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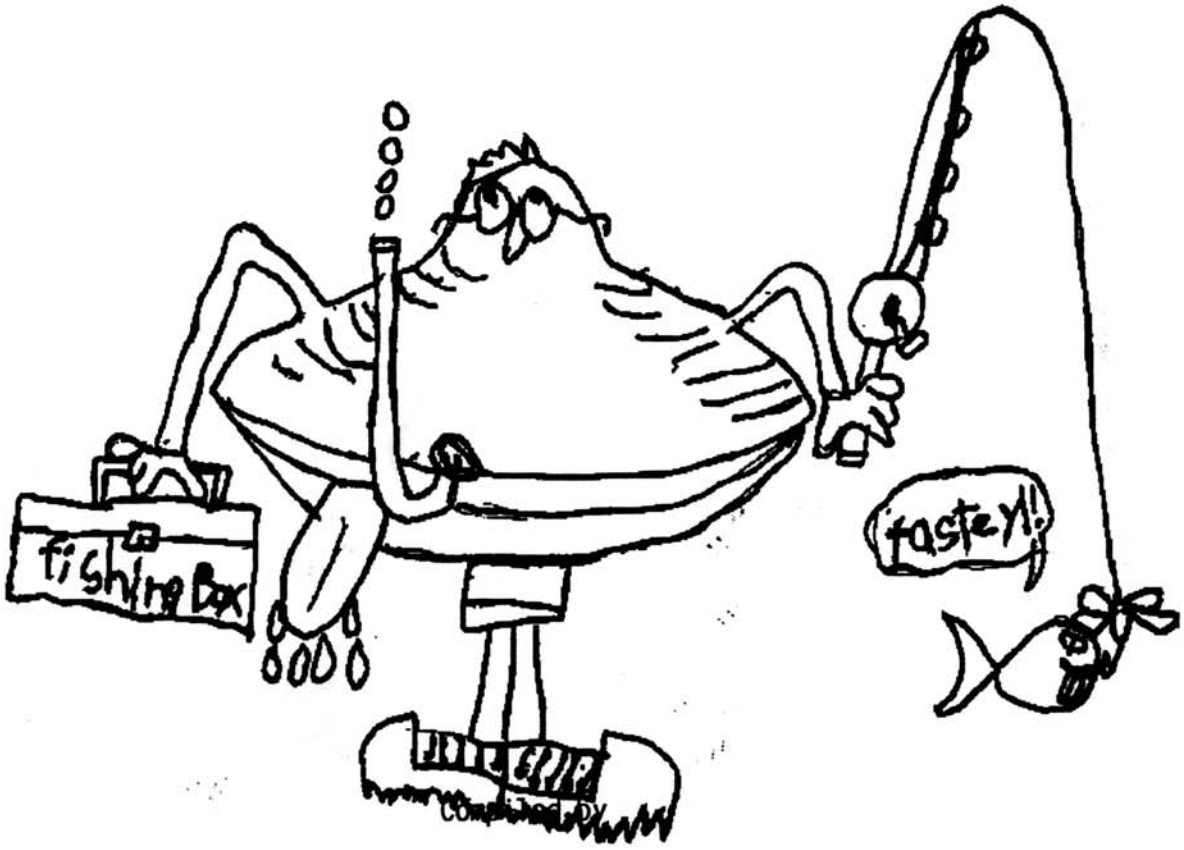
Triannual Unionid Report

Report No. 9

May 1996

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



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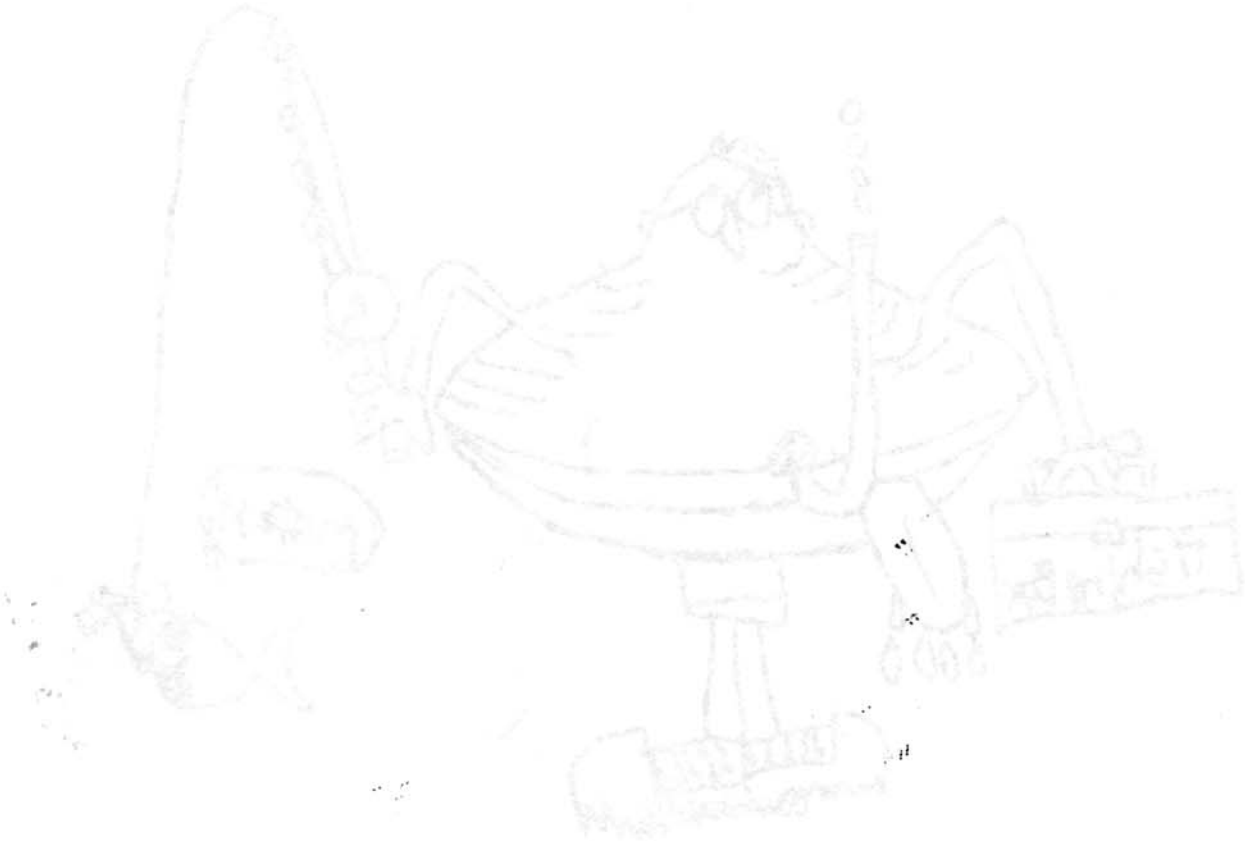
NOTE: The intent of this report is to expedite the exchange of information in an informal format. Report submissions were solicited from individuals and agencies involved in unionid conservation. The submissions were not edited. They were copied as received and assembled into the report.

