COPE

Triannual Unionid Report

Report No. 12

July 1997

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

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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.

COVER: THE MUSSEL ART AND TEXT BY JENNIFER SCHUELER, OXFORD STATION, ONTARIO, CANADA.

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National Native Mussel Conservation Committee-Outreach Subcommittee:
Survey of Outreach Products Relating to Native Freshwater Mussels

One of the goals of the National Native Mussel Conservation Committee is to increase public awareness of the plight and value of freshwater mussels. As part of this effort, the outreach committee is compiling a list of ongoing and proposed outreach activities relating to native mussels. This list will be made available to all interested parties and will be used to coordinate our efforts.

Outreach activities include educational programs, training programs, videos, brochures, pamphlets, posters, T-shirts, and exhibits. Relevant activities/materials could relate to any aspect of the biology and conservation of native freshwater mussels, and could be aimed at public or professional audiences. We would also like to be informed of outreach efforts relating to other benthic biota such as crayfishes.

Organization Name_____

Contact _____

Mussel Outreach Activities and Materials (Please include a copy, description, or picture if available)

1.Training programs_____

2.Videos_____

3.Posters_____

4.Pamphlets_____

5.Exhibits_____

Please return questionnaire and/or materials to

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Conglutinates and fish hosts of the western fanshell, *Cyprogenia aberti*

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The western fanshell is the only congener of the federally endangered *Cyprogenia stegaria*. Recent surveys of unionids within the present range of *C. aberti* indicate that it is one of the rarest mussel species present. Western fanshells comprised less than 0.1% of the collective total of over 45,600 live mussels examined in those surveys (Ahlstedt and Jenkinson 1991, Sietman and Sadler 1994, Obermeyer 1996). We sought to identify the potential fish hosts of *Cyprogenia aberti* from the Spring River of eastern Kansas and western Missouri (Arkansas River system). The distribution and rarity of western fanshells in the Arkansas system has recently been documented (Obermeyer 1996).

Six individuals were located in the summer and fall of 1996 and were caged near the point of capture. Three of these individuals were gravid with mature glochidia in early December. The marsupia of fanshells are uniquely drawn out into coils, and produce elongate, wormlike conglutinates (Chamberlain 1934). Conglutinates of our specimens were white, 5-8 cm in length, and consisted primarily of sterile eggs. The sterile eggs appear to serve a structural role and to act as a bait to entice host fish. Developed eggs containing glochidia are arrayed primarily along the sides of a ribbon-like core of sterile eggs. This core is tough and elastic and the glochidia are easily dislodged when fish attempt to ingest the conglutinate.

We tested 27 species of fishes as potential hosts of *Cyprogenia aberti*. Of these, only three species supported transformation of glochidia. The compatible species were *Etheostostoma flabellare* (fantail darter), *Percina caprodes* (logperch), and *Cottus carolinae* (banded sculpin). Glochidia attached more effectively when fish were allowed to feed on the conglutinates than when glochidia were pipetted directly onto the gills. The excystment of transformed juveniles from *Percina caprodes* peaked at 27 days following infection at 23 °C.

Incompatible fishes included the following species: *Micropterus dolomieu, Lepomis macrochirus, L. humilis, L.. megalotis, Pomoxis annularis, Stizostedion vitreum, Percina phoxocephala, Etheostoma caeruleum, E. spectabile, E. juliae, E. blennioides, E. stigmaeum, E. zonale, Ictiobus bubalus, Campostoma anomalum, Ictalurus punctatus, Noturus flavater, Cyprinus carpio, Pimephales notatus, Phoxinus erythrogaster, Notropis zonatus, N. cardinalis, N. lutrensis, and Aplodinotus grunniens*.

Literature Cited

Ahlstedt, Steven A. and John J. Jenkinson. 1991. Distribution and abundance of *Potamilus capax* and other freshwater mussels in the St. Francis river system, Arkansas and Missouri. Walkerana 5(14):225-261.

Chamberlain, T.K. 1934. The glochidial conglutinates of the Arkansas fanshell, *Cyprogenia aberti* (Conrad). Biological Bulletin 66:55-61.

Obermeyer, B.K. 1996. Unionidae (Bivalvia) of the Arkansas River System of SE Kansas and SW Missouri: Species of Concern, Historical Change, Commercial Harvesting, and Sampling Methods. M.S. Thesis. Department of Biological Sciences, Emporia State University, Emporia, Kansas. i-xix, Pp. 1-131.

Seitman, B.E. and Sadler, J.L. 1994. Survey of Curtis' pearlymussel (*Epioblasma florentina curtisi)* in southeast Missouri and northeast Arkansas. Internal report: Missouri Department of Conservation. Pp. 1-14.

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New Illustrated Mussel Guide Expected to Assist in Simplifying Identification

In the National Strategy for the Conservation of Native Freshwater Mussels, sections 7.3.1 and 7.3.2, the development of a mussel key, training courses and seminars on mussel identification, etc. are suggested. A mussel identification guide which is succinct and easy to use by individuals of various levels of interest is in the works. *An Illustrated Guide to Unionid Mussels of Kansas* will cover the 44 known taxa occurring in Kansas, including species which are rare and extirpated. The guide is expected to be used extensively by biologists, educators, students, and wildlife law enforcement personnel. Attention will be focused on the shell characteristics, rather than anatomical features. Thus, the book will be useful in identification of weathered and relic specimens as well as living and fresh dead material.

