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MUSSEL FAUNA OF THE POWELL RIVER, TENNESSEE AND VIRGINIA

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Abstract

A survey of the fresh water mussels of the Powell River conducted in 1973 through 1978 revealed a rich Cumberlandian mussel fauna inhabiting a sixty mile (96.5 km) reach of the river. Thirty-six species were found, five of which are designated endangered. Mussel densities at two selected sites were high, averaging six and twelve mussels per square meter.

With improvement of siltation problems associated with mining activities, this river will present an excellent opportunity for perservation and expansion of this unique fauna.

Introduction

The Powell River, in the headwaters of the Tennessee River System, flows in a southwesterly direction from near Norton, Virignia, through the Ridge and Valley Province of the Appalachian Mountain Range into Tennessee, where it joins the Clinch River (Norris Lake). The Powell, Clinch, and Holston Rivers share an endemic molluscan fauna characteristic of the Cumberland Plateau Region. This Cumberlandian fauna is known historically from the Clinch, Powell and Holston Rivers in Virginia and Tennessee, the French Broad River and portions of the Duck, Elk, and Tennessee Rivers in Tennessee, and the Cumberland River in Kentucky. This fauna is presently restricted to limited populations in the Clinch, Powell, North Fork Holston, and Duck Rivers. For detailed discussion of this fauna, see Ortmann (1918), van der Schalie (1973), and Bates and Dennis (1978).

Recent accounts of the mussell fauna of the Cumberlandian Region include treatments of the Clinch River (Stansbery, 1972a; Bates and Dennis, 1978), the forks of the Holston River (Stansbery, 1972b; Stransbery and Clench, 1973, 1974, 1977), and the Duck River (van der Schalie, 1973). Few publications, however, deal specifically with the mollusks of the Powell River. The work of C. C. Adams (1900) on snails of the genus *Io* presents a discussion of this river with a description of the habitat of *Io*. One significant work treating the mussels of the Powell River is Ortmann's (1918) description of the mussel fauna of the Upper Tennessee Drainage.

While the Powell River has suffered during the past fifty years from the effects of strip mining and impoundment, there remains a reach of approximately 20 miles (32km) suporting a rich and diverse molluscan fauna. Several endemic Cumberlandian mussel species, recorded from this area have been reported no whsere else. This study brings to date knowledge of the status of this fauna and points out its unique place in our faunal heritage.

Acknowledgements

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For assistance with field work, I wish to thank Randal Grace, Tuskegee Institute, Steven Ahlstedt, TVA, Forestry, Fisheries, and Wildlife Development, and Lynn Russel, Al Zale and Jane Barden, Virginia Polytechnic Institute and State University. Special thaks are due John Bates, Ecological Consultants, Inc. for his help in the field and review of the manuscript, and Henry van der Schalie for his continued encouragement.

Methods and Materials

The Powell River was surveyed in 1973, and sampled periodically through 1978. The river was examined at all available access points; results of intensive sampling at 18 sites are reported. Several long reaches of the lower river could not be sampled due to lack of access. A map of sample sites (Figure 1) and a list of stations (Table 1) are included.

TABLE I

COLLECTING SITES, POWELL RIVER, 1973-1978

Site	Location	River Mile
1	Riverview, TN	79.0
2	Buchannon Ford, TN	99.2
3	Alanthus Hill Bridge, TN	103.2
4	McDowell Ford, TN	106.6
5	Bales Ford, TN	111.7
6	Baldwin Ford, TN	115.5
7	Fletcher Ford, VA	117.4
8	Highway 833 Bridge, VA	120.4
9	Flanary Bridge, VA	130.5
10	Poteet Ford, VA	141.0
11	Cheek Spring Ford, VA	145.0
12	Poteet Ferry Bridge, VA	149.0
13	Woodway Bridge, VA	155.0
14	Highway 619 Bridge, VA	163.0
15	Dryden, VA	165.0
16	Olinger, VA	170.0
17	Big Stone Gap, VA	175.0
18	Appalachia, VA	180.0

Sampling during periods of low flow (August through October) facilitateed collecting. Mussels were collected by hand picking, pollywogging, and use of a Needham Scraper. Quantitative samples were taken using a square meter quadrat sampler designed by the author.

Records reported in this paper are of specimens found living or freshly dead (from muskrat middens). Relic shells have not been included as records of the present fauna. Shells were labeled and stored in cloth bags. Representative live mussels were relaxed in propylene phenoxytol, preserved in formalin or Bouin's solution, and stored in 70? alcohol. Most of the wet collections are presently housed by the Tennessee Valley Authority, Fisheries Lab, Norris, Tennessee.

