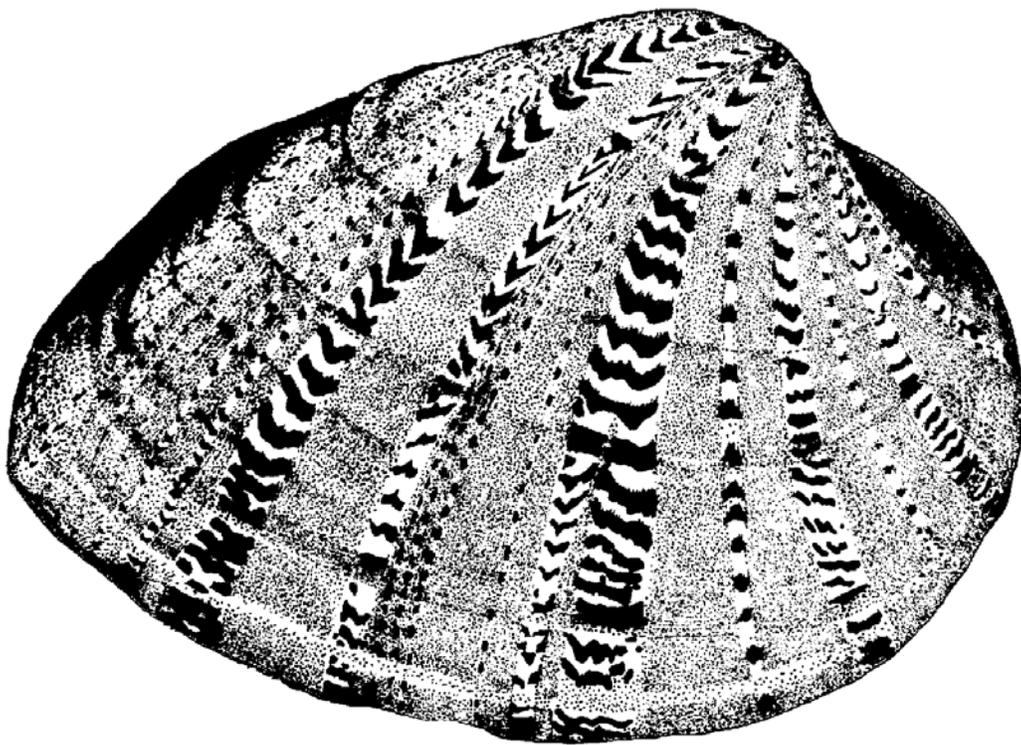


Ellipsaria

The Newsletter of the Freshwater Mollusk Conservation Society

Volume 7 - Number 2

August 2005



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2005 Symposium Report

2004 Freshwater Mollusk Bibliography

2005 Membership List

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Submissions for the December 2005 issue of *Ellipsaria* may be sent to the editor at any time but are due by **November 8, 2005**. Anyone may submit an article but you must be a member of FMCS to receive *Ellipsaria*. Please limit submissions to about one page. Categories for contributions include news, new publications, meeting announcements, current issues affecting mollusks, job postings, contributed articles (including ongoing research projects), abstracts, and society committee reports. Electronic submissions are preferred; contact the editor with any questions. Note that submissions are not peer reviewed, but are checked for content and general editing.

Please send change of address information to the Secretary, Patty Morrison.

Ellipsaria

NEWSLETTER OF THE FRESHWATER MOLLUSK CONSERVATION SOCIETY

Volume 7, No. 2

<http://ellipse.inhs.uiuc.edu/FMCS/>

August 2005

FMCS Reports:

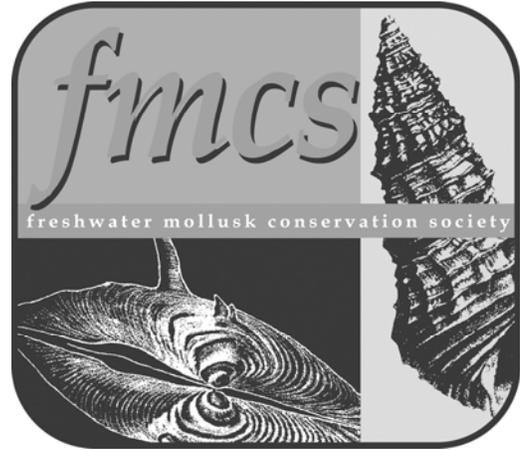
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President's Message

The Freshwater Mollusk Conservation Society has completed its Fourth Biennial Symposium. Those of you unable to attend the meeting last May in St. Paul missed an exceptional opportunity to hear about and discuss new insights into a wide variety of issues, including increased genetic understanding, behavioral differences in species, advances in conservation technology and captive husbandry, and improved measures of contaminant sensitivity. FMCS developed, in part, because other professional societies addressing freshwater invertebrate biology and conservation failed to recognize the unique challenges involved in insuring that the diversity of freshwater mollusks in North America persists. To many outside of our Society, including many in resource management and regulatory agencies, these animals are simply mussels, clams, or snails. The research that is occurring and the results that were presented in St. Paul continue to elucidate how important understanding even subtle differences can be in developing effective conservation strategies. Numerous people approached me in St. Paul to express their appreciation of the effort the meeting organizers put into developing a professional, informative meeting. I again want to thank Kurt Welke for taking the lead in organizing this meeting, and again recognize the effort and time the other organizers contributed.

The exchange of information and education regarding freshwater mollusk conservation are among the primary missions of FMCS, along with advocating mollusk conservation, promoting science-based management decisions, and facilitating the *National Strategy for the Conservation of Native Freshwater Mussels*. We accomplish these goals through symposia and workshops on alternating years, the publication of *Ellipsaria*, occasionally promoting more substantial publications, and, we hope in the near future, with the publication of a professional journal. At the last Board meeting, we agreed to review the *National Strategy* and update the tasks to keep the document relevant. If you have thoughts you would like to have considered in a revised *National Strategy*, I ask that you send them to me or to one of the Committee Chairs.

The goals of the Society are primarily accomplished by the nine standing Committees. These Committees identify issues and opportunities to advance mollusk conservation, and their success depends on members sharing their talents. Ours is a voluntary society – accomplishments are achieved solely by the time and efforts donated by our members. The ability to commit time to a particular issue is at the member's discretion and can be substantial or relatively minor, but is always important. Those who have been in FMCS for a few years may have noticed a core of a relatively few people serving on the board, although our by-laws are designed to keep membership rotating through these positions. There are many opportunities for you to lend your experience and passion to help meet the Society's goals. I encourage every Society member to become involved with the committees that interest you by contacting the appropriate Committee Chair.

This issue of *Ellipsaria* should reach most you in toward the end of the field season – I hope your summer has been safe and productive.

Bob Anderson, FMCS President

FMCS Reports

FMCS Officer Election Results

Steven Ahlstedt (USGS (retired), Knoxville, Tennessee) was elected as President. He will serve for 6 years – President-Elect (2 yrs), President (2 yrs), Past President (2 yrs) – beginning in May 2005.

Patricia Morrison (USFWS – Ohio River Islands NWR, Parkersburg, West Virginia) was elected as Secretary and will serve for 2 years beginning in May 2005.

FMCS Business Meeting Minutes

FMCS Business Meeting
May 24, 2005
St. Paul, Minnesota

Treasurer's Report

The society has taken in approximately \$31,000 this year, \$10,000 brought in with this symposium. Approximately \$90,000 is in the society account, some of which will be used to pay the expenses associated with the symposium and start up funds for the journal. The 2003 symposium auction generated about \$4000, which went to paying for student travel awards and best student platform and poster presentation awards.

Tom Watters as president urged the membership to join and become active in the committees of the society and restated that the board meeting is open to all members. The society plans to revise the strategy for conservation of freshwater mussels, which will be handled through the committees. Join a committee and be a part of revising this important document.

2006 Workshop

The society sponsored 2 very successful workshops in 2004. The Columbus Zoo and Aquarium is proposing a workshop for March 2006, focusing on propagation and holding, health and condition of animals in captivity. Other topics are also under consideration.

2007 Symposium

The 5th biennial symposium will be held in Little Rock, Arkansas. A brief summary of the board's discussion on options for the symposium and workshop was presented and the membership was given 3 options on which to vote:

- 1) Hold a 2006 workshop on both propagation/holding and habitat restoration and expand the workshop by 1 day;
- 2) Hold a special session on habitat restoration at the 2007 symposium; and
- 3) Hold a 1-day workshop on habitat restoration the day before the 2007 symposium.

