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REVIEW

PATENTING APPLICATIONS IN MARINE SCIENCE & BIOTECHNOLOGY

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Aquaculture and Marine Biotechnology sector is expanding rapidly and addressing the grand challenges towards green growth with economic and social benefits for population health, food and fuel security across the globe. The present market growth of marine biotechnology is still in a nascent stage and accounts for a tiny percentage of the overall biotechnology market. Global Marine Biotechnology market is expected to reach US $4.1 billion by 2015 (OECD, 2012). Many Universities and Institutes including Fisheries Research Institutes in India are working in mariculture, marine bio-prospecting, biotechnology, fisheries management devices and fisheries products development giving emphasis on IP protection of the resources generated through commercialization of technologies. A number of marine natural products that have found their way into pharmacies recently require scaled-up process. Despite lesser attention paid to marine natural products historically, there are notable marine-derived bio products commercially available and IP protected.

INTRODUCTION

Biotechnology is the combination of natural and engineering sciences in order to achieve the use of organisms, cells or their derivatives in production of substances or creation of wealth for specific use (Twardowski and Malyska, 2012). Commonly, it is recognised with different colours, "white" biotechnology: bio-systems used for industrial production and environmental protection, "red" biotechnology: refers to pharmacology and healthcare, 'green' biotechnology: refers to the use of genetically modified animals and plants in agriculture and 'violet' biotechnology: the studies on legal and social aspects. . The biotechnology in the area of pharmaceutical sciences carries potential risk as the cost to bring a new drug to market is very high and it requires years to commercialise an innovative medicine. Such high cost of market implementation arises from the high standard of tests, mostly the clinical trials and also marketing.

Aquaculture & Marine Biotechnology sector is expanding rapidly and addressing the grand challenges towards green growth with economic and social benefits for population health, food and fuel security both in developed and developing countries. The sector represents the marine biological resources comprising area such as marine environmental protection, marine bioactive substances, genetics, mariculture, fermentation engineering and enzyme engineering. At this stage the sector is at the nascent stage and very few countries have initiated national R & D programs to exploit benefits of biotechnology in the marine sector. Initiation of research activity has gained momentum fuelled by new

technologies that address technical challenges, advances in aquaculture, new production technology, product process development, new drug discovery and others (Ravishankar and Archak, 2000; Trivedi, 2008). These are expected to enhance the application of biotechnology in marine industry. The R & D leads on utilization of marine genetic resources contributed over 18,000 natural products, 4,900 patents associated with genes of marine organisms with greater effort on sustainable development (EMB, 2013).

Looking at the enormous potential the Governments and private sector organisations around the globe have started to recognise marine biotechnology by harnessing its potential through translation of new scientific and technological advances into economic prosperity (Maskus, 2000; Holger, 2001).

PATENTING IN BIOTECHNOLOGY

Intellectual property protection plays an important role in economic growth by promoting technology innovation through discoveries and inventions to transfer the knowledge of bioscience from academic research laboratories to the industrial application (WIPO, IP Statistics, http://www.wipo.int/ipstats/en/statistics/patents). The fast development and wide application of bio-techniques enhance the process of inventions which are novel, possess industrial application and are non-obvious. Biotechnological invention, otherwise termed as 'bio-invention' comprises biomaterial isolated from nature with human engineering activity or artificially created product in the laboratory.

India enjoys a large asset of R & D personnel and infrastructure facilities. Researchers/ Scientists and policy makers are creating awareness on gathering information and facilities required for protecting the products of intellectual knowledge base which carry significant importance for the economic growth (Pal, 2008). To bridge the gap between the research outcome and its use for the benefit of the stakeholders, scientists and policymakers need information and facilities for protecting their research. The Department of Biotechnology (DBT), Government of India has established Biotechnology Patent Facilitation Cell (BPFC) DBT in July'1999 as a single window awareness-cum-facilitation mechanism to create awareness and understanding about Intellectual Property Rights (IPRs) among scientists and researchers (http://dbtindia.nic.in/uniquepage.asp?id_pk=56).

The IPR and patenting issues are popularized well by arranging workshops, seminars, conferences, etc. at all levels and for introducing patent information as a vital input in the process of formulation of R & D programmes in biotechnology and providing patenting facilities to biotechnologists in the country and for encouraging the researchers for filing Indian and foreign patents. The creation of BPFC is providing patenting facilities to the biologists & biotechnologists for filing Indian & Foreign patent applications.

