

Endangered freshwater pearl mussel *Margaritifera laevis* with epilithic red alga found in a small stream on the Noto Peninsula, Japan

Daisuke Kishi

Gifu Prefectural Research Institute for Fisheries and Aquatic Environments, Kawashima-kasada, Kakamigahara, Gifu 501-6021, Japan.

email: kishi-daisuke@pref.gifu.lg.jp, Tel: + 81-586-89-6351.

Abstract

The freshwater pearl mussel *Margaritifera laevis*, with the epilithic red alga *Virescentia* sp. growing on its shell surface, was discovered in a small stream on the Noto Peninsula, central Japan. Although the cobbles provided sufficient attachment surfaces for red algae at the study site, red algae were also observed on freshwater pearl mussels. The study site, where both freshwater pearl mussels and red algae were distributed, is an infrequent habitat in the Hokuriku region of central Japan; therefore, the epizotic occurrence of freshwater pearl mussels with red algae in this stream is considered a unique case.

Key words: bivalve; Unionoida; epilithic algae; *Virescentia* sp.; Batrachospermaceae

Freshwater mussels from the families Unionidae, Margaritiferidae, Hyriidae, Etheriidae, Mycetopodidae, and Iridinidae (order Unionoida) comprise 958 species worldwide (Graf and Cummings 2021). Freshwater mussels play various ecological roles and contribute to the co-occurrence of organisms in lotic and lentic ecosystems (Vaughn and Hakenkamp 2001; Vaughn 2018). For example, cyprinid fish of several genera, such as *Acheilognathus* and *Rhodeus*, depend on freshwater mussels to spawn and deposit eggs in their gill chambers (Terui et al. 2011; Kitamura et al. 2012). Freshwater mussels provide habitats for macroinvertebrate communities (Spooner and Vaughn 2006; Vaughn and Spooner 2006). Freshwater mussels also provide shells as substrates for benthic algae (Francoeur et al. 2002; Spooner and Vaughn 2006).

In a small stream in the northern part of the Noto Peninsula (Wajima City, Ishikawa Prefecture), central Japan (Fig. 1), I found the freshwater pearl mussel *Margaritifera laevis* (family Margaritiferidae) with the epilithic red algae (family Batrachospermaceae) growing on the shell. Since the populations of *M. laevis* have declined due to anthropogenic influences

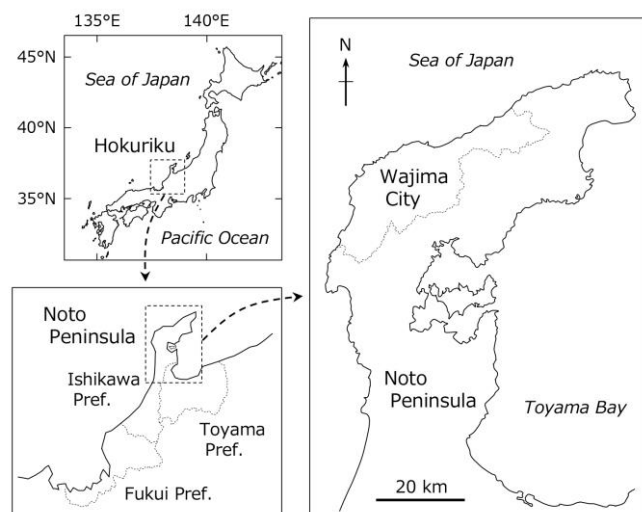


Fig. 1. Map of the Noto Peninsula in Ishikawa Prefecture, central Japan.

in recent decades, this species has been classified as EN (endangered) in the Japanese Red List (Ministry of the Environment, Japan 2020). Therefore, the precise localities are not disclosed, as in Arakawa et al. (2022). A total of 17 freshwater pearl mussels were collected at the study site (length: 73 mm; mean wetted width \pm SD: 1.53 ± 0.44 m) within the stream in April 2018. Epilithic red algae were observed on the shells of 13 out of 17 individuals, and their shell length was

