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Glochidial culture and captive breeding of freshwater mussels: A boon for conservation

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Abstract
Conservation requirement of freshwater mussels has recently prompted designing initiatives in propagating species through glochidial culture and captive breeding. The literature on the *invitro* culture of glochidia and captive breeding of freshwater mussels is scanty. **G**lochidial propagation and suitability of artificial breeding of freshwater mussels for the conservation are reviewed. Mussels of only two families are captive bred in Europe and North America. Captive breeding could help in safeguarding critically endangered populations; however current rearing methods need to be optimised. Research needs to include enhancement of glochidial culture methods and tagging them would be effective for the successful parasitism on the fish host.

Keywords: Bivalves, juveniles, fish hosts, propagation, tagging

Introduction

The freshwater mussel's larvae called glochidia are known to parasitize the fishes for their dispersal and the relationship is obligatory which helps mussels to complete the life cycle in their habitats. They are the keystone species and bioindicators, thus requiring conservation priorities. There exist knowledge shortfalls on the host limitation or specificity of glochidia which prioritises the need for conservation (D'Souza, 2025) [2]. Moreover, the formulation of conservation strategies for freshwater bivalves is quite challenging, in assessing the priority populations for conservation and undertaking decisions on captive breeding and habitat restoration. Lack of information on the propagation of glochidia and captive breeding of freshwater mussels makes this study novel. The framework of this review is to understand the advantageous of *invitro* breeding of glochidia and investigate the recent trends in artificial breeding of freshwater bivalves, addressing challenges and suggesting the best methods for effective conservation. Hence, this review delineates the available conservation strategies for the freshwater mussel larvae. It also suggests the artificial breeding in fish hatcheries with or without their host fishes as effective strategy for conservation.

Growing glochidia *invitro* in a nutrient-rich culture medium than on fish, enables efficient propagation, faster juvenile yields, and long-term growth of juvenile mussels, especially for endangered species. The need for host fish identification becomes unessential. The threats to mussels and their larvae are improperly known, yet temperature changes, habitat degradation, siltation, and pollution cause their population decline (D'Souza, 2025) [2]. Moreover, proper understanding of the host availability would help in protection of rare mussel species to lessen their population decline.

In vitro culture of mussel *Hyriopsis myersiana* has been attempted, diet was optimized, and glochidia were able to parasitize the gills, developing morphological structures. (Satit, 2008). Lima *at al*. (2012) [3] gave an alternative method to fish infestation, to propagate more juveniles without host fish's costs effective mannar. High efficiencies of *H. myersiana* have been obtained in the newly prepared glochidia culture medium, grown for 120 days and recirculated to specific diet system.

Ma *at al*. (2024) propagated glochidia of endangered freshwater mussel *Solenaia oleivora*, with unknown hosts namely carps, bovine, and rabbit fish. *IN VITRO* rearing of glochidia can help to save small populations from extinction and boost the number of individuals for eventual release into the wild once the habitats are capable of supporting early-stage juvenile mussels. Fluorescent tagging has been proven to be efficient in cryopreservation of open glochidia (Marie 2016) [4]. Further to delimit the dead or live status and proportion. Yet, research should focus on laboratory culture of glochidia to gain the optimum results in parasitizing fish hosts.

The captive breeding of freshwater mussels is gaining the importance worldwide and the larvae of some Unionids such as *Pseudunio auricularius*, *Margaretifera margaretifera*, *Unio crassus*, *Unio ravoisieri* and *Unio mancus* are propagated (Nakamura *at al*. 2019 [6]; Thomas *at al*. 2010) [9]. UK (21%), USA (36%) and Czech Republic (17%) are involved in captive breeding of mussels (Figure 1a). Only mussels belonging to families Margaretiferidae and Unionidae have been successfully captive bred in Europe and North America (Figure 1b). Boyles (2004) checked the feasibility of survival of adult freshwater mussels in captivity for the long-term was assessed and 10 species have been relocated to the Ohio River.

Of the relocated bivalves 96% survival rate was observed for *Villosa vanuxemensis* whereas *Lampsilis cardium* survival rate was the least (31%). Many studies were commonly related to optimization of rearing methods such as cryopreservation, trials on glochidial parasitism, standardisation of diets (Rytwinski *at al*. 2021) [8]. However, genetic assessments and species re-introduction studies are not available.

