21 Biodiversity, Biotechnology and Biomimicry

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This write up is an attempt to collate information on biodiversity and biotechnology interactions and inter relationships in general and examine the status of benefit sharing mechanisms in place when marine biodiversity is used in development of products and services. Additionally, the less known `biomimicry' which draws inspiration from nature for development of products and services is also introduced with examples.

United Nations Conference on Environment Development (UNCED) also known as the Rio Summit in 1992 made biodiversity a very common word. This was followed by United Nations Conference on Sustainable Development in 2012 again at Rio. Biodiversity depends on the stability of the biosphere which in turn stabilizes climate, water, soil, air and overall health of the biosphere.

Biodiversity is the resource and strength of developing countries. Evidently, developing countries are located in the tropics and sub-tropics which are richer in biodiversity when compared with temperate countries. Conservation and sustainable use of the country's biodiversity is central to all developmental planning in a country like ours because our mainstay is agriculture and animal husbandry is subsidiary to it.

Aquatic resources mainly from the marine realm also exhibits such diversity that our country has five declared marine biosphere reserves (Gulf of Mannar, Sundarbans, Great Nicobar, North Andaman and Little Rann of Kuchchh) and another five have been listed as potential ones (Malvan, Gulf of Kahmbatt, Chilka, Lakshwadeep, Bhitar Kanika).

The real value of biodiversity is in the information that is encoded in genes and molecules. But biodiversity is attached as a frill to the environment and forest agencies that have no exposure in product development from biodiversity. As mentioned, biodiversity being one of the assets of the developing countries, to extract anything from the biota a value has to be fixed. An earliest extensively discussed example in this regard is the agreement between Merck and INbio of Costa Rica.

At this juncture Koshoos model (1994) of biodiversity and biotechnology interrelationship is noteworthy. The relationship between biodiversity and biotechnology conceptualized by him in 1994 is relevant even after 21 years.

The countries of the world are divided into four as given in the Table below

Biodiversity poor, biotechnology poor	Middle east Asian countries like Saudi Arabia
Biodiversity poor biotechnology rich	Developed countries like USA, Japan, France, Germany and UK
Biodiversity rich, biotechnology poor	South America, Central Asia and Africa
Biodiversity rich, biotechnology rich	None

Flow of biodiversity is from south to north and flow of biotechnology is from north to south. It is evident that biodiversity flow is not equal to biotechnology flow because biotechnological developments are capital intensive which are faster in developed countries when compared to developing countries.

Countries capable of entering the fourth group are India and China and countries in the northern hemisphere can never make it to this group because of lack of biodiversity. They may have *ex situ* conservation methods which cannot compensate the natural selection process taking place over a period of time in countries rich in biodiversity. Thus, Koshoo (1994) describes the `biobanks' in developing nations as 'green morgues' because germplasm is only `preserved' there instead of 'conservation'

At that time itself, Koshoo (1994) said that biodiversity being

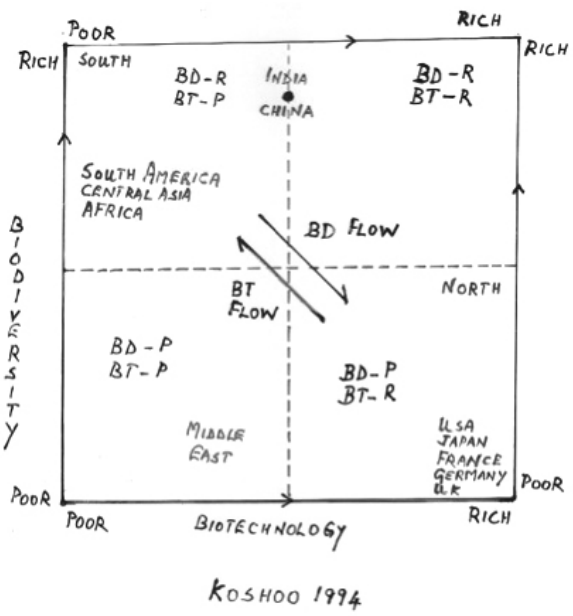

Fig. Koshoo's model of biodiversity and biotechnology inter-relationships

one of the assets of the developing countries, gene and drug rush should not take place in a policy vacuum. Gene rich and technology poor countries should avoid gene imperialism.

