LARVAL REARING TECHNIQUES AND STOCK ENHANCEMENT OF SILVER SEA BREAM (*Rhabdosargus sarba)* IN MAURITIUS

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ABSTRACT

The silver sea bream (*Rhabdosargus sarba),* has great commercial value in Mauritius. The species is a potential candidate for aquaculture. The sea bream, a winter spawner, was successfully induced to breed in captivity with HCG (Human Chorionic Gonadotropin) hormone injection (250 IU/kg body weight) in 1989 at the Albion Fisheries Research Centre. In 1997, the Coastal Fisheries Resources and Environment Conservation Project of Japanese International Cooperation Agency (JICA) was launched to enhance the stock of the silver sea bream in the lagoon. This species breeds under hatchery conditions during the spawning season. Annually, the hatchery-produced sea bream fingerlings, of 2.0 to 2.5 cm body length, were released in the coastal areas. The larval rearing method adopted at the Albion Fisheries Research Centre is described.

Keywords: *Rhabdosargus sarba* , Mauritius, broodstock management, Human Chorionic Gonadotropin, hatchery techniques, larval rearing, fingerlings, stock enhancement.

INTRODUCTION

Fishing has been a major source of food for humanity and a provider of employment and economic benefits to those engaged in this activity. However, with increased knowledge and the dynamic development of fisheries, it was realized that living aquatic resources, although renewable are not infinite and need to be properly managed, if their contribution to the nutritional, economics and social well being of the growing world's population was to be sustained, (FAO, 2001). Clear signs of over-exploitation of important fish stocks, modifications of ecosystems, significant economic losses and international conflicts on management and fish trade threaten the long-term sustainability of fisheries and the contribution of fisheries and food supply.

Since 1984, world aquaculture production has increased from 10.5 million tonnes to 25.46 million tonnes in 1994, with an average compounded growth rate of nine percent per year. During this period, freshwater fin fish production increased steadily while relatively high value crustacean production showed a comparatively rapid growth. The total contribution of

aquaculture production to global fisheries increased significantly (9.6% per year), as did the value of aquaculture production (from US$ 13 billion to 39.83 billion) (FAO/FIDI, 1996). Considering the present rate of population expansion and in keeping with the present average global per capita fish consumption of 13 kg/year, it has been estimated that the global demand for fish and shellfish may be in the order of 87 million tonnes by 2010 (FAO/Japan, 1995). In order to meet this predicted demand, the global aquaculture production would have to be doubled over the next 15 years. (FAO 1997)

The bulk of global production for terrestrial farming is based on a limited number of animal and plant species, more than 210 different farmed aquatic animal and plant species were reported in 2000. This great diversity reflects the large number of aquatic species that are readily adaptable to the wide range of production systems and conditions present in the different countries and regions of the world. However, ten species of sea bream of the Sparidae family are found in the waters around Taiwan among which the four most important species under culture are the red sea bream (*Pargus major*), the black sea bream (*Acanthopagus schlegel*), the yellow fin sea bream (*Acanthopagrus latus*) and the silver sea bream (*Sparus sarba*) (Shinn, Pyng Yeh Tony Yang, Tah Wei Chu, 1980). The artificial propagation and mass seed production techniques of these species are fully developped (Lin *et al*., 1988; Liu and Hu, 1980). In Mauritius, the silver sea bream *Rhabdosargus sarba*, is a potential species for aquaculture development. It is a carnivorous, euryhaline species and is distributed throughout the subtropical and tropical waters in the world. It is found in coastal waters throughout the Western Indian Ocean including Madagascar and Mauritius Islands; also extending to Australia and the Western Pacific. It is a bottom-living coastal fish to 60 m depth, sometimes entering estuaries. Spawning takes place near river mouths; after short planktonic period, the young fish move into the estuaries, which act as nurseries, and move out into deeper waters with growth. It feed on bottom invertebrates, mainly mollusc (Fischer and Bianchi, 1984).

MATERIALS AND METHODS

In 1989, the silver sea bream was successfully induced to spawn in captivity at the Albion Fisheries Research Centre after being administered Human Chorionic Gonadotropin (HCG) hormone. The brooders of the silver sea bream obtained from a barachois on the east coast of Mauritius were administered HCG hormone at a dosage of 250 IU/kg bodyweight. The use of hormone was discontinued in 1990 as natural spawning occurred under controlled hatchery conditions. The hatchery seed production techniques of the silver sea bream were improved during the past years.

