# Recent developments of invasive gobies in the Lower Rhine: Feeding and niche differentiation under spatial and temporal aspects

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After the opening of the Rhine-Main-Danube-canal, several Ponto-Caspian gobiid fishes invaded the Lower Rhine. Starting in 1999 with *Proterorhinus semilunaris*, invasion succeeded with *Ponticola kessleri* in 2006, *Neogobius melanostomus* and *Neogobius fluviatilis* in 2008, and was completed with *Babka gymnotrachelus* in 2010. *P. semilunaris* is actually found mainly in the more lentic backwaters of the Rhine, while *P. kessleri*, *N. melanostomus* and *N. fluviatilis* are widespread along the whole North-Rhine-Westphalian section of the Rhine. As general species descriptions are rather similar concerning used ecological niches, the aims of our studies focus on mechanisms that separate these species with respect to the competitive exclusion principle. All species showed an opportunistic feeding strategy. In *N. fluviatilis* and *P. kessleri*, a clear shift in preferred food resources was observed between individuals smaller and larger 50 mm that occurred in parallel with a habitat shift from sandy areas to riprap structures in *P. kessleri*, but not in *N. fluviatilis* that were only found on gravel and sand. In contrast, there were no distinct changes in food and habitat preference in *N. melanostomus*. While diet and habitat differences are widely accepted as separating factors, differences on temporal scales are often underestimated. In a recently conducted beach seining experiment we found significant results how diel patterns may further shape the ecological niches concerning diet, habitat usage and predator-prey relationships. These results give evidence that not only inter-specific but also intra-specific patterns with respect to size may segregate ecological niches. The results on the three invasive Gobiids in the Lower Rhine give important hints how fine-tuned spatial and temporal characteristics in intra- and inter-specific competition shape the ecological niche of these invaders in their new environment. Compared to other goby populations, those from the Rhine were in a bad condition assuming that the populations are approaching or even reached the capacity of the ecosystem.