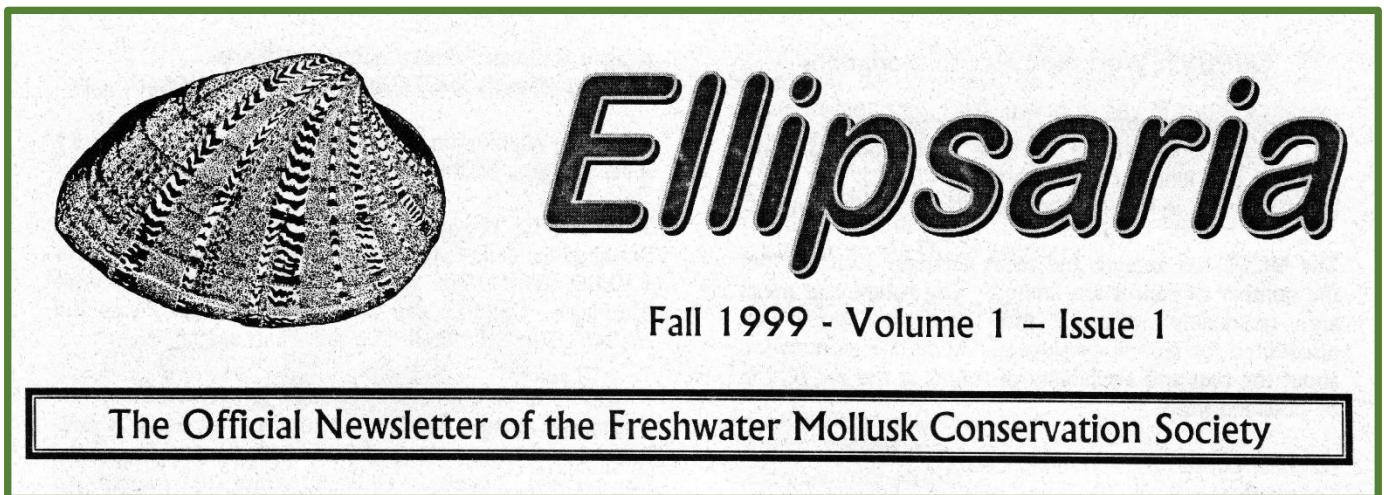




Newsletter of the Freshwater Mollusk Conservation Society
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***Ellipsaria* Turns 20!**

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As difficult as it is to believe, this issue of *Ellipsaria* marks the start of the 20th year for this publication. The inaugural issue of *Ellipsaria*, published in the fall of 1999, was a spartan eight pages in length, contained a call for abstracts for the upcoming FMCS Outreach Workshop, an introduction to the Society, a secretary’s report, a treasurer’s report [FMCS had about \$2,000

Cover Story	1
Society News	2
Announcements	5
Upcoming Meetings	6
Contributed Articles	7

Obituary	16
FMCS Officers	20
Committees	21
Parting Shots	22

at the time], committee reports, and a message from the first president (Alan Buchanan). In the first few years of FMCS's existence, this newsletter was the only mechanism to inform our members about Society activities. Long before our journal, website, and Facebook page existed, it was this newsletter, full of content submitted by a dedicated membership, that spurred FMCS through those formative years.

In addition to Society business, *Ellipsaria* soon began to include research updates that had previously been published in the Triannual Unionid Report. For nearly 10 years, Dick Biggins, with the US Fish and Wildlife Service in Asheville, North Carolina, had assembled the Triannual Unionid Report as an informal update on research, survey, and conservation news for "mussel heads." As Dick's retirement became eminent, he agreed to transition those items to the FMCS newsletter. That addition is how *Ellipsaria* achieved the basic format it still maintains today.

I recall putting that first issue together after business hours, printing some 220 copies on a photocopier, collating the pages, applying address labels, and carrying the finished newsletter to the Tennessee Aquarium mail office to be sent out. That process was made easier when we added a cover page and contracted with a print shop to assemble the finished issues; however, stuffing envelopes, applying address labels, and mailing all of those copies was still completed by hand. I continued producing the newsletter in Tennessee throughout 2000 until Christine Meyer *mercifully* agreed to begin editing *Ellipsaria*, starting in April 2001. That year, Kevin Cummings had become FMCS president and many Society operations were moved to the Illinois Natural History Survey. Christine faithfully assembled the newsletter for ten years, adding her own flair and producing a better publication. Christine's last issue appeared in December 2010 and John Jenkinson took over editorial duties in 2011 as the newsletter went online. In addition to simplifying the compilation of the issues and not having to print or mail anything, going online allowed John to greatly improve the look of *Ellipsaria* (including **color** graphics) and add internet links that were not possible in the printed format.

With the first two decades of this publication in the files, the future of *Ellipsaria* and the Society it represents indeed look bright. So, here's to the next decade of *Ellipsaria* and the Freshwater Mollusk Conservation Society.

Society News

Proposed Changes to FMCS Committee Structure

Jeremy Tiemann, FMCS President

Under the previous set of FMCS by-laws, the Society recognized ten Standing Committees (Awards, Environmental Quality & Affairs, Gastropod Distribution & Status, Guidelines & Techniques, Information Exchange, Genetics, Mussel Distribution & Status, Outreach, Propagation & Restoration, and Symposium), and maintained seven Ad-hoc Committees (Chapters, Diversity & Inclusiveness, Ecosystem Services, International, National Strategy, Mollusk Valuation, and Professional Development). During the April 2019 Symposium in Texas, the FMCS membership voted to adopt changes in the by-laws including the alteration of the Society's committee structure. Under the approved changes, FMCS now has three types of committees – Functional, Technical, and Ad-hoc – and the names and duties of those committees are no longer specified in the by-laws. The chairs of Functional and Technical Committees are to serve on the Board of Directors with voting rights, while the chairs of any Ad-hoc committees can participate in Board discussions (as can all members of the Society) but do not have voting rights on the Board. The chairs of the Functional and Technical committees are to be selected

by members of those committees at the biennial symposium, serve two-year terms, and cannot serve as chair of that committee for more than three consecutive terms (= six consecutive years). Ad-hoc committee members are appointed by the ExCom and those committees are to be either elevated into a Functional or Technical subcommittee or dissolved when that task is completed.

