Bitterling (*Rhodeus sericeus*)
Ecological Risk Screening Summary

U.S. Fish and Wildlife Service, June 2015

Photo: USGS

1 Native Range, and Status in the United States

Native Range
From Nico and Fuller (2015):

"Europe from the Seine and other rivers of France eastward to Asia Minor, and northern China (there is a very wide geographical gap in the northern part of the Asian continent separating the ranges of the two subspecies) (Berg 1949; Lee et al. 1980 et seq.)."

Status in the United States
From Nico and Fuller (2015):

"Established in the Bronx River, New York, since at least the early 1930s (Greeley 1937; Schmidt et al. 1981; Smith 1985). Previously established and abundant in Sawmill River, New York; that population is assumed to be extirpated (Schmidt et al. 1981)."

From Schofield et al. (2005):

"In the early 1980s, the Bronx River population was estimated to number only about 900 individuals and inhabit 1-2 km of the river (Schmidt and McGurk, 1982). Although native mussels (needed for reproduction) still occur in the Bronx River, the population of Bitterling appears to be declining (R. Schmidt, personal commun., 2005; J. Rachlin, personal commun., 2005)."

Means of Introductions in the United States

From Nico and Fuller (2015):

"Probable aquarium release (Myers 1925; Bade 1926; Lee et al. 1980 et. seq.; Schmidt et al. 1981)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From ITIS (2015):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Ostariophysi
Order Cypriniformes
Superfamily Cyprinoidea
Family Cyprinidae
Genus Rhodeus
Species Rhodeus sericeus (Pallas, 1776)
Taxonomic status: valid"

From Smith et al. (2004):

"The classification of the European bitterling has been problematic, because of its discontinuous distribution across its range. In the west of its distribution, it is found in Europe and Asia Minor. In the east, bitterling are reported from the River Amur system, Sakhalin Island and rivers emptying into Peter the Great Bay and Sea of Japan (Holčík, 1999). Western populations are sometimes considered a separate species, *R. amarus* Bloch, distinct from the eastern *R. sericeus*.

The western species was later reduced to a subspecies of the eastern, with the designation *R. sericeus amarus* (Bloch) (Svetovidov & Eremeev, 1935). However, Holčík & Jedlička (1994) demonstrated that the characters used to separate the eastern and western species/subspecies were size and temperature dependent and could not be reliably used to separate the two, reverting to the designation *R. sericeus* for both the eastern and western populations. In a recent review of the taxonomy of European freshwater fish, Kottelat (1997) re-classified the western bitterling as *R. amarus*, but without clear justification."

Size, Weight, and Age Range

From Froese and Pauly (2015):

"Maturity: Lm ?, range 3 - 4 cm
Max length : 11.0 cm TL male/unsexed [Page and Burr 1991]; max. reported age: 5 years [Gerstmeier and Romig 1998]"

Environment

From Froese and Pauly (2015):

"Occurs in ponds, lakes, marshes, muddy and sandy pools and backwaters of rivers [Page and Burr 1991]"

Climate/Range

From Froese and Pauly (2015):

"Freshwater; benthopelagic; pH range: 5.8 - 6.3; dH range: 2 - 3; potamodromous; depth range 0 - ? m. Temperate; 18°C - 21°C [Riehl and Baensch 1991]; 60°N - 35°N, 5°W - 145°E"

Distribution Outside the United States

Native

From Nico and Fuller (2015):

"Europe from the Seine and other rivers of France eastward to Asia Minor, and northern China (there is a very wide geographical gap in the northern part of the Asian continent separating the ranges of the two subspecies) (Berg 1949; Lee et al. 1980 et seq.)."

Introduced

From Kozhara et al. (2007):

"This fish, recognised as endangered or vulnerable in many European countries, shows a rapid expansion beyond its native geographical range within the limits of the former Soviet Union. In the last decades it has invaded the lower Volga, Kuban and Aras River basins and has recently started to colonise the upper Volga and upper Ural River tributaries."

"In Europe, bitterlings are considered as an introduced species in England (Wheeler & Maintland 1973, Lever 1977), Denmark (Møller & Menne 1998), northern Italy (Confortini 1992), and Greece (Economidis et al. 2000)."

