'standing crop' of the sizes indicated above, insects would have to be deposited at annual rates of 4-29 × 10^2/km^2 i.e. about 0.4 to 2.9kg/km^2yr. We may note that this range of values, about 1mg/m^2/yr. is less than 0.01% of the productivity of the phytoplankton in relatively unproductive ocean waters (Bowden and Johnson, 1976). These values are much lesser than what was expected from tropical seas. The reason for the same is not known. However, it can be stated that although the remains of the terrestrial insects do constitute an appreciable contribution to the pleuston, they are of only minor importance as a food source in open oceans.

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REFERENCES

BOWDEN, J. AND C. G. JOHNSON. 1976. In: *Marine Insects* (ed. L. Cheng). pp. 97-117. Amsterdam : North Holland.

CHENG, L. 1975. *Oceanography and Marine Biology, an Annaul Review,* **13** : 181-212.

——— AND M. C. BIRCH. 1977. *J. mar. biol. Ass. UK.* **57** : 995-997.

——— AND ——— 1978. *Ecological Entomol.* **3** : 87-97.

HARDY, A. C. AND P. S. MILNE. 1937. *Nature London,* **139** : 510-511.

PATHAK, S. C. AND A. H. PARULEKAR. 1988. *Mahasagar,* **21** : 117-120.

——— V. KULSHRESTHA, A. K. CHOUBEY AND A. H. PARULEKAR. 1998. *J. Biosci. (in press).*

ZAITSEV, P. 1990. Marine Neustonology, 264 pp. Moscow : Nauka Dumka (In Russian, translated by Israel Programme for Scientific translations).

ON THE SPAWNING AND LARVAL DEVELOPMENT OF *SPARUS SARBA* FORSKAL

ABSTRACT

Twenty eight specimens of *Sparus sarba* Forskal of length 30-35 cm, collected from the coastal waters of Gulf of Aden and stocked in the open air tanks at the laboratory in December 1990, spawned in February 1991. The spawning was fractional and prolonged with very high fecundity. Though the initial level of mortality was very high, afterwards it was reduced when it started feeding on food like *Chlorella* and oyster larvae. The developmental stages and larval characters have been studied. The 36 days old larvae resembled a miniature adult because of the high fecundity, prolonged and fractional spawning *Sparus sarba* is suitable for large scale culture.

SPARUS SARBA belonging to the family Sparidae is one of the most economically important groups of fishes in the Gulf of Aden. The biology and early life history of this fish need detailed study as it is a potential species for aquaculture. Tomiyama (1974) has provided a detailed pictorial illustration of the sea Bream culture and Johnson (1978) compiled some information on the development of Sparidae groups of the mid Atlantic Bight. The only

account available on its biology for this region is from Qateri waters (El Agamy, 1989). The aim of this paper is to provide some information on the spawning, and early development of this fish based on the results of the culture experiments carried out under controlled conditions in the laboratory (Terai *et al.*, 1991).

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Material and Methods

Thirteen male and fifteen female specimens of *S. sarba* of average body weight 1 kg and length between 30 and 35 cm collected in 1990 from the coastal waters of Gulf of Aden were selected for the experimental culture. They were stocked in tanks of 7 m diameter and 60 - 80 cm depths with running sea water which was pumped up through in take pipe from 500 m away from the sea-shore and passed through the sand bed filter. These tanks in the open air were protected by sun shades. The temperature and salinity were controlled to the optimum levels. The fishes were fed 3 times a day mainly on artificial food pellets made of fish, fish meal, wheat flour and vitamin prepared in the ratio 55:35:8:2. In addition they were also fed on shrimps and fishes. The spawned eggs were collected at the outlet pipe covered with net material of 200 micron mesh, numerically estimated and transferred to smaller tanks of 500 1 capacity with aeration facilities.

