

TRIENNIAL UNIONID REPORT

Report No. 17

May 1999

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



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

FRONT COVER MUSSEL ART: THANKS TO MALORIE MORRISON,
BELLEVILLE, WEST VIRGINIA.

INSIDE COVER MUSSEL ART/TOP PICTURE: THANKS TO CAITLIN
WATTERS, COLUMBUS, OHIO.

INSIDE COVER MUSSEL ART/BOTTOM PICTURE: THANKS TO WILL
HUBBS, CAMDEN, TENNESSEE.



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Freshwater Mollusk Conservation Society Business Meeting
March 18, 1999

Al Buchanan called to order the first official meeting of the FMCS.

Officers were introduced:

President: Al Buchanan
Treasurer: Heidi Dunn (3 years)
Secretary: Rita Vilella (2 years)
Exec. Assist.: Debbie Mignogno

Chairs of committees were introduced:

Commercial:	Nelson Cohen, Cheryl Ballenger, Steve Ahlstedt
Distribution/Status of Unionids:	Kevin Cummings
Distribution/Status of Gastropods:	Rob Dillon
Outreach:	Linda Drees, Mike Davis
Propagation/Restoration:	Dick Biggins/Richard Tankersley
Guidelines/Techniques:	Heidi Dunn
Water Quality/Habitat/Zebra Mussels:	Tom Muir
Information Exchange:	Madeleine Lyttle
Symposium:	Steve Ahlstedt, John Jenkinson

Treasurer's report: The society does have a bank account with 4 members having paid dues.

Minutes update: Minutes of the last meeting were published in the last triannual report. If anyone would like a copy contact Rita.

Nominations Committee: Glenn Miller, chair

How does the group want to proceed with nominations? The following was suggested:

Three to four nominations will be taken from the floor. Nominees will submit a 1 page introduction of themselves to the next triannual report. Only office for which we need to nominate candidates at this time is president elect. President elect becomes president and the president becomes past president. Past president can be chair of a fund raising committee. The triannual report is serving as our newsletter.

Nominees for president-elect: Paul Johnson -- Nominations were closed by consensus

Motion was passed to have Paul send in a 1 page introduction to the triannual report.

Symposium Committee update: Evaluation form was developed to critique the symposium. Forms were passed out for members to provide feedback to describe what everyone liked or disliked in the symposium so we can make improvements for the future. Comments can be written on the form. Return forms to the box that is located at the registration desk.

The executive committee, or board, has decided there should be an annual symposium with a similar response from the members. Originally we proposed to partner with AFS 2000 but registration is \$300 and most of the members feel this is not a good idea. The members then decided to hold a separate FMCS symposium in 2000. There was discussion that it might be advantageous to wait another year before having a symposium otherwise it may turn into more of a report of committees and the papers may not be as big a draw, actually detracting from participation in the society. It was also brought up whether we can raise the capital on an annual basis to hold a symposium. It takes 16-18 months to get a symposium off the ground so we are already behind schedule. A suggestion was made to hold a meeting in conjunction with the southeast AFS meeting, where registration is about \$60 dollars. They had 425 members attend their last meeting. The issue is who would get the proceeds from the registration fees when we hold meetings in conjunction with other society meetings. The society also needs to decide if it will be an annual or biannual

meeting. It may be a good idea to get another symposium under our belt to get a better idea of the costs involved and the commitment of members to the society. A suggestion was put forward to hold the symposium in North Carolina for 2001 and John Alderman volunteered to get a group to organize a symposium. It was also brought up that it would be a good idea to get another committee together for a 2002 symposium at the same time to get ahead and plan upcoming events.

Rob Dillon put forward the motion that the next symposium be held in 2001 and this motion was seconded. Discussion following the motion: The society needs to consider what we would like to see as sessions for the next meeting. It was suggested there is enough interest to sustain an annual meeting. If we wait till 2001 what will we do next year for society business, election of officers, etc. There may be a need for an annual meeting the first few years to get the momentum for building the society. It would be a good idea to have subcommittees meet annually at a symposium to get more people involved. A compromise is to have the year 2000 meeting in the fall such as November. We originally chose March to coincide with the timing for spring break to have more students participate in the symposium, whereas fall would be more difficult to get participation. The motion on the floor to hold the next meeting until 2001 was put forward for a vote. The society could hold a business meeting for the subcommittees on off years. The suggestion was made not to set it in stone now whether the symposium will be an annual or biannual meeting but to focus on keeping the momentum going.

Vote on the motion that the next symposium be held in 2001 -- Yes: 29 and No: 21.

The motion carried and the next symposium is to be held in the year 2001. Decided to let the symposium committee deal with when and where, starting with the subcommittee meeting on Friday.

Other business:

The following individuals received recognition awards to acknowledge their contribution to formation of the FMCS: Deb Mignogno and Dick Biggins

Committee meetings will be held from 4-6 on Friday and check the message board for location. Guidelines and techniques meeting will be from 1-3. The subcommittees need members to participate to accomplish their tasks. Outreach committee is looking for more speakers to volunteer for the speakers bureau to be mailed out with the proceedings. See Susi von Oettingen to volunteer. The gastropod committee will meet following the panel discussion from 1:30 to 3:30. Paul will announce Friday morning where each subcommittee will meet.

The following subcommittee meetings and locations were scheduled: Guidelines will meet in Commerce room, Gastropods in ballroom C, Distribution in ballroom B, Symposium in ballroom A, Commercial in board room, Information exchange in trade room, Propagation in commerce room, Water quality/habitat/zebras will meet in the basement

A more formal structure to the subcommittees would be helpful. The subcommittees are listed on the society membership form and members can check those they would like to participate. This will be put in database form and a copy will be sent to each committee chair and it is up to the chair and co-chair to send the list to their members to notify them they are members of the committee.

AMS, formerly AMU, will be holding a meeting in Pittsburgh July 4-9 and some student travel funds are still available. Packets on the meeting are also still available.

Motion to adjourn and seconded. Auction was held afterwards.

**TYPE SPECIMENS OF FRESHWATER MUSSELS
IN THE COLLECTION OF THE HEBREW UNIVERSITY OF JERUSALEM**

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A preliminary list of type specimens of freshwater mussels in the National Mollusc Collection of the Hebrew University of Jerusalem (HUJ) is presented. Each entry contains the reference to the original publication, the type locality, the type category and the collection number.

This list is published in compliance with Recommendation 72D of the International Commission on Zoological Nomenclature.

List of types

Family Margaritiferidae

01. *Margaritana marocana* Pallary, 1918: 152.
Type locality: Morocco, l'Oued Fès, leg. Capt. Martel.
Type category: Two syntypes - HUJ 36799 (= Blok 8348).

