Lamellidens marginalis: An evaluation of its potential as a bioindicator species of metal pollution

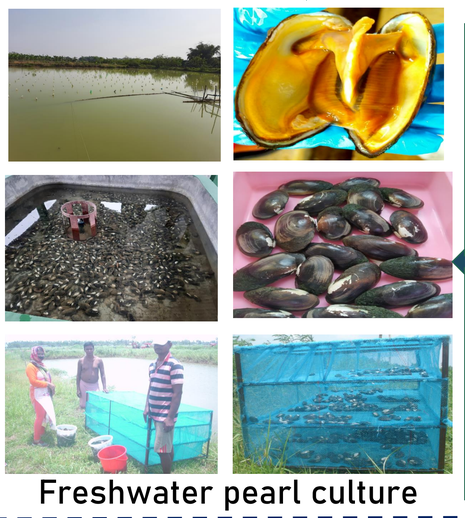
Snigdha Baliarsingh[1], Bharat Bhusan Patnaik[1,3,4*] and Shailesh Saurabh[2]

[1]PG Department of Biosciences and Biotechnology, Fakir Mohan University, Balasore-756089, Odisha, India
[2]ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar–751002, India
[3]Department of Biology, College of Natural Sciences, Soonchunhyang University, Asan, Chungchungnam-do 31538, South Korea
[4]Korea Native Animal Resources Utilization Convergence Research Institute (KNAR), Soonchunhyang University, Asan, Chungchungnam-do 31538, South Korea
* drbharatbhusan4@gmail.com

ABSTRACT

Freshwater mussels are essential to the ecology and are frequently used as environmental indicators. The mussels have been used as biological monitoring species to understand the metal loads in the riverine ecosystems. On the other hand, these mollusks are one of the most vulnerable groups for wild extinction due to anthropogenic influences and over-exploitation in search of food and pearl. *Lamellidens marginalis* is one of India's most popular freshwater mussel for making pearls. Moreover, the species has been targeted as a biofilter for restoring heavy metals contaminated aquatic environments. Although the potential of the natural resource for filtering the metal pollution load has not been equated to the conventional wastewater treatment applications, evidence suggests reclamation of contaminated habitats. In fact, the co-culture of freshwater fishes with *L. marginalis* has been found conducive for the sustainability of farming, enhancing fish survivability and productivity and supporting an integrated multi-trophic freshwater aquaculture systemic model. Novel biofilter designs using shell dust of the mollusk can be developed to optimize wastewater treatment. Further, evidence indicates the use of *L. marginalis* to establish a local environmental monitoring network and assess trends of metal contamination in freshwater ecosystems. This review broadly summarizes the research outcomes about the utilization of *L. marginalis* as a bioindicator species of metal pollution. It also suggests reducing heavy metal contamination and safeguarding both humans and aquatic ecology. The natural biofilter mechanism greatly enhances the ecosystem dynamics by safeguarding the wild habitat conditions. This is why conservation planning could protect such cost-effective natural resources.

L. marginalis : for ecology and entrepreneurship

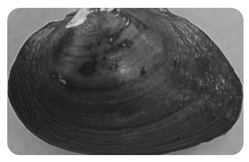


Freshwater pearl culture

Why it is important to preserve Indian freshwater mussels?

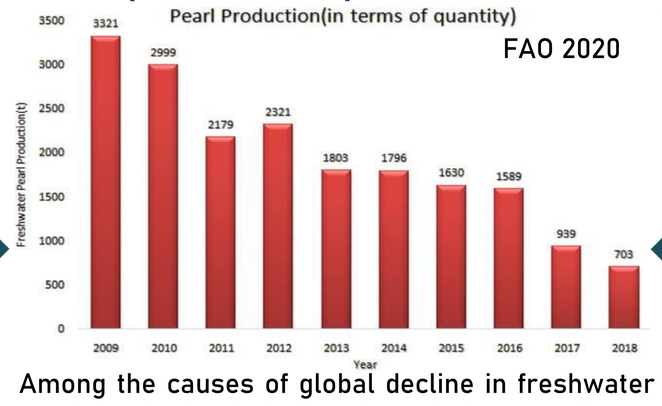
L. marginalis
Pond mussel

L. corrianus
Paddy field mussel



P. corrugata
Riverine mussel

These are 'Engineers of Ecosystem'. Their ecological service is of immense significance. A study notes, "The freshwater mussels of India are poorly understood to that of other countries. Therefore, the study on the distribution of freshwater mussels and their conservation, in India, will aid in sustaining natural ecosystems".



