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FORMATION OF THE *CHAKARA* (MUD BANK) ON THE KERALA COAST

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INTRODUCTION

THE appearance of *Chakara* along the coastal waters of Kerala is a peculiar phenomenon occurring prior to or during the South-West Monsoon. This phenomenon has been noticed from time immemorial. The first mention of the *Chakara* in recorded history can be seen as early as 1755, when Captain Cope described the Alleppy *Chakara* in his *A New History of the East Indies*. The two volumes published by Bristo (1938) contain references to the mud bank by early authors. These are mostly qualitative descriptions of the characteristics of the mud banks.

The formation of *Chakara* is restricted to a section of 270 kilometers of the Kerala coast between Calicut and Quilon at definite locations. During *Chakara* the bottom mud is kept in suspension thus making the water highly turbid and viscous. This leads to the viscous damping of the waves on the offshore side of the *Chakara* thereby making the lee side water calm. The mud banks extend in a semicircular shape towards the sea. The seaward extension of the banks is usually the six-fathom line at a distance of about $3\frac{1}{2}$ miles from the shore. The along-shore stretch varies between 2–3 miles. The depth contours broaden out seaward in the mud bank regions.

EARLIER THEORIES OF FORMATION

Various theories have been put forward to explain the *Chakara* formation. The first one was by John Rhode (1886) (*see* Bristow, 1938). He stated that the mud bank at Alleppy was formed by an underground discharge of mud by the hydraulic pressure head developed in the backwaters due to increase in water level during monsoon. Du Cane *et al.* (1938) have suggested that *Chakara* formation is due to the stirring up of the already existing bottom mud in the near-shore region by the action of high waves, generated by the pre-monsoon winds. They also emphasized the role of rivers in the supply of sediments, as most of the mud banks are found near river mouths. The lowering of salinity helps to keep the sediments in suspension for longer period. A third theory was put forward by Ramasastry and Myrland (1959). According to them the formation of mud banks is due to upwelling near the bottom, between 20–30 m. along the coast line which produce vertical accelerations with resultant lifting of bottom waters. The lifted bottom water carries along with it the fine bottom mud.

Since the maximum possible rise in water level in the backwaters is only five feet, the pressure developed due to this is insufficient to cause a subterranean mud flow (Bristow, 1938). Coggin Brown's analyses of the bore samples from Alleppy, Wellington Island and Cochin revealed that the character of the deposits is sufficient to rule out the possibility of subterranean channel flow. Even though upwelling can lift up bottom sediments as occurs in the Benguela upwelling region (Hart and Curie, 1960), it is doubtful whether an overturning of subsurface water as occurs along this coast can bring up large quantity of mud from the bottom and keep it in suspension for a sufficiently long period.

The theory of Du Cane *et al.* partly explains the role of waves in the formation of *Chakara*. However, it fails to explain their formation at definite locations along the coast.

PRESENT OBSERVATIONS AND INFERENCES

The recent observations by the authors and other published works reveal the possible physical forces responsible for the formation of *Chakara*. During the cyclone of December 1965, large quantity of mud was dumped on the beach north of Cochin entrance to a distance of about three miles (Varadachari and Murthy, 1966). By July 1966 all the mud was carried offshore by waves and *Chakara* was observed during July.

A *Chakara* was formed at Punnappura in 1966 even before the onset of S-W monsoon. In 1968 two mud banks were found, one offshore at Nircunnam and another at Nattika, about 40 miles north of Cochin where there is

no freshwater discharge from river. In 1969 prior to the onset of the S-W monsoon a mud bank has appeared 2 miles south of the Nircunnam point. It has been observed that before the formation of this *Chakara* there were persistent ground swells of 12-14 seconds period from south-west. In 1968, before the formation of *Chakara,* the wave approach at Nircunnam and Nattika was parallel to the coast. At Nircunnam the littoral current was found to be converging from either side of the mud bank.

From these observations it can be deduced that freshwater discharge from rivers has not been of much significance in the formation of *Chakara,* since they have appeared prior to the active monsoon and also at places where there is no discharge of freshwater from rivers. At the same time, the importance of wave action can be assessed, because these mud bank formations have been preceded by persistent action of high period waves.

The wave refraction studies carried out for Nircunnam region, using bathemetric charts corrected upto 1962, reveal the possibility of formation of rip currents in this region for higher period waves, which can carry finer sediments offshore and prevent onshore transport of sediments by waves. Thus localisation of finer sediments can take place at the rip head which, when settled, will extend the bottom contours offshore. This feature has been revealed by a small survey conducted by the authors off Nircunnam.

The dumping of large quantities of mud on the Elankunnapuzha beach north of Cochin, during December 1965 cyclone, shows the possibility of localised onshore transport of offshore bottom mud by mere wave action. Such onshore transport of bed-load by wave action might be taking place in other regions also and where this is opposed by rip currents *Chakara* formation takes place.

During South-West monsoon the surface salinity decreases considerably. Very near the shore the surface salinity falls to about 27‰ (Damodaran and Hridayanathan, 1966). The rip currents carry this low salinity water offshore, thereby diluting the offshore waters, which facilitates the deflocculation of sediments in suspension, which accounts for continued existence of the *Chakara.* As the salinity increases during the post-monsoon season the mud flocculates and settles down, and the *Chakara* disappears.

Such phenomenon may be taking place in other regions also where *Chakara* have been observed. Studies are being made to establish the existence of rip currents in other *Chakara* regions.

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