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Marine molluscs conservation-where we are and how to go ahead?

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Abstract
Rapid global decline in molluscs generates concerns towards their conservation. The lack of information on the threat status of molluscs and their extinctions hampers the implementation of conservation strategies. Therefore, I succinctly propose a new agenda for the conservation of molluscs that are requiring attention: Highlighting knowledge shortfalls, monitoring by the application of novel technologies, interdisciplinary projects, sea ranching and education and outreach. Use of integrated management approaches for molluscan conservation are suggested.

Keywords: Deep sea, threats, management, protected species, aquaculture

Introduction

Despite the being second largest phylum, the molluscan species are declining globally because of various reasons (Bouchet *et al.* 2016) [1]. Molluscan species are in vane due to habitat loss by the increasing anthropogenic pressures, abiotic factors, climate change and their capture for fishery (D'Souza *et al.* 2022) [4]. Perhaps, the existing knowledge gaps in terms of taxonomy, distribution, hampers the application and effectiveness of conservation measures. The framework of this review is to know the current status of molluscs in marine ecosystem and to know the progress in conservation initiatives so as to develop future prospects in this regard.

Conservation of molluscs would maintain species balance in nature, especially in the ecologically sensitive, fragile ecosystems such as intertidal, coral reef, mangroves and deep sea. Conservation needs to be driven by control of molluscan overfishing, aquatic pollution and implementation of site-specific conservation action plans. Raising the scientific and societal interest in these organisms though education and outreach eventually reduce some of the knowledge shortfalls on these charismatic species.

Our knowledge so far

Molluscan research has been focussed on developing species catalogues at different continents (Sierwald *et al.* 2018 [11]; D'Souza and Shenoy 2023) [2] and molluscs associated with the marine hotspots (Kazanidis *et al.* 2021) [6]. Through the integrated efforts, the existing Brazilian molluscs have been updated in Taxonomic Catalogue of the Brazilian Fauna (Machado *et al.*2023) [8]. The marine molluscs are included in IUCN Red list; however, status is unknown. In Indonesia, international agreements, CITES, CBD (Law No 5, Regulations 8,20), deals with protection and conservation of molluscs. Till date, 12 of mollusc species are legally protected in Indonesia and 7 are placed in Appendix II of CITES. Unprotected species are traded, included under quotas to prevent their overexploitation (Nijman, 2019) [9]. Species distribution models showed the distribution of Nautilus in the Indo-West Pacific, evaluating the conservation gaps wherein the 70% of the habitats remain unprotected (Lai *et al.*2025) [7]. European countries, India, Indonesia are involved in illegal shell trade irrespective of the legislations.

At Indonesia, listing chambered nautilus CITES (Appendix II) did not curb the illegal shell trade (Nijman *et al.*2024) [10]. Many molluscs such as King helmet *Cassis tuberosa*, Hebrew volute *Voluta ebraea*, and the Goliath conch *Eustrombus goliath*, cowries *Monetaria moneta*, endemic Brazilian chank *Turbinella laevigata* are harvested from the Atlantic Ocean and sold in Brazil. Implementing regulations for mollusc capture such as assigning quotas, minimum capture size, harvesting at specific periods by using non-destructive techniques are recommended for conservation (Dias *et al.* 2011) [5].

In India, Coastal Regulation Zone (CRZ) guidelines prohibit the industrial developments in the vicinity of the sea particularly in the ecologically fragile beaches. Section 37 of the Biodiversity Act recognizes and declares Biodiversity Heritage Sites for the protection of marine biota. Marine Biosphere Reserves are constructed at Gulf of Mannar, Sunderbans, Great Nicobar Islands. About 24 species of molluscs are considered as Scheduled species under the Wildlife (Protection) Act by the Indian Government. Schedule I describes 9 species and Schedule IV details on the 15 species of protected molluscs. CITES lists the giant clams of Family Tridacnidae in Appendix II. Gulf of Mannar Marine Biosphere Trust (GoMBRT) organises community programmes to encourage conservation of protected molluscs. Wildlife Crime Control Bureau (WCCB) aims at monitoring the coastal fauna and illegal collection of shells. Government of India has established a biosphere reserve; 9 National Parks and 96 wildlife sanctuaries are built to have effective conservation (D'Souza 2025) [3]. Despite these, the initiatives towards conservation from other countries are not known.

Future prospects

Due to the lack of data concerning the IUCN status of molluscs, in South-Eastern countries species extinctions and population declines continue unnoticed. Because of the cost-effectiveness of sampling, cooperation among researchers, funding through collaborations is crucial in solving financial problems, helping in periodical monitoring the molluscs and their habitats. To increase the investments, private sector partnerships should be sought. Besides taxonomic

understanding, unravelling the phylogeny by adopting myriad of molecular tools, data storage of conservation dependent species in Gene Banks are the best ways for conservation. Construction of Marine Protected Areas and buffer zones at regional levels would pave the way for restoration. Improved legislations regulating fishery practices such as ban on night trawling. Sea ranching or molluscan aquaculture and juvenile release into the marine habitats has been recommended to restore their population (D'Souza and Shenoy 2023 [2]; Souza 2024) [12]. Molluscan aquaculture and food production yielding high economic potential are beneficial as molluscs are the food sources with a low ecological footprint and to for their sustainable conservation.

Knowledge on the breeding biology and life cycle of protected marine species would help in preparation of conservation plans. Adopting molluscan collection methods that do not harm the species and their habitats are beneficial for their protection. Species discoveries and recovery programmes for the threatened molluscs are required (D'Souza *et al*. 2022) [4]. Rapid climate change and human induced pressures result in the extinction of these species. Sea ranching or molluscan aquaculture and their release into the marine habitats can be done to restore their population. Raising public awareness about the alien species and their biological control may help to protect the native molluscs. Studies emphasizing molluscan responses to climate change would be more effective towards species protection.

Intertidal molluscs need to be conserved by the demarcation of buffer zones near the seashore allowing the population growth, creating artificial habitats on the rocky boulders, proper planning for the management of industrial wastes, demarcating the disturbed littoral zones as ecologically sensitive areas prohibiting the developments.

Conclusion

Understanding the breeding biology and life cycle of protected marine species, Species discoveries and recovery programmes, safer species collection methods, monitoring species extinctions and changing climate, aquaculture, combating the spread of invasive species, involvement of researchers in interdisciplinary projects, genetic data preservation are necessary for effective conservation. Integrated conservation approaches by using these methods and application of drones (remote sensing of marine habitats) are dine of the need. These statergies may help to protect the overlooked molluscs prioritising conservation.

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