Nest Defense by the Non-indigenous Fish, the Round Goby, *Neogobius melanostomus* (Gobiidae), on a Shipwreck in Western Lake Erie

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This is the first documentation of nest defense by a male Round Goby (a non-indigenous fish) on an exposed nest in North America. Our observation of Round Goby nesting behaviour on a shipwreck in the western basin of Lake Erie using a video camera indicate that these fish spawn at much greater depths (7–11 m) than previously reported (≤ 2 m). Of species that approached the nest (Rock Bass, *Ambloplites rupestris*; Smallmouth Bass, *Micropterus dolomieu;* Yellow Perch, *Perca flavescens*; Logperch, *Percina caprodes*; Round Gobies, *Neogobius melanostomus*), most behavioural interactions occurred between the guarding male and other Round Gobies. During 12 min of observation, there were 63 instances in which a Round Goby approached the nest and in four cases, intruders fed on eggs at the periphery of the nest. In response, the guarding male approached (34 times), chased (18 times) and hit (4 times) Round Goby intruders. Response by the resident goby to the presence of Rock Bass (one swam by and seven approached) resulted in six approaches, four chases and one hit. The resident male responded to juvenile Smallmouth Bass (three swam by and seven approached) only once by approaching the intruder. The guarding male did not respond to either Logperch or Yellow Perch, but too few events were observed to suggest that the absence of a response by a male was typical. We anticipate that recruitment of Round Gobies will increase substantially in Lake Erie owing to the presence of artificial reefs (shipwrecks) and the ability of guarding males to defend nests effectively.

Key Words: Round Goby, *Neogobius melanostomus*, non-indigenous fish, nest defense, shipwrecks, Lake Erie.

Two bottom-dwelling fishes, *Neogobius melanostomus* (Round Goby) and *Proterorhinus marmoratus* (Tubenose Goby), of the family Gobiidae and native to the Black and Caspian seas, were first discovered in the St. Clair River in 1990 (Crossman et al. 1992; Jude et al. 1992). Although the smaller Tubenose Goby is limited to the St. Clair River, Lake St. Clair, Detroit River, and sites along the north shore of western Lake Erie (Corkum, personal observation), the Round Goby has dispersed rapidly to all five Great Lakes (Jude 1997). Reasons for the proliferation of Round Gobies include the ability of larger (total length >7 cm) fish to eat readily available Zebra Mussels (*Dreissena polymorpha*) (Ray and Corkum 1997) and the habit of Round Gobies to spawn repeatedly (every 3 to 4 weeks) throughout spring and summer (Charlebois et al. 1997). In the Detroit River, Round Gobies were observed to spawn from early June until August (MacInnis 1997). Round Goby males maintain and defend nests of eggs deposited by several females (Miller 1984; MacInnis 1997).

The persistence of a species depends on the existence of local populations (Hanski and Simberloff 1997). In the summer of 1997, we observed spatially isolated reproducing populations of Round Gobies on shipwrecks (*Conemaugh, George Stone, Northern Indiana* and *Wilcox*) in western Lake Erie at greater depths (7–11 m) than typically reported (0.2 to 2 m) (Charlebois et al. 1997; MacInnis 1997). There are 4670 shipwrecks in Canadian waters of Lakes Erie and Huron including more than 200 wrecks in the Pelee Passage of Lake Erie (Kohl 1995). Since Round Gobies prefer rocky habitats (personal observation), complex structures such as shipwrecks and natural reefs (rocky islands within a matrix of soft sediments) are likely locations for breeding populations. Shipwrecks may be particularly attractive to Round Gobies if predation risk (to eggs, juveniles, and adults) is reduced The increased habitat complexity (shelter) and availability of food (Zebra Mussels) on shipwrecks provides ideal habitat for Round Gobies.

In this paper, we document the defense by a male Round Goby of an exposed nest on a shipwreck, the schooner, *M. I. Wilcox*, in western Lake Erie. This is the first documentation of nest defense by Round Gobies in North America.

Methods

Observations were conducted on the shipwreck, the *M. I. Wilcox* (41° 59′ N, 82° 57′ W) about 0.6 km offshore of Colchester, Ontario, in western Lake Erie. The schooner, 42.7 m long, sank in 1906 in water 7 m deep. ErieQuest, a marine heritage organization, and the Canadian Coast Guard provided a mooring buoy at this and other shipwrecks for public exploration.