It is estimated that 5-30 million species exist and most of the biologists regard 10 million as a conservative estimate. Only 1.4 million of these species has been named by taxonomists. Tropical forests of Central and South America and South East Asia, contain 50 – 90 percent of all species.

Unrealized returns from natural resources lead to market reforms in valuing biodiversity and sustaining them. Till then no economic gain or loss was recorded in a basic accounting network when biological resources were used. The natural resources were considered free.

The first step towards natural resource control was taken at a summit in Managua in Nicaragua in 1992 where the presidents of Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama signed a non-binding resolution that encouraged the passage of laws to regulate and restrict extraction of natural resources from their countries. The goal of the resolution was to prevent foreigners from invading their nation's wild lands and extracting valuable natural resources without compensating the host nation.

The Madagascar periwinkle from which the valuable anticancer drugs vincristine and vinblastine was the case in point. Over the past 20 years, World Resources Institute of Washington estimated that Costa Rica lost of 4 billion dollars as unrealized returns on natural resources.

Thus, harvesting of natural resources unsustainably continued unabated till Convention on Biological Diversity (CBD) opened for signature in Rio in 1992 and entered in force from 1993. After that, as biotechnological tools and techniques lead to the development of living modified organisms (LMO) and international treaty governing movement of such organisms was governed by an international treaty called the Cartagena Protocol on biosafety in 2003.

This was followed by Nagoya Protocol adopted in 2010 which said that access to genetic resources should be fair and equitable with sharing of benefits arising out of their utilization. Biotechnology is knowledge intensive and with good infrastructure can lead to value addition to the products from biodiversity.

Contract	Parties	Type and term	Scope	Benefits to the indigenous communities
InBio-Merck	INBio-National Biodiversity Institute of Costa Rica and Merck & Co. Ltd.	Renewable non-exclusive 2 year	Evaluation of limited of plant, insect and microbial samples from 11 conservation areas	1 Million USD Equipment for processing of samples Scientific training
Peruvian	ICGB, Bristol, Monsanto, Glaxo, Wellcome	Renewable 5 years	Collection of Peruvian medicinal plants	Lumpsum payment
Suriname Maroon tribes	ICGB, Virginia Polytechnic Institute and Sate university; Conservation International; Bedrijf Geneesmiddelen Voorzeining Suriname; Missouri Botanical Gardens and Bristol-Myers Squibb Pharmaceutical Research institute	Renewable 5 years	Collection of botanical and ethnobotanical samples, inventory, extraction of compounds, screening of bioactivity and drug development	Technical capacity building to prepare the plant extracts. Laboratory equipment and the training to use the equipments.
Kerala India	TBGRI and Arya Vaidya Pharmacy	11 years	Plants with the help of Kani community	Lumpsum Royalty Training in local sample preparation and screening Protection of biodiversity

ICBG International Cooperative Biodiversity Group

TBGRI Tropical Botanical Garden and Research Institute is now known as Jawaharlal Nehru Tropical Botanical Garden and Research Institute (JNTBGRI)

The conference of parties in October 2010 in Nagoya's Aichi Prefecture, Japan, adopted a revised and updated strategic plan for biodiversity which is known as Aichi Biodiversity Targets. Under Goal B, Target 6 says "By 2020, all fish, invertebrate stocks and plants are managed and harvested sustainably".

Some of the successful terrestrial bioprospecting contracts are worth looking at because they are the success indicators of the concept of access and benefit sharing arising out of natural resources and its rapid evolution.

Since territorial jurisdictions of marine ecosystems are complex they are regulated with several instruments shown below.

Various legal instruments and organizations related to coastal and marine genetic resources regulation is summarized below.

Marine bioprospecting contracts are different from other biopsopecting contracts because of the involvement of marine traditional knowledge, skilled sample collection and processing. Issues of ownerships beyond national jurisdictions are controversial.

