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ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

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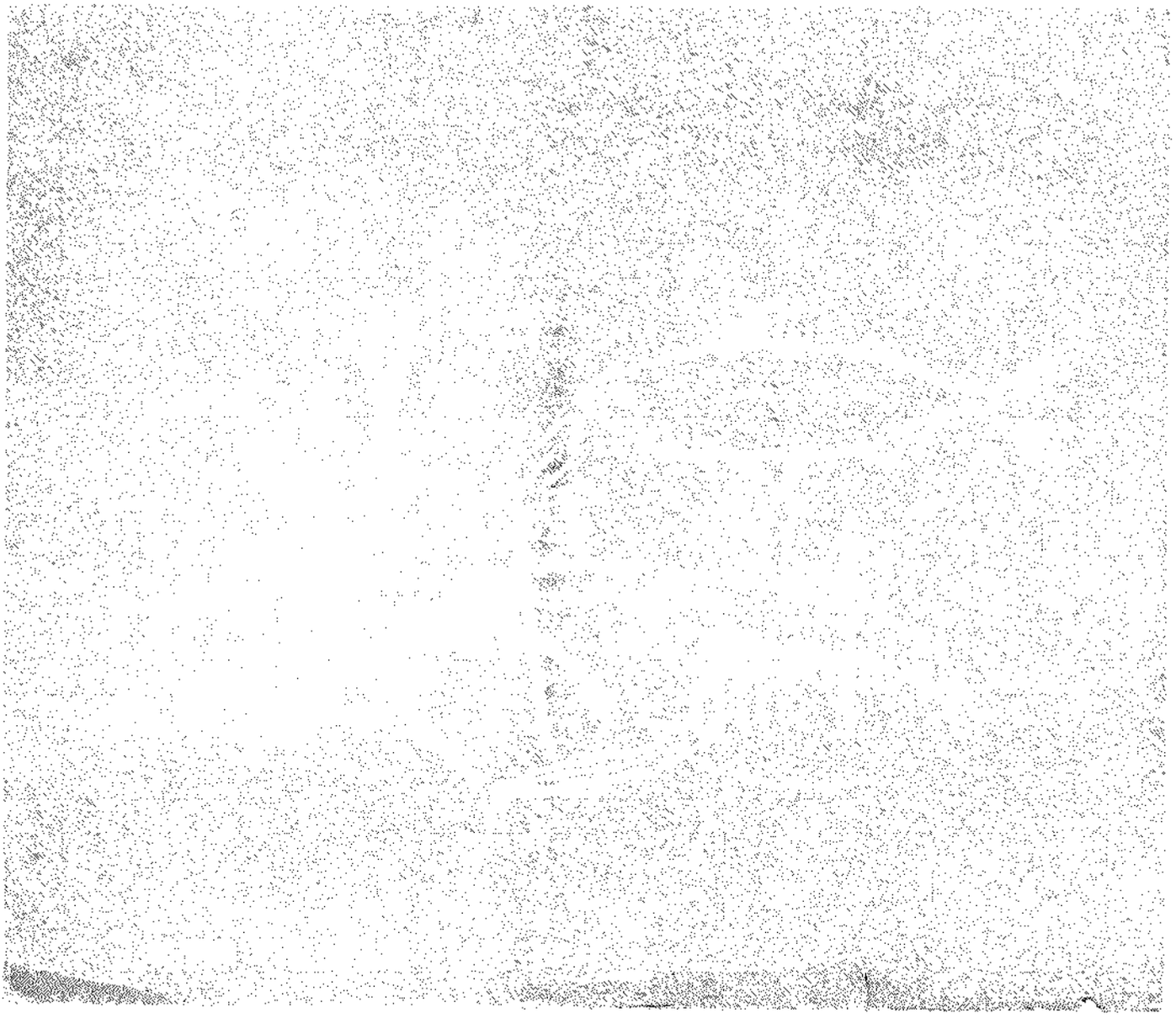

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CULTURABLE MARINE FISH FRY RESOURCES FROM BRACKISH-WATER ENVIRONMENTS

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ABSTRACT

The wealth derived from estuaries, backwaters, salt marshes and similar saline environments cannot be underestimated while assessing the marine resources. The fact that these saline regions, which represent an important connecting zone in the transition from land to sea, constitute an integral part of the overall marine environment is also well recognised. Vulnerability to human influence is an advantageous characteristic of the coastal brackish-waters, unlike the open sea which still remains beyond man's control.

