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MULLET SEED RESOURCES OF PICHAVARAM MANGROVE, SOUTHEAST COAST OF INDIA*

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ABSTRACT

Observations on the abundance and distribution of juveniles of mullets *Mugil cephalus* and *Liza* spp. were made for a perod of two years from April 1980 to March 1982. By using velon screen drag net and cast net 1934 seeds were collected. Seeds of *Mugil cephalus* constituted 33.66% and *Liza* spp. 66.34%. Availability of seeds were found to be round the year with peaks of abundance during late monsoon, early postmonsoon and summer seasons. Salinity and water temperature were found to influence the temporal variations of seeds. A note on the potential mullet seed resources and scope for brackishwater mullet culture in this region is appended.

INTRODUCTION

THE IMPORTANCE of shellfish and finfish culture as a positive means for increasing fish production has long been realised and even the countries which traditionally depend on their capture fisheries have now turned their attention to culture operations. Adequate and timely supply of quality seeds are fundamental to any organised fish farming programme and the utilisation of available natural resources is a priority consideration in this regard. Mullets are the important group of fishes being considered for culture purposes in the Indian coastal waters (Rao and Gopalakrishnan, 1975 ; Gopalakrishnan and Ghosh, 1976 ; James *et al.*, 1984 b). Studies on the availability and seasonality of mullet seeds have been made throughout the Indian coastal areas (Sorojini, 1958 ; Jhingran and Natarajan, 1969 ; Rao, 1970 ; James *et al.*, 1984 a ; Jayabalan *et al.*, 1984). Observations have been made earlier on the occurrence of number of mullet species, their early life history and feeding habits in Pichavaram mangrove area (Prince Jeyaseelan and Krishnamurthy, 1980 ; Krishnamurthy and Prince Jeyaseelan, 1981 ; Krishnamurthy *et al.*, 1984). However, a complete study on the abundance and distribution of juveniles of mullets has not yet been made in this area. Therefore the present study had been undertaken in order to evaluate the seasonal abundance, spatial distribution and the probable factors that influence the distribution of mullet seeds in the Pichavaram mangrove waters.

MATERIALS AND METHODS

Pichavaram mangrove (11°27'N ; 79°47'E) is located 200 km south of Madras city and 10 km south of Parangipettai (Porto Novo) in the Tamil Nadu State covering an area of 1100 ha. The mangrove lies between the Vellar-Coleroon estuarine complex bordered

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by the Vellar Estuary in the north and the Coleroon estuary in the south. The neritic water which enter-in through the estuarine mouths predominates in the mangrove for most part of the year, while the irrigation channels contribute freshwater intermittently and much more during the northeast monsoon season (October-December). The mean tidal amplitude is 0.5-1.0 m. The water areas have muddy and silty bottom with alluvium deposits as peats. Four different sampling sites situated well apart from each other were selected for the present study (Fig. 1).

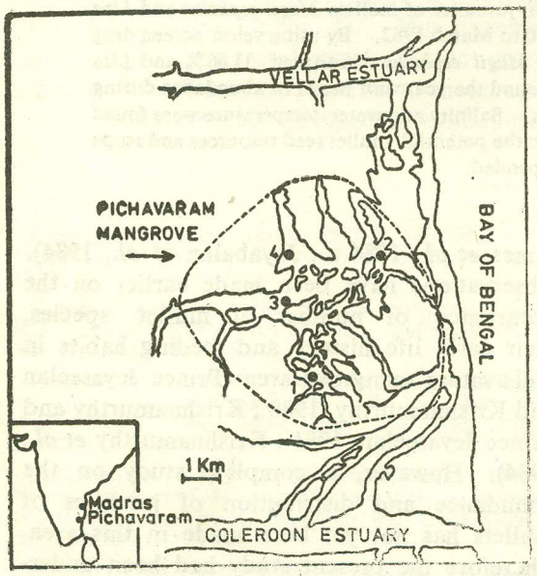

FIG. 1. Location of the four sampling sites in Pichavaram mangrove.

Fortnightly collections of seeds were made from all the four sampling sites from April 1980 to March 1982. Two types of gears (i) the velon screen drag net (1980-82) and (ii) the cast net (1981-82) were used to collect the seeds. The velon screen dragnet measuring 2×0.75 m in dimension with a mesh size of 2 mm was hauled in shallow water for a distance of nearly 6 m. The cast net measuring 4.5 m in diameter (while stretched) with a mesh size of 7 mm was thrown five times during collection at each sampling site. Both the gears were operated at random in each sampling site and quantitative estimations were made based on the number of individuals (seeds) obtained per unit area.

