OSTI NEWSLETTER

Ocean Science and Technology for Islands
National Institute of Ocean Technology
Chennai - 601 302 India

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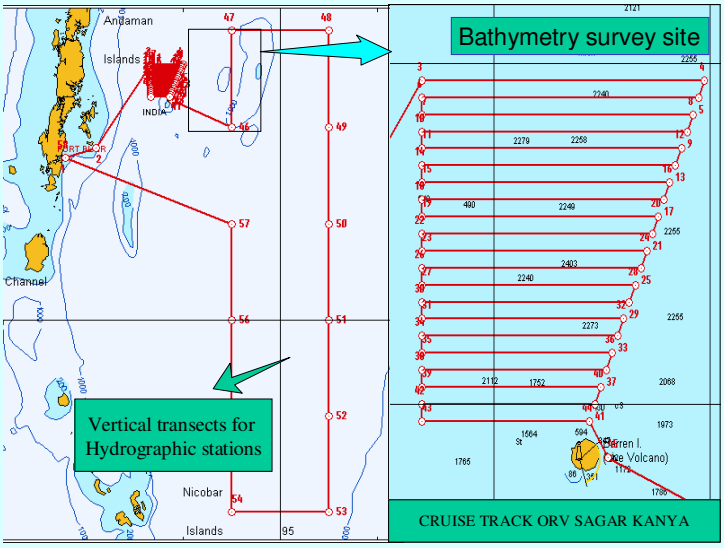
Establishment of Marine Bioinformatics Centre at OSTI

On the advice of the Governing Council of NIOT, a **Marine Bioinformatics Centre (MBiC)** is being established at NIOT under the OSTI programme. The MBiC is committed to generate data and optimum utilization of various databases for storing, organizing and distributing data created through NIOT / DOD programmes and other sources. MBiC is established with the main objectives to work out and to integrate the three different areas such as a) systematic database on marine organisms, b) development and integration of marine based bioinformatics softwares and molecular databases and c) laboratory studies on marine proteomics and genomics. MBiC will be the first of its kind in the field of marine biology and marine biotechnology, in India. For this purpose three workstations have been installed and connected with a dedicated state-of-the-art computer server (marine bioinformatics server). The marine bioinformatics network is connected to the internet through NIOT main server. Incidentally, a wet lab training is conducted for the students of the "Post graduate diploma in applied bioinformatics" of Small Industries Service Institute (SISI), under the MoU signed by NIOT, SISI and Gemeiosys. Additional funding is sought from DOD to establish a full fledged centre.

Ocean Observation for Andaman and Nicobar Islands

Two oceanographic cruises were undertaken onboard vessels ORV Sagar Kanya and FORV Sagar Sampada and valuable information on hydrography and sea surface currents were collected during these cruises. The works carried out are summarised below:



ORV Sagar Kanya
(Cruise duration: 6 - 26 June, 2004)

During this cruise 12 stations across the Andaman sea with an interval of 60 nm in two vertical transects, were surveyed. The stations were selected in such a way to represent the entire Andaman sea. Apart from the hydrographic survey, bathymetry survey was also carried out near Barren island (one of the live volcanoes in Indian territory). Around 300 sq. mile area was surveyed using single beam echosounder (ELAC 900). Further, hydrosweep and sub-bottom profiler data were collected. Based on the bathymetry data, a few dredging operations were carried out using Chain-bag dredge. Interestingly a few rock pieces of volcanic origin were collected, which are being analyzed for mineral content.

FORV Sagar Sampada (Cruise duration: 22 June to 11 July, 2004)