Means of Introduction Outside the United States

From Kozhara et al. (2007):

"The spread of bitterling outside its historical range results from man-made connections of contiguous waterway systems, from unintentional introductions by aquarists or, more likely, by anglers using bitterlings as bait fish."

Short description

From Smith et al. (2004):

"Bitterling are relatively small fish, rarely exceeding 70 mm standard length (from the tip of the snout to the origin of the caudal fin). They are relatively deep-bodied, with a body depth 29–45% of their standard length (Holčík, 1995; Reichard, 1998)."

"During the spawning season, bitterlings display a marked sexual dimorphism in their coloration. Sexually mature males develop a pink flush on their ventral and lateral sides, becoming almost red near the pectoral fins. The lateral stripe is vivid green, while the dorsal sides become dark violet. The dorsal fin is almost black, with a red triangle at its tip, and the anal fin is red with a dark border. Small, white, conical epithelial tubercles, the so-called pearl organs, typical of sexually mature cyprinids, develop around the nostrils and above the eyes (Witkowski & Rogowska, 1991). The dorsal section of the iris is red in sexually mature males and remains pigmented throughout life after sexual maturity. In contrast to the bright colours of the male, the colour of the females remains unchanged during the spawning season: grey-green dorsally, silvery laterally and yellowish ventrally, and without red pigment around the iris."

Biology

From Smith et al. (2004):

"The habitat of the bitterling is intimately tied to the distribution of freshwater unionid mussels. Typical habitats are sluggish river backwaters, oxbows, lakes, ponds and irrigation canals (Holčík, 1995, 1999). However, bitterling are also found in faster flowing rivers (Przybylski & Ziêba, 2000; Reichard, Jurajda, Šimková *et al.*, 2002)"

From Froese and Pauly (2015):

"Hides eggs in live invertebrates such as mussels, crabs or ascidians. The female develops a conduit ovipositor by which it deposits its ovules between the gills of the bivalve. The male then comes to deposit its seed close to the respiratory opening of the bivalve; at the interior of which fertilization takes place. The male keeps the eggs and alevins until they leave the refuge. In exchange, the fish rids the bivalve of its parasites [Billard 1997]. The young leave the mussel about 28 days after hatching, having reached a length of about 10 mm [Pinder 2001]."

"Feeding type: mainly plants/detritus"

Human uses

From Froese and Pauly (2015):

"Fisheries: of no interest; aquarium: public aquariums"

Diseases

From Ondračková et al. (2002):

"Black spot is a common fish disease easy recognizable by the presence of encysted metacercariae surrounded by an accumulation of black spots of melanin in the skin, muscle and fins (Schäperclaus, 1979). … YOY cyprinid fishes were sampled by hand dipnet and electrofishing in a small shallow gravel pit (0·2 ha, maximum depth 1·5 m) in a flood plain of the Dyje River (4836 N; 1656 E) (Danube Basin, Czech Republic) during the summer of 1998 and 1999. From a total of 17 YOY fish species recorded from the site (Bartošová et al., 1999), the six most common species with the highest prevalence of P. cuticola were used. These were: … bitterling *Rhodeus sericeus* (Bloch), 27·9 ± 2·11 mm (Table I)."

From Konečná et al. (2010):

"fish in five replicates suffered from infection by white spot disease (*Ichthyophthirius multifillis*)"

No OIE-listed diseases are reported for this species.

Threat to humans

From Froese and Pauly (2015):

"Harmless"

3 Impacts of Introductions

From Schmidt and McGurk (1982):

"Bitterlings feed primarily on diatoms and the digestive system is typical of a surfacescraping herbivore. Impact of this exotic species on the ecosystem appears minimal. It is unlikely that the species would cause appreciable negative impact on any habitat in the northeastern United States."

"The bitterling's small size and herbivorous diet preclude the species from being a serious predator on other fishes. It is unlikely that it would compete with native species for food since only the golden shiner may possibly utilize the same food source (Scott & Crossman, 1979)."

