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A Review: On Threat to Biodiversity of Marine Ecosystem

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Abstract

India has been endowed with a vast variety of marine ecosystem and bio-diversity, which sustains a large number of species and the coastal populace, is dependent on the resources from this marine ecosystem. The effects of ocean pollution causes harm to living resources, disruption of marine activities, degradation of seawater quality, and also damage to the maritime industry. As excess debris & melting of permafrost in the ocean slowly degrades over many years and resulting in low level of oxygen in the ocean, which lead to the death of oceanic animals such as penguins, dolphins, whales, and sharks etc. The coastal areas of India, with a coast line of over 7500 km harbour a variety of specialized marine ecosystems like mangroves, coral reefs, salt lakes and mud flats which mainly from the habitat for endangered marine species and commercially important marine flora and fauna. A number of chemicals, elements, heavy metals poisoning, petro- chemical and other industrial waste in the coastal areas have resulted in significant discharge of industrial effluents into the coastal water bodies.

An area of 6700 sq. km under mangroves is under pressure due to fishing, land use changes in land-sea interface and pollution of water. Ecological impacts of invasion are complex & dependent on the interaction between the invaders and the native community. Non-indigenous species can rapidly monopolize energy resources, act as voracious predators, overcome endemic species, or transmit parasites and diseases that can be passed to humans through the food chain of ecosystem or direct exposure. This study also focuses on the marine species invasions have been ranked the most serious potential source of stress to marine ecosystems. Only ethical & societal values contribute to define these environmental and social- economic impacts as deleterious or beneficial to our bio-diversity.

Keywords: - Marine biodiversity, invasive species, coastal pollution, coral reefs & *C. riisei*

Introduction

Marine ecosystems are subject to a variety of anthropogenic threats including disease, pollution, climate change, habitat alteration, overexploitation, and invasive species. Natural threats, such as physical destruction by storms and temperature and salinity changes from natural cycles, also occur. Coastal and marine environments can be tremendously biodiverse. Human activities, pollution, land use and development along coastlines, however, can put stress on these environments that may limit the rates of growth and reproduction of coastal flora and fauna. This can in turn reduce overall biodiversity. Marine biodiversity allows nature in our ocean to be productive, resilient and adaptable to environmental changes. Marine biodiversity can prevent one species' extinction from causing wider negative impacts on a marine ecosystem. The effects of ocean pollution include harm to living resources, disruption of marine activities, degradation of seawater quality, and damage to the maritime industry.

Marine communities are biological networks in which the success of species is linked directly or indirectly through various biological interactions (e.g., predator-prey relationships, competition, facilitation, and

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mutualism) to the performance of other species in the community. The aggregate effect of these interactions constitutes ecosystem function (e.g., nutrient cycling, primary and secondary productivity), through which ocean and coastal ecosystems provide the wealth of free natural benefits that society depends upon, such as fisheries and aquaculture production, water purification, shoreline protection, and recreation. However, growing human pressures, including climate change, are having profound and diverse consequences for marine ecosystems. Rising atmospheric carbon dioxide (CO_2) is one of the most critical problems because its effects are globally pervasive and irreversible on ecological timescales (Natl. Res. Counc. 2011). The primary direct consequences are increasing ocean temperatures (Bindoff *et al*, 2007) and acidity (Doney *et al*, 2012). This ranking has been produced by the IPBES, (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), which published in 2019 a highly comprehensive report on the question: the Global assessment report on biodiversity and ecosystem services.

The direct drivers of change in the ocean with the largest global impact are:

1. Direct exploitation of organisms (fishing)
2. Ecosystem loss
3. Climate Change
4. Pollution
5. Invasive species

Those five threats are the result of multiple underlying causes, which are underpinned by cultural and societal values and behaviors'. Each of these different threats has its specificities that require targeted and precise actions such as changes in consumption, changes in practices on land and at sea, and new policies implemented etc.

Coastal and Marine Pollution

The coastal areas of India, with a coast line of over 7500 km harbour a variety of specialized marine ecosystems like mangroves, coral reefs, salt lakes and mud flats which mainly from the habitat for endangered marine species and commercially important marine flora and fauna.

