



Newsletter of the Freshwater Mollusk Conservation Society
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**Survey Guidelines and Techniques Workshop
 August 10 – 13, 2020**

Where to sample? How to sample? How do you apply the data? What does it all mean???? These are questions everyone who samples freshwater mussels has had to answer. The FMCS 2020 Guidelines and Techniques Workshop has been designed to provide you with those answers. Whether you are a beginning biologist or an experienced malacologist, we all need to collect mussels, and interpret and apply the data.

This Workshop will include two levels of content: for introductory/intermediate field workers, and for those with more experience, but there will be overlap depending on participant interest. The content for the introductory and intermediate group will cover equipment and design for sampling mussels, including

sample size and the amount of effort to ‘adequately’ sample a site or a species. Field instruction for this group will include techniques such as qualitative, semi-quantitative and quantitative sampling, habitat measurements, protocol implementation, data collection and analysis, as well as quality assurance/quality control.

The content for the more experienced group will cover information on data applications, including density and abundance, mark-recapture, population estimates, as well as estimates of survival and mortality, and mussel mortality evaluation. Field techniques for this group will include non-traditional sampling, such as, marking and tagging mussels, collection and processing for genetic analysis and eDNA, and mortality events and valuation.

The Workshop will include both lecture and field-based sessions, a poster session, evening mixers, and an optional field trip. An introductory session, providing an overview of sampling protocols, will be presented by Dave Smith (U.S. Geological Survey). Other presenters include: Janet Clayton (West Virginia Department of Natural Resources), Heidi Dunn (EcoAnalysts, Inc.), Matt Ashton (Maryland Department of Natural Resources), and Megan Bradley (U.S. Fish and Wildlife Service).

Schedule overview:

August

- | | | |
|----|-----------|---|
| 10 | Monday | – Arrival, Registration, Evening Mixer |
| 11 | Tuesday | – Breakfast, Workshop overview, Lunch, Lecture and Field Sessions, Poster Session and Mixer (food provided) |
| 12 | Wednesday | – Breakfast, Lecture and Field Sessions, Lunch, Lecture and Field Sessions, Dinner, “Town Hall” Discussion |
| 13 | Thursday | – Field Trip, Departure |

Poster Session:

The poster session will take place on Tuesday evening, August 11. Posters will not be limited in topic and can include a wide variety of information and research pertinent to freshwater mollusks. See the Call for Abstracts for details and instructions for submitting abstracts soon to be posted on the Workshop web page: https://molluskconservation.org/EVENTS/2020WORKSHOP/2020_FMCS-Workshop.html. Abstracts will be due no later than **May 31, 2020**.

Location and Lodging:

This Workshop will be held at Henry Horton State Park in Chapel Hill, Tennessee, south of Nashville. This State Park is located along the banks of the Duck River, one of the most diverse ecosystems in the world. The Park has self-contained accommodations, meals will be catered by the Park’s Governor’s Table Restaurant, and the Tipped Canoe Lounge is on site.

Lodging also will be at Henry Horton State Park. All of the available rooms have been reserved at the Lodge in the Park, and eight cabins in the Park are also available. Reservations can be made online at: <https://tnstateparks.com/parks/henry-horton>. Please make every effort to book rooms with co-workers and friends, as space is limited. When booking, ask for the



Freshwater Mollusk Conservation Society Rate and provide our **Group Number: 4219**. Reservations must be made by **July 10**.

Room Rates:

- Two Double Beds Room in the Lodge: \$68.40/night plus taxes
- Two Double Beds Room in Motel: \$72.90/night plus taxes
- King Room: \$72.90/night plus taxes
- Suite Room (pullout sofa and small kitchen): \$86.40/night plus taxes
- Cabins (fully equipped 2-3 bedrooms): \$105-\$150/night plus taxes

Campsites for both recreational vehicles and tents are available. Camping rates vary between \$11-\$35/night, not including taxes and fees. Campsite reservations can be made by visiting: <https://reserve.tnstateparks.com/henry-horton/campsites> .

Registration:

Early registration will begin on March 9 and will close on June 15. Late registration will start on June 16 and will conclude on-site on August 10. Registration costs are:

Type	Early Registration (March 9 – June 15)	Late Registration (June 16 – August 10)
Regular FMCS member	\$200	\$225
Non-FMCS member	\$280	\$305
Student/Retiree FMCS member	\$150	\$175
Student/Retiree non-FMCS member	\$190	\$215

Register online at the Workshop web page: (https://molluskconservation.org/EVENTS/2020WORKSHOP/2020_FMCS-Workshop.html). Email reminders will be sent out when registration opens and just before early registration ends.

Transportation:

Henry Horton State Park is located in Chapel Hill, Tennessee, approximately 50 miles (1 hour) south of Nashville, Tennessee. Driving distance from Chattanooga is about 115 miles (2 hours), and from Memphis about 220 miles (3.5 hours). Nashville International Airport is the closest airport; it has a variety of car rental vendors.

What to bring:

Middle Tennessee can be relatively warm and humid in mid-August, with average high temperatures around 90°F (32°C) and lows around 68°F (20°C). Water temperature in the Duck River typically is in the mid-70s F (low-20s C) in mid-August. This is a hands-on Workshop, so come prepared to get in the water and get dirty. Bring a mask and snorkel, for sure, and a wetsuit if you want one. Otherwise, bring clothes and shoes you don't mind getting wet. Feel free to bring any other field gear you typically use in the water. Don't forget your sunscreen and your camera. Casual clothes will be appropriate at all other times.



Field Trip:

On Thursday August 13, Workshop attendees will have the option of attending a mussel sampling field trip to assist in a Tennessee Wildlife Resources Agency monitoring of mussel stocks in the Duck River, which is completed on a 5-year cycle. Attendees will be transported to one of the Duck River monitoring sites, provided a box lunch, and the opportunity to see the rich diversity of the Duck River while putting your survey techniques to good use. Attendees will need to bring their own personal wetsuit and snorkeling equipment; a decontamination station will be provided onsite. The cost for this field trip is estimated at \$50; the exact amount will be posted on the registration page: https://molluskconservation.org/EVENTS/2020WORKSHOP/2020_FMCS-Workshop.html. Space will be limited, so make sure to register early.

Sponsorships:

The FMCS is a not-for profit society, dedicated to the advocacy and conservation science of freshwater mollusk resources. Our Workshops provide great opportunities to network and build relationships with conservation professionals from state and federal governments, industry, universities, and conservation organizations. The Society has a membership of over 500, of which about 150 generally attend the biennial Workshops. Instructors for the workshops are members of the Society and other leaders in Conservation. These professionals are constantly working to conserve freshwater mollusks and we need your help. We are requesting monetary sponsorships to help cover the costs of the Workshop facilities. Different levels of sponsorship receive different levels of recognition as described in the following table.

Sponsorship Levels		
<i>River</i>	>\$2000	One Complimentary Registration, Logo Displayed at the Welcome Social, Logo on Website Registration Page, Recognition in the Workshop Program
<i>Stream</i>	>\$1000	One Registration Reduced by 25%, Logo Displayed at the Welcome Social, Logo on Website Registration Page, Recognition in the Workshop Program
<i>Eddy</i>	>\$500	Logo on Website Registration Page, Recognition in the Workshop Program
<i>Mussel</i>	>\$100	Recognition in the Workshop Program

Further Information:

For further information about the Workshop and inquiries about sponsorship, please contact one of the Workshop co-chairs: Ryan Schwegman, rschwegman@enviroscienceinc.com or Lisie Kitchel lisie.kitchel@wisconsin.gov.

We look forward to seeing you in the Duck River this August!!



Society News

FMCS Board Meeting Minutes Monday, December 16, 2019 Teleconference

President Jeremy Tiemann called the meeting to order at 2:35 EST after establishing a quorum. In attendance were: Jeremy Tiemann, Janet Clayton, Alan Christian, Greg Cope, Wes Daniel, Dave Berg, Megan Bradley, Amy Monroe, Kevin Roe, John Harris, Dave Zanatta, Amy Maynard, Lisie Kitchel, Ryan Schwegman, Susan Oetker, Emilie Blevins, John Jenkinson, David Hayes, Madeline Pletta, Mickey Matthews, Tam Smith, Nathan Whelan, Heidi Dunn, Wendell Haag, Braven Beaty, and Tim Lane.

Kevin Roe made a motion to approve the April 2019 Board Meeting Minutes as published in the June 2019 *Ellipsaria*. Heidi Dunn provided a second and all approved.

Treasurer's Report – Alan Christian

Report is for accounting from January 2019 through October 2019.

Income

Network For Good	\$175.00	
Amazon Smile	92.87	
Rewards	425.00	
Interest	150.25	
T-shirts, hats, posters	380.00	
Vests	70.00	
Auction Raffle	5,084.00	
<u>Donations</u>		
Tom Watters	100.00	
<u>Others</u>	1,215.57	
Total General Income		\$7,692.69

Memberships

Lifetime	800.00	
2021	20.00	
2020	9,720.00	
2019	9,700.00	
Total Memberships		\$20,240.00

Workshops and Symposia

2018 Italy Meeting	\$2,040.00
<u>2019 Symposium</u>	
SSA Workshop	5,250.00
Guest Banquet Tickets	1,045.00
Registration	111,545.00
T-shirts	3,170.00
Field Trips	2,225.00
<u>Sponsorships</u>	11,300.00
Total 2019 Symposium	134,535.00
<u>2020 Sponsorship</u>	500.00

Total Workshops and Symposia	<u>\$137,075.00</u>
Total Income	\$165,007.69

Expenses

Square Fees	\$861.13
Regional Meetings	200.00
Student Awards	541.71
Shipping	9.20
Webpage	6,115.19
Office Supplies	294.35
Annual Registration Fee	10.00
Taxes	8.80
Miscellaneous	(-95.00)
Bank Charges	66.00
PayPal Fees	2,658.15
FMBC	<u>18,437.32</u>

Total General Expenses	\$29,106.85
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Symposia/Workshop Expenses

2019	\$174,523.86
2020	<u>480.70</u>

Total Symposia/Workshop Expenses	<u>\$175,004.56</u>
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Total Expenses	<u>\$204,111.41</u>
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Net Income	- \$39,103.72
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Bank Savings Balance	\$10,002.55
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Bank Checking Balance	\$108,728.19
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Alan said that most of the loss was due to the 2019 symposium expenses and most of that loss was due to not hitting the target on reserved block of rooms because of weather-related cancellations.

Alan requested permission to purchase thank you cards for donations received for the Tom Watters memorial. That purchase was approved by the Board. To date there is about \$3000 from Tom's memorial.

Secretary's Report – Janet Clayton

There are currently 664 individuals on the mailing list, of which 433 are active members. There are currently 6 contributing members, 1 Life-time (paid) member, 17 Life-time (free) members, 309 regular members, and 100 student members. That is a pretty accurate count of the student membership. Currently, only four of the active student members have emails bouncing back. I had started cleaning the database but then got busy and it is not quite complete.

OLD BUSINESS**Professional development**

No report

Chapter formation – Emilie Blevins

Emilie Blevins reported that Manuel Lopes Lima has drafted by-laws after reviewing those of other organizations. There was some concern raised by the Pacific Northwest folks who are not paid malacologists. It was decided that the draft should be sent around to the Board for review. Alan noted the need to come up with an accounting system for chapters.

Update on JASM – David Zanatta

The Joint Aquatic Science Meeting (JASM) last met in 2014 in Portland Oregon. This group includes just about any aquatic society you can think of. The next meeting will be in Grand Rapids Michigan in May 2022. They are still slow on details but expecting about 5000 in attendance. The next planning phone call is in January. They are currently working on agreements.

Sterkiana – Kevin Roe

The uploading of individual articles is complete through Volume 18. Harrison Inefuku (Iowa State University library) is working on uploading PDFs of complete issues and should have the entire run finished by December 5. Harrison is also looking to hire student assistants to complete the formatting and upload of individual issues in the spring. He hopes to have the project completed by next semester.

Malacological Data Net – Jeremy Tiemann

Art Bogan has been trying to search out anyone associated with the journal but all are deceased. Jeremy reported that one of Art's colleagues said it was never copywrited and therefore should not have any issues with uploading. He will continue to pursue.

NEW BUSINESS**Restructuring of committees** – Jeremy Tiemann and Heidi Dunn

An article was published in the December issue of *Ellipsaria* outlining proposed new committee structure based on the revised by-laws. There was some discussion on how the overall process would work. It was noted that a committee may have numerous subcommittees under them and each subcommittee would have a chair who would report to the chair of the main committee. The full committee chair then reports to the Board. One suggestion for future symposia was that the full committees would meet briefly before breaking up into subcommittees.

Susan Oetker noted that the Mussel App was listed as a subcommittee. She was concerned about the requirement that rotating the chair every three symposiums (6 years) would not maintain the continuity of the group and that others may not have the qualifications needed to carry out the tasks. Jeremy noted the Names Committee had the same issue. Heidi and Jeremy said that the subcommittees need not be held to the same six year term limit as the full committee chairs. Each committee could develop their own set of operating procedures. These comments will be considered in developing how the new structure will work.

John Jenkinson suggested that the Nominations committee be changed to the Election committee. This committee is responsible for coming up with the nominations and conducting the elections.

The new committee structure will eventually be voted on by the Board, and the plan is to implement the new structure in Portland at the next symposium when the committees turn over. Board member comments about what was proposed in the December *Ellipsaria* should be sent to Jeremy and Heidi by the end of January. Once a revised structure is approved by the Board, the revision will be published in *Ellipsaria* with a request for comments from the general membership.

Webpage – Megan Bradley

We are still needing committee reports for committee pages or at least a bullet list of activities and person to contact. Also suggested at the last board meeting was a mug shot of committee chairs. Please get these to Megan. If you notice anything that does not work, let Megan know. January 31 is the deadline to get committee reports to Megan. These reports should outline the committee's mission statement with photos. This information is intended to get interested participants to join the right committee.

Walkerana – Jeremy Tiemann

The Illinois Natura History Survey (INHS) is no longer able to house the remaining stocks of Walkerana. Jeremy noted that all issues have been scanned and uploaded to the website. If you know of anyone who would like the hard copies, let Jeremy or Kevin Cummings know. INHS cannot pay shipping, there is no cost except for shipping. If the printed copies are not gone by the time of the move (March/April), they will be sent to recycling. There are approximately 20 volumes per set and multiple boxes of each issue in the present inventory.

Child Care Services at FMCS Events

Daelyn Woolnough will be sending a draft questionnaire to Jeremy about the need for childcare and/or dependent care during the 2023 Symposium. Upon his approval, it will be forwarded to the rest of the membership. The proposal was to provide assistance so that folks with these issues maybe more likely to attend FMCS events. There are questions on how to fund the program. The questionnaire should go out early next year. Dave Zanatta further clarified that they were looking for the society to pay care similar to student travel awards and would not be on-site care. The idea is that individual needs are required and there are liability concerns so individuals applying for funds would use them to make unique arrangements (e.g., bring care with them, pay for care at home, etc.). Daelyn also made contact with the folks that run the day care activities for the American Society for Virology and the Society for Molecular Biology and Evolution.

The Portland venue (2021 Symposium) does not provide childcare but the committee is looking for drop-off sites. Other options were discussed with someone noting that some societies just provided a list of nearby child care facilities with costs and left arrangements up to individuals. Lisie Kitchel noted that some other groups had grad students also attend to kids.