Members of the ExCom (current President, President-elect, Past President, Secretary, and Treasurer) have discussed proposed revisions to the committee structure and are ready to share our ideas on what we believe would be an improved and results-oriented set of Functional and Technical committees. As we see them, the Functional Committees – which take care of “the day-to-day functions” of the Society – could consist of the following nine committees:

- **Awards** (e.g., student awards, professional awards)
- **Chapters** (including International chapters)
- **Diversity & Inclusiveness**
- **National Strategy** (e.g., setting the Society’s future direction in strategy development and committee structure)
- **Nominations**
- **Outreach** (e.g., website, social media, event tools, and Professional development opportunities)
- **Professional Certification**
- **Publications** (Ellipsaria, FMBC)
- **Symposia & Workshops**

We propose that the Technical Committees – which help the Society achieve the goals and objectives of the National Strategy – could consist of the following four committees:

- **Ecology & Ecosystem Services** (would include Guidelines/Techniques, Genetics, and Ecosystem Services subcommittees)
- **Environmental Quality & Advocacy** (including our involvement in CASS)
- **Mollusk Status & Distribution** (would include Gastropods and Mussels, Atlas, Mussel App, and Scientific & Common Names subcommittees)
- **Propagation & Restoration** (would include Habitat Restoration, Propagation, and Mollusk Valuation subcommittees)

Under the amended by-laws, other committees and subcommittees could be added or the existing ones could be changed by the Board as needed to meet the National Strategy or other Society needs. Ad hoc Committees will continue to be established by the Board to explore specific issues or answer specific questions.

Both the Functional and Technical committees can develop subcommittees and subcommittee chairs, but only the committee chair has a vote on the Board of Directors. Subcommittees should be formed to address specific projects outlined in the current National Strategy or other tasks identified by the Society or that committee. During future symposia, committees could meet to elect a chair, then remain as one group or split into subcommittee meetings as needed. Following the various meetings, the subcommittee chairs would report to the committee chair, who would summarize their Committee activities for the Board and the membership.

The ExCom plans to discuss our ideas about revisions to the committee structure at the upcoming Winter 2019 Board Meeting. If our ideas are approved by the Board, the restructuring would change the number of voting members on the Board to the 13 Functional and Technical

committee chairs and the five ExCom members. If some current Standing Committees are merged, the chairs of those committees will need to decide on an overall chair and any subcommittee chairs during the upcoming months. The results of this discussion and any Board decision will be posted as part of the minutes of the Board meeting, probably in the March 2020 issue of *Ellipsaria*.

The Mussel App is Now Available

At long last, the mussel ID app has been released! This app, funded by FMCS and Texas Parks and Wildlife Department, and developed by Science Apps, Inc., may be used to help identify North American mussels in the field. Users may select identifying characters of live or dead individuals to narrow down the likely species. You can even use the map feature to narrow down the options to just species present in your area.



This is our first edition of the app; future updates may include linking species fact sheets and range maps to the species pages, or even providing an opportunity for users to upload pictures of their species for identification help.

How can you download it? In either the Google Play Store or the Apple App store, search for MusselID, or go to www.scienceapps.org. Click on "News" and there is a link to download the app. It's Free!

The subcommittee that worked so long and hard to develop this app would welcome your comments and suggestions about it. Please email those comments or questions to Susan Oetker at susan.oetker@fws.gov.

FMCS 2020 Survey Guidelines and Techniques Workshop

Hello, everyone! We hope you've had a productive field season. We would like to remind everyone that the upcoming FMCS 2020 Workshop will be held at Henry Horton State Park along the Duck River in Tennessee on August 10 – 13, 2020. The focus of the Workshop will be Survey Guidelines and Techniques. Topics covered during the Workshop will include sampling techniques, data analysis, and protocol implementations, among others. We welcome and invite any ideas on content and the level of content (introductory, intermediate or advanced) you think would be most beneficial during the Workshop. Please send comments and ideas to Ryan Schwegman, rschwegman@enviroscienceinc.com, and Lisie Kitchel lisie.kitchel@wisconsin.gov.

If you're interested in attending and would like to give an oral or poster presentation, please be thinking about your potential submission. Slots are limited and we ask that oral presentations be in line with the focus on Survey Guidelines and Techniques. Poster presentations will not be limited in topic and can include a wide variety of information and research pertinent to freshwater mollusks. Details and instructions for submitting abstracts will be included in future announcements. We hope to see you in Tennessee!

Help Wanted ! !

FMCS is looking for one or more volunteers to fill the presently vacant Nominations (= Elections) Committee. Every other year, this committee is responsible for recruiting candidates for the three new elected positions (President- elect, Secretary, and Treasurer), promoting the election in this newsletter, conducting the election (recently done online), and reporting the results to the membership. If you are interested in serving on this important but not labor-intensive committee, please contact Jeremy Tiemann at jtiemann@illinois.edu .

Announcements

Scientific River Diving Safety: A New Specialty Certification Through PADI

Declines of freshwater animals, including freshwater mussels, snails, fishes, and salamanders have led to increased funding for projects that require the use of underwater diving in flowing water environments. Unfortunately, most SCUBA training programs address safe diving practices in clear water environments with little or no current while maintaining neutral buoyancy. River diving, by contrast, requires a unique set of skills for working in areas of low or no visibility with a directional current that may require divers to be weighted to maintain position.