These coastal areas are exposed to environmental stress for several reasons which include the following: -

(1) Land based sources of pollution resulting from ship breaking, transport, tourism and industrial activities including oil spills, the discharge of sewage and industrial effluents and a heavy load of sediments.

(2) Prawn culture activities and aquaculture farms along the coastal land in the East coast.

(3) Unplanned and improper development activities without appropriate coastal zone management plans.

(4) Shipping and sea based activities including oil spills, sludge disposal and mining coastal areas.

(5) Offshore petroleum and gas exploration.

Heavy metals such as lead and cadmium were found in Thane Creek of Mumbai Coast. The Cochin region of Kerala coast has been found affected by petroleum hydrocarbons.

Coral reefs the colonies of tiny living creatures that are found in oceans. They regarded as the tropical rainforest of sea and it occupy just 0.1% of the ocean's surface but are home to 25% of Marine Species. They are usually found in Shallow areas at a depth less than 150 feet. However, some coral reefs extend even deeper, upto about 450 feet. Coral reefs, which are very productive marine ecosystem, are adversely affected by their indiscriminate exploitation for production of lime, recreational use and ornamental trade. An area of 6700 sq. km under mangroves is under pressure due to fishing, land use changes in land-sea interface and pollution of water.

Snowflake corals (*Carijos rissei*) or branched pipe coral is a species coral in the family Clavulariidae. According to earlier published report, coral species diversity was recorded a total of 208 species, 60 genera under 15 families (Raghuraman *et al*, 2013). As result of the study enhanced, the species record from 208 to

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478 species, comes under 89 genera that belong to 19 families from the four major reefs of India such as Gulf of Kuchh (49 species, 27 genera), Lakshadweep (104 species, 37 genera), Gulf of Mannar and Palk Bay (117 species, 40 genera), Andaman and Nicobar Islands (424 species, 86 genera). According to investigation by Zoological survey of India revealed that all major coral reef zones in India, except Lakshadweep are invaded by *C. rissei* (Venkataraman *et al*, 2016) its likely impacts on the indigenous biota and policies for bioinvasion of the Indian context. There is an urgent need of study on the occurrence and impacts of invasive species on the coral reef environment as this ecosystem harbors 25% of total marine biodiversity & contribute 10% fishery production. A snowflake coral was first discovered in Hawaii in 1972 at Pearl Harbor, and has since spread to all the main Hawaiian Islands. It is believed to have been transported to Hawaii on the bottom of a ship (hull fouling) or as larvae in a ship's ballast water. As a highly successful invasive species, *C. riisei* threatens Hawaii's Biodiversity. Under favourable conditions, it out competes other organisms & saturates the available space. This species can actually settle & grow on other stationery organisms like corals & shellfish; no significant predators have been identified (Coordinating Group on Alien pest species, 2005).

Ecological impacts of invasion are complex & dependent on the interaction between the invader and the native community. Non-indigenous species can rapidly monopolize energy resources, act as voracious predators, overcome endemic species, or transmit parasites and diseases that can be passed to humans through the food chain or direct exposure (Carlton, 1993). According to Coles *et al* (2002) marine species invasions have been ranked the most serious potential sources of stress to marine ecosystems. Since the 1970s, substantial increase in instances of exotic species invasion has occurred in harbors, ports, and other coastal ecosystems in temperate and tropical regions around the world [Coles & Eldredge, (2002) and Ruiz *et al* (1997). Although increased movement of larval organisms in Cargo ship's ballast water is usually attributed to be the principle cause of increase in bio-invasions (Carlton (1985), Chu *et al* (1997) & Wonham *et al* (2000)]. According to the report of Godwin & Eldredge (2001), many other factors e.g release of imported exotic aquarium or aquaculture organisms, vessel hull fouling may also have made important contributions to proliferation of non- indigenous species. It is reported to grow well in turbid waters i.e. rich in organic matter and zooplankton on which it feeds (Kahng *et al*, 2008).