Many of such brackish-waters represent unified ecosystems and are areas of high fertility, supporting a variety of biological life. Surrounding these areas there is invariably a rich natural fishery which is of considerable significance in the rural economy of developing countries like ours. Besides such a lucrative fishery, enormous amounts of culturable fish fry are also caught from these areas. It has been estimated that several lakhs of milk-fish fry are collected every year from certain centres along the coast of South India. However, we are at present tapping only a fraction of this potential source. With the expansion of our coastal fish farming activities, many of the existing fry collection centres could be developed into centres of fish fry trade. The paper thus discusses in some detail the various aspects connected with the brackish-water environments and their resources.

INTRODUCTION

WHILE taking into consideration the living resources from the sea, one is normally inclined to visualise the open sea with the fish and other organisms that are readily available for human consumption. At the same time one cannot forget the fact that long before man ventured into the open sea in search of fish, he seems to have learned to exploit the resources from the more easily accessible areas in the coastal fringes comprising the estuaries, tidal creeks, backwaters and saline lagoons. With their close proximity to man's terrestrial habitat and vulnerability to human influence, these waters are subjected to the most intensive levels of use in many places.

Estuaries have been aptly referred to as the "doorways between oceans and land masses". It has also been recognised that such regions which are more or less inorganic connection with the sea form an integral part of the overall marine environment. Although the Indian coastline is mostly even and uninterrupted, a number of river systems with their estuaries, extensive backwaters, a few salt lakes and coastal lagoons provide several hectares of water surface that are predominantly brackish. Some seasonal fishery in these waters is even now in vogue. Apart from the fish, prawns and crabs that are being caught, these places also serve as an inexhaustible source for the fry or the very young ones of certain species of fish which are ideal for culture in salt waters. However, since the advent of advanced marine fishing techniques, there seems to have been some amount of neglect of the estuarine areas, probably because of the apparently restricted potentials of a circumscribed place. The purpose of this article is to emphasise the place of these brackish-waters in the economy of our marine resources and to indicate ways of taking full advantage of their potentials.

BRACKISH-WATERS AND THEIR CHARACTERISTICS

Throughout the present discussion, the term brackish-water has been employed in a rather wide sense to include all types of saline coastal environment different from the actual sea itself. While each of these bodies of water may have its own individual characteristics, the feature common to all is their direct or indirect connection with the adjoining sea for at least some part of the year, if not for the whole period. Based on the geomorphology, ecological and biological characteristics different types of classification of such estuarine regions have been adopted by Valikangas (1933) and others in later years. While any detailed discussion on this is outside the scope of this paper, from the resources point of view it may be said that brackish-water areas may either be of the open type or of the smaller confined or embanked type. The open type includes the typical river mouths, backwaters and salt water lakes. These are more or less perennial bodies of water with a close connection with the sea for a major part of the year, with regular in- and out-flow of water according to the ocean tides. The deltaic regions of the Ganga (in Bengal) and other rivers like Mahanadi (Orissa), etc., the extensive backwaters of the south-west coast (Kerala) and the major lakes like the Chilka and Pulicat of the east coast are classical examples. Among the confined waters are the numerous salt water lagoons, mud flats and saline swamps, particularly distributed along the east coast, as in the Madras State and some in the Orissa and the West Bengal. All these, in their own way, help in augmenting our resources and are thus of some importance to us.

The most outstanding feature of such an environment is the relatively unsteady and variable factors compared to the more even conditions that prevail in the sea. Among these, the salinity and temperature are of major consequence for biological life. On account of the semi-enclosed nature of the area and the frequent mixing up with freshwater, either from the rivers or from the run-off from the surrounding water shed, the salinity in the waters constantly fluctuates. Similarly, when the area gets cut off from the sea or the feeding from the surroundings is suspended during the summer months, the salt content of the enclosed waters goes very high as a result of extreme evaporation. Other chemical constituents also may undergo similar fluctuations during the year and depending on the location, sometimes these changes can be regular and cyclic.

The estuarine region is usually regarded as a singly unified ecosystem, with all the environmental factors interacting to determine the nature and distribution of the fauna. Several factors are thus responsible for the richness or poverty of an estuarine area. Estuaries are invariably areas of high fertility and large phytoplankton populations may be encountered. The dense groups of sedentary organisms seen in such regions may indicate the high degree of primary productivity in these regions. These are of considerable advantage to the many marine species of fish and other animals that breed near the estuaries since their larvae have a plentiful supply of food during their critical period. The influence of estuaries on the biota of surrounding coastal water is, therefore, greater than the surface area would suggest.

