OCEANOGRAPHIC IMPORTANCE OF THE COCHIN LITTORAL*

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INTRODUCTION

Situated as it is on the north-western section of the Indian Ocean, the Cochin littoral has played a very significant role in the history of our sub-continent. Despite being an extremely interesting region from the point of viewof oceanographic studies, the Indian Ocean in general, until very recently, has been one of the least scientifically known regions of our planet. Oceanography is a comparatively young science and unfortunately, we in India, have not in the past, paid to it much attention which it richly deserves. The reason for this is the fact that it is a very slow and arduous pursuit which involves use of costly research vessels, expensive equipment and experienced personnel. Very often the results obtained after years of hard work may not be spectacular and appealing to the layman. Nevertheless, any information on this vast store house of life and energy will have to be built up slowly and steadily.

Covering seventyone percent of the surface of the globe, the oceans are estimated to contain 330,000,000 cubic miles of sea water. This vast watery world, besides being the abode of thousands of different species of plants and animals which can be economically exploited as a rich source of food and life-saving wonder drugs, is also a huge depository of valuable chemicals and costly minerals.

THE FRIGHTENING PROSPECT

If world population goes on increasing at the rates recorded in recent years, the present figure of about 3,000 million may well be doubled by the end of the century. Up to four fifths of this growth may occur in the food-short, developing countries. This is indeed a very frightening prospect for even the greatest optimist. This astonishing population explosion suggests that the traditional food resources of the land are bound to be hopelessly inadequate. To feed this vast number on a minimum adequate diet, there must be an increase of 200 percent in the present production of food. The arable land available for cultivation is steadily decreasing as a result of the expansion of urban areas and in this process farmlands are being sacrificed

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leading to a reduction in food production. Even at present, nearly 2,000 million people which represent two-thirds of the world's population are miserably underfed, suffering from the effects of malnutrition. With not sfficient good food to provide a fairly balanced diet, these hungry millions face serious health hazards owing to loss of resistance to diseases, general debility, lack of vigour and vitality, premature old age and early death. An analysis of the details of the food problem of developing countries like ours confirm the fear that if we do not exert ourselves sufficiently, our deficit will grow to such an extent that a state will soon be reached when the helping nations may not be able to save us from dire consequences. The undernourished people are chiefly short of animal protein and their life expectancy is very low. To them malnutrition is part of the way of life. The per capita availability of protien in our country is one of the lowest in the world. The only solution for this serious problem is to search for new frontiers for food.

WHAT SHALL WE EAT?

The Indian Ocean of which the Cochin littoral is part covers an area of 28,925,505 square miles with an average depth of about 13,000 feet and is bordered by land masses which hold nearly one fourth of the human race in perpetual undernourishment. Though our country forms only 2.4 percent of the world's land area, it has as much as 15 percent of the global population. The land itself is poor, the climate is not dependable, the fertiliser use is low, the agricultural technology is backward and the overall economic development is of a low degree. In India the calorie requirement of men has been placed at 2400-3900 per adult per day and for women 2000-2700 per adult per day. In northern India the calorie intake is above 3000 per day per adult and in most other states it ranges from 2000 to 2590. In this respect Kerala occupies the lowest position being only 1800 calories per day for adult. This state has the highest density of population - 1127 persons per square mile. A relationship between food and population is thus evident from such observations. The oceans which abound in fish, shell fish and algae can come to our rescue. There are great possibilities in this watery world. In this thickly populated state, with a steadily increasing population, the sea is a potential source of additional food. Here the adjacent waters have an enormous extent with food producing capacity. With the science, the skill and the means at our disposal, it will be possible to increase the production of sea foods proportionately to cope up with an increasing population. Our knowledge of the oceans has considerably increased in the last thiry years. Science and technology have progressed rapidly and better types of gear have been used for fishing. These have helped to find and catch more fish. As a matter of fact, it will not be an exaggeration to state that the progress in fishing in the last 30 years had been more than what man made in the previous 3,000 years. Calculations show that the world fish catch had doubled from about 20 million metric tons in 1948 to almost 45 million in 1962. Through a scientific approach it will be possible to free millions of starving people from the pangs of hunger. The present world estimates show that on an average every person gets only 10 kilograms of sea food a year. The Japanese are the biggest fish eaters with a per capita consumption of 72 pounds per year. In England, Scandinavia and Holland the average consumption is about 44 pounds a year and in the United States it is only about 11 pounds on the aveage. In India the per capita consumption is much less, being about four pounds a year. It is therefore, apparent that a substantial increase in this figure would have a salutary effect in easing the pressure of demand for food grains and giving the people a

reasonably priced palatable and nutritious substitute food.