Earlier studies on the dispersal of this non-indigenous species inferred that ballast water used for ships and ship hull fouling are major means for its invasion (Smith *et al*, 1999; Carlton, 1985 and Chu *et al*, (1997). It is estimated that about 2-3 billion tons of ballast water is carried around the world each year. Although shipping is the backbone of our global economy & it facilitates transportation of 90% of the commodities, a single bulk Cargo ship of 200,000 tons can carry upto 60,000 tons of ballast water. Translocation of organisms through ships is considered to be one of the important issues that are threatening the naturally evolved biodiversity, and consequences of such invasions are being realized increasingly in the recent years. The International Maritime Organization (IMO) of the UN adopted the International Convention for the control & Management of ships Ballast water sediments in 2004. As per the guidelines of IMO, whenever possible all ships using ballast water exchange should conduct water exchange at least 200 nautical miles from the nearest land i.e. outer area of Exclusive Economic Zone (EEZ) of the country & in water at least 200 meters in depth. Rising awareness of marine invasion impacts has led to protocols that intensively explore habitats of possible introduction viz. ports and drilling platforms. The object of such protocols is to detect the rare, so as to provide incursion management a practical control option (Hewitt & Martin, 2001).

Biological invasions are recognized as a worldwide threat to native biodiversity, ecosystem functioning, economies and human health. The nature of bioinvasion impacts can vary greatly to include elimination or

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reduction of native species populations, alterations to community structure, changes to habitats, rearrangement of food webs and altered ecosystem functioning (Narscius *et al*, 2012). According to recent reports of reporters invasion of *C. risei* (snowflake coral) is an alarming signal of Indian coral reef environment; so immediate measure has to be taken to control this invasion of reefs to prevent its further spreading. And also intensive study is required to assess the invasion of snowflakes coral in non-coral reef zone. Furthermore, Marine bio-invasions could be prevented at greater extent, if to follow & adopted the ballast water exchange guidelines of IMO. Mohamed Nisin *et al* (2023) reported that species invasions in aquatic ecosystems are also occurred due to anthropogenic activities and climate change It will accelerate the introduction, establishment & spread of invasive species to new habitats. He utilized ensemble species distribution modelling method to investigate shifts in the invasive potential of snowflake coral in current and future climatic settings on a global scale.

Climate change and human activities are the main forces that significantly affect biodiversity and habitats worldwide (Bejagam & Sharma, 2022). These forces can lead to detrimental environmental impacts such as species extinction (Maheswaran *et al*, 2021); disrupted ecological interactions (Evans and Moustakas, 2018) and introduction of alien species (Craig, 2023 & Mano *et al*, 2023). Due to increased connectivity between previously isolated regions, a process facilitated by anthropogenic and climatic factors (Hulme, 2009).Immigration of non- native species to new habitats has become occured more frequently. Once they established, some of these non-native species compete with native species for space & resources, altering local biodiversity and habitats of particular regions and hence called as Invasive Species (IS) or Invasive Alien Species (IAS). Their management & removal are very complex tasks (Pysek and Richardson, 2020). The Combined effect of invasive species and climate change creates a significant risk for global biodiversity (Mainka and Howard, 2010). Invasive species can significantly impact ecology, economy, society and human health (Gallardo *et al*, 2016). Managing invasive species is particularly challenging in marine ecosystems, which are highly interconnected and vulnerable. Coral reefs, one of the most diverse marine ecosystems, face threats from invasive species, causing biodiversity loss, conservation hindrances and accelerated reef degradation (Goldberg & Wilkinson, 2004). Researcher suggested that climate change may push marine organisms towards higher latitudes or deeper depths (Doney *et al*, 2012).