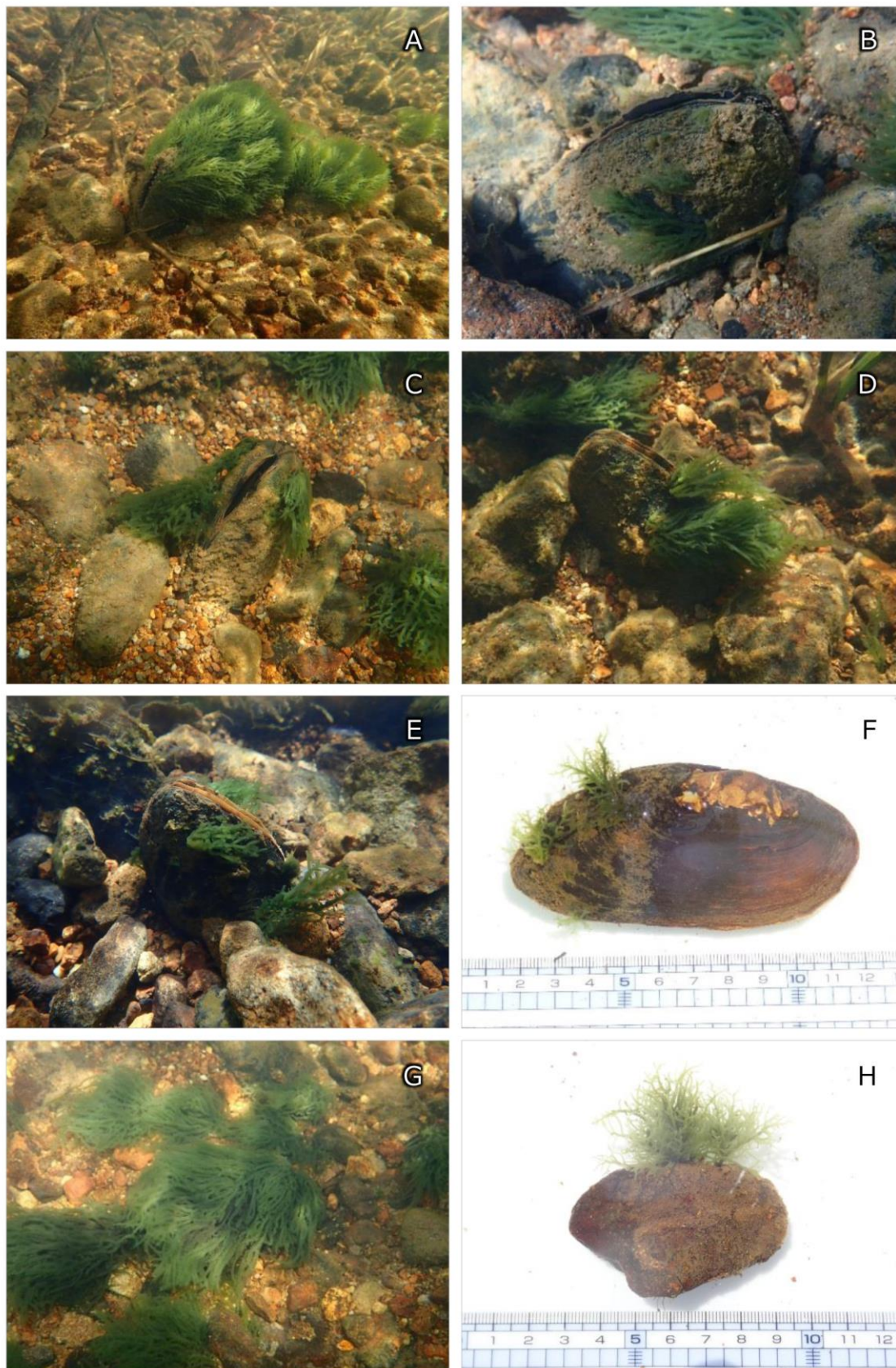


Fig. 2. Red alga *Virescentia* sp. (green-colored alga) attached to the freshwater pearl mussel *Margaritifera laevis* (A–F) and cobbles (G, H) at the study site.

measured with a digital caliper (CD-P15S, Mitutoyo Corp., Kanagawa, Japan). After the shell length was measured, the freshwater pearl mussels were returned to their original location.