Cover: The mussel on the cover was drawn by an elementary school student as part of a contest to design the character "Russel The Mussel" held by the Tennessee Aquarium, Chattanooga, Tennessee.



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Cope, W. G. and D. L. Waller. 1995. Evaluation of freshwater mussel relocation as a conservation and management strategy. ABSTRACT FROM: ***Regulated Rivers: Research & Management***. 11:147-155.---------- 16.

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The Unionid Mollusks of the Big and Little Nemaha Rivers of Southeastern Nebraska and Northeastern Kansas

The unionid mollusks of the Big Nemaha and Little Nemaha Rivers have been relatively unstudied as have the unionids of Nebraska and northern Kansas in general. In conjunction with a project to document the unionid distributions of this region, 87 sites were collected in the Nemaha basins between 1976 and 1995. Sites were collected by hand or with the use of a garden rake under low water conditions.

A total of 28 taxa were confirmed for the region in this study. One bivalve, Alasmidonta marginata, was documented through a museum record. In addition, twenty-seven taxa were collected during this survey of the Nemaha basins. Twenty-one of these document taxa first reported, though apparently unvouchered, by Aughey (1877). The remaining six taxa, Arcidens confragosus, Quadrula p. pustulosa, Obovaria olivaria, Truncilla donaciformis, Toxolasma parv s, and Lampsilis t. teres are first reported from the study area in this survey.

The unionid fauna of the region appears to have been largely destroyed. Most of the bivalves collected during the survey were represented solely by weathered or chalky shells. Only eight taxa were collected live or as relatively fresh shells, suggesting a possible decrease in the documented unionid fauna of the study area of as much as 71%. The most widely distributed bivalves recovered were Amblema p. plicata, Fusconaia flava, Strophitus u. undulatus, and Ligumia subrostrata. With one exception, all occurrences of each of these taxa were as weathered shells only. A single specimen of L. subrostrata was collected as a fresh shell at one location in northeastern Kansas.

The demise of the unionid fauna of the Nemaha basins is no doubt the product of a number of factors, however, channelization is probably the most significant of these. Beginning in 1904, both river basins were heavily channelized with a resultant loss of 164 river miles or 11.4 percent of their original stream mileage. Channelization was most heavily concentrated in the larger streams of the region where the greatest bivalve diversity was probably once located. Additional factors impacting unionids in the region include siltation, feedlot runoff and, probably, chemical pollution from pesticides and herbicides.

Aughey, Samuel. 1877. Catalogue of the land and freshwater shells of Nebraska. *Bulletin of the U.S. Geological and Geographical Survey of the Territories* 3(3): 697-704.

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Zebra mussels may kill unionids without fouling them

We have been monitoring the unionid community (*Elliptio complanata, Anodonta implicata, Leptodea ochracea*) of the freshwater tidal Hudson River through the zebra mussel invasion (1991-95). Although zebra mussels have been abundant in the river since September, 1992 (riverwide mean = 600-4000 m^{-2}), few of the unionids have been infested by zebra mussels. Infestation rates have hovered around 30%, with no difference among unionid species, and most infested animals carry only 1-2 zebra mussels. We have no idea why our infestation rates are so low. Despite these low infestation rates, the unionid community has declined sharply since the zebra mussel arrived: density is down by 56%, recruitment of young-of-year is down by 90%, and condition (body mass at a given shell length) is down by 20-50%. *Elliptio* appears to be less severely affected than the other species. We believe that these impacts have occurred not from fouling, but from competition for food: zebra mussels have reduced the biomass of phytoplankton in the Hudson to 15% of the pre-invasion levels. Our results emphasize that fouling is not the only way in which zebra mussels can strongly affect unionids; impacts through the food web must be considered as well.

A manuscript describing our findings will be submitted this month (April).

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Shells of the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) were recently discovered in the Pequest River in Warren County, New Jersey. During the months of August and September 1995, nine *A. heterodon* valves and 11 partial valves and fragments were recovered on state property by zoologists from the Division of Fish, Game and Wildlife's Endangered and Nongame Species Program (ENSP) and the Division of Parks and Forestry's Natural Heritage Program (NHP). Although no live *A. heterodon* were located, the host fish species tessellated darter (*Etheostoma olmstedi*) was abundant throughout the study area. Surveys focusing on the previously unknown site are scheduled to continue in the spring of 1996. The ENSP dwarf wedgemussel survey is made possible through USFWS Section 6 / federal aid funding.

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An Investigation Into Reproduction in a Unionid Bed Impacted by a Dam with a Hypolimnionic Drain

One of the most perplexing problems of unionid conservation is the documented loss of recruitment (reproduction) in some unionid beds. The freshwater unionid bed in the Licking River at Moores Ferry, Kentucky, is a diverse bed consisting of 29 unionid species, as well as Corbicula fluminea. Unionid densities were found to average 7.98/m^2 and C. fluminea was found to have an average density of 300.66/m^2, while, no juvenile unionids (<20 mm in length) were found (Smathers 1990). These results were supported by Kane (1990) while studying the feeding habits of muskrats. Kane (1990) sampled a total of 23 muskrat middens over an eight month period. A total of 6814 bivalve shells, comprising 13 species of unionids and C. fluminea, were collected. None of the unionid shells found were juveniles. These two studies suggested that recruitment had ceased or was dramatically decreased in this diverse unionid bed.

