FS-049

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OHSU-FS-049
1991. Reprinted 2004.

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

The spiny water flea, *Bythotrephes longimanus*
An unwelcome species to the Great Lakes

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. Invasions by the zebra mussel 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.

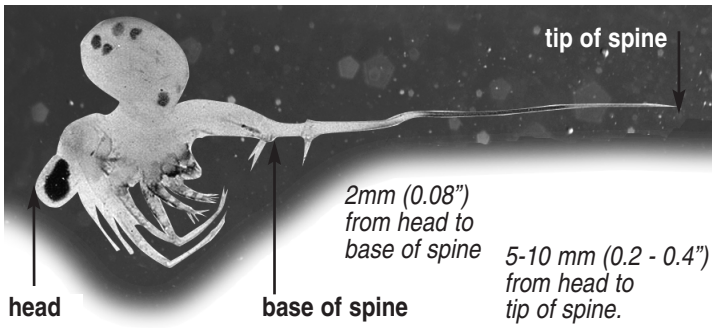
When an exotic species becomes established, it may have unforeseen and devastating consequences for the invaded ecosystem. Parasitism by sea lampreys played a major role in the decline of lake trout populations in the Great Lakes. Among forage fishes (species that serve as food for sport fishes), competition 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 invader of concern to the Great Lakes is the spiny waterflea *Bythotrephes* (bith-o-TREH-feez) *longimanus*, formerly known as *Bythotrephes 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 Ohio, Michigan, Minnesota, 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 cables.

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.

The appearance of the spiny waterflea in North American 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 lake ecosystems. Research results are now available.



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

Within several years of its appearance in the Great Lakes, 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 often 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 (Georgia Institute of Technology) and colleagues from Canada and Russia determined that North American spiny waterfleas are more closely related to populations of *Bythotrephes* from St. Petersburg than to populations from Finland, Sweden, or Germany. These results support the hypothesis that *Bythotrephes* from St. Petersburg, transported in ballast water, are the likely founders of North America’s populations.

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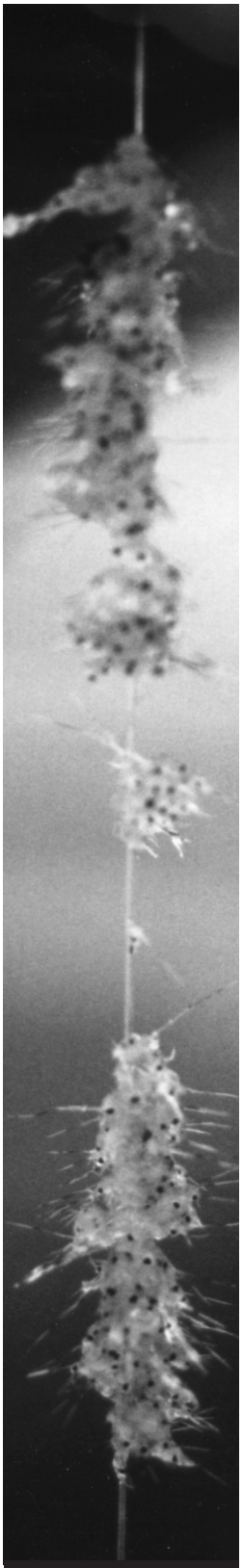
What do spiny water fleas eat?

A variety of studies have determined that *Bythotrephes* feed on smaller planktonic animals and on algae. A *Bythotrephes* seizes its prey with long, arm-like antennae and holds it in place with its legs. One spiny waterflea may consume as many as 20 prey organisms in a day.

The organisms eaten by *Bythotrephes* are also the preferred food of certain native zooplankton 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 waterflea called *Daphnia*. 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. Researchers 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. The introduction of spiny waterfleas into Harp Lake, Canada has led to the disappearance of many species of plankton. These changes in the plankton community have also been associated with potential declines of young sportfishes because *Daphnia* and other small plankton also serve as food for young fish. Such a situation may have occurred in Long Lake, Michigan, where feeding by *Bythotrephes* reduced *Daphnia* abundance, possibly leading to food shortages for young yellow perch. Thus, it is clear that spiny waterfleas have the potential to affect food webs in 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 see *Bythotrephes* before they see *Leptodora*, which are similar in size but more transparent. Spiny waterfleas 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* has been shown to discourage many smaller fish, including young sport fishes, from eating the invader. For example, young yellow perch that eat *Bythotrephes* cough them up, probably because the long tail spine prevents the fish from swallowing its prey. The young perch learn very quickly to avoid eating spiny waterfleas. From this information, one can conclude that the 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.*

What will be the impact of the spiny water flea on the Great Lakes?

The impact of an invasive 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, 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). Experi-ments 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 such as *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. In the other basins of Lake Erie as well as the other Great Lakes,where temperature conditions are more hospitable, *Bythotrephes* is present through summer and fall.

Much of the impact of the spiny waterflea on Great Lakes ecosystems depends on its interactions with other species, including a number of exotics. While *Bythotrephes* is known to be readily consumed by fishes, it appears that it has not reached the densities in western Lake Erie necessary to have an impact on native fishes such as yellow perch. The relatively low numbers of spiny waterfleas has also probably limited its immediate impact on food organisms in this same area. However, their densities are much higher in Lake Erie's central and eastern basins and in the other Great Lakes. At the same time, little is known about the effects of this invader on the food webs of these ecosystems. As with many of our inadvertent species introduction "experiments," it may take years to discover whether the presence of this European immigrant will affect Great Lakes ecosystems.