Indian Journal of Marine Sciences
Vol. 3, December 1974, pp.105-114

Mud Banks of Kerala-Their Formation & Characteristics

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Received 23 August 1974; revised received 4 November 1974

Mud banks become clearly demarcated as areas of calm water adjoining the Kerala coast, during the roughest SW monsoon conditions prevailing in the Arabian Sea. The appearance of mud banks is associated with an increase in the constancy and force of wind towards the east. Surface currents at that time run parallel to the coast and record maximum velocity. During June and July, strong swells approach the SW coast. Along the continental shelf, between Mangalore and Quilon, the nature of bottom from about 3.5 to 18 m depth is largely muddy. Mud banks occur as small elevations of consolidated mud throughout the year. During the SW monsoon, because of wave action, the fine mud particles get churned up into a thick suspension. A semicircular periphery then develops around the suspended mud in which wave energy gets consistently absorbed. This condition has been termed as the active stage of the mud bank. After the monsoon, the suspended mud settles and gets consolidated. This has been termed as the passive stage of the mud bank. Those mud banks which become active almost every year are persistent types of mud banks. When the mud gets into suspension by wave action, the southerly currents drive the entire floating mass slowly towards the south. If, however, the wave action is not strong enough, there will be no movement or when strong swells approach from the south, either the entire suspended mass or a portion of it may exhibit northern movement. These deductions have been made on the basis of observations made on a persistent mud bank near Alleppey throughout the year. Mud banks are well known for their fishery during the monsoon months. The calm waters of the mud bank act as a temporary fishing harbour. However, the mere existence of mud in an area is not enough to form mud banks. The mud of the right texture must get consolidated at the right depth where wave action could churn it up into a thick suspension. The presence of mud bank disturbs the shore stability of that region and induces coastal erosion in adjacent areas.

MUD banks of Kerala can be defined as those areas of the sea adjoining the coast, which have a special property of dampening the waves resulting in clearly demarcated areas of calm water even during the roughest monsoon conditions of the sea. These areas become distinct from the other areas which may have a muddy bottom, and the tranquillity is caused as a result of dissipation of wave energy in the large quantity of mud kept in suspension. Mud banks, as they appear and disappear in the sea, have been considered as unique formations and seem to occur nowhere else except along the Kerala coast, SW coast of India. Qualitatively, these could be described as a visual phenomenon and their appearance is frequently associated with a considerable rejoicing as these have, in the past, been thought to be ' God's gift given to Kerala fishermen '. The regions of the Kerala coast where these are noticed lie between Cannanore and Quilon[1,2].

Mud banks are generally known to appear prior to or during the SW monsoon[3], a week after the monsoon has set in[4], or immediately after the SW monsoon has commenced[5]. Several explanations have been put forward regarding the formation of these mud banks and some of the earlier concepts have been discussed adequately[2,6]. The latest explanation is that the formation of mud banks at a particular place is related to the presence of rip currents in that area[3]. Similarly, several different explanations have been given regarding the calmness of water over the mud banks. The early idea that the presence of oil in the mud and the elasticity of the mud give the calmness, fails to provide experimental proof[2]. The other explanation that the wave energy near the bottom is absorbed by the thixotropic drag, and close to the surface, because of an increase in the ratio of viscosity to its density[2], seems still valid.

Probable locations and descriptions of mud banks along the Kerala coast have been given[5,6]. Present studies are largely confined to one mud bank at Ambalapuzha, near Alleppey, which from all previous records appears to be of a persistent nature. In this communication an attempt has been made to provide an answer to this mysterious phenomenon and some of its related aspects.

Materials and Methods

Observations on the mud bank were made by making regular trips to Ambalapuzha either at fortnightly or monthly intervals from May 1972 to July 1973. These included observations on wind direction, surface currents and wave charac-

*Present address: National Institute of Oceanography, Dona Paula, Caranzalem 403301 teristics. A small country craft was used to go round the calm water of the mud bank. The thickness of the mud at the bottom was recorded with a portable echo sounder adjusted to record the firm bottom as a thin line, and whenever a layer of mud was present at the bottom, the echo sounder recorded it as a thick line. The thickness of the mud was confirmed by taking core samples at regular intervals. When the mud was in suspension, the recorder gave thin vertical lines in addition to the record of the bottom.

The seaward periphery of the mud bank was studied from the research vessel *Varuna* on 11, 12 and 13 July 1973. The period of waves was noted with the help of a stop watch from the stationary vessel and the ship's movement up and down, as indicated by the ship's echo sounder, was taken as a record of wave height. The direction of waves was also noted from the ship.

Data on the beginning of upwelling presented here were collected on board *Varuna* in April 1972. Standard oceanographic procedures were used for the analysis and treatment of data.

Physical Factors and Mud Banks

Surface wind — Surface air circulation in the nearshore area of the SW coast of India, taken from the atlas of Royal Netherland Meteorological Institute, KNMI[7], has been shown in Fig. 1. The Figure gives the resultant force, direction and constancy of the wind in 2^0 square. The orientation of the coast shown in the figure is from NNW to SSE. The wind is weakest in November. Its direction is northerly with a constancy less than 25%. In December, the direction of the wind almost becomes NNE and the wind has a greater force and constancy. From January to July, both speed and constancy of the wind progressively increase — speed approaches approximately 3 Beaufort scale units and constancy nearly 100% (Fig. 1). During this period, the direction gradually shifts from N to W. In August, the wind is directed towards SSE and by October the speed falls, although the direction and constancy remain almost similar to those of August.

Surface currents — General pattern of currents, as obtained from the data of KNMI[7], has been shown in Fig. 2 for different months of the year. The figure gives the resultant surface currents in 2^0 square. From March onwards the surface currents run parallel to the coast along SSE direction. Both current velocity and constancy in the direction increase progressively and in July, the constancy becomes greater than 75% and the range in speed is 25-40 cm/sec (Fig. 2). From July to September, the strength of the currents weakens. In October, the currents are in a transitory phase and their velocity either comes close to zero or they run northward. In November, the currents run towards the north and continue to remain so till January. The speed of this northerly drift is relatively low -of the order of 8-15 cm/sec. In January and February, the currents are once again in a transitory phase and by March they take SSE direction.

