Corals and Coral Reefs- The most amazing realities of the Marine World

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Introduction

In consonance with the provisions of the Convention on Biological Diversity, marine bio-diversity includes diversity within species, between species and of ecosystems of the marine world. It holds mysterious bacteria, amazing archaea, matchless eukarya and invisible viruses. Despite numerous human efforts only a small fraction of the existing species have been identified so far. Amidst the complex realm of the identified realities, the corals and the coral reefs constitute the group of the most fascinating components.

The Corals

In the modern parlance, corals and coral reefs are salient truths for observation and analysis. Corals are marine animals in class Anthozoa of Phylum Cnidaria. They exist in compact colonies of many identical individual "Polyps". The group includes the important reef builders that inhabit tropical oceans and secrete calcium carbonate to form a hard skeleton. A coral "head" is a colony of myriad genetically identical polyps. Each polyp is a spineless animal typically only a few centimeters in length. A set of tentacles surround a central mouth opening. An exoskeleton is excreted near the base. Over many generations, the colony thus creates a large skeleton that is characteristic of the species. Individual heads grow by asexual reproduction of polyps. Corals also breed sexually by spawning whereby polyps of the same species release gametes simultaneously over a period of one to several nights around a full moon.

The Coral Reefs

Coral reefs are underwater structures made from calcium carbonate secreted by corals. They are colonies of tiny living animals found in marine waters that contain few nutrients. Most coral reefs are built from stony corals, which in turn consist of polyps that cluster in groups. Reefs grow best in warm, shallow, clear, sunny and agitated waters. They form some of the most diverse ecosystems on Earth. They occupy less than 0.1% of the world's ocean surface, yet they provide home for 25% of all marine species. They deliver ecosystem services to tourism, fisheries and shoreline protection. The annual global economic value of coral reefs has been estimated at three hundred and seventy five billion US dollars. However, coral reefs are fragile ecosystems, partly because they are very sensitive to water temperature.

Most coral reefs were formed after the last glacial period when melting ice caused the sea level to rise and flood the continental shelves. This means that most reefs are less than ten thousand years old. As pertains to their formation, the mystery unfolds as a distinct reality in the Darwinian monograph titled 'The structure and distribution of coral reefs'. The theory sets out as a sequence of three stages in atoll formation. It starts with a fringing reef forming around an extinct volcano island as the island and ocean floor subsides. As the subsidence continues, the fringing reef becomes a barrier reef and ultimately an atoll reef. Darwin had predicted that under each lagoon would be a bed rock base, the remains of the original volcano. A fringing reef can take ten thousand years to form and an atoll can take up to thirty million years to assume its shape. The two main variables that determine the geomorphology or shape of coral reefs are the nature of the underlying substrate on which they rest and the history of the change in sea level relative to that substrate.

The biodiversty of the Coral Reefs

Reefs are home to a large variety of organisms, including fish, sea birds, sponges, cnidarians, worms, crustaceans, mollusks, echinoderms, sea quirts, sea turtles and sea snakes. Aside from humans, mammals are rare on coral reefs, with visiting cetaceans such as dolphins being the main exception. A few of these varied species feed directly on corals while others graze on algae on the reef. Reef biomass is positively related to species diversity. Over four thousand species of fish inhabit coral reefs. The mutually controversial theories supporting this diversity are "LOTTERY", "COMPETITION" and "PREDATION". Healthy reefs can produce up to thirty five tons of fish per square kilometer each year, but damaged reefs produce much less. They have fish like LABRIDAE that influence the coral feed either on small animals living near the coral,or fish like POMACENTRIDAE [DAMSELFISHES] that feed on seaweed/algae,or elsefish like SCARIDAE [PARROTFISH] that feed on the on the coral itself. They also carry fish such as TRACHINOTUS [POMPANUS], GROUPERS, and HORSE MACKERELS thatcruise the boundaries of the reef or nearby seagrass meadows. Fish that swim in coral reefs can be as colourful as the reef. POMACANTHIDAE [ANGELFISH], DAMSELFISH, CLINIDAE [BLENNIES], BUTTERFLYFISH and PARROTFISH are salient examples of the same. A number of invertebrates, collectively called CRYPTOFAUNA, inhabit the coral substrate itself, either boring into the skeletons or living in pre-existing voids and crevices. Reefs are chronically at risk of algal encroachment. Overfishing and excess nutrient supply from onshore can enable algae to outcompete and kill the coral. The algae population consists of turf algae, coralline algae and macroalgae. Coral reef systems provide important habitats for several seabird species, some of which are endangered. The MIDWAY ATOLL in HAWAII supports nearly three million seabirds, including two-thirds of the global population of LAYSAN ALBATROSS and one-third of the global population of BLACK-FOOTED ALBATROSS. Altogether seventeen species of seabirds live on MIDWAY. The SHORT-TAILED ALBATROSS is the rarest, with fewer than 2,200 surviving after excessive feather hunting in the late nineteenth century. Some land-based reptiles such as MONITOR LIZARDS, MARINE CROCODILES and semiaquatic snakes intermittently associate with reef.