S. No.	Legal instrument/organization	Key features
1	Convention on Biological diversity (CBD)	Govern the different aspects of marine scientific research Share the benefits arising from the utilization of genetic resources in a fair and equitable way
2	Bonn guidelines and Nagoya Protocol	Access to genetic resources Specialized access and benefit sharing regimes consistent with the objectives of CBD Meet the ethical concerns, competing requirements between feed of scientific research Exploitation of a resource and benefit to the source owner and society at large Use of traditional knowledge associated with genetic resources within the scope
3	United Nations Convention on the Law of the Seas (UNCLOS)	Defines the rights and responsibilities of nations with respect to their use of world's oceans Establishing guidelines for businesses, the environment, and the management of marine natural resources
4	International Sea Bed Authority	Provides rules and provisions to regulate prospecting, exploration of marine minerals in the international seabed area
5	Global Ocean Commission	Recommend policies for governance in the high seas Recommend amendment of UNCLOS Enable governance at the regional level
6	European Science Foundation	Envisages to develop principles on the simplification and harmonization of regulations on access and fair and equitable benefit sharing arising from the exploitation of marine genetic resources
7	Valencia Declaration	Governance regime for regulation of activities in the marine areas
8	Europe Micro B3 (3 Bs are Microbial biodiversity, bioinformatics and biotechnology)	Development standards for sampling marine microorganisms

Marine bioprospecting is mainly for drug discovery and development which is a very long process. Ownership, monitoring and regulation are areas where clear processes have not been defined. Staggered payments in benefit sharing have been suggested because of the prolonged time involved in drug discovery.

At present the Biological Diversity Act, 2002 enacted in line with the Convention of Biological Diversity says that foreign entities before undertaking any bioprospecting activity or transferring results of research related to the biodiversity should file applications for registration or grant of intellectual property rights and also need to seek permission from the Authority.

Equitable benefit sharing is also decided by the Authority under Section 21 of the Act. The Act has empowered the State Biodiversity Boards under Section 7 of the Act to approve collection of biological resources. However, there are no specific or distinct provisions in the Biological Diversity Act, 2002 for regulation of marine bioprospecting. Indian contract Act 1872 is also prevailing, under Sections 10 and 11 say that any agreement to be a valid contract need to have clauses on consideration that can be either monetary or non-monetary or both.

A specific example of marine bioprospecting contract is the Fiji contract between the University of South Pacific in Fiji Islands and SmithKline Beecham and later with an Institute, Glasgow Strathclyde Institute of Drug Research. The agreement offered advantages of conservation of biodiversity, upliftment of the community and rights to the community to intervene such as the community was given the right to reclaim the sample after one year. As there were no provisions to protect traditional knowledge the agreement failed to meet the first condition of the CBD which is prior consent of the community for commercialization of outcomes.

Biomimicry

Drawing ideas from Mother Nature to create technologies and products mimicking nature is known as biomimicry. The

term was coined by Janine Benyus in 1997. Her consulting firm Biomimicry 3.8 works with Nike, General Electric (GE) and Boeing to make smarter products and services. Constant researches by multidisciplinary teams have resulted in several new products and technologies out of which a few are described.

UV-reflective material is incorporated in Ornilux glass used in bird safe windows. In high rise building birds get killed by flying into windows with ordinary glass because they cannot see them. Biomicicry solved the problem when they found that spider webs contain UV reflective material which can be seen by birds and not by humans and bugs. Blue prints of cat paws are used in Continental Tyres enabling them to stop fast.

Biomimicry today has reached a stage where it can provide ecosystem services and set ecological performance standards because results of 3.8 billion years of research by nature are used or applied in biomimicry. For e.g., Carbon dioxide dissolved in seawater is used by corals which can be mimicked in the production of cement.

One of the latest examples is the development of a synthetic tree by researchers at Cornell University where water distribution is designed using capillary action without pumps and energy.

Sharkskin swimsuits used by swimmers in 2008 Olympics was made of a design mimicking the sharskins which are made of scales called dermal denticles which have grooves running down their length in alignment with water flow. These grooves disrupt formation of eddies or turbulent swirls of water making water pass by faster; prevent growth of other organisms including bacteria. Even though swimsuits made of such material were banned in sports, such surfaces are used is ship hulls and hospitals.

Termite den design was used by an architect called Mick Pearce to design the Eastgate Centre in Harare, Zimbabwe studying the cooling chimneys and tunnels of termite dens. Supplemental air conditioning was reduced by 90% to heat and cool such a building.

Lotusan is the brand name of a paint developed mimicking the properties of lotus leaf's property to repel water and dust with 4 years of research by a German Company called Ipso. The micro rough surface the paint creates similar to the lotus leaf surface is hydrophobic. The same principle is applied to develop glass containers from which food products like ketchups and sauces can be poured out completely by General Electric.

Velcro fasteners and straps are other widely known example of biomimicry. It was invented by a Swiss Engineer George de Mestral in 1941 after he removed some plant material adhering to his dog fur.

Suggested Reading

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