Among the causes of global decline in freshwater pearl production is habitat degradation and climate change that have made the species vulnerable in the wild

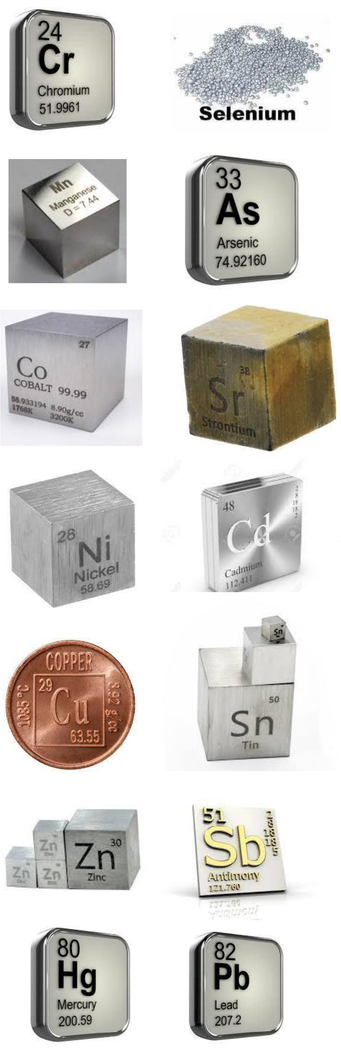
L. marginalis
Pond mussel

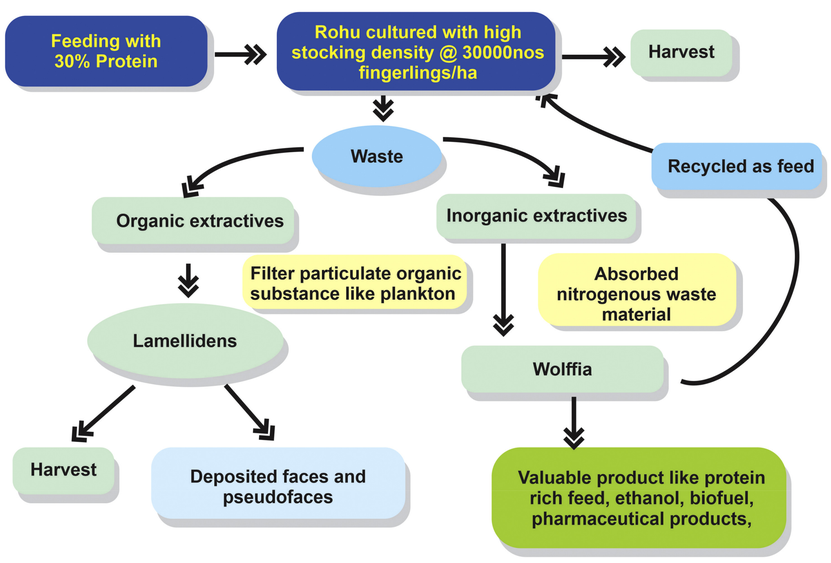
IUCN Red List
Least Concern

No-specific threats identified, but over-harvesting for human consumption and use of pesticides for fishing could be possible threats. Deforestation and sedimentation caused by clearance for agriculture, forestry and hydropower development, and pollution are other significant effects

L. marginalis : Heavy metal remediation and as a biofilter

L. marginalis : Bioindicators of metal pollution and biomarkers for monitoring contaminated freshwater ecosystems

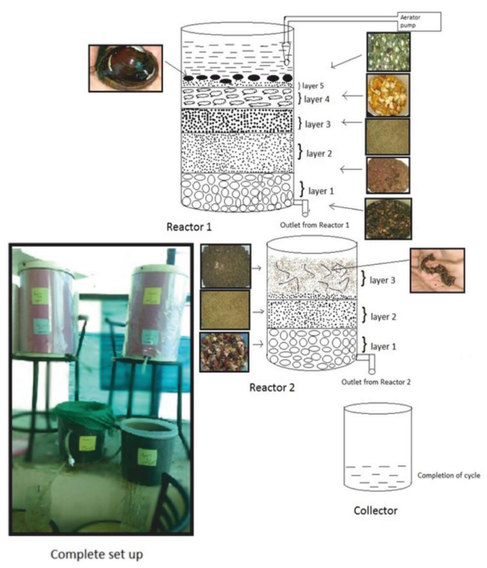




Integrated multi-trophic freshwater aquaculture system

Culture of *Labeo rohita* in an outdoor tank culture system, includes *Wolffia globosa* as inorganic extractives and *L. marginalis* as organic extractives. Addition of extractive biosamples for water remediation in freshwater aquaculture systems generates more returns and is environmentally-friendly. The immunity and survivability of fish showed improvement.