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Wild mature females and males of the silver sea bream were collected from various barachois during the winter period, from May to July, when the water temperature was around 21^0C. The broodstock was caught by seining operations and was set in tanks in the hatchery. The spawners were given a 25 ppm-formalin bath treatment for 2 hours. The tanks were provided with gentle aeration and a continuous flow-through water system. The fish fed at 15% biomass on a ration comprising crushed fresh mussels and moist feed. The moist feed is composed of 40% minced fish, 40% fish meal, 10% squid meal, 5% vitamin premix, 1% mineral premix and 4% wheat gluten.

Following spawning, the floating eggs of diameter 90 micron were collected using a nylon net egg collector of mesh size 50 micron placed at the overflow outlet. The buoyant eggs were transferred to an incubation tank of 300-litre capacity supplied with gentle aeration and continuous water flow. After an incubation period of twenty four hours, the hatched-out larvae concentrated at the water surface. They were transferred to the larval rearing tanks at a stocking density of 30-50 larvae / litre. UV filtered sea water was used for the larval rearing. The salinity of sea water was 35 ppt and the water temperature ranged between 21 and 23^0C. Aeration was adjusted according to the larval developmental stage. During the yolk-sac stage, the aeration was gentle to minimize physical shock. The rearing tanks were filled with seawater to 40% of the tank volume and the volume was increased by topping up with 10% seawater as from day 3. A continuous flow-through of seawater was maintained throughout the larval period and strainers of different mesh sizes ranging from 300 to 1000µm were used according to the age of the larvae as presented in table 1. The sediments at the bottom of the tank were siphoned to exclude growth of bacteria, fungi and pathogens.

Table 1: Mesh size of nets used for egg collection and water exchange

	Larvae (Days)			
Days	Egg	10-20	21-30	31-70
Mesh size (µm)	50	300	500	1000

The larvae fed on the yolk reserves for three days and as from the fourth day when the yolk sac was fully absorbed, they were fed on rotifers. The density of rotifers in the larval rearing tanks was maintained at 10 to 20 individuals/ml. *Nannochloropsis* sp. was added to the larval rearing tank for a period of 25 days as feed for the rotifers. The phytoplankton maintained the water quality by utilizing the metabolites. The density of *Nannochloropsis* sp. was kept at 75 to 100 x 10^4 cells/ml.

Supplementary artificial feed, NRD 1/2, NRD 2/4 and NRD 4/6 procured from overseas with particle size ranging from 80 to 600 µm was supplied to the larvae according to the mouth gape of the larvae. The composition and feeding quantity of the artificial feed is presented in table 2.

Table 2: Composition and feeding quantity of artificial feed

Artificial feed	Ingredients (%)	Feeding quantity
NRD 1/2	60 - Protein 14.5 - Lipid 11.5 - Ash 7 - NFE 7 - Moisture 10 - Others	5-30 g/ ton/day
NRD2/4	59 - Protein 15 - Lipid 12 - Ash 1 - Fibre 1.7 - Phosphorus 7 - Moisture 4.3 - Others	20-150 g/ton/day
NRD 4/6	>55 - Protein >9 - Lipid <1.9 - Fibre < 8 - Moisture	7-10% body weight

As from day 21, artemia nauplii were added at a density of 1 individual/ 2ml to the larval rearing tanks. The feeding schedule is presented in table 3.

Table 3: Feeding schedule of silver sea bream larvae

Larval age (days) / Feed used	0	5	10	15	20	25	30	35	40	45	70
Nannochloropsis sp.	←	—	—	—	—	→					
Rotifers		←	—	—	—	→					
Artemia nauplii					←	—	—	—	—	—	→
NRD 1/2 (80-200µm)		←	—	→							
NRD 2/4 (200-400 µm)				←	—	—	—	—	→		
NRD 4/6 (400-600 µm)										←	→

Kitajima, (1981) reported that during the larval rearing of marine fish, an oil film on the water surface often occurs, leading to the occurrence of Lordosis, which is a vertebral column deformation. The oil film acts as a physical barrier preventing the larvae to gulp in air from the water surface, a process required for effective swim bladder inflation. During the larval rearing of the silver sea bream, an oil skimmer made of PVC piping was used to reduce the oil film as from day 5. Battaglene and Talbot, (1990) reported that the non-inflation of the swim bladder is also linked to water quality. As a precautionary measure against infection of the protozoan, *Oodinium* sp., copper sulphate ($CuSO_4$) was applied at a dosage of 0.14 ppm to 0.28 ppm as from day 10 with an interval of five days till the end of the rearing period at day 70.

