Diversity and ecology of coral reef fishes

13

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Coral reefs are mainly found in tropical regions of the world and cover approximately 284300 sq.km or 0.1% of the world oceans. However, they harbor about 25% of the marine fish fauna.

The Indo-Pacific harbours about 92% of the reefs. The major reef areas of the world are as below:

The Golden Triangle region in Southeast Asia: The reefs surrounding Thailand, Malaysia, Indonesia, Philippines, Papua, New Guinea, Sumatra, Java, Andaman and Nicobar harbor 32% of world coral reefs and the greatest diversity of marine life. They are considered as the crucible of evolution and diversification of coral reef fishes.

The Great Barrier Reef: Located off the east coast of Australia in the Coral Sea, it is the world's most extensive coral reef system, encompassing over 2,900 individual reefs and 900 islands, stretching for an impressive 2,500 kilometers and covering an area of 216236 sq km.

Red Sea Coral Reef: This 1900 km long reef is located between Africa and Asia and borders the countries of Israel, Egypt and Djibouti.

Chagos-Laccadive Ridge: Consisting a chain of atolls from Seychelles to Lakshadweep, Maldives, Chagos and Diego Garcia this region in the Western Indian Ocean harbours

The Greater Carribbean Reefs: These include several reef formations from ***Florida Reef Tract*** to the ***Great Mayan Reef*** or the Mesoamerican Barrier Reef System which stretches from the coast of Mexico to Belize and Guatemala upto the Honduras (1126 km reef; the largest in the Western Hemisphere) and the ***Andros Barrier reef*** along with several fringing reefs of the Caribbean islands in the Coral Sea.

***The New Caledonian Barrier Reef*:** Situated around the Grand Terres island in the South Pacific this 1500 km reef is the third largest in the world after the Great Barrier Reef and the Great Mayan Reef.

An estimated 6000-8000 species of fishes inhabit the coral reefs of the world. The fish fauna of the Indo-Pacific reefs is significantly different from that of the western tropical Atlantic or the Greater Carribbean.

Indian diversity

A total of about 2810 species of fishes inhabit the coral reef regions of India though not all are strictly coral reef fishes. Considering only those fishes closely associated with coral reefs alone, the currently known diversity in Andaman and Nicobar is about 166 species, Lakshadweep islands 116, Gulf of Mannar 84 and Gulf of Kutch 42 species. Besides there are around 40-50 species of coral reef fishes reported from fringing reefs along the coastline and coastal islands of India.

Body shape and coloration

The great diversity in colour, shape, size and stricture of the coral reef fishes is a function of and adaptation to their niches in the coral reefs. A large number of coral reef fishes have flat, laterally compressed bodies which is an adaptation that gives them distinct advantage in **maneuverability.** Long, strong fins and such a body shape allow them to negotiate crevices and close formations of their coral habitat efficiently. Another important aspect is the **feeding habit** of the coral reef fishes which particularly defines the design of the head, mouth, and teeth. **Camouflage** or **behavioural adaptations** for predator avoidance also reflect on the size, shape and colouration of many coral reef fishes, so also peculiar armature. Coral reefs are crowded environs with the density of fishes being particularly high. Distinctive colouration also facilitates easy **identification** of members of the same species as well as **mate location and selection**. Some species are strikingly coloured to advertise their unpalatability or **toxicity** as visible warning signals.

Common groups coral reef fish fauna in India

Coral reef fishes comprise about 30 families. The most numerous of these on the coral reefs are chaetodontids, pomacentrids, labrids, gobioids, acanthurids and scarids.

Chaetodontids (Butterflyfishes): These typical coral reef fishes have a global diversity of 12 genera and 136 species. The Indian diversity records 31 species. *Chaetodon* is the most common genus, with *Heniochus and*

*Forcipiger*beingothers. They are distributed in the Atlantic, Indian and Pacific Oceans with a greater number of species in the Indo-west Pacific. They are bony fishes belonging to the order Acanthuriformes. They are mostly coloured white, bright yellow, and/or orange with black bands or markings and have flattened pancake-like bodies. They have extended, protrusible, tubular mouths with brush-like teeth. Dorsal fins are continuous Scales are present on dorsal and anal fins. Caudal fins are rounded to emarginate with 15 rays. They are found in heterosexual pairs and feed on coral polyps, small invertebrates, filamentous algae and plankton.