Freshwater pearl mussels with red algae are shown in Fig. 2A-F. The shell length of 13 mussels ranged from 88.5 to 111.0 mm (mean \pm SD: 99.2 \pm 6.6 mm). Red algae were attached to the surfaces of shells exposed to running water. This algal species was presumed to be *Virescentia helminthosa*; however, Vis and Necchi (2021) postponed the definitive identification of taxa in this genus distributed in Japan. In the present study, I describe the taxon distributed in the study stream as *Virescentia* sp., according to Vis and Necchi (2021). Although previous studies have reported epizoic cases of several Batrachospermaceae taxa attached to snails (Minckley and Tindall 1963; Suzawa et al. 2010) and lentic mussels (Francoeur et al. 2002), none have involved the lotic mussels. In this study, freshwater pearl mussels with red algae growing on their shell surfaces were identified in a lotic habitat. Batrachospermaceae are generally observed on abiotically stable substrates, such as cobbles (Suzawa et al. 2010; Eloranta et al. 2016). Mussels can serve as effective attachment surfaces for red algae if suitable substrates are lacking on sandy bottoms (Francoeur et al. 2002). The cobbles (particle size: ~70–150 mm) dominated the streambed at the study site and provided sufficient attachment surfaces for red algae (Fig. 2G, H). However, red algae were also observed on freshwater pearl mussels. Further studies are required to evaluate the relationship between freshwater pearl mussels and red algae in this stream.

The study site, where both freshwater pearl mussels and red algae were distributed, is an infrequent habitat in the Hokuriku region of central Japan. In this region, the red alga *Virescentia* sp. has been reported in only a few localities (Kumano et al. 2002; Hanyuda et al. 2004). Distributions of freshwater pearl mussels have been reported within several streams in the Ishikawa and Fukui Prefectures; however, the population in

Fukui was extinguished around 1970 (Fukui Prefecture 2016; Arakawa et al. 2022). In recent years, this species has been found at a limited number of sites on the Noto Peninsula, Ishikawa (Ishihara 2020; Arakawa et al. 2022). Therefore, this epizoic occurrence of freshwater pearl mussels with red algae in this stream is considered a unique case. These species and their habitats require further investigation and conservation efforts.

Acknowledgments

I am sincerely grateful to the editor and three anonymous referees for their careful reviews and constructive comments. I thank Masashige Taniguchi for providing valuable knowledge about freshwater pearl mussels distributed on the Noto Peninsula, and Yoshihiro B. Akiyama, Hiromitsu Kamauchi, Tamie Suzawa, and Yuzuru Suzawa for their helpful advice on the draft. Finally, I would like to thank Editage (www.editage.jp) for the English language editing.

References

- Arakawa, H., Kitaichi, H., Higashide, Y. (2022). Distribution of freshwater pearl mussel (*Margaritifera laevis*) and fishes during winter in the tributary in Wajima City, Ishikawa, Japan. *Rep. Noto Mar. Cent.* 28: 13–20. (In Japanese with English abstract).
- Eloranta, P., Eloranta, A., Perämäki, P. (2016). Intensive study of freshwater red algae (Rhodophyta) in Finland. *Fottea* 16: 122–132.
- Francoeur, S. N., Pinowska, A., Clason, T. A., Makosky, S., Lowe, R. L. (2002). Unionid bivalve influence on benthic algal community composition in a Michigan Lake. *J. Freshw. Ecol.* 17: 489–500.
- Fukui Prefecture (2016). Threatened Wildlife of Fukui Pref. Fukui Red Data Book. <https://www.pref.fukui.lg.jp/doc/shizen/rdb/rdb.html>. (accessed on 1 October 2025). (In Japanese).
- Graf, D. L., Cummings, K. S. (2021). A “big data” approach to global freshwater mussel diversity (Bivalvia: Unionoida), with an updated checklist of genera and species. *J. Molluscan Stud.* 87: eyaa034.
- Hanyuda, T., Suzawa, Y., Suzawa, T., Arai, S., Sato, H., Ueda, K., Kumano, S. (2004). Biogeography and taxonomy of *Batrachospermum*

