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V.N. Pillai and N.G. Menon

Central Marine Fisheries Research Institute
(Indian Council of Agricultural Research)
Tatapuram P.O., Cochin-682 014
Kerala, India

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13 The study of mud banks of the Kerala coast - a retrospect

K.J. Mathew and C.P. Gopinathan

ABSTRACT

The mud banks, an unique feature of the Kerala coast during the southwest monsoon where the surf ridden nearshore waters over restricted areas become highly quiscent due to certain physico-chemical factors have been under investigation for more than a century. These areas play an important role in the socio-economics of the coastal fisherfolk during the poverty striken southwest monsoon period. Considering the importance of mud banks from the fishing point of view, the Central Marine Fisheries Research Institute, Cochin has been monitoring the phenomenon and carried out a multi-disciplinary exclusive study during 1971-72, on the various physico-chemical aspects in respect of origin, maintenance, shifting, dissipation, ecology and fisheries of the mud banks, especially that of Alleppey area. The study brought to light a good amount of new informations on this curious phenomenon. The present article is a review of the studies conducted by the CMFRI.

Introduction

The term *'Chakara'* in Malayalam has become popular with the people of Kerala that they use it wherever they refer to plentifulness. From the fishery point of view the term refers to the abundant prawn and fish catch from a particular area of the sea coast known as mud bank or *chakara* which is prevalant in some places along the Kerala coast during the southwest monsoon. *Chakara* or *chathakara* (meaning dead coast) denotes to the quiscent nearshore waters restricted to 2-3 km along the coast and about 0.5 km across the coast devoid of waves and swells when the sea in the adjacent areas is furious with high energy breakers and surf. The mud banks which are known to exist from time immemorial have always been a matter of puzzle for the common man as well as the scientific world. The appearance and dissipation of the

mud banks, the calmness associated with them, their seasonal and annual shifting, the fishery and the mud itself have ben matters of intense investigations.

In view of the importance of mud banks from the fishery point of view, the Central Marine Fisheries Research Institute took up a two year multidisciplinary investigation in 1971 and '72. The studies were mainly confined to aspects such as types of mud banks and their causes of fomation (Murty *et al.*, 1984), the source of mud (Gopinathan *et al.*, 1984), the physico-chemical properties (Rao *et al.*, 1984), the hydrography (Rao *et al.*, 1984), the phytoplankton and productivity (Nair *et al.*,1984), the zooplankton (Mathew *et al.*, 1984), the benthic organisms (Regunathan *et al.*, 1984), the current system (Mathew *et al.*, 1984b) and the fish and fisheries of the mud bank (Regunathan *et al.*,1984b).

Given below are the salient results of the studies made by the CMFRI with regard to the mud banks of the Kerala coast.

Source of mud and its role in the formation of a mud bank

The various physico-chemical factors responsible for the formation, maintenance and dissipation of the mud banks, have been studied by Murty *et al.* (1984) from 1971 onwards. Accoriding to them, the mud banks could be divided into four different categaries mainly based on the source of the mud supplied to a mud bank.

Mud bank formed by subterranean mud

This type of mudbank as it is seen along the Alleppey Purakkad coast is the most typical and more common. Here the mud that is supplied to form the mud bank has its origin from the subterranean source which is present in the form of deep underground channels originating even from the Western Ghats and passing underneath the Vembanad Lake between 15-35m upto the shallow coastal areas. The water bearing stratum in the subterranean channel owe their leverage respectively to the hydrostatic pressure of the backwater exerted on the subterranean channel and to the hydraulic pressure in the feet of the hills (Crowford, 1860; Bristow, 1938). As the hydrolic pressure at the foot hills of the Western Ghats increases due to floods during the southwest monsoon together with the water load in the Vemband Lake, the loose

sediments in the subterranean channel is pushed up at weaker areas in shallow water regions and a mud bank is formed at such areas. The mud bank in this case would be restricted and highly calm

Mud banks formed by the aggregation of coastal mud

In this case, the mud bank is very extensive and there is no perfect calmness as the nongravity influenced mud particles in the medium do not absorb all the wave energy. By the effect of the southwest monsoon, the coastal mud is churned up, and at this time, if the environmental conditions are favourable, the mud will be brought very close to the shore and a mud bank is formed. The Parappanangadi-Tanur mud bank is of this type.