The Coral Reefs of India

India has a coast line of nearly eight thousand kilometers but the reef formation is restricted to four major centres, *viz.* Gulf of Mannar, Lakshadweep, Gulf of Kutchh and Andaman and Nicobar Islands. The list published and presented by Pillai in 1996 recognised 199 species of corals from Indian waters of 71 genera of which 55 were hermatypes and the rest ahermatypes. Wells as early as 1954 had stated that approximately 700 species of corals occur in the whole of Indo-Pacific. If one takes John Wells 1954 estimate of 700 species along with additional information provided by recent workers the total will be about 775 species. This indicates that thirty five percent of the Indopacific corals occcur in Indian waters. The waters around the reefs are reported to be nutritionally poor. The biodiversity of reef associated organisms in Indian reefs is still to be critically assessed. The dominant flora comprises Gracilaria, Gelidiella, Hypnea, Sarconema, Hydrodathrus, Cauleropa, Sargassum and Turbinaria. The major sea grasses include *Thalassia hemprichi, Halodule univervis,*

Cymodocea serrulata, Syringodium species and *Enhalus acroroides*. These are found on the reef flats and lagoon shoals. The reef associated fauna constitute, sponges both boring and free living, other coelenterates, such as hydroides, alcyonarians,gorgonids and sea anemones.Many areas on Indo-Pacific reefs are rich in hydroid corals such as millepore, Heliopora and Distichopora and black or thorny corals.It is reported that Indian waters harbour about 3000 species of crustaceans, 5000 species of molluscs, 760 species of echinoderms and about 200 species of bryozoans. Reef fishes are rich in number and species. Lakshadweep is reported to have about 600 species of reef fishes and Andaman and Nicobar Islands also have nearly six hundred species.Reef fishes are both resident and migrant. The reptilian fauna is essentially constituted by turtles.

Life of the Corals

Most corals obtain the major portion of their energy and nutrients from photosynthetic unicellular algae called zooxanthellae that live within the coral's tissue. Such corals require sunlight and grow in clear, shallow water, typically at depth shallower than sixty meters. Corals can catch small fish and plankton, using stinging cells on their tentacles. They can be major contributors to the physical structure of the coral reefs that develop in tropical and subtropical waters, such as the enormous Great Barrier Reef off the coast of Queensland, Australia. Other corals do not have associated algae and can live in much deeper water, with the cold-water genus Lophelia surviving as deep as three thousand meters. The Darwin Mounds located north-west of Cape Wrath, Scotland is a distinct example of the same.