As a response to this need, in October 2019, 12 divers from across the country came to the Potomac River and the U.S. Fish and Wildlife Service's National Conservation Training Center (NCTC) in Shepherdstown, West Virginia, for the first-ever certification in Scientific River Diving Safety. During the 4.5 day course (designed by U.S. Fish and Wildlife Service staff in conjunction with Heidi Dunn and Dan Scoggin from Ecological Specialists, Inc.; an EcoAnalysts company), divers demonstrated mastery in the following skills: diving with a full-face mask, communicating verbally with full-face mask divers from the surface, communicating with tactile and line signals, diving on a tether, tending divers on a tether, diving with a hookah, briefing a river dive, and creating a river dive safety plan. All 12 students demonstrated mastery and were presented with certifications in both Scientific River Diving Safety and Full-Face Mask through PADI.

The next session of this course will be offered October 5 – 9, 2020, at the NCTC. For more information or questions on how to register, please contact Matthew Patterson at 304-876-7473 or matthew_patterson@fws.gov.



Tether Diving



Hookah Diving



Underwater Recording

Chesapeake Bay Freshwater Mussel Workgroup Re-convenes

After a one-year hiatus, we will be holding the ninth meeting of the Chesapeake Bay Freshwater Mussel Workgroup. Currently, the meeting is planned for the University of Maryland's Center for Environmental Sciences Appalachian Lab in Frostburg, Maryland. Dates being considered are January 23rd, February 18th, and February 25th, 2020. The meeting is open to anyone, but is primarily attended by resource agency biologists, consultants, and others interested in and working on freshwater mussels in rivers and streams of the Bay watershed. Teleconferencing and webcasting capabilities will be available for those interested in participating but cannot travel. Light refreshments in the morning and afternoon will be provided. We particularly encourage any students who might be interested or involved to attend to increase exposure to the issues freshwater mussels face in the region. Past presentations include mussel ecology, propagation and relocation, range-wide status assessments, state and federal updates on the species listing, recent surveys, and toxicological studies.

For more information, contact Julie Devers at julie.devers@fws.gov or Matt Ashton at matthew.ashton@maryland.gov. Further details will be sent via email including a call for presentations, attendees, and a request for those in need of conference capabilities. Information is primarily sent through a distribution list of past and interested attendees, but will also be sent via the FMCS email list.

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/>
- Summer ? 2020** – American Malacological Society Annual Meeting “Florida Keys” [Specific Dates, Location, and Theme not yet posted] <https://ams.wildapricot.org/Meetings>
- 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 [Specific content and other details now being developed]
- 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/>
- 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 12 – 16, 2021** – FMCS 12th Biennial Symposium, Portland, Oregon, USA. Theme: *Mountains to Sea and the Mollusks Between*. Other details not yet announced.
- 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.

Actinonaias ligamentina* will Metamorphose on *Esox lucius

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Actinonaias ligamentina (Lamarck, 1819), a threatened species in Minnesota, is in need of conservation efforts. This species has declined due to a variety of stressors, including degraded habitat, altered stream hydrodynamics, and competition with *Dreissena polymorpha*, an invasive species (Minnesota DNR 2018). Understanding the life history needs of this mussel could improve species management. Laboratory studies have shown that *A. ligamentina* glochidia will metamorphose on some centrarchids, cyprinids, cottids, moronids, and percids (Lefevre and Curtis 1912, Howard 1914, Coker *et al.* 1921, Watters *et al.* 1998, Tremblay 2012, Gibson *et al.* 2015). To better understand the diversity of fishes that facilitate *A. ligamentina* glochidia metamorphosis, we conducted laboratory trials to identify suitable host fish species.

We followed standard methods to identify suitable glochidial hosts (Hove *et al.* 2016). Glochidia were obtained from St. Croix River mussels and fishes were collected from southern Minnesota streams. Laboratory water temperature, starting at 18°C, was raised to 22°C by the third day where it remained for the rest of the study. Glochidia or juvenile mussels were collected from species-specific aquaria 2-3 times per week and water filtrate was checked using a dissecting microscope.

Of the 33 fish species in nine families tested, we found one potential host for *A. ligamentina*, *Esox lucius*, which released a moderate number of juveniles (Table 1). Fish species that did not release juvenile mussels (no. inoculated, no. of survivors, attachment period (d)): *Acipenser fulvescens* (10,10,4), *Lepisosteus platostomus* (2,2,19), *Amia calva* (1,1,10), *Campostoma anomalum* (9,9,4), *Carassius auratus* (4,4,5), *Chrosomus erythrogaster* (8,8,10), *Clinostomus elongatus* (8,5,12), *Cyprinella spiloptera* (2,2,4), *Luxilus cornutus* (3,3,4), *Nocomis biguttatus* (1,1,4), *Notemigonus crysoleucas* (5,4,10), *Notropis atherinoides* (1,1,4), *N. dorsalis* (10,10,4), *N. hudsonius* (10,7,4), *N. volucellus* (6,6,4), *Pimephales notatus* (1,1,4), *P. promelas* (1,1,4), *P. vigilax* (10,9,4), *Rhinichthys cataractae* (9,9,4), *Ameiurus natalis* (9,9,4), *Noturus gyrinus* (4,4,4), *Pylodictis olivaris* (3,3,4), *Lota lota* (2,1,4), *Labidesthes sicculus* (3,1,4), *Etheostoma caeruleum* (1,1,4), *E. exile* (9,9,6), *E. flabellare* (10,10,4), *E. zonale* (7,7,4), *Percina evides* (6,6,4), *P. maculata* (9,9,4), *P. phoxocephala* (4,4,4), and *P. shumardi* (13,13,4).

Table 1. Successful *Actinonaias ligamentina* glochidia host suitability trial results.