An objective of our present work is to determine if recruitment has ceased in this unionid bed, and if it has, to determine where in the life cycle reproduction is breaking down. Is it: 1. During gametogenesis so that eggs and sperm are not even produced?; 2. That there is no fertilization so that glochidia are not produced?; 3. That glochidia are produced, but for some reason do not infect host fishes?; 4. That host fishes are infected, but the glochidia do not properly mature and form juvenile mussels?; or 5. A combination of all these factors? Another objective of this study is to determine what effects, if any, that the hypolimnionic discharge from the dam at Cave Run Reservoir is having on the unionids in this bed. It is hypothesized that the loss of recruitment in this bed is either directly or indirectly the result of the dam, which is located approximately 35.4 km upstream from Moores Ferry. It is hypothesized that the discharge from the dam has altered both the natural temperature and flow regimes of the river.

Unionids in this bed and another bed approximately 194 km downstream from the dam have been examined on a monthly to bimontly basis for the presence or absence of glochidia. Also, five individuals of two target species, Elliptio dilatata and Actinonais ligamentina, are collected each time, and returned to the lab to determine if gametogenesis is occurring. These species were chosen because they are the most common in this bed (Smathers 1990), they represent both reproductive strategies (bradytictic and tachytictic) of freshwater unionids, and they are commonly encountered throughout their respective ranges (Oesch 1984). Fish are also collected at the same time and returned to the lab to examine them for the attachment of glochidia. Finally, drift nets are being set out for one hour at each site to determine if glochidia are being released. In addition to this, temperature and discharge data for the Licking River at Farmers, Kentucky, which is near Moores Ferry, have been obtained from the USGS. Since Farmers is an historical site, temperature and discharge data are available for recent times, as well as preimpoundment times (pre 1974). With all of these data, we hope to show that the regulated flow from the dam at Cave Run Reservoir has had an adverse effect on the freshwater unionids in this bed.

One juvenile Actinonais ligamentina has been found in the bed attached to an adult of the same species by a byssal thread, and preliminary data indicate that the production of glochidia is occurring. It is apparent that reproduction may be occurring, but that it is clearly decreased. It is not yet known what the exact reproductive success of this bed is. Preliminary data also seem to indicate that the decrease in reproduction is in part the result of either: 1. Glochidia not attaching to host fish(es); 2. The encystment period being affected by water temperature; or 3. Glochidia being prematurely expelled because of extreme water temperature changes caused by the release of water from the dam.

Literature Cited:

Kane, M.A. 1990. The predation of freshwater bivalves by muskrats (Ondatra zibethicus) in the Licking River, at Moores Ferry, Kentucky. MS Thesis, Eastern Kentucky University, Richmond, Kentucky. 64 pp.

Oesch, R.D. 1984. Missouri naiades: a guide to the mussels of Missouri. Missouri Department of Conservation. 270 pp.

Smathers, K.L. 1990. An analysis of a bivalve (Mollusca: Bivalvia) community in the Licking River, at Moores Ferry, Kentucky. MS Thesis, Eastern Kentucky University, Richmond, Kentucky. 65 pp.

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The Alabama Game and Fish Division malacology program got under way a little over a year ago. Most of the first year was spent getting equipped for field work, locating study sites for mussel population assessments and perfecting data collection methods. Following is a list of current ongoing activities.

Mussel Population Assessments

Three sample stations were established on the Tennessee River during the summer of 1995. These stations will be quantitatively sampled periodically (annually or biennially) in order to monitor the health the populations. Due to time constraints, data were collected from only one site last year. During the 1996 field season, work will continue on the Tennessee River and sites will be established on the Alabama River system.

In addition to the quantitative population assessments, a catch per unit effort study is being carried out. These methods, which are much less demanding on time and resources, allow a larger portion of the state to be sampled. The sampling is aimed at determining the effects of commercial harvest on mussel populations. These data, used along with the quantitative assessments, should give an accurate picture of the health of Alabama's mussels.

Reproductive Biology Studies

In conjunction with the University of North Alabama, studies on the reproductive biology of *Potamilus alatus*, *Obliquaria reflexa* and *Megalonaias nervosa* are underway. Monthly samples have been collected since July 1995. Histological sectioning of the specimens is underway. Quantitative assessment of gametogenesis in the specimens will be carried out later this year, beginning with *P. alatus*.

Mussel Pamphlet

Alabama Game and Fish Division has funded the production of a pamphlet on commercial mussels in the state. Each commercial species is described along with a full color photograph. The pamphlet also contains introduced species and endangered mussels which may be confused with commercial species. It is being prepared by Monte McGregor and is near completion.

(5)

Frederick W. Schueler. Biological Checklist of the Kemptville Creek Drainage Basin, Bishops Mills, RR#2 Oxford Station, Ontario K0G 1T0 Canada.

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A SURVEY OF THE UNIONID MUSSELS OF THE RIDEAU AND LOWER OTTAWA DRAINAGES (in Ontario).

A.H. Clarke (Freshwater Mollusks of Canada, 1981), working from the now Canadian Museum of Nature (CMN) collection, mapped 15 unionid species in Eastern Ontario. In 1995, in a survey commisioned by the Ontario Ministry of Natural Resources, I found *Elliptio complanata*, *Lampsilis radiata*, & *Anodonta grandis* ubiquitously. In order of decreasing abundance, *Lasmigona compressa, L. costata, Strophitus undulatus, Lampsilis ventricosa, & Anodontoides ferussacianus* are widespread in suitable habitat. *Ligumia recta* is found at several sites near Ottawa. I found *Leptodea fragilis*, *Elliptio dilatata*, & *Ligumia nasuta* at single sites, but not *Obovaria olivaria*, *Alasmidonta undulata*, or *A. marginata*, though I did not search the few sites where they had been known. I found no evidence that any species had been extirpated, but found introduced Zebra Mussels (*Dressensa polymorpha*) only in the Rideau River at Monotick.

