Status of Sea Bass (*Lates calcarifer*) Culture In India

P.S.B.R. James and R. Marichamy*

CULTURE of carnivorous fish such as *Lates calcarifer* has gained importance in Southeast Asian countries in recent years. The giant perch or sea bass (locally known as 'bhekti') inhabits the brackishwater environment and is both eurythermal and euryhaline. Except in the Sunderbans area of West Bengal, and to some extent in other brackishwater areas along the east coast, no serious efforts for the culture of sea bass on a commercial scale are being made at present. In the traditional fisheries cultivation method of 'trapping and holding,' complete reliance is placed on the tidal influx to bring larvae and juveniles of this valuable species into the impoundment. Pillay (1958) and Hora and Nair (1944) have described the culture practices of the fish in brackishwater impoundments of the deltaic area of West Bengal.

A wealth of information on the biology and ecology of this fish is given by Jones and Sujansingani (1954), Jhingran et al. (1963), Jhingran and Natarajan (1966, 1969) and Patnaik and Jena (1976). The distribution pattern of different life stages in different ecosystems, such as coastal waters, estuaries, lagoons, brackishwaters, and even in fresh water, to aid in seed prospecting and procurement of breeders from the wild population is also known (De 1971; Ghosh 1973). Similarly, the growth pattern and reproduction of this species have been studied by Narasu (1939), Chacko (1956), Pillay (1954), Rao (1964) and Kowtal (1977). The present account also embodies the results of *Lates* culture carried out in a coastal pond at Tuticorin along the southeast coast of India.

Biology

Length-Weight Relationship

Ganguly et al. (1959) have given a detailed report on the length-weight relationship in a natural population of *L. calcarifer*, and concluded that the relationship does not differ significantly from Spencer's cubic law. De (1971) studied the length-weight relationship of postlarvae, fry and fingerlings of this species. The study revealed a strong positive correlation of these two parameters and obtained the equations for postlarvae (10–15 mm) as Log W = 6.41506 + 3.62342 Log L; for fry (16–45 mm) as Log W = 6.83589 – 3.188958 Log L; and for fingerling (50–200 mm) as Log W = 6.70072 – 3.22692 Log L. Based on the regression lines and length–weight relationship curves at different stages drawn from calculated values, the author indicated fastest growth when it feeds on zooplankton at postlarval stage. The growth rate gradually retarded at fry and fingerling stage when it feeds on insects and fishes respectively. The young ones and fry have been found to thrive well both in high and low salinity, being highly euryhaline.

Saha et al. (1978) analysed the interrelation between the growth of natural and controlled populations of *Lates* and found the total length–standard length relationship linear with a high regression coefficient for lower values in the control and natural groups and a lower regression coefficient for higher values in the control group. Patnaik and Jena (1976) have studied the length–weight relationship of this species based on 563 specimens regardless of sex, size and period of collection in the size range 24–1010 mm and 0.2–12 707 g and the relationship was found to be Log W = 2.9166 Log L – 4.70792.

Age and Growth

The size frequency of *L. calcarifer* is available for the period 1957–65 for the fishery of Chilka Lake. Jhingran and Natarajan (1969) have studied the average length of different age-groups by regression analysis. When modal values of sizes of constituent groups are plotted simultaneously, as many oblique rows as the age-groups are obtained. The authors followed the growth of species from young stages recruited to the fishery in February at size 162 mm and again in July–August at modal sizes 112–162 mm. The recruits reached an average length of 287 mm in 1 year and 492 mm in 2 years, 687 mm in 3 years and 799 mm in 4 years.

The fish generally grow to 300 mm and 500 g in 1 year. Mukhopadhyay and Karmakar (1981) observed that the growth of fish in 10 and 15‰ salinity to be equal but significantly different from the growth in other salinity levels. This range usually prevails in the sea bass of West Bengal during May–February and this period has been favourable for the faster growth of the

* Central Marine Fisheries Research Institute, Cochin, India.

pecies. The food intake is higher in the low-salinity ange. The higher rate of feeding and growth at lower alinities are the advantageous conditions to be rovided in the nursery stage of culture.