Sanchez and Ballesteros (2014) were recognized & concluded in their research that *C. riisei* competes directly with native octocorals & highly compromising their fitness. Local extinction of several octocorals, numerous Muricea sea Candelabra and a few Pacifigorgia seafans, has occurred in many rocky reefs. They observed aggressive overgrowth of this species in Tropical Eastern Pacific, Colombia. It deserves more attention & regular monitoring programs. It is very difficult to manage an invasive species that spreads clonally by fragmentation, where manual eradication could lead to further spread. Scientists results also reinforce the idea that *C. riisei* acts as an ecosystem engineer in coastal reef environments, creating new habitats & increasing species richness at a local scale, even though it is an alien species (Padua *et al*, 2021). The limited information is available on marine bioinvasion in tropical counties especially in India, there is an urgent need of study on the occurrence and impacts of non-indigenous species that are focused on coral reef environment as this ecosystem harbor 25% of total marine biodiversity and contribute 10% fishery production. Scientists summarized the occurrence of *C.riisei* in coral reefs, impacts & policies for bio-invasion in Indian context (Raghunthan *et al*, 2013). According to the study of Vimercati *et al* (2020), the ethical & societal values contribute to define these environmental & socio-economic impacts as deleterious or beneficial. They provide a summary of the frameworks assessing beneficial impacts of alien species across the invasion science literature. They advocate that the development of transparent and evidence-based frameworks assessing

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positive and beneficial impacts might advance our scientific understanding of impact dynamics and better information management and prioritization decisions.

Marine Biodiversity Conservation

Every organism plays a pivotal part in maintaining the intricate harmony of this marine biodiversity. Through their roles in nourishment and protection, their involvement in nutrient flow, and their influence on climate stability, seas are the vital essence of the planet. Coral reefs, one of the most diverse marine ecosystems, are under significant threat. The Global Coral Reef Monitoring Network (GCRMN) estimates that approximately 50% of the world's coral reefs have already been lost or severely degraded. Each entity plays a crucial role in protecting underwater habitat. Listed below are the measures everyone can adopt to contribute to the preservation of ecological diversity.

1. Sustainable Fishing Practices
2. Reducing Plastic Usage
3. Participating in Coastal Cleanups
4. Data Collection and Analysis
5. Conservation of Coral Reefs
6. Supporting Sustainable Seafood
7. Early Warning Systems (EWS)
8. Predictive Modeling & Smart Port Solutions
9. Environmental Monitoring
10. Government Policies
11. Corporate Responsibility
12. International Collaboration

Preserving marine species requires companies to prioritize conservation-minded development goals throughout their operations and supply chains, ensuring minimal negative consequences on fragile habitats. By adopting these systems like pollution reduction and investing in eco-friendly technologies, they can mitigate marine environmental harm. Furthermore, social responsibility initiatives, such as backing projects and advocating for policy change, play a vital role in safeguarding aquatic medium. Through these actions, companies not only minimize their ecological footprint but also contribute positively to the preservation of seas for present and future generations. By working together, marine biodiversity will be protected and secured for a prosperous future for both nature and society.

Conclusion

Sustainable changes need to be external as much as internal. "External" actions such as putting in place marine protected areas, slowing down coastal development, reducing fishing effort, and restoring actively marine ecosystems are crucial. So is our way of considering and watching the world that surrounds us, in order to find a more harmonious and balanced way to live on this planet.

1. Species invasion poses a global threat; that impacts local biodiversity, ecosystem function, economy and public health (Narscius *et al*, 2012).
2. Despite this, research on the distribution of invasive organisms in marine ecosystems, particularly those as delicate as coral reefs is also minimal (Mirianda *et al*, 2018).
3. Though the occurrence of this non- indigenous species invasion in Indian seas is relatively minor component of the total biota, it is essential to prevent further spreading on the coral reef ecosystem by adopting effective managerial plans & policies.
5. Biosecurity protocols should be socialized with dive centers, fishers and local boat owners as well as with Cargo
companies and the Ecuadorian Navy (Calle *et al*, 2021).
6. To restrict the immigration pathways of invasive species and to eradicate immediately after identification of species is one of the most effective strategies to prevent & mitigate the spread of invasive species.

7. We also advise that this development should be achieved by recognizing the underlying ethical and societal values of the frameworks and their intrinsic limitations. The evaluation of positive and beneficial impacts through impact assessment frameworks should not be seen as an attempt to outweigh or to discount deleterious impacts of alien taxa but rather as an opportunity to provide additional information for scientists, managers and policymakers (Raghunthan *et al*, 2013).
8. A Marine Protected Area (MPA) is a designated zone managed to safeguard resources, biosphere functions, and cultural heritage over the long term. They play a critical role in preserving cultural heritage and promoting sustainable management.
9. In 2020, the Marine Stewardship Council (MSC's) contribution to sustainable fishing and progress towards biodiversity goals was acknowledged by the UN. The MSC program incentivizes sustainable fishing practices that ensure target fish stocks are healthy, fisheries are well managed and the impacts on marine biodiversity are actively minimized.