The membership voted for option 3.

A presentation was made to the membership about Little Rock, Arkansas that was put together by the convention and visitors bureau. Bids have been received from the Peabody Hotel, Doubletree Hotel and the Wyndham Riverfront. Bids have been presented to the board for review and evaluation. The proposed symposium date is March 17-20, 2007 to accommodate the added day for the workshop.

Committees

The new committee chairs were introduced.

Awards – Greg Cope

Environmental Quality and Affairs – Dick Biggins and Al Buchanan

Gastropod Status and Distribution – Paul Johnson, chair and Ellen Strong, co-chair

Guidelines and Techniques – John van Hassel

Information Exchange – Kevin Cummings

Mussel Status and Distribution – Kevin Roe

Outreach – Kurt Welke

Propagation, Restoration & Introduction – Jess Jones

New Business

The subject of forming chapters was brought to the board for discussion. Chapters may be more effective in dealing with local issues affecting freshwater mollusks. Forming chapters will require a change to the society bylaws. This topic will be in the next *Ellipsaria*.

Awards Presentations

A special UMRCC award was presented to Kurt Welke in recognition of his tireless work and efforts for conservation of freshwater mussels in the upper Mississippi River.

Student Awards

Almost a third of the 130 presentations at this symposium are being given by students. Greg Cope thanked the members of the awards committee, Catherine Gatenby, David Berg, Theresa Newton, and Cristi Milam Bishop, and encouraged more members to participate on the committee.

The Student Travel Award has expanded from the previous symposium with awards presented to 14 students to help defray the cost of travel to participate in this symposium. The society was able to fund every student that applied with a cash award of \$285 each. These students also volunteered to work various activities (registration, raffle, etc.) at this symposium.

Best Student Presentation Awards:

The Best Student Platform Presentation was awarded to Daniel Spooner of the University of Oklahoma. Daniel's presentation was titled "Physiological ecology of freshwater mussel communities: effects of temperature on community structure and ecological services." Honorable mention was awarded to Pascal Irmscher of the University of Wisconsin for his presentation titled "The use of acoustic doppler current profiler system in acquiring complex hydraulic variables for the prediction of freshwater mussel distribution in a large river."

The Best Student Poster Presentation was awarded to Elizabeth Ashcraft of Arkansas State University for her poster titled "Use of relic shells to determine time since mortality." Honorable mention was awarded to Benjamin Dodd of Southwest Missouri State University for his poster titled "Persistence of acquired resistance of largemouth bass to glochidia of a unionid mussel."

Winners of the best student platform and poster presentations were awarded a plaque and a \$500 cash award for which they are encouraged to use to fund travel to another scientific meeting to present their award winning presentations. The award winners will be posted to the society web page. The committee recognized all judges and moderators that facilitated getting judges for the student platform presentations. The awards committee has decided that an honorable mention will be awarded at future symposiums to student platform and poster runner-up.

FMCS Professional Award Presentation

The society has several professional awards to recognize the accomplishments of full members of the society and the membership is encouraged to submit nominations. The Lifetime Achievement Award was established in 1998 and has been presented every 2 years at the society symposiums. The 2005 recipient of the FMCS Lifetime Achievement Award was Steve Ahlstedt in recognition of more than 30 years of dedicated service to conservation of freshwater mollusks and as one of the founding members of FMCS. The award was presented by Dick Neves, Tom Watters, Bob Butler, and Dick Biggins.

New FMCS Officers

The new president-elect is Steve Ahlstedt and the new secretary is Patricia Morrison. Tom Watters as outgoing president presented the president's hat to Bob Anderson as the new president. Thank you Tom for serving as president of FMCS, an extended term at that.

FMCS Board Meeting Minutes

FMCS Board Meeting
May 23, 2005
St. Paul, MN

A brief report on funding and membership status was presented. The society has approximately \$90,000 in operating funds. Money for the symposium was received from MICRA, \$1000 from the Virginia Department of Game and Inland Fisheries, \$5000 from the Mussel Mitigation Trust, and \$5000 from UMRCC. There were 180 pre-registrations for the 4th biennial symposium with a number of walk-ins expected. The society membership [pre-symposium] includes 280 members that have paid 2005 dues and 199 who are current through 2004 for a total of 479.

Business Meeting

The business meeting will be held Tuesday evening at 8 pm. The committee chairs will be introduced and Tom will emphasize to the membership to become active committee members.

Committee Reports

It was suggested by all committee chairs that the committees should not all be meeting at the same time at future symposiums.

Awards

Greg Cope reported that approximately 25-30% of the 130 presentations are being given by students, a sign the society is healthy and growing. Dave Berg handled the student travel awards. In 2005 there were 14 applicants compared to 4 applicants at the 2003 symposium. Each student has been awarded \$285 to defray travel costs of attending the symposium. There will be 2 student award presentations: best student platform and best student poster presentations. Judges are being chosen 2 ways: session moderators will request full FMCS members to evaluate student presentations and the awards committee has chosen a number of judges to evaluate the presentations. Judges for poster presentations were chosen prior to the symposium. The results of the platform and poster evaluations will be tallied and ready to hand out awards at the business meeting Tuesday evening. Students will receive a plaque and \$500 cash award. Student award winners will be encouraged to use the cash award to present their award winning presentation at another professional meeting. Greg requested the membership be reminded at the auction that all money raised goes directly to the student awards. If the auction generates \$5000 the society should clear between \$3000 and \$4000. Professional level awards will be given at the business meeting. The society needs to do a better job at recognizing its full members. The FMCS professional awards are the Lifetime Achievement Award, the William J. Clench Memorial Award and the Meritorious Service Award.

Commercial

Don Hubbs reported there are 250 commercial shellers operating in the states of TN, AL, KY and AR with 95% of the shell coming out of TN. About 2000 to 3000 tons of mussel shell is being exported annually. Competition from China, which uses mostly non-bead pearly, will likely keep exports low.

Environmental Quality and Affairs

The new committee co-chairs are Dick Biggins and Al Buchanan. Several issues were discussed:

1. The Big Sunflower EIS is due this fall and the committee will review the document with the help of Paul Hartfield.
2. A subcommittee was formed to work on the black water events in the Clinch and Powell Rivers due to coal fines. Jerry Ferris, Bill Henley and John Schmerfeld are the subcommittee members. They will draft a letter focusing on a strategy to solve the problem.

3. Potential draining of Devil's Lake. Though the lake goes through wet and dry cycles it does have a mussel fauna. During a long dry cycle people have moved in and now they are being flooded. The Army COE is trying to fight draining the lake but the state of North Dakota wants it drained. Heidi Dunn will keep the committee apprised of a decision, letting the committee know when it is time to send a letter to the COE.
4. The committee decided to pass in writing a recommendation to the Propagation Committee to develop a white paper on issues dealing with the collecting and over-collecting of host fish, such as disease and genetic issues, and collecting from stream where numbers are already low. The out-going chair will prepare the recommendation to send to the chair of the Propagation Committee.
5. Upcoming workshop (2008?) focusing on the topic of water quality, demonstrating the new techniques coming out of SETAC. This topic could also be a special session at the 2007 symposium. The new techniques should be out by this fall. Chris Ingersoll of USGS will be sending a second draft of a standard entitled "Standard Guide for Conducting Laboratory Toxicity Tests with Freshwater Mussels" for balloting through ASTM Subcommittee E47.03 on sediment assessment and toxicology and through the E47 Main Committee on Biological Effects and Environmental Fate. The guidelines will meet EPA rigor and will be included in future water quality criteria.

Gastropod Status and Distribution

Paul Johnson was re-elected committee chair and Ellen Strong was elected co-chair. The gastropod list, similar to the Williams et al paper on mussels documenting what species are where, will go to the AFS endangered species committee and will be given as a poster at the 2005 AFS Symposium this summer. There is still time to comment on the list. As soon as the list is formalized the gastropod committee will begin developing a conservation strategy for gastropods in North America. Of note, 3 species thought to be extinct were found during a recent survey.