Waves -Data on wave characteristics of the Arabian Sea have been given by Srivastava *et al.*[8]. According to these authors, June and July are the roughest months in the Arabian Sea. Fig. 3 gives the highest 10% high waves and their direction of propagation during the month of June along, the SW coast of India. It can be seen from the figure that the region of the highest 10% high waves (of the order of 5·0 m) lies close to Trivandrum and away from Calicut. The result of such wave characteristics is, that strong swells approach the coast from WSW.

Average monthly wave data for the coastal waters near Alleppey, obtained from the Alleppey Port have been given in Table 1. The direction of waves, as they approach the Alleppey point, varies from WNW to WSW. The data indicate that the predominant wave periods are less than 5 sec for all the months except May-August. During these months, the wave periods up to 18.5 sec are predominant.

The average height of the recorded deep water wave also has a seasonal pattern (Table 1). It is of the order of 12-19 cm from October to April. From May-July its height increases to about 70-79 cm. Thereafter, it progressively falls and reaches 12 cm in December.

Topography and nature of bottom -The width of the continental shelf varies from place to place along the SW coast of India. It is wider on the northern side and narrower on the southern side. For example, the width of the continental shelf at Calicut is 80 km and it is only 45 km at Anjengo. Along the southern side, the different depth contours are concentrated close to the shore.

Kurian[5] has identified four different zones of bottom deposits in the shelf region. These are: (i) Sandy deposit in the near shore region up to a depth of 3·5 m. (ii) Muddy deposit with small quantities of sand beyond 3·5 m depth and up to 18 m line, from Mangalore in the north to Quilon in the south. Off Cochin, the belt of grey muddy deposit extends up to 35 m. Off Quilon, however, the quantity of mud in the deposit becomes small and sand predominates. (iii) Sandy zone which begins from the end of the muddy deposit and extends up to 100 or 120 m depth. In this zone, the quantity of mud progressively decreases and that of sand increases towards deeper water.

TABLE 1 — AVERAGE DEEP WATER WAVE HEIGHT AND MOST FREQUENT WAVE PERIODS OBSERVED NEAR ALLEPPEY IN DIFFERENT MONTHS

(The three periods indicated in the table cover more than 50% of total wave periods observed)

Month	Av. deep water wave height cm	Periods sec			Predominant deep water direction during monsoon
		1	2	3	
Jan.	12	1-5	20-21	18-19	—
Feb.	13	1-5	20-21	18-19	—
March	19	1-s	18-19	6-7	—
April	14	1-5	20-21	18-19	—
May	70	18-19	1-5	6-7	—
June	73	18-19	6-7	10-11	WNW
July	79	16-17	10-11	6-7	W
Aug.	45	6-7	16-17	18-19	WSW
Sept.	24	1-5	6-7	18-19	W
Oct.	15	1-5	6-7	18-19	
Nov.	13	1-5	18-19	14-1.5	
Dec.	12	1-5	18-19	20-21	

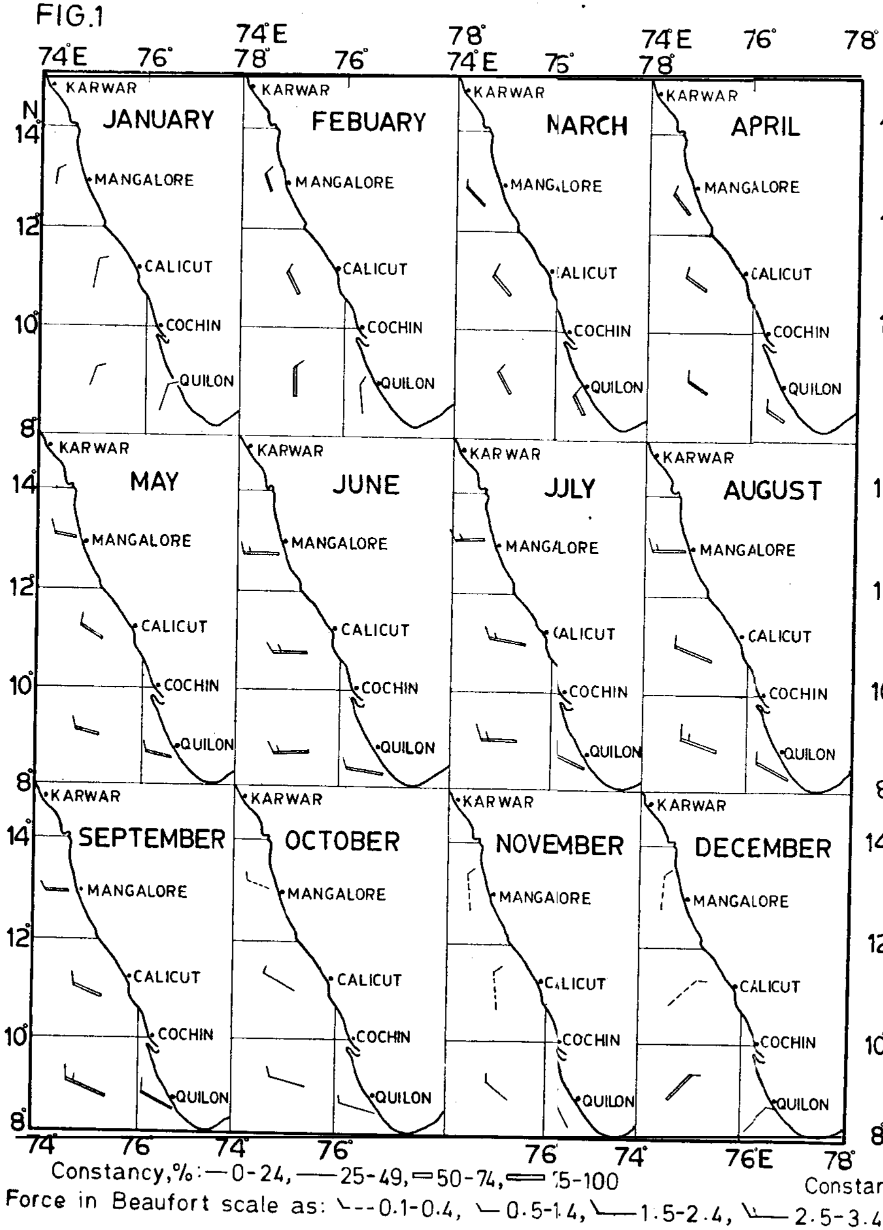

Fig. 1 — Monthly resultant surface wind circulation in 2° square along SW coast of India