Results and Discussion

The live fishes stocked in the large tank on 4th December 1990 spawned on 2nd February 1991. The eggs estimated were about 176,00 in number. The spawning continued for several days and the eggs were shed in very large numbers that about 50% of it could not be reared as they blocked the filter. About 24 - 26 hours after spawning 81.8% of the eggs were hatched. The water temperature was between 23.5 and 24.5°C. On 4th February about 28,000 larvae were transferred to 100 1 plastic tanks where the water used was filtered sea water which was further filtered using 10 micron filter. After 31 days, the larvae were again transferred to tanks of 2.5 m diameter and 70 cm depth. During the first 21 days, 50% of the water in the tank was replaced by fresh sea water and afterwards by running water circulation. The water temperature in two tanks during the period between February to April and February to May ranged between 25 - 32°C and 24 - 34°C respectively. The salinity was 35 to 38%. The ammonia content in the water was kept controlled below 0.1 ppm.

Upto 36 hours after hatching, the larvae depended on the yolk of the eggs and afterwards they were fed by oyster larvae, rotifers, *Artemia* nauplii and plankton. From 100 mm size onwards they were given moist pellets made of a mixture of fish meal, dry fish, wheat flour and vitamins. Majority of the larvae died after three weeks, and afterwards the mortality was less when the larvae started feeding on food like *Chlorella*, oyster larvae etc. On 25th May about 600 larvae of the size 30 - 65 mm in total length were found alive. During the course of 10 months, they grew up to length between 15 - 20 cms and in December 1991 about 570 juveniles were estimated in the 750 sq.m tank outside the laboratory.

The eggs are pelagic buoyant and perfectly spherical measuring 0.8 mm in diameter (pl. IA). Perivitelline space is narrow. Single oil globule present is pigmented. Yolk occupies only less than $\frac{1}{4}$ part of the eggs in unfertilized