Guidelines and Techniques

John van Hassel is chair of the committee. The committee will review the Army COE experimental dredge protocol, which proposes to skim the top 68 inches of shoal sediment and the mussels (mostly *F. ebena*) within that layer to relocate elsewhere. The board discussed several options. One is for the committee to draft an alternative protocol with funding for mitigation, propagation, and restoration using the mussel kill guidelines. The second option is for FMCS to come out against the experimental dredging protocol. There is no way to determine whether the "experiment" will work. The board recommended to the committee that another letter be drafted stating the society's concerns stated in the 2003 letter were not addresses, the project should not go forward, and the COE needs to look at alternatives. After the letter is finalized a copy should be sent to FWS.

Information Exchange

Kevin Cummings is the committee chair. Chris Mayer handles the society web page and the society newsletter *Ellipsaria*. Award winners will be placed on the web page; committee pages are available. The mailing of *Ellipsaria* is a major effort/cost, so the committee agreed that after FMCS starts publishing *Walkerana*, future newsletters be sent as a pdf file to the membership, leaving a few to be mailed to those members without email. The committee met with Jack Burch to discuss *Walkerana*. Dr. Burch will publish a 2003/2004 issue before turning the journal over to the society. FMCS will use the \$3000 approved by the board at its last meeting to print 500 copies of the next issue for FMCS members.

Mussel Status and Distribution

Committee chair is Kevin Roe. The mussel distribution accounts that have been received will be posted on the society webpage. The committee has not yet decided whether to have pdf files of the accounts or print a single page to be mailed with the newsletter.

Outreach

Committee chair is Kurt Welke. The pop-up society display is available for members to use at other meetings and can be changed/updated.

Propagation, Restoration and Introduction

Committee chair is Jess Jones. He reported 18 members attended the committee meeting. Issues discussed include:

1. Gathering the information to develop a database on juvenile releases and monitoring of juveniles, broodstock, what species are being propagated and where, survival rates, etc. and post to the website.
2. Prioritizing taxa – how to focus resources. Currently there is no prioritization scheme for mussels.
3. Compile information to develop guidelines on the nutritional requirements of juveniles.
4. Explore a white paper on host fish collection/over collection. The white paper can be used as an impetus to pursue research support to propagate host species.

2006 Workshop

A workshop focused on habitat restoration was discussed at the previous board meeting. Tom Watters said that the Columbus Zoo would like to host a workshop on holding/propagation. Use of the facility would be free, so lodging would be the only cost. The zoo will hold the workshop whether or not FMCS is a sponsor. The workshop will be held in September or November 2006. Discussion followed on possibly combining the 2 topics into an extended workshop: half focused on propagation/holding and half spent on habitat restoration/water quality, or have a special session/workshop on habitat restoration before the 2007 symposium. A session on health and condition, and long-term chronic effects would also fit with a holding/propagation workshop.

2007 Symposium

The folks in Arkansas are interested in hosting the 2007 symposium. The Little Rock Visitor Bureau put together a

presentation and has solicited several bids. The proposed date is 18-21 March 2007. The board accepted the Arkansas presentation and will review the bids. A theme has not yet been proposed, and they are open to a special session dedicated to habitat restoration and water quality. A presentation will be made at the business meeting.

The membership will be given the opportunity to vote on 3 options pertaining to the workshop and symposium at the business meeting: 1) an expanded workshop, 2) habitat restoration special session at the symposium, 3) one day workshop before the symposium.

New Business

It has been 10 years since the strategy for conservation of freshwater mussels was published. A proposal was made to the board to have the FMCS committees review pertinent sections of the strategy focusing on what has been successful and what remains to be accomplished. The strategy is a valuable resource for states and other agencies, is used to obtain funding for research and other work on freshwater mussels, and has formed the basis of the society. The goal is to have a revised strategy for the 2007 symposium. This item will be presented at the business meeting and published in *Ellipsaria*. Rachel Muir has volunteered to organize this effort.

The society has been approached about setting up a sub-committee on terrestrial gastropods. Discussion was tabled and it will be brought before the membership at the business meeting.

Elections

Steve Ahlstedt is the new President-elect and Patricia Morrison is the new Secretary.

Leroy Koch has offered to look into why more of the membership is not interested in being considered for office and getting involved in committees. Bill Henley has offered to set up an email survey and Rita will forward a list of membership emails to Bill. Discussion followed on setting term limits for committee chairs and officers. This item was put under further study before proposing an amendment to the bylaws.

FMCS Committee Reports

Propagation and Restoration Committee

Meeting Minutes, St. Paul, MN

The committee met for 1 hour on Monday, May 16 at the 4th Biennial Symposium of the FMCS, St. Paul, MN. About 20 people were in attendance to discuss new ideas for the committee to pursue over the next 2 years. The following project ideas were proposed: (1) categorize endangered mussel taxa based on relative levels of imperilment, (2) create a website and database to deposit data on propagation, release and monitoring of hatchery reared mussels, and (3) organize existing information on mussel nutrition and

dietary requirements. Interested members volunteered to work-on and develop each project as part of a team. The committee anticipates that by the next FMCS symposium in 2007, progress updates will be given on the team projects. A short synopsis of each project follows:

- Biologists are aware that varying degrees of imperilment exist for mussel species listed as endangered. For example, some species are truly on the verge of extinction, such as purple catspaw (*Epioblasma obliquata*) and the Clinch River form of tan riffleshell (*Epioblasma florentina walkeri*). These species exist only as single small populations and are vulnerable to an array of potential threats. Whereas other endangered species, such as the fanshell (*Cyprogenia stegaria*) and dwarf wedgemussel (*Alasmidonta heterodon*), exist as multiple, large populations that generally are well protected. Hence, the goal of this project is to rank endangered mussel taxa in the United States based on level of imperilment. Criteria for ranking will be based on expert opinion, IUCN Red List criteria and other methods used to assess population viability. Our intent is to create a list of endangered mussel species that are ranked by their relative levels of imperilment. Ideally, the list would help agencies prioritize recovery activities based on a species susceptibility to extinction.

- Propagation and release of cultured juveniles has become one of the primary tools to help recover mussel species. However, no central database exists to deposit information on propagation and recovery efforts. Thus, the goal of this project is to create a user friendly website and database where folks can input basic data and information on their propagation projects, such as which species and how many were released, location information, and monitoring efforts. Data would be collected and stored in a standardized format and made available to interested and qualified individuals. Concerns were expressed about level of access to the public, types of data and information that would be stored in the database, and various aspects of website design and maintenance.

- Improving our understanding of adult and juvenile mussel nutritional requirements has become one of the hot topics in unionid research and recovery. Several recent papers have implicated natural river water, various algae species, feed additives, and bacteria as important dietary constituents for mussels. To further stimulate future research into developing better diets for use in the captive care and propagation of mussels, the committee will conduct an annotated literature review on freshwater mussel diets and nutritional requirements, and create a list of people and facilities involved in such research.

The committee welcomes input and participation on these projects from any interested members of the FMCS, especially students. If folks have a paper on bivalve (freshwater or marine) nutrition that you think the membership should be aware of, please send the citation my way to Jess_Jones@fws.gov. We hope to announce and make the results of these projects available in upcoming

issues of *Ellipsaria*. It was great seeing everyone in St. Paul, kudos to another outstanding FMCS symposium!

News & Announcements

Graduate Research Assistantship

Auburn University is offering a Graduate Research Assistantship within the Department of Biological Sciences, beginning Spring 2006. Funding is available for up to 3 years (2006-2008), with additional support provided by Graduate Teaching Assistantships in Biological Sciences on a competitive basis (total annual stipend \$16,000). A full tuition waiver also will be awarded. Both M.S. and Ph.D. students are encouraged to apply. The successful applicant will conduct descriptive and experimental research designed to evaluate the impact of low-head impoundments on freshwater mussel, snail, and crayfish assemblages within streams of Alabama. Students are expected to interact with faculty and graduate students from Auburn University on parallel studies involving stream fish assemblages.

