COPE

Triannual Unionid Report

Report No. 4

June 1994

A forum for the informal exchange of information
on the status of
North American unionid research, management, and conservation

Compiled by

Richard G. Biggins
U.S. Fish and Wildlife Service
330 Ridgefield Court
Asheville, North Carolina 28806

Telephone: 704/665-1195, Ext. 228

NOTE: The intent of this report is to expedite the exchange of information in an informal format. Report submissions were solicited from individuals and agencies involved in unionid conservation. The submissions were not edited. They were copied as received and assembled into the report.

NOTE: If you are receiving duplicate mailings, have a change of address, no longer wish to receive this report, or know someone who would like to be added to our mailing list, please contact Sherrie Jager at the above address or phone 704/665-1195, Ext. 221

FRESHWATER MOLLUSCAN RESEARCH

May 23, 1994

Richard G. Biggins
U.S. Fish and Wildlife Service
300 Ridgefield Court
Ashville, NC 28806

Dear Dick,

Please find attached a note for the next Triennial Unionid Newsletter. I am faxing this to you and will put a clean copy in the mail to you tomorrow.

You might like to add a note in the newsletter regarding the availability of the following publication:

Claassen, Cheryl. 1994. Washboards, pigtoes, and muckets: historic musseling in the Mississippi watershed. *Historical Archaeology* 28(2):1-145. Available from The Society for Historical Archaeology, P.O. Box 30446, Tucson, AZ 85751-0446. Backissue cost $12.50 + $1.75 postage and handling.

Best wishes.

Sincerely,

Arthur E. Bogan, Ph.D.

USFWS
ASHEVILLE, NC

36 Venus Way, Sewell, NJ 08080-1970 Telephone/FAX 609-582-9113

Steven Ahlstedt, Tennessee Valley Authority, Aquatic Biology Lab, Norris, Tennessee 37828. Phone: (615) 632-1781

TVA - UPPER CHICKAMAUGA RESERVOIR MUSSEL STUDY

The mussel fauna in upper Chickamauga Reservoir near the Watts Bar Nuclear Power Plant has been monitored at three mussel beds since 1983. Thirty mussel species are documented from this reach of the Tennessee River and are represented by 13,518 live specimens, Of this total, 6,607 individuals were measured (length, height, and width). Because of extreme shell erosion, age-classes could not be determined by counting external growth rests.

In 1993, in order to document the lack of reproduction and age of the fauna, quadrat samples were excavated by divers and substrate sieved for juvenile mussels. Eighty-four quadrats were randomly collected between the three mussel beds being monitored. Only small specimens of Anodonta imbecillis were found. A total of 115 specimens of the five most common species (P. cordatum, C. tuberculata, Q. pustulosa, E. lineolata, and E. crassidens) were collected for shell length correlations and age-class determinations. The animals were sacrificed and thin-cross sections were cut with a diamond tipped saw-blade through the valves of the shell. Annular growth rests were counted under a microscope.

Based upon the recent 1993 quadrat excavation data and previous examination of thousands of specimens since 1983, mussel reproduction was documented for only one species (A. imbecillis). The mussel fauna consists largely of old, non-reproducing individuals. In further support these findings, mean shell-lengths and ages of the five most common species are as follows: P. cordatum (98.5 mm, age 49), E. crassidens (112.1 mm, age 36), C. tuberculata (80.1 mm, age 34), E. lineolata (87.3 mm, age 34), and Q. pustulosa (59.9 mm, age 33).

TENNESSEE RIVER (TRM 520-528) - UPPER CHICKAMAUGA RESERVOIR 1993

	P. cordatum	C. tuberculata	Q. pustulosa
Number Measured	33	27	17
Length Range (mm)	88.7-110.5	55.3-92.4	52.2-70.8
Mean Length (mm)	98.5	80.1	59.9
Number Aged	32	23	17
Age Range	28-64	26-50	23-44
Mean Age	49	34	33

	E. lineolata	E. crassidens
Number Measured	7	28
Length Range (mm)	57.5-97.0	97.2-122.1
Mean Length (mm)	87.3	112.1
Number Aged	7	28
Age Range	27-51	30-46
Mean Age	34	36

TENNESSEE RIVER - CHICKAMAUGA RESERVOIR (SCRUGGS 1960), TVA

	P. cordatum (Scruggs) 1957	P. cordatum TVA (1983-1992)	P. cordatum (TVA 1993)
Number Measured	574	1351	33
Length Range (mm)	40-119	-	88.7-110.5
Mean Length (mm)	81.71	95.6	98.5
Number Aged	212	-	32
Age Range	6-32	-	28-64
Mean Age	22	-	49

UNIONID BIVALVES (MOLLUSCA: BIVALVIA: UNIONIDAE) OF PRESQUE ISLE BAY, ERIE, PENNSYLVANIA[1]

E.C. MASTELLER, K.R. MALESKI AND D.W. SCHLOESSER[2,3]

The Pennsylvania State University at Erie
The Behrend College
Erie, PA 16563-1200

[2]*U.S. Department of Interior*
National Biological Survey
Great Lakes Center
Ann Arbor, Michigan 48105

ABSTRACT

The purpose of this study was to determine species composition and relative abundance of unionid bivalves (Mollusca: Bivalvia: Unionidae) in Presque Isle Bay, Erie, Pennsylvania 1990-1992. This information was compared with data from the only other extensive survey of unionids in the bay conducted in 1909-1911 (Ortmann 1919) to assess changes over the 80 years preceding the present study. A total of 1,540 individuals representing 18 species were collected in 1990-1992. Five relatively common species (between 7 and 42% of total individuals), six uncommon species (2 and 6%), and seven rare species (<1%) were found. The rare species were *Anodontoides ferussacianus, Lasmigona costata, Ligumia recta, Ptychobranchus fasciolaris, Quadrula pustulosa pustulosa, Strophitus undaulatus,* and *Truncilla donaciformis.* Five of the species found in Presque Isle Bay (*Leptodea fragilis, Ligumia nasuta, Potamilus alatus, Quadrula quadrula,* and *Truncilla donaciformis*) are listed as critically imperiled and one species (*Truncilla truncata*) as extirpated in the State of Pennsylvania by the Western Pennsylvania Conservancy. Comparisons between unionid populations in 1909-1911 and 1990-1992 indicate few substantial changes occurred during the past 80 years. A total of 22 species were found; 21 in 1909-1911 and 18 in 1990-1992. Seventeen species were found in both studies, an additional four in 1909-1911 and one in 1990-1992. The relative abundance of 11 of the 17 species found in both studies remained stable (i.e., common or uncommon) over the past 80 years. Only four species listed as uncommon in 1909-1911 were listed as rare in 1990-1992. However, the invasion of the zebra mussel (*Dreissena polymorpha*) is considered a threat to the continued existence of the entire Unionidae fauna in Presque Isle Bay, a unique habitat of the Great Lakes.

[J PA Acad Sci 67(3): 120-126, 1993]

INTRODUCTION

Unionid bivalve mollusks (Mollusca: Bivalvia: Unionidae) in Presque Isle Bay, Lake Erie have not been surveyed for about 80 years. The only extensive survey of unionids in the bay was performed in 1909-1911 (Ortmann 1919). A few records of unionids do occur for the interim period between 1919 and the present study in Bardarik *et al.* (1973), Genoways and Brenner (1985), Pennsylvania Fish Commission (1987), and CPADER (1993). However, these studies only mention unionids ancillary to other investigations.

