Reprinted from "Seafood Exporter" May, 1968
Vol. III, No. 1 : 43 to 51.

PERSPECTIVES IN INDUSTRIAL OCEANOGRAPHY

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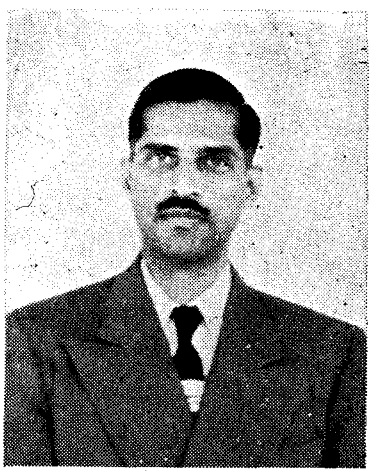

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Dr. Prasad took his M. Sc. from Madras University and joined the Stanford University, California, U. S. A. working under the famous Marine Biologist Dr. Rich and took his Ph. D. After his return to India he worked for some time in the Central Inland Fisheries. He was then posted to the Central Marine Fisheries Research Institute and served as the head of the division of Marine Biology and Oceanography. He has published a number of papers on Organic Productivity of the Sea and the distribution of Plankton.

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FROM the myths and fantasies which inspired the imagination of Jules Verne to write his fabulous book "Twenty Thousand Leagues Under the Sea", the advanced instrumentation of the space age has taken many strides to make the ocean depths no longer objects of mystery. Besides the classical oceanographic tools, Bathyscaphe, television cameras and electronic sensors have increased man's ability to probe the dark depths of the ocean.

The surface of the ocean totals about 361 million square kilometres, whereas that of land is only less than half of this. The volume of sea water is over ten times that of the land above sea-level and this huge body of water is a depository of diverse groups of plants, animals and various minerals. But the techniques of utilization of these resources are still not as much advanced as those of land. Hence one of the foremost functions of oceanographic research is to gather information about the sea and its contents which will aid in the transformation of these latent resources into usable resources. This would involve the joint efforts of a variety of scientific disciplines because whatever problem an oceanographer undertakes, he finds that it is intertwined with a number of other oceanic problems. From the beginning oceanography was considered an inter-disciplinary science and now various inter-disciplinary fields such as geophysics, geochemistry, biophysics, etc., are developing for the solution of key problems.

Mining the sea

An important aspect of the sea which aroused man's curiosity is its saltiness and the philosophers of yore attributed this to the action of the sun. This seemed logical because sea water when exposed to the sun for some time would disappear leaving behind crystals of salt. Salt was a highly prized commodity of the ancient world and the height of hospitality to a visitor or traveller was to offer salt. On festive occasions people of the highest rank sat nearest to the vessel containing the salt. Salt was also used as a medium of exchange and the soldiers of the Roman Legion were paid in salt from which the word 'salary' is said to have come into being.

Besides salt the sea is a great storehouse of other minerals. But the techniques of extraction of many of these have not become commercially profitable at present. However, from the early part of this century Bromine and Magnesium have been extracted on a commercial scale from the sea. It would be possible to obtain Rubidium and Cesium if there is sufficient demand for them. It may also be feasible in the future to combine a chemical processing plant with a plant converting sea water to fresh water. The recovery of fresh water from sea water itself is of great topical importance.

Recently large quantities of black, potato-shaped, nodules containing 25 to 30 per cent of manganese apart from small quantities of cobalt, copper and nickel have been detected on the sea floor. These deposits are being actually formed at a faster rate than the world rate of consumption of these metals. Posphorite nodules are found in many places on the outer continental shelves and offshore banks of several countries including India. Researches done so far have shown that the distribution of these is not uniform and that the chemical composition ranges within wide limits. Efficient mining of these deposits will require large scale industrial operations which have to be based on research on the mechanisms and conditions of the formations. It has been estimated that Rs. 10 crores worth of gold and Rs. 1 crore worth of silver are present in 1 cubic kilometre of sea water. But the extraction of these is uneconomical under the present know-how.

The principal mineral resources of the continental shelves that are now being exploited are oil, natural gas and sulphur and it may not be far off when man with his ingenuity turns to the sea for other resources as well. Recently several hundred crores of rupees have been staked for the exploitation of natural gas occurring in the North Sea. This gas has an energy content double that of coal and it is expected to provide an almost unlimited supply for domestic and industrial markets. The mapping of the sea bottom during oceanographic investigations led to the discovery of this vast resource which is going to give the biggest boost to the economy of Britain since the industrial revolution. Diamond bearing gravels off the south-west coast of Africa, gold bearing sands of Alaska, tin ores found off Malaysia, Thailand and Indonesia, iron ore of the Tokyo Bay, titanium and monazite sands containing thorium and rare earths occurring on the shores of India are some of the many potential mineral resources that could be profitably exploited from the continental shelves.