Using SCUBA, R. G. Wickett identified a nest defended by a male Round Goby on 19 August 1997. To expose the nest, the top covering, an iron pulley,

was removed and subsequent interactions between the guarding male and other fishes were videotaped using a video camera recorder (Sony® Hi8 model CCD-TR910) and underwater Amphibico® housing unit. The video camera was placed on a tripod and the SCUBA diver withdrew from the immediate area. Behavioural interactions on the exposed nest were recorded for 11 min 43 sec (7:32 to 7:44 p.m. EDT) before the battery ran low. The cover of the nest was then replaced and all recording gear was removed.

Videotape was analysed by noting, in order of degree of threat, the number of times individuals of each fish species (intruders) swam by the nest, approached the nest, or ate eggs. In addition, the number of times and types of response (approach, chase, hit), by the resident male were recorded. An "approach" was an orientation and slow movement or advance toward another fish. A "chase" was a quick movement or dart toward another fish. Both "approach" and "chase" resulted in the intruder moving away from the nest. A "hit" occurred when the resident round goby butted or forcibly touched another fish. Figure 1 illustrates a "hit" by the guarding Round Goby against a Rock Bass (*Ambloplites rupestris*). Occasionally, an approach was followed by a chase so these behaviours were not always independent. A hit was always preceded by a chase. Since parental males are distinctive in colour (charcoal black with a white or an orange line along the edge of the fins), the resident Round Goby was easily identified and distinguished from other fishes. Fish lengths were estimated using a known width of an object in the field of view.

Results and Discussion

The Round Goby nest was found on the keelson, a long wooden beam lying above the keel of the schooner. The schooner lies collapsed but upright on the lake bottom. A steel pulley formed the top of the nest and the floor of the nest was a shallow hollow in the wooden beam. Before the nest was exposed, the snout of the guarding male was observed extending out of the single opening. Typically, the guarding male positions himself with his head at the entrance of the nest and nips at intruders. In response to the presence of small (about 5 cm in total length) Round Gobies that approached the area, the breeding male (total length: 11.6 cm) darted forward so that its body extended out of the nest to a point where the fused pelvic fin joined the body.

FIGURE 1. A "hit" by a nest-guarding Round Goby against a Rock Bass from a videotape taken by Bob Wicket (see text for details).

Once the top of the nest was pulled back and placed upright at one end of the nest, the male left the nest, swam < 30 cm away and returned within 19 sec. During the 12-min observation period, the male would often position himself in the hollow or groove of the nest on top of the eggs, moving back and forth within the groove. The male also would dart haphazardly to different locations about the nest.

The oval eggs were packed together in a single layer on the floor of the nest, covering an area of about 35.5 cm^2. In gobiids, eggs are usually attached to the ceiling of nests. The "hanging" position and ovoid egg shape presumably aid in nest maintenance as the male can move the water around egg surfaces so that sediment particles can be easily shed (Miller 1984). Our observations of eggs on the floor of this nest and others on another shipwreck, the *Conemaugh* (41° 55′ N; 82° 31′ W), located offshore of Point Pelée, suggest that Round Gobies are more flexible in the positioning of eggs in nests than previously reported (Charlebois et al. 1997). The deposition of eggs on the floor of the nest may affect egg survival if increased effort is required by males for nest maintenance.

Five fishes including *Ambloplites rupestris* (Rock Bass), *Micropterus dolomieu* (Smallmouth Bass), *Perca flavescens* (Yellow Perch), *Percina caprodes* (Logperch), and *Neogobius melanostomus* (Round Goby) approached the exposed nest or appeared within the field of view of the camera (20 cm wide) near the nest. A Freshwater Drum (*Aplodinotus grunniens*) also approached the nest, but did not enter the camera's field of view. Each fish that approached the nest could not be identified individually and so the same fish may have left the field of view to reappear later.

Of the five species, most behavioural interactions occurred between the guarding male and other Round Gobies (Table 1). Intruding Round Gobies were typically half the body length or less of the resident male. The sex of Round Goby intruders could not be determined from the video, but all exhibited pale mottled gray and white colours with a distinctive black dot on the dorsal fin. None of the intruders exhibited the charcoal black colouration of breeding males. Of the 65 times that a Round Goby appeared within the field of view, two fish swam by and 63

TABLE 1. Behavioural interactions exhibited by the intruder and the response by the resident male Round Goby on an exposed nest located on a shipwreck, *M. I. Wilcox*, offshore of Colchester, western Lake Erie.