Mud banks formed by the sediments discharged from rivers and estuaries

Such mud banks are formed at the mouth of a number of rivers and estuaries between Cochin and Ullal (at Netravati river mouth). The sediments that are brought by the flood waters are aggregated always on the southern side of the mouth and are held up there for a while by the southerly flow of the local current.

Mud banks formed by the accumulation of mud resulting from dredging operations

The mud bank formed along the Vypin-Narakkal coast at Cochin is an example of this type of mud bank.

The phenomenon of mud bank as studied by CMFRI

The Mud :- The pre-requisite for the formation of a mud bank is the mud itself. The mud of the Alleppey mud bank is of subterranean origin. This was established by the sighting of mud cones or mud volvanoes (Bell-like formations) observed on the beach and nearshore waters through which large quantities of mud was found to be ejected at Kakkazham, near Ambalapuzha, during July '71 (Gopinathan *et al.*, 1984).

There are references in the literature of citing mud cones on the Alleppey beach as early as 1855 and 1903. However, after 1903, there had been no further records of mud cones in this region and therfore, the source of mud for the Alleppey mud bank remined a matter of controversy in recent times.

But the Scientists of CMFRI came across six active mud cones of different sizes and at ages of formation in the vicinity of the Ambalapuzha mud bank in July '72 (Gopinathan *et al.*, 1984). One of the cones that was in the intertidal zone measuring 7.5 m across was found feeding loose mud to the waves. The cones on the beach were in the form of mud heaps caused by the upward presssure exerted from far deep. A G.I pipe of 6 m length sent down to its full length without much resistance could not sound any bottom but when inserted diagonally touched hard surface all around suggesting that the well-like formation was resulted by the mud forcibly ejected from far deep, say the subterranean channel underneath the Vembanad lake that connected with the foot hills of Western Ghat.

Calmness associated with the mud bank :- It is generally accepted that the calmness at a mud bank is brought about by the mud in suspension. But the view that a purely physical process, say, the churning action of the monsoon waves put the mud into suspension is not satisfactory. The study made at the CMFRI helps to understand the sequences in the damping of waves at a mud bank. This would explain how the waves are damped once they enter into the region of mud bank. The mud particles present in a vertical water column of the mud bank exists in 3 different phases.

i) Thixotropic phase

The mud collected from the mud bank at Ambalapuzha showed ferric oxide in finest clayey form.When concentrated pasty mass of ferric oxide mixed with suitable quantities of electrolite (Sodium chloride in the present case) in aquous solution on shaking from colloidal solution and this phenomenon is called thixotropy. The mud particles involved in this case are ultra-microscopical which are subjected to liquifaction on agitation.

ii) Sol phase

The mud particles under this phase are microscopic and do not enter into liquifaction but remains as sols or suspensoids. The viscosity of the medium is tremendously increased (2-5 times) by the presence of such suspensoids.

iii) Gravity influenced phase

The mud particles entered in the 3rd phase are so big that they are

subjected to gravity. Their rate of fall will be inversely proportional to viscosity of medium. Therefore, the fraction of the mud that entered into the thixotropic phase with seawater increases the viscosity of the latter. Sea water and the thixotropically liquified mud fraction form the medium for suspensoids which are constituted by the fraction of mud under the second phase (sol phase). Now the sols, thixotropic particles and seawater altogether constitute the liquid medium for the suspended mud particles that are accounted under the last fraction which is influenced by gravity. Thus at every stage, the viscosity of the medium is stepped up with the result that the particles categorised under the last fraction will experience tremendous amount of resistance to their natural fall due to viscosity of the medium. Thus the effective viscosity of the medium depends upon the relative fractions of the mud entering into the first two phases.

