INTERNATIONAL INDIAN OCEAN EXPEDITION

NEWSLETTER

Vol. IV No. 2 INDIA September, 1966

SYMPOSIUM NUMBER

SEA EROSION IN KERALA

Issued by

THE INDIAN NATIONAL COMMITTEE ON OCEANIC RESEARCH
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
NEW DELHI

INTERNATIONAL INDIAN OCEAN EXPEDITION
NEWSLETTER
INDIA

Vol. IV No. 2 Part 1 SYMPOSIUM NUMBER September, 1966

SYMPOSIUM ON "COASTAL AND NEARSHORE OCEANOGRAPHY"

Studies on Oceanographical problems of the coastal and Nearshore areas have received considerable impetus in recent years in several institutions in the World. The result is the emergence of a new scientific discipline known as Oceanographic Engineering which is mainly concerned with the application of Oceanographic knowledge to problems in Coastal Engineering relating to harbour construction, stabilization of beaches, etc. The studies also include problems on pollution and dispersal of effluents in the coastal and nearshore areas. In a country like India with a coastline of about 3000 miles, coastal and nearshore oceanographic studies assume great importance especially in view of the urgent need to protect our shores from the intrusion of the Sea, particularly in regions like the Kerala Coast containing valuable mineral sands like Monazite, Ilmenite etc. In our harbour expansion programme, a knowledge of the littoral movements would help in an understanding of the factors responsible for silting in harbours thereby facilitating proper upkeep of harbour channels and approaches. The investigations consist of collection of extensive data on nearshore currents, variation of tides and sea level, waves and sea states, various processes in land-sea interaction brought about by the combined operation of meteorological and oceanographical factors, littoral movements leading to beach erosion and accretion and so on.

In view of the importance of these investigations, both from the fundamental and applied points of view, a few institutions in this country including the National Institute of Oceanography have taken up studies on some of these aspects and in order that these studies could be properly coordinated it is considered necessary to bring together the scientists engaged in these investigations to a common forum where the problems could be discussed and the progress made in different directions assessed. This is the principal objective of the present symposium on Coastal and Nearshore Oceanography jointly organized by the Indian National Committee on Oceanic Research and National Institute of Oceanography.

A preliminary announcement regarding the holding of this symposium already appears in an earlier issue of this Newsletter. In the present one which is being issued as Symposium Number, details regarding the symposium, and abstracts of papers received for the symposium are given.

The symposium will be inaugurated at the Central Institute of Fisheries Operatives, Ernakulam on the morning of 4th November, 1966, by Dr. K. L. Rao, Minister of State for Irrigation and Power, Government of India. A lecture on "Evolution of the Coasts of India" will be delivered by Prof M. S. Krishnan, former Director of the Geological Survey of India, at the inaugural session and this will be followed immediately by scientific sessions. A local organising committee for the symposium has been formed, consisting of:

1. Shri R. Madhavan Nair—Chairman.
2. Dr. A. N. Bose.
3. Shri K. K. N. Nambiar.
4. Shri M. C. Perumal.
5. Dr. R. Raghu Prasad.
6. Dr. S. Z. Qasim.
7. Dr. V. V. R. Varadachari.
8. Shri M. S. Narayanan.

Dr. Varadachari will be the Secretary of the organizing Committee, and all communications regarding the Symposium are to be addressed to him as: Organising Secretary of the Symposium on Coastal and Nearshore Oceanography, Physical Oceanography Division of the National Institute of Oceanography, Karikkamuri Road, Ernakulam-1. The abstracts of the papers for the symposium are given below.

ABSTRACTS: SECTION I

1.1 Water Movement and Tidal Studies in Bombay Harbour Bay

I. S. Bhat, J. R. Naidu, K. C. Pillai and A. K. Ganguly.
Health Physics Division,
Atomic Energy Establishment Trombay
Bombay

Theoretical evaluations of tidal water movement and water renewal rates in the Bombay Harbour Bay were made by the Health Physics Division from sounding data and informations of tidal timings and elevations, to assess the diluent availability of the Bay for Trombay effluents. Such studies were followed up by tracer experiments using Na-24 and K-42.

The land-locked mass of water in the bay is connected with the Arabian Sea in the south and Ulhas river through Thana creek in the north. At the Thana creek junction there is thus a dynamic exchange between the saline environment in the bay and a less saline environment of the river. The salinity differential in the high and low tides offers a means of studying the mixing and exchange processes between the waters of the bay and the river.

The paper reports experimental observations made at the Thana creek during a full tide cycle in premonsoon and monsoon periods on days on which spring and neap tides occurred during day time.

These observations showed that during premonsoon period there was practically no net flow of river water into the Bay. In monsoon the average net inflow was about 0.5% of tidal streams near the Trombay shore. Even under extremely favourable conditions of maximum low tide flow in the monsoon, the net inflow was only about 6% of tidal streams and even this flow did not reach the discharge area in a single tide cycle. It was observed that the overall contributions due to Ulhas river to the ultimate dilution of discharged effluents and water renewal rates in the Bay were not very significant.

The paper summarises the results of the water movement studies carried out in the Bombay Harbour Bay for a correct evaluation of the recipient capacity of the Bay.

1.2 Studies on tides and their effect on Visakhapatnam Beach

— G. R. Lakshmana Rao and D. P. Rao,
Deptt. of Meteorology & Oceanography,
Andhra University, Waltair.

Beach sections at Visakhapatnam opposite to Andhra University have been analysed for the year 1965. The annual variations of beach normal to the shore indicate that erosion takes place from March to September and deposition for the rest of the year. For the waves approaching the coast, this spot being neither strong zone of wave convergence nor wave divergence, the depletion and deposition of sediment from time to time is gradual. Steep waves from all directions erode the region and low waves build up the beach. The diurnal variations of beach relative to tide does not show any correlation, but typically the vertical extent of beach is more between low tide and high tide and less at half-way between high to low. Even during a day, the quantity of eroded or deposited sediments depends upon the height of waves disturbing the shore than the tide. In addition, the range of tides and the duration of actual tides from predicted tides have been discussed for a period of 20 years. The durations are more during monsoon season compared to the other seasons of the year.

1.3 Beach Cycles in Relation to tide

C. S. Murthy,
P. S. N. Murthy and
V. V. R. Varadachari.
Physical Oceanography Division of
N.I.O., Ernakulam

The paper presents the results of investigations on the nature and magnitude of the changes over a tidal cycle, on the beaches with different settings. Observations were taken of the cut and fill at hourly intervals. The study shows that during the flood tide the points on the landward side as well as the seaward side of the breaker zone in general experience a fill while considerable cut takes place at the breaker zone. During the ebb tide, the points behind the breaker zone experience a fill while the points on the landward side do not experience much change. The magnitude of the changes are studied in relation to the settings of the beaches, the range of the tide and other physical factors.

1.4 Transport and Diffusion of Radioactivity from Bombay Harbour Bay

K. C. Pillai and
A. K. Ganguly
Health Physics Division,
Atomic Energy Establishment
Trombay, Bombay

The paper reports results of a theoretical study undertaken to trace the movement of radioactivity discharged into Bombay Harbour Bay from the effluent discharge point of 40 MW reactor CIRCUS at Trombay. The calculations were based on tidal flows into the Bay at its southern entrance from the Arabian Sea, tidal elevations and speeds of water flow in high and low tides. The paper describes the technique of follow-up of the central time of radioactivity from a continuous discharge point from the peak of high tide and subjected to dilution through turbulent diffusion. These studies indicated that the discharged activity oscillates with tides and the net leakage of activity out of Bombay Harbour Bay, through mechanisms of tidal transport and diffusion is not significant during non-monsoon period. The discharge capacity will have to be assessed on the basis of water renewals in the Bay during monsoon. The paper demonstrates how permissible concentrations for sea water in the Bombay Harbour Bay have been computed on the basis of water removals and utilisation of the Bay environment.