One of the main attractions of this new mussel book is its detailed color illustrations. These will increase the practical value of this guide in the field and in clinics and workshops designed to train individuals in mussel identification. The short, one-page species accounts afford busy people a quick description of a species' main characteristics. The book's design has also eliminated the need for a key which is often difficult and time consuming.

It is hoped that the use of this guide will not be limited to government employees and/or those in Kansas. The book's format is intended also to increase public awareness of a diverse but declining natural resource.

Expected publication date is August, 1997. Copies will be available directly from the author/illustrator. Those who have responded to the Unio Listserver bulletin or have added their name to sign-up sheets at the meeting of the Kansas Chapter of the American Fisheries Society or the North American Benthological Society will be mailed ordering information (including price) when the book becomes available. Anyone else interested, please contact me at the above address.

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Spiny riversnail (*Io fluvialis*) reintroductions made into the Holston and French Broad Rivers in August 1996, will be evaluated this summer for adult survival. Preliminary observations on the French Broad indicate good adult survival, since a few dozen were observed grazing in the general location where they were placed. High water due to heavy rainfall and discharges from tributary dams have prevented any intensive look at the Holston River transplant site. Additional specimens will be transplanted this fall (August 19-20), to augment these populations. Anyone interested in helping with this please call me.

NATIONAL NATIVE MUSSEL CONSERVATION MEETING. It has been decided that our national meeting will be held in October 1999 (not 1998) and hosted by The Tennessee Aquarium in Chattanooga, Tennessee. More news on this will be sent out at a later date.

Current Status of Texas Pimpleback (*Quadrula petrina*)

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Texas pimpleback (*Quadrula petrina*) is endemic to the Colorado and Guadalupe River drainages of Central Texas (Howells et al. 1996). Like many unionids, it had seen dramatic declines in abundance and distribution throughout its range (Howells et al. 1997). Currently, small populations are known to exist only in the central Concho River, Concho County, at sites scattered over about 15-km and in limited numbers in a small tributary of the Colorado River, Runnels County.

The greatest abundance was observed in the Concho River just west of Paint Rock in one of Texas Parks and Wildlife Department's freshwater mussel sanctuaries. When first discovered in 1993, 3.0 living specimens/hour were located. When reexamined in 1994, 18.7/hour were found. This site was not surveyed again until 12 June 1997 when 15.0/hour were found. Due to small sample sizes, there is no significant difference between the 1994 and 1997 estimates and the population at this location appears not to have changed noticeably in the years between.

Drought conditions which reduced many unionid populations statewide in 1995 and 1996 and several major floods in 1997 apparently did not significantly impact Texas pimplebacks or other unionids at this site. Relatively few shells were found. Although a variety of size and apparent age classes were present, no small juveniles were located. However, extremely high densities of Asian clams (*Corbicula* spp.), which may exceed 2,000/m^2, confound location of extremely small unionids here.

Females from the Paint Rock site carried developing eggs in early June (1997), glochidia in late June (1993), and had empty marsupia by early August (1994). Although eggs and glochidia have been obtained from Texas pimplebacks, host fishes utilized remain to be determined.

References

Howells, R.G., R.W. Neck, and H.D. Murray. 1996. Freshwater mussels of Texas. Texas Parks and Wildlife Press, Austin.

Howells, R.G., C.M. Mather, and J.A.M. Bergmann. 1997. Conservation status of selected freshwater mussels in Texas. Pages 117-128 *in* K.S. Cummings, A.C. Buchanan, C.A. Mayer, and T.J. Naimo (editors). Conservation and management of freshwater mussels II: Initiatives for the future. Proceedings of a UMRCC symposium, 16-18 October 1995, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

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Temporal analysis of physiological condition in relocated Unionid mussels

Recently, the Wisconsin Department of Natural Resources and the Upper Mississippi Science Center (UMSC) undertook an experimental relocation of native unionid mussels to identify potential conservation strategies which could be employed in response to the threat of zebra mussels. In May 1995, we relocated about 1,500 mussels, representing five species, from the Upper Mississippi River (UMR) into three separate refugia. At the same time, we moved an additional 300 threeridge mussels *(Amblema plicata plicata*) from the UMR into an artificial pond at the UMSC. Ten mussels, from 80 to 90 mm in shell length, were sampled about monthly from the UMSC pond for the past 21 months. To assess the physiological health of these mussels, we measured glycogen concentrations (in foot tissue) and a condition index (tissue dry mass as a percentage of shell dry mass), on each sampling date.

Although survival of mussels was 83% during the first 12 months of the relocation (declining to 67% during the next 10 months), the physiological condition of unionids was significantly reduced after the first month of relocation. For example, glycogen concentrations averaged 26.6 mg/g (wet weight) at the time the mussels were removed from the UMR and declined by 39% to 16.3 mg/g after the first 30 days. For the next 20 months, mean concentrations of glycogen ranged only from 8.0 to 15.9 mg/g with highest concentrations generally in April and lowest concentrations in August. As an additional comparison, in May 1996, mean glycogen concentrations in mussels in the UMR was 21.7 mg/g, while glycogen concentrations in relocated mussels averaged 13.4 mg/g. The tissue condition index in threeridge mussels paralleled the temporal pattern in glycogen concentration.