Data on rainfall were obtained from the meteorological unit of this centre. Surface water temperature was recorded *in situ* with a mercury celsius thermometer marked to 0.1°C accuracy. Salinity and dissolved oxygen content of the water were estimated following the methods outlined by Strickland and Parsons (1972).

RESULTS

Abundance and distribution of seeds

Mugil cephalus : 651 seeds contributing 33.66% of the total mullet fry were encountered during the period of study. They occurred at all the sampling sites and were available round the year. More number of seeds were collected at sampling site III followed by sites II, IV and I (Table 3). However, the differences in their numbers between the sampling sites were not significant. Two peaks of abundance, a primary one during late monsoon — early postmonsoon (December - February) and a secondary peak during summer (April-May) could be observed during the first year (Fig. 2). In second year, one peak during summer 1981 and another at postmonsoon — early summer of 1982 (January-March 1982) were noted. Less number of seeds were collected during late premonsoon and early monsoon (August-September), and in October 1980 a total absence of seeds of this species was observed.

Total length of juveniles collected by velon screen dragnet samples ranged between 15.0 and 42.0 mm and 42.0 to 83.0 mm for cast net samples (Table 1). The monthly mean values of total length ranged between 16.0 and 24.3 mm for velon screen drag net samples and from

45.0 to 67.4 mm for cast net samples. Relatively large sized seeds occurred in the summer and postmonsoon seasons.

during summer (April-May) and another during late monsoon — postmonsoon (December-February) were observed (Fig. 2). During pre-

TABLE 1. *Total length (mm) of seeds of* Mugil cephalus *collected from the Pichavaram mangrove during* 1980-82

Month	Velon screen net			Cast net		
	Min.	Max.	Mean	Min.	Max.	Mean
April 1980 ..	15	19	16.57			
May ..	15	21	17.21			
June ..	16	22	18.62			
July ..	—	—	17.00			
August ..	—	—	17.00			
September ..	—	—	19.00			
October ..	—	—	—			
November ..	15	33	18.48			
December ..	15	38	17.45			
January 1981 ..	15	21	16.00			
February ..	18	28	20.74			
March ..	17	36	22.41			
April ..	16	31	18.32	44	62	49.32
May ..	18	38	21.56	52	73	58.80
June ..	19	42	24.32	48	81	63.10
July ..	16	20	18.00	—	—	—
August ..	—	—	—	50	59	55.40
September ..	—	—	—	52	61	56.20
October ..	—	—	—	—	—	45.00
November ..	—	—	—	—	—	54.00
December ..	18	26	21.0	38	64	49.00
January 1982 ..	16	27	19.68	51	71	58.20
February ..	15	36	21.53	52	83	67.40
March ..	16	27	19.11	50	78	65.50

Liza spp. : This group was represented by 1283 seeds constituting 66.34% of the total mullet seed catch. At all the four sampling sites, seeds of this genus were recorded throughout the year, except during October of both the years. The sitewise distribution of seeds was found to be in the order : I, IV, III and II. Nevertheless, the differences between the sampling sites, quantitatively, were insignificant (Table 3). The peaks of abundance, one monsoon — early monsoon (August-October) lesser number of individuals occurred.

Total length of seeds collected by velon screen drag net ranged between 13.0 and 42.0 mm and the cast net samples between 39.0 and 85.0 mm (Table 2). The mean size ranged from 15.0 to 23.4 mm for velon screen drag net samples and from 48.5 to 73.2 mm for cast net samples. Large sized juveniles were common during

late summer — postmonsoon (June-August) in samples collected using both velon screen drag net and east net.

estuarine and coastal waters. Seeds of *M. cephalus* and *Liza* spp. were encountered, in the present investigation, throughout the year