1.5 Sea Level at Visakhapatnam

C. Poornachandra Rao,
Meteorologist.
Meteorological Office, Bangalore.

A study of the mean sea level at Visakhapatnam in 1954 with reference to the local Oceanographic and meteorological factors showed that it is significantly correlated with sea surface salinity, accumulated rainfall calculated from the beginning of the calendar year and southwest component of wind force (longshore wind). The monthly mean sea level was the lowest in April and the highest in October. When the mean sea level was the lowest, the surface salinity was the highest, the longshore wind was from Southwest and the accumulated raifall was nil. When the mean sea level was the highest, the surface salinity was the lowest, the longshore wind was from Northeast and the accumulated rainfall was practically the highest.

1.6 Circulation in the Coastal Waters of Waltair.

R. Ramanadham, R. Varadarajulu and
B. Rami Reddy,*
Deptt. of Meteorology & Oceanography,
Andhra University, Waltair.

The magnitude and direction of currents in the coastal waters off Waltair in the Lawson's Bay region have been evaluated from the observations of a float using a double theodolite. The circulation patterns of alternative months for the year 1964 have been explained on the basis of the existing wave characteristics from March to September; longshore currents are northerly and the magnitudes are relatively large during S.W. Monsoon. In the rest of the year, the currents are towards the coast in the same direction as wave normals with weak southerly longshore components. Analyses of the beach profiles along the southern parts of the Bay indicate erosion from March to September and accretion in the rest of the year. Zones of rip currents have been also traced along the north of the Kailasahills. Weak offshore components of the currents from March to September may be due to the upwelling near the coast. Erosion and accumulation of sediment are associated with northerly longshore currents and southerly longshore currents respectively.

* Present address:
Lecturer,
Deptt. of Marine Biology & Oceanography,
Kerala University,
Ernakulam.

1.7 On Waves Along Visakhapatnam Coast

D. P. Rao, N. J. Rao and
K. R. G. K. Murthy,
Deptt. of Meteorology & Oceanography,
Andhra University, Waltair.

In the present investigation, the preliminary results of the wave properties along Visakhapatnam coast have been discussed. Data on waves during storms and normal weather conditions for the period 1936 to 1964 have been considered. The wave characteristics in different seasons depend upon the climatic and weather conditions. The waves are high and the sea is rough during southwest monsoon period and the sea is calm during N.E. monsoon. Exceptionally high waves have been reported during the cyclones in the Bay of Bengal. In addition, wave forecasts have been prepared for few selective synoptic situations and compared with the observed waves. For cyclones and approximately similar synoptic situation the waves approaching the coast have different characteristics. The reduction in wave heights near the coast for waves from cyclones after 1950 may be due to the shoaling of the coast areas.

1.8 Installation of wave recorder off Cochin:

P. S. Srivastava, C. K. Balakrishna Kurup, P. K. Vijayarajan and D. Krishnankutty Nair.
Indian Naval Physical Laboratory,
Cochin.

A brief review of the existing shore wave recording instruments has been presented. The necessary precautions required to be taken for the establishment of shore wave recording stations have been discussed. A wave recording station has been established off Cochin and the experiences gained thereby have been presented. The data collected by the wave recorder has been analysed for the height (average, significant and highest ten per cent) and average period. An attempt to forecast the waves off Cochin has also been made. Refraction diagram of the point where the wave recorder has been installed has also been drawn.

1.9 Wave Refraction and Beach Erosion Near Thottapally

P. Udaya Varma and
V. V. R. Varadachari.
Physical Oceanography Division of
N.I.O., Ernakulam

An attempt is made to study the refraction of the waves of different periods and deep water directions ranging from 200° to 320° as they enter the shallow waters near Thottapally area. The refraction and direction functions are obtained at various arbitrarily fixed locations along a stretch of 45 miles on the coast line between Thottapally and Manacad. From these parameters the possible regions of erosion and accretion are investigated and the direction of longshore currents evaluated.

1.10 Some Physical Aspects of Beach Erosion of Kerala

V. V. R. Varadachari.

Kerala has a coast line of about 350 miles oriented roughly in a north-south direction. The stretch of the beach on the Kerala coast may be described in general as a barrier beach, the barrier separating the sea on the west and the backwaters and estuaries on the east. One of the special features of the coast is the existence of mud banks at some places along the coast in the nearshore regions of the continental shelf. The part played by these estuaries and mud banks and the role of the shoreline configuration, waves, tides, currents, wind, storms, beach material and artificial structures in the erosion and sedimentation of the coast are discussed.

1.11 The December 1965 storm in the Arabian Sea and its Effects on some Kerala Beaches

V. V. R. Varadachari and
C. S. Murthy.
Physical Oceanography Division of
N.I.O., Ernakulam

A study of the effects of the storm that affected the Kerala coast in December 1965, shows erosion at several places along the coast and also formation of a mud flat for a stretch of about three miles between Cochin Harbour entrance channel and Elakunnapuzha. An attempt is made in this paper to explain the mechanism of formation of the mud flat through a detailed study of the course of the storm and the waves generated by the system and the refraction suffered by the waves near the coast, by working out the significant heights and periods of the waves approaching Cochin and Alleppey regions of the coast using meteorological data.

SECTION II

2.1 Shallow-water Oceanographic Studies off the Southern California Coast

Katherine G. LaFond and
Eugene C. LaFond
U.S. Navy Electronics Laboratory
San Diego, California.

The shallow-water environment off the southern California coast has been studied from a stable platform located one mile off shore in 60 feet of water. For seven years the U. S. Navy Electronics Laboratory's Oceanographic Research Tower off Mission Beach, San Diego, California has been conducting marine studies in the fields of biology, chemistry, geology and physics. Results of some of the investigations are reported here.

Biological work has included plankton and fish populations and distribution. Chemical studies have been concerned with nutrient concentrations. Geological studies of the bottom sands and sub-bottom strata have shown the recent geological history of the area. Physical studies have included temperature, tides, currents, internal waves, and ambient sound of biological origin. Different fields of investigation have been correlated in order to show their interdependence. Examples are the variation in depth of the chemical nutrient concentrations with respect to the passing of an internal wave, the effect of differing concentrations of plankton on transparency of the water, the presence or abundance of different species of fish, as well as the level of ambient sound, with respect to diurnal light intensity.

2.2 Some Hydrographical Changes During a Tidal Cycle in the Vellar Estuary at Porto Novo

Dr. K. Ramamurthy,
Marine Biological Research Station
Porto Novo.

The hourly sequence of changes in salinity (chlorinity), density and current velocity, etc. have been studied at one Station in the Vellar estuary during a complete tidal cycle. The changes are discussed in relation to mixing process and the amplitude and duration of the tides.

2.3 Some Hydrographical features of Porto Novo waters During the Year 1961-1965

V. D. Ramamurthy,
R. C. Subbaraju and
S. Krishnamurthy,
Marine Biological Research Station
Porto Novo.

A long term programme of hydrographical studies of the inshore and estuarine waters has been in progress for some years. The present paper reports some of the hydrographical features at the 10-fathom line and in the mouth of the Vellar. The variations in temperature, salinity, inorganic phosphate, total phosphate, dissolved organic pohsphate, silicate, light penetration etc. have been surveyed and discussed. The hydrographical features of the Porto Novo waters are compared with those that have been reported for waters in other regions in India.

