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Parasites of the recently established round goby (*Neogobius melanostomus*) and tubenose goby (*Proterorhinus marmoratus*) (Cottidae) from the St. Clair River and Lake St. Clair, Michigan, USA

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Abstract. Specimens of the recently established European round goby (*Neogobius melanostomus* Pallas, 1811) and tubenose goby (*Proterorhinus marmoratus* Pallas, 1811) were collected from different locations in the St. Clair River and Lake St. Clair, USA and were examined for parasites. Parasites were observed in 76% of the round gobies and 35% of the tubenose gobies. Four species of parasites in the gobies occur in the Black Sea watershed. Two of them have been reported in North America for the first time: *Sphaeromyxa sevastopoli* Naidenova, 1970 and *Ichthyocotylurus pileatus* (Rudolphi, 1802). Three parasite species found in the gobies are endemic to North America and were most likely obtained locally.

The establishment of exotic fishes in the Laurentian Great Lakes, Michigan, USA, has become common. The current assemblage of fishes in these waters includes 25 naturalized species that were either deliberately introduced, accidentally introduced, or entered by means of dispersal through man-made canals or ballast water discharged from shipping (Mills et al. 1993). Two of the most recently established fishes are European species of Gobiidae, the round goby (*Neogobius melanostomus* (Pallas, 1811)) and tubenose goby (*Proterorhinus marmoratus* (Pallas, 1811)); they were probably introduced via ballast water discharge and are now common throughout the St. Clair River and Lake St. Clair (Jude et al. 1992).

The problem of the impact of the introduced species on the Great Lakes ecosystem has been given much attention. In addition to habitat, trophic, spatial, and gene pool interactions, Kohler and Courtenay (1986), identified the introduction of diseases as a category of negative impact from introduced species. Mills et al. (1993) identified the following significant pathogens as having been introduced with fish into the Great Lakes Basin: the bacteria *Aeromonas salmonicida*, causative agent of furunculosis; the microsporidian *Glugea hertwigi*, that infests rainbow smelt; and the myxosporean *Myxosoma cerebralis* which causes whirling disease of salmonid fish. Inadvertently introduced parasites and diseases have had pathogenic impacts on native species of fish (Bauer and Hoffman 1976, Pronin 1982, Buchmann et al. 1987, Post 1987, Johnsen and Jensen 1988, Halvorsen and Hartvigsen 1989). Our objective was to identify the parasite fauna of the recently established European species of gobies and to identify their potential for causing disease problems to endemic fishes in the Great Lakes.

MATERIALS AND METHODS

Round and tubenose gobies (*Neogobius melanostomus* and *Proterorhinus marmoratus*) were collected from one location in Lake St. Clair with a bottom trawl (with a 4.0 m headrope and 9.5 mm mesh codend) and from two locations in the St. Clair River by hook-and-line during 4–11 August 1994 (Fig. 1). All fish were placed in aerated aquaria filled with water from the collection site. After 1 to 3 days, the gobies were transferred to the laboratory.

In the laboratory, specimens were killed and examined for parasites on gills, fins, in viscera, and flesh following standard procedure (Bykhovskaya-Pavlovskaya 1985). Parasites were identified according to Hoffman (1967), Shulman (1984), Gusev (1985) and Bauer (1987). Quantitative infection indices were calculated as described by Margolis et al. (1982). Permanent mounts were made of single specimens of all taxa. A maximum of 20 gobies were examined from each site (Table 1). We collected round gobies at all sites, whereas tubenose gobies were found only in Lake St. Clair. The mean length of round gobies was greatest at the Port Huron site on the St. Clair River and was related to a higher proportion of females. The tubenose gobies were mostly juveniles, in contrast to the round gobies which were all mature adults (Table 1).

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Table 1. Length, weight, numbers by sex, and dates for round and tubenose gobies collected in the St. Clair River and Lake St. Clair.