Most of the unionids in the Ottawa area were found by collections made in 1881-1882. This & subsequent CMN collecting was not directed towards a systematic survey, & resulted in no collections at all from the Kemptville Creek, Jock, & Tay drainages, & very few from the Mississippi or South Nation drainages. It is still possible to find almost all of the local species in a couple of years. The largest valve collected in 1993-1995 was larger than the largest found historically (1881-1980) in seven species, while there were only four species where the largest historic valve was larger (about 200 lots in each sample), & the relative abundances of species were similar.

The Jock River supports a rich fauna, while diversity on Kemptville Creek peaks below the Oxford Mills dam. Shells were abundant at Perth on the Tay. All three streams had very few unionids at their mouths in the Rideau Canal. One station on the Rigaud supports several species. The ubiquitous species all participate in hybrid zones. Many lower Ottawa River *Elliptio* appear intermediate between the widespread *E. complanata* & *E. dilatata*. *Anodonta grandis* & *A. cataracta* hybridize, & hybrids between the species or subspecies *Lampsilis (r.) radiata* & *L. (r.) siliquoidea* are not described by Clarke, who did not have samples from the streams where they are largest.

I hope to publish an account of this fauna after another season of surveying streams & lakes I cound not get to in 1995. The Ottawa River, the South Nation, & most lakes will be best surveyed by boat. Eastern drainages, & the Castor, Tay, & Mississippi can still be explored by vehicle. Deep water sampling will require scuba diving.

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1. New publication

Watters, G.T. 1996. Small dams as barriers to freshwater mussels (Bivalvia: Unionoida) and their hosts. *Biological Conservation* 75:79-85.

Abstract. The distributions of two unionoids (fragile papershell, *Leptodea fragilis*, and pink heelsplitter, *Potamilus alatus*) were examined in five North American Midwest river systems in relation to the location of dams on the rivers. These dams were non-navigational (without locks), lacked fish ladders, and varied in height from 1 to 17.7 m. Both species were restricted in their distribution to the river downstream of the dams. This suggests that the host fish(es) of these species was unable to move upstream of these obstacles. Both unionoids are believed to parasitize the freshwater drum (*Aplodinotus grunniens*). Several endangered unionoid species also may use this fish, or other dam-limited fishes, as hosts. Dams, even lowhead structures, may contribute to the overall depletion of unionoids by artificially restricting their distributions and isolating populations from each other. Management practices for endangered fishes and mussels must take into account these physical obstacles.

2. Cross-polarized light to detect glochidia

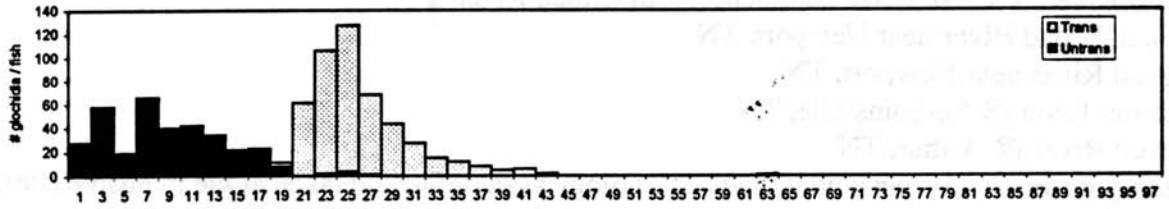
Glochidia may be difficult to detect and count in samples containing zooplankton, algae, fish waste, etc. We use cross-polarization to greatly improve the efficiency of examining these types of samples. A polarized filter is attached to the nose of a dissecting microscope, and a sheet of polarized film is taped to the glass stage. By rotating the filter, light becomes cross-polarized. This sharply illuminates glochidial shells, either open or closed. Transformed individuals appear darker than untransformed ones, and the paired adductor muscles are clearly visible. Non-prismatic material such as algae, chitin, and feces are not illuminated, but sand grains and other prismatic shell material (ostracodes, zebra mussels, etc.) are illuminated. We found this technique indispensable in sorting samples containing numerous bivalved cladocerans of the same size as glochidia, and in detecting glochidia in fish waste. Samples may be counted faster, with greater ease, and at lower magnifications using this method.

This technique was first used to detect zebra mussel veligers in zooplankton samples: Johnson, L. E. 1995. Enhanced early detection and enumeration of zebra mussel (*Dreissena ssp.*) veligers using cross-polarized light microscopy. Hydrobiologia 312: 139. We thank Dr. Dave Culver, Ohio State University, for demonstrating the technique.

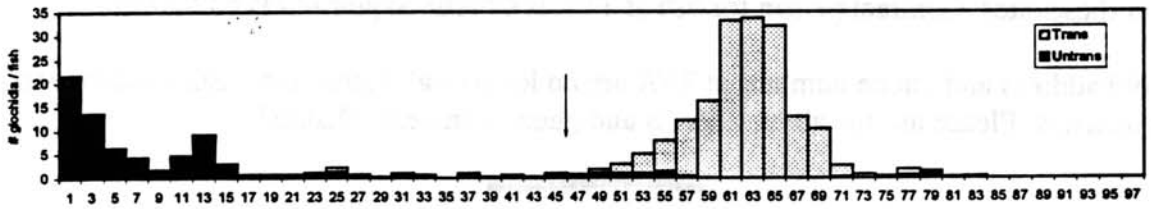
3. Glochidia overwintering on hosts - preliminary results