PATENT FILING MECHANISM

"A patent is an exclusive right granted for any process, product or device which is novel, inventive and useful. It is legally enforceable and gives the owner the exclusive right to commercially

exploit the invention for the life of the patent". The policy of DBT in filing patent application allowed filing the patent in the name of DBT and the host institution without having any financial benefits. All the commercial interest of patent will lie with the host institution and inventor with the flexibility of rules of host institution. The patent filing application supports the application for seven years from the date of filing or two year after date of grant of patent or commercialization, whichever is earlier. After that period the institution/inventor(s) has to take care of patent application/patent (Fig. 1).

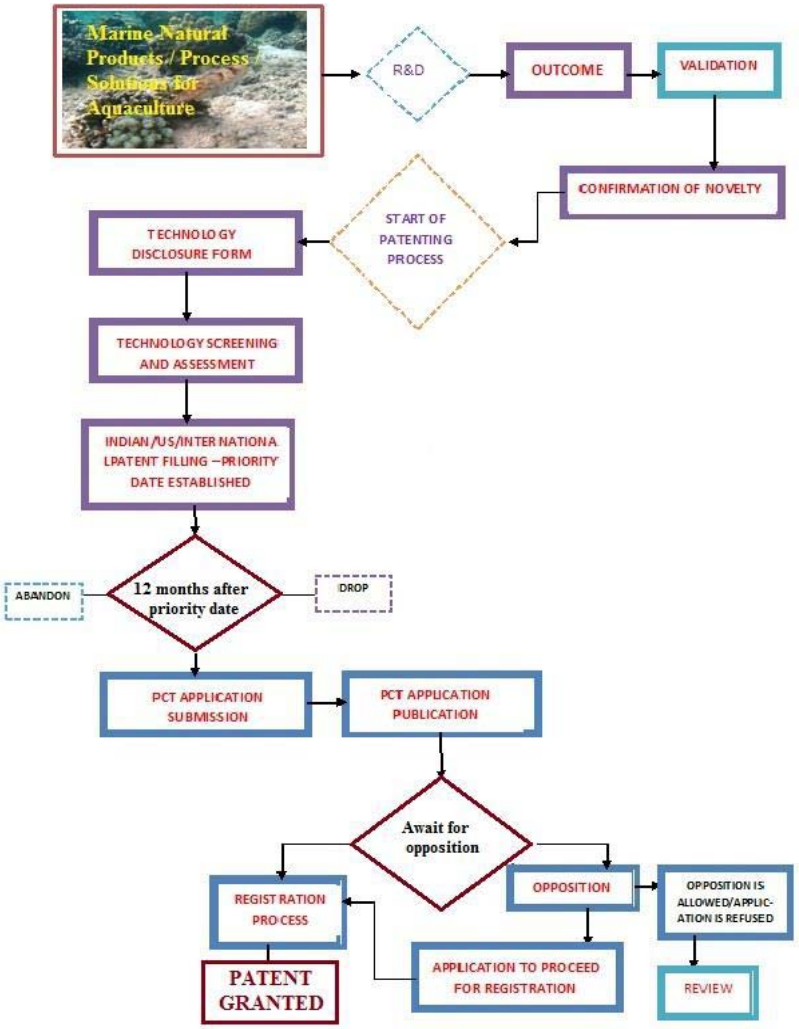

Fig. 1. Patent application process of marine natural products, process and products for aquaculture management