COMMITTEE REPORTS**Symposium** –Emilie Blevins

Plans are underway for the 2021 Symposium, April 12-16, 2021, in Portland, Oregon, at the DoubleTree Hilton by Portland. The planning committee has been meeting monthly since July. Committee consists of eight in the Pacific Northwest and two board members (Steve McMurray and Jeremy Tiemann). The contract with the facility has been signed. Rates are similar to past meetings and the federal government rate was obtained, 450 rooms were reserved. The registration fee has not yet been finalized. The theme is "Mountains to Sea and Mollusks Between". The Planning Committee is currently planning field trips. We are interested in any suggestions on possible keynote speakers or workshops.

Guidelines/Techniques – Ryan Schwegman, Lisie Kitchel

The FMCS 2020 Survey Sampling Workshop will be hosted at Henry Horton State Park on the Duck River, Tennessee, August 10 - 13, 2020. The planning committee (listed below) held a conference call in November. A schedule for the Workshop was presented with Monday as a travel day and continues through Thursday morning for field trips. We are still soliciting volunteers to assist. Lots of input has been collected on how best to conduct field exercises with

this large a group and suggestions for the Workshop topics and how best to efficiently conduct the field exercises. That information is being condensed into a single document for review and consideration by the Program Committee. We are currently working on the budget and rooms appear to be between \$68-86 per night. Registration fees should be around \$200.

The Workshop will be divided into Introductory and Experienced levels of Survey Sampling, with presentations and field exercises geared toward both. The oral presentations will be limited to topics directly relevant to Survey Sampling. Not all submissions may be accepted due to time constraints, but we are looking at evening presentations to accommodate relevant presentations. Posters will include a broader spectrum of mussel-related subjects to allow for greater participation. Details and instructions for abstract submission will be included in the March issue of *Ellipsaria* and the broader e-mail list. A concerted effort will be made to contact beginning mussel students not in FMCS through their major professors or institutes of learning.

Program Committee: Janet Clayton, Heidi Dunn, Steve Ahlstedt, Dave Smith, Joe Snavely, Steve McMurray.

Poster Session: Adrian Moore and David Foltz

Socials/ Music: Phil Mathias

Registration: Alan Christian

Sponsorships: Lisie Kitchel and Steve Ahlstedt

Local Contacts: Dave Czayka and Don Hubbs

Graphics and Marketing: Todd Amacker

Awards – Emy Monroe, David Hayes, Curt Elderkin, Susan Oetker

Duties of the Awards Committee from the last Symposium were completed with the June *Ellipsaria* article. Our committee has subdivided responsibility for leading the various awards as follows (with all members assisting the leads):

- Professional Awards -- Susan Oetker
- Presentation Awards and Judging -- Emy Monroe
- Student Travel Awards -- David Hayes
- Regional Meeting Awards -- David Hayes

A proposal to create a new award to assist young professionals in attending society symposia was proposed to the committee. Curt Elderkin agreed to take the lead on this award and would join the Awards committee if the award comes into existence. Our current draft of this proposal models that of the American Fisheries Society, and is as follows:

The FMCS Early Career Travel Award. This award provides free registration for two new professionals (<5 years post-graduation) to encourage attendance to our biennial symposia (and/or workshops). Preference will be given to individuals presenting at the meeting, those involved in committees, and those needing financial assistance.

Any FMCS member within five years post-graduation, including agency biologists, postdoctoral associates, and university faculty/staff, are eligible to apply. The application should consist of the following:

1. Letter of interest describing: a) Service to FMCS; b) Reasons for attending the meeting; c) Financial need; and d) Career goals (paragraph).
2. Current CV, including: a) Degree(s); b) List of publications and presentations; and c) Honors and awards.
3. Anticipated title and abstract of the paper(s) or poster(s) being presented.

Applications should be submitted as a single PDF file to Curt Elderkin, chair of the Early Career Travel Award

The Awards committee would review applications and select two winners. Curt Elderkin would coordinate with the Society secretary, treasurer, and meeting organizers to ensure the winners have their registration fee covered.

Based on discussion about this award in emails, we have a few questions for the Board:

1. Should it be for symposia only, or include workshops as well?
2. Should this be open to everyone as described? Award for any new young professional <5 years graduation including post-docs, assistant professors, and agency employees, or do we want to restrict it?
3. Do we want to use some source of funding to pay our society the registration fee or waive it to avoid actual payment of funds? Depending on how this is handled, it will either add to the organizing committee's considerations or not.
4. It has been proposed that we name this award in Tom Watters' honor and use the donated funds to cover the award. If we waive the fee, and don't pay our society for the registrations, then we don't need to use the funds. But, then, can we name the award for Tom anyway?

During the Board meeting, uncertainty was expressed about naming an award that does not have permanent funding. Heidi questioned whether waiving the registration fee was enough to provide incentive? Jeremy said this had previously been discussed and the idea was that the individual would have the opportunity to room with a colleague and that most of our registration fees also cover many of the meals.

Nominations

Wesley Daniel has volunteered to take over the lead for the Nominations Committee which was left vacant upon Leroy Koch's retirement.

Outreach – Jennifer Archambault , Amy Maynard, Megan Bradley

The Outreach Committee has begun work on the goals that it set at the 2019 Symposium. Committee work was quiet through the summer field season, and we have picked up the pace recently. Through electronic communication, volunteers have signed up to work the following projects that we identified as goals in April:

- educational outreach posters for mussels and snails,
- social media administration,
- website design improvements, and
- drafting an update of the Outreach Committee portion of the FMCS Procedures Manual to better describe the work this committee has been doing.

The website is due for its quarterly update at the end of the year and we are considering a few additions. The first is to add a public-facing series of pages that are linked to FMCS but separate from our current website. The theme of these public pages will be freshwater mollusk education. The second is to improve website accessibility, working with the Diversity and Inclusion Committee. If anyone has suggestions, we welcome them.

As always, if you have updates for your own committee website pages, please send them to Megan Bradley with your committee name in the email subject line. We have added four new social media administrators (Dan Symonds, Nora Straquadine, Amy Maynard, and Ieva Roznere) since April, which should help us catch and share news and updates – thanks to our new volunteers! Please remember that our pages are public and everyone is welcome to post job opportunities, notes from the field and other interesting mollusk-related news. Volunteer groups for each outreach goal are planning to touch base every month or so to keep momentum

going. We will keep you posted on progress and hope to have some new products to share in the coming year.

If have any questions to take to Sophie, let Megan know. Heidi suggested to put notice out on Unio list-serve as to what the public needs. Hard for public to find info on site; it is there but embedded. The main driving question right now is do we want to update the existing site or set up separate website for public with link. Send Megan an email with your thoughts and ideas.

Mussel App update – Susan Oetker, John Harris

The Mussel App is out and available. It has had a pretty good reception. There are a few questions still to be answered, such as how are we going to move forward with name changes and the like. We would like to add fact sheets. If we want to do any additional changes in how it works, make it slicker, we are going to eventually need to provide more money to the designer. Currently we have definitely gotten our money's worth. Is the society interested in reviewing a proposal for future modifications? Currently we are looking into refining distribution to a finer grade. Art Bogan has taken this App global and talked to folks in Europe and Japan. Our app is acting as a template for their development.

Gastropod Status/Distribution – Nathan Whelan, Wesley Daniel

Most of what the gastropod committee has done since the last meeting relates to the names subcommittee to be reported on by others. Wes Daniel will be leading an effort to get expert feedback from FMCS membership on a Field Guide to Nonindigenous freshwater snails of the United States that is being developed by the USGS Nonindigenous aquatic species project. As the field guide is developed, we may look into a formal endorsement from FMCS. We would also seek funding if a decision is made to make a print version of the field guide. We are currently looking for feedback, in particular with the native look-alikes.

Mussel Status and Distribution

Naming subcommittee – John Harris

We revised guidelines following the San Antonio meeting to address issues that arose during our first review process. Both gastropod and bivalve lists are ready to be posted. We're waiting on website update info to complete the process.

Environmental Affairs – Braven Beaty, Mickey Matthews

Our committee has been actively engaged with the Consortium of Aquatic Science Societies (CASS) throughout the past year. It is a coalition of nine societies. Involvement in this collective group of aquatic scientists is an effort to increase the potential voice of the society in policy issues and encourage interdisciplinary opportunities.

One of the most significant recent efforts of CASS was engagement regarding the proposed changes to the definition of 'Waters of the United States' (WOTUS). This important legal interpretive change would influence which surface waters receive protection and consideration under the federal Clean Water Act (CWA). CASS collectively expressed concerns about both the rationale of the proposed rule changes and procedural issues that discounted input by the Environmental Protection Agency's scientists and evidence, as well as outside professional aquatic scientists. This effort resulted in two comment letters, briefings with federal legislator offices, and a press release. To date, the outcome has resulted in reverting the WOTUS interpretation back to that prior to the 2015 changes, which extended WOTUS to cover disconnected wetlands that influence navigable surface waters and their tributaries. The new rule, effective December 23, 2019, applies the previous standards toward interpreting which water bodies are regulated waters.

CASS, with FMCS support, also responded to proposed changes to the CWA that would limit states' and tribes' abilities to interpret and enforce water quality standards within their borders, deferring to the federal standards. CASS generated two comment letters, addressing both content and procedure of this proposed rule change.

Relatedly, FMCS through CASS, supported an Amicus Brief addressing the authority of CWA agencies to regulate pollutants that enter jurisdictional waters through groundwater paths. This case involved a pollutant discharge in Maui, Hawaii, to groundwaters that subsequently entered the Pacific Ocean coastal waters. While not decided yet, according to the Los Angeles Times (November 6, 2019), the federal Supreme Court is leaning toward the environmental argument supported by CASS requiring permitting of point-source pollutant discharges that may enter groundwaters and subsequently migrate to federally protected waters.

Finally, our committee has been 'loosely' engaged with CASS on developing a joint member society and CASS conference in 2022. The conference will be held in Grand Rapids, Michigan, in mid-May 2022. At this point, FMCS has not committed to participating in an official paying capacity but does want to provide information to any members who may wish to participate.

Genetics – Kevin Roe, Dave Zanatta

The Committee re-elected current Co-chairs Roe and Zanatta to a second term. The Genetics Committee also elected members to serve as liaisons to other committees and by doing so maintain lines of communication with them.

We discussed creation of a best practices 1-pager for genetic sample collection with Curt Elderkin and Isabel Hannes volunteering to generate a first draft. Jurgen Geist later offered to assist with this document. The committee also decided to move forward with developing one or more "emerging issues" in genetics talks to be presented by the committee chairs or an invited speaker at each symposium meeting. An article summarizing these talks could be published in *Ellipsaria*.

Given the pace of development and emergence of new technologies for genetics and genomics and the speed at which new information using new technologies and techniques is being published and applied to freshwater mollusks, the committee also plans on offering an FMCS genetics workshop every six to eight years. The next proposed and available date would be in 2024 (the previous workshop was held in 2016).

The committee also discussed modifying the current mission statement as follows (crossed out text is from the previous version).

3.4 Genetics

The main duties of the Genetics Committee relate to educating the society on the value and uses of genetic techniques for the conservation of freshwater mollusks and dissemination of genetic information relating to systematics, population genetics, genomics, and aquaculture/captive propagation. The committee also serves as a source of expertise for guidance on genetics issues for government agencies and the society in general.

~~1. Further development of the use of DNA barcoding for identification of provisional species. Further development of nondestructive tissue sampling techniques is desirable. Creation of best practices "1 pagers." These short documents would address topics such as vouchering of specimens, value of sampling at type localities, DNA barcoding, genetic concerns in creation of captive, augmented, and restored populations, etc.~~

Information Exchange – John Jenkinson, Greg Cope Wendell Haag, and Dave Berg

Ellipsaria:

Ellipsaria continues to be posted on the website quarterly, as scheduled. Many thanks to all members who have contributed reports, announcements, and brief articles to the newsletter.

This past quarter, FMCS requested and received an International Standard Serial Number (ISSN) for *Ellipsaria*. This eight-digit number identifies our newsletter as a continuing serial resource. In many countries, an ISSN is mandatory for all publications subject to legal deposit. We requested this designation in response to an inquiry from one of our international contributors. The ISSN for the online version of *Ellipsaria* -- now included in the masthead -- is **ISSN 2689-2936**. Although we did not request it, we also received an ISSN for the print version of the newsletter (ISSN 2689-2928) although it is not now being produced. Both numbers were issued on October 16, 2019, by the ISSN Publisher Liaison Section, US Library of Congress.

FMBC:

Volume 22(1) (the “March” issue) had three papers. Volume 22(2) (the “September” issue) will be a special issue containing papers presented at the 2018 Freshwater Mollusk Health and Disease Workshop held in La Crosse, Wisconsin. This issue will have eight papers. We are waiting on Allen Press to send the final version of the proofs for one paper (due to us December 3). By the time of the conference call, the issue should be published. We are excited about and proud of this issue; it is a nice collection of papers. Thanks to Megan Bradley and Diane Waller who helped out in several ways on this issue, and to all of the authors who contributed.

We have had a good influx of submissions in the last few months and currently have about 14 papers in review or pending revision. This should make for more substantial issues in 2020. We would be happy if we could regularly have 5-8 papers per issue.

As you may have noticed, we are consistently having trouble getting issues out in time. Our schedule with Allen Press stipulates publication of the first issue in March and publication of the second issue in September. So far, we have not yet met this deadline; it has been more like May/June and November/December. Allen Press is flexible on the schedule, but we would like to work to improve this.

We are online with BioOne as of January 2019. This was an important step in making this a legitimate journal. Greg Cope did nearly all of the work on this.

We are still waiting on Clarivate Analytics to provide us an Impact Factor for FMBC. Apparently, they require some period of time after being on BioOne to be able to assess an Impact Factor.

In June, 2019, we contracted with Two Herons Consulting to provide copy editing services. This was necessary because the copy editing provided by Allen Press was not resulting in a consistent product. Two Herons has reviewed all of the papers in the upcoming special issue. They have been punctual and effective and have really helped us make our product tighter and more professional.

The editors for FMBC are now David Berg, Greg Cope, and Wendell Haag. Greg Cope, who has been an editor since inception of FMBC (as *Walkerana*), is planning to step down some time after the first of the year. As always, Greg has provided outstanding service and is largely responsible for emergence of FMBC as a valuable research outlet and great asset to FMCS. We will miss him terribly as editor.

The editors propose to seek a volunteer within the FMCS membership to serve as Managing Editor for FMBC. This person would be responsible for tasks such as billing and invoicing, preparation of Table of Contents, and other transactions with Allen Press, BioOne, Two Herons

Consulting (copyeditors), and other entities. The Managing Editor would have no responsibilities for handling of manuscripts.

Propagation – Rachael Hoch, Tim Lane, Maddie Pletta

The Propagation and Restoration Committee last met with members at the FMCS Symposium in April 2019. A call for information was placed to participants to provide updated information to the propagation facility database; however, no new information has been received, and the database stands at seven participants. There are some questions regarding information sharing that will be addressed in a member wide meeting/conference. The committee will setup a formal conference call in the new year with members to discuss:

- Facility database information and sharing
- Summary and guidance for mussel hatchery designs
- Updates and next steps for the restoration activities summary document
- Collaboration with the USFWS to summarize propagation and restoration activities.

AD HOC COMMITTEES

National Strategy – Catherine Gatenby, Patty Morrison, Teresa Newton

No report.

International – Art Bogan, Manuel Lopes-Lima

No report.

Monetary Values of Mollusks – Megan Bradley, Janet Clayton

There has been no activity recently and we are waiting on word from AFS.

