The spiny water flea, *Bythotrephes cederstroemi*
Another unwelcome newcomer to the Great Lakes

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OhioSeagrant

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OHSU-FS-049
1991. Revised 1992.
Reprinted 1995 and 1997.

This publication was produced by Ohio Sea Grant (Projects R/ER-10 and M/P-2, Grant NA46RG0482).

In the last 100 years, many nonnative (a.k.a. exotic) aquatic organisms have become established in the Great Lakes. These include the sea lamprey, various types of salmon, the alewife, and a variety of smaller, less conspicuous species. Most recently, invasions by the zebra mussel, river ruffe, and round goby have received extensive coverage by the popular press. In most cases, establishment of exotic organisms has been aided by human activities, such as dumping of ballast water from boats, canal building, transport and release of bait species, or intentional stocking of sport fishes.

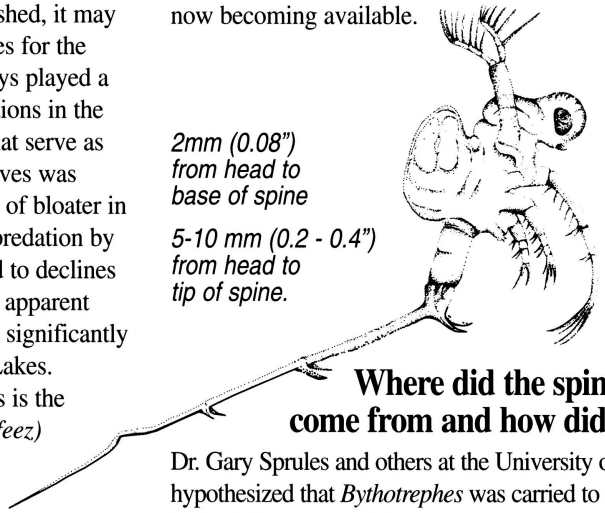
When an exotic species becomes established, it may have unforeseen and devastating consequences for the invaded ecosystem. Parasitism by sea lampreys played a major role in the decline of lake trout populations in the Great Lakes. Among forage fishes (species that serve as food for sport fishes), competition with alewives was probably responsible for diminished numbers of bloater in Lakes Michigan and Huron. In turn, intense predation by salmon (stocked by government agencies) led to declines in the number of alewives in these lakes. It is apparent that the introduction of nonnative species can significantly alter complex ecosystems such as the Great Lakes.

One recent newcomer to the Great Lakes is the spiny water flea *Bythotrephes (bith-o-TREH-feez) cederstroemi*. This species is a crustacean, distantly related to shrimp, lobster, and crayfish. A native of Europe, *Bythotrephes* made its North American debut in Lake Huron in 1984 and was present in all of the Great Lakes by 1987. The present distribution also includes inland lakes in Michigan and southern Ontario. It is a small creature (about 1/2 inch long) that is planktonic, meaning it must drift with water currents if it is to move long distances. Its long, barbed tail spine, which gives the animal its common name, makes up over half the length of the body and often catches on fishing lines and downrigger cable.

Bythotrephes is active in waters it inhabits from late spring until late autumn. As water temperature warms in the spring, individuals hatch from "resting" eggs that have overwintered on the lake bottom. Life span varies from several days to a few weeks. Throughout much of the spring, summer, and autumn, the population is composed mostly of females. These females produce eggs that remain unfertilized and are carried in the mother's brood pouch until they develop into female offspring that are genetically identical to the mother. This cycle of asexual reproduction (requiring no fertilization) continues as long as the water temperature is neither too hot nor too cold and food is abundant.

During times of stress, such as low water temperatures in late autumn, both males and females are produced asexually. The presence of males allows sexual reproduction to occur. Fertilized resting eggs develop a thick coating, which allows them to withstand extreme conditions, such as very low or high water temperatures. These eggs are released by the mother and fall to the lake bottom where they remain until conditions are again favorable. The adult *Bythotrephes* dies following reproduction. Resting eggs protected by a coating allow the species to persist in the lakes through harsh environmental conditions such as Great Lakes winters.