These data suggest that in addition to the traditional measures of growth and survival, relocation studies need to start addressing more subtle changes in the physiological health of unionids. In this case, after one-year, traditional measures would have suggested that the relocation was successful, when in fact, the mussels had significantly reduced their physiological condition after only 30 days. Future research is needed to define the thresholds at which a physiologically-stressed animal can no longer grow and reproduce. Thus, the development of techniques to rapidly assess the condition of freshwater mussels to validate traditional measures of growth and survival are greatly needed.

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1. New publications

Watters, G.T. 1997. Glochidial metamorphosis of the freshwater mussel *Lampsilis cardium* (Bivalvia: Unionidae) on larval tiger salamanders, *Ambystoma tigrinum ssp.* (Amphibia: Ambystomidae). *Canadian Journal of Zoology* 75: 505-508.

Abstract: Larval tiger salamanders (*Ambystoma tigrinum ssp.*) were infected with glochidia of the freshwater mussel *Lampsilis cardium* in laboratory experiments. At 20-21° C, metamorphosis occurred from nine to 39 days, primarily between nine to 17 days. The percentage of attached glochidia that metamorphosed varied from 0.27 to 15.7%. Compared with a known piscine host, largemouth bass, metamorphosis on the salamanders occurred more quickly, but less percent of the total attached glochidia metamorphosed. The role of amphibians as hosts for freshwater mussels in North America has not been addressed. Recognizing such a relationship could have important consequences for our understanding of mussel zoogeography.

Watters, G.T. 1997. A synthesis and review of the expanding range of the Asian freshwater mussel *Anodonta woodiana* (Bivalvia: Unionidae). *Veliger* 40:152-156.

Abstract: The freshwater mussel *Anodonta woodiana* is native to eastern Asia. In recent years, it was discovered in fish hatcheries in Romania, Hungary, France, and several Indonesian islands. It also was collected in the wild in the Dominican Republic and Costa Rica. These occurrences are believed to be the result of the incidental introduction of exotic fishes imported for food, as foraging fishes, or for mosquito control, which bore parasitic glochidia of the mussel. These hosts are grass, common, bighead, and silver carp, Nile tilapia, and mosquitofish. Because these fishes are imported throughout the world, *Anodonta woodiana* may eventually be found in additional countries. It has the potential to escape and compete with native freshwater mussels wherever it is introduced.

Watters, G.T. 1997. Individual-based models of mussel-fish interactions: a cautionary study. Pp. 45-62 *in* Cummings, K.S., Buchanan, A.C., Mayer, C.A. & T.J. Naimo (eds.), *Conservation and management of freshwater mussels II: initiatives for the future.* Proceedings of a UMRCC symposium, 16-18 October 1995, St. Louis, MO.

Abstract: Individual-based models of host-parasite interactions between mussels and fishes may simulate unionid reproductive strategies. Reproduction by specialists, those having few potential hosts, results in low population sizes. Often, this renders specialists more susceptible to extirpation and extinction. Conversely, generalists may exist in great numbers given the proper conditions. Generalists are opportunistic, and have evolved to cope with random fluctuations in their population size. Specialists have evolved to cope with fluctuating host numbers. Simulations

indicate that stable populations are very sensitive to host numbers. Threshold levels of host numbers exist below which mussel populations will become extirpated. Therefore, extirpation may result from a decrease of host numbers, although hosts are still available. Mussel population sizes and incidence of recruitment may fluctuate because of purely stochastic events. Average or stable population sizes of mussels are therefore difficult to assess without long-term monitoring. Consistent annual recruitment may not be necessary to maintain a stable population. Introduction of immune exotic hosts may drive both specialists and generalists to extirpation. Introduction of exotic mussels capable of parasitizing any host may result in the extirpation of generalists, but specialists may coexist.

2. Potential hosts for *Villosa iris* (Lea, 1829)

Laboratory infections have identified the following potential hosts (* - previously identified as a host in other studies):

Striped shiner	Streamline chub	Smallmouth bass (*)
Largemouth bass (*)	Green sunfish	Bluebreast darter
Greenside darter	Rainbow darter	Yellow perch
Siamese fighting fish		

The following fish species did not appear to be hosts:

Blackside dace	Redfin shiner	Rosyface shiner
Silver shiner	Spotfin shiner	Black redhorse
Bluntnose minnow	Creek chub	Gravel chub
Hornyhead chub	Stoneroller	Suckermouth minnow
Bluegill	Longear sunfish	Rock bass (*)
Banded darter	Blackside darter	Johnny darter
Logperch	Tippecanoe darter	Variegate darter

3. Potential hosts for *Lampsilis radiata luteola* (Lamarck, 1819)

Laboratory infections have identified the following potential hosts (* - previously identified as a host in other studies):

Bluntnose minnow	Striped shiner	Smallmouth bass (*)
Largemouth bass (*)	Bluegill (*)	Longear sunfish

The following fish species did not appear to be hosts:

Redfin shiner	Rosyface shiner	Silver shiner
Spotfin shiner	Golden redhorse	Gravel chub
Stoneroller	Suckermouth minnow	Banded darter
Bluebreast darter	Logperch	Rainbow darter
Tippecanoe darter		

SURFIN FOR CLAMS

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I'm pretty much a novice at finding my way around the internet but for other beginners I thought I would list some of the freshwater mussel resources that I was able to find on the world wide web. I haven't tried to list individual researcher's home pages because there are so many of them.