Family Unionidae

02. *Unio biformis* Monterosato, 1896: 8, textfigs.
Type locality: Italy, Sicily, Salaparuta, Belice.
Type category: Syntype - HUJ 30103 (= Coen 10692).
03. *Unio brachyrhynchus* Drouët, 1881: 246.
Type locality: Italy, Lago die Garda, near Desenzano.
Type category: Two syntypes - HUJ 36792 (= Coen 5040A).
04. *Unio marteli* Pallary, 1918: 151.
Type locality: Morocco, La Makina near Fez, leg. Capt. Martel.
Type category: Two syntypes - HUJ 36791 (= Blok 11136).
05. *Anodonta waterstoni* Tomlin, 1923: 68, textfigs.
Type locality: Greece, Lake Beschik, leg. Capt. J. Waterston.
Type category: Paratype - HUJ 36790 (= Blok 8278).
06. *Lamellidens marginalis* var. *sawaddyensis* Preston, 1912: 305.
Type locality: Upper Burma, Shuaygoomya, leg. J. Anderson.
Type category: Paratype - HUJ 36789 (= Indian Museum 2532 = Blok 8345).
07. *Lamellidens narainporensis* Preston, 1912: 305.
Type locality: Narainpore Bhil, Murshidabad, Bengal, leg. C.J. Robertson Milne.
Type category: Paratype - HUJ 36788 (= Blok 8277).
08. *Pseudodon ponderosa* Preston, 1909: 202, plt. 8, fig. 1.
Type locality: Siam, Nan-ko.
Type category: Holotype - HUJ 30101 (= Coen 5089).

09. *Lampsilis iridella* Pilsbry & Frierson, 1908: 81.

Type locality: Mexico, San Louis Potos, Valles, leg. A.A. Hinkley.

Type category: Two paratypes - HUIJ 36800 (= Blok 11903 ex coll. Hinkley).

Disclaimer

Elsewhere I have listed the presence of the holotype of *Aspatharia (Spathopsis) figulorum* Coen, 1935 in the National Mollusc Collection (HUIJ 30097) (Mienis, 1972: 53). This is not correct. The description was based on a single left valve, while the specimen mentioned above consists of a left and right valve. Although Coen's label bears the indication that we are dealing here with the holotype, this is not right. Most probably Coen has switched the original holotype (an incomplete specimen) for a better one (a complete specimen). A bad habit in those times. The current presence of the holotype, if it is still in existence, is unknown but it might be either in the "Istituto Geologico Universitario di Padova" or in the "Museo Nazionale di Antropologia di Firenze".

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STATUS OF COMMERCIAL MUSSEL SHELL INDUSTRY

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Last year during the February 1998 TWRC meeting, the commission decided to table decision on implementing increased size limits on mussels harvested in Tennessee. The mussel industry responded by cutting the weighted average price paid to harvesters from \$1.24/lb. to \$0.59/lb. (52% reduction, down 69% from 1995 level of \$1.90/lb.), and closing markets for five months during 1998. In July 1998 the Japanese-owned Tennessee Shell Company pled guilty to a felony in U.S. District Court in Jackson, Tennessee, and agreed to pay \$1 million in restitution for purchasing thousands of pounds of illegally taken mussels from rivers in Michigan, Ohio, Kentucky and West Virginia. The commercial harvest of freshwater mussels from the state's waters, reported by wholesale mussel dealers, decreased from 1061 tons in 1997, to 600 tons in 1998. The 1998 wholesale mussel harvest value totaled \$709,133 compared to \$3.33 million in 1997. Commercial mussel harvester license sales decreased from 641 in 1997 to 351 in 1998. During this downward trend in mussel harvesting, Kentucky Reservoir continues to produce 95 percent of the mussel shell harvested in Tennessee.

TWRA will address proposed changes to its commercial mussel regulations this April. The Wildlife Resources Commission has shown increased interest in the commercial aspect of Tennessee's mussel program since the Federal investigation of the shell industry and its illegal harvest activities made headlines this past summer. TWRA has evaluated existing regulations in light information gained through the investigation. We hope to implement a program which benefits the legal harvester and gives more control of the fishery to the TWRA.

The most opposition has centered on TWRA's efforts to change in mussel shell size limits to reach parity among with other states. TWRA recommends expanding several of Tennessee's mussel sanctuaries and the designation of a new management study area. Areas are declared sanctuaries in order to protect rare, threatened and endangered mussel populations and their habitats. Several endangered mussel species inhabiting the lower Tennessee River are in jeopardy of extinction throughout the rest of their range. TWRA is very concerned with the fate of these mussel species, and is closely monitoring their populations. We are currently working with Tennessee Technological University on a captive breeding program for these mussels. The area around Pickwick Dam on the Tennessee River serves as both a source of breeding adults and a release site for juveniles.

A new management study area is proposed on the northern end of Kentucky Reservoir. This area is bounded by Kentucky-Tennessee state line running down the middle of the lake for approximately 13 miles. TWRA law enforcement officers recommended closing this area to harvest, citing numerous instances of illegal shells taken from Kentucky being brought into Tennessee from this area. Under the new designation, limited harvest could be allowed under the direct supervision of the agency and according to limits established in a harvest study plan.

Effects of Sediment Size and Light Regime on Juvenile Wavyrayed Lamprussels, *Lampsilis fasciola*

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A procedure for culturing endangered species of mussels has been developed to reduce sources of high mortality and provide sufficient progeny to implement recovery plans. To increase glochidia-host contact, glochidia of endangered mussels are manually infested onto gills of appropriate host species. The transformed juveniles are then held in culture systems to increase post-transformation survival, as the first several weeks after metamorphosis have proven to be periods of high mortality. When environmental conditions are suitable, the juveniles can be released in suitable habitat to augment existing populations or to reintroduce the species to a river reach from which it was extirpated.

Conditions in the culture systems may be manipulated to attempt to increase survival and growth of juveniles. These conditions include flow rate, substrate size and composition, light availability, temperature, and food availability. In this experiment, we looked at the effects of sediment size and light regime on juvenile mussels. We used *Lampsilis fasciola* as a surrogate for endangered mussel species found in association with it. We held the newly transformed juveniles in four recirculating raceways in the greenhouse at Virginia Tech's Aquaculture Center, two of which were covered while the other two were left open to ambient light. The juveniles were in plastic dishes in one of the following four sediment types: silt ($<120\ \mu\text{m}$), fine sand ($500\ \mu\text{m} - 800\ \mu\text{m}$), coarse sand ($1000\ \mu\text{m} - 1400\ \mu\text{m}$), and mixed sediment ($<1400\ \mu\text{m}$). Ten of each sediment type were placed into each raceway, for a total of 40 dishes per raceway. A mix of the algae *Neochloris oleoabundans* and *Scenedesmus* sp. was cultured in the greenhouse and were used to feed the juveniles daily. The algal density in the water was kept at 20,000 cells/mL. Survival and growth were recorded at weeks 2, 4, 6, 8, and 12.