References:-

1. Bejagam Vijaykumar, Sharma Ashutosh (2022). Impact of climatic changes and anthropogenic activities on ecosystem net primary productivity in India during 2001-2019. Ecological Informatics; Vol 70.
2. Bindoff NL, Willebrand J, Artale V, Cazenave A, Gregory J (2007). Observations: oceanic climate change and sea level. Climate Change: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change by S Solomon, D Qin, M Manning, Z Chen, M Marquis; Cambridge: Cambridge Univ. Press: 385–432.
3. Calle Maritza Cardenas, Julian Perez-Correa, Cecilia Uzca-Sornoza, Gregorio Bigatt, Nardy Diez, Mariana Lozadas, Jorge Coronel, lleana Herreraa, Gladys Torres, Telmo De la Cuadra, Freddy Espinoza", James Mair and Inti Keith (2021). Invasion and current distribution of the octocoral *Carijoa riisei* (Duchassaing & Michelotti, 1860) in the Ecuadorian coast (Eastern Tropical Pacific). Aquatic Invasions; 16(1): 62-76.
4. Carlton JT (1993). Biological invasions and biodiversity in the sea: The ecological and human impacts of nonindigenous marine and estuarine organisms. Nonindigenous Estuarine and Marine Organism (NEMO), Proceedings of the Conference and Workshop, Washington: 5-11.
5. Carlton, JT (1985). Transoceanic and interoceanic dispersal of coastal marine organisms: The biology of ballast water. Oceanogr. Mar. Annu. Rev; 23: 313-371.
6. Chu KH, Tam PF, Fung CH & Chen QC (1997). A biological survey of ballast water in container ships entering Hong Kong, Hydrobiologia; 352: 201- 206.
7. Coles S & Eldredge L (2002). Nonindigenous species introductions on coral reefs: a need for information. Pac. Sci; 56: 191-209.
8. Colin PL & Arneson L, Tropical Marine Ivertebrates. (Coral Reef Press, Beverly Hills): 296.
9. Craig RK (2023). Marine Biodiversity: Challenges, Trends, and a New Treaty.
10. Doney SC *et al* (2012). Climate change impacts on marine ecosystems; Annu. Rev. Mar. Sci; Vol 4:11-37.
11. Evans R, Moustak Aristides (2018). Plasticity in foraging behaviour as a possible response to climate change; Ecological Informatics; 47:61- 66.
12. Gallardo Belinda, Miguel Clavero, Marta I Sanchez, Montserrat Vila (2016). Global ecological impacts of invasive species in aquatic ecosystems; Global Change Biology; 22(1):151-63.
13. Godwin LS & Eldredge LG (200l). South Oahu marine invasions shipping study (SOMISS). Bishop Mus. Tech. Rep; 20.