Species	No. Inoculated	No. Survivors	Attachment Period (days)	No. Juveniles Recovered
<i>Esox lucius</i>	7	7	17-24	154

Our results are consistent with previous laboratory studies. We observed *A. ligamentina* metamorphose on *Esox lucius*. Although *A. ligamentina* host requirements have been studied relatively broadly, the only other *Esox* species previously tested was *E. americanus*, which did not facilitate glochidia metamorphosis (Watters *et al.* 1998). Species tested by us and others that did not produce juveniles include: *Lepisosteus platostomus*, *Amia calva*, *Cyprinella spiloptera*, *Pimephales notatus*, *Etheostoma zonale*, and *Percina phoxocephala* (Howard 1914, Coker *et al.* 1921, Watters *et al.* 1998). *Campostoma anomalum* facilitates *A. ligamentina* metamorphosis variably (Watters *et al.* 1998). We did not observe metamorphosis on *C. anomalum*. Laboratory host suitability trials that produce inconsistent results among fish species or genera exposed to *A. ligamentina* are not uncommon (Lefevre and Curtis 1912, Coker *et al.* 1921, Watters *et al.* 1998, Tremblay 2012, Gibson *et al.* 2015).

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Brooding Behaviors of Three Mississippi River Mussel Species in Minnesota

Elizabeth Slaikeu¹, Mark Hove^{1,2}, Christopher Rounds¹, Alia Benedict², Logan Neu¹, Isaiah Tolo¹, Alex Franzen¹, Bernard Sietman³, Zeb Secrist³, Anna Scheunemann³, Jamie Bucholz⁴, and Daniel Hornbach² corresponding author - mark_hove@umn.edu

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Improving our understanding of unionoid ecology is an important priority in the national strategy for freshwater mussel conservation (FMCS 2016). For example, knowing when mussels brood glochidia, in particular, mature glochidia, is useful to biologists propagating juvenile mussels. Although brooding periods are known for several species (Watters *et al.*, 2009) it is often unclear when mature glochidia are present.

We studied brooding behaviors of *Amblema plicata*, *Fusconaia flava*, and *Obliquaria reflexa* at two southeast Minnesota locations: Turtle Creek, a tributary of the Cedar River, near Austin, Minnesota (15T 491957E 4839230N), and the Mississippi River at Sturgeon Lake, a reach in Pool 3 near Red Wing, Minnesota (15T 529011E 4941783N) from May-August 2018. Although high flows occasionally prevented sampling, we usually examined at least 20 individuals of each mussel species every two weeks. Age was estimated by counting external growth rests on the shell; gravidity was determined by briefly inspecting gill color and degree of inflation. We sampled inflated gill contents and assessed glochidia maturity using a dissecting microscope. Glochidia were categorized as “immature” (young that ranged from embryos to individuals with incomplete shells, i.e. tissue between shells comprised 1/2 or more of the volume inside the shell), or “mature” (glochidia with fully formed shells where tissue occupied $\leq 1/3$ rd shell volume). Following inspection, mussels were marked and returned to the stream.

We observed several aspects of brooding behavior in these three species. In Turtle Creek, *Fusconaia flava* brooded glochidia in all four gills between May and July when water temperature rose above 12 °C (Figure 1). Average age of brooding *F. flava* in Turtle Creek was 11 years \pm 4 (SD) (range 4-20 years). In the laboratory, *F. flava* released long, narrow conglutinates that were red, pink, or whitish in color (Figure 2) and contained a mixture of glochidia and structural eggs or developing embryos similar to the conglutinates of *F. cerina* (Haag and Warren 2003). Frequently, *F. flava* gill color lightened from red to light pink (Likelihood Ratio chi-square=16.61, DF=4, P=0.002) as the glochidia matured (Likelihood Ratio chi-square=15.83, DF=4, P=0.003) (Table 1) during the brooding period (Figure 2). *Fusconaia flava* brooding period in Turtle Creek averaged 36 days \pm 15 (SD) (range 22-64 days), based on six gravid individuals that were examined twice during the study. Marsupium color changed from red to light red in two individuals found brooding immature glochidia during the first examination and mature glochidia during the second examination. Marsupium color did not change in four individuals brooding immature glochidia both times. The change from darker to lighter color could be due to development of the fertilized portion of the brood into glochidia, leaving only the structural eggs to provide color.

Fusconaia flava gill color did not change consistently in relation to glochidia maturity at the Mississippi River site even though age structure (10 years \pm 5 SD; range 3-21 years) was similar to the Turtle Creek population (Table 2). Inconsistencies in color change over the brooding period at the Mississippi River site might be clarified during a larger study.

Amblema plicata brooded glochidia in all four gills that were typically cream colored. The proportion of mature glochidia increased as the brooding period progressed from June to August (Likelihood Ratio chi-square=16.65, DF=4, P=0.002) (Figure 1) in Turtle Creek. Seven of eight recaptured gravid *A. plicata* were brooding for 27 days \pm 20 (SD) (range = 7 to 64 days). Very few gravid *A. plicata* were observed at the Mississippi River site (Figure 3). Mississippi River *A. plicata* frequently exhibited unusually frayed mantle margins covered with numerous, small, unusual growths. Our high recapture rate of Turtle Creek *A. plicata*, age 13 years \pm 5 (SD) (range 3-23 years), showed that checking gravidity was not immediately lethal. In the laboratory, *A. plicata* released mature glochidia loosely bound in clear mucus.

Most *O. reflexa* (age 7 years \pm 2 (SD); range 2-10 years) held mature glochidia between late May-late July (Figure 3). The outer cream-colored marsupial gills held glochidia packaged in a few large, cylindrical, white, firm conglutinates with glochidia densely arranged throughout (Haag and Staton 2003, Watters 2008).

Our observations of *A. plicata*, *F. flava*, and *O. reflexa* brooding periods confirm these species as short-term brooders. *Amblema plicata* brooded between June and August in Turtle Creek, which falls within May-August published records (Coker *et al.*, 1921, Heath *et al.*, 2001). Similarly, *F. flava* brooded between May and July in Turtle Creek and June to early August at the Mississippi River site, which is consistent with previous May-August observations (Coker *et al.*, 1921, Heath *et al.*, 2001), and *O. reflexa* brooding between May and July at the Mississippi River site is consistent with April-August records (Coker *et al.*, 1921).