2.4 Hydrography of Godavari Estuary

R. Ramanadham and D. P. Rao,
Deptt. of Meteorology & Oceanography,
Andhra University, Waltair.

The results of the Hydrographic conditions of the Vashista branch of the Godavari estuary up to a distance of about 25 miles upstream from the confluence during four seasons have been discussed. The salinities along the axis of the river during summer months indicate a decrease along the horizontal at all depths with the increase of distance from the confluence. Vertical sections at all stations show homogenous waters and slight variations at the extreme upstream regions which may be due to thorough mixing by the surface waves and tidal currents in the shallow waters. The salt water extends only through short distance of about 2 miles from the confluence at times of high tide during the flood season.

The diurnal variations of temperature at the surface follows the diurnal variations of air temperatures and in the sub-surface layers the range of variation decreases. The currents at the surface during summer show maximum upstream currents while the tide is passing from low to high and minimum while time is passing from high to low. The current observations near the bottom observed by the drag do not indicate current magnitudes but the direction is opposite to the surface current. During flood season the river flow is modified by the tidal flow with low discharges at high tides and very high currents while the tide reversed its direction. During summer, the circulation is cellular and forms homogeneous waters along the vertical.

2.5 Diurnal Changes in Certain Oceanographic Features in the Arabian Sea Off Cochin in September 1966

N. M. Shah.
University of Kerala,
Oceanographic Laboratory,
Ernakulam.

Diurnal changes in temperature, salinity, disssolved oxygen, inorganic phosphate, nitrite, zooplankton, U.V. absorbancy of filtered sea water and phytoplankton pigments have been studied from an anchored vessel in the Arabian Sea, seven miles off Cochin on 22nd and 23rd September, 1966. The station depth was 19 metres and hourly hydrographic collections were taken during day time, from surface, 5, 10 and 15m depths. Current at 4m depth was measured five times. At six hour intervals water samples were collected from surface and 8m depth for studying phytoplankton pigments and U.V. absorbancy. Duplicate zooplankton hauls were taken from secchi disc depth to surface.

Surface salinity and dissolved oxygen content have the same pattern of fluctuation, the lowest values occurring in the early morning period. Nutrients increase nearly three to ten fold from surface to 15m and have higher concentrations at 0800 hrs. Displacement volume of zooplankton shows peak at 0800 and 1500 hrs. At about the time of the afternoon peak, large fluctuations are observed in the direction of current and the speed is only half that of morning or evening. Maximum U.V. absorbancy is at 0600 hrs. for the surface water but is at 1200 hrs. for the 8m water.

2.6 Thermocline As An Indicator of Upwelling

G. S. Sharma.
Central Marine Fishries Research Sub-Station, Ernakulam

In this paper the topographic charts representing the depth of thermocline off the west coast of India covering the area 73°30'E to 77°33'E and 07°00'N to 14°00'N for one year and the time section of temperature off Cochin for the period March 1964 to August 1965, are presented to infer upwelling and sinking.

In the area under consideration the thermocline depth does not exceed 150 metres in any month of the year and it is deepest in the months of January and February. There is a gradual upward tilting of the thermocline towards the coast from February onwards and it almost reaches the surface by July indicating an upward movement by the end of August after which the tilting of the thermocline is reversed indicating sinking near the coast.

The vertical variation of temperature with time gives a clear indication of the vertical movements of the waters. The time of commencement of upwelling varies from depth to depth. At depths greater than 100 metres it occurs around February and the upwelled water gradually reaches the surface by May. Upwelling ceases by July/August and sinking is present from September to January.

2.7 Instrumentation for Coastal Oceanography

– K. V. Sundararamam
Indian Naval Physical Laboratory,
Cochin.

Some instruments designed at the I.N.

Physical Laboratory for use in coastal Oceanographic research are described. These are the shallow water wave recorder, thermistor thermometer, current meter and transparency meter.

The principle of capacitance variation between the sea level and a brass electrode is employed in the design of the shallow water wave recorder. Waves of any period can be recorded and the maximum height of waves that can be recorded is limited to about 12".

An F-type thermistor and Wheatstone bridge are employed in the Thermistor thermometer. The operable range of this instrument is 0°C to 30°C in three steps of 10°C each with an accuracy of $\pm$ 0.25°C.

The impeller type of current meter developed makes use of the photoelectric principle for indicating the speed and a freely suspended magnet and bridge circuit for indicating the direction of flow. The contact attached to the magnet closes the bridge circuit and the position of the shore potentiometer for null deflection in the meter gives the direction of the current.

Transparency meter has been developed using a light source whose intensity can be kept constant and the resulting photo current output from a photo cell placed at a distance of 50 cm gives a measure of the transparency of the water column.

2.8 ANGRIA BANK EXPEDITION General Hydrographic and Chemical Features

K. Vijayakrishnan Nair, P. M. A. Bhattathiri.*
Atomic Energy Establishment Trombay, Bombay
and
B. F. Chhapgar
Department of Fisheries, Government of Maharashtra Bombay

Hydrographic data are presented which were obtained during a post-monsoon (November-December 1964) cruise in the Angria Bank region of the Arabian Sea. During the 16 days' cruise 45 stations were occupied of which 23 were hydrographic. Relatively high values of salinity, disssolved oxygen and inorganic phosphate were obtained in the water samples from near the Bank than in the samples obtained away from the Bank. Isotherms of temperature showed a southerly movement of water both above and below the thermocline. Current measurements indicated a net flow of water at an average speed of 0.24 knot in a southwesterly direction away from the Bank and supported the evidence obtained from temperature data.

Similarities were noticed between the hydrographic characteristics of Angria Bank and Great Bahama Bank.

(*Present Address: Biological Oceanography Division of National Institute of Oceanography, Karikkamuri Cross Road, Ernakulam-1.)

2.9 Determination of Nitrate and Nitrite in Estuarine and Nearshore Waters of Porto Novo

— S. R. Vijayaraghavan and
V. K. Venugopalan
Marine Biological Research Station,
Porto Novo.

The paper discusses the estimation of nitrate in nearshore and estuarine waters by the hydrazine reduction method of Mullin and Riley. The effect of filtration of samples of water on nitrogen values has been studied. Filtered samples gave a higher percentage of recovery than unfiltered. Filtration using different grades of filter papers (Whatman Nos. 1, 42 and SS. 589) was also investigated. Copper has neither a positive nor negative effect on the reduction process when used in excess of the minimum quantity required to act as catalyst. A correction factor for nitrate determination has also been worked out. The effect of particulate matter on the recovery of nitrate has also been studied. Suspended particulate matter interferes also with the estimation of nitrite. The hydrazine reduction method and cadmium reduction method for the determination of nitrate in sea water have been compared. With the cadmium reduction method there is 86 per cent recovery, but with the hydrazine method only 60 per cent for nitrate determination in sea water.

2.10 The Concentration of Inorganic Phosphate and Nitrate in the Slicks in the Inshore waters at Porto Novo.

S. R. Vijayaraghavan and
AL. Paul Pandian,
Marine Biological Research Station,
Porto Novo.

Observations on the concentration of inorganic phosphate and nitrate in the slicks in Porto Novo inshore waters have been made for over six months. The concentration of phosphate is consistently higher in the slicks than in the adjoining waters in the sea. The mean concentration of phosphate for 23 samples collected on different dates was 3.58 μg at/L while it was 0.63 μg at/L in the water on the shore side of the slick, and 0.62 on its farther side. There was a wide range of variation of phosphate concentration in the slick, but it was always higher than in the neighbouring waters. However, the overall trend of variation was similar.