We found that silt substratum yielded the poorest survival, especially when in covered raceways (7%). Mixed sediment in open raceways had the best survival (26%). Fine and coarse sand were intermediate, with survival of approximately 20% in both types, in either opened or covered raceways. Light regime had a significant effect on juvenile growth. Juveniles in open raceways grew significantly faster for the first eight weeks, at which time growth rates evened out in both open and covered raceways. At the end of the 16-week period, mean shell height across all sediment treatments reached 0.98 mm (sd= 0.075) in open treatments, and 0.78 mm (sd= 0.068) in covered raceways. Mean shell length was 1.27 mm (sd=0.106) in light and 1.04 mm (sd=0.097) in dark. The effects on growth rate may be due to the direct effect of light, or caused by the increase in abundance or survival of algae in the raceway open to ambient light. Subsequent experiments are planned for summer 1999.

Recent Freshwater-Mussel Surveys of the Rio Grande in the Big Bend Region

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Relatively few unionid surveys have been reported for the Rio Grande in general, with fewer still in reaches upstream of the confluence of the Pecos and Devils rivers, despite dramatic declines in freshwater mussel populations and changes in habitat locally like those seen elsewhere in North America (Howells *et al.* 1996). At least four endemic species were known to have occurred in the Rio Grande with another reported only there and in Central Texas (Howells *et al.* 1996, 1997). Texas Parks and Wildlife Department (TPWD) began statewide unionid surveys in 1992, including areas of the Rio Grande and its tributaries. These efforts were enhanced by financial support by U.S. Fish and Wildlife Service (Section 6) and cooperation with New Mexico Department of Game and Fish with respect to *Popenaias popei* abundance and distribution, as well as interest by Big Bend National Park (BBNP) staff in 1998 and 1999. In February and March 1999, the U.S. Geological Survey (USGS) also initiated ecological studies of the Rio Grande in the vicinity of BBNP including freshwater mussels.

In 1998 (Howells 1999) and 1999, TPWD, USGS, or both examined 16 locations from a site upstream of Colorado Canyon (N 29° 17' 52.9", W 103° 57' 10.3"), Presidio County, downstream through Big Bend Ranch (BBR; TPWD operated) and BBNP to Black Gap Wildlife Management Area (BGWMA; TPWD operated), Brewster County, Texas, for the presence of freshwater bivalves. Other sites from La Linda at river kilometer (rkm) 1,140 downriver to Sanderson Canyon (near rkm 1,000) were examined previously by TPWD in February and March 1998. Staff of BBNP and Pat Simms (Presidio, Texas) assisted with some of these surveys.

No living or dead unionids of any species were found at any locations from Presidio through BBR, BBNP, and BGWMA, except for a single, relatively-recent *Potamilus (Disconaias) salinasensis (metnecktayi)* valve found upstream of Boquillas Canyon. Sites on the Rio Grande in this area generally lacked even evidence of Asian clams *Corbicula* sp.; however, both Asian clam and fingernail clam shells were found upstream of Colorado Canyon; two small Asian clam valves were found at Santa Elena Crossing; a single living Asian clam was taken at Solis; and Asian clam shells were found sporadically from Solis through BGWMA. Previous TPWD surveys further downstream found Asian clam valves from La Linda to Dryden Crossing (rkm 1,017), but did not encounter unionids until rkm 1,094 where a single long-dead *Cyrtoneis tampicoensis* valve was found. Between Dean Canyon at rkm 1,075 and Sanderson Canyon, 6 *P. popei* and 18 *P. salinasensis* shells were found. Among these, several of each species appeared recently dead (*i.e.*, no soft tissue but otherwise in very good condition).

Most substrates were cobble and boulders with associated soft silt. The limited areas found with apparently-good unionid habitat of mud, sand, and gravel probably were of recent deposition. Even small Asian clams had usually not had time to invade. Much of the deposited silt was black, seemingly richly organic, and often anoxic (suggesting major nutrient input somewhere upstream). From these survey results, it seems questionable whether any large or stable unionid populations still endure upstream of the Dean to Boquillas canyons area. Immediately downstream, both *P. popei* and *P. salinasensis* appear to persist in limited numbers. Endemic *Truncilla cognata* appears not to have been reported alive anywhere in the system since about 1972 and *Quadrula couchiana* since 1898. Living *Quincuncina mitchelli* also has been unreported in several decades.

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Range and Population Stability of Rare Species of Mussels in Southern Ontario

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Most species of freshwater mussels in Ontario have experienced severe declines in the Great Lakes due to the recent impacts of the zebra mussel (*Dreissena polymorpha*). As such, the last refugia for many native mussel species are the Grand, Thames and Sydenham Rivers in southwestern Ontario. In 1997, we surveyed 37 sites on these rivers to determine the current conservation status of 21 rare species believed to be most at risk (see TUR No. 14, p.5). In 1998, we continued this research with surveys of 20 additional sites on these rivers, as well as 9 sites on two rivers in the lower Lake Huron drainage (Ausable and Maitland Rivers).

Surveys of additional sites on the Grand (7 sites), Thames (5) and Sydenham (8) Rivers in 1998 resulted in the discovery of an additional 1, 5 and 4 species, respectively, living in these systems. Species losses are therefore not as great as originally thought. Rather, 4 (11%) of the 36 species previously known from these rivers were not found alive during the combined surveys of 1997 and 1998, and the losses for individual rivers were 24% for the Grand (8 of 33), 30% for the Thames (10 of 33), and 15% for the Sydenham (5 of 34). Although a total of 32 species were found alive, nine species now occur in fewer rivers than they did historically. The Sydenham River appears to have suffered the least in terms of species losses, and there is evidence to suggest that it may now support more species of mussels than any other tributary to the Great Lakes. Although few historical data were available for comparison, the Ausable River currently supports a remarkably diverse mussel community for such a small watershed (1142 km²). A total of 18 species were found alive, and an additional 4 species were represented by shells at the 8 sites surveyed. Although only one site was surveyed on the Maitland River, 6 live species, including two rare species, were recovered.

