fish propel the body inside the sand with gentle slope towards the caudal side and normally remain buried. Handling these fishes need special care as the jaws have plenty of sharp teeth and the oral cavity is very big and flexible, it has also been observed that these fishes tend to turn back and attack the probing stimulus using their sharp dentition. Juveniles when stocked with larger

size group exhibited aggressive behavior and smaller animals were injured and starved due to competition for food.

Observation on adult female fishes sampled from the fish landings at Kovalam indicated size range from 255-545mm with fecundity ranging from 19740 to 300699. Depending on the ovarian maturation stage, the number of eggs per gram ranged from 1420 to 3850 in the wild sample, in fishes in maturity stages III and above. Sacrifice of nearly 30 fishes, for anatomical observation on gonadal maturity, have indicated that the fishes mature in the grow-out facility, with 30% of the stocked fishes entering into early stages of maturation.

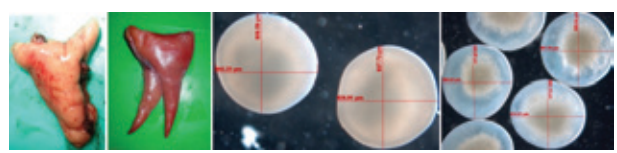
Spawning in captivity

Volitional spawning was observed in one of the broodstock tanks in August 2013. A female halibut weighing 1870 gms spawned in a 2 ton black FRP broodstock tank in the early morning hours, releasing approximately 60,000 eggs, and the male in the tank responded simultaneously. The floating single granule eggs (1540-1630µm) were collected and distributed into different incubation systems – dark coloured circular round tanks, with reduced and normal photoperiodicity. While early cell division was noticed, beyond 16 hours, the eggs turned opaque and settled at the bottom of the tank. The fishes were not induced to spawn by any hormones or chemicals. The salinity of the holding water was 36 ppt and temperature ranged between 28-29ÚC. The release of only nearly 60,000 eggs indicated that these fishes are multiple spawners, releasing eggs in frequent intervals during a single spawning season.

Halibut broodstock raised from juvenile sizes at Kovalam Field Laboratory

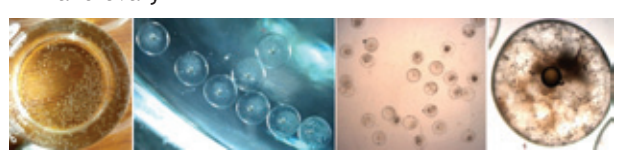
Change in external appearance in dead specimen gonads

Adult female with ripe



Developing testes and ovary

Intra-ovarian oocyte development



Spawned eggs

Eggs showing early development