Figure 1

POWELL RIVER COLLECTING SITES

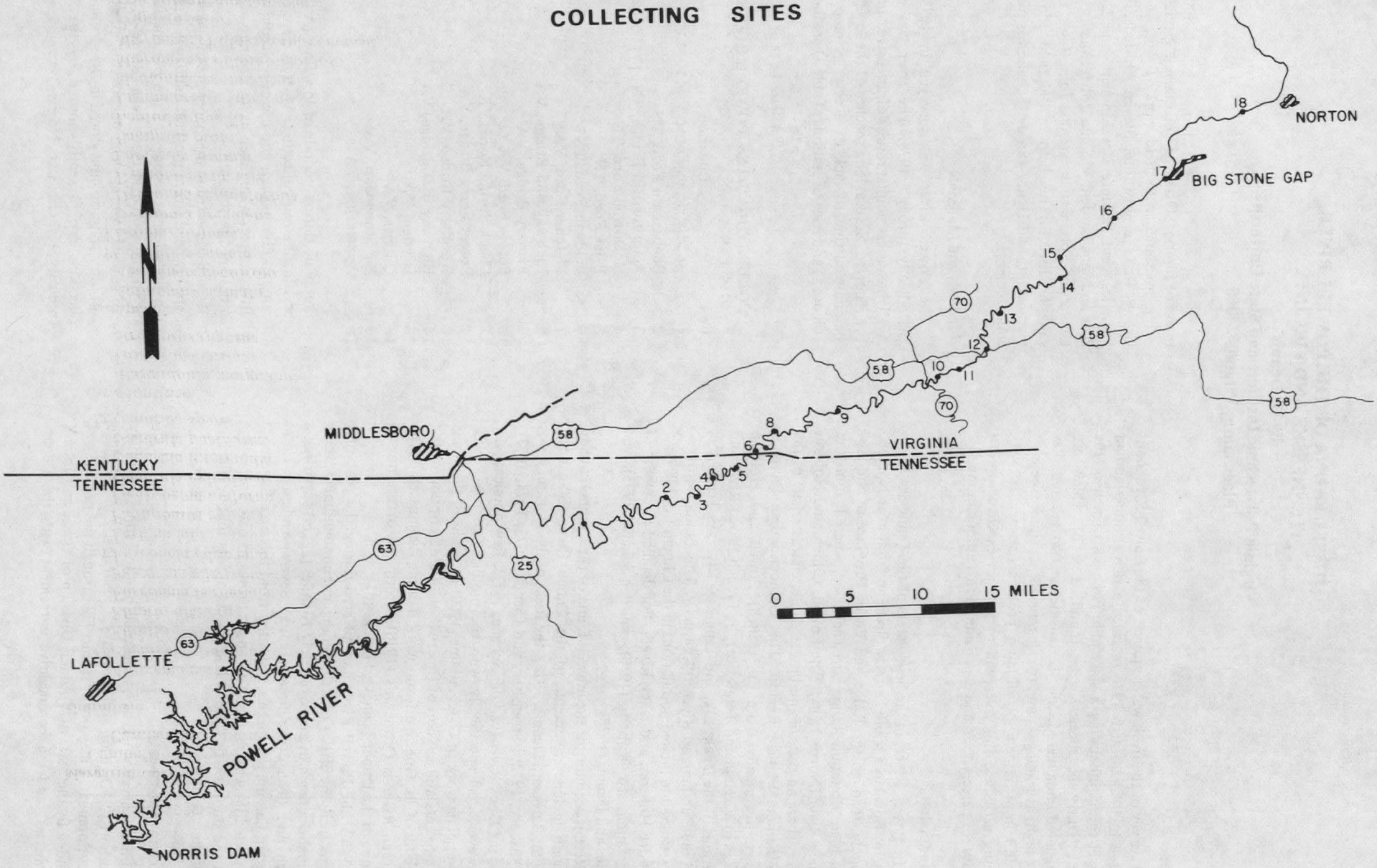

TABLE II

MUSSEL SPECIES DISTRIBUTION — POWELL RIVER, 1973-1978

Mussel Species	Sites 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Margaritanidae																		
Cumberlandiinae																		
Cumberlandia monodonta	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Unionidae																		
Unioninae																		
Amblema costata	X	X	—	X	X	X	X	X	—	—	—	—	—	—	X	—	—	—
**Cyclonaias tuberculata*	X	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
Elliptio crassidens	—	—	—	X	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Elliptio dilatatus	—	X	X	X	—	X	X	X	—	X	—	—	X	—	—	—	—	—
Fusconaia barnesiana	X	X	—	X	X	X	X	X	X	X	—	—	X	—	—	—	—	—
Fusconaia pilaris bursa-pastoris	—	X	X	X	X	—	X	X	—	—	—	—	—	—	—	—	—	—
†Fusconaia edgariana	—	X	—	X	X	X	X	X	—	—	—	—	—	—	—	—	—	—
**Lastena lata*	—	—	—	X	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Plethobasus cyphus	—	X	—	X	X	X	X	X	—	—	—	—	—	—	—	—	—	—
Pleurobema oviforme	—	X	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Quadrula cylindrica	—	X	—	X	—	X	X	X	X	X	—	—	—	—	—	—	—	—
**†Quadrula intermedia*	—	X	—	X	X	X	X	—	—	—	—	—	—	—	—	—	—	—
Quadrula pustulosa	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
**†Quadrula sparsa*	—	X	—	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Anodontinae																		
Alasmidonta marginata	—	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lasmigona costata	X	X	—	X	X	—	X	X	—	—	—	—	—	—	—	—	—	—
Strophitus rugosus	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lampsilinae																		
Actinonais carinata	X	X	X	X	—	X	X	X	X	X	—	—	X	X	—	—	—	—
Actinonais pectorosa	X	X	X	X	—	X	X	X	—	X	—	—	—	—	—	—	—	—
†Conradilla caelata	—	X	—	X	—	X	—	—	—	—	—	—	—	—	—	—	—	—
†Dromus dromas	—	X	—	X	X	X	X	X	—	—	—	—	—	—	—	—	—	—
Dysnomia brevidens	—	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
Dysnomia capsaeformis	—	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
Dysnomia triquetra	—	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
Lampsilis fasciola	—	X	—	X	—	X	X	X	—	X	—	—	—	—	—	—	—	—
Lampsilis ovata	X	X	—	X	—	X	X	X	X	X	—	—	—	X	—	—	—	—
Leptodea fragilis	—	—	—	X	—	X	X	X	—	X	—	—	—	—	—	—	—	—
Ligumia recta latissima	—	X	—	X	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Medionidus conradicus	—	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
Micromya (Villosa) nebulosa	—	X	—	X	—	X	X	X	—	—	—	—	X	—	—	—	—	—
Micromya (Villosa) vanuxemensis	—	X	—	X	—	X	X	X	—	X	—	—	—	—	—	—	—	—