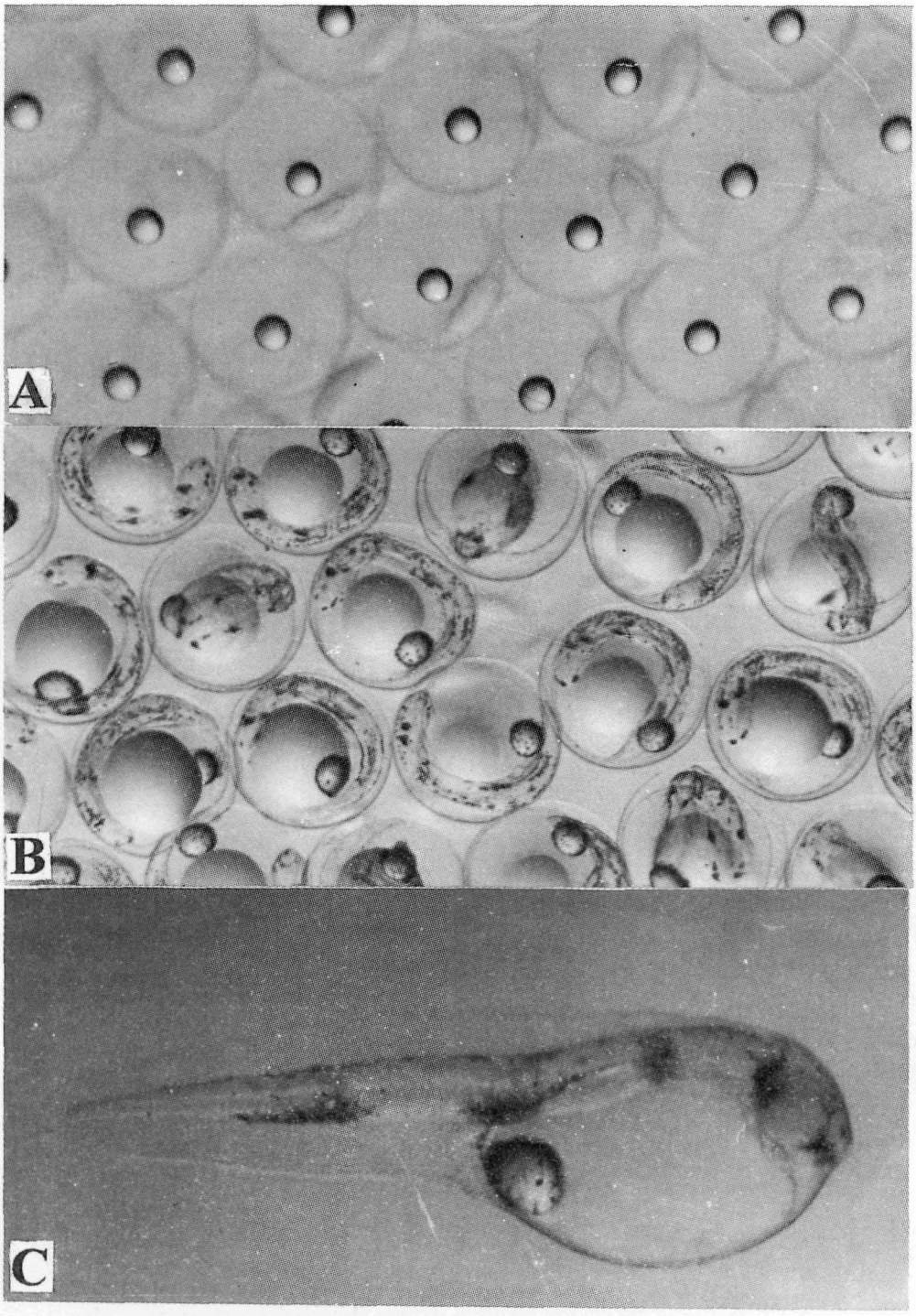

PLATE I. Fig. A - Eggs of *S. sarba* unfertilized (0.8 mm) B - Fertilized eggs and C - Larva of *S. sarba* just hatched out (length - 1.9 mm)