Estuaries and backwaters may be fertilized in three main ways: (1) river waters leach plant nutrients from the soild and carry a constant supply through the estuary, (2) pollution, either locally or within the estuary or indirectly through the river, may enrich the waters and increase productivity, and (3) subsurface counter-current may enrich the estuary when the sea-water is drawn from below the euphotic zone where nutrient concentrations are higher than at the surface.

The biological life in estuaries under conditions described above poses several problems particularly in the matter of adjustment to the environmental changes. Consequently the organisms that colonise in such regions have come to develop remarkable powers of tolerance to changes in the living medium, but it is not the intention here to go into the various types and degrees of adaptation among brackish-water animals. Notwithstanding all the physiological problems, it is amazing to find that most of the major groups of invertebrates, excepting perhaps the cubomedusae, brachiopods, pteropods, cephalopods, echinoderms and the like, find their representatives in the

estuarine regions. The penetration of a large number of marine animals into waters of low salinities seems to be a characteristic feature all over the tropical region. The factors involved in the entry of marine animals into brackish-water and freshwater are many and are specially relevant to the larvel development of the various species. Among the varied faunal elements inhabiting such estuarine habitats, there may be true fresh water species that have later come to tolerate certain amount of salts in their external medium, or the true marine species capable of accommodating themselves to a comparatively dilute medium than the sea-water or those which may be regarded as more or less permanent dwellers in brackish-waters.

From the resources point of view at present we are primarily interested in the fishes, Crustacea and, perhaps, the molluscs that occur in these regions. Among the teleost fishes are several clupeoid species (Elopidae, Channidae, Clupeidae and Engraulidae), gobioids, percoids, mugils, polynemids, hemirhamphids, cichlids and even some pleuronectids. The Gobiformes are, by and large, mostly estuarine species as also the cichlids. Among the commercially important Crustacea, the prawns of the family Penaeidae (*Penaeus* and *Metapenaeus*) and the portunid crabs *Scylla* are more important. *Ostrea, Circe, Meretrix, Modiola* and *Velorita* are the molluscan representatives. The freshwater prawns of the family Palaemonidae (*Palaemon* and *Leander*) are of fishery interest in some of these regions.

Brackish-waters as Nursery Grounds

As explained earlier, the brackish-water regions represent a transitional ground as we proceed from the shore to the sea and all kinds of intermediate conditions from the freshwaters can be expected in such places. Perhaps, this very fact makes it one of the most unique ecosystems. One strange thing that may be noticed among all the animals caught from these brackish-water areas is that only very few of them are the real adults and a good majority of the animals that occur are the post-larval stages or the juveniles. Many of the marine species of fish and crustacea that inhabit the coastal waters seem to spend the early part of their life in regions close to the land and in these areas of low salinity. The young ones probably find the estuaries and the shallow bay an ideal habitat. The post-larvae of several species of marine fish and prawns migrate from the actual spawning grounds in the sea into these landward sheltered areas near the coast until they grow large enough to lead their normal life back again in the sea. Thus, these estuarine and backwaters seem to serve as the nursery ground for many a fish and crustacea. The high productivity of these waters which afford a plentiful supply of microvegetation necessary for many of the post-larvae, the relatively calm and shallow waters and the abundant humus and detritus, as also the apparent freedom from the larger carnivorous enemies, all make this an ideal habitat where the growing young ones can graze uninterruptedly without fear from the larger predators and thus have better chances of survival and growth.

Culturable Fish Fry

The most common teleosts of marine origin which inhabit estuaries and backwaters and which can tolerate wide variations in salinities, as seen from actual field data, are the *Chanos chanos*; species of *Mugil* and *Liza, Elops indicus, Megalops cyprinoides, Engrualis purava, Lates calcarifer*, and *Polynemus tetradactylus*. The cichlids *Etroplus* and *Tilapia* (of which the latter is comparatively a recent entract into our waters) are of freshwater origin. A list of the more important places of fry collection of peninsular coast and their season of collection is appended at the end (Appendix I). While these and perhaps a few other species are regularly caught from the backwaters, those of real commercial importance from the point of view of fish culture are the milk-fish and the mullets. Even between the two, the milk-fish (*Chanos chanos*) occupies a prominent place on account of its importance in salt-water fish culture, and so, it is proposed to deal with the fish in some detail.