AQUATIC AND OCEAN SCIENCE TECHNOLOGY AND TECHNOLOGY TRANSFER

Two-thirds of the earth surfaces are covered by water with five large oceans offering an ecosystem for the growth of various forms of lives with unique properties, which are generally not present in the terrestrial ecosystem. Historically, marine ecosystem and marine biodiversity benefited mankind through direct and indirect economic benefits and industrial means. However, there is a high degree of representation of terrestrial-derived bio-products, but the number of patents that have found their way into IP protection from marine origin is thus far small (Chakraborty, 2013b). In marine and fisheries sector, the technologies developed for socio-economic upliftment on suitable craft and gear, management of inland, brackishwater, marine and coldwater fishery resources; inland, brackishwater and marine fish and shellfish culture technologies. The development of management techniques, feeds, harvest and post-harvest technology, device development for culture operation both for marine and sea farming, value addition etc are not being patented but popularized and implemented through regular interactions with user agencies by imparting training, short term courses, consultancies and frontline demonstrations. India has recognized its importance in the top ten producers of farmed aquatic animals and second after China, produces 4.6 million tonnes of fish through aquaculture (FAO, 2013). This has created tremendous impact on freshwater fish production. In a pond production system an average of 3.0 tons /ha/ year from freshwater aquaculture system has been standardized. Challenges to mitigate with climate change on fisheries and aquaculture, water budgeting, open sea cage farming of aquaculture species are being demonstrated at several Eastern and Western coastal region of India. The technology on improved feed and seed for different life stages of crabs, shrimp and sea bass are being developed and transferred to private entrepreneurs for commercial production.

Intellectual property is an important and effective policy instrument to a wide range of socio-economic and technological concern. The possession of a patent not only confers certain monopoly rights and privileges of the patented article, but certain obligations and duties also. Intellectual property safeguards the rights of an inventor in his invention, and at the same time facilitates social and economic growth by providing an impetus to the advancement of science and technology (Mashelkar, 2002). India becoming signatory to TRIPS in 1998 and with the latest amendments taking effect from 2006, the TRIPS compliant IP laws in India created the best investment opportunities and contributing to environment for protection of valuable inventions and IP rights in marine fisheries and mariculture. The Government agencies like DST (TIFAC), is actively extending technical and financial assistance for protecting IPR generated at the educational institutions including Universities, colleges, Institutions and Schools, Govt. departments and research institutions. Setting up the panel of Attorneys to undertake protection activities on their behalf and even for ITKs are being dealt.

ICAR institutes working in fisheries and marine sector are shaping a number of IP protected technologies, which are of direct or indirect benefits to the society and mankind (ICAR,

2006). Fisheries Research Institutes in India are working in mariculture, marine bio-prospecting, biotechnology, fisheries management devices and fisheries products development giving emphasis on IP protection of the resources or technologies generated. The leads found are useful for important gap filling in research and development and to achieve the great commercial value. Design, development and propagation of open sea cage device for cultivating marine fishes, cutting edge mariculture technologies of food fishes are contributing immensely towards the Blue Revolution in India (Ayyappan *et al*., 2011). The breakthrough of cobia and pompano breeding is creating a milestone towards development of food fish mariculture in India (Chakraborty 2013a). The efforts towards land-based culturing of pearl oyster in marine system, open sea green mussel farming, edible oyster farming, hatchery technology for production of clam, sea horse, ornamental fish, mass scale spat production of green mussel, fish aggregating devices (FAD), production process for sea cucumber *Holothuria scabra* and *Holothuria spinifera* seeds or fingerlings, resource management of the Indian sacred chank, propagation of soft coral *Sinularia kavarattiensis,* polyunsaturated fatty acid enriched formulation, phytase from mangrove associated bacteria, gene mining technologies for various important traits are greatly contributing to aquatic and ocean science in IPR and technology transfer.

These are further vast, unexplored and untapped resource with immense potential to develop technologies with emergence of mariculture as an alternate approach for enhancing coastal fish production. The frontier areas of research such as stock assessment of marine fisheries, mariculture, marine bio-prospecting, high value compounds, biotechnology, development of nutraceuticals and valuable bioactive molecules from sea, natural resource management, Indian fisheries database, bioinformatics, remote sensing, and climate change etc. A farming technology on Open Sea Green Mussel developed disseminated in coastal waters and estuaries of India with community participation and is now being operated small-scale commercial venture in the various estuarine regions.

The technologies by fisheries research institutes are receiving protection by patents, trademarks, geographic indications, copyright, and design (Ninan *et al.,* 2005). These technologies receive protection by one or a combination of different IPRs depending upon the nature of technology. By considering vast and unexplored potential of utilization of aquatic resources, the increasing trend in biotechnological patents in the developed countries, patenting of aquatic genetic resources will have an increasing trend in times to come. The use of aquatic resources has a significant potential in pharmaceuticals, nutraceuticals, high value compounds/ chemicals, cosmetics and food (OECD, 2012).