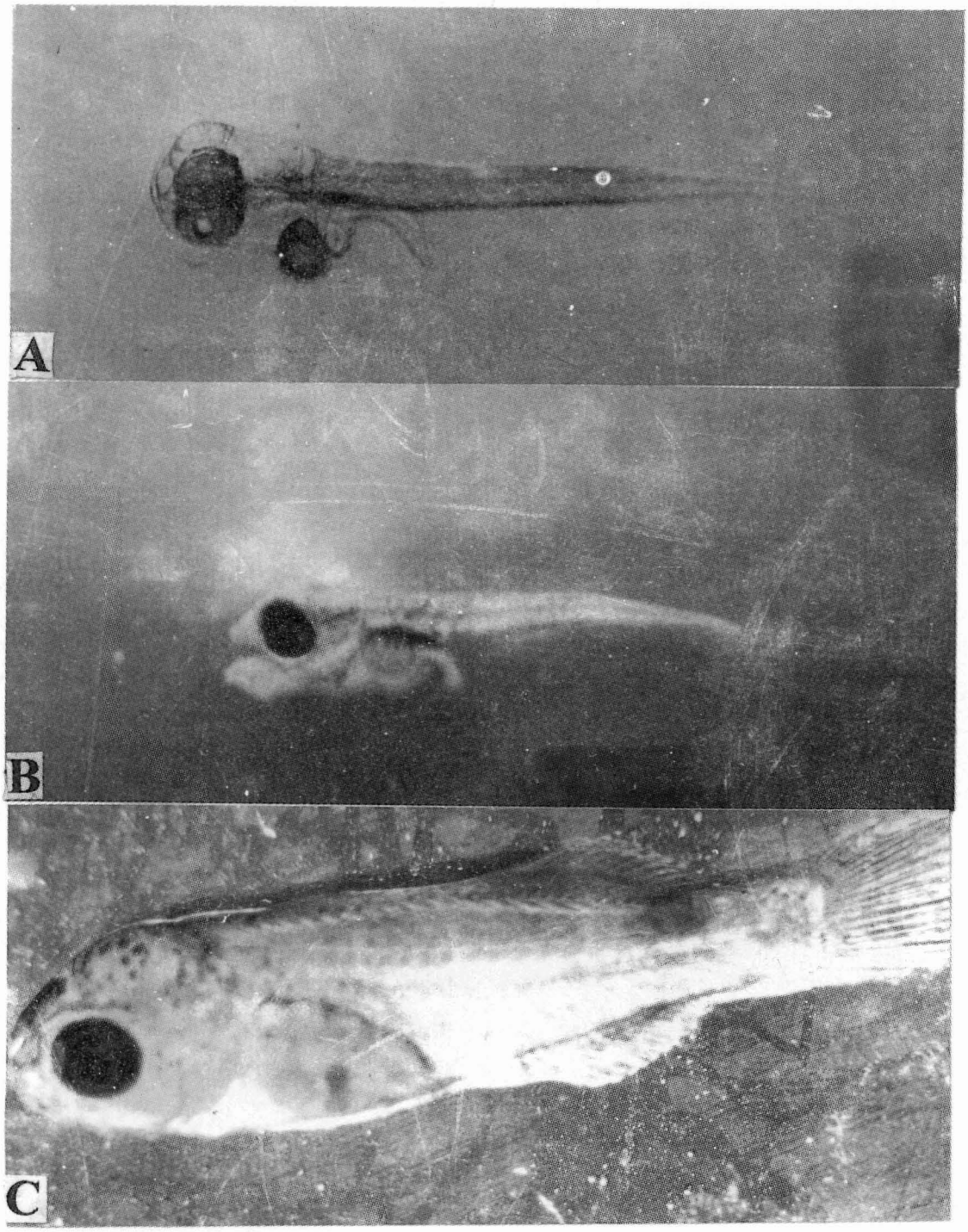

PLATE II. Fig. A - Larva of *S. sarba* 24 hours after hatching (length - 2.9 mm); B - 5 days after hatching (length - 3.2 mm) and C - 36 days after hatching (length - 9.0 mm)

eggs. Pl - IB shows fertilized eggs with well developed embryo attached to the spherical yolk mass which is glandular and opaque. The embryo occupies more than half of the circumference of yolk. The oil globule and embryo are highly pigmented. The larva newly hatched (Pl. IC) is of 1.9 m in total length. Five conspicuous bands of pigmentation are seen, two at the head region and 3 on the body. This prolarva is completely covered by the membraneous finfold which is thin and dotted with minute gland cells. The yolk sac is slightly elongated with the oil globule at its posterioventral part. Eyes are already developed at this stage. The larva 24 hours after hatching (Pl. II-A) had a length of 2.9 mm. Head, eyes and body are pigmented. Mouth is developed, with short alimentary canal opening near the 9th myotome. Oil globule is highly pigmented. The 5 days old larva (Pl. II-B) has a total length of 3.2 mm. About 25 myotomes could be counted. The yolk sac is completely disappeared. The mouth is wide and alimentary canal coiled which opens at the 10th myotome. Eyes are large and pigmented. In 15 days, the larva grew to 4.2 mm. Fin rays started appearing in the position of dorsal, anal, and caudal fins. Pigmentation has intensified especially over the head, dorsal and ventral margins of the body and also above the dorsal margin of stomach. The 36 days old larva (Pl. II-C) has a total length of 9 mm. At this stage, it resembled a miniature adult. The eyes, dorsal and lateral sides of the head and body, base of dorsal, anal and caudal fins, above the stomach and caudal peduncle are pigmented. Two dorsals are developed, first with 8 spinous rays and second with 14 soft rays. The anal fin is with 3 spinous and 11 soft rays.