The Milk-Fish

The milk-fish occurs throughout the Indo-Pacific area. Although an inhabitant of the sea in its adult stages, its fry, fingerlings and even early juveniles can be obtained mostly from the brackish-water regions. The fish by itself does not constitute any significant portion in the marine fishery at any place throughout its regions of occurrence, whereas its place in the estuarine fishery is important and is one of the most useful species for fish culture. In India it is more common in the peninsular region, from the Orissa and Andhra coasts in the east and up to the Mysore coast in the west. It also occurs around the Andaman group of islands in the Bay of Bengal and the Laccadive Archipelago in the Arabian Sea. Like many other marine species, the milk-fish also spawns in the sea but their exact spawning grounds in our seas is more a matter of conjecture. Nevertheless, year after year, immense numbers of the very young ones of this fish appear all along the coastal regions mentioned above. The several practical advantages of this species, such as the immense adaptive powers to a wide range of variations in the living medium, as well as the abundance, and its fairly fast-growing and other qualities, have been responsible for its popularity among fish culturists here and elsewhere.

Any quantitative information regarding the occurrence and actual collection of *Chanos* fry is available only from the Madras State. Milk-fish fry and fingerlings have been recorded from several centres along the east and west coasts of India which are indicated in the Map (Fig. 1). Among these various regions special mention has to be made of the Ramanathapuram and Tirunelveli districts of the Madras State which furnish the maximum annual yield of milk-fish fry and fingerlings. The relevant statistics of fry and fingerlings collection from these two districts of the Madras State are given in Table I while similar data for other regions are not available at present.

Table I

**Statistics of milk-fish fry and fingerlings collected from Ramanathapuram and Tirunelveli coast for a ten-year period (1950–60)*

(Number in Ten thousands)

Years	Ramanathapuram	Tirunelveli
1950	19·0	44·4
1951	133·6	102·7
1952	105·7	130·0
1953	147·7	190·0
1954	209·9	220·0
1955	314·8	35·2
1956	136·0	88·3
1957	20·9	77·5
1958	28·7	6·6
1959	33·4	53·1
1960	16·3	14·5

* Information obtained through the courtesy of Sri V. Ranganathan, Deputy Director of Fisheries, Madras.