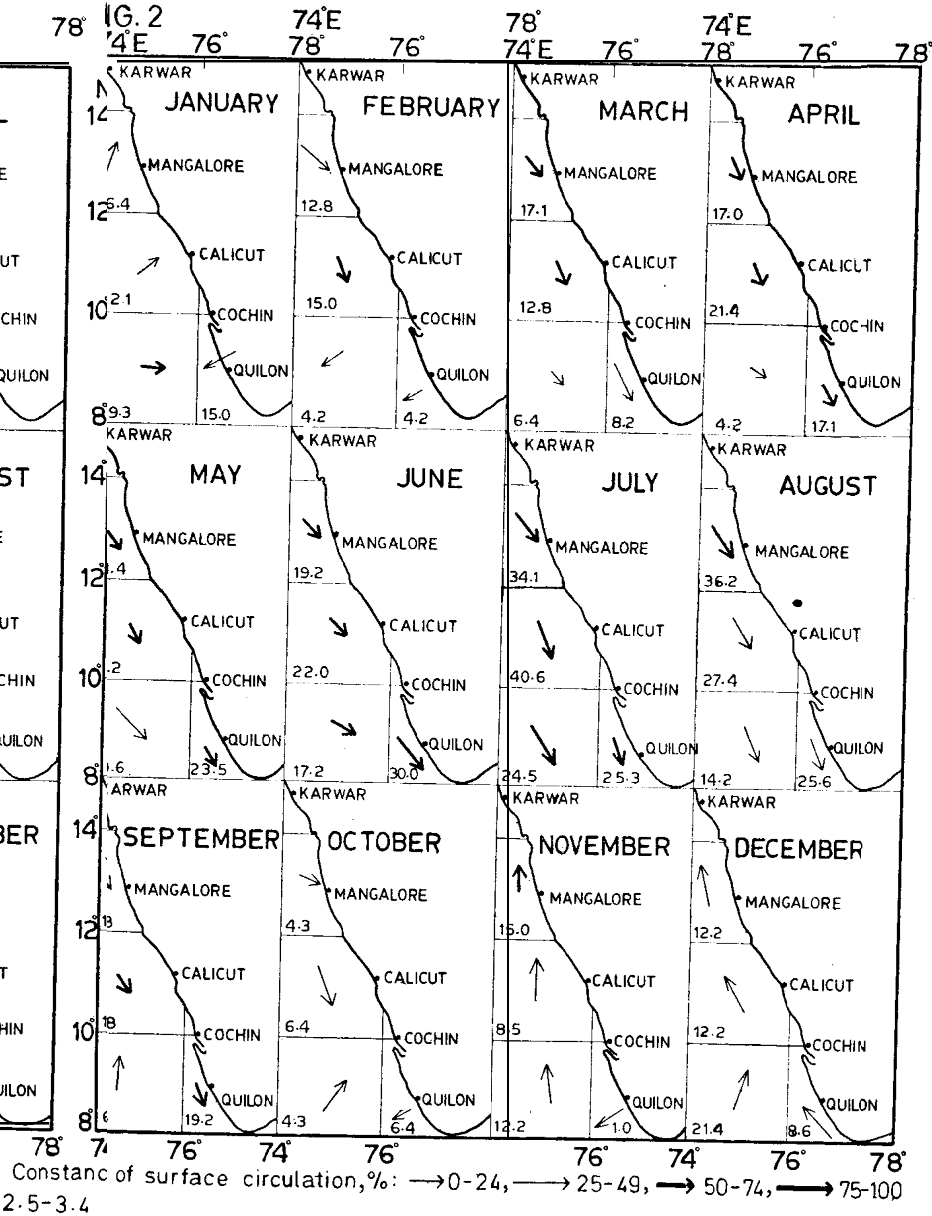

Fig. 2 — Monthly resultant surface currents in 2° square along SW coast of India [Values give current velocity in cm/sec]

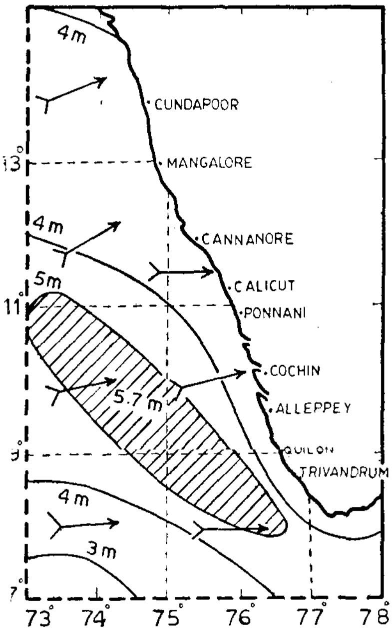

Fig. 3 — Significant wave heights and direction of movement of waves during the month of June along SW coast of India [Region of the highest 10% high waves has been shaded]

(iv) Hard bottom zone begins from about 100 m line and extends up to 260 m depth. This zone has deposits of grey/black and white sand mixed with fine shell fragments and contains very small percentage of silt. Occasionally patches of rocks also occur in this zone.

The latest fishing charts of the SW coast of India show that the area between long. 76°40'E and long. 77° 00'E and lat. 7°30'N, and further north of it along the shelf, is not only devoid of mud but it is hard and covered with sand and rocks. Probably strong currents near the bottom have prevented the natural deposition of mud in this region.

Results and Discussion

Terminology Used for Mud Banks

Since no standard terms have been applied earlier for the mud banks and their formation, it is considered desirable to use the following terms.

Mud bank is an inshore region where the sea bottom generally has a small elevation of 1-2 m due to the presence of consolidated mud. In this elevation, about 55% of the particles contained in the mud are of fine clay having a size less than 1 μm[9], largely dominated by kaolinites[10]. Above this elevation, the depth is relatively small but sufficient for surface navigation.

