Great Lakes Maritime Research Institute

A University of Wisconsin - Superior and University of Minnesota Duluth Consortium

Assessment of the Abundance and Diversity of Resting Stages of Zooplankton in Ballast Sediments of Great Lakes Ships: Phase I

PI Name

Donn K. Branstrator
University of Minnesota Duluth
Department of Biology

The objective of this study, funded by Lake Carriers' Association, was to determine the abundance and diversity of zooplankton in ballast sediments of 3 regional fleet Great Lakes ships including the *M/V American Century*, the *M/V Edwin Gott*, and the *M/V Mesabi Mine*r. The research was comprehensive in its examination of metazoan (multicellular) invertebrate freshwater zooplankton, including the dormant life stage.

Ballast sediments were collected during December 2011 to March 2012 while the ships were in port in Lake Superior in either the Duluth-Superior Harbor or Silver Bay Harbor. Each ship was sampled twice. Collected sediments were preserved in ethanol and later subsampled and examined by a light microscope in the laboratory.

All of the material identified was typical of the types of organisms and fragmentary pieces of exoskeleton that can be found in virtually any lake sediments in the Great Lakes basin. A total of 18 20-g samples, including 6 from each ship, were analyzed. Biota recovered, in decreasing order of prevalence, included bivalves, dormant eggs, ostracods, bosminid head shields, cyclopoid copepods, *Bythotrephes* tail spine fragments, harpacticoid copepods, oligochaetes, nematodes, water mites, and gastropods.

The results demonstrated that ballast sediments of the *M/V American Century*, the *M/V Edwin Gott*, and the *M/V Mesabi Mine*r contained evidence of zooplankton dormant eggs. The average number of dormant eggs in a sample ranged from 0.2 to 2.7 eggs g^{-1} sediment. There was no statistical difference detected in the average density of dormant eggs between sampling dates or among ships. Dormant eggs are of considerable interest to lake ecologists because of their likely role in dispersal processes by native and non-native species. The dormant eggs that we recovered were not taxonomically assigned and therefore we are unable to say whether they came from native or non-native species.

Previous studies have quantified the density of dormant zooplankton eggs in ballast sediments of ships arriving to the Great Lakes from transoceanic locations. Bailey et al. (2003) reported that for 9 ships entering the Great Lakes during 2000 and 2001, dormant eggs in residual ballast sediments ranged in density between < 1 to about 44 eggs g^{-1} sediment. Briski et al. (2010) studied ship ballast sediments for 39 ships arriving to the Great Lakes during 2000 to 2002 and 17 ships arriving during 2007 to 2008. They reported that the density of dormant eggs was about 3.6 eggs g^{-1} sediment for the earlier period and about 0.5 eggs g^{-1} sediment for the more recent period. The values reported in this study of between 0.2 to 2.7 eggs g^{-1} sediment can be considered typical of densities found in studies of transoceanic ship ballast.

In addition to dormant eggs, a wide range of other life forms and fragmentary evidence of organisms was discovered. One group of organisms included copepodid stages of both harpacticoid and cyclopoid copepods. Harpacticoid copepods generally inhabit benthic environments throughout their life so their presence in the sediments was not surprising. Cyclopoid copepods are primarily planktonic but can enter a dormant state as an advanced copepodid stage during which time they rest in the sediments. A second broad grouping of organisms included bivalves, oligochaetes, nematodes, water mites, and gastropods. These are all primarily benthic organisms at some stage in their life cycle and are commonly found throughout lake sediments. A third group of material included exoskeleton remains of ostracods, bosminids, and *Bythotrephes longimanus*. Lake sediments are the major repository for dead zooplankton and therefore it is not surprising that refractory portions of their exoskeletons accumulate there. Fragments of tail spines of *Bythotrephes longimanus*, for example, have been reported from lake sediments in Lake Erie (Keilty 1988). We also recovered material from the ballast sediment samples that appeared to be biological in origin but could not be securely assigned to any of the categories listed above. Most of this unidentified material consisted of fine bits of tissue and may have been aquatic, terrestrial, plant, or animal in origin.

In Phase II of this study, we will obtain additional samples of the sediment from the ballast tanks to determine the density, viability (hatchability), and species-level identity of resting eggs. We plan to obtain the ballast sediments from the 3 Great Lakes ships that were sampled in Phase I over the fall/winter of 2012/2013 to continue this research.

Bailey, SA, IC Duggan, CDA van Overdijk, PT Jenkins, and HJ MacIsaac. 2003. Viability of invertebrate diapausing eggs collected from residual ballast sediment. Limnology and Oceanography. 48: 1701-1710.

Briski, E, SA Bailey, ME Cristescu, and HJ MacIsaac. 2010. Efficacy of 'saltwater flushing' in protecting the Great Lakes from biological invasions by invertebrate eggs in ships' ballast sediment. Freshwater Biology 55: 2414-2424.

Keilty, TJ. 1988. A new biological marker layer in the sediments of the Great Lakes: *Bythotrephes cederstroemi* (Schodler) spines. Journal of Great Lakes Research 14: 369-371.