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# Expansion of *Proterorhinus marmoratus* (Teleostei, Gobiidae) into the River Moselle (Germany)

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A b s t r a c t . Following the opening of the Rhine-Main-Danube waterway in 1992 the invasive gobiid *Proterorhinus marmoratus* started colonizing the River Main and the River Rhine. In 2005, point abundance sampling revealed the presence of the species in two impoundments of the River Moselle next to the confluence with the River Rhine. This distribution pattern suggests that tubenose goby actively immigrated into the River Moselle by using locks and fishways. Highest population densities were recorded in lentic to slightly lotic habitats in headwater reaches of weirs as well as in oxbow lakes and groyne fields. Due to regulation by weir and lock systems, the River Moselle and its largest tributary the River Saar offer numerous suitable habitats facilitating the rapid further expansion upstream to river reaches in Luxembourg and France.

**Key words:** alien species, distribution, colonization, regulated river

## Introduction

The tubenose goby is a species of Ponto-Caspian origin inhabiting saltwaters and brackish as well as freshwater systems (M i l l e r 2004). In recent decades it showed a rapid expansion of its range, facilitated and accelerated by transport in the ballast water of ships (A h n e l t et al. 1998, W o n h a m et al. 2000), by transport of egg clutches on ship hulls (S o k o l o v et al. 1994), by accidental stocking together with other fish species (F r i e d l & S a m p l 2000), release of bait fish (P r á š e k & J u r a j d a 2005), and through its ability to colonize riprap structures along inland waterways (J u d e 1996, A h n e l t et al. 1998). Tubenose goby is expanding its range in Europe (e.g. B o g u t s k a y a & N a s e k a 2002, H a r k a 1990, P r á š e k & J u r a j d a 2005) as well as in North America that was probably reached via transoceanic ballast water transport. First records came from the Great Lakes region in 1990 (J u d e 1992).

The completion of the Rhine-Main-Danube waterway in 1992 opened an immigration route for tubenose goby and other Ponto-Caspian and Danubian species to the River Rhine catchment area (T i t t i z e r 1996). The crossing of the watershed was firstly observed during an investigation commissioned by the Federal Institute for Hydrology in August 1997, when numerous juvenile tubenose gobies (total length: 1–2 cm) were caught by handnet in the Lohbach, a small river connected to the River Roth which receives water from the Rhine-Main-Danube waterway (P o t e l , pers. comm.). First findings in the River Main date back to 1999 (S c h a d t 2000, R e i n a r t z et al. 2000, B o r n , pers. comm.). Further downstream expansion into the River Rhine went on very rapidly with recorded catches in the middle reach of the River Rhine in 2000 (ICPR 2002) and further to the lower reaches in the Netherlands in 2002 (W i n t e r , pers. comm., cited in F r e y h o f 2003). Ongoing fish surveys in the context of environmental impact assessments for new shipping locks in the

River Moselle offer the opportunity to study the upstream expansion of the species in this major tributary of the River Rhine.

## Methods

Fish surveys were conducted in 1999, 2000 and 2005. In 1999 and 2000, sampling took place from Moselle-km 2.1 in the first impoundment (counted upstream from the confluence with the River Rhine) up to Moselle-km 195.7 (ninth impoundment). In 2005, samples were taken in the first and second impoundments in July and September. Some additional sampling was carried out in the fifth impoundment in June and September 2005.

The fishing method employed was point abundance sampling by electrofishing (C o p p 1989) using an electroshocker fixed on a small boat. Each sampling site consisted of 50 point samples taken along 200 m of shoreline. At each sampling point, narcotization and capture of tubenose goby and fish of similar size was possible within a radius of 50–100 cm around the immersed ring of the anode with a diameter of 15 cm.

## Results and Discussion

In the River Moselle no tubenose goby were recorded in 1999 and 2000. In 2005 the species was present in the first impoundment at Koblenz (Moselle-km 2–21) and to a lesser extent in the second one at Lehmen (Moselle-km 21–37) (Fig. 1, Table 1). These are the first records of upstream migration across large dam and lock systems in the River Rhine basin. No tubenose goby were caught in the fifth impoundment at St. Aldegund (Moselle-km 78–102) in 2005. The recorded distribution pattern suggests that tubenose goby started colonizing the River Moselle by active migration through locks and fishways. Nevertheless, there is also the possibility of passive immigration as described above.