TECHNOLOGY MODE TO COMMERCIALIZATION

Marine ornamental feeds are used in the aquaculture of marine ornamental fishes, which include maintenance, breeding, larval rearing, and aquarium keeping. Presently, formulated feeds

for marine ornamentals are not indigenously produced and the demand is met through imports with a price tag. The feed for ornamental fish as an import substitute, cement and concrete moulded Artificial Reef modules such as grouper module, well ring module, and reef fish module to contribute artificial reef to a great extent for enhancement of various biological resources and to increase fish catches by artisanal fishermen.

PATENTING TREND IN MARINE SECTOR

The efforts to extract drugs from the sea started in the late 1960s. During the decade from 1977 to 1987, about 2500 new metabolites were reported from a variety of marine organisms and shown an excellent source of novel chemicals, not found in terrestrial sources. So far, more than 10,000 compounds have been isolated from marine organisms with hundreds of new compounds are still being discovered every year (Correa, 1998). About 300 patents on bioactive marine natural products were issued between 1969 and 1999 (Kathiresan *et al.,* 2008). Marine species are much diverse with 28 existing animal phyla of them 13 are exclusively marine. Hence, genetic, biochemical and physiological animal diversity is much larger in the oceans/ marine environment. Sessile or sluggish invertebrates secrete toxic substances as defensive mechanism and are the prime organisms for bioactive metabolites and potential drugs. Research on anti-cancer agent from marine resource is notably high (Boopathy and Kathiresan, 2010). Way back the review of Marine Pharmacology shows that 166 marine chemicals with about 67 marine organisms showing antibacterial, antifungal, antimalarial, antituberculosis or antiviral activities, about 45 marine derived compounds reported to have significant effects on the cardiovascular, immune and nervous system as well as possessing anti-inflammatory effects and about 54 marine derived compounds, which act on a variety of molecular targets with a potential contribution to several pharmacological classes (Walser *et al.,* 2008). There is a high degree of representation of terrestrial-derived bio-products, and, therefore, the number of marine natural products that have found their way into pharmacies is thus far small. The natural products isolated from marine sources tend to be more highly bioactive than terrestrial counterparts because they have to retain their potency despite dilution in surrounding seawater to be effective in the "chemical warfare".

MARINE ORGANISMS: A POTENTIAL SOURCE OF IP

Ocean is a potential source of bioactive compounds, which does not have a significant history of use in traditional medicine as in the case of terrestrial plants (Kamboj, 1999). Previously, the research was focused mainly on terrestrial plants because of their easier availability. The isolation of biologically unique molecules from marine organisms that are not found in terrestrial sources leads to a remarkable progress in marine bio-prospecting. The boom of marine bio-prospecting began in recent years and 18000 plus natural compounds from marine organisms have been isolated as compared to 155000 terrestrial products (Blunt *et al.,* 2004; Mayer *et al.,* 2007). Between 1969 and 1995, 63 marine substances were patented as antitumour agents, accounting for half the marine molecules patented for pharmaceutical purposes (Martınez

et al., 2002). There are a significant and growing number of marine-derived compounds with pharmaceutical potential in the pipeline.

Large numbers of marine-derived potential therapeutic compounds used for drug discovery efforts are still undergoing preclinical evaluation, but several others are currently being administered to patients as part of clinical trials (Kijjoa *et al.,* 2004). Anti-inflammatory and analgesic pseudo pterosins isolated from a Caribbean marine gorgonian *(Pseudoterigorgia elisabethae),* led to the development of bioproducts now used in Estee Lauder skin care and cosmetics lines and currently worth $3-4 million a year. Pseudopterosins belong to a class of patented compounds known as tricyclic diterpene glycosides (Kohl and Kerr 2003; Kijjoa and Sawangwong, 2004). The pioneering institutes in India are engaged in isolation and characterization of bioactive compounds with antioxidant, antibacterial, and anti-inflammatory properties from marine flora and fauna, some of them have been protected by patents. These institutes are successfully isolating high value compounds and developed a number of products for use as nutraceuticals. A patented product Green Mussel extract containing anti-inflammatory principles from *Perna viridis* to combat joint pain, arthritis/ inflammatory diseases has been developed as an effective green alternative to the synthetic drugs available in the market. Green Algal extract as a natural remedy to chronic joint pain and arthritis which have been extracted from a blend of marine macroalgae or seaweeds with an eco-friendly "green" technology.