Pomacentrids (Damselfish): Globally this family consists of 30 genera and 419 species. They are found in all tropical seas, mainly the

Indo-Pacific region. The Indian diversity consists of 47 species. *Abudefduf, Chromis, Chrysiptera, Amphiprion, Dascyllus, Pomacentrus and Stegastes*arethecommon genera. These deep-bodied bony fishes of the order Ovalentaria/misc have small moths and incomplete or interrupted lateral lines. Anal fins usually have two spines. Males brood benthic eggs. Their larval life is short. They also display aggressive territorial behavior. Most of them are ominovores or planktivores.

Labrids (Wrasses): The global diversity of labrids consists of 70 genera and 562 species. They are found in the Atlantic, Indian and Pacific Oceans. The Indian diversity consists of 55 species. *Halichoeres* and *Thalassoma* are the most speciose genera. These bony fishes belong to the order Eupercaria/misc. Scales are cycloid.

Several labrids change colour between their juvenile and mature phases. They are protogynous hermaphrodites where the initial phase consists of males and females and the terminal phase consists of often brilliantly coloured large dominant males, which females can also transform into. One male dominates several females. Labrids exhibit territorial displays, vigorously defending their areas of the reef. Most have a burrowing habit. They can be either benthic carnivores or planktivores.

Acanthurids (Surgeonfishes): Globally there are 06 genera 84 species inhabiting the Atlantic, Indian and Pacific Oceans. The Indian diversity

consists of 11 species of which *Acanthurus, Ctenochaetus, Naso, Paracanthus*and*Zebrosoma*are the most common genera. Acanthurids belong to the order Acanthuriformes and have deeply compressed bodies, an unnotched dorsal fin and long preorbital bone. The eyes are placed high on the head. They have characteristic sharp caudal spines on the caudal peduncle that are flashed erect when the fish feels threatened and are capable of inflicting scalpel-like injuries giving the family its common name as surgeonfishes. Acanthurids are predominantly

herbivores; some may be planktivores or detrivores or a combination of all these.

Scarids (Parrotfishes): 12 genera and 136 species inhabit the Atlantic, Indian and Pacific

Oceans. The Indian diversity comprises of 05 genera and 17 species. *Scarus* is the most common genus. The fused teeth are akin to parrot-beaks giving them the common name of parrotfishes. The body is covered with large cycloid scales mostly in bright green, blue or pink hues. Scarids are herbivores that scrape algae off coral rocks including dead coral rocks. Like labrids, their initial phase is males or females and terminal phase consists of large males. A single male dominates over several females

Pomacanthids (Angelfishes): The global

diversity of this family encompasses 08 genera and 91 species. They are found in the tropical Atlantic and Indo-west Pacific. The Indian diversity accounts for 09 species. *Apolmicthys, Centropyge*and *Pomacanthus* are common genera in this family belonging to the order Acanthuriformes. With their laterally compressed bodies, they live closely associated with the coral formations. Dorsal and anal fins usually have extensions. A strong spine is present on the angle of the preopercle and there are three spines in the anal fin. They have striking colour patterns with juveniles often having marked colour differentiation from adults. They are mostly planktivores and/or

herbivores and some feed on sessile invertebrates.

Lutjanids (Snappers): 17 genera and 113 species of this family belonging to the order

Eupercaria/misc are represented globally in the Atlantic, Indian and Pacific Oceans. The Indian diversity consists of 38 species. *Lutjanus, Aprion, Paracaesio, Pinjalo*and*Etilis*arecommon genera. The dorsal fin is continuous or slightly notched. They are typically schooling fish. They feed on crustaceans and fishes; some are planktivorous. Snappers are food fishes.

Muraenids (Moray eels): The global diversity of the family Muraeinidae belonging to the order Anguilliformes consists of 16 genera and 211 species distributed in the Atlantic, Indian and Pacific Oceans. The Indian diversity currently consists of 32 species. *Echidna, Gymnothorax*and U*roptrygius*arethe most common genera. These fishes have a large mouth with canine teeth. The dorsal fin origin is well before the gill opening; anal fin is confluent with the caudal fin. Pectoral and pelvic fins are absent. They are scaleless. They lie in wait in crevices and holes within the coral formations and feed on cephalopods, small fishes and crustaceans.

Caesoinids (Fusiliers): The family Caesionidae belonging to the order Eupercaria/misc consists of 04 genera and 23 species. They are mainly distributed in the Indo-west Pacific. The Indian diversity consists of 12 species with all four genera of present. They have oblong to fusiform bodies, small mouths, large eyes, and deeply forked tail which are all adaptations for a planktivorous diet. Dorsal and anal fins have scales. Scale rows on the body run horizontally. These active schooling fish feed on zooplankton.