Listservers: UNIO - Focuses on freshwater unionid mussels. To subscribe send an e-mail message to: majordomo@lists.umbc.edu The first line of text should include the following statement: subscribe UNIO your e-mail address

MOLLUSCA - Includes marine and paleontological as well as freshwater. To subscribe, send an e-mail message to: listproc@ucmpl.berkely.edu In the body of the message type: subscribe mollusca your name

CONCH-L - Shell collectors. Send a message to: listserv@uga.cc.uga.edu In the body of the message type: subscribe conch-l your name

SHELLFISH - Probably mostly marine mollusks? Send message to: shellfish-request@kenyon.edu In the body of the message type: subscribe

Web Pages

1. Illinois Natural History Survey Mollusk Collection - this page includes links to many other mussel resources including; the Triannual Unionid Report, mussel researchers list, symposium proceedings, field guide to freshwater mussels of the midwest, systematic research collections list, and of course a lot of stuff about IL. http://www.inhs.uiuc.edu/cbd/collections/mollusk.html

2. Mollia - logistic information about malacology, info about meetings, on-line collections databases, Unitas Malacologica newsletter and other links.
http://www.ucmp.berkeley.edu/mologis/mollia.html

3. Species Accounts, US Fish and Wildlife Service, Divs of Endangered Species, Region 4 - has a lot of SE US mussel species accounts from the Red Book.
http://www.fws.gov/~r9endspp/i/f/saf16.html Each saf number is a species.

4. Former Category 2 Candidate species.
http://ucmpl.berkely.edu/barry/cat2.html

5. Questions about Mussels.
http://www-personal.umich.edu/~rsherman/questions.html

6. University of Michigan, Museum of Zoology Mollusk Publications.
http://www.ummz.lsa.umich.edu/mollusks/pub.html

7. American Malacological Union 1997 meeting - paper abstracts.
http://ucmpl.berkeley.edu/mologis/meeting.html

8. Conchologists of America (COA) sponsor a bunch of different web pages. They have the same address except the ending is different for each.
http://coa.acnatsci.org/conchnet/ (add the rest of the address listed for each)

- COA information center	coatrack.html
- Freshwater mussel references	uniorefs.html
- Mussel collecting in Kansas	couch995.html
- Freshwater mussel articles	acfwmusl.html
- New species	edunew-f.html

9. Some Recent Publications on Adult and Juvenile Unionid Mussels.
http://www.wfu.edu/users.dimock/muss.html

10. Alabama Mollusks, Freshwater Species.
http://fly.hiwaay.net/~dwills/mussels/alafwspl.html

8. Rhode Island Freshwater Clams and Mussels.
http://brooktrout.gso.uri.edu/riseagrant/clams_fs.html

9. Montana Freshwater Mussels.
http://rivers.oscs.montana.edu/dlg/aim/mollusca/sum2.html

Spectaclecase (*Cumberlandia monodonta*) host(s) still elusive

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The host requirements of *Cumberlandia monodonta*, a federally listed species (Category 2), have not been determined. We are working with Chris Barnhart, Andrew Roberts, and Frank Riusech at SW Missouri State University, and Richard Neves and Michelle Steg at Virginia Polytechnic Institute and State University to determine suitable host(s) for this species.

Twenty-three fish species and the mudpuppy were exposed to glochidia this spring at the University of Minnesota. Glochidial metamorphosis was not observed for any of the species tested (Table 1).

Table 1. Species exposed to *Cumberlandia monodonta* glochidia.

Species	Number inoculated	Glochidia attachment period (days)	Species	Number inoculated	Glochidia attachment period (days)
Ichthyomyzon sp.	8	1-5	burbot I	3	1-3
bowfin	4	1-4	burbot II	2	1-4
carp	1	1-4	black crappie	10	1-4
fathead minnow	10	4-6	green sunfish	10	1-4
goldfish	5	1-4	pumpkinseed	6	1-4
spotfin shiner	10	1-4	rock bass	10	1-4
channel catfish I	1	1-4	blackside darter	6	1-4
channel catfish II	6	6-11	fantail darter	4	1-4
flathead catfish I	6	6-11	Iowa darter	10	4-11
flathead catfish II	4	1-4	Johnny darter	12	1-4
stonecat I	3	1-3	logperch	6	1-4
stonecat II	3	1-4	yellow perch	12	1-4
tadpole madtom	3	1-4			
yellow bullhead	7	1-4	mudpuppy	11	*
mudminnow	10	4-6			

* - Unclear if initially infested.