The mean concentration of nitrate in six samples of water in the slick collected on different dates was 8.98 μg at/L while in the adjoining waters it was 4.19 μg at/L on the shore side, and 4.15 μg at/L, on the farther side of the slick. There was no difference in salinity between the slick water and adjoining waters. The significance of these features is discussed.

SECTION III

3.1 Seasonal changes in the Characteristics of Beach Material

— P. S. N. Murty,
R. R. Nair,
Abraham Pylee and
V. V. R. Varadachari.
Physical Oceanography Division of
N.I.O., Ernakulam

Sand samples collected from the different zones of the beach at two points namely Ochanthuruth and Narakkal on the Vypeen bar, during the period May 1964 to May 1965, have been studied for the seasonal variations in their characteristics like median diameter and sorting. The point at Ochanthuruth is in a free zone while the point at Narakkal is in a sea wall and groyne zone. At Ochanthuruth the backshore is composed of medium sand and the foreshore is found to be composed of medium sand during the monsoon period and fine sand during the rest of the period. At Narakkal the beach is composed of fine sand and does not show any marked variations of sand size with season. At both the points the sediments are well sorted. The characteristics of the beach material have been studied in relation to the changes in beach profiles.

3.2 Studies on the currents and sediment Transport near Cochin

— C. S. Murthy and
V. V. R. Varadachari.
Physical Oceanography Division of
N.I.O., Ernakulam.

The paper presents some of the preliminary results of the investigations on the near-shore current at diffrent depths along the sections normal to the coast near Cochin. The currents at the sea bed were measured by means of a "Pisa" current meter of Carruther's design, developed in this laboratory.

A self recording T. S. K. current meter was used to obtain the surface and sub-surface currents. These studies are being undertaken to understand the nature of sediment transport near Cochin.

3.3 Physical and Chemical Studies of Mud Deposit of Vypeen Beach

– R. R. Nair,
P. S. N. Murty and
V. V. R. Varadachari.
Physical Oceanography Division of
N.I.O., Ernakulam.

Mud deposited on the sand beaches of Vypeen after a storm have been studied for their physical and chemical properties in order to understand their source and mechanism of deposition. Physical aspects comprised of the study of water content, grain size and constituents of the coarse fraction. Chemical aspects included determination of organic carbon, total phosphrous and iron. Spectrographic estimation of certain selected trace elements such as B,Mn, Ni, V, Cu, Sr and Rb was also carried out. The physical and chemical data of the muds is compared with identical data for off-shore samples and it is found that even though the median grain size and the coarse fraction constituents are similar, significant differences occur in values or PO4-P, Fe, Sr. These differences may be ascribed to differences in the environment at the original site of deposition. It is inferred that perhaps these muds originate very near the shore being entirely composed of dredged material transported northwards from Ernakulam channel under the influence of storm induced waves and currents.

3.4 A study of seasonal variations in the beaches of Kerala State:

K. K. N. Nambiar, N. S. Moni, and M. M. George,
Kerala Engineering Research Institute, Peechi.

Investigations have shown that there are seasonal changes on the beaches of the Kerala coast. Shore line accretion occurs during seasons of light wind and erosion takes place during the monsoon season. There is seasonal reversal of littoral transport in many of the beaches. A study of the seasonal change in eight reaches of beaches along the Kerala coast during June 1964 to December 1965 is discussed. Beach profiles spaced at ½ km. intervals were taken perpendicular to the shore. The profiles were taken up to L.W.L. The surveys were repeated at monthly intervals. Profiles were extended to 4 m. depth below M.S.L. in certain reaches. The study indicated that erosion is experienced even from April, prior to the outbreak of the monsoon and continues throughout the monsoon period (August-September). After this period the beach begins to accrete. It is also seen that the berm crests wander within wide limits–even up to 70 meters. During accretion the beach slope from berm crest to M.L.W. is between 1 on 5 on 1 on 7. During the erosion period the slope of beach face from berm crest to M.H.W. is about 1 on 5 and from M.H.W. to M.L.W. it varies from 1 on 12 to 1 on 20. The degree of erosion due to the cyclonic storm on 8th and 9th December 1965 has been depicted by the profile changes during November 1965 and December 1965.

3.5 A study of littoral transport along the sand coasts of Kerala.

K. K. N. Nambiar and
N. S. Moni,
Kerala Engineering Research Institute, Peechi.

In the analysis of a coastal erosion problem, the direction, amount and character of littoral drift are of utmost importance. This paper deals with the various methods of determination of the direction and rate of littoral drift and their limitations. The data collected and the studies conducted to understand the littoral processes at work along the Kerala Coast form the main subject matter of the paper. The paper analyses the residence given by the old maps, and charts of Kerala coast particularly the shore pattern and their progressive changes. A study was made of the effect of existing structures such as the break-water under construction at Neendakara, down drift erosion of existing sea wall and groyne systems, observation of the compartments of the groyne systems, the effect of approach channel at Cochin. Studies of configuration of various river mouths and the migration uncontrolled inlets at Murat, Palacode, Kallayi, Azhikode was also made. Data on the variation of characteristics of beach materials by a study of their media size was collected for different period and for different reaches. The tracer studies and current observations conducted in this coastal segment also find a part.

The studies on the shore line and shore depth changes north of Cochin outlet indicate that the shore line has far advanced seaward. As a typical case, the shore line at 2 kilometers north of Cochin outlet has advanced by 1.32 kilometers during the past 50 years. The fathom lines also has receded considerably seaward north of this channel.

The preliminary analysis of data developed indicate that the predominent direction of littoral drift of the coast from Mangalore to Cochin outlet is from north to south. It is also seen that there is a seasonal reversal of direction of littoral drift all along the coast. These tentative conclusions have to be verified and onfirmed by further analysis of data and studies.

3.6 Visakhapatnam Beach, Related Shore Processes and Lowered Sea Levels

M. Poornachandra Rao
Geology Department, Andhra University
WALTAIR

The Visakhapatnam-Waltair beach, mostly sandy, extends in a N.E.–S.W. direction from Dolphin's Nose in the south to Kailasa Hill in the north. There are a few rocky outcrops on the beach south of Waltair, at Scandal Point and at Anchor light. Visakhapatnam beach, which was fairly wide a few decades ago, has been subjected to erosion. It is believed, that the construction of Break-water at Visakhapatnam beach is an important factor influencing the beach erosion. Other natural factors, such as sea level changes, winds, rip currents, stream transport, sediment transport, cliff erosion, effecting the shore processes, are discussed. The nature, source and concentration of black sands occurring in the beach are reviewed. Evidences for the lowered sea levels along Visakhapatnam beach, based on the study of shelf sediments, are discussed.

3.7 A Preliminary Study of the Beach at Porto Novo

V. D. Ramamurthy,
R. C. Subbaraju and
S. Krishnamurthy,
Marine Biologial Researh Statio,
Porto Novo.

The shape of the shore-line at Porto Novo is influenced by the mouth of the Vellar estuary, and also by two smaller tidal creeks. The beach on the northern and southern sides of the Vellar estuary shows some characteristic differences. These and other features of the beach are described in the paper. The distribution and size of the sediment materials have been studied and are reported in the paper.

3.8 Sediment Transportation in the Vicinity of Visakhapatnam

– R. Ramanadham and R. Varadarajulu,
Deptt. of Meteorology & Oceanography,
Andhra University, Waltair.