The wave propagation involve horizontal and vertical oscillation of the particles of the liquid medium as well as the suspended gravity influenced mud particles. The particles of the liquid medium are equipped with high viscosity, resisting their relative motion, while the movement of the gravity influenced mud particles is subjected to the influence of gravity and viscosity of the medium as well as the gravity influenced suspended mud particles in it suffer a lose of vertical and horizontal velocities. Hence it results in reduction in amplitude of the wave. The more the fraction of the mud identifying itself with the medium under the first two phases, the more would be the viscosity of the medium and greater would be the reduction in amplitude of the waves. Thus as the wave damping occurs, the mud enters into tranquility while the neighbouring regions are wave beaten.

Stability and longivity of mud banks:- The relative fractions of the mud entering into the 3 stages, namely, the thixotropic phase, the sol phase and the gravity influenced suspended phase explain the stability and longivity of the mud banks. In case the first two fractions are high which identify themselves with the seawater in constituting the medium, they remain for long in the medium, supporting the longivity, itensity of calmness and stability of mud bank. If this entire mud remains in the gravity influenced suspended particle state, as the viscosity of the medium in that case reduces to that of seawater the system cannot offer any calmness to the mud bank. Such a situation is experienced many times at mud banks and elsewhere where the water was apparently muddy, but the waves were found lashing within such areas even under calm wind conditions.

Dissipation of mudbanks:- Towards the end of southwest monsoon, as the rain decreases the water level in the backwater and at the foot hills of the Western Ghats gets reduced leading to reduction of hydraulic pressure in subterranean strata which finally results in the cessation of the supply of fresh mud. The turbulence of the water column also gets reduced and mud in the bank settles down causing dissipation of the banks.

During the mud bank season, the littoral currents are observed to be always southerly and the local tides have no influence on the direction of current. Towards the end of August the current start reversing thereby setting in offshore and northerly components, the suspended and loose mud of the bank is gradually taken off by the veering currents. This leads to the fading of calmness over the mud bank. Then the rough condition sets in.

Movement of mud banks :- It has been observed that a mud bank exhibits slow movement in course of time during the same season usually in a southward direction. This is because the mud from the place of dicharge gradually move southward due to the southerly flow of water. The movement is continued till the beginning of the northeast monsoon winds when the conditions set in for the dissipation of the mud bank. In addition a year to year shift is also noticed when the source of subterranean mud also shifts from the north to the south.

The Current System

The pattern of currents with its possible influence on the physical, chemical and biological characters of this region is bound to have a direct bearing on the formation, retention, upkeep, movement and dissipation of the mud bank. Since the current velocity and other parameters would in all probability exhibit diurnal variation in relation to tide, the current system was studied at fixed intervals over two tidal cycles, one in May, prior to the formation of the mud bank and the other in August, towards the end of the formation. It was possible to obtain the mean values of the characterstics, after eliminating the tidal influence.

Throughout the period of observations, the direction of the current was between 150-180° except at times when the flow mesured 0 and the water thrust was too feeble to keep the current meter in a fixed direction. The major direction was at 180° indicating the coast-parallel southerly flow

(longshore current) during the entire period of observations. The results obtained during the second set of diurnal observations were totally different in that the water movement was in all the directions. The differences in the pattern of direction of currents at the second phase of the mud bank was considered significant.

The investigations showed that during May, the seasonal currents in the mud bank was southerly. The peaks corresponded to the high tides and the troughs to the low tides. Therefore it was assumed that the high tide corresponded to the southerly component of the tidal current. In August, changing the direction of current was observed. The weaker currents indicated the transition of the change over from the southerly currents during monsoon, to the northerly current system during the winter. It may be noticed that in August, the offshore component, though feeble, was present almost throughout the period. Such a development in the current system towards the end of the mud bank season has a definite bearing upon the dissipation of the mud bank. The stronger the development of the offshore current, the quicker will be the dissipation by mixing with the offshore waters.