Active mud banks are those- areas which have been referred to by earlier workers as 'mud banks', that is, where the waves are dampened by the special property of the mud bank along its periphery during the SW monsoon and calm water gets demarcated within the mud bank.

Passive mud banks are the same areas at a time when the wave characteristics in the region are similar to those of the other areas.

Persistent mud *banks* are those mud banks which become active practically every year during the SW monsoon or whenever there is strong wave action. These mud banks are not permanent at a particular place. When active, they can shift from one inshore region to another, but maintain their form. Hence the word presistent indicates their recurrence year after year in a particular area.

From the terminology noted above, the phrase 'formation of mud banks' can only be applied to the first appearance of the mud bank in an inshore area. Persistent mud banks are not really formed every year ; they just get activated by the SW monsoon.

General Features of Persistent Mud Bank

The mud bank near Alleppey is one of the 3 persistent mud banks of the SW coast of India — the other 2 are found at Cochin and Calicut. The occurrence of Alleppey mud bank has been reported as early as 1860 in the vicinity of the Alleppey Pier[1,2]. The available information shows that this mud bank moved slowly southward till 1895, that is, about 10 km in 35 years. Thereafter, the movement became rapid, about 10 km every year. The mud bank disappeared in 1902, after moving a distance of more than 40 km southward. The above information has been presented diagrammatically in Fig. 4. In 1925, a new mud bank appeared again a few kilometres north of Alleppey and began to move slowly southward. In 1970, it was about 12 km south of the Alleppzy Pier (Fig. 4).

In Jan. 1972, this mud bank was noticed at Ambalapuzha, 13 km south of the Alleppey Pier. From January to May, the surface currents over the mud bank were northerly. In early June, the currents reversed, and towards the end of June the currents all along the mud bank became strong and southerly. During this period, the waves

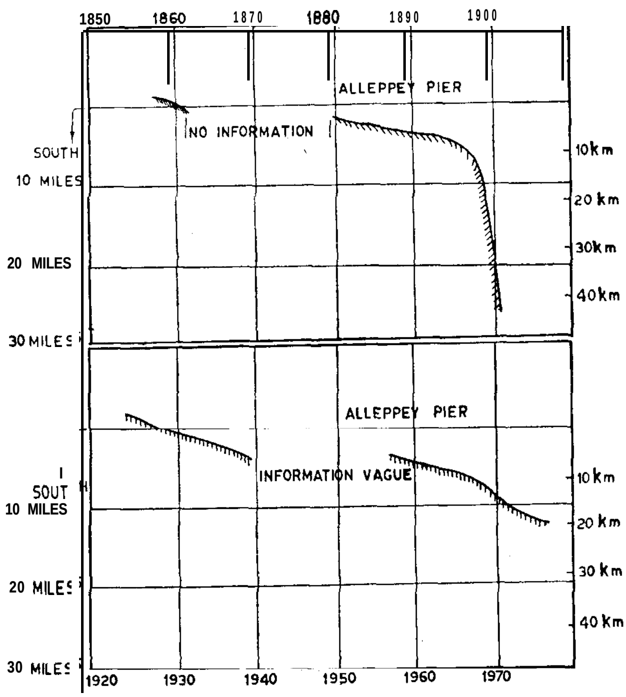

Fig. 4 — Recorded positions of mud banks near Alleppey from the years 1850 to 1973

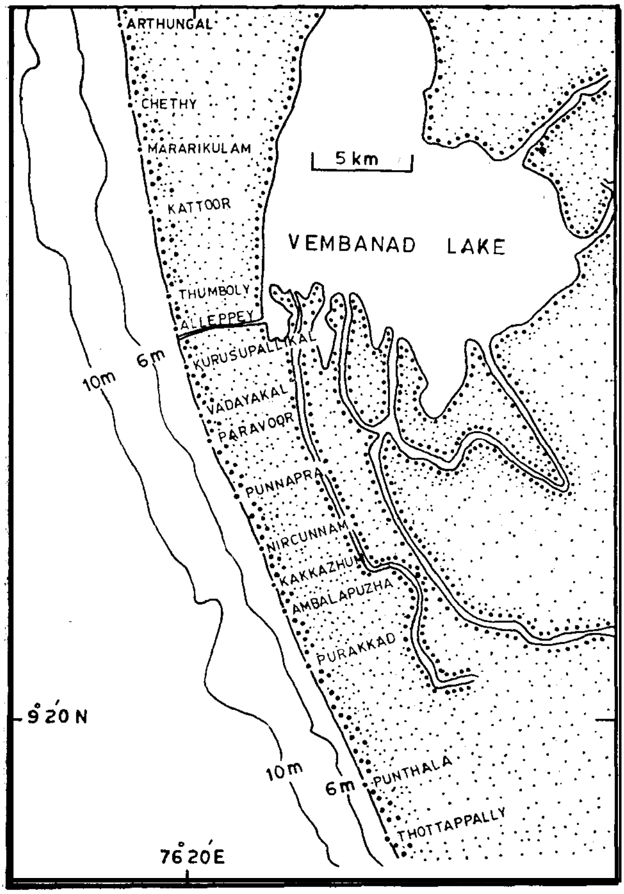

Fig. 5 — Coastal region near Alleppey and its bathymctry while the mud bank was at Purakkad

approaching the mud bank were from all directions. Strong swells, however, were always from S and SW. By Aug. 1972, the mud bank moved towards south and its southern end began to extend about 5 km south of Ambalapuzha.

In July 1973, the mud bank area at Purakkad was approached from the sea side. Wave observations showed that swell, with periods 12-15 sec approached the bank from SW, W and NW directions. However, breakers on the sea-wall at Thottapally (a village further south of Purakkad, Fig. 5), constructed to protect the beach from erosion, were always spreading from south to north, suggesting that the strongest swells were approaching the area from SSW or SW.

Structure of Mud Bank

As noted earlier, to determine the thickness of the mud in the mud bank and neighbouring areas, a portable echo sounder, adjusted to record the hard bottom as a thin line was used. The results of such soundings taken through the axis of the mud bank at different stages of its activity have been shown in Fig. 6. These were redrawn from the original echograms. The soundings were extended only up to a distance of 2 km from the shore. During the non-monsoon months when the mud bank was in a passive state, the entire area along the axis of the mud bank had 1-2 m thick deposit of mud (Fig. 6A). The mud in this season was well consolidated. An examination of the mud showed that it contained more than 60% fine clay particles. The water content of the mud was found to be more than 80%.