A major objective of the 1998 surveys was to more clearly define the ranges and population stability of nine rare species, with an emphasis on three species (*Epioblasma torulosa rangiana*, *Villosa fabalis*, and *Lampsilis fasciola*) that were recommended for national status designation on the basis of the 1997 surveys. The combined results of the 1997-98 surveys can be summarized as follows: continuous, reproducing populations of *E. t. rangiana* and *V. fabalis* were found in a 45-50 km stretch of the middle Sydenham River, and a low density population of *E. t. rangiana* was also discovered in the Ausable River. As *E. t. rangiana* is listed as Federally Endangered in the United States, with only one or two known reproducing populations left, the Sydenham River population is globally significant. *L. fasciola* was found alive in the Grand, Thames, and Maitland Rivers, with the healthiest population occurring in a 60 km stretch of the upper Grand River. Significant findings for other target species included the discovery of two species in the Sydenham River that were previously thought to be extirpated from Ontario (*Epioblasma triquetra* and *Simpsoniella ambigua*); and the complete absence of live *Obovaria subrotunda* from the study area, indicating that it has declined alarmingly and may now be extirpated. New distributional information was obtained for *Obliquaria reflexa*, *Ptychobranhus fasciolaris* and *Pleurobema coccineum* in several of the watersheds surveyed. The results of this study provided much of the information needed to proceed with recovery plans for the three listed species, and justified the consideration of six additional species for national status designation. The study concluded that the Grand, Sydenham, and Ausable Rivers are significant refuges for one or more of the target species and must be properly managed in order to conserve and protect Ontario's native freshwater fauna. This research was partly funded by the Endangered Species Recovery Fund.

Juvenile Ambloplites appear to excyst more rapidly in warm water

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We have been conducting host suitability tests using ellipse (*Venustaconcha ellipsiformis*) glochidia at the University of Minnesota (UMN) for four years. To verify our results we are attempting to collect juvenile ellipse from naturally infested darters. As part of this process we observed juvenile ambloplites excysting more rapidly in warm water.

Darters living among ellipse and other mussels were collected from the Zumbro River in Dodge County, Minnesota on November 5, 1998 and held at two locations. Eleven fantail darters and three blackside darters were brought to the MN DNR Lanesboro Area Fisheries Headquarters and held in static aquaria at $21 \pm 2^\circ\text{C}$. Eight fantail darters and one blackside darter were held at the University of Minnesota Wet Laboratory in flow-through aquaria at $11^\circ\text{C} \pm 1^\circ\text{C}$. Fish held at 21°C were fed frozen brine shrimp approximately five times a week. Fish held at 11°C were fed frozen brine shrimp or chironomid larvae once each week. All fish were exposed to a natural photoperiod. Tanks were siphoned and siphonate was searched for juveniles approximately weekly. Test fishes were removed from the study after they shed their glochidia.

Juvenile mussels excysted more rapidly at 21°C than at 11°C . All juveniles held at 21°C excysted during the first month of captivity (Figure 1). At 11°C , juveniles excysted throughout the winter and were still being collected as of March (Figure 2).

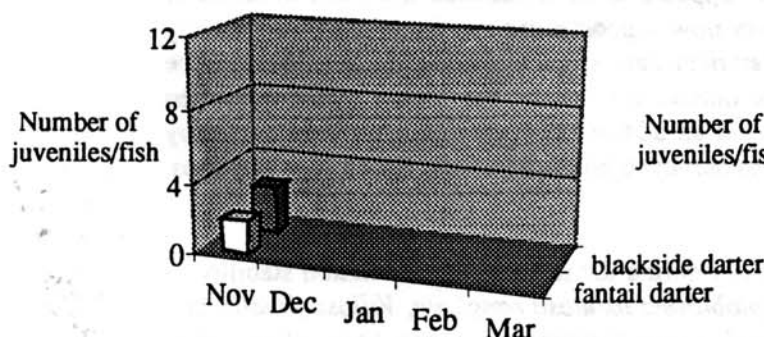


Figure 1. Juvenile Ambloplites excystment periods from darters held at 21°C .

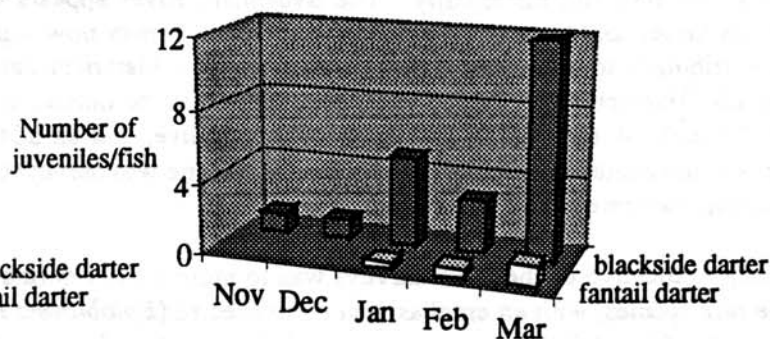


Figure 2. Juvenile Ambloplites excystment periods from darters held at 11°C .

Although juvenile excystment rates varied dramatically between the two locations, this may have been due in part to factors other than water temperature. Differences between the two holding facilities include aquarium water exchange rate, feeding rate, fish exposure to people, and light source. However, the extended juvenile transformation period at a cooler temperature is similar to that observed among flat floaters (Barnhart and Roberts 1997).

We will attempt to identify juveniles to species by comparing glochidial shell characteristics and dimensions with those reported in the literature and with known glochidia from the Bell Museum of Natural History.

Support for this study was provided by the Minnesota Legislature, as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Environmental and Natural Resources Trust Fund, University of Minnesota Undergraduate Research Opportunities Program, and Bell Museum of Natural History.

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MUSSEL AND FISH DISTRIBUTIONS IN THE LITTLE FORK AND BIG FORK RIVERS, MINNESOTA

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With Minnesota's recent increase in listed mussels (from 4 to 20 species) the need for distribution and life history information has grown. The molluscan fauna in several Minnesota watersheds has never been thoroughly surveyed. Very little survey work has been conducted in the Lake of the Woods drainage in northern Minnesota (Graf 1997). The Little Fork River, 4789 km², and Big Fork River, 5343 km², flow north to the Rainy River; Minnesota's border with Canada. Much of both rivers flow across the flat bed of Glacial Lake Agassiz. Pine and aspen forests cover much of the land in the basin, with a small number of ranches (Waters 1977).

Mussel and fishes were collected at twenty-five sites in each watershed. We used snorkeling equipment and SCUBA to collect mussels, and electrofishing and seines to collect fishes. Vouchers were deposited at the Bell Museum of Natural History. Fatmucket was observed at nearly every site. Pocketbook was the second most common species followed by equal numbers of giant floater, cylindrical papershell, and black sandshell. Minnesota listed mussel species observed included black sandshell, creek heelsplitter, and fluted shell; listed fishes included northern brook lamprey and lake sturgeon. Other mussels observed include white heelsplitter, paper pondshell, and creeper. Average live mussel density was 3 mussels/m² and ranged between 0-32 mussels/m².