Hydrography

During the mud bank season, (June-August) the temperature of the waters were between 26 and 27°C at the surface and between 25 ad 26° C at the bottom.. The salinity values at both surface and bottom were relatively high during the pre-mud bank and post-mud bank seasons. During the 1972 mud bank season, the average salinity values reached as low as 28.5 ppt. The salinity value at the bottom was slightly lower than at the surface during the mud bank season which may be due to the seepage of water-born mud from the subterranean porous strata of the coastal strip. The dissolved oxygen values in the mud bank season were the same as the pre-monsoon value at surface during 1971. However, during 1972 mud bank season, the dissolved oxygen of both surface and bottom waters was reduced to about 3.2 ml/l.

The seasonal values of phosphate at the surface and bottom waters indicated the maximum during the mud bank season of 1971 and 1972. As is the usual case, the phosphate values were more at the bottom than at the surface. The nitrate nitrogen was low during the pre-mud bank season and appreciably high during the mud bank season. The nitrogenous compounds

and the phosphate content of the water column showed an aproximate inverse relationship which indicated that the planktonic algae utilised one of the nutrient compound at a faster rate. Similarily, the silicate values were also found to be high during the mud bank season. Its higher values during the mud bank season might have been due to the fine sediments present in suspension in water.

Phytoplankton productivity

Observation made on the primary productivity of the coastal waters and connected estuarine systems indicated that the areas were highly productive with an average rate of production of over 1 $gC/m^2/day$. The mud bank, owing to the several peculiarities on account of the mud remaining in suspension may, however, be considered as a special type of ecosystem. The high turbidity, both man made and natural causes poor light penetration and thus decrease the depth of the euphotic zone to less than 4m.

The study of the phytoplankton production at the mud bank was confronted with certain problems. The normal *in situ* measurements which are necessary for the evaluation of potential assimilation in *in vitro* conditions were not possible in these waters. Therefore, the messurement of potential productivitiy at best could give a general idea of the productivity of the ambient waters and potential resources available.

The study conducted during the two mud bank seasons, one during June-August '71 and the other during May-July '72, revealed the following results: Unlike the rest of the west coast, where the monsoon months record maximum production, the mud bank showed low values during this periods, while during the pre-monsoon months, the same area indicated high rate of production. The rate of potential assimilation was uniformly high averaging 35 mgC/m^3 / hr with the maximum during February-May when no mud bank prevailed in this area. However, the standing crop measured in terms of chlorophyll *a* during the active season of the mud bank revealed high values compared to other months, probably due to the abundance of dead chlorophylls. The plankton blooms showed a gradually increasing trend from June onwards reaching the maximum in August, primarily due to the high abundance of the dinoflagellate, *Noctiluca miliaris*. After August, there was a gradual decrease in the volume of plankton reaching its lowest in December. Again after December, there was a rise in the volume of plankton through the succeeding

months and reached its peak at the period of the next mud bank formation.

The quantitative distribution of phytoplankton present in one litre of water sample indicated that diatoms dominated during the formation of the mud bank while dinoflagellates were most abundant during the period of its dissipation. However, nanoplankters were equally abundant all through the active period of mud bank. The mud bank, in spite of its limited primary production potential due to the shallow euphotic zone, supports higher standing crop, as represented by biomoss, chlorophyll at its formation as well as its maturity period, presumably favoured by abundant rainfall and enrichment of nutrients from the bottom.

Zooplankton

The monthly mean value of displacement volume of zooplankton during the mud bank season reached upto 4.08 ml/10 min. haul. During the pre and post - mud bank period, the zooplankton biomass was very low. Altogether, 19 groups of zooplankters were present, the major groups in the order of abundance were Copepods, Appendicularians, fish eggs and larvae, prawn larvae, lucifer and crab larvae. The composition of zooplankton was significant in that the fish eggs and larvae constituted a major portion than usual in the zooplankton which could be due to the large scale migration of the spawning population of fish and prawn into the mud bank area.

Benthos

The important groups identified from the benthos of mud banks were: Foraminifera, Nematoda, Polychaeta, Ostracoda, Copepoda, Amphipoda and Pelicipoda. Fluctuations of different groups through months did not show any relation to the hydrographical features. Of the benthos, foraminifers were found to be the most dominant group. Nematods and bivalves were observed to follow in the order of numerical abundance. The peak of benthic production in general was observed within the period November-January.