Selection will be based on grades, GREs, and letters of reference from at least 3 persons with sufficient knowledge of the applicant's potential for research. Those with a strong research background in stream ecology and/or crayfish ecology or malacology will be given top consideration. For more information please contact Drs. Jack Feminella, feminjw@auburn.edu / 334-844-3906, or Michael Gangloff, ganglmm@auburn.edu / 334-844-7345, Department of Biological Sciences and Auburn University Museum, 331 Funchess Hall, Auburn University, AL 36849-5407, http://www.auburn.edu/academic/science_math/biology/faculty/feminella.htm

MUSSEL Project Database

We are pleased to announce the MUSSEL Project Database: Freshwater Mussels of the Congo & Zambezi Basins (beta): <http://clade.acnatsci.org/mussel/proj/congo-zambezi.html>

The Congo-Zambezi database is arranged hierarchically, allowing you to browse the diversity of the various taxonomic levels, from the families of the order down to the individual specimen lots for each species. At both the genus and species levels, there is the option to get a complete synonymy of each taxon. These data were obtained from various sources relevant to the problem Central African mussel diversity, including Pilsbry & Bequaert (1927), Mandahl-Barth (1988) and Daget (1998). Specimen records were obtained by visiting various collections and digitally photographing each lot, including the original label material. Images of over 900 lots are provided. The copyrights to reproduce particular specimen images are retained by the collections from which they were obtained. Inquiries about image use should be addressed to the curators of those collections. We are grateful to be able to use the specimen images as part of this database project.

Comments to either Dan (graf@acnatsci.org) or Kevin (ksc@inhs.uiuc.edu) are welcome!

Publications

David C. Campbell, Jeanne M. Serb, Jennifer E. Buhay, Kevin J. Roe, Russell L. Minton, and Charles Lydeard. 2005. Phylogeny of North American amblymines (Bivalvia, Unionoida): prodigious polyphyly proves pervasive across genera. *Invertebrate Biology* 124(2): 131-164.

Megan E. Brown, Michal Kowalewski, Richard J. Neves, Donald S. Cherry, and Madeline E. Schreiber. 2005. Freshwater Mussel Shells as Environmental Chronicles: Geochemical and Taphonomic Signatures of Mercury-Related Extirpations in the North Fork Holston River, Virginia. *Environ. Sci. Technol.*, 39 (6), 1455 -1462.

Full manuscript: <http://pubs.acs.org/cgi-bin/article.cgi/esthag/2005/39/i06/html/es048573p.html>

Contributed Articles

Freshwater Mussel Diversity: The Importance of Spatial Scale

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The nested-hierarchical nature of ecological processes is becoming an accepted concept in ecology. The mechanisms controlling diversity are at work within and across nested-hierarchical spatial scales, from microhabitat interactions to interactions at the landscape level. Many freshwater mussel studies have focused on describing local scale diversity based on microhabitat variables only, but have had little success in explaining or predicting the observed pattern. The large variation in diversity and distribution observed in studies of freshwater mussels at such small spatial scales has always blurred how we as scientists interpret and understand causes and effects of species richness decline.

In our on-going study, we investigate how incorporating variables across multiple spatial scales improves our ability to describe and interpret patterns in mussel species richness throughout the Florida Parish region of Southeast Louisiana.

As of July 14, 2005, we have sampled 29 sites in four sub-basins: Upper Tickfaw sub-basin (11 sites), Upper Tangipahoa (9 sites), Lower Tickfaw (5 sites), and Lower Tangipahoa (4 sites). We collected microhabitat variables at

each site (water quality, flow, and sediment type). Using GIS techniques, we were able to calculate percent geology and land-use for a 1-Km buffer zone around each site and for each of the four sub-basins.

Armed with a large dataset including 33 variables spanning three spatial scales, we are in the analysis stage of our study. To expose a pattern in species richness, we averaged estimates of species richness over the four sub-basins. A significant difference in species richness and abundance (CPUE) is apparent. The upper sub-basins have significantly lower species richness and abundance than the lower sub-basins (ANOVA $p < .002$).

We initially planned to identify the relative contribution of each set of variables, across the spatial scales, to the pattern of species richness using multiple regression techniques. Unfortunately, our data violates several critical independence assumptions necessary to implement these techniques. We quickly realized that, due to the nested-hierarchical nature of this system, the variables at the microhabitat scale are highly correlated to the buffer zone variables, which are in turn highly correlated with the sub-basin variables. The analysis does suggest that both percent fine sediment and water hardness are the most important variables influencing species richness from the microhabitat variable set. Land-use, specifically cropland and forested wetland, coupled with geology from the sub-basin variable set seem to be driving the large-scale pattern of species richness we see across the four sub-basins in our study. Currently, we are exploring multivariate statistical techniques such as the discriminant function and factor analysis to overcome the collinearity violations within our data.

A recent literature review has revealed several articles focused on hierarchical theory as a means to explain and interpret the spatial organization of the mechanisms driving freshwater mussel diversity and distribution. We plan to further investigate hierarchical theory as a method to explain the pattern of species richness and abundance in our study area.

We hope to elucidate the statistical issues that arise when dealing with data that span multiple spatial scales. We also hope to improve management of these imperiled invertebrates by identifying functional linkages among scales that influence species richness in freshwater mussels of the southeastern coastal plains.

Historic Records for State Threatened and Endangered Unionids in Southeastern Wisconsin

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Increase A. Lapham (1852, 1860) published the first lists of Wisconsin mollusk species but, in keeping with the standards of his day, he did not tie the records to voucher specimens. A half century later in the summer of 1902, George H. Chadwick initiated an effort to document the Wisconsin molluscan fauna with the support of the Natural History Society and later reported these findings in two publications (1905, 1906), the second of which included locality data from voucher specimens in the Milwaukee Public Museum (MPM) collection. It was meant to be only the initial step in a survey of the entire state, but Chadwick's collaboration with the Wisconsin Natural History Society began with work in the Milwaukee vicinity in southeastern Wisconsin and never got any further. In terms of the records presented here, southeastern Wisconsin is the quarter bounded geographically on the east by Lake Michigan and on the south by the northern Illinois border, though one record extends the northwestern corner of this area on a diagonal roughly 200 miles up into the central Wisconsin county of Clark. Of the 19 unionid species currently given status as threatened or endangered under the Endangered Resources Program of the Wisconsin Department of Natural Resources, three have a range confined to the southeastern portion of the state according to Cummings and Mayer (1992): the threatened *Alasmidonta viridis* and *Venustaconcha ellipsiformis* and the endangered *Villosa iris*. Because of the potential conservation importance of historic records from this region, the locality information from these voucher specimens in the MPM collection is reviewed here. Where it has been possible to determine, the data for township/range/section is added in parentheses.

Alasmidonta viridis (Rafinesque 1820)

The MPM collection contains records from waterways in 8 Wisconsin counties for the state threatened unionid *Alasmidonta viridis*, the slippershell mussel. The first Wisconsin MPM specimen of this species, then designated as *A. calceolus* Lea, was one donated by the Wisconsin Natural History Society and collected from the Milwaukee River. Chadwick (1906) reported 3 county records: Lake Michigan shore at Lake Park (T07N R22E Sec 14) in Milwaukee County, Jambo Creek (T20N R24E Sec 4) in Manitowoc County, and Sheshepecomeo Park on Beasley Creek (T21N R11E Sec 4) in Waupaca County. Four counties were added by the Harold A. Mathiak survey work (Mathiak 1979) in the 1970s: Milwaukee River (T13N R19E Sec 33) in Fond du Lac County, Onion River (T14N R21E Sec 6) in Sheboygan County, Allenton Creek and East Branch of the Rock River (both T11N R18E Sec 15) in Washington County, and Rush Creek (T18N R14E Sec 25) in Winnebago County. Another Sheboygan County specimen, from the Mullet River (T15N R20E Sec 10), was received as by-catch from the Wisconsin Department of Natural Resources Fish Distribution Study. Marian E. Havlik donated a specimen collected from the Wolf River at County Highway A in Shawano County in 1992.

Venustaconcha ellipsiformis (Conrad 1836)

The MPM collection contains records from waterways in 7 Wisconsin counties for the state threatened unionid

Venustaconcha ellipsiformis, the ellipse. The earliest Wisconsin record in the MPM mollusk catalogs for the bivalve then designated as *Unio spatulatus* Lea is from Mrs. E.C. Wiswall, who specified only "southern Wisconsin" as the locality data for species that she listed (Wiswall 1897). The 1898 MPM catalog indicates that the museum purchased 97 freshwater mussel specimens from Mrs. Wiswall, including two of this species (one of them being polished), and gives 1897 as the year of collection.

Among the collection of state unionids received from the Wisconsin Natural History Society was *V. ellipsiformis* from the Fox and Milwaukee rivers. MPM catalog entries for these donations were made in the 1880s, but no collecting date or more detailed location was given. Chadwick (1906) adds detail to the river records previously noted, giving Milwaukee County sites for the Milwaukee, near Big Bend in Waukesha County for the Fox, and also adds "mill pond at Hika, Manitowoc Co." as a third county record.