Ecosystem Services – Carla Atkinson

We held two meetings this past year: One at the FMCS meeting in San Antonio and a second one over zoom in December. Here are our present major goals:

- Organizing and holding an ecosystem services themed workshop (2022?)
 1. Location ideas: TN Aquarium (Chattanooga, Tennessee), Athens, Georgia
 2. Who to invite: Marine scientists already quantifying ecosystem services of marine mollusks, economists, social scientists, science communication, historians.
 3. Setup: A couple of talks a day, perhaps form working/discussion groups (1-2 economist groups, social science groups, policy group - ESA, science communication?), evening poster session?
 4. Goal of workshop: tie back to the National Strategy - working groups will have the goal to write papers for FMBC - Papers would not have to be ready for publication immediately following the meeting - have to submit the working group papers to the committee within two-ish weeks; committee can potentially form an editorial board - help prep papers for publication (Special Issue for the Journal on the workshop?)
- Paper on future directions of ecosystem services and the FMCS society. Plan is to write it as an editorial fleshing out ideas/concepts of the data we need and future directions. Hoping to submit by 2020 and for it to be published in 2021 prior to the workshop.
- Outreach products and materials for disseminating the value of mollusks to society – there is some feedback occurring between the ecosystem services and outreach committees.
- We are concerned about our place in the proposed new committee structure. Our committee generally does not agree with being merged with Genetics and Guidelines to form an Ecology and Ecosystem Services Technical committee. Does not seem like an organic merger. We

think it would be a better fit to be with Environmental Quality and Advocacy – advocate for conservation using the ecosystem services framework. Environmental Quality and Ecosystem Services? We also think we fit somewhat with outreach – we still plan to interface and work with outreach.

Inclusiveness and Diversity (D&I) – Tamara Smith

Last group meeting via phone call November 15, 2019; continue to meet via calls/Google Drive.

Committee Tasks:

- Develop clear goals and objectives for the group. Draft a mission statement for the committee.
 - Progress: *The group has continued to draft a plan with goals, objectives and actions. Drafted a mission statement for the website (see below).*
- Continue to add photos of people on the FMCS main webpage. Sent out calls over the unio list-serve and social media to request photos and quotes to be featured on the website! (Ask – In a sentence or two, tell us why you are a member of FMCS?).
 - Update – *Received 12 responses (so far) from the latest call for photos. Compiling photos and quotes for the next website submission.*
- Create a presence on the FMCS website (of the Ad hoc committee) including:
 - Photograph of committee, contact info for interested folks, accomplishments, mission & goals.
- Committee mission statement:

“FMCS encourages participation by all individuals regardless of age, culture, ethnicity, gender identity or expression, national origin, physical or mental difference, politics, race, religion, sex, sexual orientation, socio-economic status, or subculture. We aim to cultivate a society built on mutual respect and strive for a welcoming environment for all. FMCS promotes diversity in all areas of societal activity, including fostering diversity in membership, leadership, committees, outreach, public engagement, and recruitment.”

 - Progress: The committee sent website requests for the D&I committee page to Megan Bradley to give to Sophie.
- Improve accessibility of FMCS website. *In progress.*
- Explore ways to make future meetings/symposiums/workshops more inclusive
 - Portland symposium – can a D&I committee member join the symposium planning committee?
 - Ensure that future meetings venue/vendors have diversity/inclusiveness policy.
- Explore the idea of FMCS adopting a policy for future meetings? Need to explore this with the FMCS Board. Will look to The Wilderness Society and other professional societies for examples.
 - For future vendors, help the planning committee vet vendors?
- Develop an optional demographic questionnaire to FMCS members to get baseline data to help us identify needs or areas of concern and to help measure our success.
 - Progress: The committee has started a draft questionnaire. *No new updates since April.*
- Explore ways to welcome new members to FMCS and committee members.
 - Progress: *Brainstormed ideas. Need to choose some to focus on in 2020.*

During the Board meeting, Tam noted that this committee is working with Megan and Sophie to address website issues for use by low vision members. Future venues need to have inclusive policies. We have been looking at other societies that have similar concerns. Someone from the committee should be included in the symposium planning committee.

Some targeted goals of the committee are to determine how to diversify the FMCS membership and provide resources to encourage diversity. We would like to develop a community challenge or develop media content, grants, or scholarships. We are in the process of developing optional demographic questionnaire to be sent to the membership.

Professional Development – Becca Winterringer

No report.

Motion to Adjourn was made by Wesley Daniel, second provided by Lisie Kitchel, all approved.

Respectfully submitted by Janet L. Clayton, Secretary

Announcements

Northeast Fish Health Committee Mussel Workgroup Being Formed

The Northeast Fish Health Committee (NEFHC) is concerned with aquatic pathogens, whether they originate from cultured stock or occur in wild populations of freshwater mussels. Some of these pathogens are specific to fish and some might be specific to mussels. The lack of information concerning mussel-specific pathogens and the ability of mussels to transmit fish-specific pathogens is problematic when assessing risk associated with the movement of mussels for management activities. Guidance from mussel subject matter experts would benefit fish health and culture heads of member states.

Two representatives from the U.S. Fish and Wildlife Service and four representatives from member states with experience in conducting mussel management have initially agreed to participate in a workgroup under the NEFHC along with several fish culture chiefs and state veterinarians. Their initial activity will include a one-page workgroup overview that lists workgroup members, a problem statement, steps to be taken, and a list of proposed outcomes. This will be presented to the Fisheries Administrators group at the April 19, 2020 meeting of the Northeast Association of Fish and Wildlife Agencies. If you have any questions, please contact your agency's administrator, the NEFHC chair (Brian Richardson; brian.richardson@maryland.gov), or the workgroup lead (Matt Ashton; matthew.ashton@maryland.gov).

EUROMAL 2@2@

The Ninth European Congress of Malacological Societies (EUROMAL 2@2@) will take place 6-11 September 2020 at Prague, Czech Republic. The Congress is being hosted by the Czech University of Life Sciences. Details on thematic session, symposia, and registration are available on the conference website (www.euromal.cz).



Want Printed Copies of *Walkerana* ?

The Illinois Natural History Survey is no longer able to house the remaining [printed] back issues of *Walkerana*. We are willing to store three sets of the entire run (minus Issue 2, which is depleted) but the rest must be transferred to individuals or other institutions. If no other option is presented by the beginning of April 2020, the back issues will be recycled. If anyone is interested in particular volumes, a full run of them, or the entire backlog, please let us know by April 3, 2020. We can mail them, but only if the interested party pays shipping. The weight of an entire run (box included) is 13.5 pounds. We would prefer that interested parties generate shipping forms using the vendor of their choice (UPS, USPS, Fed Ex), pay the shipping cost, and then send us a PDF of the shipping label. All inquiries should be sent to Jeremy Tiemann, Email: jtiemann@illinois.edu, Office telephone: (217) 244-4594.

Reminder: All volumes of *Walkerana* are available electronically on the FMCS website at:

https://molluskconservation.org/FMBC-Walkerana_BackIssues.html

Regional Meetings

Third Biennial Canadian Freshwater Mollusc Research Meeting



In-person attendees at the third Biennial Freshwater Mollusc Research Meeting in Burlington, Ontario, December 3-4, 2019.

The third Biennial Canadian Freshwater Mollusc Research Meeting was held at the Canada Centre for Inland Waters in Burlington, Ontario, on December 3 - 4 2019. As in previous years, the meeting was co-hosted by Fisheries and Oceans Canada and the Ontario Ministry of Natural Resources and Forestry. The 2019 meeting saw an increase in attendance from the previous meeting held in 2017, with 70 in-person attendees and another 22 groups joining the meeting via Webex. The meeting allowed for researchers and resource managers from across the country to hear about recent advances in molluscan science while providing an opportunity for the exchange of information on regional approaches being employed nationwide.

This year, the meeting was expanded to a full two days and a formal poster session was added to the afternoon of December 3. The meeting was kicked off with a plenary talk by Dr. Dwayne Lepitzki, co-chair of the Committee on the Status of Endangered Wildlife in Canada Mollusc Specialist Subcommittee who spoke about his work on the federally endangered Banff Springs Snail during an engaging talk entitled "Snails are molluscs too: what have we learned during nearly a quarter-century of field research on the Endangered Banff Springs Snail, *Physella johnsoni*?". Twenty-eight platform presentations and

eight posters were presented over the two-day gathering on general topic areas including threats and limiting factors, sampling and management tools, and distribution and life history. The meeting provided a chance to foster new and productive research partnerships and to strengthen the network of Canadian malacologists.

Proceedings of the meeting have been published as a Canadian Technical Report of Fisheries and Aquatic Sciences and can be found at: <http://waves-vagues.dfo-mpo.gc.ca/Library/4084724x.pdf>

Upcoming Meetings

- March 26, 2020** – Pacific Northwest Native Freshwater Mussel Workgroup Symposium, Vancouver, Washington, USA. Theme: *Freshwater Mollusk Updates from Across the West: Who's Doing What, Where?* <https://pnwmussels.org/pnw-2020-regional-meeting/>
- March 29 – April 2, 2020** – National Shellfisheries Association 112th Annual Meeting, Radisson Hotel Baltimore Downtown-Inner Harbor, Baltimore, Maryland USA. <https://www.shellfish.org/annual-meeting>
- June 7 – 12, 2020** – Society for Freshwater Science and Association for the Sciences of Limnology and Oceanography Joint Meeting, Madison, Wisconsin, USA. Theme: *Sustaining Aquatic Ecosystems Under Global Change* <http://sfsannualmeeting.org/>
- July 13 – 17, 2020** – American Malacological Society 86th Annual Meeting, Faro Blanco Resort, Marathon, Florida, USA <https://ams.wildapricot.org/FK-2020-Meeting>
- July 26 – 31, 2020** – Society for Conservation Biology North American Sectional Meeting, Denver, Colorado. Theme: *Crossing Boundaries: Innovative Approaches to Conservation* <http://conbio.org/groups/sections/north-america/meetings/>
- August 10 – 13, 2020** – FMCS Survey Guidelines and Techniques Workshop, Henry Horton State Park, Tennessee, USA https://molluskconservation.org/EVENTS/2020WORKSHOP/2020_FMCS-Workshop.html
- August 30 – September 3, 2020** – American Fisheries Society 150th Annual Meeting, Columbus, Ohio, USA Theme: *Learning from the past, meeting challenges of the present, advancing to a sustainable future*. <https://afsannualmeeting.fisheries.org/>
- September 6 – 11, 2020** – Ninth European Congress of Malacological Societies (EUROMAL 2@2@), Prague, Czech Republic www.euromal.cz.
- October 25 – 28, 2020** – Southeastern Association of Fish and Wildlife Agencies 74th Annual Conference, University Plaza Hotel, Springfield, Missouri, USA. <http://www.seafwa.org/conference/overview/>
- April 11 – 15, 2021** – FMCS 12th Biennial Symposium, Portland, Oregon, USA. Theme: *Mountains to Sea and Mollusks Between*. https://www.molluskconservation.org/EVENTS/2021SYMPOSIUM/2021_FMCS-SYMPOSIUM.html
- Spring ? 2023** – FMCS 13th Biennial Symposium, Michigan (?) [Dates, Location, and Theme not yet determined]

Contributed Articles

The following articles have been contributed by FMCS members and others interested in freshwater mollusks. These contributions are incorporated into Ellipsaria without peer review and with minimal editing. The opinions expressed are those of the authors.

The Plates from Rafinesque 1820

John Jenkinson, Clinton, Tennessee

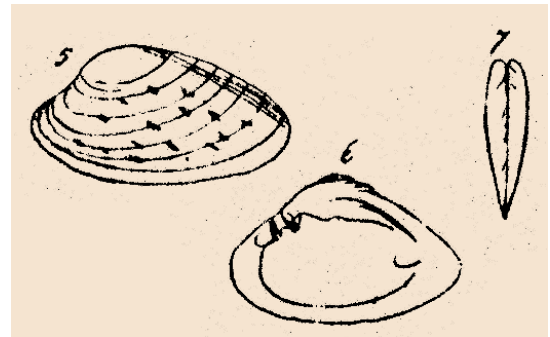
This year [2020] is the 200th anniversary of the publication of the second major paper describing new freshwater mussel species found in the United States. Unlike its predecessor (Say, 1817), however, Rafinesque's 1820 paper has been the source of controversy virtually ever since it was published.

Rafinesque's Monograph on freshwater mussels in the Ohio River was published (in French) in the Belgian journal *Annales Generals des Sciences Physique* (1820). The descriptions of the genera and species were presented in an abbreviated form, with characteristics of each grouping not repeated for the taxa listed within it, and using novel descriptive terms that were not defined. The printed Monograph also included the following footnote associated with the first reference to the plates and figures (Rafinesque, 1820:291): "The drawings having been sent to us uncolored and the shells not being available, we have been unable to show their colors on the plates, and the lithographer has been reduced to the simple role of copier." (translation by LaRocque, 1964:35).

According to Poulson (1832), Rafinesque sent copies of the paper to Poulson "who distributed them among individuals, and the libraries belonging to scientific institutions in this city [Philadelphia] and elsewhere" but, 11 years later, only four of the species Rafinesque had described were recognized by his names. In an apparent attempt to rectify the situation, Poulson translated the Monograph into English and published it privately (Poulson, 1832). That publication did not include the three original plates or any of the text references to the 71 figures on those plates. It did include a (later) figure of one of Rafinesque's species (*Unio verrucosa*) accompanied by some text indicating how the shell should be oriented. [Bogan (1988) provides much more detail on the publication history of Rafinesque's 1820 Monograph and his other publications concerning freshwater mussels.]

Isaac Lea summarized his (and other's) objections to adopting the names proposed by Rafinesque in at least the second and fourth editions of his Synopsis:

". . . It will be observed that the works of M. Rafinesque are but little quoted. This has arisen from the utter impossibility of satisfying myself as to his species, causing me at an early period to abandon the task of making out his very imperfect descriptions. His own discrepancy in the names sent to Ferussac, and those which are attached to specimens here, together with the want of accordance in the tables made out by his friends, have induced me to regard his claims as being too slender to rely upon the decisions, so contradictory, of the several parties, in the absence of the individual specimens noted. In the absence of these specimens, which no naturalist has, I believe, ever seen but the Professor, I find myself compelled to prefer other authorities, which are now almost universally received by our men of science. . . ." (Lea, 1838:120).



The three images of *Obliquaria depressa* from Rafinesque 1820, Plate LXXXI. This is the other synonym of *Ellipsaria lineolata* described in that paper.

Differences of opinion about whether to adopt Rafinesque's names have persisted ever since. When they published their compilation of Rafinesque's writings on Conchology in 1864, Binney and Tryon included the following passage in the Preface:

"In presenting to the public, for the first time, a complete edition of Rafinesque, we forebear to express an opinion on the differences which have unhappily arisen regarding the adoption of many of his generic and specific names. While the very highest authorities have differed so much, it would seem presumptuous for us to make a decision. The numerous valuable writings of our author on terrestrial and marine Mollusca (universally acknowledged as such), together with the great interest which has been awakened in his descriptions of our naiades, will doubtless render this volume an acceptable addition to conchological literature." (Binney and Tryon, 1864 page 6)

Similarly, in 1922 when Ortmann and Walker published their attempt to resolve the nomenclature of some naiades, they started their discussion with the following sentence: "The principal source of controversy has always been as to the standing of the many species described by Rafinesque in 1820 and 1831." (Ortmann and Walker, 1922:1)

In 1964, LaRocque published an intentionally separate English translation of the 1820 Monograph primarily because the Poulson translation "has been criticized as inaccurate from time to time and it has become rather scarce." (LaRocque, 1964:33). That translation retained all of the references to the figures but did not include copies of the three plates.

