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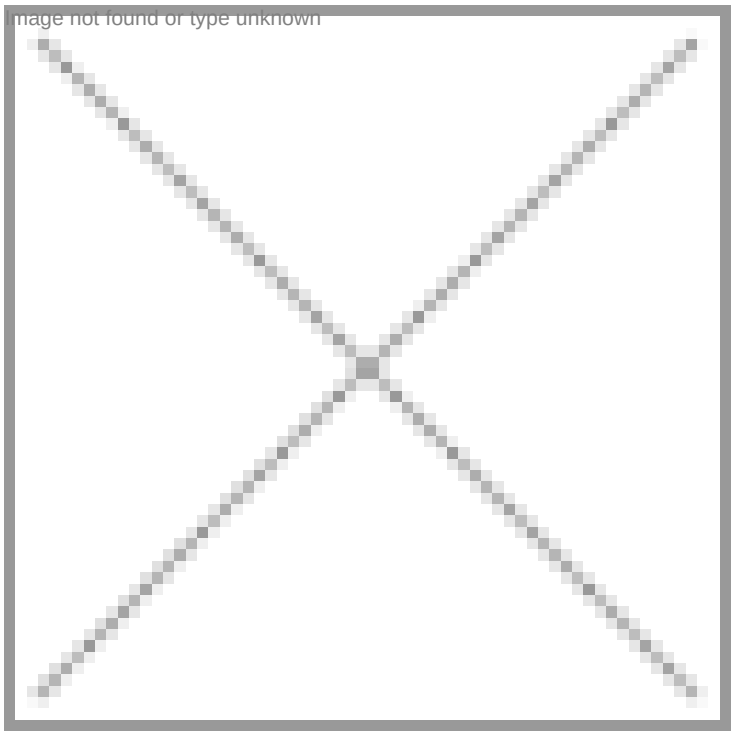


Marine biotech sector needs a shot in the arm

The applications of marine biotechnology are enormous and varied. With government backing, a lot of research activities have been going on in India, but the sector is yet to capture the attention of entrepreneurs.

Biotechnology has played a key role in the economic growth of India, with its contribution mainly in the biopharmaceuticals and agriculture space. But still there are many areas like herbal medicine, biofuel and marine biotech where India needs to focus. Nevertheless the interest level in the marine sector among researchers has been increasing mainly because of its applications in various industries.

Marine biotechnology is about the discovery and development of marine resources (like marine organisms) into a wide range of new products, e.g. food, food additives, healthcare, cosmetics, pharmaceuticals and medical applications. These organisms have been in the spotlight owing to their unique features, which part them from the rest of the terrestrial biodiversity. These organisms have been found to possess characteristics like alkalinity tolerance, thermo tolerance, baro tolerance and the ability to use unusual molecules. These attributes make marine organisms a useful resource for use in different industries, bioremediation and agriculture.

Anasuya Lahiry, sector specialist, marine and environment (Class I), Gujarat State Biotechnology Mission, Department of Science & Technology, Government of Gujarat, said, "Many marine plants and animals stay anchored to the seabed and produce toxins to ward off preys like fishes. These toxins have been shown to be promising cures against many diseases. Also, many molecules found in marine organisms have totally different patterns of construction from the molecules of medicinal value found in terrestrial plants and animals."

"More than 12,000 novel chemicals from marine plants, animals, and microbes are being worked on and a large number of pharmaceutical products, enzymes and biomaterials have been developed. Many marine organisms can be used in bioremediation, owing to their ability to produce antifouling agents which help ward off predators. These compounds with minor or no modification can serve as effective yet non-environment polluting antifouling agent."

Referring to marine biotechnology as "Blue Biotechnology", Dr Shanta Achuthankutty of the National Institute of Oceanography, Goa, said, "Marine biotechnology is the use of marine biological systems or its derivatives to make or modify products or processes for use in food science, medicine and environment. The uniqueness lies in the fact that the marine environment constitutes a major share of the Earth's biological resources and organisms often possess unique structures, metabolic pathways, reproductive systems, and sensory and defense mechanisms. Traditional marine biotechnology has been in use for removing cuttlefish toxins, cleaning wounds with seawater and in other applications."