Living resources

The utilization of protein food and other materials from the living resources of the sea dates back to pre-historic times. The world production of fish was near about 60 million tonnes last year. A conservative estimate of the potential yield is an increase of the world catch by a factor of 2 to 5. The fish catch of the world thus offers much scope for further expansion. But it is certain that this cannot be accomplished on a sustained basis unless much more knowledge of the ocean water and the life contained in them is gathered. Research on the ecology and biology of the organisms supporting the marine fisheries is of direct economic importance. For the exploited fish populations it can provide the basis for more efficient catching and of conservation and for the unexploited populations it can provide the means for developing the resource. Recent work in the Indian Ocean has revealed large unexploited populations of tuna, shrimp, lobster, sardine and mackerel. Large populations of fish and of plankton organisms which form their food are very often associated with regions of upwelling. In the regions of eastern boundary currents a sharp and shallow thermocline overlies an oxygen-poor layer as occurring on the west coast of India. This condition has profound influence on the pelagic fisheries. The shifting of the oxygen-poor layer is believed to be one of the causes for the large scale fluctuations in fisheries and in extreme cases the mass mortality of fish in the open part of the sea. Hence for the proper development of fisheries, mapping of the world ocean as a unit by available parameters monthly or seasonally is an essential prerequisite. These maps showing the existing conditions together with the anomalies for the same period for the previous years could help in proper and accurate forecasting. Fishes often make distant seasonal as well as considerable vertical migrations. So if the catch is to be good it is necessary to know where and at what depth the particular fish can be found. The drawing up of fishing charts showing the migration route of fish, the areas of their concentration and the relation between the behaviour of fish and hydrological and meteorological conditions helps in that direction. There is need to understand the processes that make some parts of the oceans fertile pastures and other sterile deserts. The relationship between the production of organic matter by marine plants and the food supply of fishes also should be studied in order to explore the possibilities of large scale fishing.

The sea abounds in a variety of seaweeds. These have many well established industrial uses and men of vision are looking ahead to the time when human skill would make it possible to prepare a type of food much different from the one eaten to-day. Japanese have been extensively using seaweeds as food for years. Now it is tasteless but with the rapid progress in the science of enzymology it may soon be possible to prepare delicious steaks composed of extracted seaweed-protein, spiced with enzymes and made chewable by suitable digestible plastic. Aspects relating to the growing, harvesting and production of seaweeds are being investigated and many scientists and nutritionists feel convinced that with proper planning one-third of the food requirements can come from this source.

Energy from the sea and weather forecast

The sea accumulates and transforms the thermal energy from the sun, dynamic energy from the wind and cosmic energy from lunar attractions into the energy of motion of huge water masses. It has been possible to convert the energy brought about by the vertical variations of water level during tides in some countries like France and the United States. The engineers in France have even succeeded in devicing turbine heads which could tilt so as to adjust with the water level during tidal changes. The tidal changes of level in Passmaquoddy Bay have been harnessed for generating electricity. Apart from tidal power stations even hydrothermal power generation would in the near future be supplementing the ever increasing demand for electric power in the world. This would be particularly beneficial to such countries whose river resources are almost exhausted and which have very little coal or oil to fall back upon.

Recent meteorological studies show that changes in large scale weather patterns are closely connected to the temperature distribution on the sea surface. A major part of the energy of storms and winds is transmitted from the sun to the atmosphere through the ocean. Enormous amounts of energy enter the air through the mechanism of evaporation at the sea surface and condensation in the upper layers. This energy contributes to the formation of hurricanes, cyclonic storms and tidal waves which bring about devastation to life and property. The seismic solitary wave, known as *Tsunami* is a much-dreaded occurrence particularly off the coasts of Japan. Tsunamis travel in the ocean with breath-taking velocity and they sweep into coastal towns and villages destroying everything in their wake. Accurate weather forecast, would minimise the havoc to people and their property.

Shipping and oceanography

Oceanographic research can make significant contributions to a reduction in shipping costs as many aspects of knowledge about the oceans have a direct bearing on their use as a major highway. For instance, due to improvements in the forecasting of waves, winds and currents, ships could be better routed along minimum time paths reducing fuel consumption and time at sea. It is also seen that when waves moving in different directions meet, they form high and steep pyramidal waves that are dangerous to shipping. Storm losses, strandings and collisions could be minimised through improvements in navigation based on more detailed study of waves, current conditions and sea bottom topography.