In an attempt to provide present workers access to all of the parts of this important early Monograph, photographic copies of the three plates in the original 1820 paper are presented on the following pages. These copies are derived from an original copy of the article that was housed in the Norte Dame University library in the 1970s. [I was unable to locate other good copies of those plates or find where I could request or take digital photographs of them.] The accompanying list of species names for the figures on each plate was taken from the text of the Monograph. Each of those Rafinesque names is accompanied by what I believe to be the name for that species used at the present time.

Literature Cited:

- Binney, William G. and George W. Tryon Jr., (editors) 1864. *The Complete Writings of Constantine Smaltz Rafinesque on Recent & Fossil Conchology*. Bailliere Brothers, New York, 103 pages, 3 plates [The plates are of extremely poor quality, at least in the Forgotten Books reprint].
- Bogan, A.E. 1988. A bibliographic history of C.S. Rafinesque's work on North American freshwater bivalves. *Archives of Natural History* 15(2):149-154.
- LaRocque, Aurèle. 1964. Monograph of the fluviatile Bivalve Shells of the Ohio River. A New Translation. *Sterkiana* 16:33-52. [All numbers of this journal will soon be available on the FMCS website.]
- Lea, Isaac. 1838. Synopsis of the Family of Naiades, Second Edition. *Transactions of the American Philosophical Society, New Series* 6:113-152.
- Ortmann, Arnold. E. and Bryant Walker. 1922. On the nomenclature of certain North American naiades. *Occasional Papers of the Museum of Zoology* No. 112, 75 pages.
- Poulson, Charles A. 1832. *A Monograph of the Fluviatile bivalve Shells of the river Ohio, containing twelve genera & sixty-eight species*. Translated from the French. Privately published. 72 pages, 1 plate. Available at: https://books.google.com/books?hl=en&lr=&id=SisHAQAIAAJ&oi=fnd&pg=PR3&dq=A+monograph+of+the+fluviatile+bivalve+shells+of+the+river+Ohio&ots=7Q-rvx5vji&sig=Wgi3D5e7b3JM2RsX00NcrQW_rE8#v=onepage&q=A%20monograph%20of%20the%20fluviatile%20bivalve%20shells%20of%20the%20river%20Ohio&f=false
- Rafinesque, Constantine S. 1820. Monographie des coquilles bivalves fluviatiles de la riviere Ohio. Contenant douze genres et soixante-huit sepecies. *Annales Generals des Sciences Physique, a Bruxelles*. Tom. 5, pages 287-322, 3 plates. Available at: <https://babel.hathitrust.org/cgi/pt?id=hvd.hxj4h7&view=1up&seq=307>
- Say, Thomas. 1817. [article on] Conchology. in *American Edition of the British Encyclopedia or Dictionary of Arts and Sciences*. Samuel Mitchell & Horace Ames, Philadelphia, 15 unnumbered pages, 4 plates.

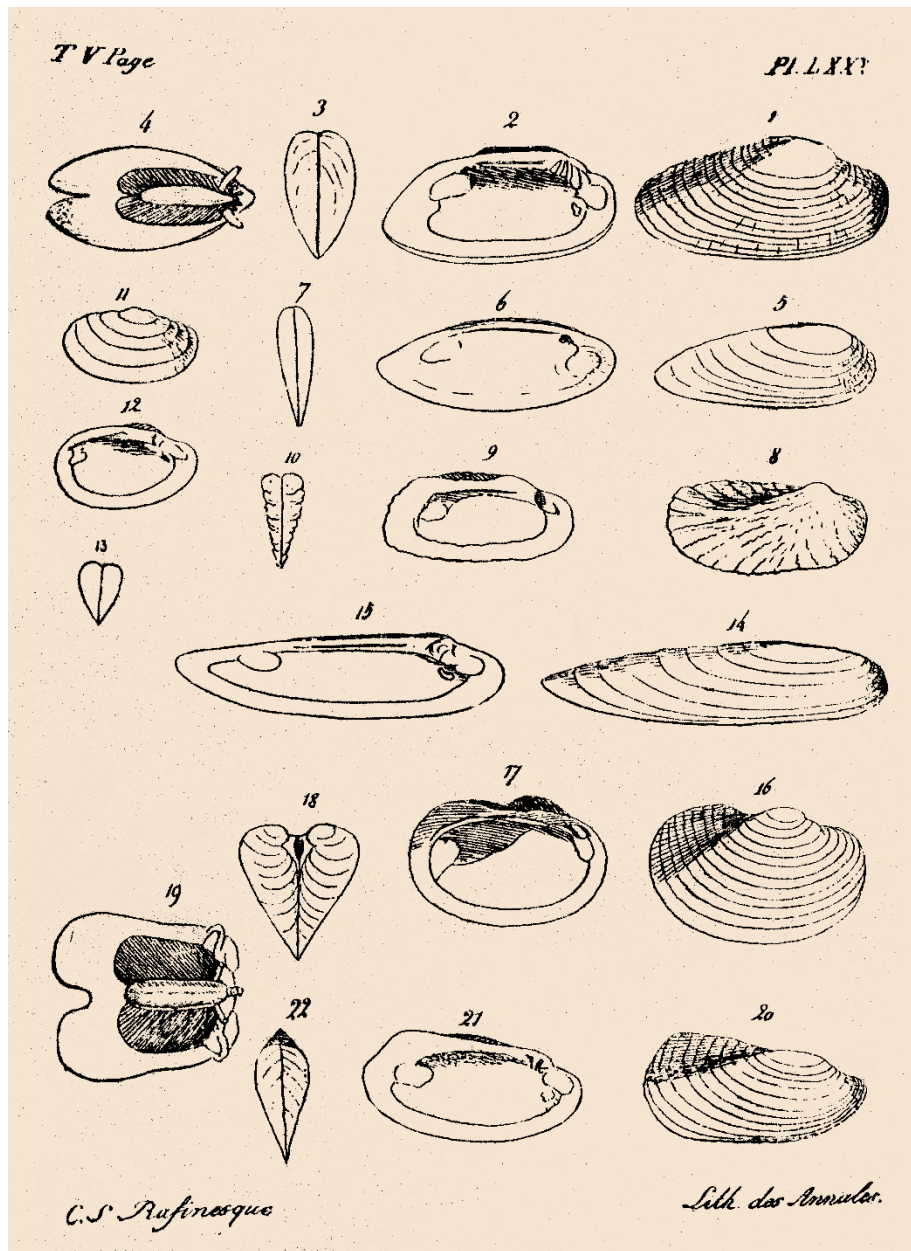


Plate LXXX

Rafinesque 1820 Name

Present Name

Figures 1 - 4	<i>Elliptio nigra</i>	<i>Elliptio crassidens</i> (Lam., 1819)
5 - 7	<i>Leptodea leptodon</i>	<i>Leptodea leptodon</i> Raf., 1820
8 - 10	<i>Elliptio nervosa</i>	<i>Megaloniaias nervosa</i> (Raf., 1820)
11 - 13	<i>Elliptio levigata</i>	<i>Obovaria subrotunda</i> (Raf., 1820)
14 - 15	<i>Elliptio latissimi</i>	<i>Ligumia recta</i> (Lam., 1819)
16 - 19	<i>Lampsilis cardium</i>	<i>Lampsilis cardium</i> Raf., 1820
20 - 22	<i>Metaptera megaptera</i>	<i>Potamilus alatus</i> (Say, 1817)



Plate LXXXI

Rafinesque 1820 Name

Present Name

Figures 1 - 4	<i>Truncilla triqueter</i>	<i>Epioblasma triquetra</i> (Raf., 1820)
5 - 7	<i>Obliquaria depressa</i>	<i>Ellipsaria lineolata</i> (Raf., 1820)
8 - 9	<i>Obliquaria cuprea</i>	<i>Actinonaias ligamentina</i> (Lam., 1819)
10 - 12	<i>Obliquaria verrucosa</i>	<i>Tritogonia verrucosa</i> (Raf., 1820)
13 - 14	<i>Obliquaria flava</i>	<i>Fusconaia flava</i> (Raf., 1820)
15 - 16	<i>Obliquaria metanevra</i>	<i>Theloderma metanevra</i> (Raf., 1820)
17 - 18	<i>Obliquaria nodulata</i>	<i>Theloderma nodulata</i> (Raf., 1820)
19 - 20	<i>Obliquaria retusa</i>	<i>Cyclonaias pustulosa</i> (Lea, 1831)
21 - 23	<i>Obliquaria subrotunda</i>	<i>Obovaria subrotunda</i> (Raf., 1820)
24 - 25	<i>Obliquaria scalenia</i>	<i>Pleurobema clava</i> (Lam., 1819)

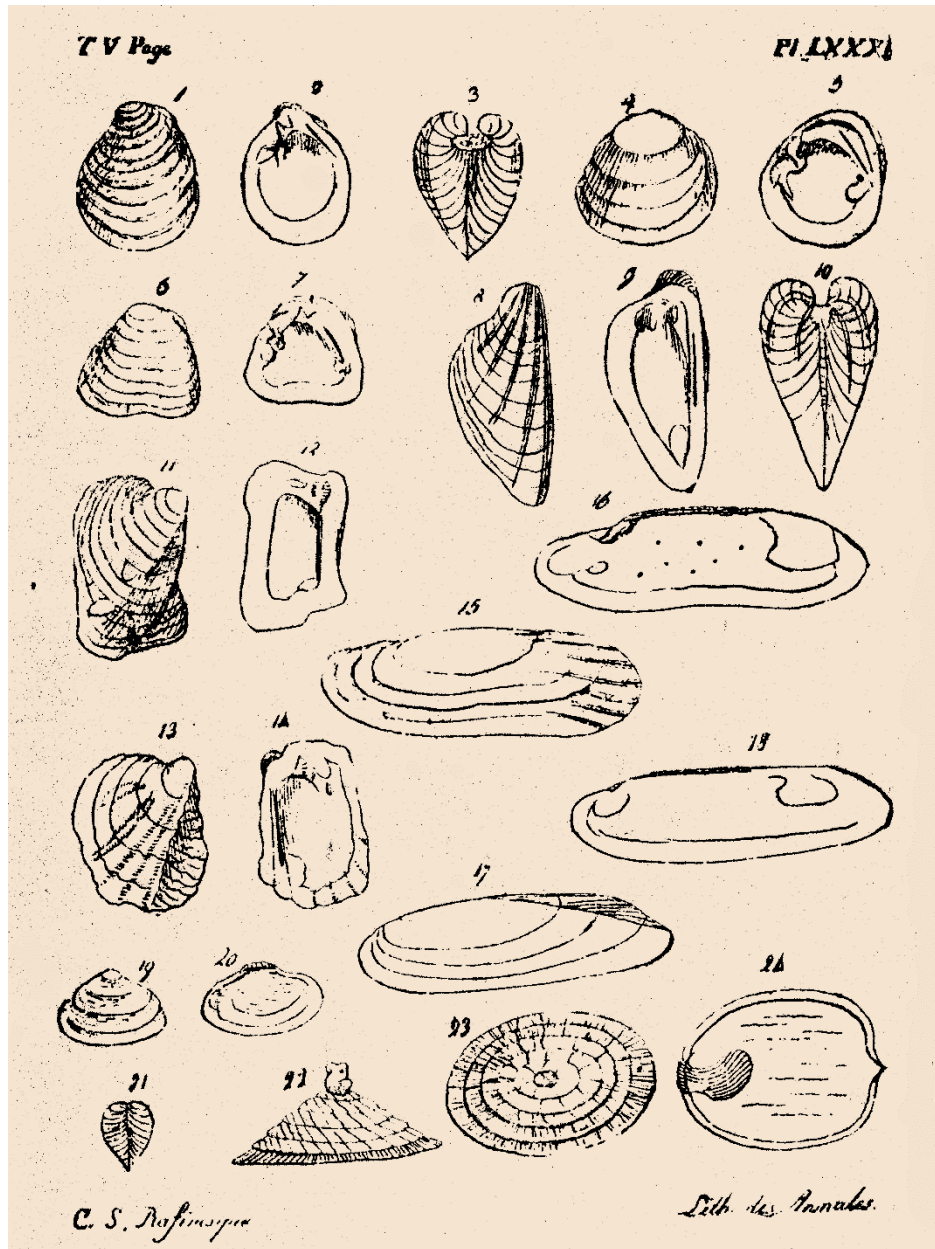


Plate LXXXII

Rafinesque 1820 Name

Present Name

Figures 1 - 3	<i>Obovaria torsa</i>	<i>Obovaria retusa</i> (Lam., 1819)
4 - 5	<i>Obovaria stegaria</i>	<i>Cyprogenia stegaria</i> (Raf., 1820)
6 - 7	<i>Obovaria cordata</i>	<i>Pleurobema cordatum</i> (Raf., 1820)
8 - 10	<i>Pleurobema mytiloides</i>	<i>Pleurobema clava</i> (Lam., 1819)
11 - 12	<i>Amblema torulosa</i>	<i>Epioblasma torulosa</i> (Raf., 1820)
13 - 14	<i>Amblema costata</i>	<i>Amblema plicata</i> (Say, 1817)
15 - 16	<i>Alasmidonta costata</i>	<i>Lasmigona costata</i> (Raf., 1820)
17 - 18	<i>Anodonta lata</i>	<i>Hemistena lata</i> (Raf., 1820)
19 - 21	<i>Cyclas lasmampsis</i>	<i>Sphaerium simile</i> (Raf., 1820)
22 - 24	<i>Tremesia patelloides</i>	imaginary

Fine Scale Genetic Variation in a Population of Freshwater Snails

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Studies of fine-scale allelic frequency variance in populations of land snails were influential in the development of the “Ecological Genetics” movement of the 1950s and 1960s (Cain & Curry 1963) and in some of the more important population genetic studies of the 1970s (e.g. Selander & Kauffman 1975). The phenomenon is surprisingly understudied in freshwater gastropod populations, however. Dillon (1988a) documented significant allele frequency discontinuity in a population of *Pleurocera proxima* inhabiting a 1,500 m section of Naked Creek, a tributary of the Yadkin River in Wilkes County, in northwestern North Carolina. This discordance was traceable to the waterfall undercutting a metal culvert, apparently constituting a significant barrier to dispersal.

The Naked Creek data set published by Dillon in 1988 was collected at a single allozyme-encoding locus (octopine dehydrogenase, *Odh*) from a series of four sample sites over a six-year period (1979 – 1985). The complete 1979 survey, however, included 16 loci, sampled from two additional sites extending another 2 km downstream in Naked Creek, corresponding to no obvious barriers, plus samples from sites in three small nearby tributaries. Although published in the Ph.D. dissertation of Dillon (1982), these data have not been widely available.

A complete map of the 1979 sample sites (including Sites 1 – 4 reported previously) is shown in Figure 1 with lat/long coordinates. Thirty snails from each of these nine sites were assayed for variance at the following allozyme-encoding loci: Aspartate aminotransferase, Acid phosphatase, Fumarase, Glucose-6-phosphate dehydrogenase, Glucose phosphate isomerase, Hexanol dehydrogenase, Isocitrate dehydrogenase, Leucine aminopeptidase, Malic Enzyme, Mannose phosphate isomerase, Octopine dehydrogenase, 6-phosphogluconate dehydrogenase, Phosphoglucomutase, Sorbitol dehydrogenase, Superoxide dismutase, and Xanthine dehydrogenase. All methods employed, together with recipes for all buffers and enzyme stains, are detailed in Dillon (1982).

In addition to the *Odh* locus, polymorphism was discovered at a second locus, Mannose-phosphate isomerase (*Mpi*). Results for (previously-reported) Site 4, plus unreported Sites 5 – 9, are shown in Table 1.