Data on the quantities of sediment deposited in the harbour channels and sand trap for the period of 30 years have been analysed and results have been discussed. The seasonal fluctuations and annual fluctuation in the quantity and direction of transport have been explained on the basis of the prevailing wave characteristics and longshore currents. The break-water installed to the south of the harbour entrance channel reduces the wave action to the north and thereby protects the harbour from turbulance and sedimentation. The beach to the north of the harbour channel had been eroded due to non-replenishment of sediment from the south; periodic changes in the structures and offshore topography are responsible for the instability of the northern beach. The beach has been eroded severely after 1936 and the extent of erosion gradually decreased towards north from the harbour channel. Between the years 1950 to 1960, the beach variations are insignificant and later, certain regions are eroded further due to insufficient supply of the sediment from south during south-west monsoon. Significant features are explained in relation to circulation, coastal structures, rockey barriers etc.

3.9 Beach Profile Changes at some Selected points on the Kerala Coast

– V. V. R. Varadachari and
Colleagues. P.O.D., N.I.O., Ernakulam.

With a view to understanding the nature of the changes taking place along the beaches of the Kerala coast, in time and space, beach profiles were measured at weekly intervals for points having different environments. A study of the profiles reveals that there are short term and seasonal changes as well as sudden changes. But in general, the beaches do not appear to undergo much annual change except in the neighbourhood of some artificial structures. The investigation also shows that entirely different types of changes in the profiles could occur within short distances along the coast. These changes are discussed in relation to the meteorological, oceanographic and environmental factors.

3.10 A Critical Analysis of Beach Profiles at Visakhapatnam

R. Varadarajulu,
Deptt. of Meteorology &
Oceanography,
Andhra University, Waltair.

The beach variations at three places along the beach between Palm beach and R.K. Mission have been discussed in relation to the prevailing longshore currents and rocky barriers. The back shore and coastline are changing from time to time and vertical extent of the beach normal to the shore is changing due to the waves generated by the occasional severe storms. The annual variations are similar to those explained in the previous investigations. Abnormal erosions are associated with the waves from the cyclones. Nature of depositions and erosion at different spots are explained in relation to the converging and diverging currents. The typical vertical sections of the beaches are due to the changing near shore circulation after the storms and the natural rockey barriers which shelter the beaches. The beach variations are normal along the centre of the region while they are abnormal along both ends of the region.

3.11 Studies on zircons in the beach sands along parts of the east coast of India:

K. Venkataratnam and A. T. Rao.
Geology Deptt.,
Andhra University, Waltair.

Studies of zircons of the beach sands along some parts of east coast of India are reported and the significance of the results obtained in tracing the provenance of sands and the sand movement along the east coast of India are discussed.

3.12 Grain Size variation of Vasishta Godavary River Sediments

Y. L. Dora,
Oceanographic Laboratory,
University of Kerala.
C. Borreswara Rao
Dept. of Geology,
Andhra University, Waltair.

The 62-mile long Vasishta branch of the Godavari river runs from the Dowlaiswaram anicut (16°55' N and 81°45' E) to the confluence near Antarvedi (16°20' N and 81°44' E). Hundred and thirty four sand samples of the post-flood period from the Vasishta Godavari river have been mechanically analysed and the conventional parameters like median, mean, sorting coefficient, skewness and kurtosis were calculated using Folk's formulae. Seventy two clayey samples were subjected to pipette analysis and the sand, silt and clay percentages were determined.

In general, the grain size decreases downstream due to general decrease of turbulence and increase in depth.

The sediments are in general sandy from the anicut to Razole, for a distance of 40 miles, and further downstream they are clayey. Near the confluence the river bottom is enriched with fine sand.

The river sands are 'moderately sorted' whereas the sands from the tidal channels are 'well sorted'. Most of the sediments are negatively skewed, though to a small extent. The general trend of the sands is meso-kurtic to lepto-kurtic.

SECTION IV

4.1 Studies along the coastal region of Andhra Pradesh and in the Godavari deltaic area with special reference to heavy mineral concentration and coastal evolution

– C. Borreswara Rao,
Deptt. of Geology,
Andhra University, Waltair.

Coastal strip extending from the confluence of Vashisht-Godavari in the south to confluence of Vamsadhara river in the north was studied systematically in three different seasons, February-March, August-September and November-December. During such surveys, location of patches of heavy minerals sands were recorded. Measurements of the distribution of both light and heavy mineral sands were made both laterally and in depths down to the level of the water table. In addition, sand levels, tide heights, wind, waves, current, river run-off were made on each survey. During these surveys, beach erosion and beach regression phenomena were noticed at a few places along this coast. Additional information about beach regression has been obtained by a comparison of naval charts of different periods. In the light of the data collected the factors for concentration of heavy mineral sands and for the development of coast line have been discussed in the paper. Concentration of heavy mineral sands at the river confluence is attributed to the direction of river flow at the confluence which is influenced by a partial barrier from the west or southern bank across the confluence. Sorting is attributed to the panning and erosion action of high waves and along shore drift. Deposition and sorting take place in July-September season and gradual deposition of sorted out heavy minerals is completed by February-March season. In addition, beach erosion and beach regression were found to play a significant role in effecting concentration of well-sorted heavy mineral sands. The absence of heavy mineral concentrates at the confluence of Gautami river is attributed to the silting nature of the river, dissipation of mineral grains and consequent lack of proper sorting.

Factors influencing coastal erosion and coastal development are the longshore currents, the waves, direction of stream flow at the confluence and the general load carried by the streams.

4.2 Studies of the Mud Banks of the Kerala Coast

R. Damodaran and
C. Hridayanathan
University Oceanographic Laboratory,
Kerala University,
Ernakulam-6.

At certain regions of the Kerala Coast the sea bottom has got a special property of reducing the wave action and producing areas of calm water during S. W. Monsoon. These calm water areas appearing near the coast are generally known as the "mud banks". This strange phenomenon which occurs only at definite localities between Calicut and Quilon is perhaps the only one of its kind in the whole world.

The occurrence of the mud banks is of great economic importance as these calm regions during the monsoon are known for the fishing of Prawns, Sardines, Mackerels and Soles.

Informations regarding the mud banks are rather incomplete though mention is made in the literature as early as 1775 and the causes that trigger their formation at particular localities at a definite period are still obscure. The number and area of the banks vary every year and even during the same season some amount of shifting also has been observed during certain years. The high fertility of the mud bank regions is owing to the concentration of phosphates and nitrates in the bottom mud. The source of the mud is the detritus brought down by rivers and when littoral currents come in contact with vast quantities of water pouring into the sea from rivers and back waters it is possible that the mud settles down and is carried to one side along the shore to some distance. A further cause of accretion to the banks or the formation of temporary banks may be due to the action of the sea on the offshore mud. The changes in the banks may also be caused by waves, cyclones, earthquakes etc. acting in the sea, particularly during monsoons. In case of all the banks the mud particles in suspension retard or reduce the waves or swells and the maximum disturbance occurs in the outer extremity.

Preliminary studies on the hydrographical conditions of the mud banks show that the bottom water gets progressively colder from May to August, while the dissolved oxygen content decreased, reaching as low as 0.327 ml/l during August. No appreciable difference in the salinity of the bottom water was noticed though the surface water showed as low as 6.33‰ in certain regions. The inorganic phosphate content of the bottom water showed high values reaching as much as 8 μg at,/l, which may be due to the monsoons. As regards the fauna, the various mud banks react in different ways, the one off Porakkad being the most fertile especially for prawn fishery. The general trend is that prawns appear first as soon as the bank is formed followed by sardines and mackerals. Though soles are present along with prawns, their intensity is maximum in the northern most banks formed near Calicut. Particular animal communities have also been noticed dependent on the nature of the bottom and hydrographical conditions.