With the development of molecular biology and advancement of instruments, marine biotechnology has been given a new perspective. Laborious and imperfect tools of marine microbiology such as culturing are being refined or replaced by the 21st century tools such as genomics and computational analysis. Evolutionary advances across science, notably the acceleration of progress in such fields as information technology and nanotechnology, coupled with the breathtaking progress in microbiology itself, has positioned marine biotechnology to enter a new realm of discovery. Yet the potential of this domain as the basis for new biotechnologies remains largely unexplored in India.

Prof. Bhavanath Jha, head, department of marine algae and marine environment discipline, Central Salt & Marine Chemicals Research Institute, Bhavnagar, said, "Marine biotechnology is an emerging thrust area of biotechnology, which harnesses the enormous but uncharted gene pool and functional diversity of marine life towards finding new genes, organisms, biosensors, natural products and unusual biochemical processes of importance to agriculture, industry, nutrition, medicine and the environment."

Market

Globally, the marine biotechnology market is projected to exceed $3.2 billion by 2007 with the non-U S segment comprising the bulk of the market. This non-US segment comprises some of the Asian, Australian, African and European countries. Also, parts of North and South America would be amongst the major contributors.

Indian coasts that extend to about 5,700 km on mainland and to about 7,500 km including two groups of islands (Lakshadweep and Andaman & Nicobar) have rich diversity of corals, fishes, important arthropods and molluscs. The Western coastline (covers states such as Gujarat, Karnataka, Maharashtra, Kerala and Goa) has a wide continental shelf having an area of about 0.31 million km, which is marked by backwaters and mud flats. The East coast consists of Tamil Nadu, Pondicherry, Andhra Pradesh, Orissa and West Bengal, which is flat and deltaic and rich in mangrove forests covering an area of about 1,430 km. Asia's largest brackish water lake Chilka, Andaman & Nicobar islands, Lakshadweep, Gulf of Kachchh and Khambat and Gulf of Mannar are also important for biodiversity studies.

Sharing his knowledge about the sector, Dr T Charles John Bhaskar, scientist and managing director, GeoMarine Biotechnologies Research & Educational Institute, Chennai, said, "At present the marine biotech segment in India is a minor one. However, in my opinion in about five years, it should account for around 20 to 25 percent share in the total biotech industry. Marine biotechnology will play a major role in various sectors such as biopharma, bioagri, bioindustries and bioenergy."

He continued, "Marine biotechnology is gearing up globally too. About 10,000 compounds are known from marine sources. Already many compounds are in the final testing stage for antiviral, anticancer, antihypertensive and anti parkinsonian activity. Many industrial enzymes could be obtained from marine organisms. In fact they can be much superior compared to those from terrestrial source. Vibrio alginolyticus, a marine bacterium produces a detergent resistant protease that can find application in detergent industries. What is interesting is since the bacterium lives in high salt concentration, the enzyme will act in low water activity situation such as those encountered in industries where organic solvents are used. For the same reason many halophilic bacteria can work better in bioremediation and effluent treatment."

Although biotechnological research has progressed in the marine sector, the industrial base in India, for marine biotech lead industries are markedly less. The key ones in this space includes Cellgen Biologicals, Samudra Biopharma, GeoMarine Biotechnologies, Nurture Aqua Technology and ABL Biotechnologies.

The companies operating purely in marine biotechnology are few. Since aquaculture and marine byproducts are also considered as marine biotechnology, there should be about 100 companies operating in this space. This figure does not include shrimp and fish hatcheries and marine food exporters. In the absence of split-up on marine biotechnology products and other products, it is difficult to determine the leader. ABL Biotechnologies, Mangalore Biotech and Parry Nutraceuticals are a few leading names.

Research activities

India has been working on drugs from the sea (bioactive compounds from mussels, sponges and microorganisms), enzymes that are salt and alkaline tolerant, natural products like pigments, glycerol, carotinoides, and antifouling products, aquatic cell line, transgenic fish and bioremediation (aquaculture farms and oil pollution).

With a large coastline, India has made progress in marine research over a period of time. India has bagged patents in marine research from various institutes conducting research work in various aspects of marine biology. Some of the research areas are aquaculture, marine biotechnology, marine fisheries, systematic and ecology, molecular taxonomy, processing technology, shrimp and oyster hatchery management, endocrinology, marine bio-deterioration, microbiology, mangrove ecology, toxic algal blooms, biodegradation of oil spills, enzymes from marine systems, marine biodiversity.