Within Naked Creek, *Odh* allele frequencies at downstream Site 7 were significantly different from all other sites, with chi-squares between Sites 4 and 7 = 18.72, between Sites 5 and 7 = 27.19, and between Sites 6 and 7 = 6.00, all with two degrees of freedom. The difference between Sites 5 and 6 was also significant, chi square = 9.07. All these differences are attributable to isolation by distance (Wright 1943).

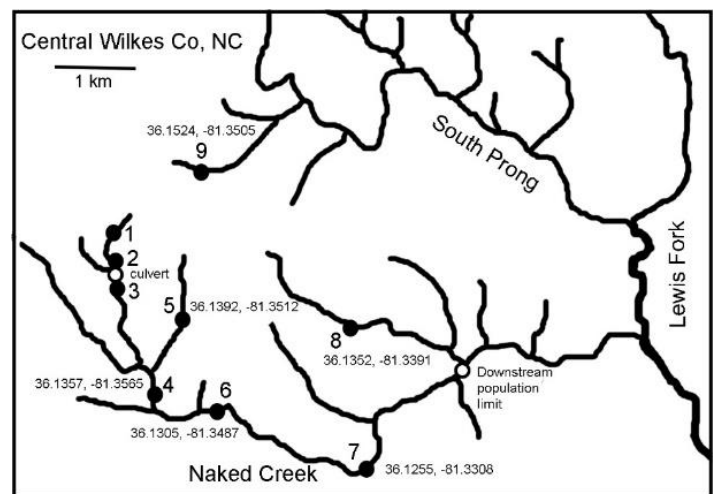


Figure 1. Sample sites for the 1979 population genetic study of *Pleurocera proxima* published by Dillon (1982).

Table 1. Gene frequencies at two allozyme-encoding loci (Odh & Mpi) in six 1979 samples of *Pleurocera proxima* collected from Naked Creek and environs by Dillon (1982).

Site	4	5	6	7	8	9
Odh 106	0.592	0.557	0.565	0.512	0.741	0.573
109F	0.099	0.094	0.178	0.270	0.259	0.427
111	0.020	0.047	0.023	0.028	0.0	0.0
113F	0.289	0.302	0.234	0.189	0.0	0.0
Mpi 95	0.831	0.827	0.818	0.825	0.883	1.00
100	0.169	0.173	0.182	0.175	0.117	0.0
No.	76	96	107	124	29	109

The inverse relationship between *P. proxima* population density and stream size has been well documented (Foin & Stiven 1970). In Naked Creek, mean population densities reached over 500/m² at the three uppermost sites, decreasing exponentially from 293/m² at Site 4 to 1.8/m² at Site 7, disappearing entirely thereafter.

At Site 8, back up a side branch, allele frequencies at the Odh locus were strikingly different, apparently missing alleles 111 and 113F entirely. Assuming the mean frequency of 24% demonstrated by allele 113F in Naked Creek, the binomial probability of drawing no individuals bearing Odh 113F in 29 attempts, as in Site 8, is 5×10^{-6} . This difference is not attributable to any obvious dispersal barrier such as the culvert between Sites 2 and 3 previously documented. Rather, we suggest that the striking allele frequency discordance between Site 8 and Sites 4 – 7 is a consequence of net population dispersal in an upstream direction.

No significant allele frequency differences were discovered at the Mpi locus at Sites 4 – 8. But at Site 9, approximately 1.5 km further downstream and another 6 km back up the South Prong of Lewis Fork, the minority allele Mpi 100 was missing entirely. Odh alleles 111 and 113f were also entirely missing at Site 9, making the Lewis Prong site both the most geographically distant and the most genetically divergent of the sample sites. The general correlation between distance and divergence in *P. proxima* was documented at a much larger scale by Dillon (1984).

Significant heterozygote deficiencies were common, even within sites. This phenomenon may result from migration rates that are not insignificant, but insufficient to maintain panmixia. Generally, the sexually mature snails, aged two years and over, were sampled for allozyme analysis. Perhaps the admixture that occurs in the *P. proxima* population over the two years between conception and insemination (Dillon 1988b) yields a Wahlund Effect in time, rather than in space.

References:

- Cain, A.J. & J.D. Currey. 1963. The causes of area effects. *Heredity* 18:467-471.
- Dillon, R. T., Jr. 1982. *The correlates of divergence in isolated populations of the freshwater snail, Goniobasis proxima* (Say). Ph.D. Dissertation, The University of Pennsylvania.
- Dillon, R.T., Jr. 1984. Geographic distance, environmental difference, and divergence between isolated populations. *Systematic Zoology* 33:69-82.
- Dillon, R.T., Jr. 1988a. The influence of minor human disturbance on biochemical variation in a population of freshwater snails. *Biological Conservation* 43:137-144.
- Dillon, R.T., Jr. 1988b. Evolution from transplants between genetically distinct populations of freshwater snails. *Genetica* 76:111-119.
- Foin, T.C. & A.E. Stiven. 1970. The relationship of environment size and population parameters in *Oxytrema proxima* (Say) (Gastropoda: Pleuroceridae). *Oecologia* (Berl.) 5:74-84.
- Selander, R.K. & D.W. Kauffman. 1975. Genetic structure of populations of the brown snail (*Helix aspersa*). I. Microgeographic variation. *Evolution* 29:385 – 401.
- Wright, S. 1943. Isolation by distance. *Genetics* 28:114-138.

Suitable Host Fishes for the Canary Kingshell, *Lampsilis sietmani* Keogh and Simons 2019

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A phenotypic variant of *Lampsilis teres* was recently recognized as a distinct species (*Lampsilis sietmani* based on morphometric and phylogenetic evidence (Keogh and Simons 2019). Given that the morphological characters of these species can overlap, they have previously been lumped within *L. teres* or treated as separate species or subspecies under several names with varying morphological descriptions (Roe 2010; Keogh and Simons 2019). Recent phylogenetic analyses, however, have shown the two species are not each other's closest living relative, and *L. teres* is more closely related to *L. floridensis*. *L. sietmani* shares a sister relationship to members of the *L. siliquoidea* species complex or a clade containing the *L. siliquoidea* group, *L. floridensis*, and *L. teres* depending on the analysis ((Keogh and Simons 2019). In the past, host fishes have been identified for *L. teres*, but the lack of morphological descriptions of the female mussels used and the overlapping ranges of *L. teres* and *L. sietmani* make it

difficult to determine which species was being studied. We presumed studies that examined host relationships of both *L. fallaciosa* and *L. anodontoides* were accurately identifying *L. teres* and *L. sietmani*, respectively, based on the taxonomic history of *L. teres* (Keogh and Simons 2019). There is broad agreement that gars are hosts for *L. teres* and presumptive *L. sietmani* (Coker et al. 1921, Howard and Anson 1922, Jones 1950), but other fishes have been identified as possible hosts for *L. teres* as well (Surber 1913, Daniel and Brown 2012). In this study, we used the recent identification clarification to help determine suitable glochidial hosts specifically for *L. sietmani*.

We used established methods to examine host suitability for *L. sietmani* (Hove et al. 2016). A gravid female was collected from the Mississippi River just north of Guttenberg, Iowa, on September 11, 2019. The identification of that individual was based on morphological characteristics (Figure 1) and was confirmed by phylogenetic analysis of two mitochondrial DNA loci using a maximum likelihood approach (Figure 2). Fully mature glochidia were obtained from this animal (Figure 3), and 18 fish species were



Figure 1: (A) the female specimen of *L. sietmani* from which glochidia were extracted. Bell Museum, #23079, collected from the Mississippi River at Guttenberg, Iowa (42.829005, -91.099582).

(B) a typical female specimen of *L. teres* for comparison, Bell Museum, #22435, collected from the Mississippi River at Harper's Slough, Iowa (43.185115, -91.1445571).



Figure 3: A micrograph of a *L. sietmani* glochidium taken using a Keyence BZX800 Life Science Microscope.

inoculated using a shallow water bath, the infected fish were held at temperatures between 20°C and 21.5°C, and monitored for 48 days. Metamorphosis success was calculated by dividing the number juveniles by the sum of glochidia and juveniles recovered from a fish species.

We recovered live juvenile *L. sietmani* from Lepisosteidae species only (Table 1). Metamorphosis success was 94.7% on Longnose Gar (*Lepisosteus osseus*) and 82.5% on Shortnose Gar (*Lepisosteus platostomus*). This, combined with previous evidence of glochidia metamorphosis on Shortnose Gar, Longnose Gar, and Alligator Gar (*Atractosteus spatula*) for presumptive *L. sietmani*, supports the hypothesis that it is a host specialist on gars (Coker et al. 1921, Howard and Anson 1922, Jones 1950). We could not confirm the mussel species used or identified in other studies that observed glochidia metamorphosis or natural infections on gar (Reuling 1919, Arey 1932, Kennedy 2009).

Fishes other than gar have been reported as suitable hosts for *L. teres* or *L. sietmani*. Green Sunfish (*Lepomis cyanellus*) produced a few juvenile *L. sietmani* (Surber 1913), however, it was an unsuitable host in other studies of *L. sietmani* or *L. teres* (Coker et al. 1921, Jones 1950, Daniel and Brown 2012). Another study found Largemouth Bass (*Micropterus salmoides*), White Crappie (*Pomoxis annularis*), Orangespotted Sunfish (*Lepomis humilis*), Redear Sunfish (*Lepomis microlophus*), and Blacktail Shiner (*Cyprinella venustus*) to be suitable hosts for *L. teres* through glochidia metamorphosis (Daniel and Brown 2012). Largemouth Bass was also reported as a host for presumptive *L. floridensis*, sister species to *L. teres* (Keller and Ruessler 2016); however, Largemouth Bass, Green Sunfish, and Orangespotted Sunfish were unsuitable hosts for *L. sietmani* in our experiment. This may indicate that these species are marginal hosts for *L. sietmani* or that *L. teres* can use a wider variety of hosts than *L. sietmani*. A direct comparison of metamorphosis success on known and presumptive host fishes for *L. sietmani* and *L. teres* is needed to clarify their host associations.

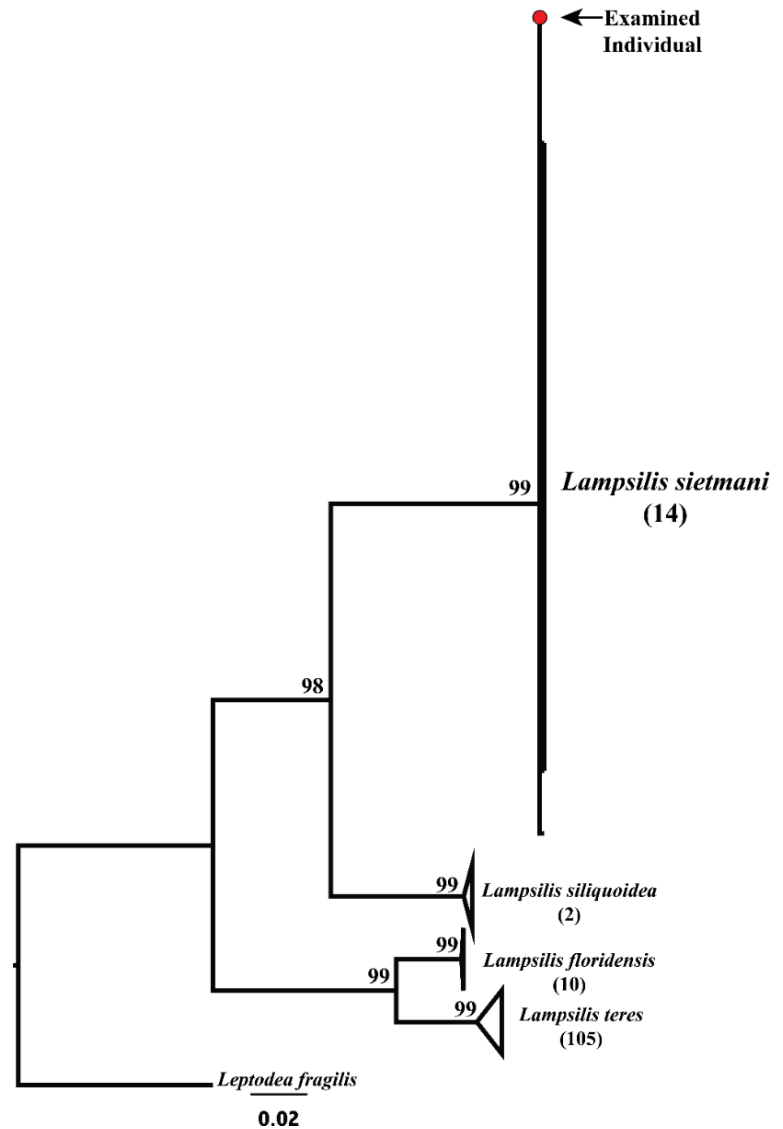


Figure 2: Concatenated phylogeny produced using two mitochondrial DNA loci, COI and NDI, using a maximum likelihood approach. Numbers above nodes indicate posterior probability. Numbers in parentheses indicate the sample size for each species. ‘Examined individual’ indicates the phylogenetic position of the specimen used in this study.

Table 1: *Lampsilis sietmani* host suitability trial results. Glochidia attachment period is the number of days glochidia were attached to non-hosts. Juvenile recovery period is the number of days post-infection that juvenile mussels were recovered. Day one is the day following inoculation.

Common Name (Scientific Name)	No. Fish Inoculated	No. Fish Survived	Glochidia Attachment Period (d)	Juvenile Recovery Period (d)	Juveniles Recovered Per Fish
Lepisosteidae					
Longnose Gar (<i>Lepisosteus osseus</i>)	3	3		27-43	83
Shortnose Gar (<i>Lepisosteus platostomus</i>)	1	1		23-32	160
Centrarchidae					
Rock Bass (<i>Ambloplites rupestris</i>)	1	1	13		0
Green Sunfish (<i>Lepomis cyanellus</i>)	3	3	6-9		0
Orangespotted Sunfish (<i>Lepomis humilis</i>)	5	5	6-13		0
Bluegill (<i>Lepomis macrochirus</i>)	5	5	3-20		0
Smallmouth Bass (<i>Micropterus dolomieu</i>)	4	4	6-20		0
Largemouth Bass (<i>Micropterus salmoides</i>)	5	5	6-13		0
Cyprinidae					
Spottail Shiner (<i>Notropis hudsonius</i>)	19	19	3		0
Fundulidae					
Banded Killifish (<i>Fundulus diaphanus</i>)	14	14	7		0
Ictaluridae					
Yellow Bullhead (<i>Ameiurus natalis</i>)	6	6	3		0
Moronidae					
White Bass (<i>Morone chrysops</i>)	6	4	6-20		0
Percidae					
Yellow Perch (<i>Perca flavescens</i>)	3	3	13		0
Logperch (<i>Percina caprodes</i>)	16	16	3		0
Sauger (<i>Sander canadense</i>)	3	3	6-23		0
Walleye (<i>Sander vitreus</i>)	4	4	6-9		0
Umbridae					
Central Mudminnow (<i>Umbra limi</i>)	6	6	11		0

Note: One Gizzard Shad (*Dorosoma cepedianum*) was inoculated but died before results could be determined.