A number of interesting observations were made this spring on the conglutinates and the way they were released. As previously observed under laboratory conditions, the unusually shaped conglutinates released by this species (Knudsen and Hove 1997) are accompanied by a viscous, sticky, transparent, gelatinous material. This year divers observed *C. monodonta* releasing conglutinates in the St. Croix River. Soon after divers removed a flat stone that covered a large group of *C. monodonta* they began to release conglutinates. Conglutinates were arranged along the length of a transparent, gelatinous strand; approximately 0.6 m in length. Another behavior witnessed in the field and the laboratory was the propensity for gravid females to release their conglutinates at the same time.

It's interesting to note that *Cyclonaias tuberculata* will also produce a large gelatinous conglutinate; 10 cm long in static water and possibly 20 cm long in a light current. Perhaps the strategy of producing "super-conglutinates" like those constructed by *Lampsilis perovalis* is more widely employed than previously thought.

Funding was provided by the Minnesota Dept. of Natural Resources, Natural Heritage and Nongame Research Program, and University of Minnesota, Undergrad. Research Opportunities Program. We gratefully thank Dave Heath, Ron Benjamen, and Mark Endris of the WI Dept. of Natural Resources for their underwater observations while collecting gravid mussels.

Literature Cited

Knudsen K. A. and M. C. Hove. 1997. Spectaclecase (*Cumberlandia monodonta*) conglutinates unique, host(s) elusive. Triannual Unionid Report. 11: 2.

Host fish suitability studies and host attracting behaviors of *Tritogonia verrucosa*, the pistolgrip

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Eleven fish species were exposed to *T. verrucosa* glochidia released by females collected from the St. Croix River at Interstate State Park, Minnesota (Table 1). While none of the species facilitated metamorphosis of glochidia into juveniles, glochidia on the 3 year old black bullheads and yellow bullheads grew significantly. Although yellow bullheads can serve as suitable hosts for *T. verrucosa* glochidia (Pepi and Hove 1997), juveniles were not observed during this study. Flathead catfish have also been reported as suitable hosts for *T. verrucosa* (Howells, 1996). Unfortunately, our flathead catfish died due to mechanical problems before metamorphosis was observed.

Table 1. Fishes exposed to *T. verrucosa* glochidia

Species	Number tested	Glochidia attachment period (days)	Results
bowfin I	4	2-5	negative
bowfin II	4	9-13	negative
northern redbelly dace	10	4	negative
carp	5	2-5	negative
quillback	3	5-9	negative
black bullhead (1 yr old)	7	23-25	negative; no growth
black bullhead (3 yr old)	3	18-21	negative; growth & tissue development
yellow bullhead (1 yr old)	4	23-25	negative; some growth, no tissue development
channel catfish	6	6	negative
flathead catfish	6	11	incomplete (all died)
brook stickleback	10	12	negative
yellow perch	9	8	negative

This mussel exhibits behaviors that may be associated with host attraction. Divers observed gravid females either protruding from the substrate to an unusual degree, or, they were lying completely exposed on the riverbed. As observed last year, gravid females displayed swollen mantles (Pepi and Hove 1997), however, the mantle appears to be inflated to a greater extent at night. One morning at 4 a.m. we observed five gravid females displaying mantles that appeared to be 20% larger than during the day.

Funding was provided by the Minnesota Dept. of Natural Resources, Natural Heritage and Nongame Research Program, and University of Minnesota, Undergraduate Research Opportunities Program. We gratefully thank Dave Heath, Ron Benjamen, and Mark Endris of the Wisconsin Dept. of Natural Resources for their underwater observations while collecting gravid mussels.

Literature Cited

Howells, R. G. 1996. Pistolgrip and Gulf Mapleleaf hosts. Info-Mussel Newsletter. 4(3): 3.

Pepi, V. E. and M. C. Hove. 1997. Suitable fish hosts and mantle display behavior of *Tritogonia verrucosa*. Triannual Unionid Report. 11: 3.

Name: Stephen Eugene McMurray

Date of Degree: May, 1997

Institution: Eastern Kentucky University

Location: Richmond, Kentucky

Title of Study: REPRODUCTION IN A FRESHWATER UNIONID (MOLLUSCA: BIVALVIA) COMMUNITY DOWNSTREAM OF CAVE RUN RESERVOIR IN THE LICKING RIVER AT MOORES FERRY, KENTUCKY

Pages in Thesis: 120 Candidate for the Degree of: Master of Science

Major Field: Biology (Applied Ecology)

Scope of Study: The objective of this study was to determine why recruitment had ceased or had been dramatically decreased in the diverse unionid community at Moores Ferry, Bath County, Kentucky, and to compare it with a unionid community 159 kilometers downstream at Butler, Pendleton County, Kentucky, which was thought to be healthy. It was hypothesized that the loss of recruitment in the Moores Ferry bed was the result of Cave Run Reservoir, located approximately 35.4 km upstream.