Proptera alata	X	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
Ptychobranchus fasciolaris	X	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
Ptychobranchus subtentum	—	X	—	X	—	X	X	X	—	—	—	—	—	—	—	—	—	—
**Truncilla truncata*	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total Species represented - 36 Totals	9	28	3	36	8	25	28	21	4	9	0	0	4	2	1	0	0	0

†Listed as Endangered (Fed. Register, June, 1976)
*Species not recorded by Ortmann (1918)

TABLE III

MUSSEL RECORDS, POWELL RIVER — ORTMANN, 1918

	Big Stone Gap Wise Co., Va.	Olinger Lee Co., Va.	Dryden Lee Co., Va.	Pennington Gap Lee Co., Va.	Jonesville Lee Co., Va.	Rose Hill Lee Co., Va.	Shawnanee Claiborne Co., Tn.	Bryant Shoals Claiborne Co., Tn.	Lower Powell River
Unionidae									
Unioninae									
Amblema costata	—	—	—	—	—	—	X	X	X
Elliptio crassidens	—	—	—	—	X	—	X	—	X
Elliptio dilatatus	—	X	X	X	—	X	X	X	X
Fusconaia barnesiana	X	—	X	—	—	—	—	—	X
Fusconaia barnesiana bigbyensis	X	X	X	X	—	X	X	—	X
**Fusconaia cuneolus*	—	X	—	—	—	—	X	—	X
Fusconaia edgariana	—	—	—	X	—	X	X	X	X
**Fusconaia pilaris*	X	X	X	X	X	X	X	X	X
**Lexingtonia dolabelloides*	X	X	X	X	—	—	—	X	X
**Plethobasus cyphyus*	—	—	—	—	—	—	—	X	X
Pleurobema oviforme	X	X	X	X	X	X	X	X	X
Quadrula cylindrica strigillata	—	—	—	X	—	—	—	X	X
Quadrula pustulosa	—	—	—	—	—	—	—	X	—
Andontinae									
Alasmidonta marginata	—	X	X	—	—	X	—	X	X
**Alasmidonta minor*	X	—	—	—	—	—	—	—	—
**Lasmigona holstonia*	X	—	—	—	—	—	—	—	—
Lasmigona costata	—	X	X	X	—	—	—	X	X
Strophitus rugosus	X	—	—	—	—	—	—	—	X
Lampsilinae									
Actiononais carinata	—	—	—	—	—	—	X	X	X
Actinonais pectorosa	—	—	—	X	—	X	X	X	X
**Carunculina moesta*	X	—	—	—	X	—	X	—	X
Conradilla caelata	—	—	—	—	X	X	—	X	X
Dromus dromas	—	—	—	—	—	—	X	X	X
Dysonomia brevidens	—	—	—	—	—	X	X	X	X
Dysnomia capsaeformis	—	—	—	—	—	—	X	X	X
**Dysnomia haysiana*	—	—	—	X	—	—	X	—	X
**Dysnomia lewisi*	—	—	—	—	—	—	—	—	X
**Dysnomia torulosa*	—	—	—	—	—	—	X	—	X
Dysnomia triquetra	—	—	—	—	—	—	X	—	X
Lampsilis fasciola	X	—	X	X	—	X	X	X	X
Lampsilis ovata ventricosa	—	X	X	—	—	—	X	—	X
Leptodea fragilis	—	—	—	—	—	—	—	—	X
Ligumia recta latissima	—	—	—	—	—	—	—	—	X
Medionidus conradicus	X	X	X	—	—	X	X	X	X
**Micromya fabalis*	—	—	—	—	—	—	—	—	X
Micromya nebulosa	X	X	X	X	—	X	X	X	X
**Micromya perpurpurea*	—	X	—	—	—	—	—	—	—
Micromya vanuxemensis	X	—	X	X	—	—	—	—	X
**Pegias fabula*	—	—	X	—	—	—	—	—	—
Proptera alata	—	—	—	—	—	—	—	—	X
Ptychobranchus fasciolaris	—	—	—	—	—	X	—	X	X
Ptychobranchus subtentum	X	X	X	X	X	—	X	X	X
Total species represented - 42 Totals	14	13	17	14	6	13	22	22	37