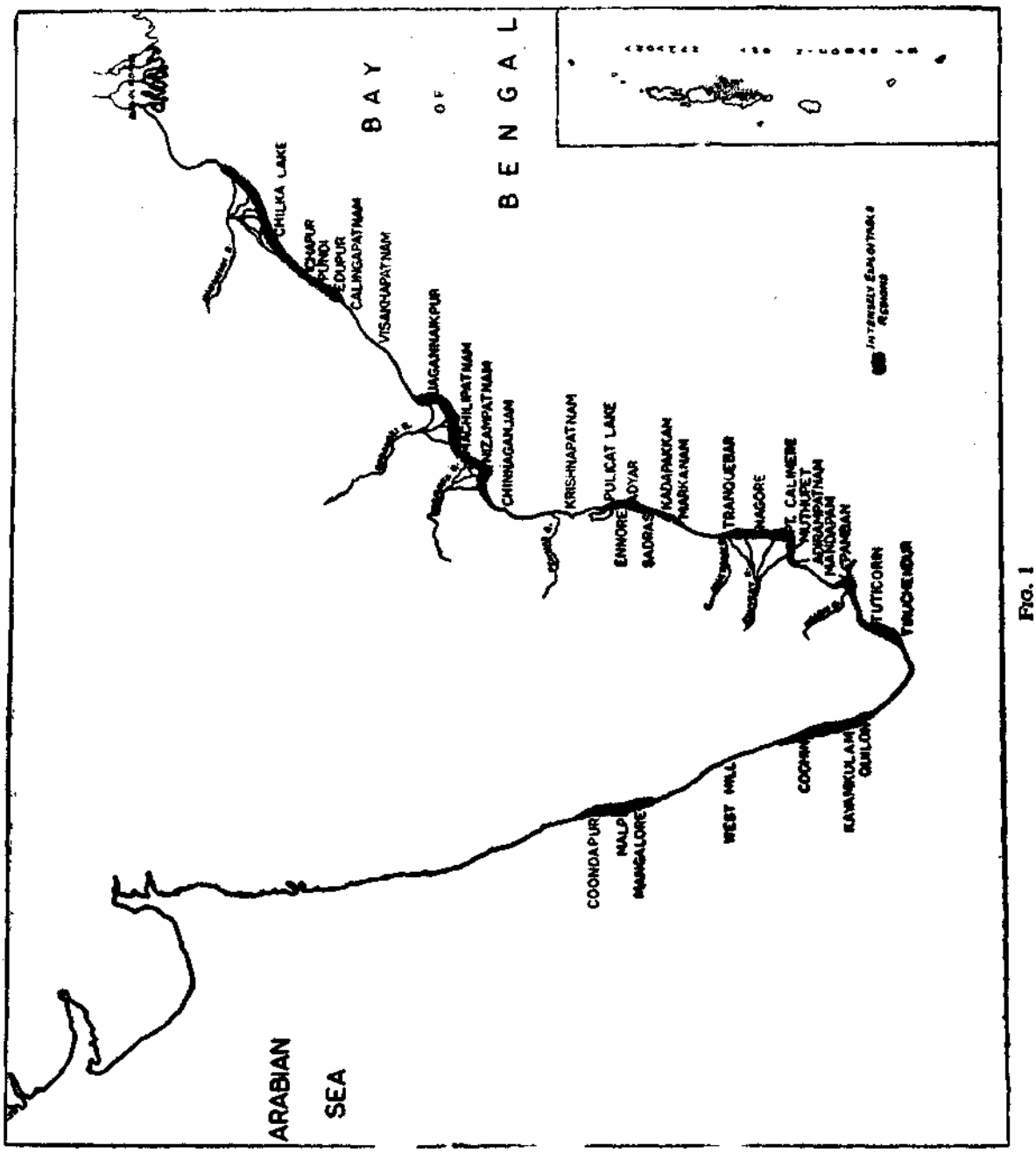
BAY OF BENGAL
ARABIAN SEA
CHILKA LAKE
KAKINADA
KONDAPUR
KUNDI
EDUPUR
CALINGAPATNAM
VISAKHAPATNAM
JAGANNAIKPUR
MACHILIPATNAM
NIZAMPATNAM
CHINNAGANJAM
KRISHNAPATNAM
PULICAT LAKE
ENNORE
KOYAR
BADRAS
KADAPAKKAM
MARKANAM
TRANQUEBAR
NAGORE
T. CALIMERE
MUTHUPET
ADIRAMPATNAM
NANDAPAN
PAMBAN
TUTICORIN
TRICHENDUR
COONDAPUR
MALPE
MANGALORE
WEST HILL
COCHIN
KAYANKULAM
QUILON

FIG. 1

The wide fluctuations in these annual figures have been explained by the special drive devoted in certain years arising out of the need for stocking some of the departmentally controlled waters. But the figures by themselves are very conservative and are at best only indicative of the fry potential of these two particular areas. Intensive collections have never been carried out at any time and no particular effort has been taken to collect all the available fry. These collections have been mostly restricted to the peak seasons. Therefore, with greater efforts and by extending the periods of collection throughout the fry season and from all similar centres along the coastline of Madras State a total of at least ten million fry and fingerlings of *Chanos* could be collected during the year. Particular mention is made of this region because of the apparently higher potential here than in the other regions, but a rough total estimate for the whole of the peninsular region would take us to the order of nearly two crores of fry and fingerlings per annum, over a coast line of about 2,050 miles, from the Orissa to the Mysore coast surrounding peninsular India.

The seasons for such large-scale collection of these fry may vary from locality to locality, but by and large, the summer months of March through July are the best periods in most places. In certain years however, small numbers of fry have been collected during September–November but the season has not been of commercial importance for India, while at the same time it may be pointed out that in the Indonesian regions the main collection season seems to extend from April to October (Schuster, 1960). This aspect is of some interest from the biology of the species.