It was not until the 1970s that additional, documented specimens of this species were added to the MPM collection. Brian Witzke donated an ellipse from the Crawfish River (T09N R14E Sec 19) in Dodge County, and Harold A. Mathiak added records for the Milwaukee River (T13N R19E Sec 33) and its West Branch (T13N R18E Sec 36) in Fond du Lac County, Sugar Creek (T03N R18E Sec 15) in Walworth County, and the Mukwonago River (T05N R18E Sec 35) in Waukesha County. The Wisconsin Department of Natural Resources donated specimens collected in 1977 from the South Fork of the Poplar River (T28N R01W Sec 15) in Clark County and the Bark River (T07N R17E Sec 34) in Waukesha County.

Villosa iris (I. Lea 1829)

The MPM collection contains records from waterways in 2 Wisconsin counties for the state endangered unionid *Villosa iris*, the rainbow. Again, the earliest Wisconsin record in the MPM collection is a specimen donated by the Wisconsin Natural History Society from the Milwaukee River. Under *Lampsilis iris* Lea, Chadwick (1906) specifies a Milwaukee County site on this river. Four Waukesha County specimens from the Mukwonago River at Mukwonago were received from Harold A. Mathiak.

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New World Physids Don't Know Borders: Exotic Physidae in Indonesia

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A few years ago I received from one of my correspondents in Indonesia several samples of freshwater molluscs, which had been collected in part under natural conditions and in part in shops selling aquarium fish. To my surprise all seven samples turned out to belong to the family Physidae. Since the natural range of the majority of the recognized species within the Physidae is largely confined to the Americas, with only a handful of species originating in Europe (Taylor, 2003), it does not come as a surprise that most probably all the samples belong to New World species.

Three different types of shells could be clearly recognized; however, due to the fact that all of the samples consisted of empty shells only, no definitive identifications are given here.

Shell type I: *Stenophysa* species.

One sample consisting of a single specimen belongs clearly to the genus *Stenophysa* von Martens, 1898. It had been collected in Indonesia, South Borneo, Kelua, Tanjung, on floating wood in a swamp, December 1995.

It is impossible to distinguish this shell from shells of *Stenophysa marmorata* (Guilding, 1828) from various localities on Caribbean Islands, present in the National Mollusc Collection of the Hebrew University of Jerusalem (HUJ), and from those recently collected in large numbers in several artificial pools in the Botanical Garden of the Tel Aviv University (Mienis, 2005). However, shells of the recently described *Stenophysa spathidophallus* Taylor, 2003, from Singapore (but more likely originating from northeastern South-America), are also almost inseparable from those of *S. marmoratus*.

Shell type II: *Mayabina* species.

Two samples are provisionally placed in the Aplexinid genus *Mayabina* Taylor, 2003. They were collected at the following localities: Indonesia, Java, Tawakal, Jakarta, on leaves in stagnant water, April 1986 (2 ex.) and Java, Jakarta, in aquarium shop, September 1995 (2 ex). Species belonging to this genus are confined in their distribution to the Central America and the west coast of South America, as far south as northern-most Chile.

Shell type III: *Haitia* species.

The following four samples: Indonesia, West Java, Patenggang Lake, South Bandung, at an altitude of 1550 m, August 1995 (8 ex.); West Java, Cipanas, at an altitude of 1100 m, May 2001 (8 ex.); West Java, aquarium shop in Jakarta, September 1995 (4 ex.); Mid Java, Guci, Tegal, on stones in small river, October 2000 (3 ex.), belong apparently to one and the same species.

If these specimens had been found somewhere in Europe or in Israel then I would classify them without doubt as *Haitia acuta* (Draparnaud, 1805). However, I prefer to call them simply *Haitia* species due to the absence of preserved animals.

All three species have to be considered as exotic species of New World origin in Indonesia. They probably reached that country by means of the international aquarium fish and plant trade. Since this trade is becoming more and more popular in S.E.-Asia, more records of introduced Physidae may be expected from that part of the world in future.

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The Freshwater Mussels/Naiades of Upper and Medium Sessions of the Uruguay River Basin, Southern Brazil: A Brief Approach to its Knowledge

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The great Uruguay River is geographically born from the fork of the rivers “Pelotas” and “Canoas” of Santa Catarina's State, in the Municipal district of Celso Ramos – Campos de Lages region, emblem with the neighbor State of Rio Grande do Sul.

In the upper and medium sessions of the Uruguay River Basin, 43 species are cited in the literature (41 natives and 2 exotic invasives, distributed in 37 Unionoida – 16 Mycetopodidae, 21 Hyriidae, 6 Veneroidea – 3 Sphaeriidae, 3 Corbiculidae). Of these, 20 are confirmed/included in the Santa Catarina's State territorial inventory (Agudo 2004b) for 6 localities (Agudo 2004a).

The zoogeographical occurrence of mussels/naiades species in this South American region has been revised in the specialized literature (Ortmann 1921; Morretes 1949;

Parodiz & Bonetto 1963; Bonetto 1964; Parodiz 1968; Haas 1969; Mansur 1970; Mansur et al. 1987; Ituarte 1994; Callil & Mansur 2002; among others). For a general overview of the zoogeographical records in the Santa Catarina State, see Agudo (2005).

Systematic Species List

Class BIVALVIA

Order UNIONOIDA

Family MYCETOPODIDAE (16)

- Anodontites clessini* (Fischer, 1890)
- Anodontites crispatus tenebricosus* (Lea, 1834) *
- Anodontites tenebricosus* (Lea, 1834) *
- Anodontites ferrarisi* (d'Orbigny, 1835) *
- Anodontites felix* (Pilsbry, 1896)
- Anodontites iheringi* (Clessing, 1882) *
- Anodontites lucidus* (d'Orbigny, 1835) *
- Anodontites patagonicus* (Lamarck, 1819)
- Anodontites trapesialis* (Lamarck, 1819) *
- Anodontites trapezeus* (Spix, 1827)
- Fossula fossiculifera* (d'Orbigny, 1835)
- Leila blainvilliana* (Lea, 1834) *
- Monocondylaea corrientesensis* d'Orbigny, 1835
- Monocondylaea minuana* d'Orbigny, 1835 *
- Monocondylaea paraguayana* d'Orbigny, 1835
- Mycetopoda legumen* (Martens, 1888) *

Family HYRIIDAE (21)

- Castalia ambigua inflata* d'Orbigny, 1835
- Castalia psammoica* (d'Orbigny, 1835)
- Castalia martensi* (Ihering, 1891)
- Diplodon aethiops* (Lea, 1860) *
- Diplodon burroughianus* (Lea, 1834)
- Diplodon charruanus* (d'Orbigny, 1835)
- Diplodon delodontus* (Lamarck, 1819)
- Diplodon delodontus wymani* (Lea, 1860)
- Diplodon ellipticus* (Wagner in Spix, 1827) *
- Diplodon expansus* (Kuster, 1856) *
- Diplodon funebris* (Lea, 1860)
- Diplodon hildae* Ortmann, 1921 *
- Diplodon martensi* (Ihering, 1893) *
- Diplodon parallelipipidon* (Lea, 1834)
- Diplodon peraeiformis* (Lea, 1860)
- Diplodon piceus* (Lea, 1860)
- Diplodon pilsbryi* Marshall, 1928 *
- Diplodon rotundus gratus* (Lea, 1860)
- Diplodon rhuacoicus* (d'Orbigny, 1835) *
- Diplodon uruguayensis* (Lea, 1860)
- Diplodon uruguayensis x expansus* (Parodiz, 1968)

Order VENEROIDA

Family CORBICULIDAE (3)

- Corbicula fluminea* (Muller, 1774) *
- Corbicula largillierti* (Philippi, 1844) *
- Neocorbicula limosa* (Maton, 1811)

Family SPHAERIIDAE (3)

- Eupera guaraniana* Ituarte, 1994
- Eupera platensis* Doello-Jurado, 1921 *
- Sphaerium observationis* (Pilsbry, 1911) *

*Species occurs in Santa Catarina State.

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Host Identifications or Confirmations

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All transformations at 20° C. * - apparently new host identification.
Studies funded through the Ohio Division of Wildlife and the US Fish and Wildlife Service.