*Species not found in present study

Description of the Study Area

The Powell River was sampled at 18 sites from the headwaters to the point of impoundment, a reach of approximately 100 miles (161 km). The headwaters of this river drain an area which has been heavily strip mined and approximately 150 miles (241 km) of the upper reaches has suffered severly from heavy siltation. The mouth of the river has been impounded for approximately 80 miles (129 km), leaving a reach of approximately 60 miles (96.5 km) of unpolluted, free flowing river.

The most heavily populated areas alond the Powell River are in the headwaters. Here there are a number of small towns (Norton, Appalachia, Richlands) supported by the coal mining industry. The river above PRM* 140 is heavily silted, particulary in the vacinity of Appalachia, Virginia, where the substrate is covered with 1 to 3 cm. of silt. Siltation gradually decreased downstream and is not in evidence below PRM 120.

Results

Thirty-six mussel specisess presently exist in the Powell River. As recorded in Table II, the mussel diveristy is greatest in the lower reaches of the river, decreeasing upstream to PRM 165, above which no mussels are found.

Ortmann (1918) recorded 42 species from the Powell River (Table III), 12 of which were not found in the present study. His list includes species collected from the lower river in an area now impounded by Norris Lake. The eight sites which ortmann sampled wiithin the presesnt study area are listed in Table III. The areas which he sampled which are now within Norris Lake have been lumped under the heading "Lower Powell River". Of the 36 recent records from the Powell Rover, 5 were not recorded by Ortmann (Table II).

Quantitative samples were taken at two locations; these data are presented in Tables IV and V.

Discussion

While twelve secies have apparently been eliminated from the Powell Rier since Ortmann's report of 1918, the 36 species still represent one of the richest molluscan faunas left in the United States.

Fusconaia barnesiana as reported in the present study includes the headwater form *F. barnesiana bigbyensis* as reported by Ortmann, (Table III).

Fusconnaia pilaris bursa-pastoris as reported here is the headwater form (Ortmann, 1918) of *f. pilaris* recorded in Table III.

Of the 12 apparently extirpated species, four *(Pegias fabula, Micromya-perurpurea, Alasmidonta minor,* and*Lasmigona holstonia)* were recorded by Ortmann from upper stations now affected by siltation; two (*Micromya fabalis* and *Dysnomia lewisi)* were collected only from an area now impounded. Two species of *Dysnomia (D. haysiana* and *D. lewisi)* appear to be extinct. Four species *(Lexingtonia dollabelloides, Fusconaia cuneolus, Carunculina moesta* and *Dysnomia torulosa)* have apparently disappered from the river.

Five species reported from present collections (Table II) were not found by Ortmann. This is probably due to a difference in sampling intensity between his and the present studies. Much of the collecting done by early malacologists was accomplished from trains, and access to the rivers was often limited. The present ease of transportation allows for repeated trips to collecting sites, increasing the likelihood of finding uncommon species.

The mussel species composition of the Powell River is similar to that of the Clinch River, with a few notable exceptions. Two species, *Cyprogenia irrorata* and *Pleurobema cordatum,* which occur in the Clinch River (Bates and Dennis, 1978) have never een recorded from the Powell (Ortmann, 1918). Conversely, there are three endangered species (Federal Register, 1976) reported from the Powell River, which no longer occur in the Clinch.

Quadrula sparsa, which is of rare occurance in the Powell River, appears to exist also in a limited reach of the Cumberland River, Kentucky (TVA, unpublished), while *Q. intermedia* appears to occur only in the Powell River. *Conradilla caelata,* rare in the Powell, occurs at one site in the Duck River, Tennessee, where ists continued existance is threatened by a proposed impoundment (Columbia Dam). A few shells of this species have been found in the Clinch River (Bates and Dennis, 1978) but its continued existance in that river is doubtful.

Two additional endangered species, *Fusconaia edgariana* and *Dromus dromas* remain extant in both the Clinch and Powell Rivers.

Quantitative studies

While survey work revealed a high diversity of mussels in the Powell River, limited quantitative sampling was conducted to provide a basis for comparison of this faunal density with others, i.e. that of the Clinch, Muskingum, and Tennessee Rivers.

