Clearing the Water for Mussels

by George Noguchi, Tom Augspurger, and Jim Dwyer

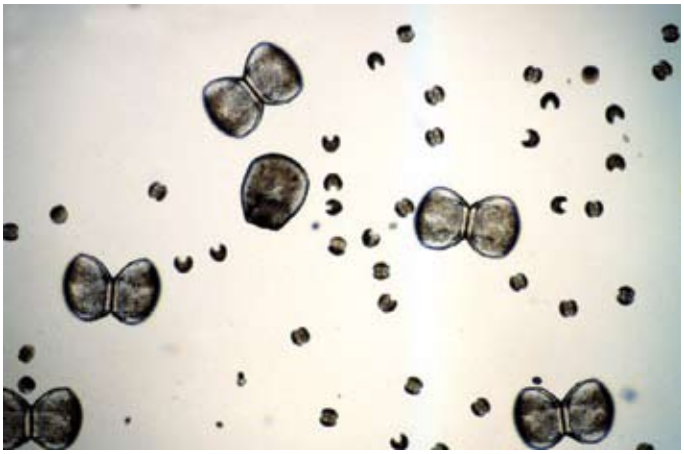
In cooperation with our partners, the Fish and Wildlife Service's Environmental Contaminants Program provides the science needed to improve water quality for restoring freshwater mussels—our Nation's largest group of threatened and endangered animals.

There is wide agreement that North America's native freshwater mussels are in decline (Master et al. 2000, Lydeard et al. 2004). Of the nearly 300 native species, 35 are considered extinct (Turgeon et al. 1998), and 70 are listed as threatened or endangered in the U.S. under the Endangered Species Act. Although many environmental problems contributed to the decline of freshwater mussels, water pollution is among the leading factors limiting their recovery (Richter et al. 1997, Strayer et al. 2004). Improving water quality will be necessary to restore many imperiled populations, and biologists working to recover mussels have looked to toxicologists for help in identifying specific pollutants. The Native Mussel Conservation Committee (1998) has issued explicit calls for determining mussel pollutant sensitivities and determining if water quality criteria and standards are sufficient for recovery.

Scientists in the Service's Environmental Contaminants Program and researchers from the U.S. Geological Survey (USGS) have answered this call by refining methods for growing young mussels and testing their sensitivity to water pollutants. As is the case with most other species, it is the very youngest mussels that are at highest risk, but the unique life history characteristics of mussels required the development of new and refined testing methods. Environmental Contaminants and USGS scientists worked with others to develop an international consensus on test methods, which was approved by the American Society for Testing and Materials (2006). Applying those methods has yielded ample data to conclude that early life stages of mussels are highly sensitive to some common water pollutants (notably ammonia and copper), of intermediate sensitivity to others like chlorine, and relatively tolerant of some other compounds. We have learned that young mussels are more sensitive to ammonia and copper than many other species, including those that are commonly used to establish water quality standards (Augspurger et al. 2003, March

Photo (left): Newly released mussels, called glochidia, are microscopic and cannot swim or crawl. Their only behavior is to close just at the right time when they come in contact with a fish gill. The larger glochidia in this photo are ¼ mm.

Photo (right): Freshwater mussels are important to aquatic ecosystems because they filter large volumes of water and serve as food for many animals, such as the raccoons that were responsible for this kill on the Verdigris River, Kansas.



Photos courtesy of Union Gallery (http://unionid.missouristate.edu)

et al. 2005). This finding raises concerns as to whether or not the current standards for regulating ammonia and copper are adequate for protecting mussels.

Because of ongoing coordination with our Federal partners*, the Environmental Contaminants Program has worked with the Environmental Protection Agency (EPA) and the National Marine Fisheries Service towards ensuring that data from mussel tests are used when water quality criteria are established. Because of the new data, EPA is evaluating the current criterion for ammonia, and the Service's Endangered Species Program now has science-based water quality thresholds to guide recovery efforts.