Mussel and fish abundance data were analyzed for simple linear relationships. Of 1590 comparisons only 16 had coefficients of determination (R^2) > 0.5 and p-values < 0.05 (Table 1).

Table 1. Fish and mussel taxa with strong linear correlations.

Mussel Taxa	Fish Taxa	
	Big Fork River	Little Fork River
black sandshell (<i>Ligumia recta</i>)	Percidae	
creek heelsplitter (<i>Lasmigona compressa</i>)	rock bass (<i>Ambloplites rupestris</i>)	
cylindrical papershell (<i>Anodonta</i> <i>ferussacianus</i>)	common shiner (<i>Luxilus cornutus</i>)	blackside darter (<i>Percina maculata</i>)
fatmucket (<i>Lampsilis siliquoidea</i>)	longnose dace (<i>Rhinichthys cataractae</i>), river darter (<i>Percina shumardi</i>)	emerald shiner (<i>Notropis atherinoides</i>), pumpkinseed
pocketbook (<i>Lampsilis cardium</i>)	black crappie (<i>Pomoxis nigromaculatus</i>)	white sucker (<i>Catostomus commersoni</i>) mimic shiner (<i>Notropis volucellus</i>), river darter
Anodontinae		golden redhorse (<i>Moxostoma erythrurum</i>) pumpkinseed (<i>Lepomis gibbosus</i>)
Lampsilinae	longnose dace, blacknose dace (<i>Rhinichthys atratulus</i>)	

Most mussels depend on host fishes for transformation from glochidium to juvenile, and one predicts a relationship between their distributions on some level. Strong relationships may be few because the relationships are more complicated. These results suggest that host requirements for these mussels may be broader than currently documented. In addition, fish are more mobile than mussels, and most species are shorter lived. It may be that the persistence of certain components of a fish community (e.g. particular species, feeding guild, etc.) over decades is a more important independent variable. Future data analysis will incorporate cluster analysis and fish data from the 1970s and the 1980s.

Financial and logistic support for this survey was provided by: the Minnesota Legislature, as recommended by the Legislative Commission on Minnesota Resources from the Minnesota Environmental and Natural Resources Trust Fund, University of Minnesota's Undergraduate Research Opportunities Program, Science Centrum, the James Ford Bell Museum of Natural History, and Chantel Cook, Jeremy Cable, Nancy Berlin, and Brenda Stauffer of the National Forest Service.

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CONTINUATION OF A UNIONID SURVEY IN THE ROOT RIVER SYSTEM, SE MINNESOTA: 1998 EMPHASIS ON THE SOUTH BRANCH AND SMALL TRIBUTARIES

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The headwaters of the South Branch Root River (Fillmore and Mower Counties, MN), is about 20 miles long, and surrounded by farmland, a golf course, and a state park which includes an extensive cave system.. A comprehensive study of the area is being conducted, particularly in the karst areas E of the golf course, and includes this mussel study, an invertebrate and fish study, and dye tracing in selected sink holes. Citizen water quality monitoring is also a study component.

During June-July 1998 we sampled nearly 120 sites in the South Branch Root River system, by hand picking and raking, and did extensive sampling at several South Branch sites. We also sampled all available accesses on Canfield, Forestville, and Etna Creeks and most of the smaller creeks. Living unionids were found at 10 sites, and empty shells were found at 10 additional sites. No evidence of unionids was found at over 95 sites, most of which were on very small creeks. The maximum living mussel densities are about 1/m². No site warranted quantitative sampling. In 1998 we found the following unionids in the South Branch System:

LIVE SPECIES:	* = Found in 1994	# Alive
1. <u>Pyganodon grandis grandis</u> (Say 1829)		13
2. <u>Anodontoidea ferusacianus</u> (Lea 1834)		36
3. <u>Strophitus undulatus undulatus</u> (Say 1817)		5
4. * <u>Venustaconcha e. ellipsiformis</u> (Conrad 1836)		22
5. <u>Toxolasma parvus</u> (Barnes 1823)		16
6. * <u>Lampsilis siligoidea</u> (Barnes 1823)		6
TOTAL ALIVE:		98

DEAD SPECIES (empty shells only)

7. Lasmigona compressa (Lea 1829)
8. *Lampsilis cardium Rafinesque 1820
Empty shells (only) found in 1994
9. Lasmigona costata (Rafinesque 1820)

Although river habitat could be improved in at least 10 areas, such as diking a gravel pit, and reducing direct animal and other farm impacts, we were impressed with the increasing number of grassy waterways in the South Branch Root River system. During a similar 1994 project on the entire Root River System we only found 5 living mussels at two of 117 sites. Thus, it takes intense looking to find living mussels in the Root River System.

**The decline of the tidewater mucket, *Leptodea ochracea* (Say, 1817)
in Halfway Pond, Massachusetts**

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The tidewater mucket, *Leptodea ochracea* (Say, 1817), is distributed along the Atlantic coast of North America and is often found on sandy substrates with little or no flow. It is typically found at low densities across its range in northeastern North America (Smith, 1991; Strayer et al., 1994; Strayer & Smith, 1996; Strayer & Jirka, 1997) and is listed as a species of special concern in Massachusetts (Williams et al., 1993). Halfway Pond, in Plymouth, Massachusetts, is one of the few remaining habitats in Massachusetts for this species, but live specimens have not been collected there since 1981. Museum collection records show specimens collected in Halfway Pond throughout the twentieth century.

In summer, 1995, the pond was surveyed in an attempt to determine if the tidewater mucket had been extirpated. Surveys were conducted by two individuals working together at six separate sites around the pond by hand picking and snorkeling for 15-30 minutes at each site. Of 213 unionids collected, including six different species, only one specimen was identified as *Leptodea ochracea*. Other species found in the pond include *Elliptio complanata* (Lightfoot, 1786), *Lampsilis radiata radiata* (Gmelin, 1791), *Alasmidonta undulata* (Say, 1817), *Strophitus undulatus* (Say, 1817), and *Pyganodon cataraeta* (Say, 1817).