The present study was undertaken to document the species composition and relative abundance of unionids in Presque Isle Bay in 1990-1992. We also compared the species assemblage of the present study to those recorded in Ortmann (1919) to determine changes in unionid populations over the past 80 years. Data collected in the present study will be useful to document expected changes that may occur in the next several years as a result of increasing numbers of the exotic zebra mussel (*Dreissena polymorpha*) in Presque Isle Bay. Zebra mussels settle and attach to shells of unionids and have been shown to be a serious threat to unionid communities in the Great Lakes and possibly throughout North America. (Hebert *et al.* 1989; Schloesser *et al.* 1990; Schloesser and Kovalak 1991; Mackie 1992; Haag *et al.* 1993).

[1]Received for publication 31 May 1993; accepted 17 November 1993.

[3]Contribution 844 of the National Biological Survey, Great Lakes Center, 1451 Green Road, Ann Arbor, Michigan.

Johnson, Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138
617/495-2466

Author: Arthur E. Bogan

A survey of the unionid fauna of the Susquehanna River Basin in Pennsylvania

A correction by: Richard I. Johnson

Bogan (Triannual Unionid Report No. 3) mentioned that the historic fauna was composed of approximately nine species (Ortmann 1919). The nine species are:

Elliptio complanata (Lightfoot, 1786), Alasmidonta undulata (Say, 1817), Alasmidonta marginata (Say, 1819), Alasmidonta varicosa (Lamarck, 1819), Lasmigona subviridis (Conrad, 1835), Anodonta cataracta cataracta (Say, 1817), Strophitus undulatus (Say, 1817), Lampsilis cariosa (Say, 1817), and Lampsilis radiata radiata (Gmelin, 1792). This list was confirmed by Clarke and Berg (1959) in The Freshwater Mussels of Central New York. With the exception of A. marginata from the Interior Basin, all of these species occur on the Atlantic Slope. Sepkoski and Rex (1974, Systematic Zoology 23: 168) included two more species supposedly based on information supplied by me. There is no evidence that Ligumia nasuta (Say, 1817) has ever been reported from the Susequehanna River System, and though I mentioned (Bulletin MCZ no. 140(6): 336) Elliptio lanceolata (Lea, 1828) as occurring in Juniata River (MCZ 225640), there is compelling evidence that the single specimen in the lot actually came from the Cape Fear River, North Carolina (MCZ 30414).

Author: Arthur E. Bogan
Address: 36 Venus Way
Sewell, NJ 0808-1970
Phone: 609-582-9113

Some notes on *Elliptio complanata* (Lightfoot, 1786).

Discussions at the November 1991 meeting on the freshwater mollusks of the Atlantic Slope, held in Arlington, Virginia, covered problems with the identity of *Elliptio complanta* (Lightfoot, 1786). This species' currently listed geographic range is from the Altamaha River to Northern Canada and is reported also from the Apalachicola River System (Johnson 1970:320). Questions were raised regarding the type locality and the location of any extant type materials. Lightfoot (1786:100, No.2190) [see Rehder (1967:18)] listed (Maryland and New Jersey) and referenced Lister's 1688 figure of a specimen from Virginia. Simpson (1914:652), Ortmann and Walker (1922:30), Baker (1928:134), and Matteson (1948:128) listed the type locality as "Maryland and New Jersey". Johnson (1947) reviewed the information available regarding *Elliptio complanata* and restricted the rather vague locality listed by Lightfoot of "Maryland" to the "Potomac River, Washington, District of Columbia". This type locality was subsequently emended by Johnson (1970:314) to "[approximately opposite Fairfax Co. Virginia]". Dance (1966:292) reported that the figured specimen in the Oxford University Museum was probably lost. If we accept this restriction of the type locality, then any attempts to define the shell, anatomical, and biochemical nature of this species, must rely upon topotypic materials and not on populations picked randomly from within the range of the species.

Literature Cited

Baker, F.C. 1928. The fresh-water Mollusca of Wisconsin. Part. II. Pelecypods. *Bulletin of the Wisconsin Geological and Natural History Survey*, No. 70:1-495.

Dance, P. 1966. Shell collecting: an illustrated history. Faber and Faber.

Johnson, R.I. 1947. The authorship of *Elliptio complanatus*. *The Nautilus*, 62:36

Johnson, R.I. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the Southern Atlantic Slope Region. *Bulletin of the Museum of Comparative Zoology*, 140(6):263-450, pls. 1-22.

Lightfoot, J. 1786. *A catalog of the Portland Museum, lately the property of the Duchess Dowager of Portland, deceased, which will be sold at auction, by Mr. Skinner and Co*...London, viii + 194 pp.

Matteson, M.P. 1948. The taxonomic and distributional history of the freshwater mussel Elliptio complanatus (Dillwyn, 1817). *The Nautilus*, 61(4):127-132; 62(1):13-17.

Ortmann, A.E. and B. Walker. 1922. On the nomenclature of certain North American naiades. *Occasional Papers, Museum of Zoology, University of Michigan*. No. 112:1-75.

Rehder, H.A. 1967. Valid zoological names of the Portland Catalogue. *Proceedings of the United States National Museum*, 121(3579):1-51

Simpson, C.T. 1914. *A descriptive catalogue of the Naiades or pearly fresh-water mussels*. Bryant Walker. Pub. 1540 pp.

Robert S. Butler, U.S. Fish and Wildlife Service, 6620 Southpoint Drive South, Jacksonville FL 32216 (904/232-2580)

As many of you know, the Common and Scientific Names Committee for Mollusks (Turgeon et al. 1988) is updating their work. The following account, in part, was sent in a letter to Dr. Art Bogan of the Committee as a rationale for the recognition of *Elliptio monroensis* (Lea, 1843), which I have dubbed the St. Johns elephantear, as a distinct and valid taxon:

An inveterate "lumper", Johnson (1970, 1972) synonomized *Elliptio monroensis* under *E. dariensis* (Lea, 1842), the Georgia elephantear. However, Morrison (1973) recognized it as valid. In addition, Dr. Gene Keferl, who is probably more familiar with these taxa than any other individual, considers *E. monroensis* valid, as do other experts of Florida area unionids (e.g., Drs. James D. Williams, Harry G. Lee, and William H. McCullagh). Shell proportions and characters seem to differentiate the two taxa; *Elliptio dariensis* reaches much greater sizes and thickness than does *E. monroensis*, and the latter species generally has a more pronounced posterior ridge. Unfortunately, no studies have taken serious comparative looks at their soft anatomy or molecular genetics.

The two taxa are allopatric; *Elliptio dariensis* is endemic to the Altamaha River system in Georgia, and *E. monroensis* is endemic to the St. Johns River in Florida, with the intervening St. Marys and Satilla rivers separating the two. It should also be noted that the Satilla River has an endemic "elephantear", *E. downiei* (Lea, 1859), the Satilla elephantear, and that the St. Marys River has an "elephantear" as well, which is possibly *E. downiei* (although Johnson (1970) called it *E. crassidens* (Lamarck, 1819), the elephantear, a widespread Gulf Slope species). At least seven and six species of *Elliptio* are known from the Altamaha River system and St. Johns River system, respectively, with multiple endemics in both systems. Only one *Elliptio* species is found in both the Altamaha and St. Johns rivers--*E. icterina* (Conrad, 1834), the variable spike, an apt vernacular name for what is most likely a large species complex. The headwaters of Black Creek and other tributaries of the lower St. Johns River system, which originate on upland areas comprising the Northern Highlands, Trail Ridge, Baywood Promontory, and Duval Upland topographic features, are an area of relatively high endemism for aquatic organisms (Burgess and Franz 1978). These geographic features were formed during either early Pleistocene or late Pliocene sea level transgressions. Such refugia may have fostered speciation of *E. monroensis*, which presently occurs in Black Creek, and possibly other unionids (two nominal species currently synonomized under *E. icterina* by Johnson (1970, 1972), *Unio fuscatus* Lea, 1843 and *U. occultus* Lea, 1843, have Black Creek as their type locality).