The bottom fauna in general showed a low intensity in the mud bank. This might have been due to the unconsolidated nature of the sediments which did not have a stable substratum for the animals to settle. It was concluded that the oil spill and churning up of the bottom, caused by propellers of boats and by anchoring of the mechanised vessels, apart from providing an unsta-

ole substratum might have polluted the overlying waters and brought about the observed faunal reduction in this area.

The fishery components were mostly of pelagic and column feeders except the soles and prawns. Since they have been identified as migrant populations and the soles came into the fishery towards the fag end of the season, the low intensities of the bottom fauna did not bear any special significance on the mud bank fishery.

Fish and fisheries of mud banks

The south west monsoon period is generally an off-season for the fisherfolk on the west coast of India. In this period of general idling, the calm areas created by the mud banks attract fishermen from far and wide. These calm areas varying in extent from 10-25 km^2 provide safe harbourage to the country crafts. Launching and landing of canoes are very easy in the mud bank areas. Taking advantage of this facility, large number of canoes are brought to the mud bank areas, even from far off places (Regunathan *et al.*' 1984b)

The fish

Fifty species of fish and six species of prawns have been identified from the mud bank areas. Fishes of the families Carcharhinidae, Cleupeidae, Dussumieridae, Dorosomidae, Engraulidae, Tachysuridae, Ambassidae, Theraponidae, Chirocentridae, Sillaginidae, Sciaenidae, Siganidae Trichiuridae, Scomberomoridae, Stromateidae, Cynoglossidae and Drepanidae were encountered in the landings. Among prawns, *Peneus indicus, P. monodon, P. semisulcatus, Parapeniopsis stylifera, Metapeneus dobsoni, M. monoceros* and *M. affinis* were represented in the catches.

Fishery

Normally fishing in the mud bank is done from the early hours of the day till noon. But on heavy fishing days, fishing continues throughout the day. The fishing is generally confined to the periferal region of the mud bank. When catches are heavy the boats have been observed to come to the shore to unload their catches and return to the same area to resume the fishing operations. It has been observed that the fishery though intense at times, is in no way a regular feature of the mud bank because there are many days when

the boats return without catch. However, very often if weather permits fishermen may go away from the vicinity of the mud bank and bring sometimes heavy catches from places north and south of the mud bank. On days of rough weather, fishing operations are carried out very close to the shore inside the mud bank proper.

The pattern of fish distribution in the coastal areas during the monsoon season has been observed to change very frequently even from day to day. This phenomenon was not only confined to the mud bank area, but also to other areas outside it, obviously because of the shoaling behaviour of the fishes. This change in pattern of fishery clearly indicates that there is no resident population in the mud bank as it was thought by some earlier authors.

Inshore fishes and prawns move from deeper waters to inshore areas during the southwest monsoon probably due to the upwelling (Banse, 1959). During the monsoon, the current along the southwest coast has been observed to be southerly. As the general tendency of fish is to swim against the prevailing current, it is possible that northward moving shoals may pass through the mud bank area also and are caught there. If so it is also possible that a shoal of a particular composition is followed by another of entirely different composition which might account for the abrupt changes in the composition of fish landed. The overall picture emerged was that the catches landed at the mud bank area are from shoals which are on the move, and that they are caught only in this area because at this time fishing is possible only in this region.

The study made on the fishery of the mud banks revealed three points (i) the mud banks act as safe launching and landing base for the country crafts, (ii) a mud bank never has a resident population of fishes and prawns and (iii) the fishes and prawns caught from the vicinity of mud banks are part of the shoaling populations migrating from offshore areas and that they may be equally present all along the southwest coast during this season , but very often not caught from other than mud bank and nearby areas because of surf and surge prevailing at other places.

The studies by CMFRI have thrown some new light, on the source of mud, the mechanism of inducing calmness over a mud bank, the dissipation and particularly the fishery. Several studies of large and small dimensions

have taken place since the CMFRI's work. The results, so far obtained, however, may not be final or conclusive and further refinement of the concepts are necessary with the help of sustained observations and collection of data which would unveil the mystery surrounding the phenomenon of mud banks.