From Reichard et al. (2006):

"The relationship between *R. sericeus* and mussels has popularly been considered mutualistic on the premise that bitterling use mussels as spawning sites, while the mussel benefits by using bitterling as hosts for their glochidia (e.g. Wheeler, 1978). However, recent studies have shown the evidence for a mutualistic relationship to be weak."

"In the present study, we found experimental evidence for a direct cost to mussels associated with hosting *R. sericeus* embryos. Mussels that hosted *R. sericeus* embryos suffered significantly reduced growth over the entire growing season."

4 Global Distribution

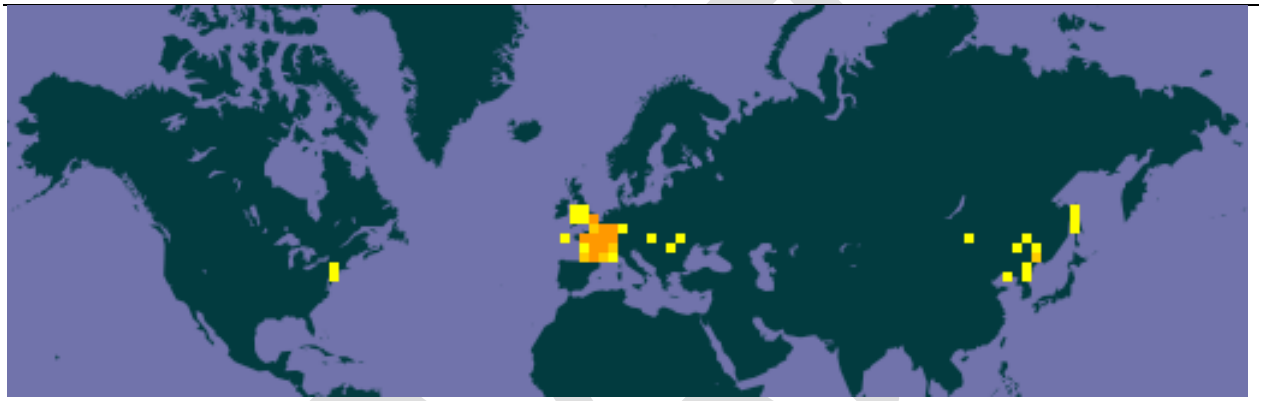

Figure 1. Distribution of *Rhodeus sericeus*. Map from GBIF (2013).