As a final argument, current genetics research conducted at the Savannah River Ecology Laboratory by Dr. Peg Mulvey on the genus *Elliptio* in southern Atlantic Slope drainages has indicated that diversity in this genus has been underestimated by previous investigators (*e.g.*, Johnson 1970, 1972). It is presumed by myself and several of my colleagues that future genetics studies in this and certain other genera will increase the number of valid taxa in this imperilled group of aquatic organisms.

Literature Cited:

Burgess, G.H., and R. Franz. 1978. Zoogeography of the aquatic fauna of the St. Johns River system with comments on adjacent Peninsular faunas. American Midland Naturalist 100(1):160-170.

Johnson, R.I. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the Southern Atlantic Slope region. Bulletin of the Museum of Comparative Zoology 140(6):263-449.

Johnson, R.I. 1972. The Unionidae (Mollusca: Bivalvia) of Peninsular Florida. Bulletin of the Florida State Museum, Biological Sciences 16(4):181-249.

Morrison, J.P.E. 1973. Sympatric species of *Elliptio* in the St. Johns River, Florida. AMU Bulletin 1973:14.

Author: G. Thomas Watters

Address: Ohio Division of Wildlife, 1840 Belcher Drive, Columbus, OH 43224
and
Aquatic Ecology Laboratory, Ohio State University, 1314 Kinnear Rd., Columbus, OH 43212

voice: 614-292-6170
fax: 614-292-0181
email: gwatters@magnus.acs.ohio-state.edu

Watters, G. Thomas. 1994. Towards a standardized qualitative method of collecting freshwater mussels. *Association of Southeastern Biologists Bulletin* 41(2): 93 [abstract].

The great potential of freshwater mussels as biological indicators for ecological metrics (IBI, etc.) has not been realized. A major problem with implementing such a metric is the lack of a standardized method of collecting mussels over a wide range of habitats. Techniques sufficient for collecting in one habitat, such as large rivers, are not effective or possible in others, such as small creeks. Often, collecting mussels for monitoring does not require complete enumeration of the diversity of the fauna, and the rarest species need not be found. Because the diversity of mussels is related to the drainage area of a system, the number of expected species for a site may be estimated if the river mile or drainage area is known. The diversity at 34 sites in three midwestern river systems was completely enumerated from literature and museum records, and personal collecting. The sites ranged from small creeks to large rivers. Rarefaction curves were fit to each site. These were used to construct similar curves for incremental drainage areas. The resulting plot may be used to calculate the number of specimens needed to be collected for a given percentage of the expected fauna for any drainage area. This allows a worker to collect a specified fraction of the total expected diversity at any site for a given drainage area. The method is independent of habitat, collecting technique, or time spent collecting. Tests of this collecting method are now being conducted. Preliminary results indicate that this may be an efficient tool for standardizing collection procedures for biomonitoring metrics.

Watters, G. Thomas. 1994. The status of native freshwater mussels in Ohio. *Bulletin of the North American Benthological Society* 11(1): 100 [abstract]

Seventy-nine species and subspecies of native freshwater mussels have been recorded from Ohio. Of these, 14 (18%) are Federally Endangered. The Division of Wildlife, Ohio Department of Natural Resources, recognizes 30 (38%) species and subspecies as State Endangered, and an additional six as Threatened. Of these, 15 appear to be extirpated from the state, and six others are extinct. In total, 48 taxa (61%) of the state's native freshwater mussel fauna are either endangered, threatened, extirpated, or extinct. Some species now occur in only one or two areas in the state. The Federally Endangered Fanshell, *Cyprogenia stegaria*, is now found only in the lower Muskingum River, but appears to be reproducing. The Pink Mucket, *Lampsilis abrupta*,

also Federally Endangered, has been found in several sites in the Ohio River, but no evidence of reproduction has been seen. The Clubshell, *Pleurobema clava*, and the Northern Riffleshell, *Epioblasma torulosa rangiana*, both Federally Endangered, occur in Big Darby Creek and Fish Creek. Fish Creek also has the only remaining population in existence of the White Catspaw, *Epioblasma obliquata perobliqua*. However, all three Fish Creek Federally Endangered mussel species have been threatened by a recent diesel spill in that creek. The effects of this spill are being closely monitored. The lower Muskingum River harbors some of the largest and densest mussel beds left in North America, including many Federal and State Endangered taxa. Unfortunately, the presence of commercial species valuable to the pearl industry has resulted in several large poaching operations in this river. Ohio is closed to commercial collecting of mussels.

NEW PUBLICATION AVAILABLE IN JUNE

Watters, G. Thomas. 1994. An annotated bibliography of the reproduction and propagation of the Unionoidea (primarily of North America). *Ohio Biological Survey Miscellaneous Contributions* (1). 165 pp.

This publication gives 547 annotated references in chronological order from 1695 through 1993. References deal with host identification, studies of reproduction, and efforts to culture freshwater mussels. Included are most of the important early European works that form the basis of our knowledge on unionoidean reproduction. References to unionoidean parasites that may interfere with reproduction or culture also are given. Appendix A lists unionoideans by their hosts, and Appendix B cross-indexes hosts by their unionoidean parasites. These appendices represent the most comprehensive compilation of the host relationships yet published. Appendix C lists all references alphabetically by author and divides the subject matter into the categories of Hosts, Culture, Ecology, Transplants, and Parasites.

Available in June from:

Ohio Biological Survey, Museum of Biological Diversity, Ohio State University, 1315 Kinnear Rd., Columbus, OH 43212-1192 voice: 614-292-9645 fax: 614-292-7774

Price: $20.00 plus $3.00 shipping and handling in continental US. Please inquire for foreign orders. Respondents to the questionnaire sent in 1992 will receive their copy free. Call for more information.

K.D. Blodgett, S.D. Whitney, S.P. Mahon; Illinois Natural History Survey, River Research Labs, 704 N. Schrader Ave., Havana, IL 62644. (3090 543-6000 or 543-2105 (fa

Zebra Mussel Research in the Illinois River 1994

The Illinois Natural History Survey, in cooperation with various state, federal, and private organizations will be continuing research on riverine zebra mussel populations during the 1994 field season. Research conducted during 1993 revealed the zebra mussels, which were only discovered in the Illinois River in June 1991, had undergone exponential population growth, with densities as high as 94,000/m^2 near the mouth (Triannual Unionid Report No. 3 January 1994). The proliferation and rapid colonization of the Illinois River has sent shock waves through the midwest as industrial water users are scrambling to prevent infestation of their facilities and biologist are trying to predict, document, and mediate the negative impacts of zebra mussels on aquatic ecosystems. The zebra mussel has now become established in almost all of the major river systems of the Mississippi River Drainage with similar population explosions expected in the near future. Therefore, there is critical need for prioritized and coordinated zebra mussel research to facilitate sound management decisions and better understanding of riverine zebra mussel populations. Resource managers can utilize this information to develop strategies necessary for the protection and preservation of individual species and the biological integrity of aquatic ecosystems. The following paragraphs summarize zebra mussel research efforts currently underway in the Illinois River. For further information concerning any of these projects please contact the primary investigators at the address or phone number listed on page 2.