The single *Leptodea ochracea* specimen, as well as the only specimens of *Strophitus undulatus* and *Pyganodon cataraeta* found in the study, were found in the Agawam River outflow area in the southwest corner of the pond along with four of the five other unionid species occurring in the pond. The outflow area had a high proportion of benthic macrophytes in a sandy substrate- typical habitat for *L. ochracea*. Increased species diversity in this area (five of six total) and increased mean size of the most common species, *Elliptio complanata*, lends to the theory that the outflow area is a vital microhabitat for freshwater mussels in Halfway Pond. Similar increased densities of filter-feeding insects have also been observed in lake outflows (Allan, 1995, p. 142).

This study confirms the decline of *Leptodea ochracea* in Halfway Pond, Massachusetts over the last 15 years. If not already gone, this species may disappear from the pond once the remaining few individuals die. The Agawam River outflow appears to be an important refuge for the continued survival of at least two of the remaining species in Halfway Pond.

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Tennessee Wildlife Resources Agency Progress Report 1998-1999
Restoration of federally listed mussel species within
the territorial boundaries of Tennessee and Alabama

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Cooperating Projects

French Broad River /Tennessee River (mussels)

In August 1998, assisted Dr. Jim Lazer, TN Research Unit and graduate students in evaluating mussel reintroductions made in 1997 into the French Broad River at Campbell Island (FBRM 8.0). Approximately 7,000 mussels of six common species (*Amblema plicata*, *Cyclonaias tuberculata*, *Fusconaia ebena*, *Obliquaria reflexa*, *Quadrula metanevra*, and *Q. pustulosa*) were collected from the Tennessee River in 1997, and reintroduced into the French Broad. Because of zebra mussel concerns, all mussels were scrubbed and held in quarantine before being moved to the river. Excellent survival rates were noted for all six species during the evaluation of the reintroductions. In October 1998, an additional 2,500 mussels of two species (*C. tuberculata* and *Q. pustulosa*) were collected from the Tennessee River at Diamond Island. These mussels are currently being held in quarantine at the TN Research Unit. All mussels will be relocated to the French Broad River in the spring 1999. The removal of mussels from the Tennessee River at Diamond Island had a dual purpose. A joint Section 6 cooperative project between Tennessee and Alabama is ongoing to inventory federally listed mussel species in the mainstem Tennessee River. Most of these mussels are big river species known to occur in the Ohio River system and are considered the Ohioan faunal group. These include: *Cyprogenia stegaria*, *Lampsilis abrupta*, *Obovaria retusa*, *Plethobasus cooperianus*, *P. cicatricosus*, and *Pleurobema plenum*. The purpose of this project is to locate gravid big river species for life-history and propagation studies which are being done by Dr. Jim Lazer, TN Research Unit. The inventory of federally listed species is a joint Section 6 project between Don Hubbs, Tennessee state malacologist and Jeff Garner, Alabama state malacologist. During the collection of 2,500 mussels for Dr. Lazer, three gravid federally listed species (*Cyprogenia stegaria*, *Lampsilis abrupta*, and *Plethobasus cooperianus*) were found. All three were taken to the TN Research Unit for life-history and propagation studies.

In September 1998, at the request of the TWRA, a list was prepared of all mussel species known to occur in the Valley and Ridge Physiographic Province of the French Broad River. With assistance from Dr. Paul Parmalee, Curator of Mollusks, McClung Museum, published reports were searched including archeological material examined from Native American shell mounds. Peggy Shute, from Conservation Fisheries, Inc., also provided old shell material recently picked up along the banks of the French Broad. A similar list is in preparation for the Holston River. Based on this information and best professional judgement, it was determined that 85 mussel species or about 85% of the mussel diversity known from the entire Tennessee River system occurred in the French Broad. A relict extant population of approximately eight species still survives in the river in low densities. Since mussel restoration of the river involves federally listed species, it was determined that 17 occurred historically in the river including one endangered aquatic snail (*Athearnia anthonyi*). This information was provided to TWRA as justification for reintroduction of federally listed species and other mollusk species. This information was forwarded to the U. S. Fish and Wildlife Service (USFWS) who sent out a public notice notifying the public, government agencies, the scientific community, conservation organizations, and other interested parties to submit written comments or recommendations to the USFWS concerning any aspects of this notice by February 10, 1999. The reintroduction of federally listed mollusk species into the French Broad and Holston Rivers will be designated nonessential experimental populations (NEP) under section 10(j) of the Endangered Species Act of 1973.

Conasauga River

In August 1998, ten miles of the Conasauga River in Tennessee was float-surveyed by canoe from Cherokee National Forest to the TN/GA state line. Snorkel searches for mussels were made with Dr. Paul Johnson (SARI), Robert Butler (USFWS), and summer interns. Day trips were also made to specific sites for more intensive sampling. The purpose of the survey was to document the present status of freshwater mollusks in the Conasauga River system, and locate federally listed species for life-history studies. Life-history studies are being conducted by Dr. Paul Johnson. At least 40 mussel species are documented historically from the river and currently, nine are federally listed. Three of the nine federally listed species (*Medionidus parvulus*, *Pleurobema perovatum*, and *Ptychobranhus greeni*) were found alive during the float-survey but, in extremely low numbers. None were gravid for life-history studies. This is an on-going project and sampling will continue this summer (1999).

Powell River

In September 1998, met with Jess Jones and Laura Zimmerman (VA Research Unit) to survey mussels on the Powell River at Buchanan Ford (PRM 99.1). This site is being considered as a reintroduction site for cultured federally listed *Epioblasma capsaeformis*. Specimens are being cultured under direction of Dr. Richard Neves at the VA Research Unit. This species was last reported in the Powell River in the mid-1980s and is now believed extirpated from the river. Buchanan Ford used to be one of the best locations for freshwater mussels in the Powell. Seventeen live species were reported during the present survey including four (*Dromus dromas*, *Epioblasma brevidens*, *Quadrula intermedia*, and *Q. sparsa*) federally listed species. No live or relict shells of *E. capsaeformis* were found.

Clinch River

At various dates from July-October 1998, met with Jess Jones and Laura Zimmerman, both tech-

nicians under Dr. Richard Neves at the VA Research Unit to show them where federally listed mussel species occurred in the Clinch River. Numerous sites on the Clinch from below Sneedville (CRM 175) upstream to Horton Ford (CRM 199) were identified for the purposes of finding the most abundant populations of federally listed species for propagation. Finding and locating gravid females is expensive without this knowledge and this information is crucial for restoration success. All brood stock used for mussel propagation/augmentation were collected in 1998 from the Tennessee side of the Clinch. Gravid specimens of six federally listed species (*Cyprogenia stegaria*, *Dromus dromas*, *Epioblasma brevidens*, *E. capsaeformis*, *Lemiox rimosus*, and *Hemistena lata*) were found. One non-listed species (*Epioblasma triquetra*), considered rare in the Clinch was also propagated. With the exception of *D. dromas*, all the above mentioned mussel species were successfully propagated at the VA Research Unit. A total of 33,3639 juveniles were cultured and released into the Clinch and, 1,706 juvenile *E. capsaeformis* were released into the Powell River. More individuals are currently under culture at the VA Research Unit. It is anticipated that by early March, additional juveniles will be released back into the Clinch. This work is being done under permit through the Tennessee Wildlife Resources Agency.