Alikunhi (1957) observed that sea bass grow to 450 mm in 1 year in fresh water. Hora and Pillay (1962) recorded an annual growth of 1.5–3 kg in a pond. The culture observations made by Ghosh (1971) indicated that the average growth in length was much faster in the first 3 months than during the subsequent period. The species attained an average length of 25.3 cm in the first year with a maximum of 50.7 cm in freshwater ponds at Kakdwip (West Bengal).

Food and Feeding Habits

Lates calcarifer is extremely predacious. It is a column feeder, with small fishes, shrimps, snails and worms being the important items of food. The species tends to be cannibalistic when food is scarce and if the pond is stocked with unequal size groups. Food and feeding habits of juveniles and adult *L. calcarifer* have been reported by Day (1878), Mookherjee et al. (1946), Menon (1948) and Pillay (1954). Chacko (1956) described this fish as highly carnivorous, feeding mainly on fishes such as *Mugil* spp., *Chanos chanos*, *Silago sihama*, *Elops indicus*, *Gobius*, *Stolephorous indicus*, *Spratelloides*, *Orizias*, *Aplocheilus* and on crustaceans (*Penaeus*, *Squilla*, *Acetes*, *Palaemon* and *Caridina*). The species also browses on rocks and consumes bivalves such as *Arca* and *Mytilus*. This perch ascends Godavari and Krishna rivers on the east coast of India to a distance of about 80 miles from the sea for feeding purposes. He further suggested that the species can be profitably used for culture in swamps and other weedy waters where there is abundant animal forage. De (1971) made a detailed study and gave indices of preponderance of food items in the gut contents of postlarvae (10–15 mm) *L. calcarifer*. Postlarvae are purely planktophagous, feeding on zooplankton and gradually switching over to entomophagous habit at the fry age. Fingerlings at the early stage prefer bigger insects and their nymphs, but gradually change to bigger crustaceans and fish. At this stage the species tends to be cannibalistic. Mukhopadhyay and Karmakar (1981) studied the effect of salinity on food intake, growth and conversion efficiency in juveniles of *L. calcarifer* and found higher food intake in 5–20‰ salinity range. The study revealed that the lower range of salinity is ideal for better metabolism of young fish. The diurnal variation in the feeding intensity has been established and the higher feeding rate observed during darker periods may be due to the predator dependence of nocturnal animals like shrimps and other crustaceans. The greater dependence on nocturnal prey requires the perch to increase its feeding activity during night.

Patnaik and Jena (1976) have given the composition of food items of *L. calcarifer* of different size groups. The planktonic forms of copepod nauplii and molluscan larvae constituted the food of young fish at 24–50 mm. The fish at 51–150 mm mainly consumed mysids, prawns and small fishes and bigger fish (above 150 mm) subsisted on fishes and prawns.

Migration

The migratory movements of young ones into estuaries, lagoons and brackishwaters have been observed by most of the workers as they appear to be the nursery grounds and offer scope for active feeding. Ghosh (1971) collected sea bass fry from Kulpi and Rajnagar in West Bengal situated 74 and 30 km respectively from the sea. Similarly, the adults ascend further into freshwater areas reaching the dams across the rivers. Chacko (1949) reported the occurrence of the fish from lower Anicut of Coleroon River. Chacko (1956) has also recorded the migration of this species in Godavari and Krishna rivers up to a distance of 80 miles from the sea. The species was reported (Anon 1951) to ascend about 130 km from the sea for feeding.

Spawning

The spawning season, breeding grounds and attainment of maturity of sea bass seem to vary according to the location. Generally, the fish spawns from January to August.

The gonads of *L. calcarifer* are strongly dimorphic and the sexuality of the species led Moore (1979) to the conclusion that it was a protandrous hermaphrodite. Based on the length-frequency study he noticed a dominant mode for mature males at 89.5 cm and a smaller mode for females at 101.5 cm and established sex ratio as 3.8:1 favouring males. Lack of sampling of large numbers of fish belonging to different size groups due to its high cost and non-availability at times are the limiting factors for the absence of adequate information on sex-ratio of the species in Indian waters. Hermaphroditism and indeterminate condition of the sex in young fish may also be the causes for lack of information in this area.