We assume that some mussels parasitize their hosts in the fall and that the glochidia overwinter on the fishes. The degree of mortality associated with this overwintering is unknown. How long glochidia may be maintained at winter temperatures, and still metamorphose when exposed to warmer temperatures, also is unknown. Our recent experimental work suggests that metamorphosis will not take place, or takes place at a greatly reduced rate, at 13°C. When the host is brought to 21°C, transformation begins. For this preliminary study, we infected hatchery raised largemouth bass (LMB) with *Lampsilis cardium.* As a control, LMB were parasitized at 13°C and then brought to 21°C. Transformation occurred from day 15 to 43, with a mode of day 25. A second group was parasitized and held at 13°C for 46 days before being brought to 21°C. Transformation began after three days and lasted 28 days, with a mode of 17 days post "warming." A third group was parasitized and held at 13°C for 64 days before being brought to 21°C. Transformation began after three days and lasted 20 days, with a mode of 15 days post "warming." No increased mortality is evident with this overwintering. Once warmed, glochidia metamorphose faster than the control by approximately one week. Apparently, glochidia undergo some development even at winter temperatures, but do not transform. We have begun a more comprehensive experiment that will study this phenomenon over seven months of "winter."

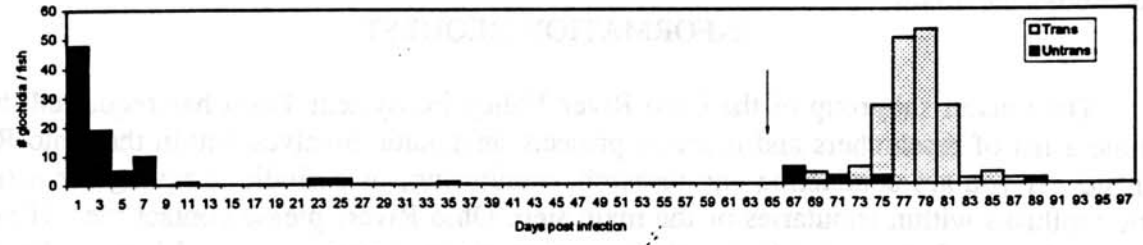
Control. Hosts parasitized at 13°C, then brought to 21°C immediately afterward.



Hosts parasitized and held at 13°C for 46 days, then brought to 21°C (arrow).



Hosts parasitized and held at 13°C for 64 days, then brought to 21°C (arrow).



4. New hosts for *Lampsilis cardium*

Two new hosts are reported for *Lampsilis cardium* based on laboratory infections. At 21°C, 30% of attached glochidia transformed on green sunfish between 33 and 47 days post-infection. At 21°C, 4% of attached glochidia transformed on western banded killifish between 13 and 19 days post-infection.

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The UTEN NAWQA study unit will commence biological sampling beginning the week of May 6. The following sites will be sampled for fish, benthic macroinvertebrates, mollusks, and algae:
Clinch River @ Tazewell, TN
Copper Creek near Gate City, VA (intensive site)
Middle Fork Holston River, VA @ seven-mile ford (intensive site)
Nolichucky River @ Lowlands, TN
Nolichucky River @ Embreeville, TN
Big Limestone Creek near Limestone, TN (intensive site)
Guest River, VA just above confluence with Clinch River
French Broad River near Newport, TN
Pigeon River near Newport, TN
Holston River @ Surgoinsville, TN
Powell River @ Arthur, TN
Weekly water quality, pesticides, and bacteriological sampling are taken at the intensive sites. The remaining sites are sampled monthly for water quality.
Synoptic collections will also be performed in the Clinch-Powell-Holston River drainages in conjunction with TVA's river action teams (RAT). TVA is our major contractor for helping us sample fish at these sites. Contract person for fish at TVA is Charlie Saylor (423) 632-1779.

My old address and phone numbers at TVA are no longer valid since the USGS has moved into new quarters. Please use the above address and phone numbers. Thanks!

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INFORMATION REQUEST

The mussel subgroup of the Ohio River Valley Ecosystem Team has requested that I compile a list of researchers and research projects on aquatic bivalves within the Ohio River drainage. If you are conducting any research, monitoring, or periodic sampling for native or exotic mollusks within tributaries or the main stem Ohio River, please contact me. If you aren't but know of someone who is, please pass along their name to me. I hope to be able to compile a list of who's-doing-what in the Ohio River Valley.

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Large scale relocation projects have been suggested as a proactive management strategy to protect native unionid populations in southeastern rivers and lakes from the negative effects of the ever-encroaching zebra mussel (*Dreissena polymorpha*). This project is designed to explore the feasibility of relocating mussels from the Kentucky Lake region of the Tennessee River, which has already been inoculated with zebra mussels, to three sections of the upper Holston River (NFHRM 6.3 & 4.6, HRM 122), where inoculation is unlikely. Initial efforts of the project included collection, quarantining, and stocking of animals, as well as snorkel surveys which were completed during the summer and fall of 1995. Seasonal estimates of recovery and survival, and annual estimates of growth and gravidity will be utilized to determine the success of the relocation.

A total of approximately 5,000 animals of 8 different species were collected for relocation. Collection was completed by purchasing animals from a commercial shell buyer, hiring a commercial diver, or by TWRA divers. Of the animals collected, three-ridge (*Amblema plicata*) comprised the largest proportion followed by, in descending order of abundance, ebonyshell (*Fusconaia ebena*), monkeyface (*Quadrula metanevra*), purple wartyback (*Cyclonaias tuberculata*), pimpleback (*Quadrula pustulosa*), washboard (*Megalonaias nervosa*), butterfly (*Ellipsaria lineolata*), and elephantear (*Elliptio crassidens*). Only five adult zebra mussels were found attached to the unionids collected. All animals were quarantined in 2400 liter aerated tanks for a period of 30-60 days to ensure that no zebra mussels were transferred from the site of collection to the relocation site. Following the quarantine period, no additional zebra mussels were found. Approximately 1,000 animals died during the quarantine period, and most of those animals were purchased from the commercial shell buyer. Therefore, it is likely that much of the mortality can be attributed to desiccation and stress prior to quarantine.