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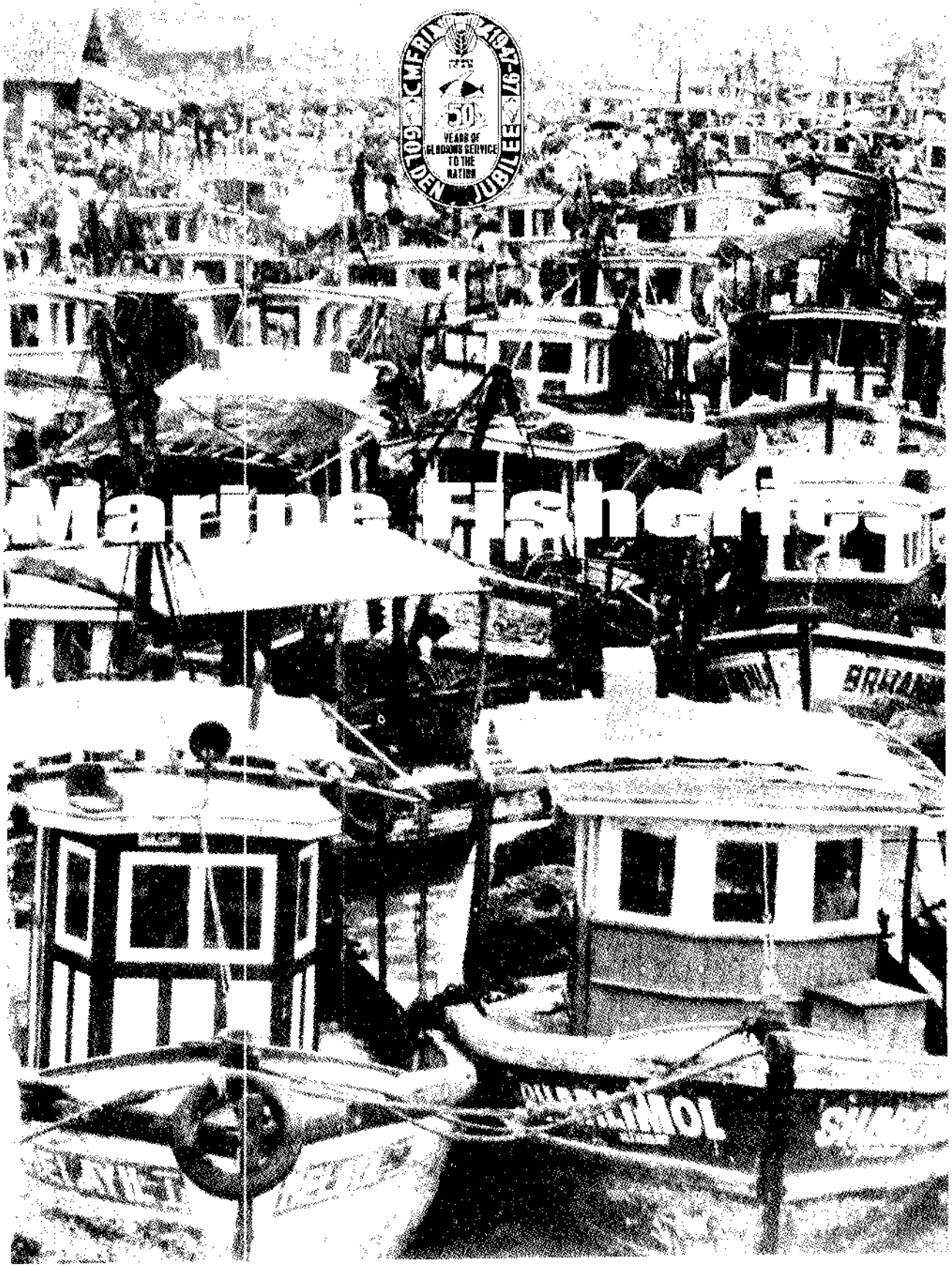
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