Vast Sea Food Resources

Backed by research and coupled with the use of improved fishing gear and other techniques being evolved at the C. I. F. T. in Cochin, it is expected that mechanisation of our fishing fleet will enable us to steadily increase the present annual catch of 1.4 million tons by about half a million tons a year. This is approximately 1/45th of the world's total yearly production. The fishing industry prodvides occupation for nearly 2.5 lakhs of fishermen spread over 1,7000 fishing villages. The importance of the west coast is evident from the fact that over 80 percent of the catches come from this area. Several productive areas have been located in this region through exploratory fishing and in such areas the catch-per-hour returns exceed 1,000 kg. per trawling hour. The curious phenomenon known as the 'mud-banks' occurring at certain localities between Calicut and Quilon needs a thorough investigation. These are well known areas for the fishing of prawns, sardines, mackerels and soles.

Sea Weed For a Hungry World

Besides the well known sea foods such as fish and shell-fish, there are several other substances in the sea which can be utilised as food materials for man as well as for poultry and cattle. The zooplankton or the tiny animals that drift about in the oceans can prove to be a good source of food. If this abundantly available material can be economically collected in a commercial scale and processed into pleasing and palatable foods, it can provide a rich source of protein food. Marine algae which grow extensively in the sea is yet another item which can prove an excellent source of food. These weeds have the ability of processing their own food by means of photosynthesis, a process of nature in which sugars etc. are formed in plant tissues containing the green pigment chlorophyll in the presence of sun light. The aquatic plants have the ability to convert the energy of sunlight into proteins nearly ten times more efficiently than land plants. Calculations show that algae farming can be several times more efficient in energy utilisation than is the average agricultural crop like rice and wheat. According to nutrition experts the energy value of certain algae exceeds that of chocolate.

The algae can also be the soursce from which valuable fodder for the livestock can be obtained or it can be processed as rich ingredients of mixed cattle feeds and even as excellent platable human foods. Certain species of algae are useful for the extraction of medicines while others can be used as fertilisers. Multi-atom solid alcohols, ethers, vinegar, nitrocellulose, starch and gelatinating agents like agar-agar and alginates can also be processed from marine algae. Of course there are certain practical difficulties in harvesting them economically. Many of these algae are diffusely scattered and when present in good numbers appear only as a thin soup in the upper lighted regions of the oceans.

Rich Organic Fertilizers

The sea bottoms especially in the tropics contain huge amounts of organic fertilisers. These fertilisers accumulate in the cold, dark floor of the deep sea when animals and plants die and sink to the bottom. The dead bodies are partly eaten by animals that live there and the rest undergo rapid decomposition through bacterial activity and transform into soluble substances that can be used by plants. But in the dismal darkness of the deep sea no plants can grow. Plants can grow well only where there is light and so they are seen only in the upper layers of the oceans where sun-

light penetrates. In the absence of any plants which can use these fertilisers, they accumulate there without being used. But if this water is brought to the surface by currents or vertical movements of sea water such as convection currents, wind mixing and upwellings etc., these become available for the plants there. In some regions of the sea there are regular upwellings and such areas have rich plant growth. To graze on these tiny plants, zoo-plankton composed of small marine animals gather in these areas and big shoals of fish arrive there in turn to feed on zoo-plankton. Such regions are excellent fishing grounds. From these it can be inferred that new fishing grounds can be created if the rich bottom water can be brought up to the surface.

Startling Possibilities

In colder seas the bottom water is regularly brought up seasonally during winter when the sea is virtually 'ploughed' through natural phenomena. This natural process enables the surface layers to get periodically fertilised. So, in these regions there is greater concentration of fish than in the tropics where no such mechanisms exist to bring up the nutrient-rich water from the bottom. This is the reason for the comparatively poorer catches from the tropics. Scientists are working on this problem with a view to finding a cheap method for stirring up the deeper parts of the oceans to bring to the surface the fertilisers to promote organic production. Taking advantage of the slight difference in temperature and salinity at the top and the bottom, vertical pipes are being employed to raise water from lower levels. Another method suggested is to set up a large heat source such as an atomic pile at the bottom to produce vertical convection currents to displace the nutrient rich bottom water. But these are very costly procedures at present. Rapid advances in science and technology may discover cheaper and effective methods in the near future which, when employed in tropical seas, may help to boost fish catches in these regions. From this it is evident that as on land, the sea too has fertile and barren areas. Some areas of the sea are very productive, others less productive while some regions are barren. One of the very productive areas of the Indian Ocean is the south-west coast of India including the Cochin littoral. We have here the main fisheries for prawns, lobsters, sardines and mackerels. The reason for this fishery in the region is related to the peculiar oceanographic nature of this area. A sequence of events happen here leading to the upwelling of nutrient-rich bottom water. Fertilising substances from the cold deeper areas rise towards the surface betweeu Cranganore and Cape Comorin. This leads to a dense growth of plant and animal life which provide a feeding ground *par excellance* for commercially important fishes.