Mussels were stocked in either large study reaches (~600-1000m^2) or smaller quadrats (9m^2) by individually placing each animal in the substratum. Animals placed in study reaches were identified by a file mark on their valve, while animals in quadrats were identified by a numbered tag. A total of 4,030 mussels were stocked as follows: NFHRM 6.3, 1,907; NFHRM 4.6, 977; HRM 122, 1,146. The species composition relocated to NFHRM 6.3 and 4.6 were similar and consisted of three-ridge (83%), purple wartyback (10%), and pimpleback (7%), while the species relocated HRM 122 were ebonyshell (44%), monkeyface (39%), washboard (10%), butterfly (4%), and elephantear (3%).

Fall snorkel surveys were completed at all sites to obtain baseline estimates of survival, recovery, and abundance. Visual observations during quadrat surveys at NFHRM 6.3 and 4.6 indicated that initial survival (~30 days) was similar among sites and ranged from 75 - 100% for all species, and that recovery success was high for three-ridge (67-83%) but lower for purple waryback (57-63%) and pimpleback (32-60%). However, vertical migration in the substratum was believed to account for the lower recovery success of purple wartyback (45.8% buried)and pimpleback (19.4% buried). Transect surveys at NFHM 6.3 and 4.6 also indicated that initial survival was high and similar among sites, ranging from 87-100% for all species. Survival of animals observed during transect surveys conducted at HRM 122 was 70%, slightly lower than NFHRM 6.3 and 4.6. Snorkel surveys are planned for the spring, summer, and fall of 1996. In addition to abundance and survival, estimates of gravidity, growth, and glochidial release will also be determined.

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Genetic relationships among some *Elliptio* species: RFLPs analysis of amplified ITS region

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Evolutionary studies of unionides have long been hindered by lack of an adequate species concept. The species concept that has been most frequently used is based almost entirely on conchology. The morphological variance within and among populations and species is so great that it is frequently difficult to distinguish species on the basis of conchology, especially genus *Elliptio*. The purposes of this study are: (1) to determine whether restriction fragment length polymorphisms (RFLPs) of ITS region could be used to differentiate *Elliptio* species and (2) to assess the relationships among 20+ *Elliptio* species.

Although study and analysis are ongoing, the following are our preliminary results and comments.

1. RFLPs of ITS region are useful to differentiate *Elliptio* species.
2. We would like to comment on the result of another RFLPs study. In 1996 newsletter, released by National Biological Service, Leetown Science Center at West Virginia, reported that *E. fisheriana* and *E. producta* are indistinguishable based on the RFLP analysis of ITS-1 region. However, in our RFLPs study, *E. producta* is significantly different from *E. fisheriana*. Several explanations are possible for the contradicting results.
    a) Similar but different DNA regions were amplified. We amplified the entire ITS region that includes ITS1, 5.8S and ITS2 regions, NBS only amplified the ITS1 region. Therefore, different fragment patterns would likely be obtained and lead to different conclusion.
    b) Different restriction enzymes may have been used. It will again lead to different fragment patterns and conclusion. In our study, we found that most of the six-base cutters are not informative.
    c) "*E. producta*" specimens might be "*E. fisheriana.*" Our study includes "*E. producta*" from Virginia and Georgia and "*E. fisheriana*" from Virginia. These names were applied based on shell features. We detect no genetic difference between "*E. producta*" from Virginia and "*E. fisheriana*," but significant difference between "*E. producta*" from Georgia and "*E. fisheriana.*" *E. producta* from Georgia was taken from the Savannah River near Augusta, Georgia essentially the type locality. The name *E. producta* probably should be restricted to the phenotypes from the Savannah River and the name *E. fisheriana* applied to those found in Virginia.

Considerations when conducting host suitability tests

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Identification of fish hosts is a priority item listed under the basic biology research goal in the national strategy for freshwater mussel conservation (Biggins et al. 1995). Although protocols have been established for conducting host suitability tests (e.g., Zale and Neves 1982) you may want to consider these additional points.

Protect juvenile mussels from being consumed by test fish

The following observations have led me to believe that juvenile mussels should be protected from being consumed by suckers and small fish species during host suitability trials. On three occasions I've collected very few glochidia after inoculating white suckers and northern hog suckers. The catostomids quickly sloughed the glochidia and apparently consumed them after they fell to the bottom of the aquarium.

On another occasion I inoculated two groups of spotfin shiners with glochidia to determine if separating the fish from juveniles would increase the number of juveniles recovered. Eleven juveniles were recovered from five unrestricted shiners, while fifty-five juveniles were collected from six shiners that were prevented access to the bottom of the aquarium by a plastic screen. I suspect the unrestricted shiners consumed the juvenile mussels.

Test fish can be separated from juvenile mussels to avoid this problem. I've held fish in suspended nets and used false tank bottoms to separate fish from the tank bottom. However, siphoning under a suspended net is much easier than siphoning under a false tank bottom. Trdan and Hoeh (1986) designed a test chamber which separates fish from the mussels and enables the user to collect glochidia and juveniles without siphoning.

Check fish for glochidia before tests

Occasionally I've observed natural infestations of glochidia on test fish. I checked the fins and gills of each fish before conducting a study and replace those individuals which are already infested with glochidia. However, sometimes glochidia escape detection. I've collected Anodontine juveniles while studying Lampsiline glochidia. Holding test fish in warm water a month before conducting experiments will facilitate juvenile excystment. Repeated trials will help identify false positives.

Culture recovered juveniles

You can add a valuable component to your host suitability study by conducting culture experiments on the juveniles you've worked so hard to recover. Knowledge of juvenile mussel culture is badly needed if rare mussel reintroduction programs are to succeed.

Literature Cited

Biggins, R. G., R. J. Neves, and C. K. Dohner. 1995. Draft National strategy for the conservation of native freshwater mussels. USFWS, Asheville, NC. 26 pp.

Trdan, R. J. and W. R. Hoeh 1986. A chamber for monitoring glochidial infections of fish hosts. Malacological Review 19: 119-120.