Although mature glochidia generally occurred later in the season, *A. plicata* and *F. flava* holding immature glochidia could be found throughout the brooding period. Therefore, when seeking mature glochidia, we recommend letting females release glochidia naturally, which are frequently mature; or checking glochidia maturity before extracting the brood.

Finally, we observed individual mussels, primarily *F. flava*, having glochidia in various stages of development, even within a single conglutinate, suggesting multiple fertilization events or variability in rates of development. Studying glochidium development can reveal multiple reproductive events

(Ferguson et al. 2013) and could show how fertilization rates vary with species abundance, proximity among reproducing animals, or concentration of sperm stressing agents.

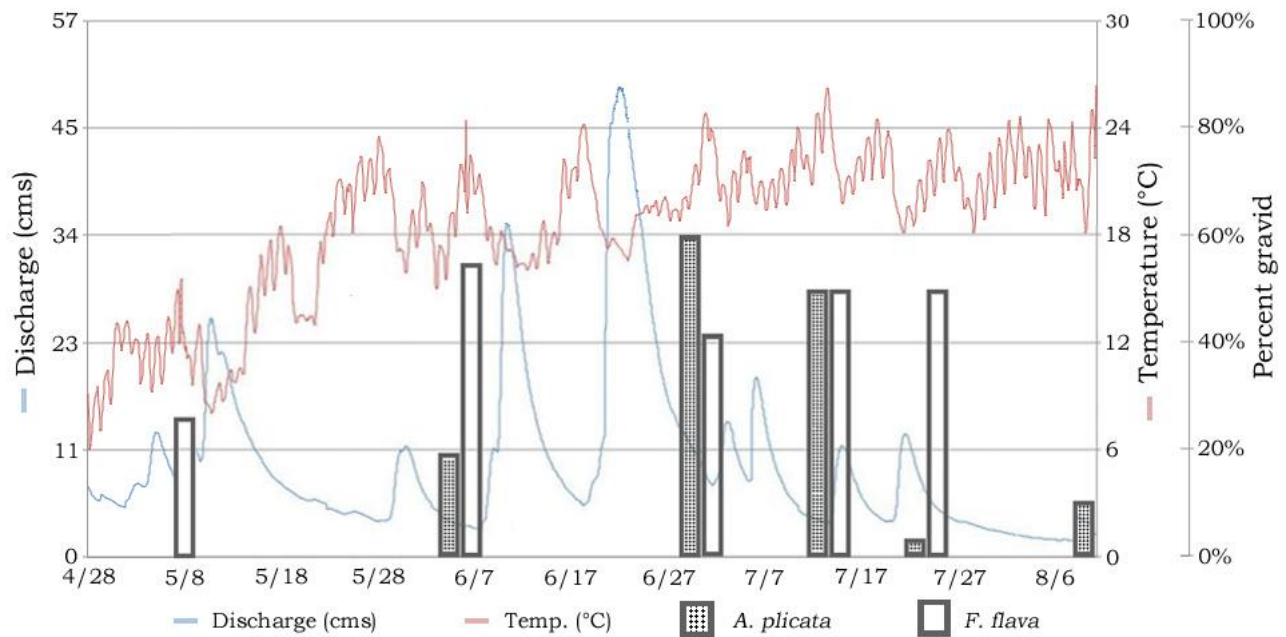


Figure 1. Mussel brooding periods in Turtle Creek during 2018 in relation to discharge and water temperature. Water temperature (red graph) was measured at the study site with a HOBO temperature logger. Discharge data (blue graph) were obtained from the MNDNR Cooperative Stream Gage No. 48027001 approximately 8 km downstream of the study site (https://www.dnr.state.mn.us/waters/csg/site_report.html?mode=get_site_report&site=48027001).



Figure 2. Variation in *Fusconaia flava* conglutinate color from Turtle Creek.

Table 1. Timing of glochidia maturity for *Amblema plicata* and *Fusconaia flava* in Turtle Creek during 2018. For individuals that had both immature and mature glochidia (mixed), we averaged the percentage of each component for that date. Structural eggs in *F. flava* conglutinates were not included in % maturity counts.

Date	<i>Amblema plicata</i>		<i>Fusconaia flava</i>	
	Sample Size	Glochidia Maturity	Sample Size	Glochidia Maturity
May 8	20		10	2 immature
June 6	21	4 immature	20	3 immature, 8 mixed maturity (86% immature, 14% mature)
June 28	20	12 immature	19	8 immature
July 12	20	8 immature, 1 mature, 1 mixed (44% immature, 56% mature)	20	5 immature, 5 mature
July 26	32	1 mature	20	6 immature, 4 mature
Aug 9	20	2 mature	20	
Aug 23	20		20	

Table 2. Timing of glochidia maturity for *Amblema plicata*, *Fusconaia flava*, and *Obliquaria reflexa* at the Mississippi River site during 2018. For individuals that had both immature and mature glochidia (mixed), we averaged the percentage of each component for that date. Structural eggs in *F. flava* conglutinates were not included in % maturity counts.

Date	<i>Amblema plicata</i>		<i>Fusconaia flava</i>		<i>Obliquaria reflexa</i>	
	Sample Size	Glochidia Maturity	Sample Size	Glochidia Maturity	Sample Size	Glochidia Maturity
May 18	20	*	20	*	20	*
June 13	20		20	9 immature	20	1 immature, 4 mature
June 29	20		20	1 immature	20	1 immature, 3 mature
July 13	20	1 immature	20	3 immature, 2 mixed (59% immature, 41% mature)	21	5 mature
July 27	20	1 immature	20	5 immature, 2 mature	22	1 mature
Aug 10	21		20	2 immature	20	
Aug 24			23			