4.3 Petrological Methods in the Study of Transport and Dispersion of Near Coastal Sediments—

C. Karunakaran
&
H. N. Siddiquie
Geological Survey of India, Calcutta.

The petrological study of sediments provides significant information on the nature of sediments, their environments of deposition, source areas, dispersal and transportation.

The size analyses of sediments, their statistical parameters coupled with a binocular study of the coarse fraction forms the basis for the classification of sediments and the interpretation of their depositional environment. In some cases it is also possible to suggest the direction of movement from these values. The mineralogical studies (particularly heavy minerals) are of primary importance in delineating the provenance of sediments.

Regional patterns of transport and dispersal of sediments over a wide range of time are perhaps better defined by mineralogical studies. The availability of suitable tracer minerals in sediments (i.e., Silliminite on the east coast of India) with known and restricted source areas are essential for the success of this approach.

In local studies of transportation and dispersal of sediments tagged isotopes and flourescent dyes offer many advantages but here also detailed studies of more than one fraction offer considerable scope in deciphering long term directions of transport and dispersal of sediments.

4.4 Preliminary Note on Sedimentation During a Single Tidal Cycle

Ch. Madhusudhana Rao and
M. Subba Rao
Geology Department,
Andhra University, Waltair.

The depositional and erosional trends on the inter-tidal beach at Waltair during a single tidal cycle in relation to the water table have been investigated. The results of the investigation are as follows:

(i) As the tide advances each point on the beach has registered a depositional peak before erosion has set in.

(ii) The rate of deposition or erosion at any station throughout the depositional or erosional period is not uniform.

(iii) The deposition in cross section always appears as thin and convex-upward lense-shaped over its previous profile. These lenses vary in size and shape.

(iv) At any time of the tide, the swash-backwash area may be divided into three segments: (a) the most landward segment which is invaded by the swash occasionally. This enjoys continual deposition, though by small increments. The deposited material is rather coarse-grained. (b) The middle segment which is frequently visited by the up-rushing swash. This segment records a higher rate of deposition, and (c) the seaward-most segment extending from a few feet below the foreshore-water table intersection line, undergoes net erosion.

4.5 Geomorphology of the Godavari Delta

—A. S. Naidu & C. Borreswara Rao,
Geology Department,
Andhra University, Waltair.

The recent and paleogeomorphic parameters of the Godavari Delta discussed include the Gautami-Godavari distributary, Kakinada spit, backwater, and the barrier islands situated off the estuarine mouth. A critical analysis of the variation in the alluvial channel shape as a function of change in the bed load indicates that with an increase in the weighted mean per cent silt-clay (M) the sinuosity of the channel also increases. In the light of these findings it is surmised that the change in the Godavari river course over the past century may be due to the coarsening of the bed load. The formation and growth of the Kakinada spit and the barrier islands closely follow the change in the river course. The exact mechanism that gives rise to the barrier islands is not well understood. It is assumed that even before the change in the river course offshore bars might have been in existence at the site of the present barriers, and were built by deposits excavated from the outer shelf floor of the bars. It is quite likely that the change in the river course supplied into the area surplus sand which, on being redistributed on the bars enabled them to become subaerial barriers. That the process of excavation of the shelf outside the barrier island is still in continuance is exemplified by the occurrence of slabs of recent sand stones, shells, pebbles and clay boulders on the seaward beach of the barrier islands.

4.6 Coastal protection works and Marine Structures in Kerala—A preliminary study

K. K. N. Nambiar and
N. S. Moni,
Kerala Engineering Research
Institute, Peechi.

Coastal erosion has become a serious problem in Kerala. Through the past twenty years the problem has intensified as beach front areas become developed and subject to greater damages from the forces of the sea. Construction of marine structures as jetties, piers, breakwaters, approach channels as part of port and harbour development also has its effect on the shores.

This paper presents data of the existing marine structures and of the corrective constructions along the coast to control erosion. The data were collected with the help of the officers of the P.W.D. engaged in this work and also from Cochin Port authorities.

A preliminary study of these structures and their effect on the beach is made. The changes made in the plans and specifications of the protective structures with the growing understanding of the shore processes at work and from the knowledge and experience gained from an analysis of previous constructions is also noted.

4.7 Coastline Formation and Nearshore Circulation in Relation to Wave Action Along the East Coast of India

R. Ramanadham,
Deptt. of Meteorology &
Oceanography,
Andhra University, Waltair.

The shore line development along the east coast of India between Chilka lake and Ramayapatnam has been investigated theoretically from wave refraction studies and the results are in good agreement with the survey charts for the past 100 years. Wave refraction diagrams are prepared for periods ranging 6 to 14 seconds and for all possible directions. Conclusions on the direction and magnitude of longshore currents drawn from the wave refraction diagrams are used to explain the shoreline changes.

The waves of all periods approaching Chilka lake region are subjected to reduction in wave heights except at a few places for 12 and 6 second period waves. Southerly and south-easterly waves produce northerly longshore currents and waves from easterly directions generate southerly current. This is a strong zone of wave divergence and hence it might have been closed by the deposited sediment, but for the huge quantities of waters discharged into the sea. During summer months, there is a possibility for the closing of the mouth. The decrease in breadth during summer has been observed and the lake mouth is gradually shifted towards north which may be due to the vigorous deposition of sediment by the northerly longshore currents and the subsequent cut by the lake flow towards north.

Investigations for the past 15 years along Visakhapatnam beach indicate that erosion is associated with steep waves during March to September and deposition for the rest of the year when low waves prevail under calm weather conditions. Erosion is more along the zones of convergence and deposition is more along the zones of divergence. Local variations in erosion and deposition are due to the break watersand rockey barriers.

The formation of the Godavari Point has been explained on the basis of the current systems and the prevailing waves. A nodal zone is located to the north of the point which is shifting towards north. The changing current systems keep the locus of the stagnation point to the north-western part of the Godavari point and thus it may be responsible for the growth of Godavari point towards north-west.

Along Ramayapatnam-Narasapur point, the development of the falsedevi point to the south of Krishna estuary is associated with the formation of the nodal zone when littoral currents carrying large quantities of sediment diverge and leave the sediment in the calm zone to its north. Along this region longshore currents are converging at two places which may result in developing rip currents carrying large quantities of sediments and this process may be responsible for the development of shoals near Kottapatnam and Mutapalli.

4.8 The Studies on the Sediments of Krishna Delta

A. Seetaramaswamy and M. Poornachandra Rao
Geology Deptt.,
Andhra University, Waltair.

The sediment samples collected from Krishna delta and nearby beaches have been subjected to size analysis, coarse fraction and certain chemical studies (organic matter and calcium carbonate). The ill-sorting, positive skewness, comparatively high kurtosis of river sediments are distinctive from well-sorting; negative skewness, low kurtosis of the sediments of the beach environment. The percentage of the constituents, namely Foraminifera, Ostracoda, Mollusca, Corals, Plant fragments and Terrigeneous sand grains are determined in the coarse fractions, which form more than 0.5% of the bulk sample. The high content of organic matter in the shelf environment may be due to fineness of the sediments, high organic production and deposition rates. The above environments can also be distinguished with regard to calcium carbonate content. Based on the above results, an attempt has been made to differentiate the various environments in the Krishna delta and to establish criteria for identifying them.

4.9 Studies of Shelf Sediments off Mangalore

H. N. Siddiquie, T. V. Viswanathan, P. C. Shrivastava
&
T. K. Mallik
Geological Survey of India, Calcutta.

78 grab samples of bottom sediments were collected during the cruises in the shallow shelf area off Mangalore.