Effects of native unionid mussel displacement in the presence of high densities of zebra mussels. S.D. Whitney, K.D. Blodgett, and R.E. Sparks. Zebra mussels have rapidly colonized native unionid mussels which may soon lead to unprecedented mortality within this group of organisms in the Illinois and other Midwestern Rivers. This threat supported by excessive infestation rates in the Illinois River prompted a number of state resource management agencies to consider closing commercial mussel harvest in their respective waters as a means of reducing unnecessary losses of thousands of non-target mussel species. Commercial harvest may create an additional stressor that may act synergistically with zebra mussel infestation leading to the demise of native mussel populations. To date, only the Illinois Department of Conservation has opted to take this controversial step by banning the commercial mussel harvest in the Illinois River for 1994. Disturbing mussels either by brailing or hand collection by divers may add to non-target native unionid mortality by allowing additional infestation and death of those organisms that are removed from the substrate. This study will evaluate the impact of unionid displacement at three sites in the Illinois River having significantly different zebra mussel densities.

A Mussel Survey of the Illinois River. S.D. Whitney, K.D. Blodgett, and R.E. Sparks. Information on current populations and trends is needed to facilitate the development and implementation of effective strategies to protect, manage, and possibly even enhance this ecologically and economically valuable resource. Current data needs are similar to those previously fulfilled by the comprehensive survey of the Illinois River completed by Starrett (1971) of the Illinois Natural History Survey (INHS) in 1966. The Illinois is one of the first North American rivers to be severely impacted by zebra mussels. Therefore there is an urgent need for baseline and follow-up data on native unionid mussels and investigations of the impacts of zebra mussels on them. Information collected on the Illinois should assist managers dealing with zebra mussels in other Midwestern rivers as well. To collect the requisite information on native unionid mussel densities, diversities, and population structures, we propose a quantitative survey and assessment of a minimum of three representative mussel beds along the length of the Illinois River during 1994. The survey will collect data similar to those of the 1966 Starrett survey, but will use improved, currently more effective collection techniques. Preliminary summaries of collected data will be prepared and disseminated as soon as practical and throughout the project because of the immediate threat of zebra mussels to native mussel populations and the urgent need to develop and implement strategies for their protection. Manuscript detailing 1993 research currently in preparation for Journal of Freshwater Ecology.

Zebra Mussel Research in the Illinois River [continued]

Growth of Zebra Mussels in the Illinois River. S.P. Madon, J.A. Stoeckel, D. W. Schneider, and R.E. Sparks. Size-specific growth of the zebra mussels will be assessed from May 1994 - May 1995 in growth chambers placed at strategic locations in the Illinois River. The growth chambers contain plates with mussels attached to a grid to track individual growth. Individual growth will be assessed on a monthly basis in 4 size-classes of mussels: 10-14, 15-19, 20-24, and > 24 mm. Water quality parameters such as current velocity, suspended sediments, organic component of seston, temperature, pH, and dissolved oxygen will be assessed at all chamber locations on a bi-weekly basis. The growth data will be used to corroborate the zebra mussel bioenergetics model currently being developed by INHS researchers.

Veliger Project. J.A. Stoeckel, K.D. Blodgett, and R.E. Sparks. Due to the planktonic nature of the zebra mussel larvae, recruitment to the zebra mussel population in a particular stretch of the river is dependent upon production and drifting rates of veligers spawned by the upstream population. In order to develop effective and economic management strategies for riverine zebra mussel populations, it is necessary to obtain a better understanding of veliger production rates and the drift and settlement characteristics of zebra mussel veligers. For example, some facilities on the Illinois River anticipate spending from $250,000 to $750,000 annually for chemicals to treat for zebra mussels. If particular stretches of the river are subjected to two or three distinct pulses of veliger drift and settlement throughout the year (as indicated by 1993 length frequency data) rather than a continuous drift of various stage veligers, chemicals may be used more sparingly, reducing cost to companies and pollution to the river. We are currently monitoring the zebra mussel veliger drift in the Illinois River in order to characterize the temporal and spatial distribution of the various veliger stages throughout the year.

Bioenergetics of the Zebra Mussel. S.P. Madon, J.A. Stoeckel, D.W. Schneider, and R.E. Sparks. The recent spread of the zebra mussels in the Illinois River has generated tremendous interest in the ecological and economic consequences of this invasion. A bioenergetics model based on an energy budget that balances energy gains (consumption) and losses (metabolism and wastes) in an individual mussel, is one way to assess growth potential or consumption of zebra mussels in novel river environments. We hypothesize that in large rivers, sediment load, particulate organic matter concentration, and current velocity affect processes of energy supply and demand in the zebra mussels, thereby affecting growth potential, and ultimately population levels. We plan to predict where zebra mussels will reach nuisance populations in the Illinois and Upper Mississippi Rivers via the use of a bioenergetics model. All physiological parameters in the model are temperature- and weight-specific. We have recently completed laboratory experiments that assessed the effects of suspended sediment and algal concentrations on functional responses of ingestion, clearance rates, assimilation, metabolism, feces, and pseudofeces production rates in the zebra mussel. We will also conduct experiments to determine the effects of current velocity on energetic parameters. Empirically derived functional responses to environmental variables will be incorporated into the model to predict temporal and spatial distributions of the zebra mussels in the rivers, as well as assess ecological impacts of zebra mussels on the riverine food web. The model will be rigorously tested against field measures of zebra mussel growth (see summary on growth study). Manuscript is currently in preparation for Ecology.

For more information concerning zebra mussel research efforts on the Illinois River contact K.D. Blodgett, S.D. Whitney, or S.P. Madon at:

Illinois Natural History Survey
River Research Labs
704 N. Schrader Ave.
Havana, IL 62644
Phone (309) 543-6000 fax (309) 543-2105.

Lampsilis higginsi (Lea, 1857)

HIGGINS' EYE PEARLY MUSSEL RECOVERY TEAM

Army Corps of Engineers Centre
190 Fifth Street East, St. Paul, MN 55101-1638
(612) 290-5264

CALL FOR INFORMATION ON *LAMPSILIS HIGGINSI*

On June 14, 1976, the Higgins' Eye Pearly Mussel *Lampsilis higginsi* (Lea, 1857) was listed as an endangered species by the Fish and Wildlife Service. In 1982, the Higginsi Recovery Team prepared a recovery plan for this species. Since Recovery Plans are subject to periodic updates and information from anecdotal reports indicates that there may have been major shifts in some mussel beds in Mississippi River as a consequence of last summer's floods, the Fish and Wildlife Service has called together a new recovery team to examine the current status of *Lampsilis higginsi*. The current Recovery Team has placed, as a high priority, an improved understanding of the past and current distribution and abundance of this species.

To assist the team in its work, we request that if you have any information available on the distribution, population characteristics, or habitat requirements of *Lampsilis higginsi* that you contact the individual listed below. The Recovery Team, as part of its charge, will be making recommendations to the Fish and Wildlife Service and other agencies, concerning the direction of future research and for other activities needed to recover this species. To make the best informed decisions, the Recovery Team urgently needs all information regarding *Lampsilis higginsi*. Comb your memories and your files - any information including field reports will help in this effort.

Please Forward your information:

Robert J. Whiting
Higgins' Eye Mussel Recovery Team Leader
Corps of Engineers Center
190 Fifth Street East
St. Paul, Minnesota 55101-1638
Phone: 612-290-5264
Fax: 612-290-5800

Bruce S. Lieberman
Department of Geology and Geophysics, Kline Geology Laboratory,
Yale University, P.O. Box 208109, New Haven, CT 06520-8109
203-432-5990
blieber@minerva.cis.yale.edu

ENVIRONMENTAL CHANGE AND EVOLUTION IN FRESHWATER MOLLUSKS

My study will consider how climate change and the formation of new habitats effect species and faunas evolutionarily using the aquatic molluscan fauna of the Great Lakes and their tributaries and the Erie Canal. Phylogenetic analysis of DNA sequences and RAPDs will be used to deduce the evolutionary relationships of populations of several species of gastropods and unionid bivalves from several different habitats and geographic locales.