Types of Corals

Corals divide in to two subclasses, depending on the number of tentacles or lines of symmetry, and a series of orders corresponding to their exoskeleton, nematocyst type and mitochondrial analysis. Hermatypic corals in the subclass Scleractinia are stony corals that built reefs. They mostly obtain at least part of their energy requirements from zooxanthellae, symbiotic photosynthetic microalgae. They secrete calcium carbonate to form a hard skeleton. Those having six or fewer lines of symmetry in their body structure are called hexacorallia or Zoantharia. This group include reef-building corals, sea anemones and zonathids. At least fifty species of uniquely structured hard coral exist in the Caribbean alone. Among them Brain corals, Acropora corals, Staghorn corals, Pillar corals and Leptopsommia (rock) corals are the well-known types. Brain corals grow up to 1.8 meters in width. Acropora corals and Staghorn corals grow fast and large and are important reef-builders. Pillar corals form pillars which can grow to three meters in height. Leptopsommia or rock coral, appear almost everywhere in the Caribbean. Contrary to Hermatypic corals Ahermatypic corals have no zooxanthellae. They sport eight tentacles and are also called octocorallia. Ahermatypic corals,such as sea whips, sea feathers and sea pens, are also known as soft corals. Unlike stony corals, they are flexible, undulating in the current and are often perforated, with a lacy appearance. Their skeletons are proteinaceous, rather than calcareous. Soft corals are somewhat less plentiful than stony corals. Corals can be perforate or imperforate. Perforate corals have porous skeletons, which allow their polyps to connect with each other through the skeleton. Imperforate corals have hard solid skeletons.

The Myth and the Reality

Corals were believed to be plants till the seventeenth century. In the eighteenth century the eminent biologist William Herschel used a microscope to establish that corals had the characteristic thin cell membranes of an animal. The polyps interconnect by a complex and well-developed system of gastrovascular canals, allowing significant sharing of nutrients and symbiotes. In soft corals these range in size from 50-500 micrometres in diameter and allow transport of both metabolites and cellular components.

The Fascinating Polyps

Polyps feed on a variety of small organisms from microscopic plankton to small fish. The polyp's tentacles immobilize or kill prey using their nematocysts. The tentacles then contract to bring the prey into the stomach. Once the prey is digested, the stomach

reopens, allowing the elimination of waste products and the beginning of the next hunting cycle. Many corals as Aiptasia (a sea anemone) form a symbiotic relationship with a class of algae Zooxanthellae. Typically, each polyp harbours one species of algae. Via photo-synthesis, these provide energy for the coral and aid in calcification. The algae benefit from a safe place to live and consume the polyp's carbon dioxide and nitrogenous waste. Due to the strain the algae can put on the polyp, stress on the coral often drives them to eject the algae. Mass ejections are known as coral bleaching, because the algae contribute to coral's brown coloration. However, other colours are due to host coral pigments, such as green fluorescent proteins. Ejection increases the polyp's chance of surviving short-term stress. They can regain algae, possibly of a different species at a later time. If the stressful conditions persist, the polyp eventually dies.

Reprodution in the Corals

Corals can be both gonochoristic (unisexual) and hermaphroditic,each of which can reproduce sexually and asexually. Reproduction also allows coral to settle in new areas. Corals predominantly reproduce sexually. About twenty percent of stony corals form single sex colonies, while the rest are hermaphroditic. About seventy five percent of all hermatypic corals "BROADCAST SPAWN" by releasing gametes into the water to spread offspring. The gametes fuse during fertilization to form a microscopic larva called a planula, typically pink and elliptical in shape. A typical coral colony forms several thousand larvae per year to overcome the odds against formation of a new colony. Synchronous spawning is very typical on the coral reef. Often, even when multiple species are present,all corals spawn on the same night. They rely on environmental cues, varying from species to species,to determine the proper time to release gametes into the water. The cues involve temperature change, lunar cycle, day length and possibly chemical signaling. Synchronous spawning may form hybrids and is perhaps involved in coral speciation. The spawning event can be visually dramatic, clouding the usually clear water with gametes. Within a coral head , the genetically identical polyps reproduce asexually, either via budding or by longitudinal or transversal division. Budding involves splitting a smaller polyp from an adult. As the new polyp grows, it forms its body parts.