During the monsoon months, as the mud bank became active, a marked difference was noticed in its structure. Traces obtained from the echo sounder have been shown in a horizontally expanded scale in Figs. 6B and 6C. In these figures, the mud in suspension near the bottom is recorded as thin vertical lines. The liquid mud in the mud bank was observed at about 1 km west of the shore and its thickness increased westward. The soundings could be continued only up to 2 km from the shore, and along this axis, a thick suspension of the mud was found from 2 m below the surface to the bottom. Fig. 6D shows the settling mud soon after it had moved to a new area.

The soundings along the seaward regions of both non-mud bank and mud bank areas were taken with another echo sounder and some of the echograms obtained have been shown in Fig. 7. The nature of bottom of a non-mud bank area during the non-monsoon months (Fig. 7A) differs from that of the monsoon months (Fig. 7B). These echograms are also quite different from the bottom record; of a mud bank area. The latter have been shown in Fig. 7C and were obtained when the mud bank was active. The suspended mud can be clearly seen at the extreme left of Fig. 7C when the ‘ white line ’ was put on. During the monsoon months, the mud in suspension is found even in non-mud bank areas (Fig. 7D) but the quantity of suspended material is far less than that of the mud bank area shown in Fig. 7C (compare B, C and D). The mud in suspension does not normally extend beyond a depth of 20 m, although consolidated mud may occur in deeper areas. Fig. 7E shows an echogram of thick mud deposit found at depths of 30-40 m, a few kilometres north of Ambalapuzha (off Nircunnam).

Movement of Mud Bnnk

Southern movement — The mud bank of Alleppey is known to move southward either every year or every few years (Fig. 4). This is a slow, continuous movement of the floating mass of the mud when the mud bank becomes active. The movement occurs after the fine clay particles are churned up and form a thick colloidal solution. During the active phase of the mud bank, the periphery demarcating its seaward boundary is the main region of the production of mud suspension. When the thick suspension comes close to the surface, the continuous wave action begins to drive the suspended mud towards the shore, but because of strong southerly currents prevalent during July and August, the floating mass begins to move in a southerly direction.

In April 1972, the mud bank was at Ambalapuzha. Along the axis of the mud bank, the coastline had a distinct protrusion into the sea (Fig. 8a). In Aug. 1972, the suspended mud was seen to extend adjoining the coast towards Purakkad (Fig. 8b). When this happened the protrusion of the coastline was partly eroded. The rest of the suspended mud followed the extension and the entire mud bank shifted and acquired a new position along Purakkad (Fig. 8c). Later on, when the

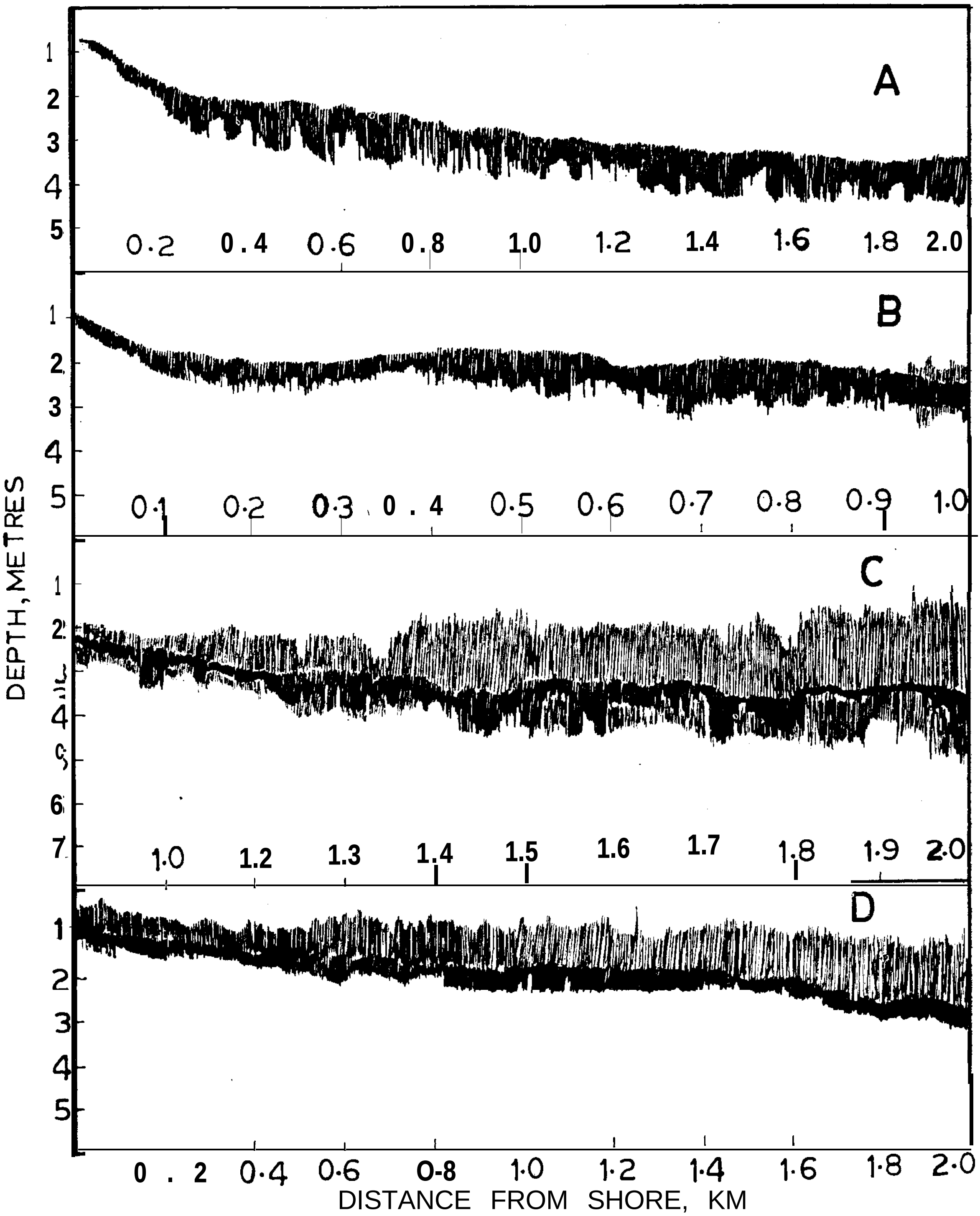

Fig. 6 — Sounding through the axis of the Alleppey mud bank from shore to 2 km seaward [A, echo traces of the mud bank during the premonsoon months. B and C, the same area during the monsoon months. D, echo traces-of the settling mud soon after the mud bank had moved to a new position]