Of the 18 sites examined, two, Buchannon and McDowell Fords, showed the greates diversity and abundance of mussels. Sampling 10m² at each of thes sites produced average densities of 12.1 and 6.1 musels per m² respectively (Tables IV and V). These figures compare favorably with mussel densities found in areas of the Clinch River (Dennis, unpublished); 31m² sampled at Kyles Ford, Tennessee averaged 30.6 mussels; 32m² taken at Speers Ferry, Virginia averaged 7.7 mussls. Bates (1970) has reported mean densities of 11 per m² for one reach of the Muskingum River, Ohio (McConnelsville to Devola) with one m² at Beverly yielding 103 individuals. Scruggs (1960) reported densities of 6.7 and 16.7 mussels per squard yard sampled in Wheeler and Chickamauga Resevoirs respectively, of the Tennessee River.

Mussels often exhibit extreme clumping in their distribution patterns within a river (i.e. occurance of "mussel beds"). Densities reported for quadrat samples taken within the limits of a "mussel bed" are thus not necessarily reflective of average densities for an entire reach of river. A detailed treatment of quantitative analysis of mussel data has been prepared (Bates, Dennis and Kovalak) and is in press (Sterkiana, No. 72).

* PRM = Powell River Mile, taken from U.S.G.S. topographic maps.

TABLE IV

Quadrat Results — Buchannon Ford

Species	Quadrat Number 1	2	3	4	5	6	7	8	9	10	Totals
Unioninae:											
Amblema costata	1										1
Elliptio dilatatus									1		1
Fusconaia barnesiana					1	1		1	1		4
Fusconaia edgariana								1		1	2
Quadrula intermedia		1									1
Quadrula sparsa					1						1
Anodontinae:											
Alasmidonta marginata						1					1
Lasmigona costata				1		1	1				3
Lampsilinae:											
Actinonais carinata	7	2		3	1	6	3	1	4		27
Actinonaias pectorosa	7	2	5	8	8	9	4	12	6	3	64
Dromus dromas		1							1		2
Dysnomia brevidens		1									1
Dysnomia triquetra				1							1
Lampsilis fasciola							1				1
Lampsilis ovata	1										1
Medionidus conradicus	4	2									6
Micromya (Villosa) nebulosa										1	1
Ptychobranchus fasciolaris										1	1
Ptychobranchus subtentum						1		1			2
Totals	20	9	5	13	11	19	9	16	13	6	121

Average 12.1 per square meter

TABLE V

Quadrat Results — McDowell Ford

Species	Quadrat Number 1	2	3	4	5	6	7	8	9	10	Totals
Unioninae:											
Amblema costata	2										2
Cyclonaias tuberculata									1		1
Elliptio dilatatus	2	1							1	1	5
Fusconaia barnesiana	2										2
Fusconaia edgariana		1									1
Quadrula cylindrica		1									1
Quadrula intermedia	1						1				2
Anodontinae:											
Lasmigona costata								1			1
Lampsilinae:											
Actinonaias carinata	1		1	1		1				1	5
Actinonaias pectorosa		2	1	2		1	2	5	7	2	22
Conradilla caelata				1							1
Dromus dromas							1	1		2	4
Dysnomia brevidens								1	1		2
Medionidus conradicus	1		1	3	4	2					11
Ptychobranchus fasciolaris								1			1
Totals	2	9	6	7	4	4	4	9	10	6	61

Average 6.1 per square meter

Conclusions and Recommendations

The Powell River continues to support a rich and diversemolluscan fauna which includes five species designated as endangered. The areas which support this fauna are relatively isolated and sparsely populated. While siltation from headwater mining operations continues to be a threat to this fauna, there are no other polluting industries of major consequence within the watershed. Implementation of reclamation measures could enhance habitat in the Powell River for continued survival of the present fauna, and possible recolonization of headwater areas.

This River has tremendous potential as a preserve for the endemic mussels of the Comberland Plateau. The Scenic attributes and remoteness of this river recommend it highly for consideration as a wild and scenic river.

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PAST, PRESENT AND FUTURE STATUS OF THE MOLLUSCA OF THE UPPER TOMBIGBEE RIVER

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HISTORY:

Studies of the mollusks of Alabama drainages (including rivers such as the Tombigbee flowing through Mississippi) were undertaken at the turn of the century over an extended period by a group of well-known malacologists. Their work was sponsored largely by Dr. Bryant Walker, a wealthy lawyer who developed an international reputation as a malacologist; in the museum built in back of his Detroit home he amassed a collection of about 100,000 lots. With Walker's initiative a "syndicate" was established involving the following investigators and their respective institutions: Bryant Walker, whose work and collections are now a part of the Mollusk Division of the University of Michigan's Museum of Zoology in Ann Arbor; Truman Aldrich, a geologist sponsoring the work and studies at the Alabama Museum in Tuscaloosa; George H. Clapp (founder of the Alcoa Aluminum Company and trustee of the Carnegie Museum in Pittsburg), who was mainly interested in land snails; H. A. Pilsbry, generally recognized as the "dean" of American malacology, who encouraged studies that would benefit the Philadelphia Academy of Natural Sciences; and John B. Henderson, a staff member of the U.S. National Museum. This consortium employed Herbert H. Smith and his wife, Daisy, to make intensive and systematic collections of mollusks throughout Alabama and contiguous drainages. Bryant Walker was primarily responsible for directing their activities as well as for identifying the material. A large volume of personal letters was made available when the Bryant Walker collections and library came to the Mollusk Division of the University of Michigan.

