

NEW RECORDS FOR THE ALIEN ORIENTAL WEATHERFISH, *MISGURNUS ANGUILLICAUDATUS*, IN THE LAKE MICHIGAN BASIN, INDIANA (CYPRINIFORMES: COBITIDAE)

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ABSTRACT. The oriental weatherfish, (*Misgurnus anguillicaudatus*), a native of southeast Asia, was collected from six locations in the Grand Calumet River, Lake Michigan basin, during the summer of 2005. This loach species was collected in the West Branch from the junction with the Indiana Harbor Canal west to Columbia Avenue, and from the East Branch upstream from the junction to the Kennedy Avenue bridge and throughout the Indiana Harbor Canal to 151st Street bridge. Females collected during mid-June had distended abdomens and were ripe with eggs. Female urogenital pore openings showed that eggs had been extruded and that the species was at the beginning of the spawning period. The discovery of reproducing populations of this alien species increases the total number of fish species known from Indiana to 213 species.

Keywords: Cobitidae, alien species, invasive exotic, nonindigenous species, ship ballast

The oriental weatherfish (*Misgurnus anguillicaudatus*) is a freshwater, subtropical species native to southeast Asia. The species was described from Chusan Island, China (Cantor 1842). The species is considered native to Cambodia (Tirant 1929), China (Walker & Yang 1999) including Hong Kong (Man & Hodgkiss 1981), India (Kapoor et al. 2002), Japan and Thailand (Masuda et al. 1984), Korea (Welcomme 1988), Laos (Kottelat 2001), Myanmar (Talwar & Jhingran 1991), the Russian Federation (Bogutskaya & Naseka 1996), Taiwan (Kottelat 1998), and Viet Nam (Kottelat 2001b).

This species proved successful in the aquarium fish trade and has been introduced widely into other countries where it has escaped and become naturalized (Welcomme 1988). The oriental weatherfish has been introduced and naturalized into Australia (Welcomme 1988), Germany (Freyhof & Korte 2005), Italy (Razetti et al. 2001), Palau (Welcomme 1988), Phillipines (Welcomme 1988), Turkmenistan (Sal'nikov 1998), and the United States including Hawaii (Yamamoto 1992; Fuller et al. 1999).

During investigations of the Grand Calumet River during the summer of 2005, we found oriental weatherfish in the West Branch, East Branch, and the Indiana Harbor Canal. The purpose of this paper is to summarize current knowledge of this species in Indiana and the Lake Michigan drainage.

METHODS

Study area.—The Grand Calumet River comprises a small watershed located in northwestern Indiana (Fig. 1) where it encompasses about 17,500 ha. contained almost entirely within Lake County, Indiana. The Grand Calumet River is about 34 km long and has been designated an Area of Concern by the International Joint Commission. The Grand Calumet River and Indiana Harbor Canal occupy a low-relief area in the glacial bed of geological Lake Chicago. The general flow is sluggish and westward in the East Branch of the Grand Calumet River, east- or westward in the West Branch depending on Lake Michigan levels, and northward in the Indiana Harbor Canal, an artificial connection to Lake Michigan. Land-use disturbance in the area has

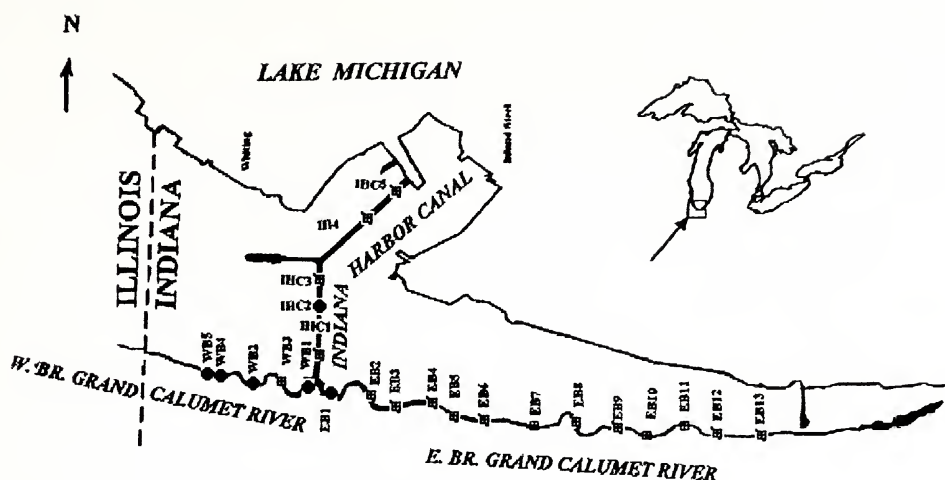


Figure 1.—Study area in the Grand Calumet River and Indiana Harbor Canal Area of Concern showing the 23 study sites (■). Black dots (●) show sites where oriental weatherfish were collected during 2002 and 2005.