Jhingran and Natarajan (1969) determined the minimum size at first maturity of the species as 425 mm in year II. Alikunhi (1957) and Chacko (1956) found the size range of breeders from 50 to 60 cm and the breeders to occur close to the river mouths during the colder season. Patnaik and Jena (1976) encountered the smallest mature female at 700 mm and male at 505 mm (TL).

Naidu (1939) observed sea bass breeding in the Sunderbans in the winter season, where large numbers of young ones were seen in the pools and ditches on the sides of estuaries in April. Jhingran and Natarajan (1969) observed mature specimens during April–July and suggest two peaks of spawning: one in January-

March and the other during June–July. Rao (1964) and Shetty et al. (1965) on the basis of availability of ripe specimens and large numbers of fingerlings (60–80 mm) have inferred October–November to be the breeding period for Mahanadhi sea bass. De (1971) suggests the breeding season of *L. calcarifer* to be July–August from the occurrence of postlarvae (10–15 mm) in the vicinity of Junput in West Bengal. In Madras area, the breeding is reported to occur in the inshore areas at the mouths of estuaries (Anon 1951). Gopalakrishnan (1972) collected the fry of this species in good numbers from Kulpi on Hoogly River and Thakuran and Matlah rivers during May–October. Rao and Gopalakrishnan (1975) observed the fingerlings 50–70 mm long in the northern sector of Pulicat Lake in May–June. Patnaik and Jena (1976) recorded mature specimens during April–July and ripe fish as well as spent fish in the outer channel of Chilka Lake during May–June and advanced fry measuring 22–52 mm in the mouth area of the lake during July–September. They have estimated the fecundity of the species to be 0.76 million eggs/kg of fish at one spawning and the results are comparable to those of Dunstan (1959).

A number of workers (Chacko 1949, 1956; Jones and Sujansingani 1954; Jhingran et al. 1963; Jhingran and Natarajan 1969; and Patnaik and Jena 1976) have concluded that the species is catadromous, spawning and hatching taking place in the sea. The advanced fry and fingerlings move into the lake for feeding and growth. But this species migrates upstream for breeding in Thai waters and Smith (1945) assumed that the fish is anadromous. Rao (1964) suggests the possibility of *L. calcarifer* breeding at Hukitola Lake in Mahanadhi estuarine system in India. Based on the collection of ripe and oozing specimens of this species from Kaluparaghat area in the northern sector of Chilka Lake during May–June, Kowtal (1976, 1977) suggests the possiblity of this fish breeding in the lake beside the adjoining water of Bay of Bengal.

Early Life History

Mukhopadhyay and Verghese (1978) have described the techniques of collection and segregation of the fry of *L. calcarifer* with notes on identification of larvae. Ghosh (1973) gave useful aids for identification of the larvae and juveniles ranging between 6 and 69 mm. De (1971) in his detailed report on the biology of postlarvae and juvenile stages of *Lates* tabulated the morphomeristic features of different size groups and revealed easy distinguishing external characters for identification of postlarvae 10–15 mm, fry 16–45 mm and fingerlings up to 200 mm. The fry of *Lates* above 2 cm have a close resemblance to the adult in general body contour and other features, except in colour. The bands of black chromatophores extending between dorsal and ventral, rayed dorsal and anal and at caudal base are useful aids for field identification. The white stripe originating from the tip of the snout extending up to 1st dorsal on the head and the presence of preopercular spine are useful for field collection.