It is possible at present to give no more than a cursory account of what was found in the bulk of the Walker-Smith correspondence. It took about a week to peruse these letters which covered the period from January, 1905, to February, 1915. Actually, H. H. Smith worked continuously and diligently under Walker's sponsorship for some twenty years until his (Smith's) untimely death when he was struck by a train which he did not hear because he was deaf. The information on specific rivers such as the Warrior and the Tombigbee is scattered through an amazing amount of detailed letter writing. A summary account of the pertinent information contained in those letters follows:

January 25, 1905 - Tried to collect on Tombigbee working out of Jackson but it was "too cold and wet for field work."

May 26, 1905 - Sent Box 48 to Walker with "material from flood plain of Tombigbee, 2 miles above Jackson."

October 27, 1908 - Collected at Squaw Shoals on Black Warrior River. Collected 700 to 800 mussels representing 35 to 40 species. Visited Yellow Creek Shoals and Rose Shoals (Lock 15). The weather was "fine" and the river low.

November 14, 1908 - Black Warrior River near Yellow Creek Bar produced about 40 species - "many rare and unique." The river divides Jefferson from Tuscaloosa counties and covers 12 miles of shoals. The mussels here "not same as those down below." Locks 16 and 17 were being built so collecting was done in vicinity of Lock 15. Describes various shoals on down to where the Mulberry and Locust branches from the Black Warrior River. The Black Rock shoals were very extensive but easy to work and mussels were more abundant than anywhere else. Reported finding about 90 species at upper part of Squaw Shoals.

November 29, 1908 - Collected about 1100 mussels in 5 days of collecting near Forks of Black Warrior River. Many specimens taken from muskrat deposits. These sites provided from 9,000 to 10,000 specimens - mostly small. Found shoals were gone on Mulberry branch but still present in Locust where collecting was "rather poor." The country was rough and it was hard to get to the river.

December 17, 1908 - Stated to Walker that the Showalter Collection "has singularly few of the Black Warrior species." Describes a flood on Black Warrior River after they finished collecting when the river rose 15 feet and most of the boats on the river were carried away! Damage was done to Locks 14 and 15 where work was at that time unfinished. The shoals were flooded and Walker was reminded: "You will have a monopoly of Black Warrior Unionidae."

February 1, 1909 - A long and rambling letter, but mentions getting *Strophitus subvexa.*

February 8, 1909 - Proposes to collect in the Sipsey River and indicates that upper portion is rocky and dries up while the lower is deeper and sandy. He then commented: "All larger streams of the Alabama system have peculiar shells."

February 12, 1909 - Smith was making inquiries about the Tombigbee River which he said was called the "Bigbee" here. Dr. Spillman lived at Columbus and many specimens came from him. Showalter collected lower down in the area of Big Prairie Creek. Gave a sketch of regions Showalter collected.

July 30, 1909 - Collected near Sipsey River about 7 miles north of Fayette, Alabama. The Sipsey was called the "New River" there and it had high clay banks and few shoals. In 4 days they collected 250 mussels and it was hard work since they were digging in mud, sand and gravel. "Quite half are new to me;" and only a few of the Black Warrior species occur. He went up river 17 miles where the railroad crosses and where shells were much more common. Also reported good shoals for mussels about 2 miles above Columbus. Stated that the Columbus area was collected by Spillman and Hinkley. He mentions going both to Buttahachee and Beaver Creek.

August 12, 1909 - Letter written from Hamilton, Alabama, and he collected the Buttahachee which proved much larger than he supposed. It reminded Smith of the Cahaba. The bed in the shoals is rock, the current swift, and mussels were in deposits of sand and shingle - abundant. In one day they picked up more shells than they could carry. Made an estimate of 15 species; half were like those from the Sipsey. Moccasin snakes much in evidence!

August 18, 1909 - Letter written to Walker by Daisy Smith reporting that her husband was "prostrated by the

heat" and was in bed. They sent 225 mussels. Although low, the Buttahatchee was muddy.

September 29, 1909 - Collected near Bear Creek in Franklin County. They went to Vina on Illinois Central railroad where they found 20 species of mussels.

September 22, 1911 - Charles T. Simpson (of U. S. National Museum) visited them for 3 days. They visited the North River which they found rather inaccessible. They also went to the Sipsy River at Elrod. In 1909 that river was too high but now they obtained several hundred mussels - about 25 species which were different from those collected higher up from forks.

