Bythotrephes cederstroemi in Ohio Reservoirs: Evidence from Fish Diets[1]

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ABSTRACT. **The invading European cladoceran *Bythotrephes cederstroemi*, previously reported in North America from the Great Lakes and inland lakes in Ontario and Minnesota, was found in diets of juvenile largemouth bass (*Micropterus salmoides*) from three Ohio reservoirs in the Ohio River drainage, representing a potential expansion of the range of this exotic species. In summer 1996 samples, we found *B. cederstroemi* in the stomachs of small largemouth bass (37.0-115.0 mm total length) from Knox, Pleasant Hill, and Tappan Reservoirs, all within the Muskingum River watershed. Although uncommon, *B. cederstroemi* occurred in diets collected during mid July and late August.**

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INTRODUCTION

The predaceous European cladoceran *Bythotrephes cederstroemi* (Schoedler) was first discovered in the Laurentian Great Lakes in the 1980s (Garton and others 1993), presumably introduced via freshwater ballast of ships from European ports during peak shipping traffic of the late 1970s and early 1980s (Sprules and others 1990). Commonly known as the spiny water flea, *B. cederstroemi* is a large zooplankter with an average length of approximately 10.0 mm. The majority of the length is a barbed tail spine. More recently, the distribution of *B. cederstroemi* has expanded to include 16 inland lakes in Ontario and 3 inland lakes in Minnesota (Yan and others 1992; Hall and Yan 1997). Its distribution in Europe spans lakes and reservoirs that range widely in size, depth, productivity, and fish communities (Nilsson and Pejler 1973; Hobæk and Raddum 1980; Næsje and others 1987; Ketelaars and others 1995), *B. cederstroemi* will likely find suitable habitat in most inland lakes and reservoirs in temperate North America (Lehman 1987; Yan and others 1992). Herein, we report the occurrence of *B. cederstroemi* in diets of age-0 largemouth bass (*Micropterus salmoides*) in 3 Ohio reservoirs lying outside the Great Lakes basin.

METHODS

As part of a study of factors influencing their recruitment, juvenile largemouth bass were sampled in 1996 using daytime seining and electrofishing surveys on five Ohio reservoirs: Caesar Creek, Delaware, Knox, Pleasant Hill, and Tappan. These reservoirs are warm, shallow eutrophic systems that range from 225-1146 ha, with maximum depths of 8.5-30.0 m and secchi depths of 0.3-1.4 m (Youger 1982). They support typical temperate warmwater fish communities with abundant populations of gizzard shad (*Dorosoma cepedianum*), sunfishes (*Lepomis* spp.), spotted bass (*Micropterus punctulatus*), and largemouth bass (Garvey and Stein 1998; Garvey and others 2000). Zooplankton abundance was not critical to our investigation of largemouth bass recruitment and was not collected. Macrozooplankton communities typical of these reservoirs include small-bodied cladocerans, calanoid and cyclopoid copepods, with copepod nauplii abundant in all seasons. Typical mean zooplankton size range is 0.2-0.6 mm (Bremigan and others 1991).

Largemouth bass were collected in each reservoir every six weeks, from late June through October. Collections were made using 100 min of shoreline electrofishing (DC pulse) and three to five pulls along shore (25 m for each haul) using a seine net 1.8 m depth × 15.0 m length with 3.0 mm mesh. All largemouth bass were measured (nearest mm total length) in the field. At least 25 fish were placed on ice and later frozen to preserve the diets for analysis. Diet items from the largemouth bass stomachs were identified and counted using dissecting microscopes (for more detail see Garvey and others 2000). Water temperatures were recorded 5 to 6 times daily in each reservoir with HoboTemp® data loggers placed at a 1.0-m depth.

RESULTS

B. cederstroemi occurred in juvenile largemouth bass diets from three of our five study reservoirs: Knox, Pleasant Hill, and Tappan (Table 1), all found in the Muskingum River watershed. *B. cederstroemi* were present in the diets of largemouth bass from each of these reservoirs in late August and in the mid-July sample from Tappan reservoir. No *B. cederstroemi* were found in diets from October samples or in mid-July samples from Knox or Pleasant Hill reservoirs. Largemouth bass diets consisted mainly of copepods, cladocerans, macroinvertebrates, and fish. *B. cederstroemi* were rare compared to these prey. Typically, *B. cederstroemi* occurred in multiple pieces with the spine broken away from the body; consequently, we could not measure individual lengths. Of the 16 *B. cederstroemi* found in the diets with intact spines, there were 9 third instar, 6 second instar, and 1 first instar adults.