Literature Cited:

- Arey, L.B. 1932. Microscopical study of glochidial immunity. *Journal of Morphology* 53:367-379.
- Baker, F. C. 1928. *The Fresh Water Mollusca of Wisconsin*. University of Wisconsin Madison, Madison, Wisconsin.
- Coker, R. E., A. F. Shira, H. W. Clark, and A. D. Howard. 1921. Natural history and propagation of fresh-water mussels. *Bulletin of the Bureau of Fisheries* 37:151-155.
- Daniel, W. M., and K. M. Brown. 2012. Reproductive biology and host fishes of four unionids from the Lake Pontchartrain Basin, Louisiana, U.S.A. *Freshwater Mollusk Biology and Conservation* 15:11-16.
- Hove, M. C., B. E. Sietman, M. S. Berg, E. C. Frost, K. Wolf, T. R. Brady, S. L. Boyer, and D. J. Hornbach. 2016. Early life history of the sheepnose (*Plethobasus cyphus*) (Mollusca: Bivalvia: Unionoida). *Journal of Natural History* 50:523-542.
- Howard, A. D., and B. J. Anson. 1922. Phases in the parasitism of the Unionidae. *The Journal of Parasitology* 9:68-82.
- Jones, R. O. 1950. Propagation of fresh-water mussels. *Progressive Fish-Culturist* 12:13-25.

- Keller, A. E., and D. S. Ruessler. 2016. Determination or verification of host fish for nine species of unionid mussels. *American Midland Naturalist* 138:402–407.
- Kennedy, T. B. 2009. *Aquatic community organization in a diverse floodplain river fish fauna of the Southeastern United States*. Doctoral Dissertation. Graduate School of The University of Alabama.
- Keogh, S. M., and A. M. Simons. 2019. Molecules and morphology reveal ‘new’ widespread North American freshwater mussel species (Bivalvia: Unionidae). *Molecular Phylogenetics and Evolution* 138:182–192.
- Reuling, F. H. 1919. Acquired immunity to an animal parasite. *Journal of Infectious Diseases* 24:337–346.
- Roe, K. J. 2010. Conservation assessment the yellow sandshell, *Lampsilis teres* (Rafinesque, 1820). Department of Biological Sciences. St. Louis, Missouri.
- Surber, T. 1913. Notes on the natural hosts of fresh-water mussels. *Bulletin of the Bureau of Fisheries* 32:101–116.

Citizen Scientists and Researchers Identify Suitable Glochidial Hosts for *Fusconaia flava*

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Citizen scientists contribute valuable data and services for scientific projects throughout the United States. For example, there are over 1000 active citizen science projects described on the SciStarter website (SciStarter.org). The conservation needs of North American freshwater mollusks are diverse and extensive (Freshwater Mollusk Conservation Society 2016). Citizens regularly work on native mollusk projects such as volunteers assisting with mussel culture at Genoa National Fish Hatchery (Eckert 2014) and participating in mussel surveys through the Iowa DNR (Iowa DNR 2015, Iowa Outdoors 2015) and the Wisconsin Mussel Monitoring Program (<https://www.inaturalist.org/projects/wisconsin-mussel-monitoring-program>). Citizen scientists comprise a valuable talent pool available to assist with management or research efforts.

Fusconaia flava occurs throughout the Ohio and Mississippi River basins in the United States and well into Canada, but its abundance has declined in some areas. Natural resource managers are considering propagating this mussel to restore reduced or extirpated populations, which requires knowledge of suitable hosts to produce juveniles. Previous studies have shown that Common Shiner, Fathead Minnow, Mimic Shiner, and Spotfin Shiner are natural hosts (Boyer *et al.* 2011, Hove *et al.* 2016, Benedict *et al.* 2019) and that Silver Shiner and Creek Chub are suitable hosts in the laboratory (O’Dee and Watters 2000). In addition, Bluntnose Minnow, Black Bullhead, Black Crappie, and White Crappie have been observed naturally infested with *F. flava* glochidia (Surber 1913, Wilson 1916, Coker *et al.* 1921, Boyer *et al.* 2011, Benedict *et al.* 2019).

The primary purpose of this study was to combine the resources of citizen scientists with university and DNR researchers to improve our understanding of suitable hosts for *F. flava*. Secondly, this study also explored the impacts of participation on the citizen scientists who were involved in this research and on the professional scientists who worked with them. Some of these citizen scientists were members of the UMN Master Naturalists Program. In that program, volunteers take a course, agree to log 40 hours of volunteer service, and participate in 8 hours of advanced training annually, in this case specific training concerning mussel fish host research.

Standard laboratory inoculation and monitoring methods were used to identify suitable *F. flava* host fishes (Hove *et al.* 2016). Glochidia were obtained from gravid *F. flava* collected from the St. Croix River and Upper Cedar River in Minnesota, and from the Mississippi River at Prairie Du Chien, Wisconsin. Host suitability trials were conducted between 2014-19 using fishes from various Minnesota streams and rivers, except for *Cyprinella galactura*, which was collected in southeast Missouri. Master Naturalists helped with the most extensive trials, which occurred in 2019. A total of 51 fish species from nine families were inoculated during this study. Glochidia and juvenile mussels collected from fish species-specific aquaria were counted and tabulated (Table 1).

Table 1. Positive results from *Fusconaia flava* host suitability trials.

Fish species	Trial	No. of initial/ surviving fish	Juvenile release or glochidia attachment period (days)	No. of juvenile mussels recovered
<i>Campostoma anomalum</i>	1	13/13	13-20	865
<i>C. anomalum</i>	2	3/2	14-18	436
<i>Chrosomus erythrogaster</i>	1	10/10	13-27	635
<i>C. erythrogaster</i>	2	7/7	14-21	313
<i>Clinostomus elongates</i>	1	3/3	13-27	166
<i>C. elongates</i>	2	3/3	14-24	614
<i>C. elongates</i>	3	6/4	14-21	685
<i>Cyprinella galactura</i>		1/1	14-18	273
<i>Cyprinella lutrensis</i>	1	3/3	13-20	108
<i>C. lutrensis</i>	2	4/4	14-27	580
<i>C. lutrensis</i>	3	3/3	14-18	250
<i>Cyprinella spiloptera</i>	1	25/25	13-25	464
<i>C. spiloptera</i>	2	6/6	13-29	2051
<i>Hybognathus hankinsoni</i>		1/1	18-22	95
<i>Luxilus cornutus</i>	1	2/1	17-25	69
<i>L. cornutus</i>	2	1/1	18-22	234
<i>L. cornutus</i>	3	5/5	14-21	1472
<i>L. cornutus</i>	4	3/2	14-21	509
<i>Macrhybopsis storeriana</i>	1	1/1	14-26	350
<i>M. storeriana</i>	2	3/3	14-18	231
<i>Nocomis biguttatus</i>	1	4/4	13-20	51
<i>N. biguttatus</i>	2	2/2	14-18	89
<i>Notemigonus crysoleucus</i>	1	2/1	16-23	89
<i>N. crysoleucus</i>	2	1/1	14-18	146
<i>Notropis atherinoides</i>		5/5	13-22	204
<i>Notropis dorsalis</i>	1	16/12	13-25	163
<i>N. dorsalis</i>	2	2/2	13-22	345
<i>N. dorsalis</i>	3	3/3	14	0
<i>Notropis heterolepis</i>		17/12	16-23	698
<i>Notropis hudsonius</i>	1	1/1	13-23	25
<i>N. hudsonius</i>	2	3/3	13-20	873

Table 1. (Continued)

Fish species	Trial	No. of initial/ surviving fish	Juvenile release or glochidia attachment period (days)	No. of juvenile mussels recovered
<i>Notropis stramineus</i>		4/4	11-18	324
<i>Notropis volucellus</i>	1	6/5	13-20	35
<i>N. volucellus</i>	2	4/4	14-26	38
<i>Pimephales notatus</i>	1	10/10	13-24	1439
<i>P. notatus</i>	2	5/5	13-20	39
<i>P. notatus</i>	3	5/4	11-18	274
<i>Pimephales promelas</i>	1	3/3	13-23	24
<i>P. promelas</i>	2	3/3	14-22	256
<i>P. promelas</i>	3	1/1	14-18	165
<i>Pimephales vigilax</i>	1	5/5	18-22	4
<i>P. vigilax</i>	2	1/1	6	0
<i>Rhinichthys atratulus</i>		3/3	14-18	273
<i>Rhinichthys cataractae</i>	1	10/9	13-30	476
<i>R. cataractae</i>	2	6/6	18-29	1990
<i>Semotilus atromaculatus</i>	1	2/1	13	6
<i>S. atromaculatus</i>	2	1/1	11-18	606
<i>Fundulus diaphanous</i>	1	7/7	13-23	291
<i>F. diaphanous</i>	2	4/4	13-26	205
<i>Fundulus sciadicus</i>		1/1	16-20	28
<i>Culaea inconstans</i>		3/2	18-29	132

As indicated in Table 1, twenty-three minnow, two killifish, and one stickleback species were identified as suitable hosts. We did not observe glochidia metamorphosis for any of the following fishes (number of trials, number of survivors, glochidia attachment period (days)): *Acipenser fulvescens* (1, 6, 2), *Cyprinus carpio* (1, 6, 2), *Moxostoma macrolepidotum* (1, 1, 5), *Ameiurus melas* (1, 5, 4), *Ictalurus punctatus* (2, 7, 4), *Noturus gyrinus* (1, 1, 4), *N. flavus* (1, 6, 4), *Pylodictus olivaris* (1, 1, 4), *Lepomis gulosus* (1, 2, 4), *L. humilus* (1, 6, 4), *L. macrochirus* (1, 5, 7), *Micropterus salmoides* (1, 2, 6), *Pomoxis nigromaculatus* (1, 3, 21), *Etheostoma caeruleum* (1, 7, 4), *E. exile* (1, 6, 4), *E. flabellare* (1, 17, 4), *E. nigrum* (1, 8, 13), *E. zonale* (1, 10, 4), *Perca flavescens* (1, 2, 6), *Percina caprodes* (3, 14, 4-6), *P. evides* (1, 5, 4), *P. maculata* (2, 10, 4), *P. phoxocephala* (2, 2, 3-4), *P. shumardi* (2, 15, 3-4), and *Aplodinotus grunniens* (1, 1, 4).

The results of this study are consistent with previous observations indicating that Cyprinidae is the primary host group for *Fusconaia flava* (O’Dee and Watters 2000, Boyer *et al.* 2011, Hove *et al.* 2016, Benedict *et al.* 2019). The results also corroborate previous findings on host relationships for this mussel genus (Bruenderman and Neves 1993, Haag and Warren 2003, White *et al.* 2008, Dudding *et al.* 2019). This study adds cyprinids, two fundulids, and Brook Stickleback to the list of potential *F. flava* hosts, which should improve propagation planning efforts.

Qualitative social science methods (Merriam 2002) were used to analyze informal interviews and written reflections of the researchers to document the impacts of Master Naturalist participation on the researchers. The university researchers found that investing time to train and work with Master Naturalists was worthwhile in that the Master Naturalists helped to collect high-quality data. Researchers found the enthusiasm of the Master Naturalists contagious and valued the new perspectives and ideas learned through interactions with Master Naturalists. The Master Naturalists valued the opportunities to meaningfully contribute in the development of new scientific knowledge in all stages of this study.

Additionally, they reported gaining confidence in understanding and communicating about native mussels and the processes of science. Both researchers and Master Naturalists valued the passion the others had for the natural world.

This project was made possible with numerous contributions from citizen scientists (Master Naturalists and volunteers). Master Naturalists included: Bill Clausen, Nancy Corcoran, John Curry, Arthur Decker, Melia Derrick, John Fitch, Mary Gaasch, Mark Gleisner, Tom Haberman, Kevin Harter, Hannah Keller, Mark Miller, Pat Owen, Melanie Ruda, Laura Saher, Lorrie Tucker, Ise Varghese Mac, and Cynthia Vehe. Volunteers included: Tim Dirr, Colin Gardner-Springer, Emily Gardner-Springer, Zoe Gibson, Allie Holdhusen, Juan Saez Moron, Greg Seitz, Dan Westphal, Michelle Weisgerber, and Danny Westphal.

References:

- Benedict, A., M. Hove, B. Sietman, A. Franzen, L. Neu, C. Rounds, E. Slaikeu, I. Tolo, M. Pletta, and D. Hornbach. 2019. Natural hosts of some common Mississippi River mussel species. *Ellipsaria* 21(2):33-35.
- Boyer, S. L., A. A. Howe, N. W. Juergens, and M. C. Hove. 2011. A DNA-barcoding approach to identifying juvenile freshwater mussels (Bivalvia: Unionidae) recovered from naturally infested fishes. *Journal of the North American Benthological Society* 30(1):182-194.
- Bruenderman, S. A. and R. J. Neves. 1993. Life history of the endangered fine-rayed pigtoe *Fusconaia cuneolus* (Bivalvia: Unionidae) in the Clinch River, Virginia. *American Malacological Bulletin* 10(1):83-91.
- Coker, R. E., A. F. Shira, H. W. Clark, and A. D. Howard. 1921. Natural history and propagation of fresh-water mussels. *Bulletin of the Bureau of Fisheries* 37:75-181.
- Dudding, J., M. Hart, J. Khan, C. R. Robertson, R. Lopez, and C. R. Randklev. 2019. Host fish associations for two highly imperiled mussel species from the Southwestern United States: *Cyclonaias necki* (Guadalupe Orb) and *Fusconaia mitchelli* (False Spike). *Freshwater Mollusk Biology and Conservation* 22:12-19.
- Eckert, N. 2014. Mussel cage harvest yields bumper crop at Genoa NFH. *Genoa News and Notes*, p. 4.
- Freshwater Mollusk Conservation Society. 2016. A national strategy for the conservation of native freshwater mollusks. *Freshwater Mollusk Biology and Conservation* 19:1-21.
- Haag, W. R. and M. L. Warren. 2003. Host fishes and infection strategies of freshwater mussels in large Mobile Basin streams, USA. *Journal of the North American Benthological Society* 22(1):78-91.
- Hove, M. C., B. E. Sietman, M. S. Berg, E. C. Frost, K. Wolf, T. R. Brady, S. L. Boyer, and D. J. Hornbach. 2016. Early life history of the sheepsnose (*Plethobasus cyphus*) (Mollusca: Bivalvia: Unionoida). *Journal of Natural History* 50(9-10):523-542.
- Iowa DNR. 2015. Biologists track Iowa's mussels. 27 Aug. 2015. *Globe Gazette*, Mason City, Iowa.
- Iowa Outdoors. 2015. Searching Iowa waterways for native mussels. Episode 504, broadcast on 6 Aug 2015. Iowa Public Broadcasting Service, Johnston, Iowa.
(<http://www.iowapbs.org/iowalandandsky/story/31224/searching-iowa-waterways-native-mussels>)
- Merriam, S. B. 2002. *Qualitative research in practice: Examples for discussion and analysis*. San Francisco, California: Jossey-Bass.
- O'Dee, S. H. and G. T. Watters. 2000. New or confirmed host identifications for ten freshwater mussels. Proceedings of the Conservation, Captive Care, and Propagation of Freshwater Mussels Symposium. Pp. 77-82. [in:] Tankersley, R.A., D. I. Warmoltz, G. T. Watters, B. J. Armitage, P. D. Johnson, and R. S. Butler. *Freshwater Mollusk Symposium Proceedings*, Ohio Biological Survey, Columbus, Ohio.
- SciStarter: science we can do together. 2020. <https://scistarter.org>. [date accessed January 31, 2020]
- Surber, T. 1913. Notes on the natural hosts of fresh-water mussels. *Bulletin of the Bureau of Fisheries* 32:101-116.
- White, M. P., Blalock-Herod, H. N., and Stewart, P. M. 2008. Life history and host fish identification for *Fusconaia burkei* and *Pleurobema strodeanum* (Bivalvia: Unionidae). *American Malacological Bulletin* 24:121-125.