	Intruder			Resident Male		
Species	Number of times fish swam by	Number of approaches	Number of times eggs were eaten	Number of approaches	Number of chases	Number of hits
Rock Bass	1	7	0	6	4	1
Smallmouth Bass	3	7	0	1	0	0
Yellow Perch	1	0	0	0	0	0
Logperch	2	1	0	0	0	0
Round Goby	2	63	4	34	18	4

approaches were noted. In response, the guarding male approached (34 times) or chased (18 times) Round Goby intruders. These approach and chase behaviours were independent events. Four of the 63 approaches by Round Goby intruders resulted in fish eating eggs from the periphery of the nest. In three of the four cases in which eggs were eaten, the resident goby was distracted by the presence of fish other than the successful egg eater (once, by the presence of a Logperch and another Round Goby intruder; a second time by the presence of a Rock Bass; and a third time by the presence of another Round Goby intruder). In all four cases, the resident goby was facing away from the intruder when eggs were eaten. There was no evidence of co-operation or coordinated activities among intruders. In all cases, the guarding male chased the intruder from the nest. Four hits were recorded by the resident male against Round Goby intruders. During our 12 minutes of observation, the guarding male did not feed on eggs within the nest.

Our observations of fish interactions over exposed nests on another shipwreck, the *Conemaugh*, revealed extended fighting bouts between two guarding Round Gobies. In this case, two nests were adjacent and the interactions occurred over the eggs of one nest. Numerous bites and butts were exchanged between the males. Also, the fish would lock jaws and tug away in opposite directions. Neither male was observed feeding on exposed eggs.

In gobiids, females typically mate with males that already have eggs in their nests (Forsgren et al. 1996; Kraak and Weissing 1996). Since guarding males of many species of gobies are known to eat eggs or offspring (Kraak and Weissing 1996), this strategy may dilute the risk of the breeding male eating newly laid eggs. In this study, the strategy would also dilute the risk of predators eating eggs deposited by a single female. Kovtun (1980) reported high egg mortality in larger nests than smaller ones because larger proportions of eggs are exposed and susceptible to predators when nests are large. However, since eggs of most gobiids are covered completely and nests have one small opening, one would not expect differences in egg mortality by intruders.

Response by the resident goby to the presence of Rock Bass (one swam by and seven approached) resulted in six approaches, four chases and one hit (Table 1, Figure 1). All Rock Bass approaches were followed immediately by a chase. The estimated total length (TL) of Rock Bass ranged from 10.5 to 18 cm.

All Smallmouth Bass that approached the nest were juveniles, characterized by distinctive caudal fins "unmistakably marked orange at base followed by a black band" (Scott and Crossman 1973). The largest Smallmouth Bass observed was about 12 cm TL. The Round Goby approached Smallmouth Bass intruders (three swam by and seven approached), only once. The resident male typically hovered over the nest when either one or two Smallmouth Bass approached.

The resident Round Goby male did not respond to either the presence or approach of Logperch (two swam by, one approached) or Yellow Perch (one swam by). However, too few events were observed to suggest that the absence of a response by the resident male was typical.

We observed nest maintenance behaviours by the resident male. Once, the Round Goby picked up a large piece of debris from the edge of the nest and spit it into the water column. A Yellow Perch appeared, swam by, and captured the discarded debris. This was the only incident of a Yellow Perch appearing in the field of view of the camera. Thus, potential predators that are attracted to exposed nests may obtain energy benefits without interacting directly with prey.

The resident male also exhibited fanning behaviour (a mechanism to disperse debris and increase aeration) over the eggs on the nest. The male fanned the nest three times for 2 sec each time. The three fanning episodes occurred during the last 3 min of the observation period.

Several predators of Round Gobies have been reported in the literature. On the basis of stomach analysis of fish caught in the St. Clair River, Walleye (*Stizostedion vitreum*), Smallmouth Bass, Rock Bass, Tubenose Gobies, Stonecats (*Noturus flavus*) and Yellow Perch all ate Round Gobies (Jude et al. 1995). Anglers use Round Gobies for bait to catch Smallmouth Bass. The presence of Round Gobies in

the Flint and Shiawassee rivers in central Michigan are likely the result of bait bucket transfers (D. Jude, CGLAS, University of Michigan, Ann Arbor, personal communication). To limit the distribution of the non-indigenous Round Goby, anglers should be encouraged to empty their bait bucket on land before leaving a waterbody. In Ontario, it is illegal to release baitfish from one waterbody to another (Ontario Ministry of Natural Resources Fact Sheet, undated). Similar regulations exist in the United States.

All types of rocky habitats may be used by Round Gobies, but some locations (i.e., shipwrecks) may be particularly attractive to Round Gobies if predation risk (to eggs, juveniles and adults) is reduced. We suggest that predation rates may be reduced on shipwrecks because of the abundance of cover and crevices available in such a complex structure. In this study, the most successful evidence of predation was by small Round Gobies feeding on eggs at the periphery of the nest. No other predator was successful in preying on eggs in the nest.