5 Distribution within the United States

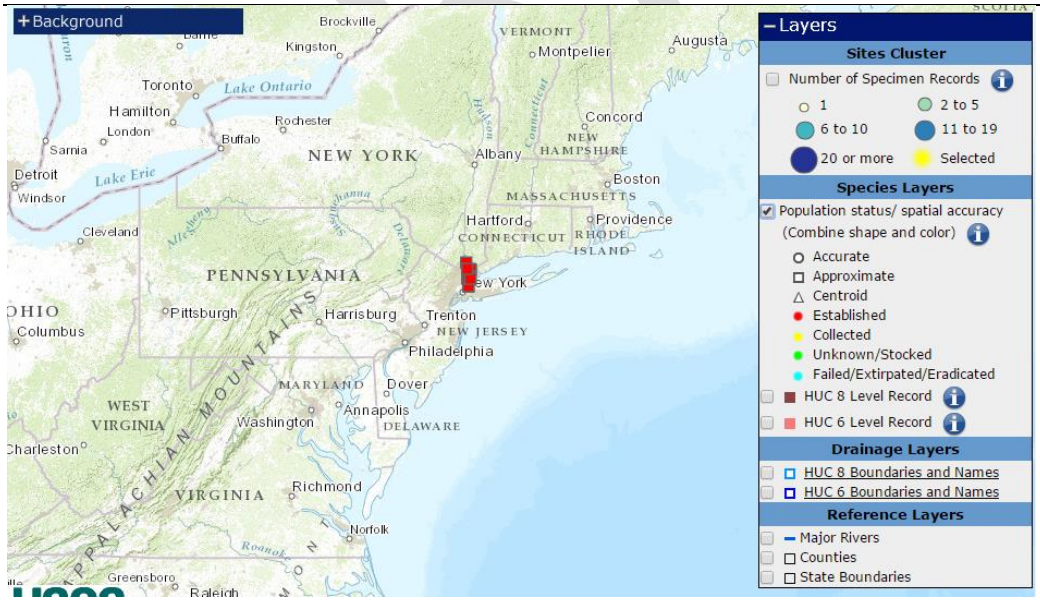

Figure 2. Distribution of *Rhodeus sericeus* in the US. Map from Nico and Fuller (2015).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match (Sanders et al. 2014; 16 climate variables; Euclidean Distance) was very high in the Mid-Atlantic and North Central regions of the contiguous US. The climate match was also moderately high for the western edge of the Southern Plains and for a segment of the Mississippi River basin extending into the South. Climate match was low for most of the South, the Central Plains, and the entire West Coast. Climate6 proportion indicated that the contiguous US has a high climate match overall. The values indicating a high climate match are values >0.103; the climate match of *Rhodeus sericeus* is 0.358.

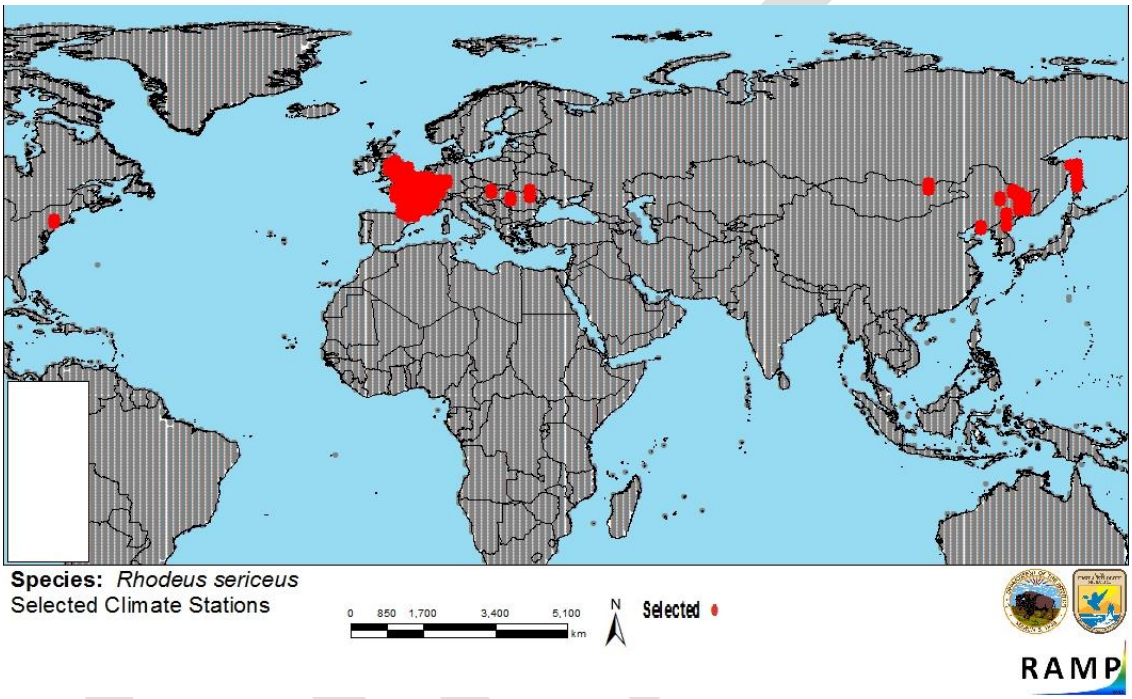

Figure 3. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Rhodeus sericeus* climate matching. Source locations from GBIF (2013) and Nico and Fuller (2015).