* Glochidia maturity was not recorded on May 18

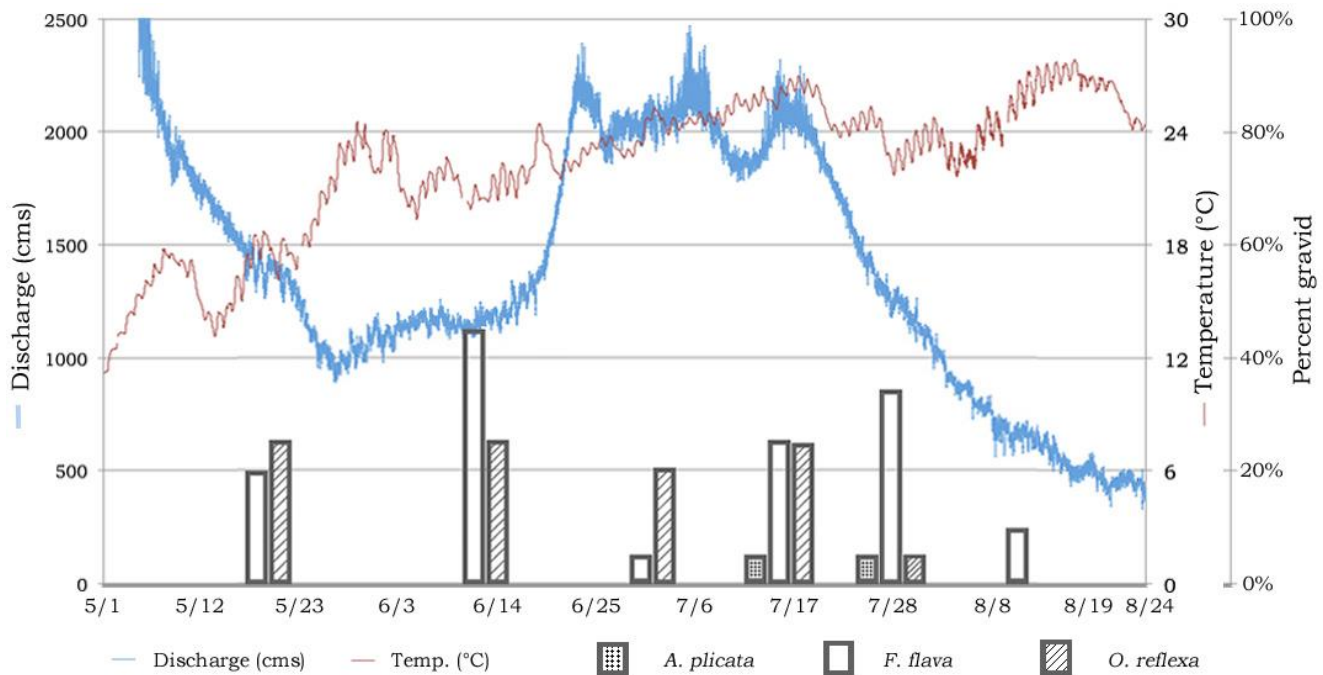


Figure 3. Mussel brooding periods in the Mississippi River during 2018. We obtained discharge (blue graph) and water temperature (red graph) data from USGS gaging stations 05355250 and 05355235, respectively, approximately 10 km downstream of the study site.

https://waterdata.usgs.gov/mn/nwis/uv/?site_no=05355250&PARAMeter_cd=00065,00060.
https://waterdata.usgs.gov/mn/nwis/uv?site_no=05355235.

We thank Rachel Nguyen for field assistance, Jim Fleming for access to the Turtle Creek study site, and the following project funders: Competitive State Wildlife Grants program, Grant F19AP00119, in cooperation with the U.S. Fish and Wildlife Service; Wildlife and Sport Fish Restoration Program; Macalester College; and coauthor contributions.

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**First Confirmed Record of the Native Freshwater Mussel Hyriidae *Diplodon*
(- *Rhipidodonta*) *suavidicus* (Lea, 1856) in Santa Catarina State,
Central Southern Brazil**

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Up until now, the family Hyriidae of native freshwater bivalves/ naiads has been represented in Santa Catarina State (member to the South American Atlantic Slope of the Southern Cone) by nine species of the genus *Diplodon* Spix, 1827 (Agudo-Padrón 2018:57-Table 1, 2019; Agudo-Padrón & Carneiro 2019).

On June 18, 2019, the second author of this report forwarded some photographs of a singular mussel/ naiad (Figure 1). This specimen in question (a dead shell) was found along the Rio Benedito (Figure 2), located in the Benedito Novo Municipal District, geographical domain of the Itajaí River Basin Valley in the Blumenau Micro-region (~ 26°47'05.991"S; 49°25'21.375"W), Malacological Region Number 6 of Santa Catarina State/ SC (Agudo-Padrón 2018: 58-Figure 1).

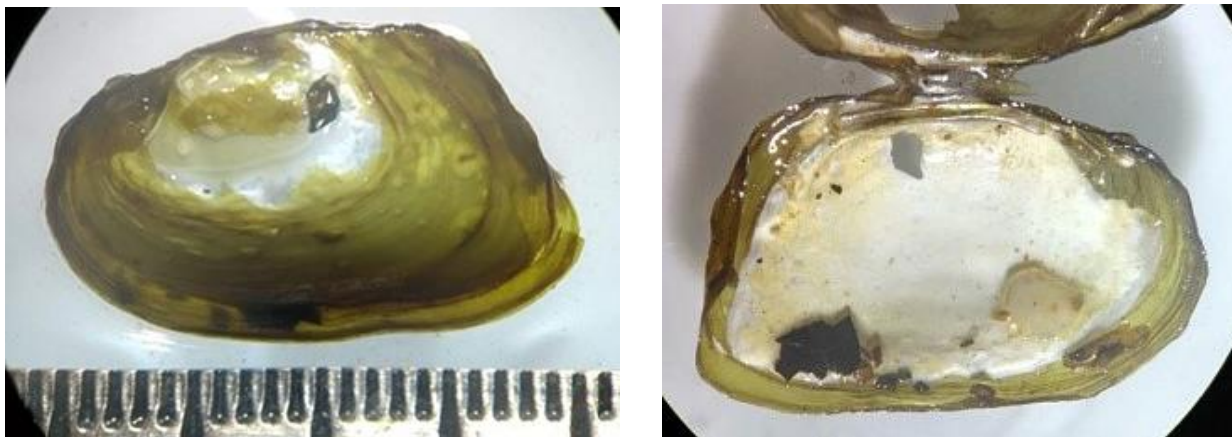


Figure 1. Dead shell of native limnic/ freshwater mussel/ naiad Hyriidae *Diplodon* (- *Rhipidodonta*) *suavidicus* (Lea, 1856) found in the Rio Benedito hydrographic microbasin. All photographs by Francisco Carneiro.