Table 1. US patents issued on marine natural products from 2012 - 2013.
(Source: Gogineni *et al.,* 2015)

Original Assignee	Publication number	Products	Inventors
Nippon Soda Co., Ltd.	US8598367 B2	Nitrogen-containing heterocyclic compound and pest control agent	Jyun Iwata, Masahiro Kawaguchi
Santen Pharmaceutical Co., Ltd.	US8486960 B2	Formulations and methods for vascular permeability-related diseases or conditions	David M. Kleinman, Thierry Nivaggioli, Mary E. Gerritsen, David A. Weber
Reata Pharmaceuticals, Inc.	US8440820 B2	Antioxidant inflammation modulators: oleanolic acid derivatives with saturation in the C-ring	Eric Anderson, Xin Jiang, Xiaofeng Liu, Melean Visnick
Vertex Pharmaceuticals Incorporated	US8450489 B2	Azaindoles useful as inhibitors of janus kinases	Luc Farmer, Gabriel Martinez-Botella, Albert Pierce, Francesco Salituro, Jian Wang, Marion W. Wannamaker, Tiansheng Wang
Eisai R&D Management Co., Ltd	US8445701 B2	Intermediates for the preparation of analogs of halichondrin B	Brian Austad, Charles E. Chase, Francis G. Fang, Marc Pesant

Dimerix Bioscience Pty Ltd	US8568997 B2	Detection system and uses therefor	Kevin Donald George Pfleger, Ruth Marie Seeber, Heng Boon See, Karin Ann Eidne
Icos Corporation	US8586597 B2	6-fluoro-3-phenyl-2-[1-(9H-purin-6-ylamino)ethyl]-3H-quinazolin-4-one as an inhibitor of human phosphatidylinositol 3-kinase delta	Kerry W. Fowler, Danwen Huang, Edward A. Kesicki, Hua Chee Ooi, Amy Oliver, Fuqiang Ruan, Jennifer Treiberg, Kamal Deep PURI
Icos Corporation	USRE44599 E1	Quinazolinones as inhibitors of human phosphatidylinositol 3-kinase delta	Kerry W. Fowler, Danwen Huang, Edward A. Kesicki, Hua Chee Ooi, Amy Oliver, Fuqiang Ruan, Jennifer Treiberg, Kamal Deep PURI
Oil Chem Technologies, Inc	US8389448 B1	Anionic ether amines and process for using same	Paul Daniel Berger, Christie Huimin Berger
Heliae Development, Llc	USD679965 S1	Aquaculture vessel	Jason D. LICAMELE
Island Kinetics, Inc.	US8293943 B1	Prevention of cellular senescence in mammals by natural peptide complexes	Shyam K Gupta, Linda Walker
Neptune Technologies & Bioressources, Inc.	US8383675 B2	Natural marine source phospholipids comprising polyunsaturated fatty acids and their applications	Fotini Sampalis
Rohm And Haas Company	US8546494 B2	Isocyanate-terminated prepolymer	Larry F. Brinkman, Amira Avril Marine, David E. Vietti, Joseph J. Zupancic
Olympic Seafood, As	US8557297 B2	Method for processing crustaceans and products thereof	Inge Bruheim, Mikko Griinari, Jon Reidar Ervik, Stig Rune Remoy
Arizona Board Of Regents For And On Behalf Of Arizona State University	US8318963 B2	Extraction with fractionation of lipids and co-products from oleaginous material	Aniket KALE, Qiang Hu, Milton Sommerfeld
Old Dominion University Research Foundation	US8455699 B2	Production and separation of glycerol-related products using various feed stocks	Patrick G. Hatcher, Zhanfei Liu, Elodie Salmon
Old Dominion University Research Foundation	US8455699 B2	Production and separation of glycerol-related products using various feed stocks	Patrick G. Hatcher, Zhanfei Liu, Elodie Salmon
Magnachem International Laboratories, Inc.	US8546444 B2	Synthetic lactone formulations and method of use	Federico M. Gomez, C. Federico Gomez Garcia-Godoy
U.S. Nutraceuticals, LLC	US8524980 B2	Composition and method to alleviate joint pain	John A. Minatelli, W. Stephen Hill, Swati Sebastian