The sediments of the area comprise sand and dark grey clays. The sands are confined to a very narrow strip (less than a kilometre) along the coast; Md of these sands ranges from 0.1 to 0.3, So from 1.14 to 1.31, Sk from 0.96 to 1.06 and Kr from 0.20 to 0.26. The sands are mainly terrigenous (over 90 per cent mineral and rock fragments) in composition; foraminifera and shell fragments comprise a minor proportion i.e., less than 10 per cent.

The coarser fraction (i.e., $> 125\mu$ and 62-125 of the clays consists of 40-90 per cent of terrigenous material and 5-60 per cent of foraminifera, shell fragments and oolite.

The light minerals in the coarser fraction are mainly quartz and felspar while the heavy minerals suite consists of hornblende (20-60 per cent), tremolite-actinolite (2-8 per cent), hypersthene (0-2 per cent) enstatite (1-3 per cent), muscovite (2-89 per cent) garnet (2-4 per cent), sillimanite (5-8 per cent) kyanite (1-5 per cent), zircon (1-5 per cent) epidote (1-8 per cent), opaques (6-43 per cent) with minor amounts of staurolite, clinozoisite, monazite and augite-diopside. The suite is suggestive of derivation from a mixed igneous and metamorphic terrain.

4.10 Classifications of marine coast and shore lines with special reference to the east coast of India:

– K. Venkataratnam.
Senior Research Fellow of N.I.O.,
Geology Deptt.,
Andhra University, Waltair.

The various classifications of marine coasts and shore lines are described. There are two main groups of classifications—some purely descriptive and some others genetic. It is shown that one or at the most two of the three main factors namely the form of the land surface against which the sea is resting, the movement of sea-level relative to the land and the modifying effect of marine process, have been taken into account in devising classifications by different workers. The different classifications have been discussed and the merits or demerits of these have been pointed out while applying them to categorize the shore lines especially of the east coast of India.

4.11 Formation of the spit and the development of chilka lake, a coastal lagoon.

– K. Venkataratnam
Senior Research Fellow of N.I.O.,
Geology Deptt.,
Andhra University, Waltair.

An attempt is made here to evaluate the influence of different factors in the formation of the barrier spit and the evolution of Chilka as a coastal lagoon.

From the available evidence, it is shown that when the sea-level gradually rose in the holocene period, the land near Chilka was under sea; then Chilka existed as a bay. Subsequently the barrier spit and the islands were built, and emergence of land occurred. The beginning of the spit formation marked the birth of Chilka as a lagoon.

From the consideration of various factors it is inferred that abrupt change in the direction of coast line, longshore drift, constructive wave action, flat coastal gradient, presence or absence of strong river and tidal currents in the different areas were essential in the formation of the spit. The small tidal range and emergence of the coast, might have aided the feature to become permanent. The islands adjacent to the spit are believed to have been built partly by waves and partly by tidal currents as tidal deltas. From the data on mineralogy and other information at hand, an endeavour is made to trace the source of the material for the spit and predict the behaviour of the mouth in the future. From the dating of a 'sub-fossil' shell, *Ostrea virginiana* an attempt is made to assess the age of the Chilka lake.

Also the significance of the study of the barrier spit near Chilka lake in Stratigrapy is discussed.

SECTION V

5.1 The Distribution of Corals on the Indian Coasts.

N. K. Panikkar
National Institute of Oceanography
C.S.I.R., New Delhi.

The paucity of coral reefs adjoining the Indian coasts is well known. This is in sharp contrast to Islands in the Bay of Bengal (Andamans & Nicobar Group) and in the Arabian Sea (Laccadives and Maldives Group) where extensive formations are known as also in the Persian Gulf and the Red Sea. The paper deals with the distribution of the reefs and discusses the probable causes for their absence in most regions of the Indian mainland.

5.2 The Problem of Timber Destroying Organisms Along The Indian Coasts

N. Balakrishnan Nair

University Oceanographic Laboratory,
Kerala University, Enakulam-6.

According to the revised estimates the chief marine timber destroying organisms active along the coasts of India are two species of *Martesia*, 21 species of shipworms, 4 species & a variety of *Sphaeroma* and 9 species of *Limnoria* besides the wood infesting bacteria and fungi especially in the *Ascomycetes* and in the *Fungi imperfecti*. The pattern of distribution of marine timber borers along the coasts of India is described. The nature and activity of the different species of borers show variations in the major harbours of India, each harbour having its own dominant set of species and an assemblage of less important forms. Exposing a planned system of test panels and their subsequent examination after varying periods of immersion provide direct information on the seasons of settlement, growth rates and many other useful information such as the influence of environmental faitors on the activity of borers. The need for initiating test panel exposures in selected areas along the coasts is pointed out. Such data obtained for the Cochin Harbour is presented. The nature of damage by the crustaceans and the molluscs and the role played by bacteria and fungi in the 'conditioning' of timber are explained. The results of recent studies on the wood borers at Cochin Harbour have been briefly reviewed. The different species of borers have their own characteristic preferences, life histories and seasons of attachment and a scheme evolved for one locality may prove ineffective for another owing to different species composition in the different harbours even along the same coast. The heavy ciliate and other infection observed especially in certain destructive species of borers and their effects on the host deserve detailed study since an understanding of the parasites, predators and other associates is likely to provide us with useful information regarding the biological control of these pests.

5.3 Zinc, Manganese and Cobalt Contents of some Marine Bivalves from Bombay

Y. M. Bhatt, V. N. Sastry, S. M. Shah and T. M. Krishnamoorthy.

Health Physics Division

Atomic Energy Establishment Trombay

Bombay

Levels of zinc, manganese and cobalt were determined in the soft parts of six species of marine bivalves to study their suitability as 'indicator organisms' for the radioisotopes of these elements in sea water. It is found that the oyster, *Crassostrea gryphoides* accumulates zinc from sea water by factors ranging from 5,500 to 13,000 and may be utilized as an indicator for radioisotopes of zinc in sea water. Likewise, the clam, *Sunetta donacina* shows a high affinity for manganese and may be used for a similar purpose in the study of contamination of sea water by radioisotopes of manganese. The concentration factors for cobalt in these bivalves range from 30 to 1,730; and among the species studied, no suitable indicator for cobalt was noticed.

5.4 Primary Productivity Studies in Bombay Harbour Bay Using Carbon-14

T. M. Krishnamoorthy
Health Physics Division,
Atomic Energy Establishment,
Trombay.

Carbon-14 has been employed to estimate the changes in rate of primary organic production in Bombay Harbour Bay as affected by hydrogarphic characteristics such as temperature, chlorophyll, alkalinity and salinity. A liquid scientillation suspension counting technique, involving the use of polystyrene as gelling, agent, was standardized for counting carbon-14 in seawater particulates. The productivity tended to decrease in April—May and reached a minimum in June—July. In June—July, the very low values of primary productivity were associated with high wind force and low salinity of Bay water. Primary productivity was negatively correlated with water temperature during February—April and positively correlated with water temperature in the period August—December. Primary productivity in the Bay ranged from 0.06 mg C/m^3/hr to 665.3 mg C/m^3/hr with a mean value of 41.6 mg C/m^3/hr during 1964-65.

5.5 Uptake of Radionuclides by Some Marine Shellfish of Commercial Importance

B. S. Patel, Y. M. Bhatt, T. M. Krishnamoorthy, G. R. Doshi, P. M. A. Bhattathiri, C. K. Unni and R. Viswanathan
Health Physics Division,
Atomic Energy Establishment,
Trombay, Bombay

Experiments were conducted on the uptake, accumulation and loss of radionuclides by two species of bivalves, *Anadara granosa* Linn, and *Katelysia marmorata* Lam, and a crab *Scylla serrata* (Forskal).