Zale, A. V. and R. J. Neves. 1982. Fish hosts of four species of lampsiline mussels (Mollusca: Unionidae) in Big Moccasin Creek, Virginia. Can. J. Zool. 60: 2535-2542.

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SHALL I AGE MY UNIONIDS? IS A POOR AGE ESTIMATE BETTER THAN NO AGE INFORMATION?

Field aging of unionids is a challenge. While amblemines have fairly distinct rest rings, lampsilines often have indentations rather than darkened rings. Age gives much more data to assess a unionid population rather than length alone. Using a large 1990 Prairie du Chien, WI, data set as a baseline, information has been compared from the Illinois, Meramec, Rock, and Mississippi Rivers (including Lake Pepin). 1240 unionids were field aged on each valve; a mean age was determined for each specimen. Of these specimens, 42.1% were the same age, 31.2% were within one year of each age, 13.8% were within two years of each age, 7.5% were within three years of each age, and 5.5% had an age difference of four to six years. For each population, data has been compared as mean length/age class, abundance/age class, and abundance and mean age for size classes. Just over three percent of 754 Amblema p. plicata (Say, 1817) were less than 35 mm long, but they ranged from 2 - 7 years of age. Thirty-six seven year olds had the largest size range for an age class, 58 mm (31 to 89 mm long). At age 11 the range in length of 56 A. p. plicata was 27 mm (51 to 78 mm). At age 23 the range in length of 49 A. p. plicata was 25 mm. The overall mean length range for each age class was 24.7 mm. Two 67 mm long A. p. plicata from the same quadrat were eight and 23 years of age. Similarly, two Obliquaria reflexa Rafinesque, 1820, from the lower Rock River, IL, each 73 mm long, were seven and 25 years of age. Number/size class for A. p. plicata from Prairie du Chien showed the expected bell curve, but age data showed a bimodal distribution with a decline at 14 years corresponding to the large 1976 dredging. Age data on 100 specimens per species is preferred, and 200 specimens of a species per site gives good information on a population. In another study, using Lampsilis higginsi (Lea, 1857) from Prairie du Chien, WI, at least 10 specimens of each age class were measured, or back measured, to get data for each age class. At Prairie du Chien unionids only grow about two mm/year after sexual maturity. Age and length data for 200 A. p. plicata, obtained in 1988 on the Illinois River, showed among the most mean growth per age class. Unionids from Lake Pepin also showed a higher mean growth rate per age class than Prairie du Chien specimens. When analyzing commercial populations, height gives information on the age structure. Sixty-one A. p. plicata 65 mm high, ranged from 7 to 30 years of age. One hundred seven A. p. plicata that were over 67 mm (legal height) ranged from 13 to 32 years of age, yet five unionids over 27 years were not of a commercial height. A. H. Clarke's early 1990's Prairie du Chien data yielded a mean length per age distribution curve like ours, but Miller's 1995 extrapolation of Prairie du Chien data revealed a higher mean length for each age class, for essentially the same area. This means extrapolations must be very carefully done if aging is not done concurrently. So, learn how to age those unionids and look at your data from another perspective.

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Host Fishes of Some Mobile Basin Unionids

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Very little is known about fish hosts of mussels endemic to the Mobile Basin. Some of these species are among the most critically endangered in North America and host fish information is urgently needed. We are conducting host trials for several mussel species occurring in tributaries of the Black Warrior River system in Bankhead National Forest, Alabama. Our procedures largely have followed those of Zale and Neves (1982). Trials were run at 18-20°C.

The following table summarizes our results as of April 29, 1996. Suitable hosts are those that produced transformed juvenile mussels; non-suitable hosts (NS) are those from which all glochidia were sloughed and no juveniles were produced. An asterisk (*) denotes a species that has carried glochidia for at least 10 days and continued to carry glochidia as of April 29. A question mark (?) denotes a species that carried glochidia for more than one week but all specimens died before completion of the trials. A dash (-) denotes a species that was not determined. *LP = Lampsilis perovalis; SS = Strophitus subvexus; PG = Ptychobranchus greeni; VN = Villosa nebulosa.*

	LP	*SS*	*PG*	*VN*
Cyprinella callistia	NS	?	NS	NS
C. venusta	NS	-	-	-
Campostoma oligolepis	NS	?	NS	NS
Notropis asperifrons	NS	?	NS	NS
Semotilus atromaculatus	NS	Host	NS	NS
Hypentelium etowanum	NS	Host	NS	NS
H. nigricans	-	?	-	-
Ictalurus punctatus	NS	?	-	-
Fundulus olivaceus	?	?	-	-
Percina nigrofasciata	NS	Host	*	NS
P. shumardi	NS	-	*	NS
P. sp. *cf. caprodes*	NS	-	-	NS
Etheostoma whipplei	NS	-	*	NS
E. douglasi	NS	Host	*	NS
E. bellator	-	-	*	NS
Lepomis megalotis	?	Host	NS	*
L. macrochirus	?	?	NS	*
Micropterus coosae	Host	-	NS	*
M. punctulatus	?	-	NS	*
M. salmoides	?	?	-	-

Zale, A.V. and R.J. Neves. 1982. Fish hosts of four species of lampsiline mussels in Big Moccasin Creek, Virginia. Can. J. Zool. 60:2535-2542.

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News about *Margaritifera auricularia*

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One of the most endangered naiad mollusks is *Margaritifera auricularia*. This large species once lived in most large rivers throughout western Europe, Britain and Morocco. As reported previously (Biol. Cons., 52: 271-286), the only known population occurs in the lower course of the Ebro river, in Catalonia. The question remained of what was the size and structure of this last population. This river is not easily amenable to studies of its bottom fauna, because it is often deep, the current is fast, and the water is murky.

A project aimed at restoring the historic navigation along the Ebro (at least in its lower course, below two large dams) was started without any previous survey of the naiads in the area. Since the beginning of the waterway works, it became evident that large numbers of these animals were at risk. The finding of *M. auricularia*, a species protected at the highest level by European, Spanish and Catalan law, triggered the design of a thorough sampling program. This is aimed at assessing the environmental impact of the works and the possibility of making them compatible with the legal mandate of protecting endangered species.