The unionid taxa I will be concentrating on are Amblema plicata (Rafinesque, 1820) and Lasmigona costata (Rafinesque, 1820) and the prosobranch gastropod is the pleurocerid Elimia livescens (Menke, 1830). I would like to sample localities of each of these species from throughout their range in the Ohio-Missippi River Drainage System and in the Erie Canal, and I hope to do a substantial amount of collecting in the upcoming summer. I would be very appreciative if any scientists in the course of their collecting might be able to collect specimens of these taxa from any localities and freeze them, if they happen to come across any. In addition, I would be glad to pick up specimens of any taxa that anyone else is interested during the course of my collecting. Moreover, if anyone knows of any particularly rich localities for these taxa I would be grateful if they could let me know.

E.C. Masteller, K.R. Mateski, and D.W. Schloesser*
Penn State University at Erie
The Behrend College
Erie, PA 16563-1200
814/898-6404

*U.S. Department of the Interior
National Biological Survey
Great Lakes Center, Ann Arbor, MI 48105

Abstract

The purpose of this study was to determine species composition and relative abundance of unionid bivalves (Mollusca: Bivalvia: Unionidae) in Presque Isle Bay, Erie, Pennsylvania 1990-1992. This information was compared with data from the only other extensive survey of unionids in the bay conducted in 1909-1911 (Ortmann 1919) to assess changes over the 80 years preceding the present study. A total of 1,540 individuals representing 18 species were collected in 1990-1992. Five relatively common species (between 7 and 42% of total individuals), six uncommon species (2 and 6%), and seven rare species (< 1%) were found. The rare species were *Anodontoides ferussacianus, Lasmigona costata, Ligumia recta, Ptychobranchus fasciolaris, Quadrula pustulosa pustulosa, Strophitus undaulatus*, and *Truncilla donaciformis*. Five of the species found in Presque Isle Bay (*Leptodea fragilis, Ligumia nasuta, Potamilus alatus, Quadrula quadrula*, and *Truncilla donaciformis*) are listed as critically imperiled and one species (*Truncilla truncata*) as extirpated in the State of Pennsylvania by the Western Pennsylvania Conservancy. Comparisons between unionid populations in 1909-1911 and 1990-1992 indicate few substantial changes occurred during the past 80 years. A total of 22 species were found; 21 in 1909-1911 and 18 in 1990-1992. Seventeen species were found in both studies, an additional four in 1909-1911 and one in 1990-1992. The relative abundance of 11 of the 17 species found in both studies remained stable (i.e., common or uncommon) over the past 80 years. Only four species listed as uncommon in 1909-1911 were listed as rare in 1990-1992. However, the invasion of the zebra mussel (*Dreissena polymorpha*) is considered a threat to the continued existence of the entire Unionidae fauna in Presque Isle Bay, a unique habitat of the Great Lakes.

EFFECT OF WATER TEMPERATURE ON LOCOMOTION AND BURROWING IN UNIONID MUSSELS.

Diane L. Waller and Jeffrey J. Rach. National Fisheries Research Center, Box 818, LaCrosse, WI 54602-0818 608/783-6451

Unionid mussels are collected from early spring to late fall for surveys, relocation projects, and commercial harvest. Mussel activity generally correlates with water temperature, but there are few data that establish guidelines for handling mussels at different water temperatures. Mussels that do not properly position and burrow may be more susceptible to predation, colonization by zebra mussels, and current movement. Our objective was to compare locomotion and burrowing at three water temperatures among four unionid mussel species. We collected threeridge (*Amblema plicata plicata*), pink heelsplitter (*Potamilus ohiensis*), pigtoe (*Fusconaia flava*), and pocketbook (*Lampsilis cardium*) mussels from Navigation Pool 8 of the upper Mississippi River. Mussels were transferred to three holding tanks that measured 2.92 x 0.69 x 0.61 m and contained 0.3 m sand and 0.3 m water. Fifteen mussels of each species were placed into each tank, total density=36 mussels/m^2. Mussels in each tank were acclimated to one of three test temperatures (7, 14, or 21°C) for at least 3 weeks. Following acclimation, mussels were removed from the tank, tagged, and placed back into the tank on their sides. We recorded observations of shell position, percent of shell buried, and mussel location in the tanks at 1, 2, 4, 6, 12, 24, 48, 72, and 96 h. We found that burrowing and locomotion increased significantly with temperature, and that activity varied significantly among species. At 7°C, only 20-60% of mussels were turned upright after 48 h compared to >90% at 21°C. Pink heelsplitter and pocketbook mussels moved further and more often than threeridge and pigtoe mussels. Moreover, they turned upright and burrowed more quickly than threerige and pigtoe mussels. Our results demonstrate the importance of planning surveys and relocation projects at water temperatures in which mussels are active and can reestablish quickly after displacement.

Marian E. Havlik, Malacological Consultants, 1603 Mississippi Street, La Crosse, Wisconsin 54601-4969. Phone/FAX: 608-782-7958.

ARE UNIONID TRANSLOCATIONS A VIABLE MITIGATION TECHNIQUE? THE WOLF RIVER EXPERIENCE CONTINUED, AUGUST 1993.

Unionid translocation has been suggested to offset the effects of introduced mollusks, and to preserve genetic variability. Some relocations have reported 50% to 90% mortality. Prior to a 1992 bridge demolition, 8120 marked unionids (14 taxa) were translocated from County A bridge, Wolf River, Shawano, WI, into similar, nearby habitat. Preliminary transplant site mean densities were 20.7/m^2, and mean densities at the bridge were 9.7/m^2. Over 114% of the expected bridge population was salvaged (mean 10.8/m^2, maximum density 152/0.25 m^2), including 33 small, threatened specimens. Unionids were out of water only a few minutes to identify, mark, and translocate the same day. At least 0.05% of the hand planted unionids, and 2% of those from a special quadrat, were unable to re-establish themselves shortly after being translocated.

The 1993 follow-up, privately funded by Malacological Consultants, showed successful collection and relocation methods. The bridge mean density was 4.13/m^2. The translocation site survival rate of 98.4% (mean density 68.14/m^2) was attributed to careful hand relocation in warm weather. About 40% of the tripled densities were from the relocated unionids; 30% were from mean ambient densities, and 30% of the increased densities were from an unknown cause, perhaps from 1993 high water, or else results represented a sampling artifact. Two of the small, relocated threatened Alasmidonta viridis (Rafinesque, 1820) were recovered, with no mortalities found among the 33 transplanted threatened unionids. Anodonta imbecillis Say, 1829 was added to the site species list.

At a special translocation site 1.0 m^2 quadrat, four relocations methods were used. Unionids in each 0.25m^2 section were uniquely marked and handled: 25 unionids were pushed into the substrata ("/_\"); a pit was dug for 25 specimens with a trowel ("T"); a pit was dug for 25 specimens by the diver's finger ("L"); and 25 unionids were laid on the substrata ("X"). At least 75% of these unionids survived, and were recovered from within the same 1.0 m^2 area, although 6% had moved around within the frame, and 1% were found immediately outside the frame. None of the eight uniquely marked Lampsilis radiata luteola (Lamarck, 1819) were found in the quadrat, however this is an active species. One commonly marked unionid ("/") moved into the frame. Ambient density within the quadrat was represented by 31 unmarked, living unionids in 1994; no dead specimens were found in the quadrat. Time did not permit searching for uniquely marked unionids outside the quadrat frame. Long-term studies should be done on survival and recruitment at our translocation site, and on repopulation of the old bridge site. Some large unionid relocations can be very successful. If funding is available, we plan extensive followup at the translocation site in 1994.