Asexual reproduction has several benefits for these sessile colonial organisms. Cloning allows high reproduction rates, supporting rapid habitat exploitation. Modular growth allows biomass to increase without a corresponding decrease in surface to volume ratio. Modular growth delays senescence, by allowing the clone-type to survive the loss of one or more modules. New modules can replace dead modules, reducing clone-type mortality and preserving the colony's territory. It spreads the clone-type to distant locations thus reducing clone-type mortality from localised threats.

The Evolutionary History

Historicity of the evolution of corals is quite interesting. It is believed that they first appeared in the Cambrian period, some five hundred and forty two million years ago. But fossils pertaining to this period are extremely rare. Fossils of the Ordovician period(100 million years later) when Rugose and Tabulate corals became common are comparatively easier to trace. Rugose corals became dominant by the middle of the Siliurian period and became extinct early in the Triassic period. They existed in solitary and colonial forms and were composed of calcite. Tabulate corals occur in limestones and calcareous shales of the Ordovician and Silurian periods, and often form low cushions or branching masses alongside rugose corals. Their numbers began to decline during the middle of the Silurian period, and they became extinct at the end of the Permian period, two hundred and fifty years ago. The skeletons of tabulate corals are composed of calcite. The scleractinian corals filled the niche vacated by the extinct rugose and tabulate species. Their fossils may be found in small numbers in rocks from the Triassic period, and became common in the Jurassic and later periods. Their skeletons are composed of a form of calcium carbonate known as aragonite. They are geologically younger than the tabulate and rugose corals but their aragonitic skeleton is less readily preserved and their fossil record is less complete. Fossils of fellow reef-dwellers algae, sponges and the remains of many echinoids, brachiopods, bivalves, gastropods and trilobites appear along with coral fossils.

The Universal Stress

Coral reefs are under severe stress around the world. Coral mining has disturbed the harmony inherent within their essence. Agricultural and urban runoff has distorted their beauty and phenomenal charm. Pollution both organic and inorganic, is adulterating their purity. Overfishing, blast fishing, disease and the digging of canals and access into islands and bays are the other salient localized threats to coral ecosystems. Corals are affected by various fungal and bacterial diseases. In Gulf of Mannar and Lakshadweep three types of disease have been recorded in the recent past, *viz*. white band diseases, black band diseases and bacterial/fungal infection. Silt and sedimentation cause asphyxia on polyps and corals die.Pests and predators also cause death of corals. Among the predators the echinoderm *Acanthaster planci* is the most disastrous. The major broader threats are sea temperature rise, sea level rise and pH changes from ocean acidification. They are associated with greenhouse gas emissions. In the year 1998, sixteen percent of the world's reefs died as a result of increased water temperature. General estimates vindicate that about ten percent of the world's coral reefs are dead and about sixty percent of the world's reefs are at risk due to human -related activities. The threat to reef health is immensely strong in southeast Asia where eighty percent of reefs are endadangered. The latest assessments conducted by experts of ecology indicate that if adequate measures and remedies are not introduced immediately, over fifty percent of the world's coral reefs may be destroyed by the next decade. Research scholars have deduced that water temperature changes of more than 1-2 degrees Celsius or salinity changes can kill coral. The Submarine Springs found along the coast of MEXICO'S YUCATAN PENINSULA are a distinct illustration of the same. Latest surveys have discovered multiple species of live corals that appeared to tolerate the acidity.

Protection and Conservation

As time has marched much ahead, human knowledge and wisdom has realised that corals and coral reefs constitute and carry the essence of marine bio-diversity. Marine Protected Areas, Biosphere Reserves, Marine Parks, national monuments world heritage status, fishery management and habitat protection can potect reefs from anthropogenic damage. The immediate global necessity to prohibit removal of coral from reefs has been realised and accepted at some major international conferences. Several nations have already enforced the much needed prohibition. Coastal residents are being made aware about reef protection and ecology. At many significant spots local action such as habitat restoration and herbivore protection are being implemented to minimise the local damage. To eliminate destruction of corals in their indigenous regions, projects have been started to grow corals in non-tropical countries. But the longer term threats of acidification, temprature change and sea-level rise still remain a challenge.