1) *Epioblasma triquetra* (June)

Suitable host:

Mottled Sculpin (days to transformation – 18; % transformed – 2%)

Hosts yielding no transformation:

Greenside Darter

2) *Elliptio complanata* (June)

Suitable hosts:

Bluegill (days to transformation – 10; % transformed – 38%) *

Pumpkinseed (days to transformation – 10; % transformed – 55%) *

3) *Lampsilis cardium* (Oct.-June)

Suitable hosts:

Largemouth Bass (days to transformation – 24; % transformed – not measured)

4) *Lampsilis radiata luteola* (Nov.-July)

Suitable hosts:

Largemouth Bass (days to transformation – 21; % transformed – not measured)

Green Sunfish (days to transformation – 21; % transformed – not measured) *

5) *Lasmigona costata* (April)

Suitable hosts:

Bluegill (days to transformation – 10; % transformed – not measured) *

Creek Chub (days to transformation – 10; % transformed – not measured) *

Goldfish (days to transformation – 10; % transformed – not measured) *

Central Stoneroller (days to transformation – 10; % transformed – not measured)*

6) *Plethobasus cyphus* (May-June)

Suitable hosts:

Central Stoneroller (days to transformation – 16; % transformed – 19%) *

Hosts yielding no transformation:

Bluegill, Brown Trout, Goldfish, Greenside Darter, Largemouth Bass, Silverjaw Minnow, Yellow Bullhead, White Crappie

7) *Pleurobema cordatum* (May)

Suitable hosts:

Brook Stickleback (days to transformation – 27; % transformed – not measured)

Creek Chub (days to transformation – 27; % transformed – not measured)

Guppy (days to transformation – 27; % transformed – not measured)

Hosts yielding no transformation:

Bluegill, Goldfish, Green Darter, Green Sunfish, Stonecat, White Crappie

8) *Pleurobema sintoxia* (June)

Suitable hosts:

Bluegill (days to transformation – 13; % transformed – 1%)

Creek Chub (days to transformation – 13; % transformed – 18%) *

Southern Redbelly Dace (days to transformation – 13; % transformed – 1%)

Hosts yielding no transformation:

Goldfish, Mottled Sculpin

9) *Ptychobranhus fasciolaris* (April)

Suitable hosts:

Brook Stickleback (days to transformation – 50; % transformed – not measured) *

Hosts yielding no transformation:

Creek Chub, Johnny Darter, Rainbow Darter, Spotfin Shiner,

10) *Pyganodon grandis* (Dec.-Feb.)

Suitable hosts:

Bluegill (days to transformation – 9; % transformed – not measured)
Creek Chub (days to transformation – 11; % transformed – not measured)
Goldfish (days to transformation – 9; % transformed – not measured) *
Guppy (days to transformation – 12; % transformed – not measured) *
Largemouth Bass (days to transformation – 10; % transformed – not measured)
Pumpkinseed (days to transformation – 12; % transformed – not measured)
Round Goby (days to transformation – 9; % transformed – not measured) *
White Crappie (days to transformation – 9; % transformed – not measured)

Hosts yielding no transformation:

Green Sunfish

11) *Strophitus undulatus* (April)

Suitable hosts:

Rainbow Darter (days to transformation – 13; % transformed – 5%) *
Red-eared Sunfish (days to transformation – 15; % transformed – 31%)

Hosts yielding no transformation:

Goldfish

12) *Toxolasma parvus* (June)

Suitable hosts:

Johnny Darter (days to transformation – 12; % transformed – 3%) *

Hosts yielding no transformation:

Bluegill, Creek Chub, Mottled Sculpin

13) *Villosa iris iris* (April)

Suitable hosts:

Mottled Sculpin (days to transformation – 26; % transformed – not measured) *
Smallmouth Bass (days to transformation – 26; % transformed – not measured)

Hosts yielding no transformation:

Banded Darter, Bluegill, Brook Stickleback, Central Stoneroller, Creek Chub, Johnny Darter, Rainbow Darter, Spottfin
Shiner, Stonecat

Specific Gravity and Freshwater Mussels

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Specific gravity (SG) can be defined as the relationship between the mass of an object and its volume. This physical characteristic is calculated by dividing the weight of an object by its displacement in water. By definition in the metric system, one gram of water occupies one milliliter of volume and, therefore, has an SG of 1.0. With regard to freshwater mussels and their habitats, SG is a quantitative way to compare the tendency of an animal to float higher or lower in the substrate than objects around it. I have not found any previous examination of SG in freshwater mussel literature.

During this exploratory study, I used a battery-powered postal scale (1g increments) to determine the weight of objects and a 100-ml graduated cylinder (1 ml increments) to determine their volume. Objects that would not fit into the graduated cylinder were put in a water-filled container, the overflow was collected, and the volume of that water was measured. All substrate materials were tested wet: either as they came from a waterbody or after soaking in water for at least 24 hours. All mussels were tested alive and prodded to ensure their shells had closed under water (without air in the mantle cavity).

So far, I have calculated SG values for 24 native mussel species, *Corbicula fluminea*, and examples of 15 actual or potential substrate materials (numerical results on reverse). SG values for substrate materials range from 1.2 (some coal rocks) to 11.9 (some lead weights). Most typical [= sedimentary] substrate materials have SG values between 2.0 and 2.5.

With regard to native mussels, SG values calculated so far range between 1.1 (*Alasmidonta arcula*) and 2.4 (*Obliquaria reflexa*). When several representatives of a species were tested, they strongly suggested that SG does not vary with size: small and large individuals (at least within the same population) yielded very similar SG values. I have not yet compared SG values among different populations of the same species.

As might be expected, representatives of the two (classic) Anodontine species that have been tested yielded low SG values, *most* of the eight Lampsilinae species yielded mid-range values, and *most* of the 14 Unioninae species yielded higher SG values. More interestingly, however, almost all of the species yielded SG values comparable to the SG values of the substrates where they are found in large numbers, regardless of their phylogenetic relationships. Coastal Plain and sand-dwelling species have low SG values (1.3 – 1.7, comparable to sand and clay) while big-river shoal-dwelling species have relatively high SG values (1.9 – 2.0, comparable to mixed [sedimentary] rocks).

These initial results suggest that native mussels maintain their position in the substrate, in part at least, because of the physical similarity of their SG to the SG of the surrounding particles. Changes in the SG of the substrate (e.g., after the introduction of much lighter coal particles) could create strictly physical conditions in which some species would be unable to maintain their normal position in the bottom.

Specific gravity appears to be an informative but, until now, overlooked physical characteristic of native mussel species. When evaluated more fully, SG probably will help explain the presence or absence of mussel species in various types of habitats, may point out unexpected variations in mussel behavior, and could help identify the principles controlling the range and apparent convergences in mussel shell shapes and ornamentation.

Specific Gravity Values for Some Freshwater Bivalves and Substrate Materials

Bivalve Species	N*	Specific Gravity Value	95% Confidence Interval
<i>Alasmidonta arcuata</i>	12/4	1.15	± 0.07
<i>Pyganodon grandis</i>	8/4	1.19	± 0.01
<i>Hamiota (=Lampsilis) altilis</i>	15/5	1.34	± 0.06
<i>Potamilus alatus</i>	3/3	1.37	± 0.03
<i>Cantheria spinosa</i>	12/4	1.49	± 0.17
<i>Lampsilis fasciola</i>	3/2	1.55	± 0.10
<i>Villosa iris</i>	2/2	1.56	± 0.41
<i>Elliptio icterina</i>	8/4	1.64	± 0.10
<i>Lampsilis teres</i>	1/1	1.70	--
<i>Corbicula fluminea</i>	4/4	1.71	± 0.18
<i>Megaloniais nervosa</i>	3/3	1.76	± 0.04
<i>Lampsilis claibornensis</i>	1/1	1.88	--
<i>Fusconaia subrotunda ?</i>	2/2	1.91	± 0.03
<i>Elliptio dilatata</i>	1/1	1.91	--
<i>Amblema plicata</i>	3/3	1.94	± 0.08
<i>Tritogonia verrucosa</i>	5/5	1.94	± 0.26
<i>Quadrula metanevra</i>	2/2	1.97	± 0.06
<i>Elliptio crassidens</i>	15/13	1.97	± 0.05
<i>Cyclonaias tuberculata</i>	10/9	1.98	± 0.05
<i>Plethobasus cooperianus</i>	14/14	1.99	± 0.04
<i>Ellipsaria lineolata</i>	8/6	1.99	± 0.08
<i>Quadrula pustulosa</i>	13/8	2.03	± 0.08
<i>Fusconaia ebena</i>	10/6	2.03	± 0.10
<i>Pleurobema cordatum</i>	4/4	2.05	± 0.05
<i>Obliquaria reflexa</i>	2/2	2.43	± 0.04