Wilson, C. B. 1916. Copepod parasites of fresh-water fishes and their economic relations to mussel glochidia. *Bulletin of the Bureau of Fisheries* 34:333-374.

Assessing the Feasibility of a Mussel Reintroduction into a Recently Restored Portion of the Urban San Antonio River, San Antonio, Texas

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San Antonio, Texas, is a heavily urbanized city in south-central Texas that has a long history of human habitation; a history in which the people have relied heavily on the resources of the San Antonio River. Today, the river runs directly through the heart of downtown creating a unique experience for tourists and, conversely, a unique challenge for the biota that call it home. These urban reaches of the river have experienced multiple shifts away from ecological functionality through the years to make way for the needs of infrastructure and human demand. This reach was once home to a diverse freshwater mussel community before urbanization caused a drastic degradation of the ecosystem and an almost complete extirpation. Small, relict populations of native mussels can be found in remnant channels near downtown which were left connected and spared of construction activity during flood conveyance projects.

The San Antonio River Improvements Project, completed in 2013 by the San Antonio River Authority, has rehabilitated a previously channelized eight-mile portion of the San Antonio River downstream from downtown by providing better quality instream cover, increased sinuosity, and improved resiliency. Some post-restoration studies have taken place to showcase this ecological lift; namely the Mission Reach Avian Study and the successful introduction of Guadalupe bass, *Micropterus treculii*, the state fish of Texas.

Another post-restoration validation study, the Mission Reach Mussel Survivability Study, is now being conducted by the River Authority to determine if the ecological lift has made this stretch more accommodating to native freshwater mussel species that are found in the Lower San Antonio River. The primary goal of this study is to determine the feasibility of a future reintroduction effort in this improved reach. The four species being used in this study (*Cyclonaias pustulosa*, *Amblema plicata*, *Tritogonia verrucosa*, and *Lampsilis teres*) were chosen because of their abundance in the downstream portions of the river, evidence of their past occurrence in the upper reaches in the case of *C. pustulosa*, *A. plicata*, and *T. verrucosa*, the extended upstream range of *L. teres*, as well as their diversity in shell shape and weight. These species will not necessarily be chosen for the reintroduction class, if there is one. Likewise, species outside of this study group will not necessarily be excluded from consideration. Members of these species are being held at two sites in the Mission Reach and at a Control Site in the Lower San Antonio River (where they are known to thrive) to compare survival and growth. If the Mission Reach mussels grow at a similar rate as the control mussels, then a mussel reintroduction could be possible in the future.



Figure 1. Map showing the locations of the two Mission Reach Study Sites and their proximity to downtown San Antonio, along with a view of one of the Study Reach sites.

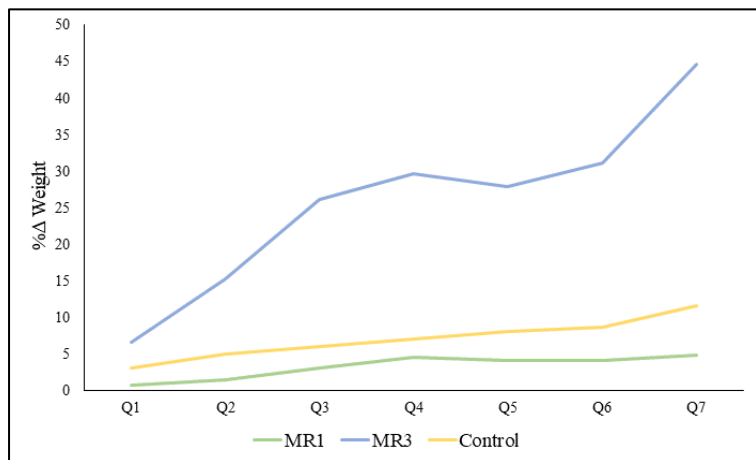


Figure 2. Custom bunker used in the study. Bunkers use the same principles as silos but are made to house larger adult mussels.



Figure 3. Mussels housed in a "bowl". The bowls slide into the bunkers and allow water to flow through them from the bottom.

Figure 4. Average percent change in mussel weight over seven quarterly growth inspections.



The Mussel Survivability Study began in November 2017 and preliminary results are promising. After two years, average percent increase in total length is 0.15% at Mission Reach Site 1 (MR1) and 7.90% at Mission Reach Site 3 (MR3), compared to 1.68% at the Control Site. Average percent increase in weight is 4.85% at MR1, 44.58% at MR3, and 11.58% at the Control Site (Figure 4). While these differences in growth could be a function of stream conditions at the specific sites, the results are promising because they show the potential the Mission Reach has for mussel growth.

River Authority staff are currently working with the United States Fish and Wildlife Service (FWS) to produce juvenile mussels for the Study as they would be a stronger indicator of survival and give higher resolution of growth discrepancies. As a part of the contract with FWS, work also is being done to determine best practices for large scale production of these species if reintroduction is deemed appropriate. The River Authority also plans to perform toxicology work among all life stages using different concentrations of storm water runoff, to determine genetic diversity of the current stock of mussels within the basin, and to develop appropriate size-at-stocking guidelines. A stocking recommendation will be made by Winter 2020. If the evidence deems it appropriate, a reintroduction could likely begin around Fall 2021.

The Limnic/Freshwater Mollusks of Hispaniola Island, Greater Antilles, Caribbean

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For the last five years (since September 2014), and with invaluable participation, assistance, and support from local researchers, naturalists, environmental photographers, and informal field collaborators, Project AM has been developing taxonomic, bioecological, and conservation research about the non-marine mollusks present in Central American countries (Agudo-Padrón 2019a), the Venezuelan mainland (in progress) and, mainly, the Caribbean island of Hispaniola (Agudo-Padrón 2019 b, c), including its limnic/ freshwater forms (Agudo-Padrón 2019 b: 20).

Second in physical size after Cuba, Hispaniola is part of the great archipelago, known as the Greater Antilles, located in the North Caribbean marine basin. Geo-politically, Hispaniola is divided in two independent nations: Haiti and the Dominican Republic (Figure 1). The main geographical aspects of this island are conveniently described in the emerging regional literature (Agudo-Padrón 2019b: 19).

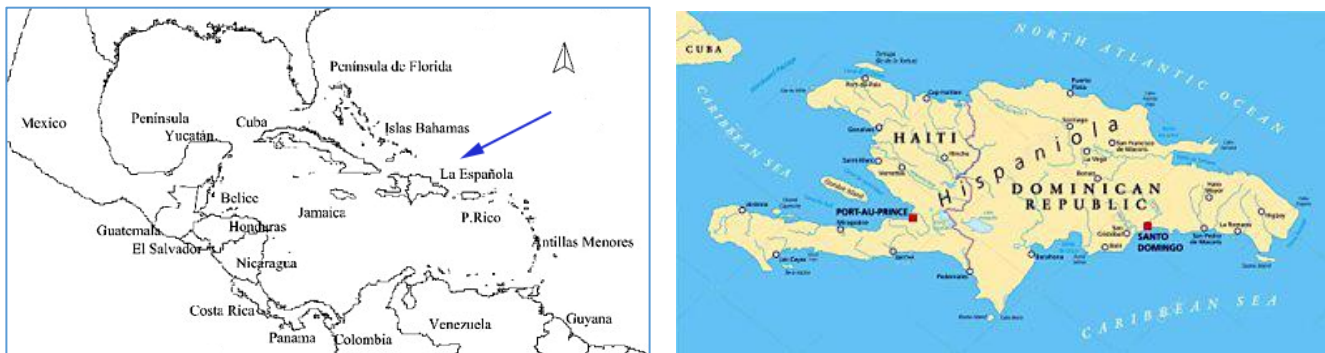


Figure 1. Location of Hispaniola (arrow) in the Greater Antilles and the relationships of Haiti and the Dominican Republic on the island.

Freshwater Mollusks – Regional Background

In recent years, several researchers have identified freshwater mollusks from various places on Hispaniola. These reports include:

- Seven species of aquatic snails, in four families (Thiaridae, Lymnaeidae, Planorbidae and Neritidae), reported to be present in Macaya National Park, Haiti, by Grego & Steffec (2006:7 – Table 1, 13).
- Technical information presented in Gómez *et al.* (1986), Bastardo & Sánchez-Rosario (2017:76, 77- Table 1) provided a list of taxonomic categories of aquatic macroinvertebrates, involving eleven mollusk families -- eight gastropods and three bivalves known from Dominican Republic and the Hispaniola general territory.
- Bastardo and Espinosa J. (2019) reported 29 species, including 25 gastropods and four bivalves, from Dominican Republic.
- Álvarez-Abreu *et al.* (2019) discussed the gastropod family Planorbidae, including 15 species distributed in seven genera, four tribes and two subfamilies occurring in Dominican Republic.
- Nine species that occur in the Hispaniola territory, including eight gastropods and one bivalve, was presented by Agudo-Padrón (2019b: 20) based on the examination of documented photographic reports from the field.
- Castro *et al.* (2020) used molecular techniques to reconfirm the presence of the Lymnaeid snail *Galba cubensis* (Pfeiffer, 1839) in the Northeastern and Southern region of the Dominican Republic.

The following is a list of freshwater gastropod and bivalve species found in Hispaniola that were directly verified by the AM Project during the research carried out with the help of our collaborators on the island:

Gastropoda

Ampullariidae

Marisa cornuarietis (Linnaeus, 1758) (Figure 2)

Pomacea canaliculata (Lamarck, 1804) (Figure 3)

Pomacea lineata (Spix, 1827) (Figure 3)



Figure 2. Operculate neotropical snail Ampullariidae *Marisa cornuarietis* (Linnaeus, 1758) from mouth of the Chavón River, Dominican Republic, ?/?/2004. Photograph by Stefano Pace.



Figure 3.- Operculate neotropical snails Ampullariidae *Pomacea canaliculata* (Lamarck, 1804) (center) and *Pomacea lineata* (Spix, 1827) (left & right) from San Fernando de Monte Cristi, Dominican Republic, 03/05/2018. Photograph by Bamban Abud.

Thiaridae

Melanoides tuberculata (Müller, 1774) (Figure 4)

Tarebia granifera (Lamarck, 1816) (Figure 5)



Figure 4. Operculate invasive snail Thiaridae *Melanoides tuberculata* (Müller, 1774) from Lac Azuei, Haiti, 01/10/2018. Photograph by Haiti Ecology



Figure 5. High population density of operculate invasive snail Thiaridae *Tarebia granifera* (Lamarck, 1822) at Trou Caïman, Ouest, Haiti, 20/09/2018. Photograph by René Durocher

Cochliopidae

Pyrgophorus parvulus (Guilding, 1828) (Figure 6)

Planorbidae

Biomphalaria straminea (Dunker, 1848) (Figure 7)



Figure 6. Morphotype operculate snail Cochliopidae *Pyrgophorus parvulus* (Guilding, 1828) from Lac Azuei, Haiti, 01/10/2018. Photograph by Haiti Ecology



Figure 7. Panamerican freshwater snail Planorbidae *Biomphalaria straminea* (Dunker, 1848) from the National Botanical Garden, Santo Domingo, Dominican Republic, 30/05/2018. Photographs by Juan Manuel Rodríguez Gil

Bivalvia

Unionidae

Pyganodon (- *Anodonta*) *grandis* Say, 1829 (Figure 8)



Figure 8. North American invasive limnic mussel/naiad Unionidae *Pyganodon* (- *Anodonta*) *grandis* Say, 1829 from Samaná Peninsula, Dominican Republic, 30/05/2019. Photographs by Liliana Solis Pais

A second introduced giant mussel/naiad Unionidae, the invasive Asiatic species *Sinanodonta woodiana* (Lea, 1834), is cited in the literature for the Dominican Republic by Watters (1997). Additional references include Parry (2019), <https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=2824> and https://en.wikipedia.org/wiki/Sinanodonta_woodiana.

Of the thirty-five limnic/ freshwater species counted so far on Hispaniola (Grego & Steffec 2006; Álvarez-Abreu *et al.* 2019; Bastardo & Espinosa J. 2019; and the present contribution), eleven are exotic and invasive species (almost 32 percent of the total), (Darrigran *et al.* 2020: supplementary material 2; this contribution) (Table 1).

Table 1. The non-native freshwater mollusk species known to occur on the island of Hispaniola. Source: Archive/ Database of the Project AM

Gastropoda
Ampullariidae <i>Marisa cornuarietis</i> (Linnaeus, 1758) <i>Pomacea canaliculata</i> (Lamarck, 1804) <i>Pomacea glauca</i> (Linnaeus, 1758) <i>Pomacea lineata</i> (Spix, 1827)
Thiaridae <i>Melanoides tuberculata</i> (Müller, 1774) <i>Tarebia granifera</i> (Lamarck, 1816)
Lymnaeidae <i>Galba cubensis</i> (Pfeiffer, 1839) <i>Pseudosuccinea</i> (- <i>Lymnaea</i>) <i>columella</i> (Say, 1817)
Physidae <i>Physa acuta</i> (- <i>cubensis</i>) Draparnaud, 1805
Bivalvia
Unionidae <i>Pyganodon</i> (- <i>Anodonta</i>) <i>grandis</i> Say, 1829 <i>Sinanodonta woodiana</i> (Lea, 1834)

References:

Agudo-Padrón, A.I. 2019a. Los moluscos no marinos ocurrentes en la República de El Salvador, América Central: una breve revisión panorámica introductoria de su actual conocimiento. *BIOMA*, 5(50):48-53. Available online at: https://edicionbioma.files.wordpress.com/2019/10/los-moluscos-no-marinos-ocurrentes-en-la-rep3bublica-de-el-salvador.pdf?fbclid=IwAR1m4r0o01RrAEzqU8ZZ6S7qIz9yjrZcopB_EqUMj29i9dPNrfUr9l-Pjlg

Agudo-Padrón, A.I. 2019b. Joyas malacológicas forestales de la República Dominicana, Isla La Española (Hispaniola), Caribe insular: informaciones preliminares disponibles y desafíos en agenda. *BIOMA*, 5(51):18-22. Available online at: https://edicionbioma.files.wordpress.com/2019/12/joyas-malacolc3b3gicas-forestales-de-la-rep3bublica-dominicana.pdf?fbclid=IwAR28cP1NofnjCWj9RUZnLufvHoVjTwDU76SWv8_h7OUf1kT_ZchqVZIN9k

Agudo-Padrón, A.I. 2019c. Joyas malacológicas forestales de la Isla La Española (Hispaniola), Caribe insular: Apuntes acerca de los caracoles rupestres Annulariidae. *BIOMA*, 5(52):71-76. Available online at: <https://edicionbioma.files.wordpress.com/2019/12/apuntes-acerca-de-los-caracoles-rupestres-annulariidae.pdf?fbclid=IwAR04vmNk1JOvEHU9bzBy6tRuMOynTfna2JnnNZO0yILoC58kC2CJBdBRUL4>

Álvarez-Abreu, O.; Mateo, S.; Espinosa, A. & Bastardo, R.H. 2019. Diversidad, distribución y estado del conocimiento de la familia Planorbidae (Gastropoda: Hygrophila: Lymnaeoidea) en República Dominicana. Santo Domingo, R.D.: *XV Congreso Internacional de Investigación Científica (XV CIC)*. Available online at: https://www.researchgate.net/publication/338047733_Diversidad_distribucion_y_estado_del_conocimiento_de_la_familia_Planorbidae_Gastropoda_Hygrophila_Lymnaeoidea_en_Republica_Dominicana

Bastardo, R.H. & Espinosa J., A. 2019. Hacia la actualización del catálogo de los moluscos de agua dulce de la República Dominicana. Santo Domingo, R.D.: *XV Congreso Internacional de Investigación*