The Indian Scenario

India had the privelege to host the First International Symposium on Corals under the auspices of the Marine Biological Association of India in January 1969 in which Reef Scientists from eleven countries participated. Realising the need for the protection of this valuable marine resource the Government of India has taken steps to conserve and manage the reefs from early 1986. A national committee on corals and mangroves was constituted by the Ministry of Environment and Forests and expert scientists, administrative staff and state government officers were incorporated. Thrust areas were identified and Marine Parks and Biosphere Reserves were estabished. The Gulf of Kutchh Marine Park in Gujarat, Mahatma Gandhi Marine Park in Wandoor South Andamans, Gulf of Mannar Biosphere and Jhansi Rani Marine Park in Andaman and Nicobar were established. Nodal institutions in these were identified to carry out research and monitoring. The Government of India promulgated various legislations covering coral reef conservation and in the year 1991 issued a Coastal Regulation Zone notification. Several amendments were made in subsequent years. The collection of corals either dead or live was prohibited except for scientific research by identified institutions. All scleractinians and gorgonids were brought under Wild Life Protection Act. 1972 from July 2001. The Ministry of Environment and Forests has initiated action for the establishment of a National Institute of Coral

Reef Research at Port Blair. Zoological Survey of India, National Institute of Oceanography and Central Marine Fisheries Reseach Institute are the major national centres of current reef research. The Suganthi Devadason Marine Research at Tuticorin(TAMIL NADU) is a private organization that is actively engaged in reef research in Gulf of Mannar.

The Salient Benefits

Corals and coral reefs bestow several salient benefits upon the flow of human life. They protect the coast from wave action. Local economies near major coral reefs benefit from an abundance of fish and other marine creatures as a food source. Pearl oysters are normally found in the reef environs. In medicine, chemical compounds from corals are used for the treatment of cancer, aids, pain and other uses. Coral skeletons, Isididae are also used for bone grafting in humans. They provide raw material for lime, cement and calcium carbonate since the skeleton of corals contains 98.5% pure calcium carbonate. They are building blocks for houses in atolls and coastal areas. The non-extractive use of coral reefs is chiefly tourism. Tourists are mainly attracted to the reefs for skin and SCUBA DIVING and SPORT FISHING. But all these activities have to be appropriately controlled and regulated because their excessive intensity can damage corals. Live corals are highly sought after for aquaria. The various colours of corals makes them appealing for necklaces and other jewellery. Intensely red coral is prized as a gemstone. But red coral has become extremely rare because of overharvesting. Coral reefs on land provide lime for use as building blocks.

The Novel Indications

In the past decade corals have indicated the feasibility of some novel modes in climatic research. The annual growth bands in deep sea bamboo corals (Isididae) and others are most likely to become the ocean's first organisms to display the effects of ocean acidification. They produce growth rings similar to those of trees and can provide a view of changes in the condition in the deep sea over time. They allow geologists to frame and construct year-by-year chronologies.

In the Offing

The latest terminology that has emerged in the context of corals and coral reefs is Coral Aquaculture. It is also known as Coral Farming or Coral Gardening. In accordance with its definitive provisions, it is the art and science of cultivation of corals for commercial purposes or coral reef restoration. Under it, coral seeds are grown in nurseries and then replanted on the reef. Coral is cultivated by coral farmers who live locally to the reefs and farm for reef conservation or for income. It is also farmed by scientists for research or by businessmen for the supply of the live and ornamental coral trade or else by private aquarium hobbyists.

The Concluding Essence

Corals and coral reefs correlate with the charms inherent in the core of the marine world. They imbibe within the purity of their existence, colourful imaginations and amazing realities. They hold utmost fascinations for intellectual tourists and adventurous explorers. They collectively constitute an infinite scope for the cravings and aspirations of numerous scientists and research scholars. Most experts of Ecology feel that their present is fragile while their future is at peril. Their protection and conservation can be ensured only through incessant proliferation of knowledge pertaining to them and their sustained utilisation. We need to be cautious and aware of the profound biological diversity they represent and recreate.