Mullets, perhaps, rank next only to milk-fish as far as salt-water fish farming is concerned. Species of *Mugil* and *Liza* constitute the main stay of the mullets employed for the purpose. Their fry and fingerlings have more or less the same habitat and habits as the milk-fish and, therefore, are encountered in the same surroundings. Their number, compared to the milk-fish are far less, perhaps only less than a fifth of the milk-fish fry collections. However, in certain regions like the backwaters of the west coast, these are fairly abundant and are being exploited in a limited scale for culture in brackish-water farms. One of the advantages of these mullets is that the fingerlings of one species or the other seem to be available more or less throughout the year, in several places (*see* Appendix I), with a maximum abundance during periods when the backwaters remain connected with the sea following the monsoons. Even in summer months, fairly large numbers of mullets occur in the shallow waters of the Adyar, Ennor, Pulicat and such brackish-water areas. The more common species are *Mugil cephalus*, *M. troschelii*, *M. waigiensis*, *M. seheli* and *Liza parsia*, *L. tade* and *L. macrolepis*.

Besides these two groups, a number of other fish are mentioned in fish culture literature as useful for our salt-water. *Lates calcarifer* or the 'Bekti' is more popular in the Bengal region. But the comparative poor abundance of the fry and predatory habits of the growing fish limit their use for general culture. *Tilapia mossambica*, which has been introduced in our waters only the last decade and a half, is another species which has found itself at home in some of the brackish-waters, but like the other cichlids it is of freshwater origin and hence is not being included in this discussion which deals more with the marine species. The other major groups which may be used for rearing in salt-waters has already been listed earlier.

Special mention of the marine prawns may be made in this context. While prawns of the penaeid group are known to breed only in the sea, like the fish fry, many prawn larvae and post-larvae tend to swarm towards the coastal and estuarine regions. Large numbers of such prawn fry or post-larvae and juveniles enter the estuarine and backwater regions, particularly the open backwaters of the west coast and the Pulicant lake in the east. Like the fish fry, these post-larvae and juveniles use the protected waters of the lakes and estuaries as their nursery ground, as a result of which the lake or backwater fishery of prawn is largely constituted by the juvenile population. At present very little of these resources is utilized by way of any actual selective collection and rearing, except through simple processes of trapping them in the fields and fishing them periodically as is being done along the west coast. We have little reliable data on their density of occurrence.

Fry Resources and Utilization

Production of consumable fish being the ultimate goal in assessing our resources, it may be worthwhile to attempt here at a general estimate in terms of possible fish yield out of the fry collections and in relation to the available coastal fish farming opportunities in our country.

The fry collection figures from the various parts during the past few years indicate that an average of not more than about five million fry are being collected in any year from our coast. However, considering the dense population of fish fry in certain regions, it is obvious that we are at present collecting only a meagre fraction of what is freely available. For example, the number of *Chanos* fry collected from the Ramanathapuram and Tirunelveli coasts represents, perhaps, a tenth or even less of the fry and fingerlings that could be seen during the season. Thus, judging from the availability it may be safely argued that a total of at least 400–600 million should be a reasonable estimate for the peninsular region as a whole. Table II would help to compare our figures with *Chanos* fry estimates of three of the major salt-water fish culturing countries, as given by Schuster (1960).

Table II

Estimate of fry catches (in *millions*)

Country	Total annual catch	Average annual catch	No. required for stoc ing
Indonesia	150–300	200	275
Philippines	300–500	350	425
Taiwan	20–100	45	80
India	3– 10	5	800

Out of a total of 7 lakh hectares (3,000 sq. miles) of estuarine waters (Bhimachar, 1959), which might include some freshwater areas as well, nearly a third or about 260 thousand hectares (1,000 sq. miles) could be gradually converted into salt-water fish ponds. At present well organised ponds, where selective stocking of salt-water fish fry are carried out, might not cover more than about 150 hectares, while a comparatively vast extent of brackish-water fields of the south-west coast and other areas is depending only on natural entry of fish and prawn fry. At a time when all the 260 thousand hectares are brought under systematic culture operations, nearly 800 million *Chanos* fry alone would be needed in one year. Even this figure seems to be well within our attainment provided sufficient effort is put in to collect the fry occurring in every coastal niche and through the entire season of availability. It may be pointed out here that our present methods of fry collection and the efforts expended in the process are not adequate, leaving considerable room for improvement. The simple but efficient way of collecting *Chanos* fingerlings by means of a scare line in the shallow tidal creeks of Pamban with a net or a cloth piece closely following the line to trap the leaping fish, as described by Ranganathan and Ganapathi (1949), is a typical example where advantage is taken of the behaviour of the fingerlings. It has also been found from our experiments that *Chanos* fry would be induced to swarm into artificial channels dug at certain places along the coast where these fry have not been ecnountered. This clearly shows that the fry have a distinct preference for shallow, sheltered and generally low salinity bays and creeks. Their comparative abundance during the high tides indicates that they are perhaps brought in with the flow of water. Thus, based on the behavioural characteristics of the fish, suitable collection methods should be evolved. Along with improved methods of collection, satisfactory means of fry transport and nursery management will have to be adopted in order that the fry collected are properly utilized. Similarly more systematic