Information on the abundance and distribution of sea bass fry is better known from the east coast of India. Estuaries of the various river systems particularly the Hoogly-Matlah, Mahanadhi, Krishna, Godavari and the coastal lakes like Chilka and Pulicat and lagoons and tidal creeks are rich sources as they form nursery areas and ideal shelter for this species. Intertidal pools with grassy vegetation in Sunderbans have been identified by many earlier workers as the main source for collection of *Lates* seed. The fry gain entry into nursery areas of West Bengal along with the tide (Jhingran 1983). The distribution of this fry in Muthupet saline swamp has been reported by Chacko (1949). De (1971) recorded a swarm of postlarvae entering Junput Brackishwater Fish Farm at Contai, West Bengal, along with the high tide during July–August in a new moon period. They get nursed and reared there till the subsequent full moon tide occurs when they get caught.

Fry and fingerlings of *L. calcarifer* are collected by small meshed drag-nets and cast nets (Hora and Pillay 1962). Happa net is widely used for collection of fry at the end of the high tide. The spawn collection net is fixed against the receding tide in creeks. The collections are filtered through a tray of 2-mm mesh. *Lates* fry less than 6 mm will pass through this filter retaining the large specimens of other groups in the sieve. The scoop net collections contain fry of the size range 4–45 mm. The seed was abundant in the collections made at Kakdwip. The catch per net per hour in the happa net was 140 during May and the catch by shooting net was 167/net/hour during July (Mukhopadhyay and Verghese 1978). Ghosh (1971) made some observations on transportation and acclimatisation of sea bass fry from collection centres at Kulpi and Rajnagar to Kakdwip Farm in West Bengal and found that no mortality occurred when the collections were kept in enamel hundies. The fry are hardy and withstand transportation without oxygen for 2–3 hours. The system can be improved and more seeds can be packed in collapsible type of oxygenated polythene seed transportation bags now available. Studies on quantitative distribution of the seed in space and time for charting out potential grounds and for evolving suitable methods for collection of seed should be conducted for successful farming.

Culture

India possesses vast stretches of cultivable estuaries and brackishwater areas estimated by different authors at 1.4 to 2.02 million ha. The brackishwater fish culture practice has been in vogue for a long time in Kerala and West Bengal. In general, the aquaculture systems are categorised into extensive, semi-intensive

and intensive systems. The extensive system includes unselective stocking accomplished by the seed being carried in by the rising tides, holding them to grow, feeding on available natural food without any control over predators and harvesting them periodically. More recently, the Central Inland Fisheries Research Institute and Central Marine Fisheries Research Institute have started projects on culturing *L. calcarifer* on an experimental level under a semi-intensive system.

Due to the vagaries of nature, a dependable supply of seed from natural sources cannot often be ensured. Production of *Lates* seed by induced breeding and stripping may become practicable since possibilities for the collection of breeders from lakes are reported by several workers. The main constraint in the culture of the species is the availability of seed. However, till such time as induced breeding techniques are perfected for production of seed, the culture of *Lates* will have to depend on seed available in nature.

Methods of Culture and Review of Results

Lates calcarifer can be profitably cultured in ponds, net cages and pens. Most of the traditional culture practices in the country are made in ponds. In Thailand and Singapore rapid development of cage culture has taken place. The carnivorous fish are normally reared in floating cages as they need sufficient depth and flow of water.

Available information on the culture of this species is scarce, with little detail on survival or production rates. Information such as stocking rate, feeding practices, environmental monitoring and other farm management practices is lacking. Pillay (1954) observed sea bass fry that entered ponds at 2–5 cm size during rainy months attain a size of about 12.5 cm by October–November, attaining an average growth up to 25 cm in the second year. Better growth results are recorded in the culture of *Lates* in paddy fields in West Bengal. *Lates* entering the paddy fields in September at an average size of 12.9 cm was found to grow to 21.5 cm in October and 36.4 cm in November. This striking growth was attributed to the presence of forage fish as food (Pillay and Bose 1957). Another freshwater culture experiment conducted by Ghosh (1971) also indicated much faster growth in the first 3 months from a stocking size of 38–205 mm. The fish attained an average size of 253 mm in 1 year. Prior to stocking of *Lates*, the pond was already stocked with a variety of fish seeds to serve as forage fish. Jhingran (1977) recorded a gross production of 2759.5 kg/ha in 8 months by rearing *Lates* in feeder canals during the production phase. This was possible because of the surplus of natural food organisms like prawn fry and fish brought in by the tidal water.