Hansen and Johnson (1999) highlighted freshwater mussels as a group of animals for which cooperation among conservation biologists and environmental toxicologists is crucial for meeting long-term conservation goals. The Service's Environmental Contaminants Program biologists are conservation biology-focused toxicologists who have embraced this challenge to improve test methods, define specific pollutants of concern, and work with others to implement practical, science-based recommendations. By providing sound science and using it to guide regulations, the Service is fulfilling its responsibility to restore and conserve our valuable natural resources.

* *Memorandum of Agreement Between the Environmental Protection Agency, Fish and Wildlife Service, and National Marine Fisheries Service Regarding Enhanced Coordination Under the Clean Water Act and the Endangered Species Act. February 22, 2001.*

References

ASTM International. 2006. Standard guide for conducting laboratory toxicity tests with freshwater mussels (ASTM E2455-05). ASTM annual book of standards volume 11.06, ASTM, West Conshohocken, PA.

Augspurger T, Keller AE, Black MC, Cope WG, Dwyer FJ. 2003. Water quality guidance for protection of freshwater mussels (Unionidae) from ammonia exposure. Environ Toxicol Chem 22: 2569-2575.

Hansen LJ, Johnson ML. 1999. Conservation and toxicology: Integrating the disciplines. Conserv Biol 13: 1225-1227.

Lydeard C, Cowie RH, Ponder WF, Bogan AE, Bouchet P, Clark SA, Cummings KS, Frest TJ, Gargominy O, Herbert DG, R. Hershler, K.E. Perez, B. Roth, M. Seddon, E.E. Strong and F.G. Thompson. 2004. The global decline of nonmarine mollusks. BioSci 54: 321-330.

March, F.A., Dwyer, F.J., Ingersoll, C.G., Wang, N. and Augsporger, T. 2005. Evaluation of copper water quality standards and criteria for freshwater mussels. SETAC North America 26th Annual Meeting, Baltimore, MD. November 13-17, 2005.

Master LL, Stein BA, Kutner LS, Hammerson GA. 2000. Vanishing assets: Conservation status of U.S. species. Pages 93-118 in: B.A. Stein, L.S. Kutner, and J.S. Adams (editors). Precious heritage: the status of biodiversity in the United States. Oxford University Press.

Native Mussel Conservation Committee. 1998. National strategy for the conservation of native freshwater mussels. J Shellfish Res 17: 1419-1428.

Richter BD, Braun DP, Mendelson MA, Master LL. 1997. Threats to imperiled freshwater fauna. Conserv Biol 11: 1081-1093.

Strayer DL, Downing JA, Haag WR, King TL, Layzer JB, Newton TJ, Nichols SJ. 2004. Changing perspectives on pearly mussels, North America's most imperiled animals. BioSci 54: 429-439.

Turgeon DD, Quinn JF, Bogan AE, Coan EV, Hochberg FG, Lyons WG, Mikkelsen PM, Neves RJ, Roper CFE, Rosenberg G, Roth B, Scheltema A, Thompson FG, Vecchione M, Williams JD. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. Second edition. American Fisheries Society Special Publication 26: 1-509.

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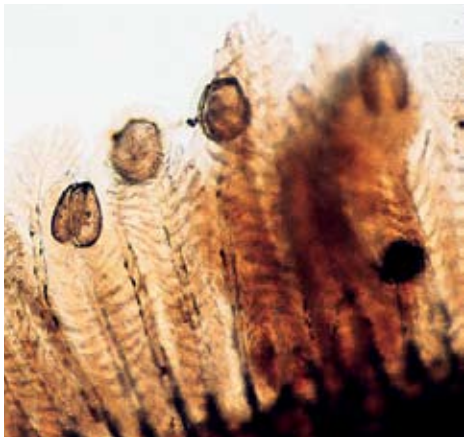

One of the unique life history characteristics of mussels is the "parasitic" stage when glochidia attach to the gills of host fish. The glochidia eventually metamorphose into juvenile mussels, drop off the fish, and begin feeding on algae. This photo shows glochidia attached to fish gills.