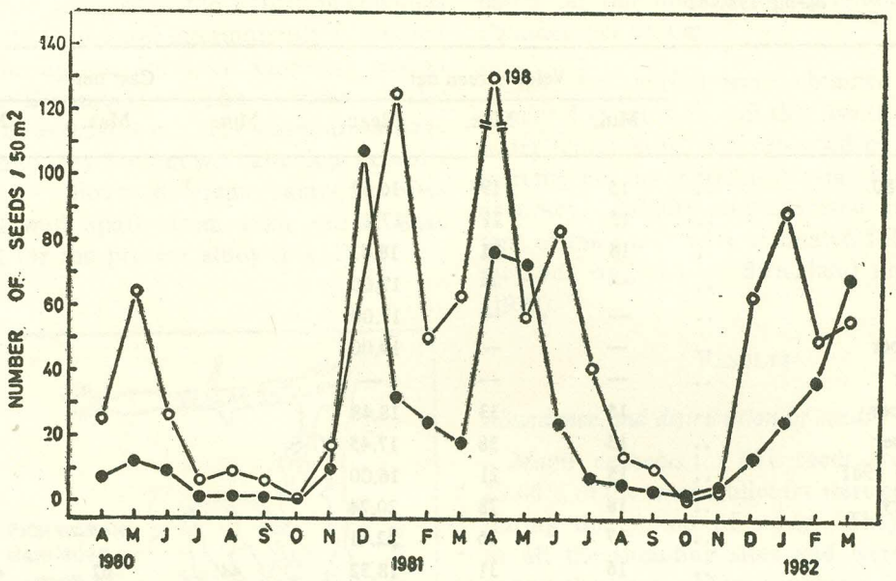

FIG. 2. Variations in the abundance of *Mugil cephalus* (●——●) and *Liza* spp. (○——○) seeds at Pichavaram mangrove during April 1980 - March 1982.

Hydrological parameters

The surface water temperature ranged from 20.0 to 36.0°C with a mean of 30.14°C. The salinity was fluctuating from 1.03 to 35.01 ppt with a mean value of 16.09 ppt. The dissolved oxygen content of the water ranged between 1.70 and 10.43 ml/l and the mean value recorded was 5.46 ml/l (Table 3). There were no marked variations in the parameters among the sampling sites. The temporal variations in seed abundance correlated positively with salinity and negatively with temperature.

DISCUSSION

The results of the present investigation at Pichavaram mangrove area share a number of features in common with studies on the abundance and distribution of mullet seeds in various

and were collected in large numbers during summer, late monsoon to early postmonsoon seasons. Round-the-year occurrence of mullet seeds have been recorded earlier in Kulti Estuary of West Bengal (Thakur, 1975), Hooghly—Matlah estuarine systems (Gopalakrishnan *et al.*, 1976), Madras coastal waters (Basheeruddin and Nayar, 1962), Vellar Estuary (Jayabalan *et al.*, 1984), Tuticorin waters (Natarajan *et al.*, 1980) and Mandapam coastal waters (James *et al.*, 1984 a).

Continuous recruitment of larvae and post-larvae, their growth, short or long term residential phase in estuarine and brackishwater areas and their emigration as late juveniles, result in the succession of juvenile populations. Although reproductive activities of coastal marine fishes often extend for a considerable

period of the year, there are certain times in a year when unusually large number of species and many individuals in each species reproduce. Such periods are referred to as spawning peaks which were found to be alike in many tropical coastal waters, indicating a possible environmental influence over spawning strategy (Johannes, 1978). The bimodal pattern of recruitment of mullet seeds observed in the present investigation indicates such collective spawning peaks, with subsequent recruitment into the mangrove during summer and post-northeast monsoon seasons.

Round the year availability of mullet seeds with their mean size around 20 mm could be attributed to their protracted spawning periods. Nearly 10 species of mullets, predominantly the genus *Liza* have been recorded from Pichavaram mangrove (Krishnamurthy *et al.*, 1984). As such, the perpetual occurrence of smaller size groups of *Liza* spp. could be explained as due to seasonal spawning and recruitment of each species (in different combinations) overlapping with periods of recruitment, all these resulting in a continuous recruitment pattern. Kurian (1975) also suggested that

TABLE 2. *Total length (mm) of seeds of* Liza *spp. collected from the Pichavaram mangrove during* 1980-82

Month	Velon screen net			Cast net		
	Min.	Max.	Mean	Min.	Max.	Mean
April 1980 ..	14	31	18.20			
May ..	15	27	16.50			
June ..	13	38	15.80			
July ..	17	22	19.20			
August ..	17	24	20.40			
September ..	14	19	16.00			
October ..	—	—	—			
November ..	14	38	18.32			
December ..	16	42	20.34			
January 1981 ..	14	23	16.36			
February	15	20	18.55			
March ..	14	34	19.32			
April ..	17	36	21.43	52	81	66.00
May ..	16	28	19.51	42	62	52.30
June ..	18	29	22.00	48	76	69.90
July ..	17	27	20.71	54	85	72.83
August ..	14	21	17.30	65	81	73.25
September ..	14	18	15.00	49	82	58.20
October ..	—	—	—	—	—	—
November ..	16	28	20.68	39	54	48.50
December ..	15	32	21.80	48	71	52.00
January 1982 ..	18	41	23.40	59	70	63.08
February ..	15	32	20.20	62	75	68.20
March ..	14	26	15.30	52	76	58.00

availability of mullet seeds in brackishwater systems, in general, might be due to differential recruitment periods for different species.