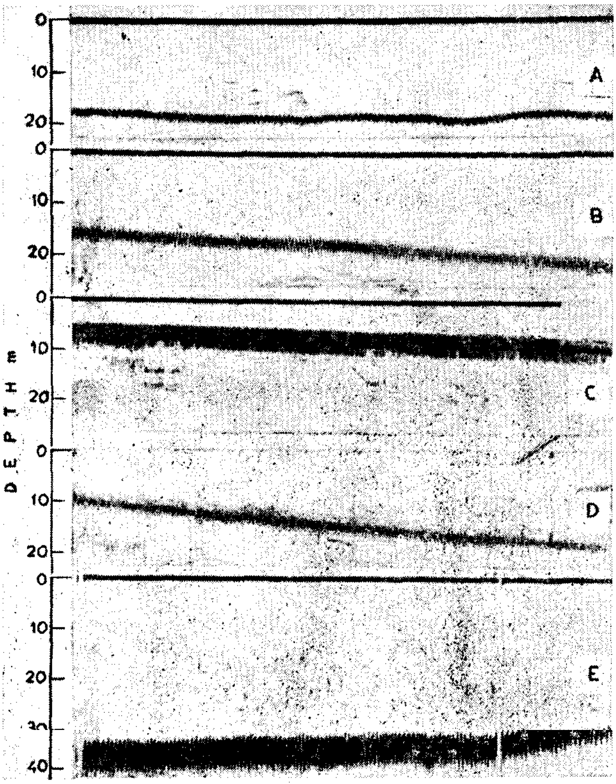

Fig. 7 -- Echograms of the Allcppcy mud bank and of mud bottom. Distance covered in all the recordings is 4 km. For all recordings, the gain of the recorder was kept constant [A, echo traces of the bottom of a non-mud bank area during the non-monsoon months. B, echo traces of the same area during the monsoon months. C, echo traces of a mud bank when it became fully active. Difference in the structure of the deposit is seen when the 'white line' was switched on towards the end of the record. D, echo traces of a non-mud bank area during the monsoon months with the 'whit,: line' on. E, echogram taken off Nircunnam where thick mud was found at depths of 30-40 m]

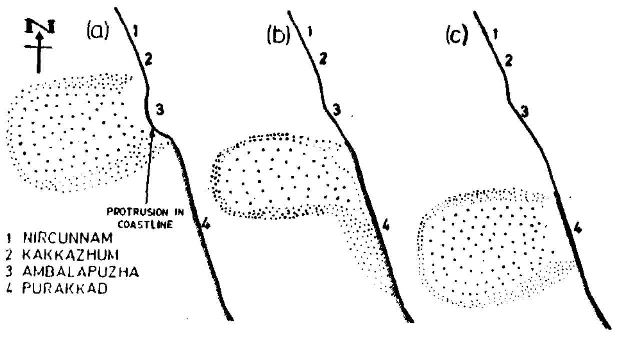

Fig. 8 -- Diagrammatic representation of the southern movement of mud hank [a, initial location of the mud bank: h, extension of the suspended mud towards south; and c, new position of the mud bank. Periphery of the mud bank is shown by closely placed smaller dots]

wave force declined, the fine mud began to settle down at the new position. The suspended particles of the mud seem to have a very high degree of cohesion and hence the mud bank moves very slowly towards the south.

Northern movement — Occasionally the mud hank, or at least a part of it, has been observed to move towards north. In April 1973, the mud bank was

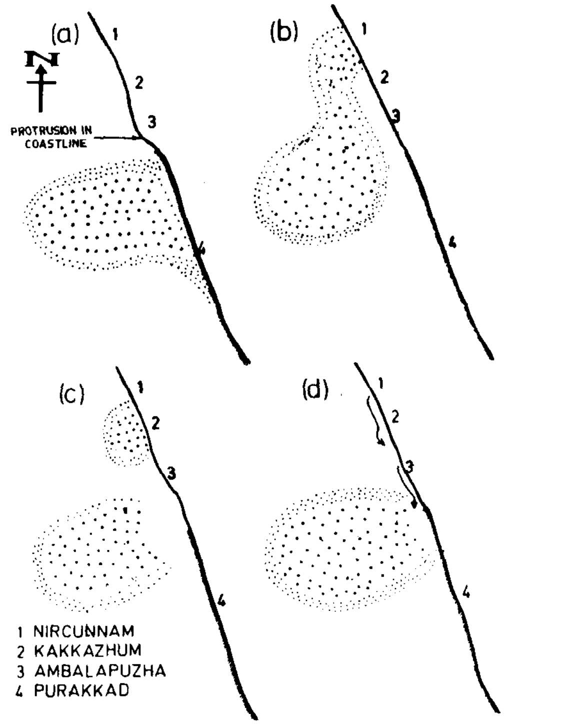

Fig. 9 — Diagrammatic representation of the northern movement of mud bank [a, initial position and outline of the mud bank; b, northern extension of the suspended mud; c, separation of the northern extension; and d, cohesion of the two separated portions]

seen in between Amhalapuzha and Purakkad (Fig. 9a). At this time the protrusion in the coastline was at Amhalapuzha. In late April, a portion of the mud hank adjoining the coast got detached and moved to Kakkazhum. Before the separation took place, strong swells were seen from 23 to 30 April 1973 approaching the mud hank area from the south. These led to a complete disappearance of the protrusion from the coastline, followed by an extension of the suspended mud towards the north (Fig. 9b) and its eventual division into two unequal portions (Fig. 9c). The detached portion of the suspended mud remained close to the shore and at Kakkazhum it formed a temporary mud bank with its western (seaward) boundary occupying only about 300 m into the sea (Fig. 9c). However, being devoid of a well defined supporting periphery along its seaward margin, it could not retain its identity very distinctly. By the first fortnight of June, when a strong southerly drift was established, the movement of the temporary mud bank was reversed. In July when the waves brought the mud into a thick suspension, the currents shifted the deposit southward until it joined the detached portion of the original mass which had by this time developed a supporting periphery along its seaward side (Fig. 9d). It is interesting to note that all along the northern movement of the mud bank and its subsequent shift towards the south, the coastline was devoid of any protrusion.