surveys along the coast will reveal many other fry collection centres. Besides *Chanos*, the fry of other salt-water species mentioned earlier can greatly supplement our future needs for saline fish culture. Thus, when the brackish-waters could be brought under organised fish culture, these alone could provide nearly 75 million kg. of fish per year, which will be a substantial addition to our present annual fish production of about 2 million tons.

Summary

A brief discussion of the more salient features of our brackish-waters, in relation to an overall marine environment, is given. These brackish-waters serve as the nursery ground for the young ones of many a fish and edible crustacea which normally inhabit the sea. Among these the milk-fish constitutes the most important fish fry which has immense potentialities for salt-water fish culture. The fish fry resources from these coastal areas, together with the possible extent of utilization of these regions, are generally discussed in this account.

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APPENDIX

*Culturable salt-water fish fry and their season for collection along the coast of peninsular India.**

State	Locality	Kind of fry	Best season for collection
ANDHRA ..	Ichapur to Pundi	Milkfish	June–August
	Edupur	Milkfish Mullets	June–August Throughout
	Naupada	Milkfish Mullets	June-August Throughout
	Calingapatnam	Milkfish	June-August
	Bimmilipatnam	Mullets	Throughout
	Visakhapatnam	Milkfish Mullets	June-August Throughout
	Kakinada	Mullets	October-February
	Jagannaikpur	Milkfish Mullets	June-August Throughout
	Kotipalli to Narsapuram	Mullets	November-March
	Chinapandraka to Manginiapudi	Milkfish	May-June
		Mullets	November-February
	Machilipatnam	Mullets	Throughout
	Nizampatnam	Milkfish	May-June
	Chinnaganjam	Mullets	October-February
	Ullapalem	Mullets	December-March
	Tummalapenta	Milkfish	May-June
	Krishnapatnam	Milkfish Mullets	May-June November-February
MADRAS ..	Pulicat	Milkfish	April-June
		Mullets	November-April
	Ennore	Milkfish	April-June
		Mullets	November-February
	Adyar	Milkfish	May, July and October-November
		Mullets Etroplus Megalops	December-February Throughout October-November
	Sadras	Mullets Etroplus	Throughout November-February
	Kadapakkam	Milkfish Mullets	April-February December-February
	Markanam	Milkfish	April-May
	Ariyankuppam	Mullets	Throughout

APPENDIX I (*Contd.*)

State	Locality	Kind of fry	Best season for collection
	(Pondichery State)	Milkfish	April-June
	Cuddalore to Porto novo	Mullets	November-February
	Tirumalaivasal	Milkfish	May-June
	Tranquebar	Milkfish	May-June
	Nagore	Mullets Megalops	November-February October-November
	Nagapattinam	Mullets	November-February
	Point Calimere	Milkfish	May-June
	Muthupet	Mullets	January-February
	Adirampatnam	Milkfish	May-June
	Pamban	Milkfish	March-June
	Mandapam	Mullets Etroplus	Throughout June-August
	Tuticorin Palaiyakayal Pinnakayal	Milkfish Mullets	April-June April-August
	Tiruchendur to Colachel	Milkfish Mullets	April-June November-March
KERALA ..	Anjengo	Milkfish Mullets	April-June April-June
	Ashtamudi to Ayiramthengu	Milkfish Mullets Etroplus	April-July Throughout April-July
	Cochin (Vypeen)	Milkfish Mullets	April-July Throughout
	Vaipadu to Beypore	Etroplus	Throughout
	West Hill	Milkfish Mullets Megalops	May-June October-January December-January
	Elathur	Etroplus Mullets	Throughout Throughout
	Tellichery	Etroplus Mullets	Throughout Throughout
MYSORE ..	Nileshwar	Etroplus	Throughout
	Mangalore to Malpe	Milkfish Mullets Etroplus	May-June Throughout Throughout
	Coondapur	Milkfish Mullets Megalops Etroplus	May-June Throughout December-January Throughout

* Also refer Ganapathy, S. V. *et al.* (1950)