APPLIED ECOLOGY

Non-native gobiid fishes – an emerging model in invasion biology

Since the 1990s, several Ponto-Caspian gobiid species appear to have expanded their ranges in Europe and North America. These species have become a subject of interest for fish biologists, mostly due to the detrimental impact of round goby (*Neogobius melanostomus*) in the Laurentian Great Lakes. The aim of this project has been to follow the spread of invasive gobiid species in Europe, focusing particularly on those species that threaten Czech rivers (two species have recently expanded into Czech waters: *N. melanostomus* and tubenose goby (*Proterorhinus semilunaris*)), and to evaluate their pattern of spreading, their ecological demands and their effect on native biota. The project has documeted the recent spread of several gobiid species (i.e. bighead goby (*N. kessleri*), *N. melanostomus*, monkey goby (*N. fluviatilis*) and *P. semilunaris*) from the River Danube into the lower Rhine (Germany), supporting the hypothesis that such "discontinuous" spreading through Europe is facilitated by shipping. Further support for the "ship transport" hypothesis arises from sudies comparing the external morphology of non-native (middle Danubian) and native (lower Danubian) *N. melanostomus* populations, where significant differences indicate differing environmental influences and/or a possible founder effect. These findings also indicate that invasive gobies are characterised by high morphological plasticity.

A pilot study on the biological characteristics of native *N. fluviatilis* populations, a species introduced to Croatian, Hungarian and Slovakian waters and, more recently, into the lower Rhine, provides the basis for future comparative studies in non-native regions and will help to evaluate the future invasive potential of this species.

A study on the habitat preferences of *P. semilunaris* indicates that, as with other gobiid species, adult fish occur most frequently along boulder banks and avoid more "natural" sections (e.g. beaches and eroded banks). As channelised rivers with boulder banks are common in European waters, such habitats are predicted to facilitate further expansion of the species. A preference of early life stages for small rocks and low flow, however, suggests that expansion may be limited in systems that lack such habitats.

Littoral fish sampling along the Rhine.
(Photo by M. Ondračková)

Monkey goby (*Neogobius fluviatilis*).
(Photo by K. Halačka)

P. semilunaris, which colonised and began expansion in two adjacent rivers at around the same time (differing only in direction of expansion, i.e. up- or downstream movement), showed significantly different expansion patterns, with downstream colonisation far more rapid and intense than upstream colonisation. Drift of earliest life stages was suggested as supporting this phenomenon.

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Voles are important pests in forest management

In the past, economical interests were the priority in forestry management, which led to the cultivation of coniferous monoculture forests over the majority of areas planted. Present management methods; however, reflect the need to increase environmental diversity and the ecological stability of forest stands through increasing the proportion of broad-leaved trees planted. One factor that has negatively affected this process, however, is the impact of voles, which damage the bark of young broad-leaved trees. The aim of our study was to collect information on vole damage from Czech forest plantations and determine the main factors influencing the extent of damage. Two vole species cause the majority of bark damage in forest clearings, the bank vole (*Clethrionomys glareolus*) and field vole (*Microtus agrestis*), with the common vole (*Microtus arvalis*) also important in some areas. Bark consumption mainly took place in winter due to an absence of higher quality food. In addition, an increased density of vole species could also result in an increase in bark damage. In general, lowland forests (up to 400 m a.s.l.) suffered little vole damage due to improved food supply and lower snow cover. In highland forests, a relationship was noted between vole damage and a good tree-seed harvest in combination with snow cover. In mountainous regions, tree bark consumption was mainly related to increases in the abundance of the vole population. Preventing damage to young trees is difficult as it relies on the reliable prediction of all risk factors in any forest environment. In contrast to agriculture, there is no service for predicting vole damage in Forestry. If a synchronous common vole population dynamic was to be confirmed in agricultural and forest environments, warnings provided by the plant protection administration could prove effective. The most effective means of preventing vole damage to young tree saplings, however, is to avoid planting on grassy clearings and to make use of known forest regeneration strategies, e.g. shelter wood regeneration.

A young beech tree with bark damaged by voles (*on left*) sends out adventitious roots to bridge the damaged part of the stem (*on right*). Trees with such levels of damage usually die within two years. (*Photo by M. Homolka*)

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