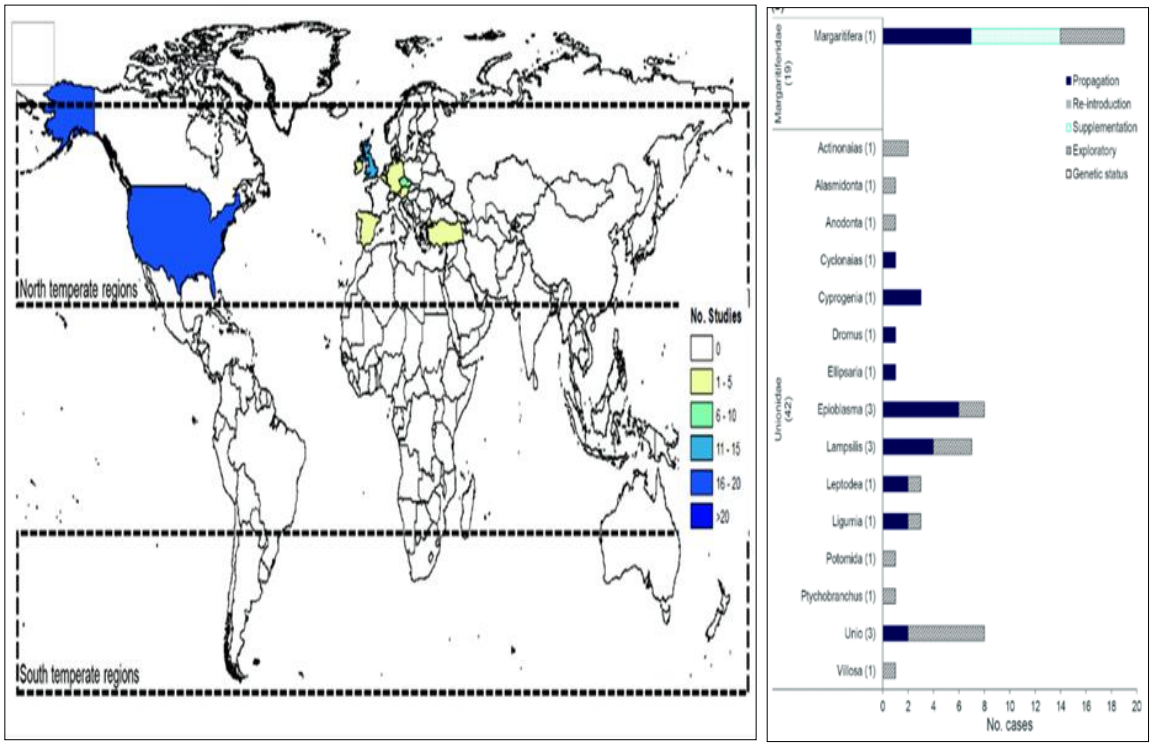

Fig 1: (a, b): Captive breeding of mussels a) global scale, b) bivalves propagated.

Conclusion

Given the knowledge shortfalls on glochidial culture and artificial breeding of freshwater mussels, recently, few studies have been emerging on this aspect towards the conservation of threatened species. Future research needs to consider integrative conservation by obtaining genetic and ecological data. Use of molecular genomic techniques in maintaining genetic integrity of endangered freshwater mussels apart from the ecological research enables population increase. Understanding ecological processes, speciation and evolutionary lineages needed to protect the diversity freshwater bivalves. Application of efficient genetic markers for the species and the knowledge of the life cycle, particularly during glochidia infestation and post-parasitic phase, are imperative towards conservation.

Evaluation of previous actions and management decisions may help in initiating conservation actions. Selection of endangered freshwater species for conservation, avoiding in- and outbreeding by genetically distant parent individuals, and networking among researchers, collaboration with the aquaculture labs would increase the effectiveness of conservation. I recommend that future studies should evaluate *invitro* host infestation, Tagging the glochidia for the parasitizing the hosts, advanced glochidia propagation techniques, captive breeding programs at three stages (juvenile collection, rearing/release, post-release monitoring) for a variety of freshwater bivalve species.

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