been extensive with modification including ditching, channelization, flow modification, development of urban centers, and one of the most concentrated steel and petrochemical industrial complexes in the United States (U.S. EPA 1985).

Community collection and reach selection.—Fish communities were sampled along select reach segments based on previous water and sediment sampling stations above and below point-source discharges in the Grand Calumet River (Simon et al. 1989; Simon & Moy 2000; Simon et al. 2002). Nineteen reaches were evaluated between 13 June and 19 July 2005 to quantify fish assemblage presence in the Grand Calumet River and Indiana Harbor Canal (Fig. 1).

Twenty-three sites were surveyed to assess fish assemblage condition. The West Branch of the Grand Calumet River (WBGCR) had five reaches distributed between Columbia Avenue and the junction with the East Branch at 1) east of Columbia Avenue (WB5), 2) west of Indianapolis Boulevard (WB4), 3) east of Indianapolis Boulevard (WB3), 4) the East Chicago Sanitary District earthen channel (WB2), and 5) the mouth of the West Branch (WB1). The EBGCR had 13 reaches distributed between Broadway Avenue to the junction with the WBGCR. Collection reaches included 1) the mouth of the East Branch (EB1), 2) west of Kennedy Avenue (EB2), 3) east of

Kennedy Avenue (EB3), 4) west of Cline Avenue (EB4), 5) east of Cline Avenue (EB5), 6) east of Clark Road (EB6), 7) east of Bonji (EB7), 8) west of Bridge Street (EB8), 9) east of Bridge Street (EB9), 10) east of Buchanan Street (EB10), 11) west of Buchanan Street (EB11), 12) east of the triple train trestles of USX (EB12), and 13) west of Broadway Avenue (EB13). We also sampled five locations in the Indiana Harbor Canal including 1) the area north of the junction (IHC1), 2) south of Columbus Drive (IHC2), 3) north of Chicago Avenue (IHC3), 4) north of 151st street (IHC4), and 5) south of Dickey Road (IHC5).

Fish species composition and relative abundance (catch-per-unit-of-effort or CPUE is the number of fish/minute of electrofishing effort) data were gathered by performing electrofishing surveys at each river reach using a model 6A Smith-Root boat-mounted electrofisher. Electrofishing surveys included systematic sampling of representative habitat within reaches, including the thalweg or deepest point in the cross sectional profile, usually for distances of 500 m for a minimum of 900 s. Captured fish were placed in an onboard holding tank until sampling was completed. Data recorded for each survey event included species identifications and weights, number of fish caught, examination for external disease and anomalies (DELTS), and sample and habitat conditions.

RESULTS AND DISCUSSION

The presence of reproducing populations of oriental weatherfish in the Grand Calumet River increases the number of naturalized fish species in Indiana to 213 species. We provide a brief history of the species world-wide introduction, occurrence in Indiana and Lake Michigan, and information on the species life history.

History of introductions.—The first reported introductions of *Misgurnus anguillicaudatus* were during the early 1900s until about 1924 from Asia to the Hawaiian Islands of Kauai, Maui and Oahu (Welcomme 1988). The species was introduced from northeast Asia to North America in 1939 for the aquarium trade. As a result of escapes from aquarium fish culture facilities, it became established in California, Idaho and some flood control channels in Michigan (Lake Huron) (Schultz 1960). The species has proven to be difficult to eliminate once established (Courtenay & Hensley 1980). In Trinidad Valley and rice terraces in Bontoc Province, Philippines, the species became established prior to 1937 in some waters where it forms the basis of a local fishery (Juliano et al. 1989). In 1984, the species was accidentally released by aquarists into Lake Burley Griffin, and in the Yarra and Owens rivers, Australia. It became established in the local streams around Canberra, Sydney, New South Wales, and in Victoria. The species was banned from importation to Australia as an aquarium fish due to its documented feral habits (McKay 1989). The only failed introduction of the species was in Mexico. The species had been cultured in the Chapingo Fish Hatchery, but has not been seen since the hatchery was closed (Contreras-B. & Escalante-C. 1984).