October 8, 1911 - Smith made several excursions to the Sipsey and found it one of the richest in Alabama; it was very different from other rivers he explored. Found river mostly "dead water" but now and then there were gravel shoals with strong current over a gravel layer a foot thick. Found great numbers of mussels "under cemented portion of rock." From Elrod and above they got 2,000 mussels - mostly alive. He corresponded with A. E. Ortmann and was "picking up alcoholic specimens for him."

October 18, 1911 - Reported sending "45 Unio numbers principally from the Sipsey" and prefers to get "authoritative labels from you." He asked for names of 9 specimens from the Sipsey River.

November 24, 1911 - Smith suggested going to the Sipsey a day or two at a time suggesting that: "We can get one Alabama river thoroughly worked up from its source to its mouth." Mentions that Truman Aldrich became post master at Birmingham.

October 28, 1912 - Found Valley Creek at Toadvine (Black Warrior drainage) very rich and in 2 hours collected 22 species of Unionidae. Both Lost and Wolf creeks in Walker County were good collecting. Reported that a dam will flood Valley Creek. The Warrior shells were small while those from Valley Creek were large.

December 22, 1914 - Letter sent to Walker contains a list of 9 species of mussels from "Forks of the Warrior."

January 14, 1915 - Smith hired girls to clean Warrior mussels since they were harder to clean than most Alabama Unionidae. Mussels need cleaning to discover their identities. Smith collected 9,000 mussels from the Warrior in 1908 and "probably 7,000, at least, are Pleurobemas."

January 17, 1915 - Observed that the Tombigbee and Alabama mussels are quite similar but comparisons show in many cases that the Tombigbee forms vary considerably from those of the Alabama system. The rivers join far to the south in Alabama so that the flood plains probably had brackish water to prevent passage of species between drainages. It would be interesting to work out the relationships of the two systems. Gives a list of the mussels dredged at McIntosh on Tombigbee near its junction with the Alabama. (A dozen species listed using the older names).

January 21, 1915 - Walker agreed to send mussels back to Alabama for cleaning by the girls hired there. The 1914 catch had 137 lots and the *Pleurobema* gave trouble in identification.

January 29, 1915 - Smith became interested in faunal relations and stated in this letter to Walker that: "Many of the Tombigbee species and those of the lower Cahaba (Pratt's Ferry) are a comparatively recent migration from the mouth of the Tombigbee." He observed that the relationship of the two drainage areas is one of those questions that have to do with geology as well as zoology. Smith talked the matter over several times with the State Geologist, Dr. Eugene A. Smith, who recommended a careful assessment of the faunal elements so as to have the zoogeography align with geological records. Then, Smith added: "I must do all I can in the Tombigbee drainage...I must take up that river again, as well as Coalfire, Lubbub, Bear and Jacannochee creeks, all quite accessible from here."

In this same period at the turn of this century, Anson A. Hinkley collected extensively in Mississippi and Alabama. His work was reported in an article appearing in *The Nautilus* (20: 34-36; 52-55, 1906) and as indicated by van der Schalie (1939:4), the collections from the Tombigbee came largely from the vicinity of Columbus, Mississippi, where he cited 39 species of mussels in the drainage at that time. As was the custom at that time, Hinkley traveled by train to reach stations on rivers otherwise inaccessible. "The streams along the Illinois Central railroad where the stops were made, have sandy beds and not favorable for molluscan life,..."

Present Status of Mussel Fauna in Tombigbee Drainage

In the thirties a number of extensive expeditions were undertaken, mainly by Calvin Goodrich, William J. Clench and Henry van der Schalie. These collections in Alabama, Georgia, Kentucky, Tennessee, Mississippi, etc. - mainly southern states - were often combined with visits and collaboration with the Alabama Museum at University, Alabama. Much interest was expressed and encouragement provided by the State Geologist at that time, Walter Jones, and the curator in charge of the collections, Miss Winnie McGlamery. The information bearing on the mollusk fauna of the Tombigbee and the other important rivers in the Alabama River drainage was published mainly in three papers, all of which allude to the importance of ecology and distribution of the mollusks as these considerations relate to the geology and physiography of the region.

The first of these as they appeared chronologically was a report with the title: *The Naiades (Fresh-Water Mussels) of the Cahaba River in Northern Alabama* by Henry van der Schalie (Occ. Pap. Mus. Zool., Univ. Mich., 392: 1-29, 1938). The mussels gathered were shown as they occurred in the several portions of the Cahaba drainage system so that it was possible to draw the following important conclusions based on a study of the ecology and distribution of the 48 species collected there:

> "It seems necessary to conclude that in geologically recent time tributaries of the headwaters of the Alabama drainage were connected with tributaries of the Tennessee drainage. This confluence permitted the three creek species known to belong to the Tennessee drainage to enter the headwaters of the Alabama drainage.
>
> The seven representative species which entered the Alabama system from the north by way of the Tennessee drainage indicate that streams somewhat larger than creeks were connected. Since these forms are at present more or less differentiated in the two river systems, sufficient time must have elapsed to permit differentiating evolutionary tendencies. Thus, the connection of the larger streams must have preceded that of the creeks."