The rate of uptake of manganese-54 by *A. granosa* was a function of the weight of the animal; smaller the animal, higher was the concentration factor. The various tissues reached apparant equilibrium in 3-4 days of exposure. The gills and the mantle folds showed the maximum concentration. On return to non-active medium about 50% of radioactivity was lost in 15 days.

Zinc-65 was also concentrated to a greater extent in the soft parts of *A. granosa*. The concentration factor for the radionuclide was dependant upon the carrier zinc concentration. The CF was higher with lower amounts of carrier zinc in the medium.

When exposed to medium containing uranium, the shell of *A. granosa* concentrated more uranium than the soft parts. About 50% uranium was lost within 3 days on transfer to non-active medium. Medium concentration of 5 μg of uranium per ml affected the physiological processes of the animals adversely.

When exposed to secondary coolant effluent from Canada India Reactor (CIRUS), *A.granosa* concentrated cesium-137, zirconium-95 and cerium-144.

In *K.marmorata* also the rate of uptake of cobalt-58 was dependant on the carrier cobalt concentration. The CF generally higher with lower amounts of carrier-cobalt.

Uptake of cesium-137 by *K.marmorata* reached an equilibrium state in about 3 days of exposure. About 73% of cesium-137 was lost in 4 days on transfer to non-active medium.

The concentration factor for cesium-137 in crab *S.serrata* was sex-dependant, the female crab concentrating the maximum amount. The hepatopancreas showed the maximum concentration of cesium-137. Equilibrium was reached in about 9-10 days of exposure.

The chronic concentration factors for transition elements in the two species of bivalves were significantly higher than the acute concentration factors obtained under laboratory conditions.

5.6 Solar Radiation, Light Penetration and Compensation Depth in Cochin Backwaters

S. Z. Qasim, P. M. A. Bhattathiri and S. A. H. Abidi

Biological Oceanography Division,
National Institute of Oceanography,
Ernakulam, South India.

On bright days the average solar radiation falling on the surface of Cochin backwater is approximately 500-700 kilolux hours each day. On cloudy days with intermittant sunshine the range is 300-500 kilolux hours and on very cloudy days with rain at times, the range in the light intensity is 100-200 kilolux hours. Seasonal changes in the solar radiation showed that maximum light intensity reaches the water surface from December to March and minimum from June to September.

As light penetrates the water, it is partly absorbed by the water and suspended particles and partly it is scattered back. Measurement of the extinction coefficients with depths throughout the year, at four different stations, showed that in the pre-monsoon months, 25% of the surface light reaches 1 metre and at 4 metres it is reduced to about 1%. In the monsoon months, due to very high turbidity, the depth of penetration is reduced to 1% within 2 metres. Measurements of the scattering of light at different angles and at different depths showed the back-scattering from suspended matter is very high.

By Secchi disc measurements throughout the year, the average percentage transmission of surface light intensity, at Secchi disc depth was found to be 22.5%. The compensation depth (1% of the surface light intensity) was maximum during January to March (5M) and minimum during the monsoon months, June to September (1.5 M). The compensation depth varied from the Secchi disc readings by a factor 3-4. Due to very high turbidity and much particulate matter present in the water, the euphotic zone in the backwater is greatly reduced throughout the year with the result that much of the nutrients present in the water-column remain un-utilized.

5.7 Minor and Trace Elements in the Marine Environment of the West Coast of India

C. Sreekumaran, J. R. Naidu, S. S. Gogate, M. R. Rao, G. R. Doshi, V. N. Sastry, S. M. Shah, C. K. Unni and R. Viswanathan.

Health Physics Division

Atomic Energy Establishment Trombay
Bombay)

In view of the affinity of marine organisms and sediments for minor and trace elements and their radioisotopes, analyses were carried out on marine environmental samples from five stations on the West Coast of India (Bombay, Veraval, Ratnagiri, Mangalore and Cochin) during the period 1962-'64. The following ranges of concentrations were observed in sea water: potassium 374-528 ppm, calcium 388-511 ppm, strontium 2.8–6.8 ppm, phosphorus 65-173 μg/1, iron 2-26.6 μg/1 copper 2.7-16.8 μg/1, manganese 2.4-10 μg/1, and uranium 1.7-3.3 μg/1. Analyses were also carried out on set water samples collected from the Indian Ocean during International Indian Ocean Expedition. The samples from the coastal waters differed from the open ocean samples mainly in their contents of phosphorus and manganese; the average concentrations for the two elements in the open ocean being respectively 45.5 μg/1 and 4 μg/1.

From the observations on the elemental concentrations in marine organisms, it appeared that the following would serve well as indicators for potassium, rubidium and caesium respectively: *Katelysia marmorata* (K 11,700 ppm) *Gracilaria sp.* (K 6630-10990 ppm) and *Enteromorpha* sp. (Rb 32.9-491.4 ppm; Cs 0.18-1.56 ppm).

5.8 Estimations of Plant Pigments of Cochin Back water

S. Z. Qasim and

C. V. Gangadhara Reddy

Biological Oceanography Division,
National Institute of Oceanography
Ernakulam.

Spectrophotometric estimations were made of chlorophylls *a*, *b* and *c* and plant carotenoids of the Cochin backwater by using revised equations of Parsons and Strickland. The Cochin backwater which is an estuarine system on the west coast of India receives considerable amount of freshwater during the monsoon months and becomes highly turbid. The salinity changes during these months from one station to the other and from surface to the bottom are considerable. The phytoplankton crop is made up of diatoms and dinoflagellates. The most predominant pigments were found to be chlorophyll *c* and plant carotenoids. Chlorophyll *c* to *a* ratios were higher than 1 and generally fell within a range of 1.5-3. A comparison of soluble and insoluble filters on pigment extract showed that even when non-soluble filters are used the chlorophyll *c/a* ratio does not decrease significantly.

Carotenoid to chlorophyll *a ratios* were also high and fell nearer to 2.5. It is suggested that the high values of chlorophyll *c* and carotenoids may be because the extract contained dead chlorophylls and their derivatives coming from detritus and stirred up sediments. These have a high absorbance and probably interfere with the pigments estimation of living plants.

Seasonal changes in the chlorophyll *a* values at the surface showed two peaks. In the marine zone one peak was obtained during June to September and the other during January to March. In the freshwater zone the first peak was somewhat delayed and appeared two months later, but the other peak almost coincided with the marine zone. Plant carotenoid values showed almost similar fluctuations.

5.9 Wave Conditions and Littoral drift near Belledune Point, Chaleur Bay

M. P. M. Reddy
Bedford Institute of Oceanography
N. S., Canada

An investigation of the wave conditions and the direction of longshore currents near Belledune Point, Chaleur Bay, is presented in this paper. The deep water wave characteristics for all possible directions were predicted using wind data, and the wave heights in shallow water for all directions were determined by constructing wave refraction diagrams. The probable directions of longshore currents were also derived using wave rerfraction diagrams.

It was found that the west side of Belledune Point is protected from the high wave action of the eastern swell coming from the Gulf of St. Lawrence waves from other directions are not expected to cause any high wave action on the west side of the point due to the limited fetches and the absence of wave convergence. The study predicts that the net littoral drift is from east to west around the point.

INDEX TO AUTHORS AND TITLES

1.0 : Waves, Tides, Currents, Sea Level Variation and Storm surges.

2.0 : Hydrography of Shallow Waters and Estuaries

3. 0 : Shore Processes, Beach material and Sediment transport

4.0 : Nearshore sediment, Geomorphology of Indian Coasts and harbour problems

5. : Biological and other Miscellaneous studies