In 1997, sea ranching of the hatchery-produced silver sea bream fingerlings of body length ranging between 2.0 and 2.5 cm was effected under the Coastal Fisheries Resources and Environment Conservation Project (JICA); this activity is ongoing. The fingerlings were released near large estuarine systems which are suitable brackish water eco-habitats. The river mouths are spawning niches and many fingerlings of different fish species remain and wean there as theses ecosystems are rich in plankton and have fewer predators than in the lagoonal waters. These areas are also rich in mangrove cover which contributes to the productivity of the eco-habitats.

RESULTS

In 1989, two sea bream brooders were administered with HCG hormone and spawning occurred after 24 hours. Some 85 000 eggs were obtained and 5 000 fingerlings were produced after 45 days of larval rearing, representing a survival of 5.9%. From 1989 to 1996 a total of 93 824 sea bream fingerlings were produced. They were released in various barachois on the eastern coastal waters. The production of silver sea bream fingerlings from 1997 to 2004 is presented in table 4.

Table 4: Number of hatchery-produced larvae and fingerlings of *R. sarba* (million) (1997-2004)

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Total number of eggs	4.2	1.3	1.2	2.53	46	15	20.2	5.5
Buoyant eggs	3.5	1.0	0.73	2.25	17.7	12	7	1.8
No. of eggs stocked	1.2	0.9	0.536	1.7	5.2	1.5	1.5	1.2
No of hatched larvae	-	-	-	0.9	3.8	1.1	1.2	0.8
Hatching (%)	-	-	-	52.9	73	73	80	66.6
No. of fingerlings produced	198 606	85 186	93 140	152 474	181 610	283 200	292 000	255 400
Survival (%)	16.55*	9.46*	7.3*	16.9	4.7	25.7	24.3	31.9

Survival rate of larvae refers to survival from egg to fingerlings.

From 1997 to 2004, sea ranching of 867 890 silver sea bream fingerlings was effected in seven barachois (Montagu, Nozaic, Oozeerally, Virginia, Beau Rivage, Belmont and Melville) and in four estuarine systems as presented in table 5

Table 5: Number of silver sea bream fingerlings released in the lagoon of Mauritius (1997-2004)

Year / Site	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**Total**
Barachois *	19 425	7 358	-	-	-	-	-	-	26 783
Ferney	-	-	-	-	-	155 900	100 000	-	255 900
Tamarin	-	-	-	-	-	24 000	85 000	-	109 000
Albion	-	-	3 000	1 542	1 265	105 000	107 000	122 000	339 807
Trou d'Eau Douce	-	-	3 000	-	-	-	-	133 400	136 400
Total	19 425	7 358	6 000	1 542	1 265	284 900	292 000	255 400	867 890

****: Released at Montagu, Nozaic, Oozeerally , Virginia, Beau Rivage, Belmont and Melville barachois***

The mean values of salinity, sea water temperature and pH for the larval rearing cycles of the silver sea bream from 1990 to 2004 is presented in table 6. The salinity varied between 34 and 36 ‰, the pH values ranged between 7.5 and 8.5 and the temperature was between 21 and 23 °C.