- helminthosum* (Batrachospermales, Rhodophyta) in Japan inferred from rbcL gene sequences. *J. Phycol.* 40: 581–588.
- Ishihara, K. (2020). Molluscs. In: Nature Conservation Division, Ishikawa Prefecture (Ed.) Red Data Book 2020 (Animal), Threatened Wildlife of Ishikawa. Ishikawa Prefecture, Kanazawa, p. 280–318. (In Japanese).
- Kitamura, J., Nagata, N., Nakajima, J., Sota, T. (2012). Divergence of ovipositor length and egg shape in a brood parasitic bitterling fish through the use of different mussel hosts. *J. Evol. Biol.* 25: 566–573.
- Kumano, S., Kamura, S., Arai, S., Sato, H., Iima, M., Suzawa, Y., Suzawa, T., Hanyuda, T., Mitani, S. (2002). Japanese localities of the taxa of freshwater Rhodophyta recognized since 1995. *Jpn. J. Phycol. (Sôrui)* 50: 29–36. (In Japanese).
- Minckley, W. L., Tindall, D. R. (1963). Ecology of *Batrachospermum* sp. (Rhodophyta) in Doe Run, Meade County, Kentucky. *Bull. Torrey Bot. Club* 90: 391–400.
- Ministry of the Environment, Japan (2020). Ministry of the Environment Red Lists in 2020. <https://www.env.go.jp/content/900515981.pdf>. (accessed on 3 October 2025). (In Japanese)
- Spooner, D. E., Vaughn, C. C. (2006). Context-dependent effects of freshwater mussels on stream benthic communities. *Freshw. Biol.* 51: 1016–1024.
- Suzawa, Y., Suzawa, T., Fukushima, S. (2010). Distribution of *Batrachospermum* (freshwater Rhodophyta) in Kanagawa Prefecture and vicinity. *Nat. Hist. Rep. Kanagawa* 31: 1–7. (In Japanese).
- Terui, A., Matsuzaki, S. S., Kodama, K., Tada, M., Washitani, I. (2011). Factors affecting the local occurrence of the near-threatened bitterling (*Tanakia lanceolata*) in agricultural canal networks: Strong attachment to its potential host mussels. *Hydrobiologia* 675: 19–28.
- Vaughn, C. C. (2018). Ecosystem services provided by freshwater mussels. *Hydrobiologia* 810: 15–27.
- Vaughn, C. C., Hakenkamp, C. C. (2001). The functional role of burrowing bivalves in freshwater ecosystems. *Freshw. Biol.* 46: 1431–1446.
- Vaughn, C. C., Spooner, D. E. (2006). Unionid mussels influence macroinvertebrate assemblage structure in streams. *J. N. Am. Benthol. Soc.* 25: 691–700.
- Vis, M. L., Necchi, O. Jr. (2021). Subphylum Eurhodophytina, class Florideophyceae, subclass Nemaliophycidae, order Batrachospermales. In: M. L. Vis, O. Jr. Necchi (Eds.) *Freshwater Red Algae—Phylogeny, Taxonomy and Biogeography*. Springer, Switzerland, p. 129–332.

Received: 18 February 2026 | Accepted: 22 February 2026 | Published: 25 February 2026