No movement — If, during the active phase of the mud hank, the wave action is not strong enough to churn up the mud into colloidal suspension and bring it close to the surface, there will be no movement in the suspended mud. Hence the mud will settle there itself and the mud bank will appear at the same position next year.

Periphery of Mud Bank

During the active phase, the area of calm water is distinctly enclosed in a clearly demarcated semicircular periphery or margin where the waves get continuously dampened. Outside this periphery, the sea is as rough as anywhere else along the coast; but inside, there is perfect tranquillity; and if any waves appear, these are generated within the enclosed area. In July 1973, some of the details of the mud bank and its periphery were worked out. The width of the periphery was found to vary from place to place but at one place, where the width was somewhat narrow, the following characteristics were noticed :

Approx. width of periphery	= 240 m
Approx. distance from shore to periphery, EW direction	= 6 km
Approx. distance in between periphery, NS direction	= 4 km
Depth of water outside periphery	= 7.5 m
Depth of water inside periphery	= 7.0 m
Thickness of suspended mud above consolidated mud	= 2.0 m
Total thickness of mud	= 4.5 m
Approx. location of hard bottom from the surface	= 11.5-12 m
Predominant wave height just outside periphery	= 1.8 m
Predominant wave height outside the mud bank area	= 2.6 m
Predominant wave height inside periphery	= 0.1 m

Swells entering the 240 m wide periphery have the bulk of their energy dissipated within the periphery of the mud bank, which at its farthest point is about 6 km away from the shore. It is the main site of the production of colloidal mud of very high viscosity in which practically the entire wave energy is absorbed. Thus the periphery acts as a wide submerged breakwater for the mud bank.

While discussing the wave pattern in and around the mud bank, it seems desirable to make a distinction between the swells which are generated in the sea, well outside the mud bank, but move towards the shore, and the gravity waves which continue to be produced by the action of strong winds. The periphery simply acts like a submerged breakwater absorbing most of the energy of the swells.

Monsoon Fishery and Mud Bank

In Kerala, there is considerable variation in fish landings from year to year and from season to season. As an example, monthly fish landings for an average fishing year are shown in Fig. 10. It is clear from the figure that April-July is the period of minimum fish catches. This is partly because of the lack of fish in the nearshore areas and partly due to rough weather conditions prevailing in the sea which lead to suspension of fishing activity during these months11, particularly by the non-mechanized indigenous crafts, which even today contribute to the bulk of fish landings. Nevertheless, even small catches of fish during the monsoon months are important, as these fetch a high price and very often penaeid prawns contribute a substantial portion of the catches.

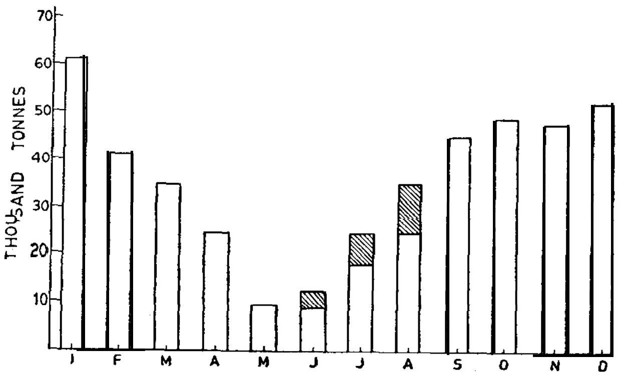

Fig. 10 — Average monthly fish landings in Kerala. Shaded portions indicatq, the quantities largely contributed by the Alleppey mud bank area during the monsoon months

A combination of several natural factors seems to affect the concentration of fish and prawns in certain areas of the west coast during the monsoon months. The vigorous stirring up of mud by the wave action probably forces the fish and prawns to move upwards. Monsoon is also a period of upwelling along the Kerala coast. During upwelling, bottom water of low oxygen concentration moves towards the shallow areas. In July 1973, dissolved oxygen at a depth of 10 m was 2.5 ml/litre in nearshore areas. It was still lower at about the same depth in offshore waters. Probably one of the effects of upwelling is to force fish and prawns to move towards the shore to avoid the oxygen deficient water[11]. This condition, in conjunction with the southerly surface drift of the intensity of about 25-40 cm/sec, may bring shoals of fish and prawns more towards the shore, close to the mud bank, where it is possible to do fishing by indigenous crafts through the mud bank even in highly turbulent conditions. Such concentrations invariably occur north of the mud bank as was observed in July 1972. Intensive fishing was possible along the northern fringes of the mud bank during this period. Thus, during the three monsoon months (June-August), the mud bank contributes to significant quantities of fish and prawn catches of Kerala (Fig. 10), by functioning as a temporary fishing harbour.

Upwelling and Mud Bank

A continuous belt of mud extends from Mangalore to Quilon, from about 3.5 to 18 m depth[5]. However, the mere existence of mud at a particular location is not conducive to mud bank formation. If any of the dynamical forces such as a cyclone, moves the mud deposit to a depth of about 12 m and consolidates it in a smaller area, and if such a situation is aided by some of the physical factors given above, a temporary or a persistent mud bank can come into existence. In Dec. 1965, a storm in the Arabian Sea gave rise to the formation of a mud bank on the shore occupying a stretch of about 5 km bstween Cochin and Elamkunnapuzha[12]. There is also a strong possibility of under currents during upwelling moving the mud deposit from deeper areas to shallow areas.