This species is also cultured in sewage-fed ponds using *Tilapia* as forage fish by a team of workers in CIFRI Barrackpore. Prasadam et al. (1984) tried to culture this fish in pen and cage in lagoon system at Pulicat Lake, and found the fingerlings stocked at 142 mm/30 g in velon cages in September 1983 grew to 164 mm/339 g and 208 mm/496 g with survival rate of 50–55% in a period of 14 months.

The results of culture experiments carried out in coastal ponds at Tuticorin are presented in Table 1. The particulars of the culture site are described in Marichamy and Rajapackiyam (1982). The seeds for stocking are gathered from other ponds at the time of harvest of earlier experiments. Young *Lates* stocked at an average size of 217 mm in March 1983 have grown to 424 mm/878 g in a period of 15 months in the first experiment. In the subsequent experiment the stock released at 285 mm during September 1984 progressed to 472 mm/953 g in 17 months duration. The monthly average growth rate varied from 10 to 17 mm/20 g to 80 g in these size groups. The big fish were lost due to

Table 1. Results of experimental culture of *Lates calcarifer* in coastal ponds.

Size of pond(m)	Stock No.	Rate of stocking/ ha	Date of sampling	Size range (mm)	Average size (mm)	Wt. range (g)	Average wt.(g)	Average growth: Size (mm)	Average growth: Wt. (mm/g)	Overall average growth (%)	Survival rate
60×42	26	104	18.3.83	176–255	217.0	65–205	138.0	—	—		
			30.6.83	230–275	254.0	165–250	208.0	10.0	20.0		
			30.9.83	284–325	310.7	320–565	460.3	14.4	76.5		
			30.12.83	332–365	350.4	556–692	641.6	13.9	52.4		
			21.3.84	390–440	415.0	710–865	791.0	15.7	51.8		
			28.7.84	370–485	424.0	590–1350	875.0	12.5	44.4	12.5/44.4	77.0
60×42	44	176	18.9.84	235–340	285.0	110–385	225.0	—	—		
			27.12.84	270–375	326.4	166–468	338.7	12.4	34.1		
			28.3.85	338–440	393.3	615–866	734.0	17.0	80.4		
			25.6.85	385–470	418.0	680–1025	807.3	14.2	62.4		
			29.9.85	405–478	435.8	702–1040	846.1	12.0	41.7		
			26.12.85	446–482	469.0	780–1070	945.0	11.8	46.5		
			1.3.86	428–520	472.0	790–1200	953.4	10.5	41.3	10.5/41.3	45.5

poaching in the farm. The fish were fed with frozen trash fish at 10% body weight. The results were better than those obtained at Pulicat Lake in the cage culture system. The growth recorded by Dhebtaranon et al. (1979) on *Lates* in net cages was more or less similar to the present observation, but gain in weight was more in Thailand. When compared to brackishwater culture, the present results are lower, since the salinity in the pond was well above (35–54‰) the normal salinity of sea water during most of the period. It appears that low salinity and live food in the form of forage fish promotes the growth of *Lates* in culture system.

The present observations indicated that better water exchange in the culture site, particularly to maintain the salinity at least equivalent to open bay water around 33‰ and the supply of fresh trash fish obtained from commercial trawlers as food and stocking rate at 400/ha would be suitable conditions for increasing production.

Marketing and Commercial Aspects

A good demand exists for the fish as it is esteemed as a highly delicious fish and also fetches a fair price. The bulk of the catch is handled by intermediaries who sell either direct to consumers in retail markets or to markets where it is auctioned. From places where it is cultured, the catch is transported by a variety of means to consumer markets or storage establishments. Most of the collections are sent to Calcutta markets and sometimes preserved in ice for transportation to distant places.

Lates is cultured in freshwater paddy fields by private farmers in eastern India. Larger farms in Sunderbans area are organised by Central or State Fisheries departments and no organised hatchery for the species has been developed so far in the country.

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