Siganids (Rabbitfishes): 01 genera 29 species of this family belonging to the order Acanthuriformes is found in the Indo-Pacific and eastern Mediterranean. The Indian diversity

consists of 12 species. The spines are poisonous. Juveniles form large schools. They are predominantly herbiovorous, feeding on algae and seagrass

Epinephilids (Groupers): The 16 genera and 170 species of this family belonging to Perciformes/Serranoidei are found in the Atlantic, Indian and Pacific Oceans. The Indian diversity consists of 06 genera and 42 species. *Epinephelus, Athaloperca, Cephalopholis, Variola, Plectropomus are the* genera common in Indian waters. They are protogynous hermaphrodites. All fins are rounded. Carnivorous.

Balistids (Triggerfishes): The 12 genera and 42 species of this family belonging to the order Tetraodontiformes are found in the Atlantic, Indian and Pacific Oceans. The Indian diversity has 11 species. *Balistoides, Balistapes, Odonus*, *Sufflamen* are the common genera. Skin tough and leathery with large scales forming distinguishable units. First of the three dorsal spines can be locked erect by the second. Mouth is small and terminal with eight teeth in in outer row of both jaws. Females aggressively guard eggs. Triggerfishes may be diurnal, solitary carnivores feeding on shelled molluscs or sea urchins or planktivores.

Mullids (Goatfishes): These fishes belonging to the order have 06 genera and 100 species distributed in the Atlantic, Indian and Pacific Oceans. The Indian diversity has 03 genera *Upeneus, Parupenaeus*and *Mulloidichthys* and 16 species. The dorsal fins are located far apart. Two chemosensory chin barbels are used to probe food. They feed on benthic invertebrates and small fishes.

Carangids (Jacks, pompanos, trevallys): A diverse family belonging to the order Carangiformes with 39 genera and 148 species widely distributed in the Atlantic, Indian and Pacific Oceans. The Indian diversity consists of . The first two spines of the three anal fins are separate and placed separately from the third in the abdomen. The caidal fin is deeply forked with slender caudal peduncles, designed for fast swimming. In some species lateral line scales modified into scutes and also in some there are

finlets along the posterior margins of the body. Small cycloid scales render the bodies silvery. Carangids are carnivorous or planktivorous. They are major food fishes.

Scorpionfishes: The order Perciformes/Scorpeinoidei consisting of 20 families has some of the most venomous fishes as its members. They are found in all seas. The family **Scorpaenidae** has 25 genera and 233 species distributed in all tropical and temperate seas and **Synanceiidae (stonefishes)** 9 genera and 40 species and are especially found in lying camouflaged as rocks in coral reefs. Fishes of Scorpanidae have a single dorsal fin and ridges and spines. Dorsal fin is single and deeply notched. Dorasl, anal and pelvic fins have

venom glands. Synanceiidae have a body covered with warts. The sharp needle-like dorsal spines have neurotoxic venom glands at their base.

Diodontids (Porcupinefishes): This family belonging to the order Tetraodontiformes has 7 genera and 18 species distributed in the Atlantic, Indian and Pacific Oceans. The Indian diversity consists of 04 species belonging to *Diodon* and *Cyclithis* genera. There are two fused teeth parrot like in jaw. Body greatly inflatable with ingestion of water. Body is covered with spines which are erected at the time of inflation. Adults found near reefs and the juveniles are pelagic. They are usually found in heterosexual pairs. They feed on hard shelled invertebrates.

Sygnathids (Seahorses): 59 genera 304 species.

Atlantic, Indian and Pacific Oceans. Indian diversity 10 species. *H. trimaculatus, H. kuda* and *H. kellogi*are the common species. Body with tubular snout, bony rings on body and prehensile caudal peduncle.Dorsal, anal, and pectoral fins may be lacking in adults of some species. No pelvic fins are present. Branchiostegal rays are 1-3 and gill openings very small. Basisphenoid and supracleithrum are lacking. Swimming ability is very reduced. Male broods eggs in pelvic pouch and give birth to live young. They feed on minute invertebrates sucked into mouth. They are found in calm shallow regions.