This shell was found in sandy substrate with many rocks (Figure 2) with the aid of a Surber Sampler for Benthos during biotic sampling campaign. It has been confirmed as an native limnic/ freshwater mussel/ naiad Hyriidae *Diplodon* (- *Rhipidodonta*) *suavidicus* (Lea, 1856) and has been deposited in the Malacological Collection of the Regional University Foundation of Blumenau, Blumenau/ SC (~ Voucher FURB-MO 366).



Figure 2. Location of the Benedito Novo Municipal District in the Itajaí Basin Valley region of Santa Catarina State/ SC (map – red color), and a view of the collection area in the Rio Benedito Microbasin where this shell was found.

The Rio Benedito microbasin has been proving particularly interesting because it is the scene of previous important regional malacological discoveries in the State, such as the initial confirmed field reports of the mussel/ naiad Hyriiidea *Diplodon charruana* (d'Orbigny, 1835) (Agudo-Padrón & Carneiro 2019) and the non-native/ exotic European freshwater snail *Galba* (- *Lymnaea*) *truncatula* (Müller, 1774) (Agudo-Padrón & Carneiro 2018), as well as extending the known distributions of the mussel/ naiad species *Diplodon expansus* (Küster, 1856) (Agudo-Padrón & Carneiro 2019: 25-Figure 3) and the tiny pea clam Sphaeriidae *Pisidium globulus* Clessin, 1888 (Figure 3 ~ Voucher FURB-MO 371), this last the third geographical record for this species in Santa Catarina/ SC (Agudo-Padrón & Luz 2015).

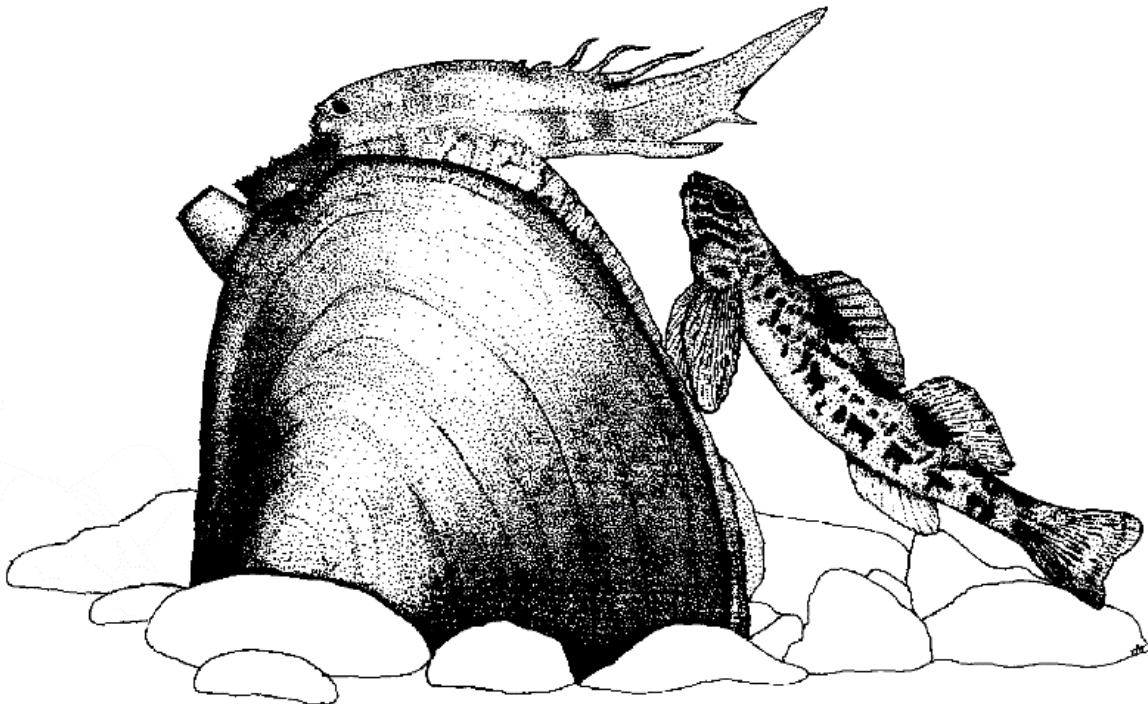


Figure 3. Specimen of pea clam Sphaeriidae *Pisidium globulus* Clessin, 1888 (Voucher FURB-MO 371) found in the Rio Benedito hydrographic microbasin.

Thus, the present report represents the first confirmed geographical record of *Diplodon* (- *Rhipidodonta*) *suauidicus* (Lea, 1856) in Santa Catarina State; raising to eleven the number of regional known freshwater mussels/ naiads of the family Hyriidae Swainson, 1840, to ten the number of representatives of the genus *Diplodon* Spix, 1827; to 22 the total of Unionoida Stoliczka, 1871 species listed; and to 249 the general inventory of State continental/ non-marine mollusks (Agudo-Padrón 2018: 57-Table 1, 2019).

