

Risk of extinction cascades from freshwater mussels to bitterling fish

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Freshwater fish distributed in Japan, South Korea, and China. Listed as near threatened in Japanese Red List. Credit: Hiroki Hata (Ehime University)

Reproduction of native and invasive bitterling fishes and their hybridisation was studied in Japan. We collected mussels in which these bitterlings lay their eggs, kept them in aquaria, collected eggs/larvae ejected from mussels, and genotyped them. We found that hybrids occurred when local mussel density was low. The rapid decline of the host mussels and artificial introduction of an invasive congener interacted to cause the rapid decline of a native fish.

Bitterling fishes (Subfamily: Acheilognathinae) spawn in the gills of living [freshwater mussels](#) obligately depending on the [mussels](#) for reproduction. On the Matsuyama Plain, Japan, populations of unionid mussels—*Pronodularia japonensis*, *Nodularia douglasiae*, and *Sinanodonta lauta*—have decreased rapidly over the past 30 years. Simultaneously, the population of a native bitterling [fish](#), *Tanakia lanceolata*, which depends on the three unionids as a breeding substrate, has decreased. Furthermore, a congeneric bitterling, *Tanakia limbata*, has been artificially introduced, and hybridisation and genetic introgression occur between them. Here, we surveyed the reproduction and occurrence of hybridisation between native and invasive species of bitterling fishes. We collected mussels in which these bitterlings lay their eggs, kept them separately in aquaria, collected eggs and larvae ejected from the mussels, and genotyped them using six [microsatellite markers](#) and mitochondrial cytochrome b sequences.

The introduced *T. limbata* was more abundant, had a longer breeding period, and produced more juveniles than the native *T. lanceolata*. Hybrids between the two species occurred frequently, and in total 101 of the 837 juveniles genotyped were hybrids. The density of *P. japonensis* was low, at most 0.42 individuals/m². *Nodularia douglasiae* and *S. lauta* have nearly or totally disappeared from these sites. Hybrid clutches of the *Tanakia* species occurred more frequently where the local density of *P. japonensis* was low. The mussels were apparently overused and used simultaneously by three species of bitterlings.



Freshwater unionid species endemic in Japan. Credit: Hiroki Hata (Ehime University)

The decline of freshwater unionid populations has heightened hybridization of native and invasive bitterling fishes by increasing the competition for a breeding substrate. We showed that a rapid decline of host mussel species and an introduction of an invasive congener have interacted to cause a rapid decline of native bitterling fish. The degradation of habitat and the introduction of invasive species interact to cause a cascade of extinctions in the native species. In our study, obligate parasite species are threatened because the host [species](#) are disappearing, resulting in a serious threat of coextinction.



Excessive crowding of a native *Tanakia lanceolata* (orange fin) and invasive *Tanakia limbata* (olive brown body) of a mussel, *Pronodularia japonensis*, seen at the bottom center in the image. Credit: Hiroki Hata (Ehime University)

More information: Hiroki Hata et al. Decline of unionid mussels enhances hybridisation of native and introduced bitterling fish species through competition for breeding substrate, *Freshwater Biology* (2020). [DOI: 10.1111/fwb.13629](https://doi.org/10.1111/fwb.13629)

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