The appearance of the spiny water flea in the Great Lakes has scientists at universities and government laboratories, including The Ohio State University's F.T. Stone Laboratory, studying the impact of this invader on other organisms in the Great Lakes. Research results are now becoming available.



2mm (0.08") from head to base of spine

5-10 mm (0.2 - 0.4") from head to tip of spine.

Where did the spiny water flea come from and how did it get here?

Dr. Gary Sprules and others at the University of Toronto have hypothesized that *Bythotrephes* was carried to North America in the ballast water of freighters from European ports, especially the port of St. Petersburg, Russia. These freighters carry grain to Europe but return empty to North America. To stabilize the empty freighters, large amounts of water are carried in ballast. Small planktonic organisms, and even fish, are pumped in with the ballast water and may survive the ocean voyage. When ships take on cargo in North America, the ballast water and the organisms in it are discharged.

Normally, oceangoing ships take on salt water as ballast (and salt water animals), so a freshwater organism such as *Bythotrephes* would not be in the ballast water. However, in the spring, St. Petersburg becomes a freshwater port due to runoff from snow melt, and freshwater animals may be taken into the ballast tanks. Thus, spring may provide conditions that enable *Bythotrephes* and other freshwater organisms to be transported to the Great Lakes.

Genetic studies by Ohio Sea Grant researchers David Berg (Miami University) and David Garton (Indiana University) determined that North American spiny water fleas are more closely related to Finnish *Bythotrephes* than to populations from Sweden or Germany (i.e., populations nearer to St. Petersburg are more closely related to North American populations). Currently, Ohio Sea Grant is funding an additional study by these researchers to compare *Bythotreohes* from Russia with populations in the Great Lakes. If the Russian population is more closely related to North American populations than to other European populations, these results will confirm the transport of individuals from Russia to North America.

For other publications or advice from local experts, contact the Sea Grant program or state natural resources management office nearest you. Phone numbers of several Sea Grant programs follow.

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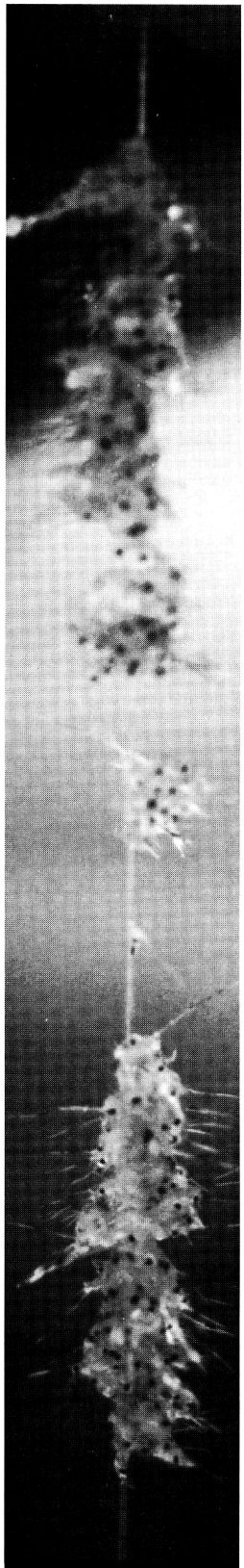
What do spiny water fleas eat?

Research conducted by Dr. E.D. Mordukhai-Boltovskaia of the USSR Academy of Science determined that *Bythotrephes* is a planktivore, feeding on smaller planktonic animals. *Bythotrephes* seizes prey with long arm-like antennae and hold them in place with its legs. One spiny water flea may consume as many as 20 prey organisms in a day.