Intensive work during the month of April has shown that there are four species of naiads in the lower Ebro: *Margaritifera auricularia*, *Unio elongatulus*, *Psilunio littoralis*, and *Anodonta cygnea*. The former appears to have a healthy but vulnerable population at this its last stronghold: it is relatively common in some small areas, and the young age classes are well represented. A detailed study of several aspects of the biology of these mollusks is now in progress.

Amazingly, not all the authorities involved in the Ebro agree about the importance of naiads. As a result of this, their study and conservation is now in jeopardy. Once more, we are having to fight for the enforcement of environmental legislation.

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Effects of Handling and Aerial Exposure on the Survival of Unionid Mussels

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Abstract

We conducted a relocation study of unionid mussels in Navigation Pool 7 of the upper Mississippi River (river mile 713.2) to evaluate survival after handling and aerial exposure. Two separate studies were conducted to compare seasonal differences in mussel survival; the first was initiated in June and the second in October. Amblema plicata plicata (subfamily Ambleminae) and Obliquaria reflexa (subfamily Lampsilinae) were studied. Mussels were marked, held out of water for either 0, 1, 4, or 8 h, and then placed into a 3 x 3 m grid (divided into nine 1-m^2 units). The mussels were re-examined after four-five months to measure mortality in the control and treatment groups. Mussels of both species had >90% survival after aerial exposure up to 4 h in both studies. However, survival (number recaptured live / number recaptured live and dead) of mussels showed a decreasing trend with duration of exposure in the first study, but not in the second study. The overall recovery of marked mussels (number recaptured/number marked) was 91% in the first study and 87% in the second study. However, only 37% of O. reflexa mussels in the 8-h treatment were recovered in the first study; the adjusted survival (number live recaptured/number marked) of this treatment group was significantly ($p < 0.05$) lower (35%) than all other treatments.

Introduction

Presently, the North American unionid mussel (Superfamily Unionacea) fauna is rapidly declining as a result of anthropogenic activity and is threatened with widespread extirpation by the exotic zebra mussel, Dreissena polymorpha (Williams et al. 1993). State and federal agencies are actively conducting status surveys and relocation operations in an effort to preserve the remaining unionid fauna. Information on threshold and tolerance limits of different mussel species to collection and handling conditions is especially critical at this time for planning management and conservation activities for unionid mussels.

The effects of handling and aerial exposure on mussels are often considered minimal, but the condition and survival of mussels after disturbance are seldom assessed. Handling methods for unionid mussels have not been systematically evaluated in controlled studies to isolate individual variables that affect mussel survival. Variables that may potentially influence mussel survival during collection include duration of aerial exposure, water-air temperature differential, relative humidity, and collection and marking methods. Additionally, tolerance to handling may vary among mussel species, size, and with the metabolic and reproductive condition of the mussel.

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EVALUATION OF FRESHWATER MUSSEL RELOCATION AS A CONSERVATION AND MANAGEMENT STRATEGY*

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ABSTRACT

The relocation of unionacean mussels is commonly used as a conservation and management tool in large rivers and streams. Relocation has been used to recolonize areas where mussel populations have been eliminated by prior pollution events, to remove mussels from construction zones and to re-establish populations of endangered species. More recently, relocation has been used to protect native freshwater mussels from colonization by the exotic zebra mussel *Dreissena polymorpha*. We conducted a literature review of mussel relocations and evaluated their relative success as a conservation and management strategy. We found that 43% of all relocations were conducted because of construction projects that were forced to comply with the Endangered Species Act 1973 and that only 16% were monitored for five or more consecutive years. Most (43%) relocation projects were conducted from July to September, presumably a period when reproductive stress is relatively low for most species and the metabolic rate is sufficient for reburrowing in the substrate. The mortality of relocated mussels was unreported in 27% of projects; reported mortality varied widely among projects and species and was difficult to assess. The mean mortality of relocated mussels was 49% based on an average recovery rate of 43%. There is little guidance on the methods for relocation or for monitoring the subsequent long-term status of relocated mussels. Based on this evaluation, research is needed to develop criteria for selecting a suitable relocation site and to establish appropriate methods and guidelines for conducting relocation projects.

KEY WORDS: bivalves; conservation; management; mussels; relocation; river; translocation; transplant; unionidae

INTRODUCTION

The North American freshwater unionacean mussel fauna, once represented by about 297 taxa (Turgeon *et al.*, 1988; Neves, 1993; Williams *et al.*, 1993), has declined to about 276 taxa since the early 1900s due to overharvesting, commercial navigation, pollution and habitat degradation (Neves, 1993). Fifty-eight mussel species (21% of the remaining species) are listed as federally threatened or endangered (Code of Federal Regulations, 1993). Because of the drastic decline in the mussel fauna and the authority of the Endangered Species Act 1973, resource agencies have attempted to mitigate the effects of human activities on unionacean mussels.

Relocation has been used as a conservation and management technique by state and federal agencies to recolonize areas where mussel populations have been eliminated by prior pollution events (Ahlstedt, 1979; Sheehan *et al.*, 1989), to remove mussels from construction zones (Oblad, 1980; Harris, 1986; Berlocher and Wetzel, 1988; Dunn, 1991), and to re-establish populations of endangered species (Jenkinson, 1985; Hubbs *et al.*, 1991). More recently, relocation has been used to protect unionid populations from colonization by the zebra mussel (*Dreissena polymorpha*), an invasive introduced species (Ogawa and Schloesser, 1993).

Although relocation projects have been conducted for more than 20 years, their effectiveness for the conservation and management of unionacean populations has not been assessed. Moreover, there is presently little guidance on methods for relocation projects or for monitoring the subsequent long-term status of the relocated mussels. Little is known about the habitat requirements of mussels or the biological responses of mussels to removal from the substrate, handling, transporting and relocating to a new site. Our objectives were to summarize the literature on mussel relocation, to evaluate the relative success of mussel relocation projects and to identify research needs.

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