Marian E. Havlik, Malacological Consultants, 1603 Mississippi Street, La Crosse, Wisconsin 54601-4969, Phone/Fax: 608-782-7958, and Mary K. Clausen, Nebraska Game and Parks Commission, P.O. Box 30370, Lincoln, Nebraska 68503-0370, Phone: (402)471-5421, Fax: (402)471-5528.

A SURVEY OF THE UNIONID MOLLUSKS (MOLLUSCA: BIVALVIA) OF THE ELKHORN RIVER BASIN, NEBRASKA, A DISTURBED FLOODPLAIN RIVER.

The Elkhorn River drains 18134,7 sq. km in northeast Nebraska while flowing southeast 456.5 km to the Platte River. Over 154.8 km have been lost to channelization. The Basin slope varies from 1.89 m/km in the west to a much steeper slope in the east, with local slopes of 37.8 m/km. The lower Elkhorn River is a fourth order stream. The sand substrata and channel shift readily. Unionid information is scant. An 1877 paper reported 20 species from the Elkhorn River; only three voucher specimens are known to exist. A specimen of the endangered Lampsilis higginsi (Lea, 1857) was collected in 1891, from West Point, NE, the survey focal point. The location of this collection has been questioned.

During August and September of 1993, 149 sites were sampled by canoe (67.4 km), john boat (9.7 km), and wading at bridge and road accesses. 231 living individuals, representing seven species, were found in occasional pools and on sandbars. Lampsilis ventricosa (Barnes, 1823) accounted for 64% of the living individuals, Anodonta grandis Say, 1829 23%, and Lasmigona complanata (Barnes, 1823) 11%. Four species were represented by one or two individuals, and an additional two species were represented by fresh shells only. One living individual of the uncommon Nebraska unionid Ligumia subrostrata (Say, 1831) was found. Over 53% of the living individuals were found at one site. Some specimens were compressed and stunted, and others had reduced shell sculpture.

The Elkhorn River mainstem is devoid of mussels, except as shells, downstream of Holt County. Due to channel modifications, pollution, and a shifting substrata, the Elkhorn River is probably not suitable for Lampsilis higginsi reintroduction.

This project was funded by Nebraska Game and Parks Commission Nongame Checkoff Fund, and the U.S. Fish and Wildlife Service, Section 6.

A poster presentation will be given on this project at the International Conference "Sustaining the Ecological Integrity of Large Floodplain Rivers: Application of Ecological Knowledge to River Management", 12 - 15 July 1994, La Crosse, WI.

Marian E. Havlik, Malacological Consultants, 1603 Mississippi Street, La Crosse, WI 54601-4969, Phone/Fax: 608-782-7958.

UNIONIDS AND MARGARITIFERIDS (MOLLUSCA: BIVALVIA), SAINT CROIX RIVER, AFTON AND WILD RIVER STATE PARKS, MINNESOTA, JUNE 1992.

Over 40 bivalve mollusk species have been reported from the St. Croix River since the mid-1980's, but large areas have never been sampled. From 8 - 17 June 1992 we did semi-quantitative, quantitative, and random sampling by wading and SCUBA diving near the Minnesota shorelines of Wild River and Afton State Parks to determine the presence and habitat of rare bivalves. A total of 1560 living margaritiferids and unionids were found, representing 20 species. Four additional species were represented among 391 empty shells. Aquatic habitats differed greatly in the two parks. No Dreissena polymorpha (Pallas, 1771), Zebra Mussel, were found.

Wild River State Park sites were up to two meters deep, and had a diverse, abundant mussel fauna, particularly in sand, gravel, and cobble areas that also served as habitat for submergent aquatic vegetation. Thirteen sites (32 sub-sites) along the 18.7 mile border of Wild River Park yielded 1480 living unionid and margaritiferid mollusks with densities to 74/m^2 representing 19 living species. Elliptio dilatata (Rafinesque, 1820), Spike (32.0%) and Actinonaias ligamentina carinata (Barnes, 1823), Mucket (30.8%) dominated the fauna. Proposed as federally endangered, 40 large, old Cumberlandia monodonta (Say, 1829), Spectacle Case, were found at Wild River Park. The largest was 235 mm long and about 70 years old (independently aged three times). Their unique habitat of large boulders was limited. Since the smallest C. monodonta was 165 mm long, the absence of young adults strongly suggests a host fish problem. C. monodonta is reproducing below the nearby Northern States Power dam, St. Croix Falls, Wisconsin.

Other rare living unionids at Wild River Park were Cyclonaias tuberculata (Rafinesque, 1820), Purple Warty-Back (23 specimens up to 50 years of age), Alasmidonta marginata Say, 1818, Elk Toe (29 specimens) and Pleurobema sintoxia (Rafinesque, 1820), Round Pig-Toe (17 specimens). Six species showed evidence of recruitment. Two species were represented by empty shells only. Unionid diversity decreases downstream of the south boat landing due to the impoundment effects of the St. Croix Falls power dam.

Afton Park's unionid habitat was limited, and the fauna sparse in numbers and diversity. Depths were six or more meters near the shoreline. Twelve sites (14 sub-sites) along the two mile border of Afton Park yielded 80 living unionids (eight species). Three additional species were represented by empty shells, including a federally endangered, female Lampsilis higginsi (Lea, 1857), Higgins' Eye, found near Afton's north boundary. Recruitment was minimal, and some specimens were slow growing (stunted length and height for age). Project was supported by MNDNR Nongame Wildlife Program & Tax Checkoff, and MN Division of Parks and Recreation.

Paul Hartfield
U.S. Fish and Wildlife Service
6578 Dogwood View Parkway
Jackson, Mississippi 39213
601/965-4900

STATUS REVIEW OF SELECT *PLEUROBEMA* SPECIES ENDEMIC TO THE MOBILE RIVER BASIN

The Service has been actively assessing the current status of the Mobile River basin mollusk fauna. To date, over 1000 collections have been made from the Alabama, Tombigbee, Black Warrior, Cahaba, Coosa, and Tallapoosa River drainages by the Service and others since 1990. These survey efforts have revealed a severely depleted faunal community, composed of fragmented populations in a state of decline. As a result, 17 mollusk species have been listed as endangered or threatened under the Endangered Species Act. At least four snail species are under consideration for proposed listing, while 33 others are presumed extinct. Two endemic mussel species are considered extinct.

The following species, or their synonyms have not been recorded in the scientific literature, technical reports, or confirmed in museum collections for at least 50 years:

highnut (*Pleurobema altum* (Conrad 1854))
Pleurobema hartmanianum (Lea 1860)
longnut (*Pleurobema nucleopsis* (Conrad 1849))
true pigtoe (*Pleurobema verum* (Lea 1860))
yellow pigtoe (*Pleurobema flavidulum* (Lea 1831))
Alabama pigtoe (*Pleurobema johannis* (Lea 1859)).
Warrior pigtoe (*Pleurobema rubellum* (Conrad 1834))

Collections of the following species, or their synonyms, have not been recorded in the scientific literature, technical reports, or confirmed in museum collections for at least 20 years:

Pleurobema aldrichianum Goodrich 1931
hazel pigtoe (*Pleurobema avellanum* (Simpson 1900))
Georgia pigtoe (*Pleurobema hanleyanum* (Lea 1852))
Alabama clubshell (*Pleurobema troshelianum* (Lea 1852))
painted clubshell (*Pleurobema chattanoogaense* (Lea 1858)
Pleurobema hagleri Frierson 1906
Coosa pigtoe (*Pleurobema murrayense* (Lea 1868))

Although the Warrior pigtoe was reported in a technical report from the Black Warrior drainage in 1985, subsequent examination of the specimens revealed them to be typical *Pleurobema furvum*, currently listed as endangered.