Findings and Conclusions: A total of 20 unionid glochidia were collected by drift nets, compared to 235 juvenile Corbicula fluminea. Six of the fish collected from Moores Ferry and none of those collected from Butler had infestations of glochidia. Only 10.1% of the unionids observed from Moores Ferry and only 13.5% of those observed from Butler had their gills modified as marsupia. Histological examination revealed that the sex ratios for Actinonaias ligamentina and Elliptio dilatata at Moores Ferry and A. ligamentina at Butler did not differ significantly from 1:1. The sex ratio for E. dilatata at Butler was statistically different from 1:1. One of the A. ligamentina from Moores Ferry was found to be hermaphroditic. Most of the males from both sites had more than one cell type of spermatogenesis present in their testes, and usually the most advanced type present dominated the acini. Spermatids were most common in E. dilatata and sperm morulae and spermatids were most common in A. ligamentina from Moores Ferry. Spermatids and

spermatozoa were observed in E. dilatata and spermatocytes, spermatids, and spermatozoa were observed in A. ligamentina from Butler. Oogonia, oocytes, and ova were observed in the ovarian alveoli of female E. dilatata from Butler. Oogonia were round to oval, up to 40 μm in diameter, and were usually embedded in the alveolar wall. Oocytes were oval to tear drop or balloon shaped, 50 to 150 μm in diameter, and were attached to the alveolar wall by a cytoplasmic stalk. Ova were round to oval in shape, 65 to 165 μm in diameter, and were usually free in the lumen of the alveoli. Most of the E. dilatata from Moores Ferry were in the second stage of oogenesis (oocytes), while the first stage of oogenesis (oogonia) was predominantly found at Butler. Most of the females of A. ligamentina and E. dilatata from Moores Ferry had empty marsupia. Most of the female A. ligamentina from Butler had mature glochidia in the marsupia. For E. dilatata, however, most of the females had empty marsupia. Post-impoundment water temperatures for the Licking River at Farmers, Kentucky, were significantly lower than pre-impoundment temperatures for the months of May through July. There was no significant decrease in temperature for the month of August and a significant increase in water temperature for the month of September. The average monthly discharge increased from pre- to post-impoundment periods for the months of June through September and decreased during the month of May. Even though there were no significant differences in discharge and only significant decreases in temperature for a few months, the impacts of these changes were still important. The average monthly discharge and temperature at Moores Ferry may not have been as important as the spikes of discharge and decreases in temperature caused by releases of hypolimnionic water from Cave Run Reservoir. These data clearly showed that these releases had impacted the downstream faunas. Based on these data, it was recommended in order to ameliorate the combined effects of discharge and temperature that: 1) the individual spikes of discharge be reduced; and 2) the water for discharge be epilimnionic or mixed to produce a warmer discharge. Further study at Butler needs to be completed to determine the impacts to, and assess the current health of, this community.

ADVISOR'S APPROVAL _____
DATE SIGNATURE

Identification of host fishes for *Lampsilis altilis* and *Villosa vibex*

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We have completed laboratory host identification trials for *Lampsilis altilis* and *Villosa vibex*. Gravid females of these two species were collected in March 1997 from Shoal Creek (Coosa River drainage) in Talladega National Forest, northeastern Alabama. Methods followed closely those of Zale and Neves (1982). All trials were conducted at 19°C. Host fishes are species that produced live juvenile mussels; non-hosts are species that rejected all glochidia without producing juveniles. Marginal hosts are species that carried glochidia for extended periods but produced no juveniles, only inactive juveniles, or extremely low numbers of active juveniles (<5).

Lampsilis altilis

Hosts	Non-hosts	
Micropterus punctulatus	*Ambloplites ariommus*	*Hypentelium etowanum*
M. salmoides	*Aphredoderus sayanus*	*Lepomis auritus*
M. coosae	*Campostoma oligolepis*	*L. gulosus*
	Cottus carolinae	*L. macrochirus*
Marginal hosts	*Cyprinella trichroistia*	*Notropis asperifrons*
Fundulus olivaceus	*C. callistia*	*N. xaenocephalus*
Lepomis cyanellus	*Etheostoma coosae*	*Percina nigrofasciata*
	Fundulus stellifer	*Semotilus atromaculatus*

Villosa vibex

Hosts	Non-hosts	
Micropterus punctulatus	*Ambloplites ariommus*	*L. gulosus*
M. salmoides	*Cottus carolinae*	*L. macrochirus*
M. coosae	*Cyprinella trichroistia*	*L. marginatus*
	C. callistia	*Luxilus chrysocephalus*
Marginal hosts	*Etheostoma coosae*	*Noturus leptacanthus*
Fundulus olivaceus	*Hypentelium etowanum*	*Percina nigrofasciata*
Lepomis megalotis	*Lepomis auritus*	*Semotilus atromaculatus*
L. cyanellus		

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Confirmation of Lampsilis altilis as a superconglutinate producer

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As of this year, three North American unionid species (Lampsilis perovalis, L. subangulata, and L. australis) had been confirmed as producing superconglutinates, a large, minnow-shaped conglutinate containing the entire glochidial contents of both gravid gills and tethered to the female mussel by a hollow mucus strand (Haag et al. 1995; O'Brien et al. 1997). In addition, Lampsilis altilis, endemic to the Coosa and Tallapoosa River drainages in Alabama, Georgia, and Tennessee, was suspected to produce superconglutinates, based on having gravid gill morphology similar to that of confirmed superconglutinate producers (P. Hartfield, USFWS, Jackson, MS, personal communication). However, this behavior had never been observed in L. altilis.