Gobiidae (Gobies): The Gobiidae, or gobies, are the largest family of fish, with over 2,000 described species in more than 200 genera. They are typically small, bottom-dwelling fish with big heads and tapered bodies. They can be found in marine, brackish, and freshwater environments all over the world. One of their most characteristic features is their fused pelvic fins, which form a suction cup that allows them to cling to rocks or other surfaces in strong currents. Gobies are also known for their wide variety of colors and patterns, which can help them camouflage themselves in their environment. Most gobies are carnivores and feed on small invertebrates, such as worms, crustaceans, and insects. Some species are also known to clean parasites off other fish.

Blenniidae (Combtooth Blennies): The Bleniidae family, are another interesting group of

fish closely related to gobies. Their namesake feature is their specialized teeth. Unlike gobies, blennies have numerous, closely packed teeth that resemble a comb. This toothy apparatus is perfect for scraping algae and other encrusting organisms off rocks and corals. Blennies typically have elongated, slender bodies that allow them to navigate through crevices and tight spaces in rocky reefs, their preferred habitat. Their large eyes provide excellent vision in these often dimly lit environments. Blennies can have a variety of fin shapes and sizes. Some sport long dorsal fins, while others have flamboyant, fan-like pectoral fins used for display or stability. Blennies are almost exclusively marine fish, dwelling primarily in rocky tide pools and coral reefs. They cling to rocks and coral using a combination of their body shape, fins, and sometimes even suction from their mouths. Many blennies are masters of camouflage, able to rapidly change their color and blend in with their surroundings to avoid predators. Blennies can exhibit a range of social behaviors. Some species are territorial and quite aggressive, while others live in small groups or pairs. Certain blennies even form cleaning symbioses with other fish, similar to some gobies.

Elasmobranchs: Around 31 species of elasmobranchs (sharks and guitarfish (21 species) and rays and skates (10 species)) are commonly found in the Indian coral reefs. Some sharks such as *Trienodonobesus* (whitetip reef shark), *Carcharhinus melanopterus* (blacktip reef shark) and *Chilloscyllium indicum* (bamboo shark) are frequently encountered on the reefs.

The unique fish assemblages of the coral reefs form a vibrant and ecologically inter-related

community with structural and behavioural adaptations and occupying every available niche.

Pomacentrids and gobioids are an important prey base in the reef food chain. The acanthurids and scarids along with siganids are vital to keeping algal growth on the reefs in check, preventing them from taking over coral formations, through herbivory. Other reef organisms including the corals are dependent on the fishes for continued ecological sustenance as much as the fishes depend upon them for varied life processes.

Animal interactions on coral reefs have developed as a result of **co-evolution.** Fish specieshave entered in **symbiotic relationships** with other fishes or reef inhabitants that may be classified into three major categories: **mutualism, commensalism** and **parasitism** as part of **Evolutionary Stable Strategies.** Removal of ectoparasites from larger fish by cleaner wrasses, gobies or blennies is a form of**facultatitive mutualism.** Guarding of the burrows of housekeeper shrimps by shrimp gobies falls under **defensive mutualism.** The mutually beneficial adaptations of sea anemonies and clown fish come under the category of **facultative defensive mutualism.** Theassociation between remora and larger elasmobranchs is termed as **commensalism** by some but **parasitism** by others. Sabre-toothed blennies mimic cleaner wrasses for feeding advantages in a case of **aggressive mimicry**.

Fishes also show diverse colour patterns, social behaviour or morphological adaptations as part of **predator avoiding strategies.** Ocelli or stripes on the body to create **predator confusion,** bright warning colours announcing toxicity, **schooling** or **shoaling behaviour,** spines on the body, ability to inflate the body, sheltering among coral formations and **camouflage** are some such adaptations seen among coral reef fishes.

Coral reef fishes belong to the **trophic guilds** of **herbivores, omnivores, carnivores, planktivores, detritivores and corallivores** with many showing a mixed pattern of feeding as well.

Anthropogenic effects on coral reef fishes and their ecosystem include habitat destruction and trophy hunting as a fallout of tourism, disruption of community structure through commercial fishing, pollution as a result of human population pressure and land runoffs, a marked increase in extreme events, ocean acidification and coral bleaching as a result od climate change and pollution, habitat destruction and introduction of marine invasives through shipping. Extreme or prolonged disruptions in the ecosystem results in **phase shifts** in the coral reef ecosystem.

The conservation tools that can be implemented for preserving coral reefs and fishes include the creation of marine protected areas, promulgating legislation for individual species, restricted tourism and trade, planned development based on the **Precautionary Principle** in coral reef areas, community participation on conservation and crating public awareness.

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