Recent collection efforts for these species have included historical collecting sites, as well as numerous additional stream and river localities. At all localities, the freshwater mussel fauna has proven to be severely reduced due to sedimentation, eutrophication, pollution, impoundment, and/or channel modification. Based on this analysis, the Service presumes the species listed above to be extinct.

Paul Hartfield
U.S. Fish and Wildlife Service
6578 Dogwood View Parkway
Jackson, Mississippi 39213
601/965-4900

OBSERVATIONS ON THE REPRODUCTIVE ANATOMY AND BEHAVIOR OF CERTAIN GULF COAST UNIONIDS.

Recent field observations in the Mobile River Basin suggest an intense competition for host fish attraction and infestation in unionid mussels. Foremost among these observations is the superconglutinate method of glochidial release/host fish attraction recently documented for *Lampsilis perovalis* (Conrad). Conglutinates of *Ptychobranchus greeni* (Conrad) have been found to mimic aquatic dipteran larvae, and use a novel method for maintaining position in shoals and rapids. Temporal, anatomical, and behavioral differences in the display of mantle flaps of live gravid females have been noted between populations of *Villosa vibex* (Conrad). This suggests one or more cryptic species within this taxon, or an inordinate amount of individual and population variation.

Recent collections have found most small individuals (35-95 mm) of *Potamilus inflatus* (Lea) in the Amite River, LA, and the Black Warrior River, AL, to be gravid. Although larger individuals (100-150 SL) are more abundant in both rivers, they have not been observed in the gravid state. This suggests protogyny, which is rare in bivalves and has not been previously reported in the Unionidae. Glochidia of *P. inflatus* are distinct from all other members of the genus, and have valve characters unique to this species.

Abstract submitted to American Malacological Union Annual Meeting, Houston, Texas, July 1994.

Dr. David Patrick
Department of Geology
University of Southern Mississippi
Hattiesburg, MS 30406
601/266-4530

Paul Hartfield
U.S. Fish and Wildlife Service
6578 Dogwood View Parkway
Jackson, MS 39213
601/965-4900

THE CONSEQUENCES OF RIPARIAN MINING ON MISSISSIPPI'S STREAMS

In Mississippi, the mining of surface and near-surface sand and gravel deposits is an important local and regional economic activity which may also have significant detrimental impact on the region. Both upland and riparian mining operations may contribute to erosion and sedimentation related problems; however, riparian mining may have the most detrimental effects. On the basis of reconnaissance-level field and imagery studies, we have observed significant accelerated erosion and sedimentation occurring on a number of streams in which riparian mining operations have been or are being conducted. Those streams exhibiting the greatest effects of mining include: the Amite, Bogue Chitto, Buttahatchee, East Fork of the Tombigbee, Leaf, and Pearl Rivers. The character of the observed erosion and sedimentation is generally similar to that exhibited in streams which have been channelized; however, channelization conducted for flood control or navigation is not a factor in most of these streams. Even so, they have been channelized by mining, particularly by in-channel mining, in which the point bars have been removed. The mining of point bars as well as the channel proper results in a shortening of the stream, the development of a knickpoint, and, in many cases, headcutting. These processes have resulted in modification of floral and faunal habitats, property loss, decreased recreational value, and damage to bridges. We recommend that further investigations be directed toward the effects of riparian mining and, on the basis of these studies, that guidelines be developed by the State to regulate this industry.

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Shawn E. Dueitt and David M. Patrick
Department of Geology
University of Southern Mississippi
Hattiesburg, MS 30406
601/266-4530

Paul Hartfield
U.S. Fish and Wildlife Service
6578 Dogwood View Parkway
Jackson, MS 39213
601/965-4900

FLUVIAL INSTABILITY AND ITS IMPACT ON MUSSEL FAUNA, EAST FORK, BUTTAHATCHEE, AND LUXAPALILA DRAINAGES, NORTHEASTERN MISSISSIPPI

Investigations on the East Fork, Buttahatchee, and Luxapalila Rivers are currently being conducted for the purpose of documenting and describing fluvial instability. Field studies indicate that portions of these systems are experiencing active bank erosion and channel bed degradation. These types of instability present serious problems for substrate dwelling organisms, such as mussels. Federal authorities list five species of mussel as threatened or endangered on the East Fork system, six species on the Buttahatchee, and four on the Luxapalila. The research hypothesis contends that navigational improvement and/or gravel mining has initiated or accelerated fluvial erosion along these systems, and thus, has had adverse impacts on mussel fauna habitats. This hypothesis will be validated through: (a) extensive field investigations of the area, (b) analyses of historical and current areal photographs, and (c) comparisons of historical and current stream profiles. Successful completion of the investigation will provide engineers, planners, and scientists a database to aid in the understanding of how anthropogenic activities may influence sensitive ecosystems of fluvial environments through geological and geomorphological processes.

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Life history research on *Ligumia recta* and *Lasmigona costata*

Mark Hove, Robin Engelking, Margaret Peteler, Laurie Sovell
University of Minnesota, (612) 624-3019

Research on the life history of various mussels living in the St. Croix River, Minnesota has been an ongoing project since 1991. During the fall of 1993, laboratory tests were conducted on a variety of fish species to determine and/or verify suitable hosts for *Ligumia recta* and *Lasmigona costata*. Thirteen species of fish were infested with *Ligumia recta* glochidia, but only largemouth bass and walleye served as hosts.

Number of fish tested	Species tested	Days to metamorphosis
2	largemouth bass*	27-29
4	walleye	22-24

Number of fish tested	Species tested	Period of attachment
1	black bullhead	1-3 d
1	yellow bullhead	2-5 d
1	channel catfish***	1-4 d
3	northern pike	7-11 d
1	green sunfish**	13 d
2	pumpkinseed	8-11 d
6	bluegill**	20-22 d
1	black crappie	7-10 d
3	Iowa darter	1-5 d
2	Johnny darter	1-5 d
3	yellow perch	14 d

Average water temperature was 19 ± 2°C.

Six of eight fish species tested were found to be suitable hosts for *Lasmigona costata* glochidia.

Number of fish tested	Species tested	Days to metamorphosis
1	bowfin	10-13
3	northern pike	15-17
2	bluegill	13-16
2	largemouth bass	6-9
2	yellow perch	9-11
4	walleye	8-10

Number of fish tested	Species tested	Period of attachment
3	yellow bullhead	2-8 d
3	bluegill	3-7 d
1	largemouth bass	7-8 d
2	black crappie	7-10 d

Note that positive and negative results were observed for bluegill and largemouth bass. Negative results in bluegill and largemouth bass may be explained by their having been previously exposed to *Lasmigona costata* glochidia. Average water temperature was 21 ± 2°C.

Attempts were made to maintain juvenile mussels in the laboratory. Juvenile *Ligumia recta* and *Lasmigona costata* were held in empty 100 ml glass beakers and fed a powdered marine invertebrate diet. Juvenile *Ligumia recta* lived 22 d under these conditions while juvenile *Lasmigona costata* lived less than 7 d.

Life history studies on various species of mussels living in the St. Croix River will continue this summer and next year. Host suitability tests will be conducted on the previously mentioned mussel species in addition to others. Further host tests will be conducted on fish species for which fewer than 10 individuals have been tested and for trials with conflicting results.