During the period from January to March the *S. sarba* spawned several times in the controlled conditions, each time producing large number of eggs. El Agamy (1989) reported that in Qatari waters, the spawning season of this fish was from April to July, based on his observations on the gonadal conditions of the females. He is of the opinion that 20% of the fish attained its first maturity during the second year of its life. The minimum length recorded for maturity was 13 - 15 cm. The prolonged spawning of the fish observed in the present work also is in agreement with the findings of El Agamy (1989) who found the presence of more than one size of eggs in the ovary which suggested a fractional spawning resulting - in a longer spawning period. He estimated the fecundity range from 23000 to 99000. In the laboratory, although the fish was fed on artificial food, its natural food, as observed by El Agamy (1989) consisted of polychaetes, crustaceans, molluscs and fishes. The high rate of mortality of early stages of larvae observed in the present study was due to non-availability of suitable food immediately after the yolk is completely exhausted This situation could be overcome by providing them with *Chlorella* and rotifers as their first food. Because of its high fecundity, prolonged and fractional spawning, *S.sarba* is an ideal fish for large scale culture.

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REFERENCES

EL AGAMY, A.E. 1989. *J. mar. biol. Ass. India* **31** (1 & 2) : 127-137.

JOHNSON, D.G. 1978. Sparidae, *Biological service Programme, Fish and Wildlife Service.* **4** : 263-380.

TERRAI, A., N.H. ABDULRAHIMAN, SHAEF, Z.A. AND I.M. ABDUL KARIM. 1961. Progress report on *Sparus sarba* (Harabt). Aquaculture Research Centre, Ministry of Fish Wealth. Aden. 5 pp

TOMIYAMA, T. 1974. Fisheries in Japan, Sea Bream, *Japanese Marine Products Photo Materials Association* 178 pp.

PROLINE ACCUMULATION OF *SESARMA BROCKII* DE MAN LARVAE IN RESPONSE TO THE LARVAL DEVELOPMENT AND SALINITY STRESS

ABSTRACT

The 5 larval stages (4 zoea & 1 megalopa) were exposed to different salinities ranging from 5 to 40 ppt with 5 ppt. increment and the proline content was estimated in each stage. The mean proline content increased with not only increased salinity but also with the stage of larval development. The result was subjected to 't' test and 'ANOVA' and they were found to be significant at 5% level.

AMINO ACIDS are known to play an important role in the life-cycle of crustaceans (Florkin and Scheer, 1970) and more specifically during osmotic stress (Virkar and Webb, 1970). Further, the amino acids are essential intermediates in protein synthesis. Among the free amino acids (FAA), proline (Pyrrolidine -2- Carboxylic acid) is well known for its phenomenal accumulation in biological system under saline stress (Kathiresan, 1983). However, no such serious attempt has been made to investigate proline accumulation in estuarine and mangrove animals which are subjected to saline stress. This prompted the study of proline accumulation during larval development of *S. brockii* in response to its development and to changes in environmental salinity.

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MATERIAL AND METHODS

Ovigerous females of *S. brockii* were collected from Pichavaram mangroves and maintained in the laboratory at a salinity of 25±1 ppt, a temperature of 28±1°C and a photoperiod of 12h L: 12h D. After hatching the larvae were utilized for the analysis proline content.

The proline content of the samples was estimated using the method of Bates *et al.* (1973) with modification by Kathiresan (1983). Five mg. of newly hatched larvae were rinsed with distilled water and homogenized with 2 ml of 2% sulphosalicylic acid using pestle and mortar. The homogenate was centrifuged for 5 minutes at 4000 g to get a clear supernatant which was the proline source. 2 ml of this sample was mixed with 2 ml of glacial acetic acid and 2 ml of acid ninhydrin reagent. The tubes containing the mixture were incubated in a boiling water bath for 1 hour at 100°C and then cooled down by placing the tubes in an ice bath. Four ml of toluene was added to the mixture which was then shaken. The mixture was allowed to separate into two layers for 10-15 minutes. The upper layer was eluted using a pasteur pipette. The color intensity was read at 520 nm with a CECIL-303-Spectrophotometer. The same procedure was