	Round goby *Neogobius melanostomus*						Tubenose goby *Proterorhinus marmoratus*	
	St. Clair River near Marine City		St. Clair River near Port Huron		Lake St. Clair		Lake St. Clair	
Total length (mm)	74–120	96.00	101–149	121.00	64–89	74.00	37–57	51.00
Weight (g)	4.4–23.6	11.00	11.1–54.8	22.80	2.8–7.2	4.70	0.5–1.8	1.20
Number by sex (male/female/juv.)	13/7/0		7/13/0		5/1/0		3/0/17	
Date of collection	4–7 Aug. 1994		8–9 Aug. 1994		11 Aug. 1994		10–11 Aug. 1994	

RESULTS

Round goby *Neogobius melanostomus*

Ten species of parasites of 5 classes were found in the round gobies (Table 2). Most parasites occurred as larvae, except for *Sphaeromyxa sevastopoli, Chilodonella* sp., *Apiosoma* sp., and *Leptorhynchoides thecatus.*

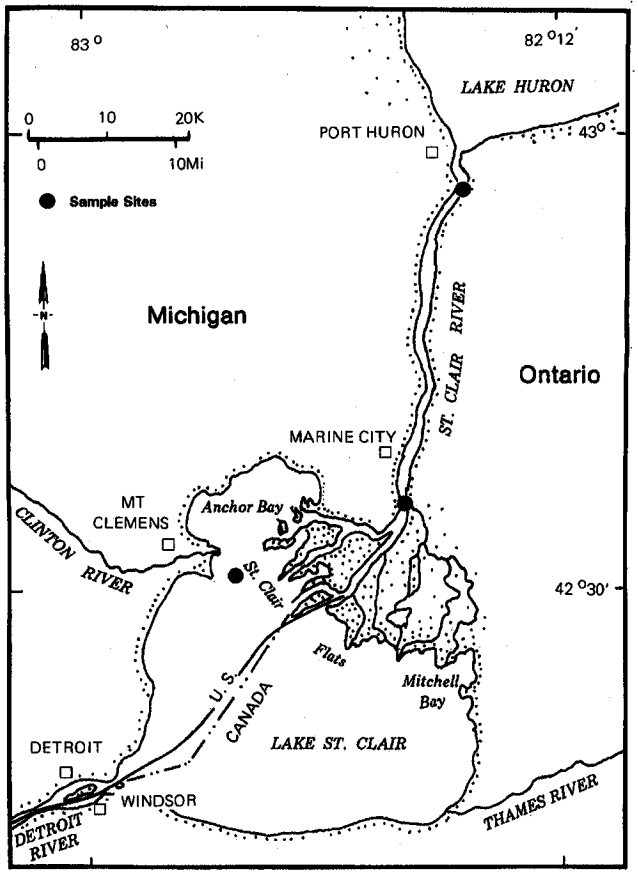

Fig. 1. Map of the St. Clair River and Lake St. Clair with collection sites (shown with filled circles) for round gobies an d tubenose gobies. —·— – border between USA and Canada; —— – fairway

Fins of one goby were infected by fungus *(Saprolegnia* sp*)*. Seventy-six percent (35/46) of the round gobies were infected with one or more parasites (Table 2). The most common parasite of the round gobies, *Diplostomum spathaceum,* occurred in 65% of fish collected near Port Huron. In contrast, only 5% of the gobies were infected with *Clinostomum complanatum* and *Eustrongylides tubifex.* Mean intensities of infection for all parasites ranged from 1–5.5 individuals per fish (Table 2).

Tubenose goby *Proterorhinus marmoratus*

Six species of parasites of 6 classes were found in the tubenose gobies (Table 2). Three of these species occurred also in the round gobies. Thirty five percent (7/20) of the tubenose gobies examined were infected by parasites. Mean intensities of infection ranged from 1–1.3 parasites.

Characteristics of parasites

Below we give brief characteristics of parasites found in both fish species. Parasites are listed alphabetically by class. Epizootic significances and specificity have been cited for potentially harmful species and specific for hosts.

Myxozoa

Sphaeromyxa sevastopoli Naidenova, 1970. Single sporocysts were found in gall bladders of both goby species. Specific parasite of some species of Black Sea gobies including tubenose goby. Specific to brackish water. This species had not been recorded in North America, previously.

Ciliophora

Chilodonella sp. found on skin and gills of one tubenose goby. Members of this genus are common parasites of many freshwater fish but have not been reported in marine species such as the two species of gobies. The species detected is similar to *C. piscicola*

Table 2. Prevalence and mean intensity of infection for parasites in round gobies and tubenose gobies from St. Clair River and Lake St. Clair, August 1994.