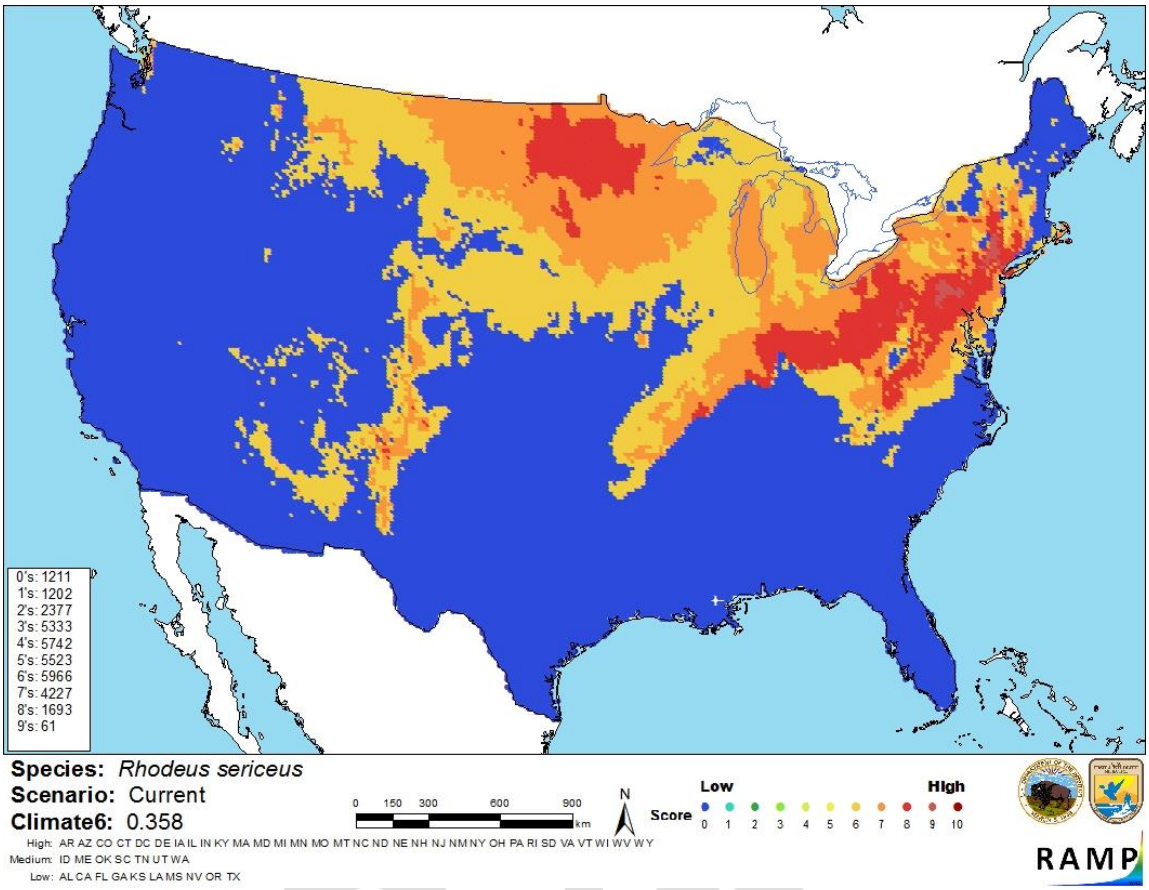

Figure 4. Map of RAMP (Sanders et al. 2014) climate matches for *Rhodeus sericeus* in the continental United States based on source locations reported by GBIF (2013) and Nico and Fuller (2015). 0= Lowest match, 10=Highest match. Counts of climate match scores are tabulated on the left.

7 Certainty of Assessment

The biology and ecology of *Rhodeus sericeus* are well-known, but little information about impacts of the species has been published. Significant adverse impacts are unlikely, given the decades-long establishment of the species in the US without major consequences; minor adverse impacts may have been overlooked. Certainty of this assessment is low.

8 Risk Assessment

Summary of Risk to the Continental United States

Rhodeus sericeus is a small fish in the family Cyprinidae. There is some confusion over its taxonomy because of its disjointed distribution in Eurasia. In Europe, the species is introduced in the United Kingdom, Denmark, Italy, and Greece, although in many other countries within its range, the species is considered vulnerable to extirpation. Only one case of an adverse impact of this species has been documented in the scientific literature, and this impact was measured on European mussel species in a laboratory setting. In the U.S., a population has been established in New York for about eight decades without any signs of detrimental impact and that population is

currently declining. The climate match of *R. sericeus* is high. Overall risk of this species is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3):** Uncertain
- **Climate Match (Sec.6):** High
- **Certainty of Assessment (Sec. 7):** Low
- **Overall Risk Assessment Category: Uncertain**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

Froese, R., and D. Pauly, editors. 2015. *Rhodeus sericeus*. FishBase. Available: http://www.fishbase.org/summary/2948. (June 2015).