Temperature and salinity are known to have significant correlations with dispersal of organisms, which either show an increase or decrease in their numbers depending upon an increase or decrease of temperature and/or salinity (Horn and Allen, 1981). The physico-chemical conditions of Indian (tropical) coastal ecosystems, in general, seem to be influenced by monsoonal rains (southwest and northeast monsoons). Changes in salinity associated with rainfall and flooding-in by freshwater do seem to influence the distribution of mullet seeds in the Pichavaram mangrove. A distinct decline in the seed abundance when salinity was at its minimum and peaks at the time of high salinity are evidence for the strong influence of salinity over their temporal distribution. A similar situation had been also observed for mullet and other fish juveniles in various coastal biotopes (El-Zarka *et al.*,

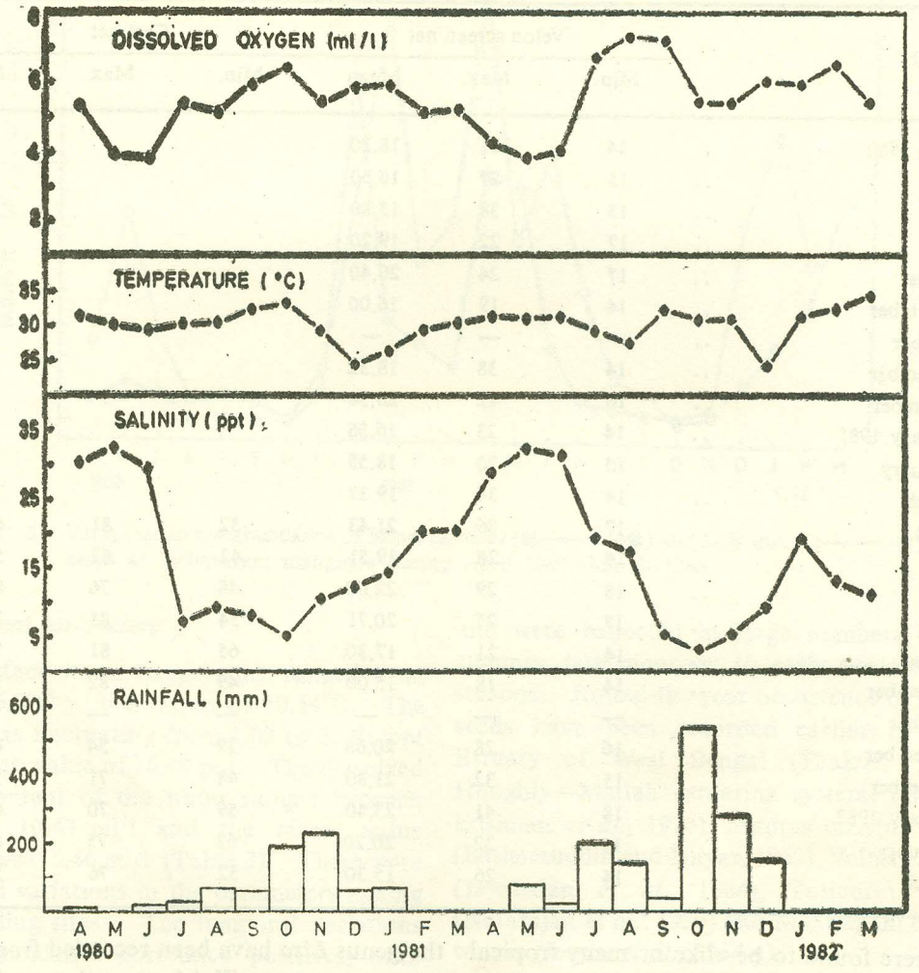

FIG. 3. Rainfall and hydrological parameters recorded at Pichavaram mangrove for the period April 1980 - March 1982.