Substrate Materials	N*	Specific Gravity Value	95% Confidence Interval
Coal - Stream Rocks	12/4	1.24	± 0.04
Coal - Stream Rocks	10/2	1.39	± 0.02
Clay Hardpan	9/3	1.43	± 0.02
Clay Hardpan	9/3	1.48	± 0.02
Fine Creek Sediment	10/2	1.68	± 0.04
Sand -Emory River, TN	15/3	1.80	± 0.02
Sand -Padre Island, TX	15/5	1.86	± 0.01
Creek Gravel	9/3	2.08	± 0.03
Limestone Riprap	3/1	2.24	± 0.07
Rocks -Emory R., TN	20/5	2.28	± 0.08
Stained Glass Pieces	10/1	2.40	± 0.03
Limestone Riprap	12/4	2.56	± 0.05
Quartz Gravel	9/3	2.58	± 0.04
Vermont Marble	10/2	2.59	± 0.06
Steel/Iron	8/2	7.29	± 0.22
Brass	4/1	7.53	± 0.50
Copper	4/1	8.28	± 0.33
Lead Fishing Weights	6/2	10.78	± 0.08
Lead Fishing Weights	6/2	11.97	± 0.06

*Number of Observations/Number of different animals or samples

FMCS 2004 Freshwater Mollusk Bibliography

Compiled by Kevin S. Cummings
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This bibliography lists freshwater mollusk papers that have been published up to and including 2004 and that have not appeared in previous FMCS bibliographies. Citations are split into five groups: Unionoida, Sphaeriidae, Corbiculidae, Other Bivalves, and Gastropoda. Papers that list taxa from more than one category are included in each group. A searchable database of over 15,000 references on freshwater mollusks (including all previous FMCS bibliographies on freshwater mollusks) is available on the web at <http://ellipse.inhs.uiuc.edu:591/mollusk/>

To insure that papers are cited correctly, researchers are encouraged to send reprints to: Kevin S. Cummings, Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, Illinois 61820 or ksc@inhs.uiuc.edu

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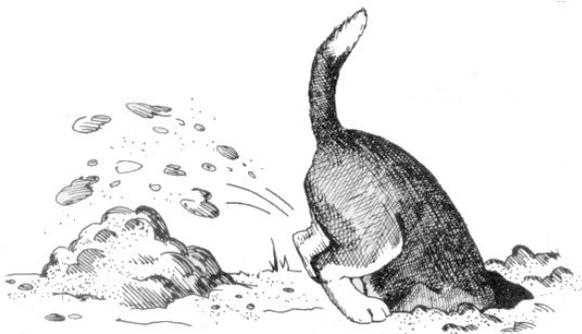
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Helpful Hints from Hoppy:



Hoppy Says — Big time heat wave...excellent sampling conditions...great time for shelling!!!

Submitted by Steve Ahlstedt

Freshwater Mollusk Conservation Society Membership List - August 2005

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HABITAT AND LIFESTYLE CHOICES OF FRESHWATER MUSSELS (UNIONIDAE) IN WEST TENNESSEE

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ABSTRACT: During many grueling years of field research, some of which was conducted in the actual outdoors, we pursued the slimy trail of the freshwater mussel (Unionidae) across the trammled wilderness of western Tennessee. We had brief yet surprisingly poignant encounters with 10,113 individuals of twenty-eight species in thirty-two ZIP Codes, and our lives were changed forever by communing with these brave bivalves whose quiet dignity belies their wretched poverty and unsanitary living conditions. But perhaps this abstract is becoming a little *too* abstract; we apologize. We seem to have developed a crippling inability to relate to *H. sapiens*. To summarize for the impatient, most of whom have skipped to the results section by now, we found a clear correlation between local environmental factors (i.e., water temperature, pollution levels and irritable cottonmouths) and the presence or absence of mussels.

The freshwater mussel fauna of the United States is among the richest in the world (Money Magazine, 2001). The noble class *Bivalvia* first arrived on this planet 300 million years ago, give or take an epoch, and they were doing just fine, thank you very much, until you showed up. Because of the greedy, cruel, selfish and essentially vile nature of human beings (Bible, ca 1600 BCE—90 CE), this century has witnessed a steep decline in freshwater mussel populations. Human attitudes toward mussels are largely either negative (Shakespeare, 1610-11), for which we may thank the divine injunction against aquatic biota that lack fins and scales (Bible, ca 1405 BCE), or purely culinary, for which we may thank legions of hungry heretics whose names have been, rightfully, cleansed from the history books.

Our research is an ongoing attempt to speak for the shellfish who have been silenced, to stand up for those who lack legs of their own, to help the mussels tell their heartbreaking story in their own burbles (Lofting, 1922). It is in pursuit of these simple goals that we find our purpose in life (Spurge, 2003). The bulk of our research is elsewhere described, in the scientifically incisive yet heartwarming film, *It's a Wonderful Mollusc!* (rated PG-13 for profanity and casual sex), but we also recorded a number of peripheral observations on the attitudes and lifestyles of our tiny subjects. These observations we now share with the world in the fervent hope that our work will shed the pure light of selfless science upon the shadowy suffering of shellfish (Poetry Techniques, 2002).

MATERIALS AND METHODS

In order to stalk, capture and identify the wily and elusive freshwater mussel, we employed a cornucopia of sampling methods (Smith, 1994). First we tried luring our prey with gravy-soaked biscuit crumbs and aromatic bits of fruit peel, which we placed at the water's edge atop a small red-checked tablecloth. This method proved uniformly disappointing, as the frenetic pace of scavenging ants and beetles set an impossible standard of competition. We moved on to an escalating series of mussel snares that ranged from simple (tiny string noose) to complex (tiny mechanical "girly mussel," gaping slightly, waving plump superconglutinate in provocative manner). All of these seemingly foolproof traps ultimately failed to capture any mussels, for a variety of reasons that we are unable to think about without feeling very silly (Horst, 1999).

Finally, in sheer desperation, we resorted to a technique that we had earlier rejected as "primitive and undignified" (ADG, pers. comm.) and "Yeah, um, I don't THINK so!" (TV, pers. comm.). To be brutally frank, we *groped* for mussels, and most of them seemed to enjoy it. This technique is best illustrated by the condition of our garments at the end of a day's work: sopping wet, permanently soiled with muck and botanical effluvia, and generally gross-o-rama. At one point we attempted to calculate the total mass of filthy socks we discarded on roadsides during the course of our research, but were daunted by the complexity of the equation (Guo, 1999).

Our materials consisted of endless changes of clothing (we later realized that nudity would have been more economical) and little waterproof notebooks in which we doodled potential designs for mussel-related tattoos whenever we got bored. We used a handheld GPS receiver to identify the precise locations of our sampling areas, except when the secret spy satellites were blocked by the alien space rays (Southern Baptist Reader, 2001). We also verified beyond all doubt the healing powers of chocolate and cheese (Pansy, 2001).

RESULTS AND DISCUSSION

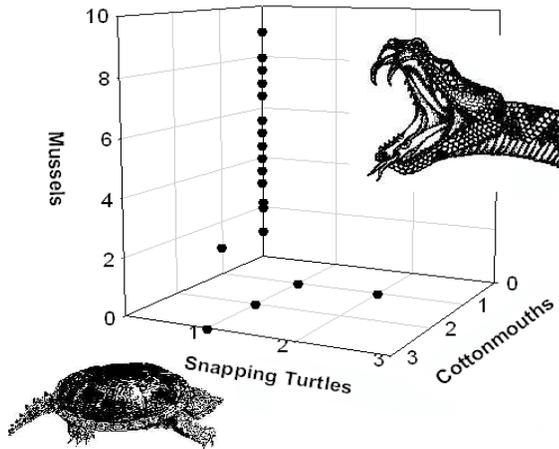
Our results were statistically significant (Bulger, 1992) and somewhat surprising (Schmeerl, 1967). Through our intimate contact with 10,113 individual mussels of twenty-eight species in thirty-two ZIP codes, we formulated a multi-part hypothesis regarding the habitat and lifestyle choices of these enigmatic beasts. At first it may appear that our hypothesis is based on wild conjecture, but we promise that all of the really important bits are firmly grounded in accurate field observations and totally objective facts (Custer, 1867).