Global Biodiversity Information Facility (GBIF). 2013. GBIF backbone taxonomy: *Rhodeus sericeus* (Pallas, 1776). Global Biodiversity Information Facility, Copenhagen. Available: http://www.gbif.org/species/2360803. (June 2015).

Integrated Taxonomic Information System (ITIS). 2015. *Rhodeus sericeus*. Integrated Taxonomic Information System, Reston, Virginia. Available: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=163607. (June 2015).

Konečná, M., C. Smith, and M. Reichard. 2010. Population and individual consequences of breeding resource availability in the European bitterling (*Rhodeus amarus*). Behavioral Ecology and Sociobiology 64(7):1069-1079.

Kozhara, A. V., A. V. Zhulidov, S. Gollasch, M. Przybylski, V. G. Poznyak, D. A. Zhulidov, and T. Y. Gurtovaya. 2007. Range extension and conservation status of the bitterling, *Rhodeus sericeus amarus* in Russia and adjacent countries. Folia Zoologica 56(1):97-108.

Nico, L., and P. Fuller. 2015. *Rhodeus sericeus*. USGS Nonindigenous Aquatic Species Database, Gainesville, Florida. Available: http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=643. (June 2015).

Ondračková, M., P. Jurajda, and M. Gelnar. 2002. The distribution of *Posthodiplostomum cuticola metacercariae* in young-of-the-year cyprinid fishes. Journal of Fish Biology 60:1355–1357.

Reichard, M., M. Ondračková, M. Przybylski, H. Liu, and C. Smith. 2006. The costs and benefits in an unusual symbiosis: experimental evidence that bitterling fish (*Rhodeus sericeus*) are parasites of unionid mussels in Europe. Journal of Evolutionary Biology 19:788–796.

Sanders, S., C. Castiglione, and M. Hoff. 2014. Risk Assessment Mapping Program: RAMP. US Fish and Wildlife Service.

Schmidt, R. E., and J. McGurk. 1982. Biology of the European bitterling *Rhodeus sericeus* (Pisces: Cyprinidae) in the Bronx River, New York, USA: an apparently benign exotic species. Biological Conservation 24:157-162.

Smith, C., M. Reichard, P. Jurajda, and M. Przybylski. 2004. The reproductive ecology of the European bitterling (*Rhodeus sericeus*). Journal of Zoology (London) 262:107-124.

Schofield, P. J., J. D. Williams, L. G. Nico, P. Fuller, and M. R. Thomas. 2005. Foreign nonindigenous carps and minnows (Cyprinidae) in the United States - a guide to their identification, distribution, and biology. U.S. Geological Survey Scientific Investigations Report 2005-5041. Available: http://fl.biology.usgs.gov/Carp_ID/html/rhodeus_sericeus.html. (June 2015).

10 References Quoted But Not Accessed

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

Bade, E. 1926. The central European bitterling found in the States. Bulletin of the New York Zoological Society 29:188, 205-6.

Bartošová, S., P. Jurajda, and M. Ondračková. 1999. Posthodiplostomosis of 0+ juvenile cyprinid fish. Helminthologia 36:123–136.

Berg, L. S. 1949. Freshwater fishes of the USSR and adjacent countries. Vol. 2, 3. 469–925; 926–1382. Izd-vo Akademii Nauk SSSR, Moskva-Leningrad (in Russian).

Billard, R. 1997. Les poissons d'eau douce des rivières de France. Identification, inventaire et répartition des 83 espèces. Delachaux & Niestlé, Lausanne, Switzerland.

Confortini, I. 1992. Presenza del rodeo amaro, *Rhodeus sericeus* (Pallas, 1776) nel Fiume Menago (provincia di Verona) (Pisces, Cyprinidae). Bollettino del Museo Civico di Storia Naturale di Verona 16:329-332.

Economidis P. S., E. Dimtriou, R. Pagoni, E. Michaloudi, and L. Natsis. 2000. Introduced and translocated fish species in the inland waters of Greece. Fishery Management Ecology 7:239-250.