1970 ; Thakur, 1975 ; Cavalcanti *et al.*, 1979). Reduction in salinity of the whole mangrove ecosystem during monsoon might have eliminated or reduced the juvenile populations as observed presently and subsequent sharp increase in the populations during late monsoon and early postmonsoon could be attributed to the triggering of spawning activity in and around the mangrove and re-establishment of the juvenile populations.

TABLE 3. *The mean and range (in parentheses) of hydrological parameters and mullet seed distribution at four different sampling sites of the Pichavaram mangrove*

Sampling site	Salinity (ppt)	Water temperature (°C)	Dissolved oxygen content (ml/l)	Seeds of *Mugil cephalus* (%)	Seeds of *Liza* spp. (%)
I ..	14.96 (1.52—33.51)	30.24 (21.0—36.0)	5.28 (1.70—10.21)	21.35	31.02
II ..	17.95 (2.03– 34.52)	30.14 (21.0—35.0)	5.27 (2.25– 9.64)	24.12	18.16
III ..	15.38 (1.03– 35.01)	29.98 (20.0– 36.0)	5.37 (2.27– 10.21)	30.57	21.51
IV ..	16.08 (1.52—32.51)	30.19 (20.0—35.0)	5.93 (2.40—10.43)	23.96	29.31

Temperature is considered to be a significant factor influencing the distribution of animals in estuarine and backwater environments (Kinne, 1963 ; Gunter, 1967 ; Subrahmanyam and Coultas, 1980). An inverse relationship has been observed for the mullet seeds and temperature in the present study. Because of the very shallow nature of the sampling sites, the populations inhabiting these areas might be subjected to fluctuations in water temperature. Most probably, the fish juveniles inhabiting these shallow areas might migrate to the deeper areas of channels or else move to some sheltered areas, such as, the prop-roots or the weeds which are abundant in that area, so as to avoid the warmer areas at the times of higher water temperature, especially during summer. Relatively more number of finfish seeds collected during night than in day collections (Chandrasekaran, 1986) also supports the above phenomenon.

PROSPECTS OF MULLET CULTURE IN PICHAVARAM MANGROVE

The Pichavaram mangrove covers a 12 km stretch of brackishwater areas, shallow and suitable for culture operations. The right range of salinity, temperature (except during monsoon), high litter production of 6.24-14.56 tonnes/ha/year (Muniyandi, 1985) and thereby the high organic carbon content and rich detritus of this area promise scope for mullet farming. Construction of dykes and preparation of ponds in these shallow areas may affect the ecosystem by altering not only water quality, but also the water flow and mixing up of valuable nutrients and detritus. The proper utilization of this mangrove water body for culture practice can therefore be achieved best by constructing pens in shallow areas and floating cages in relatively deeper channels.

From the present survey, it is concluded that sufficient number of mullet seeds (normally 1.0-1.6 seeds/m²) could be collected throughout the year, except during the 3 months period of late premonsoon — early monsoon (August

October) and good numbers (2-4 seeds/m)^2 during peak seasons. Therefore two crops of profitable mullet culture operations could be planned for every six months during June-November and December-May of each year, coinciding well with the peak periods of seed abundance, which will be helpful in stocking the farm at the start of each crop.

REFERENCES

BASHEERUDDIN, S. AND K. N. NAYAR 1962. A preliminary study of the juvenile fishes of the coastal waters off Madras city. *Indian J. Fish.*, **8** (1) 169-188.

CAVALCANTI, L. B., P. A. COELHO, E. E. LECA, J. A. C. LUNA, S. J. DE MACEDO AND M. N. PARANGUA 1979, Ecological conditions in the Suape area (Pernambuco. Brazil). *UNESCO Reports in Marine Science*, **9** : 1-29.

CHANDRASEKARAN, V. S. 1986. *Studies on prawn and finfish seed resources of the Pichavaram mangrove (Southeast coast of India)*. Ph.D. Thesis, Annamalai University, 218 pp.

El-ZARKA, S., A. M. El-MAGHARABY AND K. H. ABDEL-HAMID 1970. Sudies on the distribution' growth and abundance of migrating fry and juveniles of mullet in a brackish coastal lake (Edku) in U.A.R. *Gen. Fish. Coun. Medit.*, **46** :1-19.

GOPALAKRISHNAN, V. AND A. GHOSH 1976. The mullet resources of the Hooghly-Matlah estuarine system in West Bengal, India — A case study. *IPFC/76/SYM/12* : 1-8.