The idea of designing ships specifically for certain limited trade routes has recently been advanced. This should enable to modify the ship design to withstand waves to be expected only along one particular route and thereby reduce the construction costs. For more sophisticated crafts like hydrofoils, hovercrafts or cargo-carrying submarines greater knowledge of the conditions near the sea surface based on oceanographic knowledge is required. If the cause of waves, the mechanisms for their growth, propagation and decay in space and time throughout the world oceans and the effect of waves on ships were completely understood it would be possible to route the ships along an optimum time track or routed for maximum safety and comfort. This is being done on a limited scale in certain countries now. Thus waves for the time being play only a negative role, as far as man is concerned. They make navigation difficult or even dangerous and sometimes destroy harbour installations.

Oceanographic research can contribute a lot to the reduction in losses from fouling organisms. Practical anti-fouling methods must rest on increased understanding of the geographical distribution, life-histories, physiology and behaviour of the different organisms. The annual loss to world shipping due to fouling organism is estimated as over 200 crores of rupees. It would be possible to reduce this loss substantially by carrying out intensive research into the behaviour and physiology of these pests together with studies on the effects of various chemical deterrents on these animals.

Cities under the sea

Mention should also be made on the benefits of the exploration of ' inner space ' as, of late, many dreamers and far out thinkers in revolutionary architecture have visualised about drilling the ocean floor and carving out secret bases or oceanographic research stations or protected work sites from which to drill deep ocean oil wells. One Japanese architecht visualises an ocean city on man-made floating platforms, a French version would follow a honeycomb metropolis under the river Seine, whereas a British architect's underwater city is a maze of connected spheres. An American architect invented an undersea island as a stable oil drilling rig. Oceanographic research findings to-date suggest that the exploration of 'inner space' will be at least rewarding.

Sea as a sewer

The role of oceanographic research in the public health and welfare which includes the protection of the natural resources of the coastal zones for the benefit of man is an important aspect which should be considered. The ocean being the biggest hole on earth filled with water is used as a sewer for disposal of all kinds of domestic and industrial wastes. In the normal course they get diluted by the mixing process and the micro-organisms break down the organic constituents. However, indiscriminate dumping of wastes can interfere with other uses and oceanographic research could provide the information needed in determining the type and degree of sewage treatment and the best location for sewage discharge. In recent times radioactive wastes from nuclear reactors are also dumped into the sea. But if the period of renewal of deep-sea waters is shorter than that of the complete decay of radioactive substances the dumping of these wastes into the sea can cause disaster because the animals in the sea take up the radioactive isotopes both directly and with their food. Radioactive Strontium and Calcium accumulate in the bones of animals and Iodine in their thyroid glands. Phytoplankton especially has a capacity for concentrating radioactive isotopes. In the fishes the radiocative substances are concentrated chiefly in the bones, scales and intestines. Some of the long-lived isotopes like Strontium-90 are retained for a very long time in their bodies. Radioactive substances cause a double harm to living creatures. In the event of excessive contamination they give rise to leukemia, resulting in the death of the organism. Even a low degree of contamination has a disastrous effect on posterity as long-lived isotopes are carried through the generations. It is not possible to foresee the consequences of increased radioactivity in a part of the sea, as the effect of anything happening in one part of the sea may be carried far away by the action of waves and currents. Modern oceanography can, however, precisely calculate the age of deep water by Carbon-14 dating and how soon they are renewed.

Another problem of contamination of the sea which confronts the oceanographers is brought about by the cleaning of oil-tankers and other ships which use oil as their fuel. The oil fields situated near the seashore also play a notable part in the pollution of sea water. Liquid oil spreads on the sea surface as a thin film. It is carried away by currents and cause much havoc to plant and animal life. Oceanographers have estimated that the oil pollution of coastal waters annually brings about a substantial loss of sea food. Oil pollution causes great damage to oyster hatcheries off the coast of France. It is also observed that fishes which keep close to the surface of the sea have stopped approaching the coasts of North America where the shipping is intense.

The prospects

The sea is thus the most valuable repertory of food, minerals and energy for the growing millions and at the same time can spell immense danger if not protected from contamination, pollution and irrational use of the resources. The investigations of the oceanographers throughout the world are opening up new vistas of knowledge on the development of waves, current formation, weather forecasting, better utilization of the mineral resources, development of seashores, biological structure of the ocean, productivity of the sea, distribution and behaviour of fish and the scientific basis for harvesting the living resources. Thus, it may be seen that human needs for protein food, minerals, security and greater knowledge of weather and climate are but a few of the benefits that could accrue from a concerted study of the oceans. Some of these may appear as just intellectual games but the proper utilization of the resources of the sea is a challenge and a responsibility which must be met with imagination and wisdom.