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Obituary



George Thomas Watters, 1953 – 2019

George Thomas (Tom) Watters VIII, 66, passed away on October 10, 2019. Tom was born on Feb 28, 1953, in Dayton Ohio to George and Mae "Chris"(Chisholm) Watters. He graduated from Beavercreek High School, received a Bachelor's degree from University of Miami in Florida, a Master's Degree from the University of Rhode Island, and PhD in Zoology from The Ohio State University (OSU). After graduation, Tom worked for a time with Heidi Dunn at Ecological Specialists, Inc., and, eventually, became Curator of Molluscs in the Department of Evolution, Ecology and Organismal Biology at the Museum of Biologic Diversity at OSU. He also was the founding Science Director of the Columbus Zoo and Aquarium Freshwater Mussel Conservation and Research Center. He taught Invertebrate Zoology classes at OSU, mentored several graduate students, and authored a number of books and papers in his field.

He was preceded in death by his father George Thomas Watters VII, grandparents, and Aunts and Uncles. Tom is survived by his mother Mae "Chris" Watters of Beavercreek, his wife of 34 years Renee (Skorepa), his three children (Caitlin Marie, George Thomas IX, and Ian Michael) as well as numerous cousins, nieces, nephews and their families. Tom also leaves behind many friends and colleagues.

Tom dedicated his life and unique passion to the research, public education, and conservation of mollusks with a focus on freshwater mussels of Ohio. He was a member of numerous shell and mollusc organizations and was well respected in his field. He spent his life helping to build and curate The Ohio State Mollusc Collection, which is perhaps the largest collection of freshwater mollusks in the world.

Tom was a brilliant, stoic man with a dry wit. You knew he liked you if he gave you a hard time. Tom's humor and expertise made him one of the most highly sought speakers in the field. He loved his cats, the Ohio State Buckeyes, music, cooking, gardening, history, traveling, video games, and, most of all, Christmas. He was an inspiration and wealth of knowledge to all who knew him, and will be missed immensely.

In honor of Tom, the family kindly asks that donations be made to The Freshwater Mollusc [Tom would insist that "Mollusk" should end in a "c"] Conservation Society, FMCS. Tom was a proud founding member and past president of FMCS. In the words of Dr. Watters, "These animals that we take for granted are fascinating; we can't give up on them." Please make donation checks payable to FMCS and send them to Dr. Alan Christian, FMCS Treasurer, 20 Pleasant Street, Potsdam, New York, USA 13676.

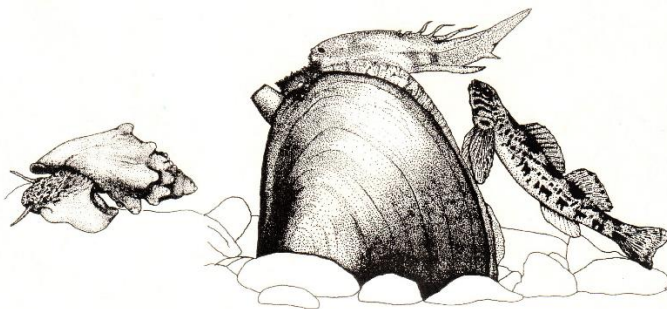
*When constantly asked if you can eat freshwater mussels... "You can eat anything once."
-Dr. G.T. Watters*

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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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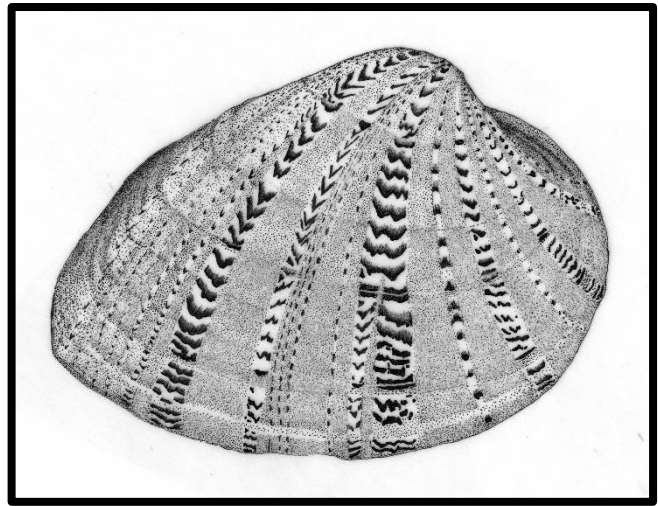
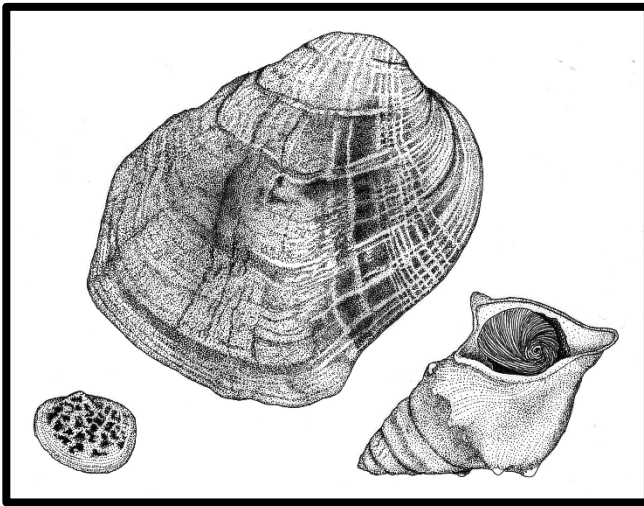
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Parting Shots



This 20th anniversary issue of *Ellipsaria* offers an appropriate – and long overdue – opportunity to acknowledge the artist who created some of the most enduring symbols of our Society. Thomas Tarpley was an intern at the Tennessee Aquarium in the mid-1990s and drew the triad image (above left) in 1997 for the National Native Mussel Conservation Committee, the group that reorganized to become our Society. Thomas also drew the image of *Ellipsaria lineolata* (above right) that was used in the masthead of this newsletter throughout its printed life [see Page 1] and the snail, mussel, and fish image now used (in various forms) in the online issues of *Ellipsaria*. Thomas obtained a Scientific Illustration certificate from the University of California, Santa Cruz, in 1999, and currently works for the Alabama Department of Conservation and Natural Resources at the Alabama Aquatic Biodiversity Center in Marion, Alabama.

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.