14. Goldberg, Jeremy, and Wilkinson, Clive (2004). Global threats to coral reefs: coral bleaching, global climate change, disease, predator plagues and invasive species; Status of Coral Reefs of the World: 67-92.
15. Hewitt CL & Martin RB (2001). Revised protocols for Bascline Port surveys for Introduced Marine Species: survey design, sampling protocols and specimens handling. Hobart, Australia: CSIRO Marine Research; 46.
16. Hulme M (2009). Why we disagree about climate change: Understanding controversy, inaction and opportunity. Cambridge University Press.
17. Kahng SE, Yehuda B, Wagner D & Rothe N (2008). Sexual reproduction in the invasive Octocoral *Carijoa riisei* in Wawaii. Bull. Mar. Sci; 82: 1-17.
18. Maheswaran Gopinathan, Sharma Lalit Kumar, Mondal Himadri Sekhar, Mukherjee Tanoy (2021). White-bellied heron a species on the verge of extinction: Ensemble model reveals loss of habitats and resultant prolonged isolation driving the species to extinction, Economy Informatics; 64.
19. Mainka Susan A, Howard Geoffrey W (2010).Climate change and invasive species: double jeopardy, Integrative Zoology; 5(2): 102-111.
20. Mano GB, Aline Lopes, Maria Teresa F Piedade (2023).Will climate change favor exotic grasses over native ecosystem engineer species in the Amazon Basin? Ecol. Inform, Vol 75.
21. Miranda RJ, Jose de Anchieta, Nunes CC, Eduardo Mariano-Neto, James Z Sippo, Francisco Barros (2018). Do invasive corals alter coral reef processes? An empirical approach evaluating reef fish trophic interactions. Mar. Environ. Res; Vol 138: 19-17.
22. Mohamed Nisin KMN, Sreenath KR, Miriam Paul Sreenath (2023). Change in habitat suitability of the invasive Snowflake coral (*Carijoa riisei*) during climate change: An ensemble modelling approach. Ecological Informatics; Vol 76.
23. Narscius A, Ergej Olenin, Anastasija Zaiko, Dan Minchin (2012). Biological invasion impact assessment system: from idea to implementation; Ecological Informatics; Volume 7(1): 46-51.
24. Natl. Res. Counc (2011). Climate Stabilization Targets: Emissions, Concentrations and Impacts over Decades to Millennia. Washington, DC: Natl. Res. Counc.
25. Padua Stella Maris Feitosa De, Lucia Botter Carvalho Monica, Paula Braga Gomes, Camilla Silva de Oliveira, Jose Carlos Pacheco dos Santos, Carlos Daniel Perez (2021). The alien octocoral *Carijoa riisei* is a biogenic substrate multiplier in artificial Brazilian shipwrecks; Aquat Ecol. 8; 56(1):183-200.
26. Pysek Petr and Richardson David M *et al* (2020). Scientists' warning on invasive alien species. Biol. Rev.; 95: 1511–1534.
27. Raghunathan C, Venkataraman Krishnamoorthy, Satyanarayana Ch, Rajan Rajkumar (2013). An Invasion of Snowflake Coral *Carijoa riisei* (Duchassaing and Michelotti 1860) in Indian Seas: Threats to Coral Reef Ecosystem; Indian Journal of Geo-Marine Sciences 45(11): 381-393.
28. Ruiz GM, Carlton JT, Grosholz ED & Hines AH (1997). Global invasion of marine and estuarine habitats by nonindigenous species: Mechanism, extent, and consequences, Am Zool; 37: 621-632.
29. Sanchez Juan Armando & Ballesteros Diana (2014). The invasive snowflake coral (*Carijoa riisei*) in the Tropical Eastern Pacific, Colombia.
30. Smith LD, Wonham MJ, McCann LD, Ruin GM, Hines AH & Carlton JT (1999). Invasion pressure to a ballast flooded estuary and an assessment of inoculants survival. Biol. Invasion; 1: 67-87.
31. Thomas WJ (1979). Aspects of the micro-community associated with Telesto riisei, an introduced alcyonarian species (M.S. thesis, University of Hawaii at Manoa, Honolulu).

32. Venkataraman K, Raghunathan C, Satyanarayana Ch & Rajkumar R (2016). Invasion of Snowflake Coral, *Carijoa risei* (Duchassaing and Michelotti, 1860), in Indian Seas: Threats to Coral Reef Ecosystem. Indian Joumal of Geo Marine Sciences; 45(11): 1403-1408.
33. Vimercati Giovanni, Kumschick Sabrina, Probert Anna F, Volery Lara, Bacher Sven (2020). The importance of assessing positive and beneficial impacts of alien species; NeoBlota, 62: 525-545.
34. Wonham MJ, Carlton JT, Ruiz GM & Smith LD (2000). Fish and ships: Relating dispersal frequency to success in biological invasions, Mar. Biol. (Berl,); 136: 1111-1121.
35. www.msc.org.
36. www.ocean52.com; Impact report 2023: Threat to Biodiversity (March 2024).
37. www.sinay.ai; SINAY, Maritime Data Solution.
38. www.unep.org