In the past 15 years or so, the sea-food industries in this region has developed into a very promising and growing concern. The most valuable shrimp industry is centred in Cochin with modern well-equipped freezing and canning factories equal to those found anywhere in the world. The Indian Oceaw in general and the Arabian Sea in particular abound in untapped fisheries resources. The effective exploitation of these plentiful supplies of protein rich food depends on a precise understanding of the oceanography of this area- an understanding of the physical, chemical and biological factors involved. Accurate data on regions of upwelling and their extent and significance ow fisheries will be very beneficial for the industry concentrated in this area. Despite serious limitations such as the paucity of fishing harbours, insufficient mechanisation, and inadequate facilities for fish handling and

storage, it is indeed commendable that India took the second place in the production of shrimp in the world, producing 77,300 tonnes in 1965. This was very much less than the production in the previous year viz, 94,900 tonnes. Inspite of this large fall in production India kept its position as the second largest producer of shrimp, yielding only to the United States of America (101,400 tonnes of shrimp during 1965.)

Industrial Chemicals

Sea water is a unique solution with a very small quantity of everything dissolved in it. Many useful salts besides sodium chloride can be commercially extracted from sea water. Sodium sulphate used in the manufacture of paper pulp and glass, in medicines, in dyeing and in the preparation of cattle powders and caustic soda is one such salt. Other such salts present are magnesium chloride, magnesium sulphate, calcium sulphate and potassium sulphate. The light and strong magnesium highly useful in air craft industry for the manufacture of super light alloys can be commercially extracted from sea water (by using magnesium the weight of alloys can be reduced by 20 to 30%. Three lakh tons are annually extracted at present from the sea). Potassium salts used in farming, photography, pharmaceutics, and in the manufacture of glass, soap, gun powder etc., are present in sufficient quantities in sea water which can be commercially exploited. In India the 'bitterns' which is the solution left after the separation of common salt, rich in marine salts is not used properly. Scientists feel that it will be possible to recover at least 3.8 lakh tons of magnesium sulphate, 65,000 tons of potassium sulphate and 7,000 tons of bromine from the salt bittern annually in India. Valuable and rich fertilisers can also be recovered from sea water. Boron, Zinc, Copper and Manganese are other important minerals that can be obtained from the sea water. At present it would cost more to extract many of the metals from the sea than these metals are worth. But as the supply from the land mines are exhausted, we may be forced to depend on the sea for these metals and chemicals.

Processes for the recovery of salts and metals must be so designed that during the process good fresh water can also be obtained as a side product and this if planned properly may prove to be economical. The process of desalting sea water is at present costly being about Rs. 5.40 for 1,000 gallons. Low cost caustic soda, bromine, flourine, chlorine, magnesium compounds, hydrochloric acid, soda ash, and potassium compounds can also be produced from the thick brine after the fresh water is separated for humn use.

Even Miracle Drugs

Besides the much needed food, water, chemicals and minerals, the sea can also provide us with miracle drugs. The varied forms of animals, plants and microbes that live in the sea will in the near future prove to be a limitless source of much needed pharmaceuticals. Many kinds of anti-biotics and other valuable drugs can be obtained from the sea. The poison present in marine fish and other animals of the sea contain effective curative substances. A substance called holothurin present in sea cucumbers has been found to possess growth inhibiting properties and may prove effective for the treatment of cancer. Similarly, the poison of the toad fish has been found useful to combat diabetes.

Certain substances that can be extracted from oysters and abalone have been found to destroy influenza and polio viruses in mice. A sea weed extract has recently been proved to be efficacious

in the treatment of stomach ulcers. Recent studies have also brought to light yet another interesting fact that certain fish liver oils such as that of Cod can actually reduce the cholesterol content, in direct contrast to the effect of other animal fats. Cholesterol is a substance which when present in large quantities lead to diseases of the circulatory system and the heart. A substance called algion extracted from certain brown algae has been found to be a valuable substitute for blood plasma.