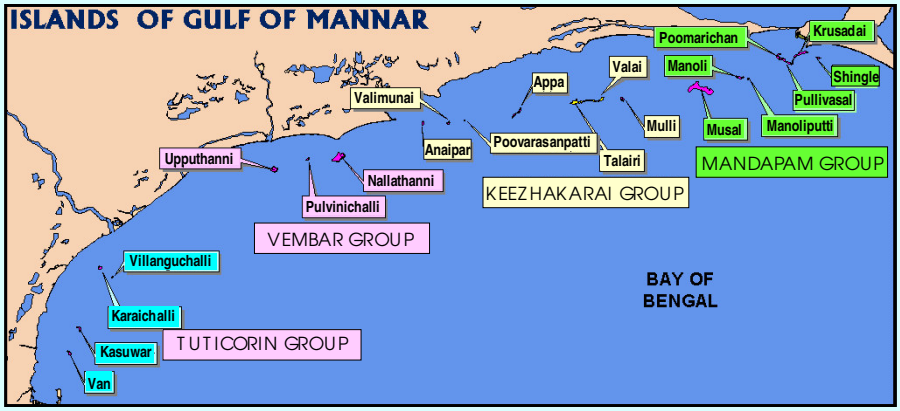
During this cruise, sea surface currents off Nicobar area were studied by deploying drifter buoy and labeled plastic bottles. The drifter buoy location is being monitored after its deployment through satellite and the data are received at National Institute of Oceanography (NIO), Goa. This work is undertaken to study the marine debris accumulation along the coast of Car Nicobar on the request of Andaman and Nicobar Administration.

Focus on an Island

Krusadai Island, Gulf of Mannar

The Gulf of Mannar falling in the Indo-Pacific region, is considered the world's richest in marine biological resources. The Gulf has been chosen as a biosphere reserve primarily because of its biological and ecological uniqueness. The region has a distinctive socio-economic and cultural profile shaped by its geography. It has an ancient maritime history and famous for production of pearls.

The Gulf of Mannar, with its spectacular biological wealth, was declared a Marine National Park in 1986 and a Biosphere Reserve in 1989. The Reserve is comprised of 560 km^2 core area of coral islands and shallow marine habitat, surrounded by 10 km wide, 160 km long buffer zone. The Gulf of Mannar Biosphere Reserve is made up of 21 uninhabited islands ranging in size from 0.25 ha to 130 ha and lying between one and four km offshore, surrounded by shallow waters. It extends from 78°11' to 79°15' E longitude and from 8°49' to 9°15' N latitude.



The Gulf of Mannar constitutes a live scientific laboratory of national and international value. It has about 3,600 species of plants and animals that make it the biologically richest coastal region in India. It is, of course, specially known for its corals, of which there are 117 species belonging to 37 genera.

The Park's Krusadai Island with an approximate area of 65.80 ha exemplifies the biological significance of the Gulf. The island has a live coral reef area of about 1.5 km^2 which is 33 % of the total coral reef area of Gulf of Mannar. The island's surrounding shallow waters harbour 12 species of seagrass. Representatives of every animal phyla known (except amphibians) are found on this island. The island is also home to balanoglosus (*Ptychodera fluva)*, a taxonomically unique living fossil that links vertebrates and invertebrates. The island is referred to in the region as a "biologists' paradise".

Instrument / Technique

Ultracentrifuge

Ultracentrifuge is a device being used for applying force to a sample, usually by motor driven rotary motion of the sample. There are different kinds of centrifuges, for very specialized purposes.

The ultracentrifuge was invented in 1925 by Theodor Svedberg, a Swedish scientist, who won the 1926 Nobel Prize in Chemistry for his work on disperse systems.

The ultracentrifuge is optimized for spinning a rotor at very high speeds, capable of generating gravitational forces (g) as high as 1,000,000 g, allowing the observation of sedimentation rates of macromolecules, and for the determination of their approximate molecular weights. The ability to generate such speeds and forces through ultracentrifugation has contributed much to our understanding of biological sciences and has made ultracentrifugation a most basic and essential separation technique.

There are basically two kinds of ultracentrifuges, the preparative and the analytical ultracentrifuge. Marian von Smoluchowski developed the technique of analytical ultracentrifugation, and demonstrated its utility in distinguishing pure proteins.

Biochemical study of subcellular components like ribosomes, endoplasmic reticulum, microsomes etc., was greatly facilitated in the early 1940's with the commercial availability of the instrument known as the preparative ultracentrifuge. The preparative ultracentrifuge allowed fractionation of subcellular particles from a homogenate of tissue by centrifuging at different speeds.

Understanding the importance of such an equipment in marine biological research, NIOT has recently procurred and commissioned a preparative ultracentrifuge for the biochemical studies.