Fig. lla gives the density (sigma-t) distribution off the SW coast of India at a depth of 30 m. The data were collected during April 1972. From the density distribution and the direction of currents shown in Fig. llb, there is a clear indication of well-developed undercurrents associated with the early stages of upwelling along the Kerala coast.

Shore Stability and Mud Bank

The beach profiles of the Kerala coast undergo marked seasonal changes, and from March-July the beaches are subjected to severe erosion. During August-November, accretion occurs along the coast and from December to February there is normally no change in the beach profile”. The main reason for the beach erosion is the continuous chain of swells which keep on hitting the beaches during the pre-monsoon and monsoon months. With the presence of a mud bank along the coastline, the beach protrudes into the sea along the axis of the mud bank and on either side of the protrusion the coastline is subjected to erosion. In 1972, when the mud bark was at Ambalapuzha, the protrusion in the coastline at its farthest point, was about 150 m. The protrusion was probably caused by the gradual deposition of sediments from the eroded beach material. As a result of this, at a distance of 800 m north and 1600 m south, the coast got eroded to the extent of 100 m (Fig. 12). The effect is similar to what happens after the construction of a groyne or a sea wall to act as a breakwater for the protection of beaches. While this saves the beach immediately behind the breakwater, the adjacent areas get eroded quickly because the natural stability of the coast gets disturbed and a larger area becomes vulnerable to further attacks of the sea. The pattern of waves in relation to the mud bank along the coastline has been shown in Fig. 12.

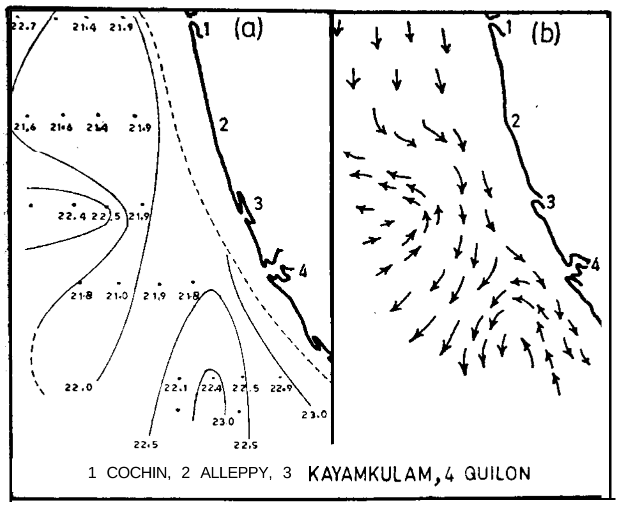

Fig. 11 — (a) Distribution of density (sigma-t values) at 30 m depth, and (b) direction of currents at 30 m depth off SW coast of India in April 1972

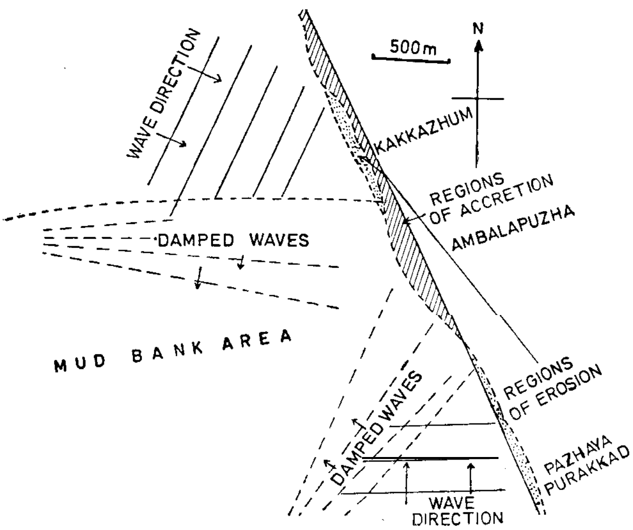

Fig. 12 -Shoreline changes induced by the presence of mud bank near Ambalapuzha during 1972 [Both southern and northern areas adjacent to mud bank get eroded, but the erosion is severe on the southern side, probably because of the proximity of a seawall nearby. Wave directions have been shown by large arrows. Damped waves within the mud bank are indicated by smaller arrows]

Cause and Effect

Some earlier investigators have noticed a general convergence of waves towards the mud bank. Varma and Kurup[3] have indicated that littoral drift converges along certain parts of the coastline and this creates rip currents which stop the shoreward transport of the sediments and form mud banks. No strong rip currents were observed in the area of Alleppey mud bank either before or after the mud bank became active. This is primarily because the waves converging towards the mud bank get somewhat dampened and the coastal currents in the region of the mud bank are always stronger than any rip current that might be produced as a result of wave breaking in adjacent areas.

In earlier communications it has also been stated that the disappearance of mud bank is due to an increase in salinity of the water during the post-monsoon months. The fall in salinity during the monsoon months has been thought to be one of the factors inducing the suspension and flocculation of the mud[3]. Salinity values observed at 10 m depth during the monsoon and post-monsoon months were 32.0 and 35.0‰ respectively. It is, therefore, doubtful if such small changes in salinity can have much effect on flocculation and deflocculation[13]. The reason for the active mud bank becoming passive is the decrease in the intensity of high energy swells approaching the shoreline during the post-monsoon months. The waves of post-monsoon period are largely gravity waves generated locally which have periods of less than 5 sec. In such a situation, the mud bank area and the non-mud bank area would look alike.

At many places along the Kerala coast, the mud deposits have probably accumulated during long periods of years[14]. These deposits have presumably been formed as a result of silt-loaded discharge by many rivers into the Arabian Sea. Several of these deposits are at depths greater than 20 m. If by some natural forces, these deposits could move to nearshore areas where other forces, get combined to stir the mud up and develop a suitable periphery around the suspended mud, a mud bank would come into existence. If, however, a relatively small deposit gets transported into much shallower depths where large steep waves pass by, the entire accumulated mud will go into suspension and will be transported into the sea along the direction of prevailing currents. If, by chance, the deposition happens to come along the periphery of an existing mud bank, it would add to its size.

From these deductions it is now possible to provide an explanation of the annual appearance and disappearance of the mud bank, its movement, and several other aspects related to the mud banks of Kerala.

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