Rohm And Haas Company	US8546494 B2	Isocyanate-terminated prepolymer	Thomas, Lingan Rajendran, Rudi E. Moerck, Larry F. Brinkman, Amira Avril Marine, David E. Vietti, Joseph J. Zupancic
Donaldson Company, Inc.	US8496774 B2	Process and materials for coiling z-filter media; and/or closing flutes of filter media; and, products	Kevin Schrage, Eugene Lensing, Donald Mork, Troy Murphy, Jeff Rahlf, Gregory Reichter, Daniel Risch
U.S. Nutraceuticals, LLC	US8507757 B2	Composition and method to alleviate joint pain	John A. Minatelli, W. Stephen Hill, Swati Sebastian Thomas, Lingan Rajendran, Rudi E. Moerck,
Heliae Development, Llc	US8308948 B2	Methods of selective extraction and fractionation of algal products	Aniket KALE
Heliae Development, Llc	US8318019 B2	Methods of dewatering algae for extraction of algal products	Aniket KALE
Chevron U.S.A. Inc., Commonwealth Scientific And Industrial Research Organisation	US8258195 B2	Acetylene enhanced conversion of syngas to Fischer-Tropsch hydrocarbon products	Charles L. Kibby, Minquan Cheng, Yun Lei, David Lawrence Trimm, William L. Schinski
Island Kinetics, Inc.	US8258343 B1	Prevention of cellular senescence in mammals by natural peptide complexes	Shyam K Gupta, Linda Walker
The Rockefeller University, The Scripps Research Institute	US8586051 B2	Glycolipids and analogues thereof as antigens for NKT cells	Moriya Tsuji, David D. Ho, Chi-Huey Wong, Douglass Wu, Masakazu Fujio, Xiangming Li
Heliae Development, Llc	US8308950 B2	Methods of dewatering algae for diesel blend stock production	Aniket KALE
Codexis, Inc.	US8574877 B2	Production of fatty alcohols with fatty alcohol forming acyl-CoA reductases (FAR)	Robert McDaniel, Behnaz Behrouzian, Louis Clark, Douglas A. Hattendorf, Fernando Valle
Heliae Development, Llc	US8318018 B2	Methods of extracting neutral lipids and recovering fuel esters	Aniket KALE
Heliae Development, Llc	US8329036 B2	Manipulation of polarity and water content by stepwise selective extraction and fractionation of algae	Aniket KALE
Heliae Development, Llc	US8308949 B1	Methods of extracting neutral lipids and producing biofuels	Aniket KALE

Kraft Foods Global Brands Llc	US8563065 B2	Production of low calorie, extruded, expanded foods having a high fiber content	Jeanny E. Zimeri, Lynn Haynes, Allan R. Olson, Vijay Kumar Arora, Louise Slade, Harry Levine, Meera Kweon
Fahs Stagemyer, Llc	US8440154 B2	Processes and uses of dissociating molecules	W. Fahs II Richard, Matthew D. W. Fahs
H R D Corporation	US8491778 B2	High shear hydrogenation of wax and oil mixtures	Abbas Hassan, Gregory G. Borsinger, Rayford G. Anthony, Aziz Hassan
H R D Corporation	US8497309 B2	Gasification of carbonaceous materials and gas to liquid processes	Aziz Hassan, Abbas Hassan, Rayford G. Anthony, Gregory Borsinger
Lanzatech New Zealand Limited	US8383376 B2	Carbon capture in fermentation	Sean Dennis Simpson, Richard Llewellyn Sydney Forster, Simon David Oakley, Michael Charles Milner Cockrem, Michael Koepke
The Procter & Gamble Company	US8431520 B2	Perfume systems	Johan Smets, Hugo Robert Germain Denutte, An Pintens, David Thomas Stanton, Koen Van Aken, Inge Helena Hubert Laureyn, Bram Denolf, Freek Annie Camiel Vrielynck