Parasite		Round goby *(Neogobius melanostomus)*						Tubenose goby *(P. marmoratus)*	
		St. Clair River (Marine City) n = 20		St. Clair River (Port Huron) n = 20		Lake St. Clair n = 6		Lake St. Clair n = 20	
		Prevalence (%)	Mean intensity	Prevalence (%)	Mean intensity	Prevalence (%)	Mean intensity	Prevalence (%)	Mean intensity
*Sphaeromyxa sevastopoli**		–	–	25	few	17	few	5	few
Apiosoma sp.		10	few	20	few	–	–	5	few
Chilodonella sp.		–	–	–	–	–	–	5	few
Proteocephalus ambloplitis **	plerocercoid	10	1	5	1	–	–	–	–
Proteocephalus sp.		–	–	–	–	–	–	5	1
*Scolex pleuronectis**	plerocercoid	10	1.5	–	–	17	1	–	–
Clinostomum complanatum	metacercaria	5	1	–	–	–	–	–	–
*Ichthyocotylurus pileatus**	metacercaria	–	–	–	–	34	1	–	–
*Diplostomum spathaceum**	metacercaria	10	2	65	2.2	34	5.5	–	–
Rhipidocotyle sp.	metacercaria	10	1	–	–	–	–	–	–
Raphidascaris acus	larva	10	1	15	2	50	2.3	15	1.3
Eustrongylides tubifex	larva	5	4	10	1	–	–	–	–
*Leptorhynchoides thecatus***		–	–	–	–	–	–	5	1

* occurs in Black Sea watershed

** endemic to North America

(Zacharias, 1894), which is also known as *C. cyprini* Moroff, 1902 in Eurasia and North America. This species often causes disease in hatchery fish (Bauer et al. 1977).

Apiosoma sp. Single individuals were found on skin and fins of the round goby. The representatives of the genus *Apiosoma* are freshwater parasites and have not been reported from marine species of *Gobiidae*.

Cestoda

Scolex pleuronectis Müller, 1788 larv. Plerocercoids of this species complex were detected in the intestinal walls of two round gobies. This species complex is very common in marine, brackish and diadromous fish (e.g. Cottidae, Salmonidae) and is reported for the first time from freshwater basins of North America.

Proteocephalus ambloplitis (Leidy, 1887). Single plerocercoids of this cestode were detected in the intestines of three round gobies. This freshwater species is endemic to North America.

Proteocephalus sp. One young specimen (length of 2.5 mm) of this genus was found in the intestine of a single tubenose goby.

Digenea

Rhipidocotyle sp. larv. Metacercariae were found in the gills of one round goby.

Clinostomum complanatum (Rudolphi, 1819) larv. Metacercariae were found beneath the mucosa of the oral cavity in a round goby from the St. Clair system. A common parasite of fish from North America and southern Europe.

Diplostomum spathaceum (Rudolphi, 1819) larv. This common parasite infects the crystalline lens of both goby species. This was the most prevalent parasite found in the gobies from the St. Clair system.

Ichthyocotylurus pileatus (Rudolphi, 1802) larv. Metacercariae were found in the body cavity of two round gobies. This parasite is reported for the first time in North America.

Nematoda

Raphidascaris sp. larv. Single specimens were found in the liver of both goby species from all sites. This parasite can be potentially pathogenic to the recently established gobies. Cases of epizootic raphidascaridosis were reported in Russia (Bauer et al. 1977).

Table 3. Taxonomic and ecological comparison of parasites of tubenose goby and round goby from the Black Sea watershed and the St. Clair system.

	Black Sea			Lake St. Clair /St. Clair River		
Class	Tubenose goby	Round goby	Combined	Tubenose goby	Round goby	Combined
Microsporidia	1	1	1	0	0	0
Myxozoa	4	1	5	1	1	1
Cyrtostomata	0	0	0	1	0	1
Peritricha	3	6	7	1	1	1
Monogenea	1	1	1	0	0	0
Cestoda	2	4	4	1	2	3
Trematoda	9	23	26	0	4	4
Nematoda	0	6	6	1	2	2
Acanthocephala	1	2	2	1	0	1
Hirudinea	1	0	1	0	0	0
Bivalvia	1	1	2	0	0	0
Crustacea	0	5	5	0	0	0
Marine species	13	14	20	1	1	1
Freshwater species	5	14	16	5	9	11
Brackish-water species	5	22	24	0	1	1
Total	23	50	60	6	10	13

Eustrongylides tubifex (Nitzsch, 1819) larv. Encapsulated larvae occurred on the intestinal walls of round goby. This nematode is a parasite of piscivorous birds in Eurasia and North America. The life-cycle involves oligochaetes as first intermediate hosts and fish as second intermediate hosts.

Acanthocephala

Leptorhynchoides thecatus (Linton, 1891). One female was found in the intestine of a tubenose goby. This parasite occurs in many North American fish species.