Izergyn and Dushkina (1994) reported that Round Gobies spawned on artificial reefs ("polychlorvinyl pipes and polystyrol 'little houses' kapron nets") positioned at depths of 5–7 m in the Sea of Azov. Recruitment of Round Goby stocks increased tenfold during the time (1984–1990) in which the artificial reefs were examined (Izergyn and Dushkina 1994). Although artificial reefs attract several species of fish including piscivores (Brock 1994), these fishes also occupy rocky substrates nearshore. Although it may be unusual for nests to be exposed in nature, it is likely that energetic costs exhibited by males in nest defense are high. Energy costs of nest defense and lack of feeding by guarding males have lead to the assumption that males die after spawning (Charlebois et al. 1997). Thus, predation risk may differ between breeding and non-breeding males. If so, dispersal of male Round Gobies may depend on their mating status. We anticipate that the recruitment of Round Gobies will increase substantially in Lake Erie owing to the presence of artificial reefs (shipwrecks) and the ability of guarding males to defend nests effectively.

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Literature Cited

Brock, R. E. 1994. Beyond fisheries enhancement: artificial reefs and ecotourism. Bulletin of Marine Science 55: 1181–1188.

Charlebois, P. M., J. E. Marsden, R. G. Goettel, R. K. Wolfe, D. J. Jude, and **S. Rudnicka.** 1997. The round goby, *Neogobius melanostomus* (Pallas), a review of European and North American literature. Illinois-Indiana Sea Grant Program and Illinois Natural History Survey. INHS Special Publication Number 20. 76 pages.

Crossman, E. J., E. Holm, R. Cholmondeley, and **K. Tuininga.** 1992. First records for Canada of the rudd, *Scardinius erythrophthalmus*, and notes on the introduced round goby, *Neogobius melanostomus*. Canadian Field-Naturalist 106: 206–209.

Forsgren, E., A. Karlsson, and **C. Kvarnemo.** 1996. Female sand gobies gain direct benefits by choosing males with eggs in their nests. Behavioural Ecology and Sociobiology 39: 91–96.

Hanski, I., and **D. Simberloff.** 1997. The metapopulation approach, its history, conceptual domain, and application to conservation. Pages 5–26 *in* Metapopulation Biology. *Edited by* I. A. Hanski and M. E. Gilpin, Academic Press, San Diego.

Izergyn, L. V., and **L. A. Dushkina.** 1994. [Abstract] Biotesting of the effects of artificial reefs in the Azov Sea ecosystem. Bulletin of Marine Science 55: 1338.

Jude, D. J. 1997. Round gobies: cyberfish of the third millennium. Great Lakes Research Review 3: 27–34.

Jude, D. J., R. H. Reider, and **G. R. Smith.** 1992. Establishment of Gobiidae in the Great Lakes Basin. Canadian Journal of Fisheries and Aquatic Science 49: 416–421.

Jude, D. J., J. Janssen, and **G. Crawford.** 1995. Ecology, distribution and impact of the newly, introduced round and tubenose gobies on the biota of the St. Clair and Detroit rivers. Pages 447–460 *in* The Lake Huron Ecosystem: Ecology, Fisheries and Management. *Edited by* M. Munawar, T. Edsall, and J. Leach. Ecovision World Monograph Series, SPB Academic Publishing, The Netherlands.

Kohl, C. 1995. Dive Ontario! Privately published by C. Kohl, Chatham, Ontario.

Kovtun, I. F. 1980. Significance of the sex ratio in the spawning population of the round goby, *Neogobius melanostomus*, in relation to year-class strength in the Sea of Azov. Journal of Ichthyology 19: 161–163.

Kraak, S. B. M., and **F. J. Weissing.** 1996. Female preference for nests with many eggs: A cost benefit analysis of female choice in fish with parental care. Behavioural Ecology 7: 353–361.

MacInnis, A. J. 1997. Aspects of the life history of the round globy, *Neogobius melanostromus* (Perciformes: Gobiidae), in the Detroit River. M.Sc. thesis, University of Windsor, Windsor, Ontario.

Miller, P. J. 1984. The tokology of goboid fishes. Pages 119–153 *in* Fish reproduction: strategies and tactics. *Edited by* R. J. Wooton, Academic Press, London.

Ray, W. J., and **L. D. Corkum.** 1997. Predation of zebra mussels by round gobies, *Neogobius melanostomus*. Environmental Biology of Fishes 50: 267–273.

Scott, W. B., and **E. J. Crossman.** 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada. Bulletin 184. 966 pages.

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