"Indian labs are concentrating on bioactive substances from marine animals such as horseshoe crab, green mussels, sponges and corals for characterization of novel molecules. Some of the novel molecules have been isolated and commercialized. The Department of Biotechnology (DBT) has been promoting marine biotechnology in India for the last one and half decades. Many R&D programs on marine biotechnology sponsored at different Indian Universities and Institutions and in collaborative mode are leading towards products and process development and development of viable technology for commercial production systems," said Dr AS Ninawe, director, DBT.

Marine biotechnology also called marine bioprospecting in India, began in the early Nineties as the national project on development of potential drugs from the sea. The Central Drug Research Institute, Lucknow is the co-ordinating body together with several other collaborating institutes and universities. Organisms from both the long Indian coastline, particularly the mangroves of the Sundarbans and the Andaman & Nicobar Islands are identified, screened and specimens stored at the national repository at the National Institute of Oceanography, Goa.

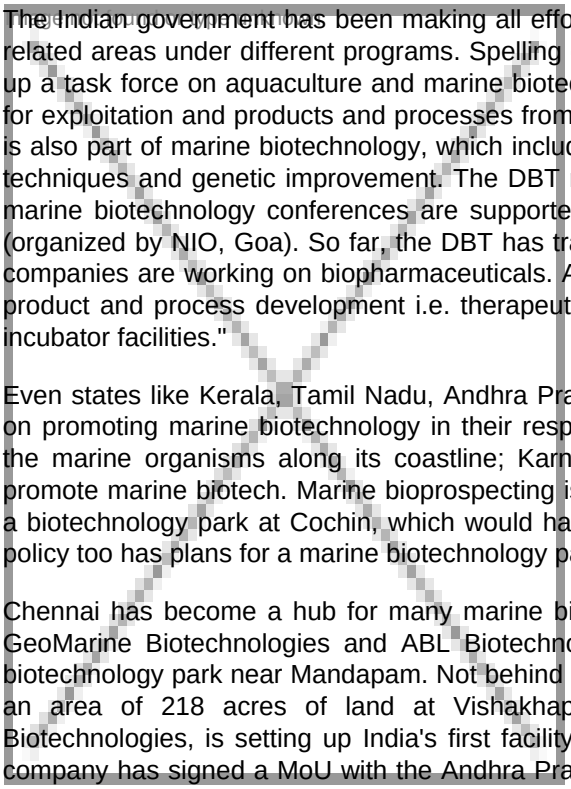
Prominent Indian institutes such as the Central Institute of Brackish Water Aquaculture, Central Institute of Fisheries Technology, Cochin, Central Marine Fisheries Research Institute, Central Salt and Marine Research Institute, National Bureau of Fish Genetic Resources, National Centre for Antarctic & Ocean Research, National Institute of Oceanography, National Research Centre on Coldwater Fisheries, and MS Swaminathan Research Foundation, Chennai have been working on projects related to the marine sector.

Dr Shanta Achuthankutty said, "In India this science is really in its infancy except in the field of aquaculture. Certain universities have contributed to the field of marine biotechnology such as Cochin University of Science and Technology, Mangalore University and Bharthiyar University, Trichy. However, the work has been sporadic depending on the availability of grants and has not been the national thrust area. Although the DBT has a program in marine biotechnology and is conducting an MSc course, there are very few institutes/companies absorbing marine biotechnology candidates. So the students tend to

move over to general biotechnology or quit for green pastures. Realizing the importance of marine resource, the CSIR has included marine microorganisms in its two networking projects. I think India should start an institute on marine biotechnology (R&D) wherein the charter should be on basic research on the functioning of marine organisms. It will be the answer for many metabolic disorders in our system, to develop sustainable energy, new assay methods for bioactive screening, enzymes in collaboration with the big players/industries."

Government initiatives

Along with the opportunities and vast potential for marine biotechnology, there are some hindrances that marine biology or biotechnology research encounters. The challenges include identifying new sources of marine bioproducts, developing novel screening technologies, providing a sustainable source of supply, optimizing production and recovery of the bioproducts, developing cultivation techniques for marine organisms, cloning of genes of interest, successful technology transfers for industrial growth and culturing marine organisms in the lab.