MARINE-DERIVED DRUGS

The first modern marine-derived drugs dated back more than 50 years. Werner Bergman extracted the novel compounds spongothymidine and spongouridine from the Caribbean sponge *Tethya crypta* in the early 1950s. These compounds were nucleosides similar to those forming the building blocks of nucleic acids (DNA and RNA). These natural nucleoside analogs were discovered to have unexpected antiviral properties. There are about 10,000 sponge species, found from the intertidal zone to the deepest ocean trenches. Sponges are an important source of new IP protected drugs. Acyclovir, derived from a Caribbean sponge, is used to treat herpes and encephalitis. Arabinosides, used in making antiviral medications, is made from the marine sponge *Tethya crypta*. AZT (Zidovudine) was originally isolated from *Tethya crypta* and manufactured under the trademark Retrovir® and was the first drug licensed for the treatment of HIV infection. There are a total of 7880 patents granted on Zidovudine till 2011. (Source: www. thomsoninnovation.com).

The arabinoside Vidarabine® (ARA-A) and Cytarabine® (ARA-C) (two of the first ever discovered marine drugs) are the compounds extracted from the marine sponge *Tethya crypta.* Vidarabine is patented, and is commonly prescribed for viral infection as ophthalmic ointment, whereas patented Cytarabine® (ARA-C) is a chemotherapy drug. This medicine reduces the growth of cancer cells, and can suppress the immune system. Cytarabine® is sold under the trade name Cytosar-U® by Pharmacia & Upjohn. It was FDA-approved for the treatment of certain leukaemia in 1969, making it the first such approved marine-derived drug for use in cancer chemotherapy.

Azidothymidine (or Zidovudine, AZT) is an antiretroviral drug used for the treatment of HIV/AIDS based on a group of compounds (arabinosides) extracted from the sponge *Tethya crypta* more than 40 years ago. AZT was the first approved treatment for HIV, sold under the names Retrovir. AZT use was a major breakthrough in AIDS therapy in the 1990s that significantly altered the course of the illness. This success story from marine ecosystem represents an annual market of about $50 million. AZT works by inhibiting the action of reverse transcriptase (Mitsuya *et al*., 1985, 1990; Yarchoan *et al*., 1987). Pseudopterosins have been originally isolated from marine soft coral species called a sea whip (*Pseudopterogorgia elisabethae*) and the pseudopterosin bioproducts (Estee Lauder skin care & cosmetics) belong to tricyclic diterpene glycosides.

Ziconotide (trade name Prialt®) is a synthetic form of a compound extracted from the venom of predatory tropical cone snails *(Conus* spp). The conotoxins from the various species of cone snails alone represent more than 100 patents and patent applications. In December 2004, Prialt® was approved by the FDA (approval was granted to Irish pharmaceutical company Elan Corporation to market its product for pain management) as a treatment for severe cases of chronic pain in patients who require intrathecal analgesia and conditions such as cancer and AIDS.

Marine flora and fauna are rich with long-chain polyunsaturated fatty acids (PUFAs), which have vital pharmacological effects on human health. Polyunsaturated fatty acid concentrates from marine sources by chemical and lipase-catalyzed procedure for use as a source for enriching larval feeds and brood stock diets of marine finfish and crustaceans and as nutraceutical supplements. There are several reported works on PUFAs and preparation of PUFA enriched supplements from marine flora and fauna (Chakraborty *et al.,* 2012).

CONCLUSIONS

There is need to develop knowledge in IP and patent protection of technologies developed by the inventor(s) to give due recognition to the ownership of an inventor over his/her innovative idea and safeguarding the rights of an inventor in his invention/ intellectual richness while benefiting the end users and society as a whole. The IP system operates protection and enforcement of intellectual property rights contributing to technological innovation and to the transfer and dissemination of technology, for the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare and encourage scientific research, new technology and industrial progress (ICAR, 2006). The patent protection system must be worked out towards the benefit of all stakeholders-patentee, society, and above all, the nations as far as the products are concerned. The patent rights contribute to technological innovation, and to transfer and to disseminate technology for the mutual advantage of producers and users of technological knowledge. Indian coastline and EEZ is gifted with an enormous resources of valuables hidden into the depths of sea, and can be explored to develop

products with valuable patent protected nutraceutical, pharmaceutical and biomedical products for human health and well being. In doing so, our country can be the leader in this area if we efficiently harness the valuables for marine ecosystem and deliver efficient technologies from the sea, and to avoid other countries to intrude into our rich resources that happened earlier with turmeric, neem, and basmati rice.

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