Popular Article

Deep Ocean Water
– A natural resource

N. Saravanane,
Scientist, OSTI, NIOT

World ocean basins are filled with cold, nutrient rich and pathogen free water. This water is generally termed as Deep Ocean Water (DOW). The changes in physico-chemical properties in DOW, as compared to surface water, are relatively less. The reason is

1. Meager density of animals in deep areas
2. Low current velocity
3. Less impact of wind-driven changes.

Generally there is no clear cut definition for DOW. However, it is referred that the water that occupy the depth below the thermocline layer or from water depth at which light is absent (aphotic zone), may be accounted as DOW.

Most marine animals and plants live in the top 40m of the water column . When they die, they remain as sink in biogeochemical cycles. In shallow coastal waters the nutrients can be recycled because of the turbulence and therefore these areas will be highly productive. However, if the water is deeper than about 40– 100 m, they sink below the euphotic zone and reaches DOW and therefore becomes unavailable to primary producers. The nutrients can then re-enter the food chain only where this nutrient-rich DOW is brought to the surface. This does not generally happen in warm and temperate regions of the oceans due to the density difference between the warm surface water and the cold DOW. As a result most tropical and temperate oceans have low productivity. In cold waters at high latitudes and in regions where currents bring cold polar water from the high latitudes, the ocean surface temperature drops to about 4°C and its density is similar to that at the bottom, the nutrient-rich DOW is then easily brought to the surface by turbulent mixing. Upwelling of DOW also occurs near some coasts, especially the west coasts of Southern Africa and South America due to ocean circulation. These regions of natural upwelling correspond to some of the most productive ocean fishing grounds of the world, contributing 90% of global ocean natural production The primary productivity of the ocean where upwelling occurs is recorded to be around 250 - 2000 g C/m^2/yr. A recent estimate shows that if the DOW is pumped at 50m^3/s, it would produce $ 3.3 million revenue through enhanced fish production.

Physico-chemical characteristics of Deep Ocean Water
(Typical values based on experiments conducted during cruises conducted by OSTI in Arabian Sea, Bay of Bengal and Central Indian Ocean)

Parameter	Values (Range)
Temperature (°C)	5 - 7
Salinity (PSU)	35 - 36
pH	7.4 - 7.6
Dissolved Oxygen (mg/l)	3 - 3.5
Nitrate (µ mol/l)	37 - 40
Nitrite (µ mol/l)	Nil
Ammonia (µ mol/l)	BDL - 0.2
Phosphorus (µ mol/l)	2.8 - 3
Reactive Silicate (µ mol/l)	65 - 70

Application of DOW

There is sufficient evidence to support the assumption and promote the vision that deep ocean water technology can provide the essential components needed to establish self-sufficient, environmentally sustainable communities in the coastal regions of many coastal countries. These components encompass – nonpolluting electrical power, inexpensive cooling for industry, air conditioning, fresh potable water and highly productive agricultural and aquacultural enterprises to produce food and create new jobs.

Ocean Thermal Energy Conversion (OTEC)

Ocean Thermal Energy Conversion (OTEC) is a renewable energy technology which produces power using a heat engine driven by the temperature difference between warm surface ocean waters and cold deep ocean waters .

Cold water agriculture

DOW is pumped in to fibrous network of plastic pipes buried underground at a plant roots depth. The moisture in the warm tropical air is drawn down to the cool soil causing the formation of freshwater condensate. This process irrigates the crops. Further, a drastic temperature difference between the root level and the ground surface on a hot day account for the plant's rapid growth and superior flavour. Also this temperature difference induces pumping of large amount s of nutrient from the soil to roots and in turn to the plants. This work is being demonstrated at pilot scale level in Hawaii

Fishery and Sea water Ice production

High concentration of nutrients is used to raise plankton including live feeds in natural lagoons or ponds in Hawaii. This will create an ideal environment to fish nursery. Further, to store various marine products in its freshness, a lot of ice is necessary. Utilizing surplus deep-seawater, ice can also be manufactured.

Air conditioning by Cold Seawater

The temperature of DOW after use in power generation and desalination, will be about 13°C, suitable for air conditioning use. This DOW with a temperature of about 13°C is used to cool freshwater which in turn is circulated through the cooling coil laid in the ceilings, as a result, room temperature can be maintained at about 23 to 25°C.

Lithium Recovery

Lithium ion contained in the deep seawater is allowed to adsorb to a manganese dioxide column. Then, it is made to melt from the column with diluted hydrochloric acid, and finally 99% or more of high purity chlorinating lithium can be taken out. Since impurities, such as organic matter and plankton, are hardly contained in deep seawater, the adsorption and recovery processes are very efficient.