On March 11, 1997 (water temp. = 18°C), we surveyed for mussels in Shoal Creek, a Coosa River tributary in Talladega National Forest, northeastern Alabama. We found one female Lampsilis altilis releasing a superconglutinate. The female was perched upright with about one-half of her shell exposed above the substrate and trailing a mucous strand about 40 cm in length. In addition, we found one female perched upright in sand trailing a short segment of a mucous strand (suggesting that the superconglutinate had been torn off), and two detached superconglutinates were found snagged on twigs in the stream.

In addition to using superconglutinates, L. altilis appears to also employ the host attraction strategy of other species of Lampsilis. On this same date, we found six gravid female L. altilis displaying mantle flaps characteristic of non-superconglutinate producing species of Lampsilis. The mantle flaps were pigmented with a dusky gray stripe on the outer surface, a row of black spots on the inside surface, and a distinct eyespot on the posterior-most end. The flaps were pulsated in a manner similar to the behavior of L. cardium. All of the displaying females had fully gravid gills visible through the shell aperture, but none showed any sign of producing superconglutinates. The one female found producing a superconglutinate was not displaying mantle flaps, but the flaps, complete with eyespots, could be seen lying retracted, anterior to the siphons.

These observations bring the total number of known superconglutinate producers to four, with two species in the Mobile Basin (L. altilis and L. perovalis), one in the Escambia/Choctawhatchee system (L. australis), and one in the Apalachicola/Ochlockonee system (L. subangulata). No other species are known to have the unusual marsupial morphology characteristic of these species, thus, superconglutinate production may be unique to these four taxa. Other superconglutinate producers have modified mantle margins that may be rhythmically undulated during the breeding season (Hartfield and Butler 1997). However, these mantle flaps are greatly reduced relative to the typical Lampsilis condition and the "display" is inconspicuous and probably does not serve to attract a host. Lampsilis altilis is unique among these four species in having and displaying a well-developed lure-like mantle flap in addition to producing a superconglutinate. This suggests that the presence of well-developed mantle flaps such as those of L. altilis may represent the basal condition for this group, mantle flap lures having been lost in the other three species along with increased specialization for infecting host fishes by superconglutinate production. However, additional characters are needed to test this hypothesis.

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Another Year Surveying the Distribution Of Unionids in Eastern Ontario. I have continued the survey of the Unionids of eastern & central Ontario I began with support from the Ministry of Natural Resources in 1995 *(Schueler, 1996. A Survey of the Unionid mussels of the Rideau and lower Ottawa drainages (in Ontario). Triannual Unionid Report 9:5).* The commonest species have or are hybrid populations. Some lower Ottawa River *Elliptio* appear intermediate between the widespread *E. complanata & E. dilatata* (historically known from the vicinity of Montreal). *Anodonta (=Pyganodon) grandis* and *A. cataracta* seem to intergrade (while *A. grandis*-like shells predominate, I found *A. cataracta*-like shells at the outlet of Fawn Lake, Mississippi drainage, and Higley Lake & Lyn Creek, Leeds Co). *Lampsilis (r.) radiata* and *L. (r.) siliquoidea* seem to hybridize freely throughout the area. These three "common species," or complexes, are represented at most sites that I sampled. I am unsure of the taxonomic status of diverse *Lampsilis* that resemble *L. ovata.*

In southern Renfrew Co, despite high water, in May 1996, I found the common species at several sites with, at Lake Dore, *Strophitus undulatus*, at Muskrat River/Hwy 17, *Lasmigona compressa*, and at Black Bay, Calabogie Lake, *Lampsilis cf ovata.* In Lanark Co, the Mississippi River from Almonte to Blakeney has the most diverse fauna in the area, with the common species, *L. cf ovata, Lasmigona costata, Ligumia recta, & Alasmidonta marginata.* Upstream of the falls at Almonte *S. undulatus* was at three sites, *L. compressa* at two headwater sites, *Anodontoides ferussacianus* in Bolton Creek, a shell of *L. costata* in the main river at Glen Isle, but only 1-3 of the common species at 16 other sites.

In Ottawa-Carleton Region, the upper Jock River supports the common species, *Strophitus undulatus, Anodontoides ferussacianus*, and *Lasmigona compressa.* The Rideau River lock-bypass rapids at Andrewsville (where no *Dreissena* were seen in 1996) contain large old *Lasmigona costata & Ligumia recta*, and many *Lampsilis radiata* (a 154 mm *L. radiata* shell is the largest known from E. Ont.). Downstream, in Ottawa, below Hogsback Falls (one of the historically richest Unionid sites in the area), water was startlingly clear and the bottom covered with 1st-yr *Dreissena* in September 1996. In June, 1997, shells of dead *Dreissena* formed 30 cm deep drifts, water was more turbid, and though there were many mussels they did not pave the bottom. In 1996 *L. radiata* were crowded with *Dreissena:* in the substrate as if killed *in situ*, freshly dead on the surface, or bearded with *Dreissena* but still alive. In 1997 there were only a very few living *L. radiata & E. complanata*, and shells of *L. costata & Ligumia recta.*

At Spenserville, Grenville Co, the only clear rocky stretch of the South Nation River supports the common species, *Strophitus undulatus, & Lasmigona compressa.* I found *Leptodea fragilis* in the South Nation near its muddy mouth at the Ottawa River (first fresh modern E. Ont. specimens). Along the Ottawa River from Hudson to Pointe Fortune, Quebec, *Elliptio complanata* predominates, and while many shells are heavy and diverse in shape and colour, none were clearly *E. dilatata.* Sites along the St Lawrence River all had many *Dreissena* and shells of the common species (mostly *E. complanata & L. radiata*), but no living Unionids (Leeds Co: St Lawrence Pk in Brockville & Halsteads Bay, Grenville Co: Claybank Bay, Maitland, & Windmill Battle Pk).