A Mine of Wealth

Further, the sea bottom is a huge store of valuable ores. Large quantities of manganese, iron, copper, cobalt and nickel, phosphorus etc., occur on the ocean floor in the form of lumps called nudules. New techniques and devices are being worked out to bring these to the surface. Recently engineers have used methods to suck them off the sea floor. Large mineral deposits have been discovered recently in many parts of the oceans even in shallow waters. Thus, rich tin ores have been located near Thailand and Indonesia, diamonds off the coast of south west Africa and gold near Alaska. Rich under-sea oil fields exist in the Caspian and Gulf of Mexico. The shelf of the oceans is estimated to contain about 40,000 million tons of oil. Surveys for oil have indicated large possibilities of off-shore oil reserves in our country. According to Dr. Malovitsky, the leader of the Indo-Soviet Seismic exploration, the continental shelves of India up to a depth to 100 meters are of importance from the point of view of oil and gas exploration. Recent exploratory surveys have proved a great success and the participating scientists as well as the Oil and Natural Gas Commission are highly optimistic about the potential oil wealth beneath the sea bed. Plans are in progress with a view to undertaking expanded off-shore survey with foreign co-operation. Thus in the exploration of this region we have the economic incentive of looking for rich mineral resources.

Tidal Power

The sea is a huge reservoir and transformer of the heat of the sun. It is also a transformer of the energy of the wind as well as the cosmic energy of the moon's attraction. Thus the sea represents a gigantic source of energy. It is possible to produce electric power from the sea. In one method, the generation of power is from the thermal energy of the sea on the principle that the change of heat into energy requires a hot source and a cold source. In 1954 the consumption of electricity of the world was 1,345,000 million kilowatt hours and the demand for electric power is increasing at an annual rate of 7 to 10 percent. The hydro-power capacity of all the rivers on our planet equals 3,750 million kilowatts. The energy of the tides in the oceans is estimated at 1,000 million kilowatts. Harnessing at least a part of this energy will be a substantial contribution to the world's power resources. The advantages of tidal power stations is that their working is not affected by seasonal droughts and are independant of climatic conditions. It is also possible to design hydro-thermal power stations especially in the tropics using the heat energy of the sea by taking advantage of the temperature difference between deep and surface water layers.

The Quest for Fresh Water

Every day the need for fresh water is increasing. The expected increase in population demands greater food production on land and this depends on the skilful management of water resources. According to Ritchie Calder the amount of water needed for agriculture is enormous. To

grow a ton of sugarcane by irrigation method, about 1,000 tons of water must be consumed. A ton of rice requires 4,000 tons of water and a ton of wheat about 1,500 tons of water. At present only about 4 percent of the total river flow is used to irrigate 310 million acres of land which represent one percent of the land area of the earth. To feed a population which will reach 4,000 million by 1980 and more than 6,000 million by 2,000 A. D, extended irrigation, farming and more intensive cultivation are essential. For this the availability of water is a vital factor. The need for the expansion and proper management of world's water supply has been engaging the attention of experts. The demand for water will double in 20 years and scientists warn that without massive water development, "the hope of great strides in food production for a hungry, ever more populous world will wither." In our search for new horizons for water we will certainly have to seriously consider ways and means to de-salt the sea or brackish water to provide us with water both for daily use as well as for agricultural purposes. Desalting sea water is not easy. The sea water must be boiled and the steam when condensed is pure water. By freezing also, the fresh water can be separated, but these are expensive processes. Different methods and processes are employed in the various countries for desalting. At San Diego, California, a process called 'Flash evaporation method' is used which costs Rs. 5 00 for 1,000 gallons and electrodialysis is in operation at Israel. Nuclear powered desalting plants are being planned in California which can produce a billion gallons a day at an estimated cost of about 00.15 P. per 1,000 gallons. The plant would also produce electricity at a cheap rate.

From the above it will be seen that the different aspects of the oceans of the world need be understood in much greater detail than what we know at present for the effective utilisation of the vast resources available there. Until now man has been able to exploit only a very tiny fraction of what the sea can offer him. This is partly due either to our ignorance or incomplete knowledge about this region of the earth. While our knowledge of the Mediterranean, the Atlantic and the Pacific are fairly satisfactory, we know very little about the Indian Ocean which borders the most thickly populated regions of the world.