Largemouth bass that consumed *B. cederstroemi*

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TABLE 1

Percent occurrence of prey types in the diets of age-0 largemouth bass from 1996 when B. cederstromi *was present.*

Lake	Date	# of bass	Temperature	% Occurrence					
				B. cederstroemi	Other Cladocerans	Copepods	Macro-invertebrates	Fish	Empty
Knox	28, 30 Aug	26	26.2, 25.8	19.2	88.5	38.5	88.5	3.8	3.8
Pleasant Hill	28 Aug	27	25.3	7.4	92.6	74.1	59.2	11.1	0.0
Tappan	16 July	30	22.6	3.3	53.3	36.7	66.7	26.7	13.3
Tappan	27 Aug	31	24.4	6.4	32.2	16.1	71.0	29.0	6.4

ranged from 54-96 mm in Knox on 28 and 30 August, 62-111 mm in Pleasant Hill on 28 August and 37 mm on 16 July and 67-115 mm on 27 August in Tappan. These sizes were similar to those for all juvenile largemouth bass found in the reservoirs on the respective sampling dates.

DISCUSSION

The presence of *B. cederstroemi* in inland reservoirs in Ohio demonstrates a range extension in North America from the Laurentian Great Lakes and inland lakes in Ontario and Minnesota to the Mississippi River drainage. Largemouth bass diet, ichthyoplankton, and zooplankton collections from prior years suggest that *B. cederstroemi* was absent or at least below our detection limits in Knox, Pleasant Hill, and Tappan before 1996. Unfortunately, we did not sample zooplankton in 1996 and, therefore, we cannot estimate *B. cederstroemi* abundances or determine the impact of this exotic species in these reservoirs. As was found in Harp Lake, Canada (Yan and others 1992), establishment of *B. cederstroemi* in Ohio reservoirs could lead to the reduction of small-bodied zooplankton, which are important as food for larval fishes (Bremigan and Stein 1994).

Similar to other invading species in North America, such as the zebra mussel (*Dreissena polymorpha*; Griffiths and others 1991) and the rusty crayfish (*Orconectes rusticus*; Ludwig and Leitch 1996), we suspect humans facilitated the introduction of *B. cederstroemi* into Ohio reservoirs. *B. cederstroemi* was likely transported via live wells, bait buckets, or fishing line from Lake Erie, and then further transported among the reservoirs, which are close to each other geographically. The three reservoirs where we observed *B cederstroemi* in largemouth bass diets are in separate subwatersheds, indicating that passive downstream transport from a single upstream introduction could not account for the pattern of occurrence.

Given the typical pelagic distribution of *B. cederstroemi* (Garton and others 1993), we would have expected to find it in diets of fishes with more pelagic distribution than juvenile largemouth bass. Age-0 largemouth bass occupy the shallow inshore (<1.0 m) in Ohio reservoirs, feeding on zooplankton, macroinvertebrates and small fishes (Garvey and Stein 1998). Largemouth bass have large relative gapes and diets that routinely include spined fish, suggesting an ability to handle spiny zooplankters (Hambright 1991; Garvey and Stein 1998) and permitting the inclusion of *B. cederstroemi* in the diet when smaller than other fish species that routinely eat the zooplankteer (Barnhisel and Harvey 1995).

The Ohio reservoirs we studied appear to be less than ideal habitats for *B. cederstroemi.* Although *B. cederstroemi* inhabits lakes that vary widely in size, depth, and productivity (Nilsson and Pejler 1973; Hobæk and Raddum 1980; Næsje and others 1987; Ketelaars and others 1995), mean summer water temperatures in the three reservoirs where we found the zooplankteer exceeded 26° C, the upper temperature that causes 50% mortality after 12 hours of exposure for *B. cederstroemi* (Garton and others 1990), about 32 days of every year between 1994 and 1996 (Garvey and others 2000). Although these reservoirs can thermally stratify potentially providing a cool water refuge, the hypolimnion in each is anoxic by late summer (Bremigan and others 1991).

With its tolerance for a wide range of abiotic conditions, *B. cederstroemi* may continue to invade and become permanently established in Ohio reservoirs. Clearly, research is needed to determine the extent to which this species has become established outside of the Great Lakes basin in North America. As occurred in the invasion of the Great Lakes (Bur and others 1986) and in this study, fish diets may provide an early indicator of the presence of this exotic species. Fishes likely sample their environments for *B. cederstroemi* far better than our gear.

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