A brief (August, 1996) visit to streams draining the Oak Ridges Moraine north of Lake Ontario (records plotted in *Metcalfe-Smith,* et al. 1997. **Biodiversity of Freshwater mussels in the Lower Great Lakes Drainage Basin.** NWRI Contribution 97-90), found very few Unionids. *Strophitus undulatus* was the only Mollusc in Bowmanville Creek at Hampton. At Garden Hill a large *Lasmigona costata* was the only Unionid in a rocky riffle below a milldam. In Cold Creek, at Orland (a clear pasture creek sampled at a bridge riffle), *Elliptio & Lampsilis* were absent, but *S. undulatus, Anodontoides ferussacianus, & Lasmigona compressa* were present. First-year *Dreissena* were widespread in lakes and locks of the Trent Canal system, but were not evident at the Trent River (7 km SSW Campbellford), where the common species were found with *L. costata & Ligumia recta* (mostly old clams in rubble on limestone bedrock), *Lampsilis cf ovata, Alasmidonta undulata* (first L. Ontario drainage record, a few old shells), *Villosa iris, A. ferussacianus, & S. undulatus.* The introduced crayfish *Orconectes rusticus* was so abundant here that it was hard to imagine that any juvenile Unionid could survive.

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THE 1995 AND 1996 EVALUATION OF A UNIONID MOLLUSK POPULATION AFTER A 1994 TRANSLOCATION PROJECT: THE WOLF RIVER, N OF SHIOCTON, WI.

A unionid translocation was done August 1994, at STH 54 bridge, Wolf River, Shiocton, WI. Our 1993 preliminary survey (20-0.25 m^2 samples required) showed a mean density of 3.0/m^2 with threatened Tritigonia verrucosa (Raf. 1820) at 13.33% (0.4/m^2). 17 species (957 specimens) were collected at bridge (2.46/m^2). All were marked or numbered on both valves, including 124 T. verrucosa (12.96%, 0.318/m^2, 3-31 years, 9 juveniles, 58 males and 57 females). Per WDNR permit, 10 T. verrucosa were placed in each of 3-1.0 m^2 replicates. Translocation habitat was limited. Unionids were placed 0.3 m apart in an area 2.0 m X 100 m, along the rock/ sand interface, upstream and downstream of replicates. Several T. verrucosa were found at the translocation site which was marked at treeline with orange plastic survey stakes; replicates were similarly marked underwater. In 1995 we sampled the downstream half of site, and 2 replicates. Of 87 unionids, 49 were hash marked, 12 numbered, and 26 unmarked. Only one 27 year old hash marked unionid was dead (98.4% survival). Mean density was 5.08/m^2 for marked, and 2.17/m^2 for unmarked shells. Replicate #2 included 4 T. verrucosa, 1 Ligumia recta, 1 hash-marked, and 3 unmarked unionids. Replicate #3 included 3 T. verrucosa and 5 unmarked shells. 4 numbered T. verrucosa were recovered from 40-0.25 m^2 quadrats. T. verrucosa were found clumped in several areas. Actinonaias l. carinata (Barnes, 1823) were buried up to 2 inches under sand. Divers only found 3 stakes marking replicates (in riprap); others were either buried or washed away. Replicates were again marked. In 1996 we sampled the upstream half of the site, and all 3 replicates. Of 92 mussels found, 55 were alive and 37 dead; 32 were hash marked, 14 numbered, and 46 unmarked. 5 hash marked and 2 numbered mussels were dead (84.8% survival). Mean density was 3.0/m^2 for marked and 1.23/m^2 for unmarked mussels (mean 4.23/m^2). Recovered from replicate #1 were 6 T. verrucosa, 6 hash-marked and 5 unmarked mussels; from replicate #2 were 3 T. verrucosa (#48 dead), and 6 unmarked mussels, and from replicate #3 were 3 T. verrucosa (#34 dead) and 4 unmarked mussels. 2 numbered T. verrucosa were recovered from 40-0.25 m^2 quadrats. Of the 52-0.25 m^2 quadrats, 19 were negative, including 2 in replicate #2. No empty mussels were fresh-dead. Most marked mussels continued to be found near the rock riprap/sand interface. Divers only found 3 stakes (in riprap) marking replicates. The channelward stakes were either not found, buried in sand, or washed away. Our results show that careful quick handling of mussels out of water give an acceptable survival rate 2 years post-project. The mortality of marked mussels did not appear to be associated with this translocation because 100% of the unmarked mussels were found alive in 1995, whereas only 35.6% of the unmarked mussels were found alive in 1996. This indicates that unusual relocation efforts are generally unnecessary, however we recommend hand planting of special status mussels when habitat is restricted in width.