Most of the mussels we studied exhibited a strong preference for stable and relatively unpolluted aquatic habitat, with a notable exception being *Utterbackia imbecillis* which was found to survive and even thrive in such inhospitable habitats as exposed sand bars, drying puddles, and treetops. Fortunately for us, given our obsessive Calvinistic need to divide the natural world into tidy and predictable categories, the other species we studied were more tractable and quickly learned to play by the rules (Gazpacho, 1999). Our research shows distinct trends of behavior among these "good" mussels as follows.

Trend 1: Mussels prefer to live in habitat that is free of leeches, snapping turtles and excessively active fish; mussels

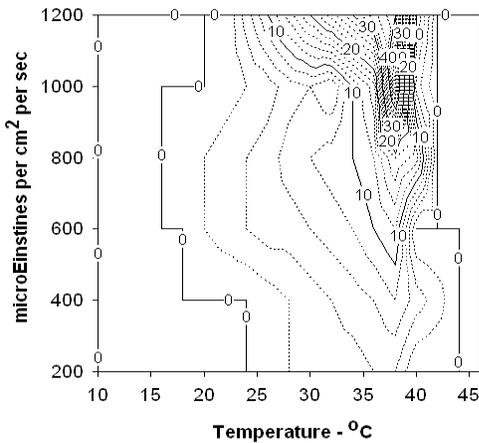
are *never* found in areas frequented by poisonous snakes (Fig. 1). This last “cottonmouth effect” is evidenced by the sharp drop we noted in the numbers of mussels collected in the vicinity of *Agkistrodon piscivorus*.

Fig. 1



Trend 2: Mussels are highly influenced in their habitat choices by seasonal temperature changes, preferring air and water temperatures roughly equivalent to those preferred by the average human (Brody, 1974). Our data show that mussels actively seek comfortable temperatures by moving to the sunnier side of the river in cold weather and moving to the shadier side in hot weather (Fig. 2). When the weather is intermediate such trends become less clear, with some mussels (usually younger males) moving to shady areas, and others (usually older females) opting for sunny areas.

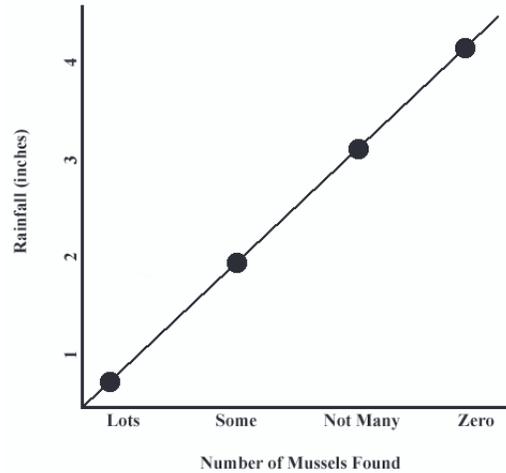
Fig. 2



Trend 3: Mussels exhibit avoidance behaviors during inclement weather. When a light rain shower begins, mussels undertake a rapid migration toward the deepest portion of the sampling area, quickly moving out of reach of all but the most long-armed researchers (Cabbage, 1982). By the time a light rain shower turns into a thunderstorm, the local mussel populations have effectively disappeared (Fig. 3). At such times, we have found it best to seek hot showers and microbrews until the mussels choose to return to the surface. In a similar behavior not yet observed by us personally, it has been reliably reported that mussels in colder climates often

migrate southward in wintertime by clinging to the backs of geese (Old man who lives under bridge, pers. comm., 2001).

Fig. 3



Trend 4: Mussels prefer to live in pristine, unpolluted water (Fig. 4) within five miles of a park, library, grocery store, and movie theater (Uvula, 1999). Mussels are seldom found immediately downstream of industrial or municipal wastewater outfall pipes. Our data also indicate that mussels have the ability to distinguish between types of wastewater discharges, possibly on the basis of smell, taste, texture, or official signage. For example, we found that large numbers of mussels will inhabit the area immediately downstream from the cooling water outfall for a chocolate factory, but mussels are seldom found in conjunction with the “chunky style” wastewater discharge of a large metropolis (Juniper, 1996). Mussels are never found immediately downstream from hog and chicken farms, metal-plating facilities or nuclear reactors (Jerkins, 2000).

Fig. 4

Dear pepul,
 We are sick
 of yor shit.
 Somday soon
 you wil pay.
 -THE MUSSELS

After taking a few minutes to analyze the clear trends outlined above (Klezmer, 1954), we reached the conclusion that freshwater mussels are capable of making complex choices regarding habitat and lifestyle (Cornball, 1997). Until now many scientists and normal people have assumed that mussels are without intelligence, free will, or emotional baggage, but we trust that our findings will open such closed minds to a pearly dawn of new understanding and empathy for this most maligned and neglected of creatures, this tiny glob of

dirty mucus in a calcium-based casket, this shy voluptuous beauty with whom we have shared so many hours of silent, yet deeply passionate, joy.

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We wish to thank the many bivalves who helped to make our research possible, except for *U. imbecillis* which was not as helpful as it could have been. We thank the legions of former and current employees of the U.S. Army Corps of Engineers, the U.S. Soil Conservation Service, and the West Tennessee Basin Authority for ensuring that most of the rivers and creeks in our region have been permanently stripped of their natural meanders, woody debris, riparian vegetation and freshwater mussels, thus greatly reducing our sampling obligations. We thank the five anonymous reviewers who told us that our manuscript was a delusional piece of crap, because we know they were just kidding (Vito, 2002). Ha ha! Finally, and most importantly, thanks to Doctor Dolittle for solving the Shellfish Riddle and teaching us the importance of being a Good Noticer.

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ERRATA

The authors are available for awards ceremonies, lavish dinner parties in their honor, or for any social function that includes free alcohol. Contact the authors via their amanuensis and factotum, Naomi Van Tol (naomi@spiny.com).

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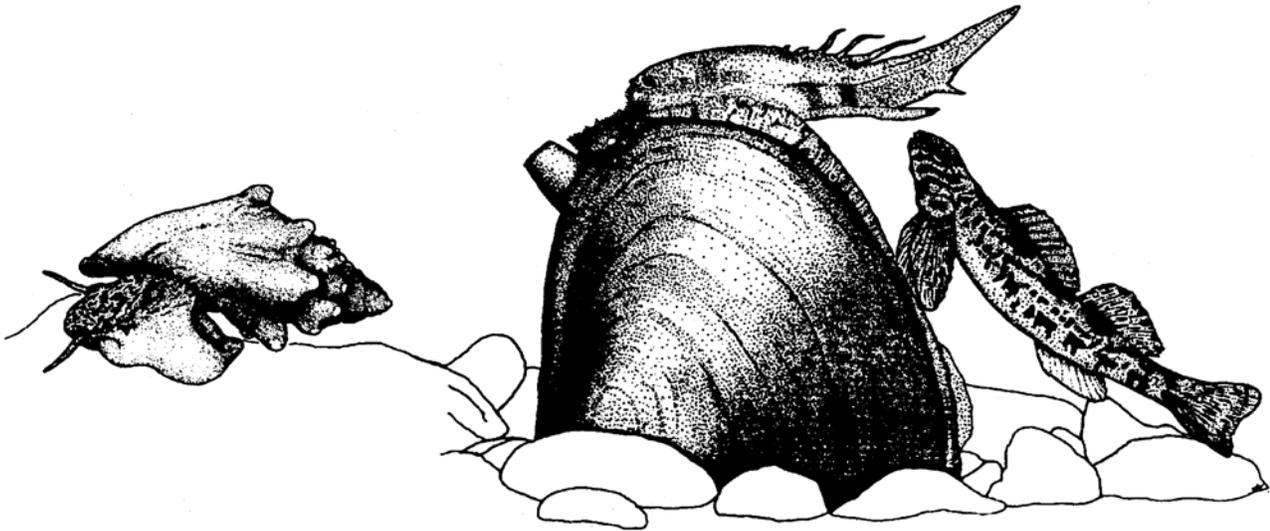
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