- Científica (XV CIC)*. Available online at: https://www.researchgate.net/publication/334638399_HACIA_LA_ACTUALIZACION_DEL_CATALOGO_DE_LOS_MOLUSCOS_DE_AGUA_DULCE_DE_LA_REPUBLICA_DOMINICANA
- Bastardo, R.H. & Sánchez-Rosario, A. 2017. Estado del conocimiento de los macroinvertebrados acuáticos de la isla La Española. *Actualidades Biológicas*, 39(107): 75-81. Available online at: https://aprendeonline.udea.edu.co/revistas/index.php/actbio/article/view/330389/20786841?fbclid=IwAR0m_3jkOsp5tGJBO7eX_T9CPuiaieMLV9eQMXZ0Uygp-7EE2SDIK5VyDbU
- Castro, M.D.V.; Jiménez, J.T.C.; Hoz, J.M.L.; Castillo, J.C.; Paulino, D. Alarcón-Elbal, P.M. 2020. Reconfirmation of *Galba cubensis* (Gastropoda: Lymnaeidae), host of *Fasciola hepatica* (Trematoda: Digenea), by molecular techniques in the Dominican Republic. *Novitates Caribaeae*, (15):51-62. Available online at: <http://www.novitatescaribaeae.do/index.php/novitates/article/view/215/200>
- Darrigan, G.; Agudo-Padrón, I.; Baez, P.; Belz, C. et al. 2020. Non-native mollusks throughout South America: emergent patterns in an understudied continent. *Biological Invasions*, 22(3), 853-871, 7 Electronic Supplementary Materials. Available online at: <https://sci-hub.tw/10.1007/s10530-019-02178-4> ; <https://link.springer.com/article/10.1007/s10530-019-02178-4>
- Gómez, J.D.; Vargas, M. & Malek, E.A. 1986. Moluscos de agua dulce de República Dominicana. Santo Domingo: UASD, *Editora Universitaria*, 135 p.
- Grego, J. & Steffec, J. 2006. The mollusks of Macaya National Park, pp. 4-37. In: *Macaya Biodiversité. Haiti: Société Audubon Haiti, Expédition Scientifique Dans La Réserve De La Biosphère de Macaya/* 2006, 102 p. Available online at: http://audubonhaiti.org/wordpress/wp-content/uploads/2012/09/Macaya_Biodiversity_2006.pdf?fbclid=IwAR39EHdtxf6OJTC9l3F5u6WgzwBW6PVMyzweNHr16l7Qg1A9akwyLBH7agA
- Parry, W. 2019. Invasive monster mussels discovered; officials say they averted an 'ecological nightmare'. Pennsylvania, USA: The Associated Press. Available online at: https://www.pennlive.com/news/2019/11/invasive-monster-mussels-discovered-officials-say-they-averted-an-ecological-nightmare.html?fbclid=IwAR1b-MsNCyEIWwVDUUC_aN5_WRu7eTTKp01rsgX9zll00KaT3oPhDNZ-BBk
- Watters, G. T. 1997. A synthesis and review of the expanding range of the Asian freshwater mussel *Anodonta woodiana* (Bivalvia: Unionidae). *Veliger*, 40(2):152-156. Available online at: <https://www.sciencebase.gov/catalog/item/5053a20be4b097cd4fce8a54>

First Confirmed Record of the Plemic Limnetic/ Freshwater Native Apple Snail Ampullariidae *Pomacea maculata* Perry, 1810 in Santa Catarina State/ SC, Central Southern Brazil

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Up until now, the family of native freshwater operculate snails Ampullariidae Gray, 1824 has been represented in Santa Catarina State/ SC by seven species, five of them representative apple snail forms of the genus *Pomacea* (Perry, 1810), of which four are native and one is exotic nearctic (Agudo-Padrón 2018:55-Table 1).

On the rainy southern summer night of January 27 2020, we found three adult reproductive specimens of a singular/ curious apple snail (Figure 1) spawning (Figure 2) at the ragged edges of a sport fishing lake (Figure 3) at the Aguas Mornas Palace Hotel Hydrothermal/ Thermo-mineral Spa located in the Aguas Mornas Municipal District (Greater Florianópolis Mountain sector ~ 27°41'38"S & 48°49'25"W). This spa is in the Parque Estadual da Serra do Tabuleiro [Tabuleiro Mountain Range State Park], Santa Catarina State/ SC, Central Southern Brazil (Figure 3), in Malacological Region Number 1 of the State (Agudo-Padrón 2018:58-Figure 1).



Figure 1. Live adult reproductive specimens of native limnic/ freshwater operculate snail Ampullariidae *Pomacea maculata* Perry, 1810 found in the Tabuleiro Mountain Range State Park, Santa Catarina State/ SC, Central Southern Brazil.

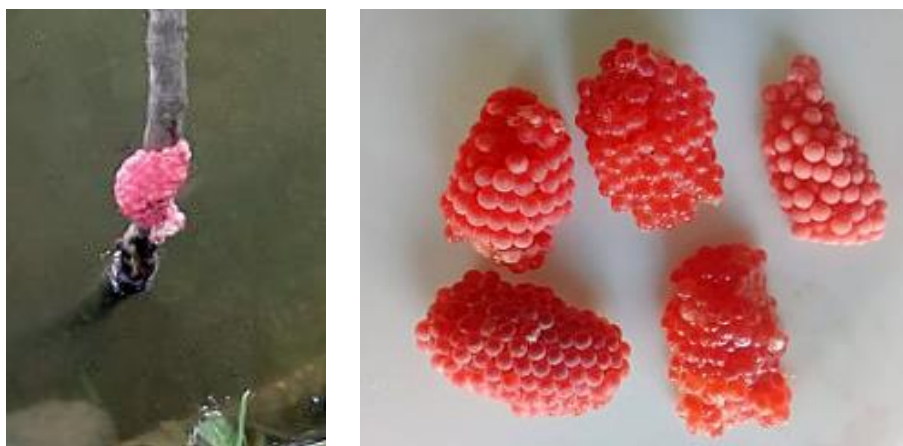


Figure 2. Egg masses produced by native apple snails Ampullariidae *Pomacea maculata* Perry, 1810, found on the edges of the sport fishing lake.



Figure 3. Location (map – red color) of the Aguas Mornas Municipal District in the Greater Florianópolis Mountain sector of Santa Catarina State/ SC, and a view of the sport fishing lake where the snails were found.

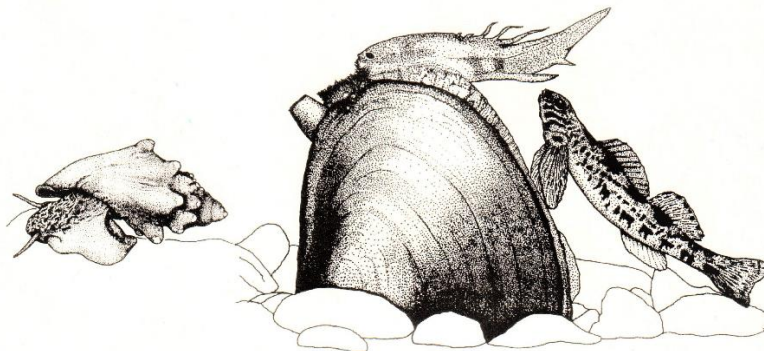
The general environment of the resort consists of ornamental gardens/flower beds, extensive lawns, and lush Atlantic native forest vegetation typical of preserved mountain slopes. No other aquatic mollusk species were found at this site. Additionally, no traces or evidence of malacophagous activities by aquatic/swampy birds (dry shells in the lake riversides) were found in the area. The only other mollusks found in the locality were four land/terrestrial species: one native leatherleaf slug Veronicellidae, *Belocaulus angustipes* (Heynemann, 1885) = namesake *Latipes* (- *Sarasinula*) *erinaceus* (Colosi, 1921), and three exotic (asian) invasive forms typical of anthropized environments: slug Philomycidae *Meghimatium pictum* (Stoliczka, 1873), common garden snail Camaenidae *Bradybaena similaris* (Férussac, 1821), and turricular microsnail Subulinidae *Subulina octona* (Bruguière, 1789).

Using the pertinent malacological literature (Simone 2006:55; Hayes *et al.* 2012:729-Figure 2; and Ishikawa 2012 a and b), the specimens finally were confirmed as native limnetic/ freshwater operculate snails Ampullariidae *Pomacea maculata* Perry, 1810 (Figure 1), one of the polemic worldwide invasive South American apple snails. This species, along with *Pomacea canaliculata* (Lamarck, 1819), has been introduced in irrigated rice camps/ cultures and global hydrographic basins [for a broad discussion ~ based mainly on the analysis of the contribution produced by Hayes *et al.* (2012), see Ishikawa (2012a and b)].

Thus, the present report represents the first confirmed geographical record of this native limnetic/ freshwater species for the geographical territory of Santa Catarina State/ SC. It raises to eight the number of regionally-known freshwater snails listed in the family Ampullariidae Gray, 1824 (Agudo-Padrón 2018:55-Table 1); to 84 the number of aquatic species registered so far in this State; and to 250 the current general inventory of continental/ non-marine mollusks known from Santa Catarina State (Agudo-Padrón 2018).

References:

- Agudo-Padrón, A.I. 2018. Revised and updated systematic inventory of non-marine molluscs occurring in the State of Santa Catarina/SC, Central Southern Brazil region. *Advances in Environmental Studies*, 2(1):54-60. Available online at: <http://scholarlypages.org/Articles/environmental-studies/aes-2-007.pdf?jid=environmental-studies>
- Hayes, K.A., Cowie, R.H., Thiengo, S.C. and Strong, E. 2012. Comparing apples with apples: clarifying the identities of two highly invasive Neotropical Ampullariidae (Caenogastropoda). *Zoological Journal of the Linnean Society*, 166(4):689-722. Available online at: <https://scihub.bban.top/https://doi.org/10.1111/j.1096-3642.2012.00867.x>
- Ishikawa, W. 2012a. *Pomacea (Pomacea) maculata* Perry, 1810. Parte I. In: *Planeta Invertebrados Brasil*, 16/04/2012. Available online at: http://www.planetainvertibrados.com.br/index.asp?pagina=especies_ver&id_categoria=27&id_subcategoria=0&com=1&id=156&local=2&fbclid=IwAR31dcTVgwwhB726voAUEEePy8wPheDeTbIDsnBhJvAbC2WeykPbYyiPXWs
- Ishikawa, W. 2012b. *Pomacea (Pomacea) maculata* Perry, 1810. Parte II. In: *Planeta Invertebrados Brasil*, 16/04/2012. Available online at: http://www.planetainvertibrados.com.br/index.asp?pagina=especies_ver&id_categoria=27&id_subcategoria=0&com=1&id=332&local=2&fbclid=IwAR1_UrlazisyUFJ9Lh9CbRcGt5jWoPlml-0TD_N8ucUnZivZEKHcTZSXX0A
- Simone, L.R.L. 2006. *Land and freshwater molluscs of Brazil*. São Paulo, SP: FAPESP, 390 p.



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Ellipsaria is posted on the FMCS web site quarterly: around the first of March, June, September, and December. This newsletter routinely includes Society news, meeting notices, pertinent announcements, and informal articles about ongoing research concerning freshwater mollusks and their habitats. Anyone may submit material for inclusion in *Ellipsaria* and all issues are accessible to anyone on the FMCS website (<http://molluskconservation.org>).

Information for possible inclusion in *Ellipsaria* should be submitted via e-mail to the editor, John Jenkinson, at jjjenkinson@hotmail.com. Contributions may be submitted at any time but are due by the 15th of the month before each issue is posted. MSWord is optimal for text, but the editor may be able to convert other formats. Graphics should be in a form that can be manipulated using PhotoShop. Please limit the length of informal articles to about one page of text. Note that submissions are not peer-reviewed but are checked for clarity and appropriateness for this freshwater mollusk newsletter. Feel free to contact the editor with questions about possible submissions or transmission concerns.

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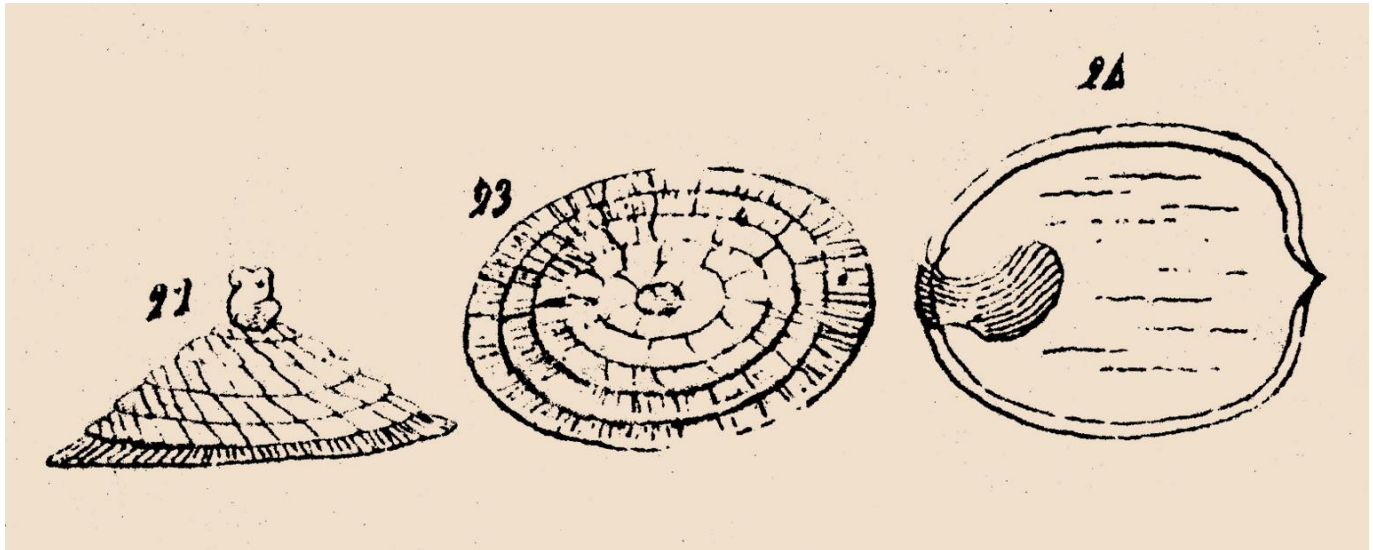
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Parting Shot



These last three figures on Plate LXXXII of Rafinesque's 1820 Monograph are all identified as *Tremesia patelloides*, a unique tri-valved mollusk -- in "a new family intermediate between the Brachiopods, the Tereidos and the Parellas." The same animal was described in Rafinesque's 1819 contribution to the *American Monthly Magazine and Critical Review* (Vol 3, page 356); however, that animal was identified as the brachiopod *Notrema fissurella*. While the 1820 description for this species is more detailed, includes these figures, and lists the habitat as "the lower part of the Ohio, attached to stones," it excludes the fact (presented in the 1819 article) that Rafinesque had not seen this rare creature but "Mr. Audubon of Hendersonville [Kentucky] has drawn it." John James Audubon, the widely-regarded early illustrator of birds and mammals, is known to have hosted Rafinesque for a time and is credited with deceiving him into believing, and describing, several imaginary fishes, mammals, and this limpet-like tri-valve mollusk. This set of hoaxes has added to the ridicule that Rafinesque's work has received during much of the past 200 years.

If you would like to contribute a freshwater mollusk-related image for use as a **Parting Shot** in *Ellipsaria*, e-mail the picture, informative caption, and photo credit to jjjenkinson@hotmail.com.