In September 1998, met with Dr. Richard Neves, Bill Henley, Jess Jones, and Laura Zimmerman all from the VA Research Unit to survey mussels in the Clinch River at Horton Ford (CRM 199). Horton Ford was chosen as one of the release sites and included two additional sites Wallen Bend (CRM 192.5) and Sneedville (CRM 174.8). Live specimens of other federally listed species were observed during our searches for targeted species. These include: *Fusconaia cor*, *F. cuneolus*, *Pleurobema plenum*, and *Quadrula cylindrica strigillata*.

In October 1998, a media event was held on the Clinch River at Horton Ford for the release of 2,500 juvenile *E. brevidens*. Representatives from the USFWS (Regions 4 and 5), VA Research Unit, TWRA, TVA, USGS, and local newspapers and television crews were present. The press coverage was excellent for showing the plight of our native mussels.

Clinch/Powell Quadrat Sampling

Beginning in 1979, and continuing in 1983, 1988, and 1994, quantitative sampling for freshwater mussels has been conducted on the Clinch and Powell Rivers at numerous sites in both Tennessee and Virginia. Both rivers will be resampled this year (1999) beginning in mid-July. Quantitative sampling has produced excellent long-term trend data on the health and recruitment of mussels in both rivers. Anyone interested in participating please contact Steve Ahlstedt.

Pleurocerid riversnail restoration (Tennessee and Alabama)

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Holston and French Broad Rivers (snails)

Spiny riversnails (*Io fluviatilis*), reintroduced into the Holston and French Broad Rivers in 1996 and 1997, are surviving and dispersing. In August 1998, an additional 500 specimens were moved from the Clinch into the Holston at Surgoinsville (HRM 118) and 600 were moved into the French Broad at Campbell Island (FBRM 8.0). This project was done with assistance from Tennessee Wildlife Resources Agency biologist Mark Fagg and U. S. Fish and Wildlife Service biologist Dick Biggins. This brings the total number of snails reintroduced into the Holston to 1,100 individuals and 1,200 in the French Broad. All snails were collected by snorkeling, measured

(lengths), and marked with a numbered tag which was glued to the outer shell. The Holston River population was of concern since no specimens from the previous two years could be found. However, under exceptional sampling conditions (low flows, clear water, bright sunny day), snails were found and appeared to be doing well. Some had moved approximately 150 feet upstream and are probably moving out into the main current of the river. One small specimen 22.4 mm was found without a tag which may be an indication of reproduction because only four specimens smaller than 22.4 mm were released in either 1996 or 1997. Snail populations in the French Broad River continue to survive since we have found specimens from the previous two years. As in the Holston, snails are dispersing and becoming increasingly hard to find because of the abundance of aquatic vegetation. Snails have been observed grazing on top of the vegetation and are well hidden under it. Some individuals have been found dead in muskrat middens and overall, many specimens are showing signs of severe shell erosion. Snails will continue to be monitored for adult survival and reproductive success. Because snails have survived in the French Broad since 1996, this has set the stage for reintroduction of mussels in the river by Dr. Jim Lazer of the TN Research Unit. Spiny riversnail reintroductions were planned for the Little River (Blount County) in 1998; however, this work will be initiated in 1999. Spiny riversnails were apparently extirpated from the Little River around the turn of the century when the drainage was logged and the lower river impounded from the backwaters of Ft. Loudoun Reservoir (Tennessee River).

Pigeon River (French Broad River system)

Pleurocerid river snails of four common species (*Elimia simplex*, *Leptoxis praerosa*, *Pleurocera canaliculata*, and *P. curta*) were collected from the Nolichucky River from 1996-1998, and reintroduced into the Pigeon River near Newport, Tennessee. The river has been polluted by paper plant effluent originating from North Carolina for almost 100 years. All pleurocerid river snails are extirpated below the outfalls of the plant and no records exist on the historical occurrence of snails in the Tennessee portion of the river. The Pigeon River is beginning to recover (better water quality (clarity), greater diversity of fish and benthic macroinvertebrates) because of stricter EPA color and effluent standards. The river has been monitored cooperatively since 1985 by TVA, TWRA, Oak Ridge National Laboratory, and more recently (1996-1998) by the U. S. Geological Survey (NAWQA). Because of the recovery potential of fish and benthic macroinvertebrates, it was determined that snails would be reintroduced to see if they could survive and reproduce. Successful snail reproduction will determine if native mussels can be reintroduced and recovered in the Pigeon. Snails were first reintroduced in 1996 and 1997 (approximately 25,000 individuals) and have continued to survive in the river. In 1998, approximately 25,000 more were placed in the river bringing the total to 50,000. We are using snail species taken from the Nolichucky River that probably occurred historically in the Pigeon. Both the Nolichucky and Pigeon Rivers are tributaries of the upper French Broad River system. The snail reintroductions were done with the assistance of the TWRA biologist Mark Fagg. This project will continue until reproduction is observed and if successful, will set the course for future mussel restoration.

Locust Fork (tributary to Black Warrior River, AL)

Snail collections were made in August 1998, in Larkin Fork for *Leptoxis plicata*, a pleurocerid river snail proposed for federal listing. This work is being by Dr. Paul Johnson, Southeast Aquatic Research Institute (SARI). Dr. Johnson is working on transport holding methodologies, life-history, propagation, and feeding of the species. Working in conjunction with Jeff Garner, Alabama state malacologist, 168 specimens were collected and moved to holding facilities at the Tennessee Aquarium. Since the collection of this species in August, the snail was federally listed by the USFWS. The goal of this project is to learn about the species life-history and culture large numbers in captivity, then release them back in streams within the historic range of the species.

The Freshwater Mussels of the Lower Missisquoi River in Vermont: Current Status and the Potential for a Refugium from Zebra Mussel Impacts

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In 1998, we conducted a survey of a 26 km reach of the lower Missisquoi River in Northwestern Vermont in the Lake Champlain Basin between Lake Champlain and the principal fall line at Highgate Falls. This reach is a large (100m mean width) low-gradient river. The survey focused on documenting the current status of seven regionally rare freshwater mussel species: *Ligumia recta* (black sandshell), *Lasmigona costata* (fluted shell), *Anodontoidea ferussacianus* (cylindrical papershell), *Lampsilis ovata* (pocketbook), *Leptodea fragilis* (fragile papershell), *Potamilus alatus* (pink heelsplitter), and *Pyganodon grandis* (giant floater). I also assessed the potential of the river to serve as a refugia for these species from zebra mussel impacts, as the latter four species are known to occur in Lake Champlain (Fiske and Levy 1995), from which they are rapidly disappearing due to overgrowth by the invasive zebra mussel (*Dreissena polymorpha*).