If you would like further information, or would like to share freshwater mussel life history information please contact Mark Hove at: 200 Hodson Hall; 1980 Folwell Ave.; St. Paul, MN 55108; (612) 624-3019; FAX (612) 625-5299; or at mh@finsandfur.fw.umn.edu

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Shawn E. Dueitt and David M. Patrick
Department of Geology
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Paul Hartfield
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Number of fish tested	Species tested	Days to metamorphosis	Number of fish tested	Species tested	Period of attachment
2	largemouth bass*	27-29	1	black bullhead	1-3 d
			1	yellow bullhead	2-5 d
4	walleye	22-24	1	channel catfish***	1-4 d
			3	northern pike	7-11 d
			1	green sunfish**	13 d
			2	pumpkinseed	8-11 d
			6	bluegill**	20-22 d
			1	black crappie	7-10 d
			3	Iowa darter	1-5 d
			2	Johnny darter	1-5 d
			3	yellow perch	14 d

Average water temperature was 19 ± 2°C.

Six of eight fish species tested were found to be suitable hosts for *Lasmigona costata* glochidia.

Number of fish tested	Species tested	Days to metamorphosis	Number of fish tested	Species tested	Period of attachment
1	bowfin	10-13	3	yellow bullhead	2-8 d
3	northern pike	15-17	3	bluegill	3-7 d
2	bluegill	13-16	1	largemouth bass	7-8 d
2	largemouth bass	6-9	2	black crappie	7-10 d
2	yellow perch	9-11			
4	walleye	8-10			

Note that positive and negative results were observed for bluegill and largemouth bass. Negative results in bluegill and largemouth bass may be explained by their having been previously exposed to *Lasmigona costata* glochidia. Average water temperature was 21 ± 2°C.

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SUBMITTED BY: Don Hubbs (615)781-6575 wrk. or (901)584-9032 Hm.
Tennessee Wildlife Resources Agency
P.O. box 40747
Nashville, Tn 37204

The following list describes major activities performed under the commercial musseling project conducted by the TWRA for 1993.

Commercial Harvest Survey: During the 1993 Kentucky Reservoir Survey (Tennessee River) 86 musselers were interviewed with a total catch of 15,824 mussels weighing 6163.8 pounds. The average individual weight of these mussels is 0.38 lbs. down from the 1992 individual average of 0.46 lbs. This decrease is due to an increase in the number of ebony shell (*Fusconaia ebena*) being bought by commercial shell dealers. Ebony shell made up 72 % (by number, 65 % by weight) of the commercial catch during 1993. The three ridge (*Amblema plicata*) was second at 16 % by number and 17 % by weight. Average wholesale price paid for shell during 1993: 2 3/8" ebony $0.21, 2 5/8" ebony $0.63, 3 3/4" washboard $1.90, $\geq$ 4" washboard $2.85, three ridge/mapleleaf/pigtoe group 2 5/8" $1.67.

Population Surveys: Data collected from sites on the Tennessee, Duck and Cumberland Rivers will be detailed in the 1993 statewide commercial musseling report available sometime this summer. Three sites on the lower Duck River in Perry County produced 143 mussels of 20 different species including 2 specimens of *Quadrula c. cylindrica*. On the Tennessee River, 3360 mussels were collected representing 29 species. Collection efforts on the Cumberland were hampered by inclement weather and adverse flows, howerver 406 mussels of 25 species were collected. Individual weight and size data are collected from mussels in these samples and will be analyzed along with age data at the end of the sampling year. Density is measured at selected sites by collecting at least 10 0.5 m^2 samples. Densities have ranged from 4 to 38.2 mussels per square meter. Endangered mussels encountered thus far: *Lampsilis abrupta* TRM 197.3, TRM 517.9, CRM 264.0 and *Cyprogenia stegaria* TRM 170.2.

Zebra Mussel: The zebra mussel has been collected by TWRA biologist in the Tennessee River at miles 101 (Benton County) and 197.3 (Hardin County). Both collections were of one individual adult. Commercial mussel divers have periodically reported sightings of zebra mussels in Kentucky Reservoir. These encounters normally involve 1 to 3 zebra mussel adults that have probably been dislodged from populations which exist on barges navigating the river. One musseler collected 15 zebra mussel adults at approximately mile 107 (Benton County) during a one week period.

David W. Garton
Department of Biological and Physical Sciences
Indiana University Kokomo
2300 S. Washington St., Kokomo, IN 46904
(317) 455-9244; E-mail dgarton@indiana.edu

IMPACT OF FOULING BY *DREISSENA POLYMORPHA* ON UNIONIDS OF LAKE WAWASEE, INDIANA.

(adapted from a presentation at the International Zebra Mussel Conference, Madison, WI)

Zebra mussels were reported from Lake Wawasee (the largest natural lake in Indiana) in late 1990, several years following the initial introduction of *Dreissena* into Lake St. Clair. Although substrates in Lake Wawasee are predominately soft silts and mud, zebra mussels presently occur in high densities on vegetation and any available hard substrate. In particular, zebra mussels have colonized shells of native unionids. The present study was initiated to determine critical thresholds for zebra mussel encrustations resulting in reduced survival and biochemical fitness of native unionids. Lake Wawasee is bisected by a large, shallow sandbar, approximately 1 m depth. Average density of live unionids on the sandbar is 2.0 m^{-2} (mean of 20 0.25 m^2 quadrats) but the distribution of individuals is not uniform (maximum density in one quadrat 20 m^{-2}). *Lampsilis radiata*, *Strophitus undulatus* and *Pyganodon* (*Anodonta*) *grandis* are the common species at this site, with occasional specimens of *Villosa iris* and *Alismodonta sp.* Live specimens of the three common species were collected by SCUBA in the spring (n = 40) and fall (n = 32) of 1993. Encrusting zebra mussels were removed, weighed and counted. The total wet mass of the "host" unionid was measured, then soft tissues removed and frozen for glycogen analysis.

The mass of zebra mussels encrusting unionids increased significantly between spring and fall of 1993 (three common species pooled). The ratio of host mass to encrusting zebra mussel mass decreased from 7.05 in the spring to 2.87 in the fall, reflecting a doubling of encrusting zebra mussel mass relative to host unionid mass. Similarly, unionid glycogen content declined significantly from the spring to fall of 1993. Tissue samples contained approximately one-half the glycogen content in the fall than in the spring.

Presently, the encrustation of native unionids by *Dreissena* is less severe than reported for unionid populations that were subsequently extirpated in Lakes St. Clair and Erie. The mean number of adult zebra mussels per unionid in Lake Wawasee is less than one half that reported for Lake Erie (70/unionid, spring and fall samples combined, versus 200/unionid, respectively). In the spring sample only one freshly dead unionid specimen was collected, however, later in the fall several dozen freshly dead specimens were collected and many heavily encrusted unionids were observed lying exposed on the substrate, rather than buried. In May, 1994 nearly half of all specimens collected were freshly dead. These preliminary observations indicate that zebra mussels encrusting Lake Wawasee unionids will likely cause a significant increase in mortality.

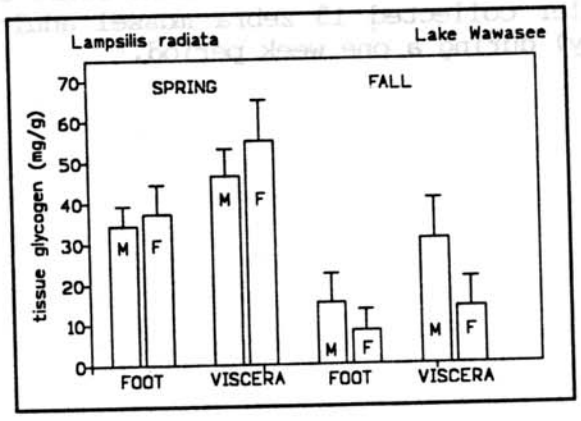

Figure 1. Glycogen content of *Lampsilis* from Lake Wawasee. 1994. M = male, F = female.