Gerstmeier, R., and T. Romig, 1998. Die Süßwasserfische Europas: für Naturfreunde und Angler. Franckh-Kosmos Verlag, Stuttgart, Germany.

Greeley, J. R. 1937. Fishes of the area with annotated list. Pages 45-53 *in* A biological survey of the lower Hudson watershed. Supplemental to Twenty-sixth Annual Report, 1936. New York Conservation Department, Albany, New York.

Holčík, J. 1995. *Rhodeus sericeus*. Pages 208-215 *in* V. Baruš and O. Oliva, editors. Mihulovci petromyzontes aryby osteichthyes. Academia, Prague.

Holčík, J. 1999. *Rhodeus sericeus*. Pages 1-32 *in* P. M. Bănărescu, editor. The freshwater fishes of Europe 5 I. Cyprinidae. AULA-Verlag, Wiebelsheim, Germany.

Holčík, J., and L. Jedlicka. 1994. Geographical variation of some taxonomically important characters in fishes: the case of the bitterling *Rhodeus sericeus*. Environmental Biology of Fishes 41:147-170.

Kottelat, M. 1997. European freshwater fishes. Biologia (Bratisl.) 52(Suppl. 5):1–271.

Lee, D. S., C. R. Gilbert, C. H. Hocutt, R. E. Jenkins, D. E. McAllister, and J. R. Stauffer, Jr. 1980. Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh, North Carolina.

Lever, C. 1977. The naturalised animals of the British Isles. Hutchinson and Co., London.

Møller, P. R., and T. Menne. 1998. Bitterling *Rhodeus sericeus* (Pallas, 1776) – first record from Denmark. Flora og Fauna 104:29–34 (in Danish with English summary).

Myers, G. S. 1925. Introduction of the European bitterling (*Rhodeus*) in New York and of the rudd (*Scardinius*) in New Jersey. Copeia 140:20-21.

Page, L. M., and B. M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston.

Pinder, A. C. 2001. Keys to larval and juvenile stages of coarse fishes from fresh waters in the British Isles. Freshwater Biological Association, The Ferry House, Far Sawrey, Ambleside, Cumbria, United Kingdom. Scientific Publication No. 60.

Przybylski, M., and G. Ziêba. 2000. Microhabitat preferences of European bitterling, *Rhodeus sericeus* in the Drzewiczka River (Pilica basin). Polish Archives of Hydrobiology 47:99-114.

Reichard, M. 1998. A morphological comparison of riverine and oxbow bitterling populations with respect to allometric growth. Folia Zoologica 47:65–73.

Reichard, M., P. Jurajda, M. Šimková, and I. Matějusová. 2002. Size-related habitat use by bitterling (*Rhodeus sericeus*) in a regulated lowland river. Ecology of Freshwater Fish 11:112–122.

Riehl, R., and H. A. Baensch. 1991. Aquarien Atlas. Band. 1. Mergus, Verlag für Natur-und Heimtierkunde, Melle, Germany.

Schäperclaus, W. M. 1979. Fish diseases. Academie Verlag, Berlin (in German).

Schmidt, R. E., J. M. Samaritan, and A. Pappantoniou. 1981. Status of the bitterling, *Rhodeus sericeus*, in southeastern New York. Copeia 1981:481-482.

Scott, W. B., and E. J. Crossman. 1979. Freshwater fishes of Canada, 2nd edition. Bulletin of the Fisheries Research Board of Canada 184:1-966.

Smith, C. L. 1985. The inland fishes of New York State. New York State Department of Environmental Conservation, Albany.

Svetovidov, A. N., and G. K. Eremeev. 1935. On the European and Amur bitterling (*Rhodeus sericeus*). Doklady Akademii Nauk SSSR 1:582–587.

Wheeler, A. 1978. Key to the fishes of Northern Europe. Warne, London.

Wheeler A., and P. S. Maintland. 1973. The scarcer freshwater fishes of the British Isles I. Introduced species. Journal of Fish Biology 5:49–68.

Witkowski, A., and M. Rogowska. 1991. Breeding tubercles in some European cyprinid fishes. Zoologische Abhandlungen 46: 131–156.