GOPALAKRISHNAN, A., K. K. BHANOT, S. N. DATA AND S. B. SAHA 1976. Procurement of stocking material for brackishwater fish culture from the Hooghly-Matlah estuarine system. *J. Inland Fish. Soc. India*, **7** : 216-224.

GUNTER, G. 1967. Some relationship of estuaries to the fisheries of the Gulf of Mexico. *Publ. Am. Assoc. Adv. Sci.*, **83** : 622-628.

HORN, M. H. AND L. G. ALLEN 1981. Ecology of fishes in Upper Newport Bay, California : seasonal dynamics and community strucure. *Mar. Resource Tech. Rep.*, **45** : 1-102.

JAMES, P. S. B. R., V. S. RANGASWAMY, A. RAJU AND G. MOHANRAJ 1984 a. Studies on diurnal variations in the occurrence of grey mullet seed at Mandapam. *Proc. Symp. Coastal Aquaculture, MBAI*, **3** : 765-775.

———, G. MOHANRAJ, V. S. RENGASWAMY AND A. RAJU 1984 b. Preliminary experiments on the culture of grey mullets at Mandapam. *Ibid.*, **3** : 791-796.

JAYABALAN, N., G. S. THANGARAJ AND K. RAMAMOORTHI 1984. Finfish seed resources of Vellar Estuary. *Ibid.*, **3** : 742-749.

JHINGRAN, V. G. AND A. V. NATARAJAN 1969. A study of the fisheries and fish populations of the Chilka Lake during the period 1957-'65. *J. Inland Fish. Soc. India*, **1** : 49-126.

JOHANNES, R. E. 1978. Reproductive strategies of coastal marine fishes in the tropics. *Env. Biol. Fish.*, **3** (1) : 65-84.

KINNE, O. 1963. The effects of temperature and salinity on marine and brackishwater animals. *Oceangr. Mar. Biol., Annu. Rev.*, **1** : 301-340.

KRISHNAMURTHY, K. AND M. J. PRINCE JEYASEELAN 1981. The early life history of fishes from Pichavaram mangrove ecosystem of India. *Rapp. P.-V. Rivn. Cons. int. Explor. Mer.*, **178** : 416-423.

———, ——— AND M. A. SULTAN ALI 1984. The distribution of fishes in the global mangroves. *Curr. Sci.*, **53** (17) : 901-906.

KURIAN, C. V. 1975. Mullets and mullet fisheries of India. *Aquaculture*, **5** (1) : 114.

MUNIYANDI, K. 1985. *Studies on mangroves of Pichavaram (southeast coast of India)*. Ph.D. Thesis, Annamalai University, 215 pp.

NATARAJAN, P., N. RAMANATHAN AND K. VENKATARAMANUJAM 1980. Fish and prawn seed resources of Tuticorin. *Proc. Seminar on coastal and inland fish culture in Tamilnadu, Tuticorin*, 25 April 1980, pp. 275-281.

PRINCE JEYASEELAN, M. J. AND K. KRISHNAMURTHY 1980. Role of mangrove forests of Pichavaram as fish nurseries. *Proc. Indian natn. Sci. Acad.* B **46** (1) : A8-53.

RAO, A. V. P. 1970. On the seasonal abundance of larvae and juveniles of cultivable brackishwater fish in the Pulicat Lake. *IPFC/C-70/SYM.*, **30** : 1-23.

——— AND V. GOPALAKRISHNAN 1975. Seed resources and bionomics of culturable brackishwater fishes of India. *J. Inland Fish. Soc. India*, **7** : 142-155.

SAROJINI, K. K. 1958. On the collection, acclimatization and transport of mullet seed in West Bengal (India). *J. Bombay Nat. Hist. Soc.*, **55** (1) : 42-53.

STRICKLAND, J. D. H. AND T. R. PARSONS 1972. A practical handbook of sea water analysis. *Bull. Fish. Res. Bd. Canada*, **167** : 310 pp.

SUBRAHMANYAM, C. B. AND C. L. COULTAS 1980. Studies on the animal communities in two north Florida salt marshes. Part 3. Seasonal fluctuations of fish and macro-invertebrates. *Bull. Mar. Sci.*, **30** (4) : 790-818.

THAKUR, N. K. 1975. Observations on the availability of brackishwater fish seed in the Kulti Estuary, West Bengal. *J. Inland Fish. Soc. India*, **7** : 105-108.