The Indian government has been making all efforts to support research activities and initiatives in marine biotechnology and related areas under different programs. Spelling out the initiatives of the government, Dr A S Ninawe said, "The DBT has set up a task force on aquaculture and marine biotechnology, under which the projects are funded for utilizing marine resources for exploitation and products and processes from marine organisms utilizing biotechnology tools and techniques. Aquaculture is also part of marine biotechnology, which includes aquaculture biotechnology for the improvement of germ plasm, breeding techniques and genetic improvement. The DBT regularly organizes seminar symposia through HRD program through which marine biotechnology conferences are supported. One such good conference is going to be held in November in Cochin (organized by NIO, Goa). So far, the DBT has transferred five technologies under marine biotechnology. Most of the biotech companies are working on biopharmaceuticals. A few of them have just started concentrating on marine organisms for novel product and process development i.e. therapeutics of marine origin. Many states are coming forward for support of marine incubator facilities."

Even states like Kerala, Tamil Nadu, Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Orissa, and West Bengal are keen on promoting marine biotechnology in their respective states. Maharashtra's biotechnology policy includes efforts to exploit the marine organisms along its coastline; Karnataka biotech policy plans to set up a marine biotech park at Karwar to promote marine biotech. Marine bioprospecting is a major theme of Kerala's biotechnology policy. Kerala too plans to set up a biotechnology park at Cochin, which would have marine biotechnology as the thrust area. The Orissa draft biotechnology policy too has plans for a marine biotechnology park at Chilka Lake, one of the largest lagoons in India famous for its prawns.

Chennai has become a hub for many marine biotechnology companies such as Cellgen Biologicals, Samudra Biopharma, GeoMarine Biotechnologies and ABL Biotechnologies. Hence the government of Tamil Nadu plans to set up a marine biotechnology park near Mandapam. Not behind is Andhra Pradesh. The state is pushing for marine biotech park spread over an area of 218 acres of land at Vishakhapatnam, where Celgen Biologicals, a wholly owned subsidiary of ABL Biotechnologies, is setting up India's first facility for the production of the essential fatty acid DHA. Biogenus, a US-based company has signed a MoU with the Andhra Pradesh government to invest $20 million for a marine biotech research station and bacterial culture and enzyme plant in the park.

Gujarat too is active in promoting marine biotechnology. It has already set up a Center of Excellence (CoE) for marine biotechnology at CSMCRI, Bhavnagar. The state government has been organizing seminars on marine biotechnology to get the feedback from academicians, scientific community and industrialists, so as to prepare a road map for entrepreneurs.

Akshay K Saxena, mission director, Gujarat State Biotechnology Mission, Department of Science & Technology, Government of Gujarat, said, "Gujarat has been making all efforts to promote marine biotechnology in the state. In this regard we had organized a day-long summit in January 2006, focusing on drawing out some conclusive bottomlines for promoting marine biotechnology in the state. The findings from this summit were aimed to aid, to device long term and short-term strategies, which would lead to fast track development of marine biotechnology in the state. Similarly in July 2006, we organized a summit to gather inputs for setting up an incubator for marine biotechnology in the state."

Brighter outlook

The possibility of obtaining drugs and food additives from marine plants and animals is just unveiling its huge economic potential worldwide. India is blessed with a long coastline with shallow tropical seas surrounding most part of the continent. The time is ripe for the Indian industry to dive into the oceans and reap the benefits, which this huge natural marine laboratory offers. There will be huge employment opportunities in these industries and it is necessary to create a reserve talent pool in this area. The DBT has taken up initiatives in creating human resources, which is the need of hour for marine biotechnology sector besides funding projects.

"Marine biotechnology will provide us with more technological tools and application. Several marine based pharmaceuticals are under active commercial development, ecosystem health is high on the public's list of concerns, and aquaculture is providing an ever-greater proportion of the seafood in developed countries. Nevertheless, marine biotechnology has not yet caught the public's, or the investor's attention in India," felt Dr Shanta Achuthankutty.

It is high time the successful marine biotechnology entrepreneurs brief venture capitalists at forthcoming conferences like BIOInvest and IVCJ conference scheduled in November 2006 in Mumbai, about their success stories. This might be interesting for VCs or private equity funds to make investments beyond biopharmaceuticals, bioservices, and bioinformatics sectors.

Narayan Kulkarni