The size of tubenose goby caught on 8–27 July 2005 was 32 ± 8 mm total length (range: 20–43 mm, n = 19). On 9–15 September 2005 fishes measured 52 ± 10 mm (range: 35–73 mm plus one individual with a size of 92 mm, n = 100). Most likely, the majority of fish caught were age class 0+ and 1+, although length-frequency-histograms failed to reveal different size – or age-classes. This is in accordance with findings in other gobiid species (E r ő s et al. 2005) and probably due to the protracted spawning season of this species (L e s l i e et al. 2002).

Prefered habitats in the regulated River Moselle are lentic or slightly lotic areas in oxbow lakes, groyne fields, and headwaters just upstream of the weirs at Koblenz and Lehmen (Fig. 1). The shoreline at most sites consists of riprap partly with overhanging vegetation and macrophytes. These sites are not or only slightly exposed to ship waves. A preference for habitats with slow flow velocities and numerous hiding places under stones, overhanging vegetation or between macrophytes was also noted by other authors (e. g. L u s k & H a l a č k a 1995, J u d e 1996, A h n e l t et al. 1998, S c h a d t 2000, L e s l i e et al. 2002, P r á š e k & J u r a j d a 2005). Since there are many suitable habitats in the regulated River Moselle and its largest tributary, the regulated River Saar, and since all weirs in these rivers are equipped with locks and very often with fish passes, further active upstream expansion of tubenose goby can be expected. It is very likely that via these rivers the inland waters of France and Luxemburg will be colonized in the near future.

The rapid expansion of tubenose goby might be favoured by the presence of food organisms like *Dikerogammarus villosus*, *Corophium curvispinum* and *Jaera istri* which are