DISCUSSION

Sixty species of parasites have been reported from the round and tubenose gobies in their native waters of the Black, Azov and Caspian Seas (Bykhovskaya-Pavlovskaya et al. 1962, Naidenova 1974, Greze et al. 1975, Shulman 1984, Gusev 1985, Bauer 1987) – see Table 3. The endemic parasites of these gobies are typically marine and brackish-water species that are characterized by a small proportion of species with a direct life-cycle (Protozoa and Monogenea) and the predominance of trematodes (40% and 46% of total species of parasites in round and tubenose gobies, respectively). Four species of parasites in gobies from the St. Clair system also occur in the Black Sea watershed: *Sphaeromyxa sevastopoli, Scolex pleuronectis, Icthyocotylurus pileatus* and *Diplostomum spathaceum.* The first three species are reported for the first time in North America. The last two species are widespread and have a broad range of hosts. We believe that myxosporidian *S. sevastopoli* was introduced with the gobies because this parasite being specific to the gobies is endemic to the Black Sea watershed.

Two parasite species found in the gobies are endemic to North America: *Proteocephalus ambloplitis* and *Leptorhynchoides thecatus.* These parasites have a broad range of hosts and were undoubtedly obtained locally.

As expected, many parasites specific to marine and brackish waters were not detected, excluding *S. sevastopoli* and *S. pleuronectis,* in the recently established gobies.

The combined parasite fauna of both gobies in the Black Sea watershed was 60 species (Table 3). At any given location in the Black Sea watershed, however, the number of parasites on either goby is usually only 10 to 15 species (Naidenova 1974), which is comparable to the numbers we found associated with round goby (10 species), but greater than those in tubenose goby (6 species) in the St. Clair system (Table 3). Larger sample sizes would be needed to detect rare occurrences of parasites in the gobies.

The parasite species composition of the round goby is richer than that of tubenose goby in both the Black Sea and St. Clair system (Table 3). This difference in diversity is probably explained by wider use of different

habitats by the round goby (Naidenova 1974). The only distinct difference between the infection of round goby comparing Port Huron and Marine City is the infection by metacercariae of *D. spathaceum* (Table 2). The large proportion of infected round goby from Port Huron could indicate a relatively greater abundance of the molluscs of genus *Lymnaea*, intermediate hosts of *D. spathaceum* in this area.

The most prominent feature of the parasite fauna in these recently established gobies is the relatively low infection rate. The prevalence of parasites of both round and tubenose gobies in the native Black Sea was typically 100 % with mean intensity of about 1,000 parasites per fish (Naidenova 1974).

Another feature is the impoverishment of the parasite fauna of the exotic gobies, which may have several causes. Impoverishment of parasite fauna in fish is common if fish invade new water bodies where their closely related species are absent (Bauer and Hoffman 1976, Bauer 1991). The principal cottid species in the St. Clair system, the mottled sculpin *(Cottus bairdi)*, is currently not abundant and has declined recently in conjunction with the establishment of the gobies (Jude et al. 1995). Food is another important source by which fishes acquire new parasites. The tubenose and round gobies are specialized molluscivores (Naidenova 1974). In Lake St. Clair, the diet of round gobies, especially larger fish, includes zebra mussels *(Dreissena polymorpha)* (Jude et al. 1995), a recently established exotic mollusc that has become very abundant in the St. Clair River and Lake St. Clair (Griffiths 1993). We also found zebra mussels to be an important food item in the gobies' stomachs. Toews et al. (1993) reported very low infection of parasites in zebra mussels from Lake St. Clair. Zebra mussels do not appear to be a significant potential source of infection.

The relative poverty of the parasite fauna in the recently established gobies is probably due to poor survival of endemic European marine and brackish water parasites in freshwater (we assume a typical parasite load on the source gobies) combined with a lack of related native fish species (e.g. Cottidae) or associations with other sources of local parasites (e.g. diet) in the St. Clair system.

However, the process of acquiring local parasites is probably not complete for the gobies, especially given the current dynamic nature of the biota in the St. Clair. We would expect an increase in future infection parameters and perhaps the appearance of additional parasites for which these gobies are suitable hosts. The infection rates of the two invaders by native pathogenic parasites is currently low, and it is unlikely that these parasites could regulate the goby populations.

The round and tubenose gobies do not appear to represent a risk as vectors for introduced pathogenic parasites due to low infection of the marine species of parasites.

We agree with the opinion that the gobies, especially the round goby, appear to have a greater potential for negative impact on endemic fish by competitive interactions (Jude et al. 1995). The gobies may, however, play a positive role in the regulation of the abundance of the zebra mussel, another invader.

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