Distribution in Indiana and the Lake Michigan drainage.—Page & Laird (1993) and Laird & Page (1996) indicated that the species was probably established in the Chicago Ship Canal, Cook County, Illinois, by 1994 and in the North Shore Channel, Cook County, Illinois prior to 1987. The species was present in tributaries of Lake Michigan and in the Illinois River. Thus, occurrence in Indiana represents a natural range extension of the previously established population in northern Illinois. Nine species including rainbow smelt (*Osmerus mordax*), white perch (*Mo-*

rone americana), and round goby (*Apollonia melanostoma*), have crossed from Lake Michigan into the Illinois River system using the Chicago Sanitary and Ship Canal to expand their range from Lake Michigan to the Illinois River drainage. American eel (*Anguilla rostrata*), gizzard shad (*Dorosoma cepedianum*), goldfish (*Carassius auratus*), yellow bass (*Morone mississippiensis*), skipjack herring (*Also chrysochloris*), and oriental weatherfish have gone from the Illinois River into Lake Michigan.

Misgurnus anguillicaudatus was first collected in Indiana from the West Branch of the Grand Calumet River, Indiana, by Greg Bright and Mike Unger on 4 November 2002. Two specimens were collected using DC boat electrofishing near Hammond Sanitary District, Columbus Drive, Hammond. Earlier electrofishing during 1998 and 1999 by the U.S. Fish and Wildlife Service in the Grand Calumet River found no specimens. During 2002 a specimen was thought to have been observed in the vicinity near Hammond; however, it was not captured.

During June 2005, *Misgurnus anguillicaudatus* were collected from six locations in the Grand Calumet River, Lake Michigan drainage (Fig. 1). A total of 16 individuals was collected from the West Branch Grand Calumet River from all four sites sampled from the mouth of the West Branch at its junction with the Indiana Harbor Canal west to Columbia Avenue (WB1-4). A single specimen was collected from the East Branch Grand Calumet River from the mouth at its junction with the Indiana Harbor Canal upstream to the Kennedy Avenue bridge (EB1). Two specimens were found in the Indiana Harbor Canal upstream of the Columbus Avenue bridge (IHC3).

Habitat and life history.—The native habitat for the species includes mangrove swamps among stream and lake habitats (Kottelat 1998). Oriental weatherfish occur in rivers, lakes and ponds, as well as in swamps and rice fields (Berg 1948–1949). The species prefers muddy bottoms, where individuals hide in the muck and leaf litter with only their heads sticking out. In Hawaii, the species has also been found under mats of honohono (*Commelina diffusa*) and California grass (*Brachiara nuatica*). In our study area, the species was always found slightly buried in

the sediment near areas with woody debris or emergent wetland vegetation.

Oriental weatherfish are omnivorous (Lee et al. 1980), with their diet typically consisting of bottom dwelling animals, such as insect larvae, snails and worms (Sterba 1973). In its native habitat, the species' usual temperature range is from 10–25 °C; however, the species has been known from the Cal Sag Channel, Illinois at lower temperatures (Laird & Page 1996).

The species has a mean population doubling time of 1.4–4.4 yrs with mean female fecundity of 2000 eggs (Berg 1948–1949). We found females ripe with ova in mid-June. Females had urogenital pores that were distended and showed obvious evidence of eggs being extruded, suggesting that the spawning season had just begun.

In conclusion, species introductions, whether intentional or accidental, show that long-range spread of species can occur even after decades of relative inactivity. We do not know the ramifications of the presence of the oriental weatherfish from the Lake Michigan drainage; but based on the experience of others, it will be difficult to eradicate this species from the Lake Michigan nearshore and coastal wetlands. Since it is reproducing in the Grand Calumet River, it will probably not require too long before it will continue to spread elsewhere in the southern Lake Michigan drainage because of its short mean generation time and access through the Indiana Harbor Canal.

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