We used a two phase sampling approach modeled after Smith *et al.* (1995), modified for large-river conditions. Sampling was conducted via SCUBA and snorkeling: qualitative surveys (timed searches, 44 sites) were first conducted to assess species distribution and habitat-species relationships. This data was used to stratify the river into high and low density strata. Quantitative surveys then were conducted via sampling from 0.25m² quadrats with substrate excavation and sieving, primarily in high - density strata.

Overall, 12 species were observed. Of the target species, four were moderately abundant in high density strata, which were widely distributed enough to suggest that the populations of these species are viable: *Lampsilis ovata* (0.9 - 2.2/m²; 8 sites), *Anodontoidea ferussacianus* (0.1 - 2.3/m²; 8 sites) *Leptodea fragilis* (0.3 - 0.10/m²; 4 sites), and *Pyganodon grandis* (0.1 - 1.0/m²; 4 sites). *Potamilus alatus*, *Ligumia recta*, and *Lasmigona costata* were rare: Seven live specimens of the former were observed during quantitative surveys in the lower section of river near Lake Champlain, which appears to support a small population. No live specimens of *L. costata* were observed, although 16 spent shells were found; and three live specimens of *L. recta* were observed. These observations were obtained from 28 hours of underwater search time during the qualitative sampling phase and from 13 quantitative sites. *L. costata* and *L. recta* are especially rare in the Champlain Basin and are known only from a few rivers emptying into Lake Champlain in Vermont (Fichtel and Smith 1995).

Calcium levels appear to be too low in the Missisquoi to support zebra mussel populations. Measurements made for this study and by the VTDEC (1998) ranged from 5.4 and 15.3 mg Ca²⁺/l, which is considerably below limiting thresholds reported by several authors (Hinks and Mackie 1997; Mellina and Rasmussen 1994; Ramacharan *et al.* 1992). Thus it appears unlikely that the Missisquoi River will become heavily colonized by zebra mussels.

The lower section of the Missisquoi River is clearly critical habitat for the rarer species found in Vermont, given the progressing invasion of Lake Champlain by zebra mussels. *P. alatus*, *P. grandis*, and *L. fragilis* have considerable lake-dwelling populations (also, fewer numbers of *L. ovata* and *A. ferussacianus* have been found in the lake) that are rapidly vanishing due to zebra mussel invasion. Thus the lower Missisquoi appears to offer an important refugium where these species can persist despite zebra mussel invasion.

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More *Anodonta woodiana*

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Virgilio Liverani of Faenza, Italy, recently sent to me some magnificent specimens of *Anodonta woodiana*. They were found in concrete irrigation channels and earthen ditches running from the River Po to Bologna. To quote Mr. Liverani: "it seems that the spreading started about nine-ten years ago, as lots from that date are made of *cygnea* (same channel) and only after *woodiana* appears. Now they find a *cygnea* in one hundred *woodiana*. Some minor channels are now overcrowded and the shells are small and stout and the indigenous bivalves and gastropods very reduced in number. They probably came through the introduction of fishes from east Europe (Romania, Hungary, etc.) that have been released for replenishment of game stock. The fishes are carp..."

Specimens recently were collected from Cebu Island, Philippines, as well as the previously reported occurrence on Luzon. *Anodonta woodiana* now occurs as an exotic in France, Hungary, Italy, Romania, Singapore, the Philippines, Sulawesi, Indonesia, the Dominican Republic, and Costa Rica. It probably occurs in Panama as well.

Potential hosts for *Villosa constricta*

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Fishes were infested in a slurry of glochidia and were maintained at 55-60°F.

Species (n) = # fish infected	Parasitic Duration (days)	#Glochidia Attached	#Juveniles Recovered
Longnose Gar (1)	19	2	0
Channel Catfish (3)	21	54	0
Rosyface Shiner (3)	24	10	0
Sand Shiner (3)	24	25	1
Silverjaw Minnow (2)	31	8	0
Bluntnose Minnow (4)	33	32	0
Fathead Minnow (4)	21	31	0
Central Stoneroller (1)	28	30	4
Striped Shiner (2)	26	5	0
Creek Chub (1)	33	39	0
Bluehead Chub (3)	0	0	0
Northern Hogsucker (3)	21	10	0
White Sucker (1)	17	18	0
Shorthead Redhorse (1)	14	53	0
Goldfish (3)	24	6	3
Siamese Fighting Fish (2)	21	21	1
Blackside Darter (3)	28	9	1
Tessellated Darter (1)	28	11	2
Logperch (2)	28	72	1
Yellow Perch (1)	28	324	2
Bluegill (11)	21	52	0
Redbreast Sunfish (1)	19	22	1
Longear Sunfish (5)	26	113	2
Pumpkinseed (2)	28	18	0
Smallmouth Bass (1)	26	145	5
Rockbass (3)	21	111	1
Bullfrog tadpole (1)	31	74	4

A proposed study of the Yellow Lampmussel, *Lampsilis cariosa* in the Maritime Provinces of Canada.

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Nova Scotia lies in a relatively isolated corner of continental northeastern North America and has a low diversity of freshwater mussel species compared to some nearby provinces and states. As a result of limited post-glacial colonization and recent loss of habitat, for both the mussels and host fishes, the populations of some species are highly vulnerable. Of the eleven species and subspecies reported, one in particular, *Lampsilis cariosa* (Say, 1817) is considered most vulnerable. The main population occurs in the Sydney River, in Cape Breton Island, Nova Scotia. It was first reported by Clarke and Rick (1963). Subsequently it was recorded in the St. John River in New Brunswick. (Clarke, 1981) The Sydney River population was further documented by staff of the Nova Scotia Museum of Natural History during field work in 1989-90 (unpublished).

A study of the status of *L. cariosa* in New Brunswick and Nova Scotia will be carried out by the author in the summer of 1999, supported by funding from the Committee on Status of Endangered Wildlife in Canada (COSEWIC), the Province of New Brunswick and the Acadia Centre for Conservation Biology, Nova Scotia.

Any information on the status of *L. cariosa* populations and the identity of its fish host, in the Maritime Provinces or throughout its range to the south would be appreciated.

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