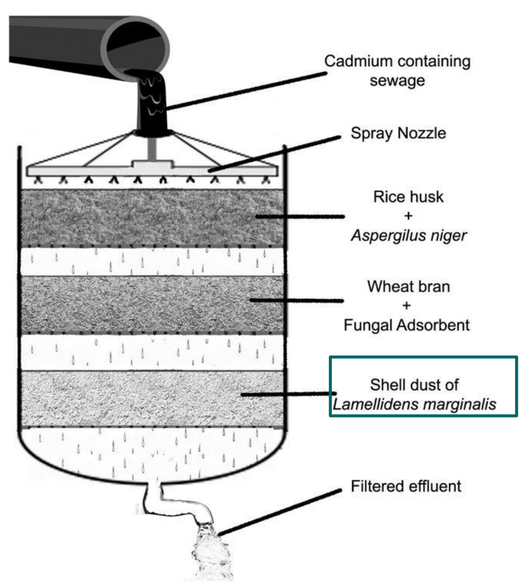
Nath et al. 2021, Aquaculture
https://doi.org/10.1016/j.aquaculture.2020.736207



Invertebrate Biofilter for wastewater treatment

Two reactors were designed. In the top layer (layer 5) of reactor 1, *L. marginalis* were placed. This design also included the earthworm *Eisenia fetida* in the top layer of reactor 2 (layer 3). The integrated biofilter was efficient in the removal of contaminants. But cost-efficiency and evaluation of specific parameters need to be further studies.

Gulia et al. 2021, Indian Journal of Environment Protection



Schematic diagram of biofilter

After filtration of cadmium-containing raw sewage by rice husk and *Aspergillus niger* (first layer), wheat bran and fungal adsorbent (second layer), the filtrate passes through *L. marginalis* shell dust (third layer) and finally ejected.

Ghosh et al. 2018, Human and Ecological Risk Assessment
https://doi.org/10.1080/10807039.2018.1530588

L. marginalis : Key research questions

- Do we have sufficient genome-driven data to conserve the wild stocks of *L. marginalis* using molecular-level interventions? Further, the discovery of microsatellite markers would be necessary to identify the stocks in newer habitats and prevent over-exploitation and illegal trafficking of native species.
- Do we have sufficient information on the candidate genes that provide a fitness advantage to the species against xenobiotics and pathogens? In that case, a gene atlas would be necessary that will shed insights to mucosal and systemic immunity in the species against infections?
- Can the benefits of selective breeding reach the *L. marginalis* farmers and entrepreneurs? Selection of beneficial traits pertaining to disease resistance, growth, reproduction, and quality pearl production can only be accomplished using selective breeding. Presently, only captive breeding is practiced.

L. marginalis waste shell as biomaterials

- Bioremediation of heavy metals and dye
- Catalyst in biodiesel production
- Artificial bone preparation
- Amelioration of soil condition including prevention of pest infestation
- As filters and alternatives for construction materials
- Reduction of eutrophication solely or in combination with microalgae

Do we need mussel processing factories?

L. marginalis : Scope of genomic and genetic resources

Entrez records	
Database name	**Direct Links**
Nucleotide	121
Protein	80
Genome	1
Popset	7
PubMed Central	23
Gene	37
Identical Protein Groups	51
BioProject	1
Bio Sample	1
Taxonomy	1

As of 15.02.2023, no genomics / transcriptomics resources is known for the species. Only the mitochondrial genome is in the public domain. This has restricted an understanding of molecular resources that could be utilized for an informed conservation approach for the species in the wild, understanding of intricate pathways to innate immunity and xenobiotic stress and application of selective breeding approaches for development of robust breeds. To address all these issues and in particular the informed use of the species in sustainable integrated aqua-farming and novel bio-filter designs, there is an urgent need to elucidate the molecular resources and characterize it based on functional genomics approaches.

We have collaborated with ICAR-CIFA and Soonchunhyang University, South Korea to characterize the genomic and genetic resources for this valuable species. We seek funding support from the generous seed grant of FMU, Odisha and other National agencies to support this BioProject.

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