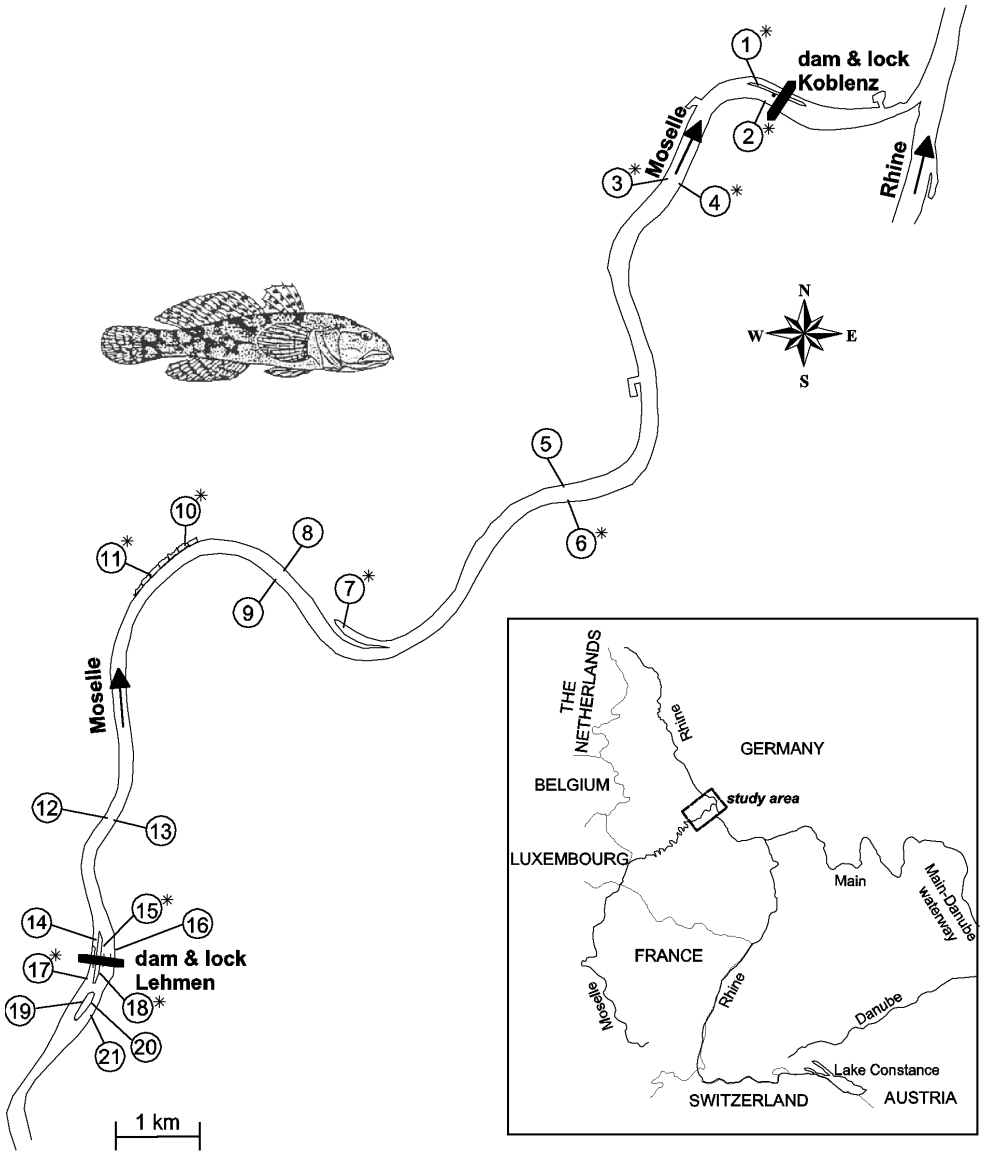


**Fig. 1.** Sampling sites in the impoundments of the River Moselle between Koblenz and Lehmen (* = records of tubenose goby in 2005).

also of Ponto-Caspian origin and now inhabit the Rhine and its large tributaries in very high densities (T i t t i z e r et al. 2000). The present increase in population density of tubenose goby in the River Moselle offers the opportunity to investigate if this fish species can significantly reduce some of its food organisms in the manner of a top-down control.

Tubenose goby – as well as other invasive gobiids – are regarded as competitors of benthic fish species (F r e y h o f 2003). An increase in population density of tubenose goby is believed to be the reason for a decline in population densities of bullhead *Cottus gobio* and whitefin gudgeon *Gobio albipinnatus* in the Slovak reach of the River Danube in the

**Table 1.** Characteristics of sampling sites and numbers of tubenose goby and bullhead caught per sampling site (= 50 point samples) in July 2005 and September 2005 in the River Moselle (overh. = overhanging).

| Site no. | Habitat | Shoreline structure / Vegetation | Tubenose | | Bullhead | |
|---|---|---|---|---|---|---|
| | | | 7/05 | 9/05 | 7/05 | 9/05 |
| 1 | Headwater | Riprap / overh.grass, macrophytes | 7 | 32 | 7 | 0 |
| 2 | Headwater | Riprap / overh. bushes | 0 | 5 | 3 | 0 |
| 3 | Main channel | Riprap / overh. bushes, overh. grass | 6 | 13 | 1 | 1 |
| 4 | Main channel | Riprap / overh. bushes | 1 | 10 | 1 | 1 |
| 5 | Main channel | Riprap | 0 | 0 | 1 | 3 |
| 6 | Main channel | Riprap | 0 | 2 | 2 | 1 |
| 7 | Oxbow lake | Mud / overh. bushes, macrophytes | 2 | 17 | 0 | 0 |
| 8 | Main channel | Riprap | 0 | 0 | 0 | 0 |
| 9 | Main channel | Riprap | 0 | 0 | 0 | 0 |
| 10 | Groyne field | Sand / macrophytes | 0 | 8 | 0 | 0 |
| 11 | Groyne field | Mud, riprap / macrophytes | 0 | 11 | 0 | 0 |
| 12 | Main channel | Riprap | 0 | 0 | 0 | 0 |
| 13 | Main channel | Riprap | 0 | 0 | 1 | 0 |
| 14 | Lock canal | Riprap | 0 | 0 | 0 | 1 |
| 15 | Tailwater | Riprap | 0 | 1 | 0 | 0 |
| 16 | Tailwater | Riprap / overh. bushes | 0 | 0 | 1 | 0 |
| 17 | Lock canal | Riprap / macrophytes | 0 | 1 | 2 | 1 |
| 18 | Headwater | Riprap / overh. grass, macrophytes | 3 | 0 | 1 | 1 |
| 19 | Main channel | Riprap / overh. bushes | 0 | 0 | 1 | 1 |
| 20 | Side arm | Riprap / overh. bushes,macrophytes | 0 | 0 | 0 | 0 |
| 21 | Side arm | Wall, riprap, macrophytes | 0 | 0 | 0 | 1 |

early-to-mid-1990s (J u r a j d a et al. 2005). In the River Moselle bullhead and tubenose goby share habitats, especially in headwater reaches of weirs. Though data are insufficient yet to analyze relations between the two species, the absence of bullhead in the headwater of the weir at Koblenz in September 2005 (Table 1) might be a first indication of negative impacts of increasing numbers of tubenose goby on a native benthic species in the River Moselle.

It is expected that very soon the gobiids *Neogobius melanostomus, N. fluviatilis, N. kessleri* and *N. gymnotrachelus* will follow tubenose goby in colonizing the River Rhine (F r e y h o f 2003) and finally its tributaries like the River Moselle. According to the findings by Jurajda et al. (2005) the impacts of these species on other benthic fishes will probably be more pronounced than that of tubenose goby.

A c k n o w l e d g e m e n t s

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