Where Sea and Sky Meet

Perhaps less understood, but even more important than all the above mentioned aspects are the factors associated with meteorological studies. Weather has been Indias oldest enemy-and friend. It has been calculated that a better weather forecasting could save the world's economy Rs. 126,00 crores a year and this could be achieved by a system costing Rs. 2520 crores. This figure is arrived at by adding up the savings that would accrue in agriculture, construction, fuel, utilities, forestry, government service and air and marine transport, if weather forecasting were more accurate.

We are in need of accurate day-to-day predictions. Long range forecasts too are of great importance in our agricultural operations. The arrival and action of the monsoon is of vital importance for the food growing operations of this essentially agricultural country. This is the reason for the well known saying that India's budget is a monsoon gamble.

A capricious monsoon can seriously upset the food production of these areas and may lead to severe consequences as was demonstrated in the last two years. Variations from the normal pattern in respect to rainfall such as a delayed monsoon,

prolonged breaks in the rainfall or an abrupt termination of rains associated with the monsoon may seriously affect crop growth. Again, when depressions and cyclonic storms follow one another in rapid succession along the same track, concentrated spells of rain occur in a narrow belt and may cause serious floods. Similarly, continuous rains for a prolonged period may lead to disastrous floods with dire consequences.

From these it is clearly evident that development of improved forecasting techniques is an essential pe-requisite for the developmental plans in the field of agriculture, exploitation of water resources and flood control programmes and for ameliorating the consequences of weather calamities such as cyclones, severe rains and floods.

Outlook for Weather Forecasting

One of the reasons for the uncertainty of weather forecasting has been the scarcity of weather data from the great expanse of the ocens which cover nearly seven-tenths of the earth's surface. It is at the air-sea interface that moisture passes from the sea to the air, ultimately to form the clouds, then the rain. It is here that storms are conceived as are the ocean currents which have profound influence on the climates of the neighbouring land masses. New information is urgently needed on the way the winds pick up their moisture and this is likely to help to improve forecasting of the dates, and the intensity of the rains upon which Indian agriculture depends. Recent studies in the Arabian Sea and the Bay of Bengal are providing us with very valuable information about the world's largest single wind system, as the monsoon has been called. The data from these observations indicate further that our information regarding the exact origin of the monsoon is not very accurate. Quite contrary to what has hitherto been believed, it has recently been shown that the monsoon winds pick-up most of its moisture content not over the southern Ocean but over the Arabian Sea itself. This has been confirmed during the recent Indian Ocean Expedition. Current research is also examining ways of forecasting the date and intensity of the monsoon, both matters of great importance to India. There seems to be a connection between the evolution, in the latter part of April of a trough lying about 10 degrees north of the equator and the onset of rains on the coast of Kerala.

Meteorological studies in this area, therefore, have great importance and if accurate forecasts could be made, these would, no doubt, represent one of the most significant achievements of science and would certainly have considerable political and economical implications of great magnitude.

Problem of Coastal Engineering

Oceanographic knowledge is also becoming increasingly handy and very useful concerning problems in coastal engineering relating to harbour construction, stabilisation of beaches etc., besides problems such as pollution and disposal of effluents. Along the south-west coast of India, near-shore oceanographic studies have recently assumed great importance in view of the need to protect our shores from erosion. In Kerala alone, the anti-erosion works have so far cost more than seven crores of rupees and we are still at the beginning of the protection works. In our harbour expansion programmes, a knowledge of the nature of littoral movements and sediment transport will be very benefical for an understanding of the factors responsible for silting in harbours. Proper maintenance of shipping channels depends on an accurate knowledge of the prevailing water movements in the area together with the

nature of the sediments, their environments of deposition, source, areas, dispersal and transportation. Our annual cost in dredging in ports amount to six and a half crores of rupees involving the removal of over twenty million tons of sand annually. Data are therefore, required on the nature of the littoral currents, variations of tides and sea level, waves and other processes associated with land-sea interaction. Seasonal changes have been noticed on the beaches of Kerala coast with shore-line accretion during seasons of light wind and erosion during the period of the monsoon. A thorough analysis of of the several factors associated with the coastal erosion is urgently needed. The directions, amount and character of the littoral drift will have to be studied in detail in relation to meteorological, oceanographic and environmental factors. Data on all possible aspects will have to be collected and the careful analysis of such data is likely to provide us with valuable information which may help to evolve proper and cheaper solutions to these problems.

As a result of man's interference along the sea-front and elsewhere, the coastal and near-shore problems have assumed great complexity and an understanding of the different forces at work calls for concerted scientific enquiry and determined assault.