Fertilization of Seawater by Density Current Diffusion Equipment

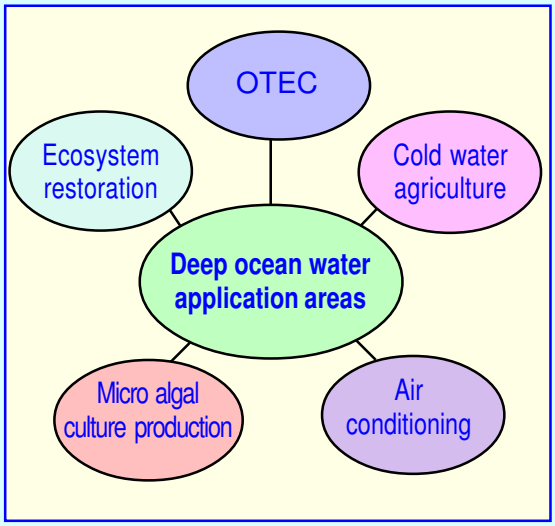
Density of DOW is relatively high as compared to surface water because of coldness. Even when the DOW is pumped to surface water, it tends to sink again to the aphotic zone. Hence, nutrients available in DOW will not be used for primary production by phytoplankton. Therefore, in order to bring down the density of DOW, surface water is mixed at a ratio, so that the DOW will remain at the surface.

Fresh water production – the Hurricane tower and simple condensate

The hurricane tower is a patented desalination (rain-making) device that simulates the processes that occur in a hurricane.

Experimental Marine microalgal culture in DOW

NIOT is building the world's first 1 MW floating OTEC plant . Ammonia is used as working fluid. Cold DOW is used



to condense ammonia. Volume of cold sea water is accounted to be 1600 lit/sec. Obviously this huge amount of water will bring large amount of nutrients to photic zone which in turn is expected to increase primary productivity in the vicinity. NIOT is planning to study the qualitative and quantitative changes.

Experiments were carried out onboard to grow phytoplankton species such as *Dunaliella salina*, *Chlorella sp*, *Isochrysis galbana* and *Chaetoceras pelagicus* in the deep ocean water taken from 1000 m depth. Experiments indicates that amongst the four species tested, *Chlorella sp* was found to grow faster.

News Clippings

Nano-technology from Nature

Dr. Dan Morse and his research team of the University of California, Santa Barbara, have been studying the ways that nature builds ocean organisms at the nanoscale for over ten years. They are now looking to learn new biotechnological routes to make high performance electronic and optical materials.

Most recently, Morse and his students have made advances in copying the way marine sponges construct skeletal glass needles at the nanoscale. The research group is using nature's example to produce semiconductors and photovoltaic materials in an environmentally benign way. They have discovered that the center of the sponge's fine glass needles contains a filament of protein that controls the synthesis of the needles. By cloning and sequencing the DNA of the gene that codes this protein, they discovered that the protein is an enzyme that acts as a catalyst, a surprising discovery. Never before had a protein been found to serve as a catalyst to promote chemical reactions to form the glass or a rock-like material of a biomineral. From that discovery, the research group learned that this enzyme actively promotes the formation of the glass, simultaneously serving as a template to guide the shape of the growing mineral (glass) that it produces.

The group had also discovered that these activities can be applied to the synthesis of valuable semi-conductors, metal oxides such as titanium and gallium that have photovoltaic and semi-conductor properties. Currently, these materials are produced at very high temperatures in high vacuum, using caustic chemicals. With these latest discoveries, scientists have found that nano-technology can copy nature and produce materials in a much more environmental friendly way than the current state-of-the-art.

Source: Press release of University of California, Santa Barbara, California.

Update on cage culture of lobsters

The success of fattening of lobsters in sea cages at Tharuvaikulam, near Tuticorin in Tamil Nadu, prompted the National Institute of Ocean Technology to distribute 3 more cages to coastal fishers. A second harvest was done in May 2004. The Tuticorin District administration has sanctioned Rs.2.4 lakh for distribution of 12 more cages to members of Self Help Group comprising fisherwomen.

Sea cages for lobster fattening at Tharuvaikulam

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