The organisms eaten by *Bythotrephes* are also the preferred food of native plankton and fishes, leading to concerns that the invader may be competing for food with native species. One important food item of these native planktivores (species that feed on plankton) is a small water flea called *Daphnia.* Research conducted by Dr. John Lehman of the University of Michigan found that the appearance of *Bythotrephes* in Lake Michigan coincided with dramatic declines in the abundance of *Daphnia.* In addition, a native species related to *Bythotrephes*, the predator *Leptodora* (lep-to-DOR-a), also declined. Lehman concluded that feeding of *Bythotrephes* on *Daphnia* had reduced the abundance of the prey organism and that this reduction had left less food available to *Leptodora,* resulting in decreased numbers of this native crustacean. In addition, he hypothesized that declines in the abundance of fishes may result because *Daphnia* and other small plankton also serve as food for young fish. Later research conflicted with this interpretation, leaving scientists unsure as to whether *Bythotrephes* really has altered food abundance in the Great Lakes. However, it is clear that this invader has the potential to affect the food webs of the Great Lakes.

Examination of stomach contents has revealed that adult yellow perch, walleye, and salmon consume *Bythotrephes*, which is rather large and conspicuous compared to other planktonic species. Experiments have determined that hungry yellow perch are likely to spot *Bythotrephes* before they spot *Leptodora,* which are similar-sized but transparent. Spiny water fleas are also easily captured because they are slow swimmers; however, nothing is known about the nutritional value of *Bythotrephes*.

The long tail spine of *Bythotrephes* may discourage smaller fish, including young sport fishes, from eating the invader. Rae Barnhisel of Michigan Technological University found that young yellow perch cough up *Bythotrephes*, probably because the long tail spine prevents the fish from swallowing its prey. The young perch learn very quickly to avoid eating spiny water fleas. From this information, one can conclude that ability to consume *Bythotrephes* depends on the size of the fish.



During times of peak Bythotrephes *abundance, it clusters on fishing line and downrigger cable.*

Ultimately, what will be the impact of the spiny water flea on the Great Lakes?

The impact of a newly-arrived species on the biological community of a lake depends on many factors, including how the organism adapts to the physical environment (e.g., water temperature and depth) and how it interacts with other organisms in the lake. Important biological interactions include competition for food between the exotic and native species, and feeding by the exotic on native species, and by native species on the exotic.

European lakes inhabited by *Bythotrephes* tend to be rather cold and deep. With the exception of the western basin of Lake Erie and several large bays (Saginaw Bay, Green Bay), this is also the case for the Great Lakes. Thus, most of the Great Lakes appear to provide suitable depth and thermal conditions for *Bythotrephes*.

Lake Erie's western basin is considerably warmer than most Great Lakes basins, primarily because it is shallow (30 feet or less). Experiments conducted at Ohio State's Stone Laboratory show that *Bythotrephes* is sensitive to water temperatures above 25°C (77°F). Most basins of the Great Lakes reach higher temperatures only in the surface waters, and *Bythotrephes* is able to escape these temperatures by swimming to greater depths. However, in western Lake Erie, the entire water column is greater than 25°C during the summer, leaving no refuge from these temperatures. Native planktonic species of Leptodora are able to acclimate to the warm temperatures but *Bythotrephes* does not. During midsummer, *Bythotrephes* is present in the western basin for only a short time, disappearing rapidly as water temperatures climb. There is some evidence that this species is present throughout the summer in the other basins of Lake Erie as well as the other Great Lakes, where temperature conditions are more hospitable.

Much of the impact of the spiny water flea on Great Lakes ecosystems will depend on its interactions with other species. If *Bythotrephes* turns out to be a preferred food of perch and other fishes, its invasion of the Great Lakes may have a beneficial impact on fish populations. If it is unsuitable as a fish food, and competition with *Bythotrephes* lessens numbers of preferred food organisms, the amount of food available to fish may decrease. This may have dire consequences for fish populations. As with many of our inadvertent species introduction "experiments," it may take years to discover how the presence of this European immigrant will affect the Great Lakes ecosystem.