Table 6: Details on salinity, water temperature and pH values (1990-2004)

Year	Salinity range (‰)	Average salinity (‰)	pH	Temperature range (°C)	Average temperature (°C)
1990	34-35	34	7.5	21-22	22
1991	34.5-35	35	8.2	21-23	22
1992	34-35	35	8	21-22	22.5
1993	34-36	34.5	8.5	21-22	22
1994	34-35.5	35	7.5	21-22	22
1995	34-35	35	8.3	21-23	22
1996	34-35	34	8	21-24	23
1997	34-35	35	7.5	21-24	23
1998	34-36	35	7.8	21-23	22
1999	34-35	35	8.2	21-23	22.5
2000	34-36	36	8.5	21-23	22
2001	34-35	35	8.2	21-23	23
2002	34-35	34	7.8	21-23	23
2003	34-35.5	35.5	8.2	21-23	22
2004	34-35	35	8	21-23	22.5

DISCUSSION

The larval rearing technique of the silver sea bream was improved over the past fourteen years resulting in an increase in production of the silver sea bream fingerlings. Consequently, as from 2002, there was an increase in the number of the silver sea bream fingerlings released in the lagoon. From 1989 to 1996, the larval rearing technique was gradually established and a total of 93 824 fingerlings were produced. From 1997 to 2004, the production of silver sea bream fingerlings increased 16 fold and was 1 541 616; this was attributed to the improvement in the seed production techniques, in the maintenance and management of the broodstock, a better filtration of the sea water and the production of quality live feed.

As from 1989 to 2000, the broodstock of silver sea bream was maintained in tanks of 3-tonnes capacity. The eggs were collected by drifting a net along the surface of the broodstock tank. It was observed that this egg collection technique caused much stress and physical shock to the brooders, thus affecting the production and quality of eggs. Hence, as from 2000, concrete tanks of 30-tonnes capacity were used for the maintenance and conditioning of the broodstock. The

broodstock tanks were fitted with a continuous water flow-through system which enabled the eggs to be carried away by the water current and were collected in a nylon egg collector of 50 µ mesh-size placed at the water outlet. Another important change introduced in the larval rearing techniques was the incubation of the eggs for a period of 24 hours prior to stocking in the larval rearing tanks. The newly hatched-out larvae of the silver sea bream were of a body length of 2.5 to 3.0 mm. From day 3, the yolk sacs were absorbed. It is of prime importance to feed the larvae as from day 2 in the afternoon to ensure that they do not starve. Daily the larvae were fed with 10 to 20 rotifers/ml of seawater.

From 1997 to 2001, the hatchery-produced fingerlings were transferred to the outdoor nursery ponds and were reared for two to three months prior to their release in the lagoon. High mortality of fingerlings was observed during the nursery phase, attributed to unavailability of appropriate feed and *Oodinium* sp. infection which is directly proportional to an increase in the sea water temperature. As from 2002, the larval rearing period in the hatchery was extended from 40 days to 70 days. Under controlled hatchery conditions, the survival of the fingerlings increased from 4.7% in 2001 to 31.9% in 2004. After a culture period of 70 days, the fingerlings of a body length ranging between 2.0 and 2.5 cm were released.

The absence of the swim bladder development is a major pathological problem in the larval rearing of many sea fish species. Fish with no functional swim bladder show delayed growth (Al Abdul Elah *et al* 1983; Chatain, 1982) and high mortality rates when they are subjected to stress. (Chatain and Dewavrin, 1989). The swim bladder-inflation process is triggered by gulping in air at the water surface. In the silver sea bream larva, swim bladder inflation occurs as from day 5 onwards. The skimmer was used as a device to help in the inflation of the swim bladder. In 2004, 60-70 % of the larvae had an inflated swim bladder which consequently reduced the incidence of Lordosis.

The mean water temperature during the larval rearing cycle was best at 22^0C. It was observed that at a water temperature of more than 24 ^{0}C, the *Oodinium* sp. infection was more pronounced. Mortality was also observed after day 40 when there was a high-size variation in the larval population leading to cannibalism. At this developmental stage, the larvae were fed with various rations during the day to minimize cannibalism. An automatic feeder was placed in the middle of the rearing tanks and at 15 minutes intervals throughout the day, the feed was automatically sprayed on the water surface.

Good management of the broodstock and improved larval rearing techniques, including feeding schedule, feeding methods, disease control, water quality, aeration and water exchange are prerequisites for successful seed production.

The silver sea bream larval rearing techniques were gradually acquired and established with the use of a PVC skimmer to remove the oil film at the surface of water in the rearing tanks thus minimizing the occurrence of Lordosis, *Oodinium* sp infection controlled at temperature 21-22^{0}C. Better survival was obtained when the fish larvae were reared for a period of 70 days under controlled hatchery conditions. The release programme was continued for stock enhancement.

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