In 1939 the only published paper to give a list of the species that occupy the Tombigbee River appeared with the title: *Medionidus mcglameriae, A New Naiad from the Tombigbee River, with Notes on Other Naiads of That Drainage*, by Henry van der Schalie (Occ. Pap. Mus. Zool., Univ. Mich., 407: 1-6, 1 plate). The new species was actually collected by the late Winnie McGlamery at Epes,

Sumter County, Alabama. With the information then available, it was possible to make comparative lists (p. 4) showing the species collected by Hinkley (1906), Goodrich and van der Schalie (1931), Clench and van der Schalie (1933), and McGlamery (1935). With the use of the H. H. Smith letters, tributary species were given for: Sipsey River at Elrod; Lubbub Creek at Reform; and Coalfire Creek at Coalfire. With the exception of the new species found by Miss McGlamery, this faunal list probably contains a fairly accurate account of the mussels in that drainage at that time.

Another publication too often overlooked since it has a bearing on the fauna of the Tombigbee and Black Warrior rivers appeared in 1941 entitled: *Distribution of the Gastropods of the Cahaba River*, Alabama, by Calvin Goodrich (Occ. Pap. Mus. Zool., Univ. Mich., 428: 1-30). In the introduction to this paper he stated:

> "A fact well recognized is that the molluscan fauna of a river alters as the stream itself alters in its course from headwaters to its mouth. The alteration may be restricted to that of the shell configuration within a given species, as in members of the *Lampsilis* group of Naiades of the larger Great Lakes affluents, or to the development of conspicuous sculpture, a striking illustration of which is *Io* of the Tennessee River system."

In this study, Goodrich finds that the Pleurocerid snails occupy three zones or sections in their distribution pattern. His studies reveal clines developed in relation to the up or down river position they occupy in the river and perhaps as shown by the distribution of the mussels in that same river (van der Schalie, 1938: 17-23) where the three major zones are correlated as verified by Dr. Walter B. Jones of the Alabama Geological Survey with the geology and physiography of the region.

In summary, the work of H. H. Smith as sponsored by the "syndicate" and the surveys made in the thirties of the rivers in the Alabama drainage system does reveal essentially the rich assemblages of mollusks in the system as a whole. The Tombigbee and the Black Warrior have not been studied so far as publications reveal in the present period of rapid economic development. Consequently, it was of considerable interest to find the First Supplemental Environmental Report of the Tennessee-Tombigbee Waterway for Alabama and Mississippi with an article (Volume IX, Appendix F) by Paul Yokley listing the mussels he found recently at several stations between Aberdeen, Mississippi and Gainesville, Alabama. From this account Yokley and Gooch collected 40 mussels (species and forms) in the Tombigbee in 1974. The comparison (Table 1) made with the collections of Hinkley as reported in 1906 and van der Schalie published in 1939 shows a surprisingly rich fauna which differs not so much in its overall species assemblages as it does in composition from place to place. It is just this vital matter of analyzing which species occupy the various portions of the stream (creeks, small river, medium sized bodies or the larger stream); their relation to bottom conditions; nature of flow to determine the effects of current or need for sluggish conditions; the pressures placed on the benthic faunal assemblages by sewage, industrial wastes, heated effluents from steam plants or reactors, etc., etc. - all of which could indicate what prospects there are to find sites that could be set aside as reserves or preserves in view of alterations that must come about with the completion of the new seaway.

Future Status:

The proposed seaway as planned for the Tennessee and Tombigbee rivers will bring about enormous changes with profound impact on the biota of the region. Mussels are animals that can serve as monitors for assessing the changes. They should be studied both *before* and *after* the drainage alterations are made. It has been shown that some knowledge exists for the "before" aspects as briefly recorded in the foregoing history section. Several studies were reviewed to show the value of mussels in tracing stream confluence. Consequently, it is strongly recommended that these animals be used for intensive studies as a part of the work involved in feasibility for some of the work contemplated.

If mussels are to be used, a far more comprehensive program will need to be developed than is now being conducted by Dr. Paul Yokley. It has been well established that mussels are quite specific in their ecology and distribution so that it is urgent that the species living in the Tombigbee and Black Warrior drainages be carefully mapped and localized as to their ecology. If this information is known there will be better assessment as to whether species eliminated in some part of a drainage might still be preserved in another part of the system. That work cannot be done without proper equipment which would include proper boats, crawfoot bars, scuba diving, etc. Visiting the caches at muskrat feeding places is helpful but certainly not sufficient for the kind of assessment required.

It is recommended that a preliminary survey be made and, with consultation with the proper authorities, an intensive mussel survey be instituted as soon as possible before too many changes are made in the drainage pattern. The data gathered could then be integrated with what is available at centers where the historic material is stored (University of Michigan, The Alabama Museum, etc.).

References:

In addition to the wealth of information contained in the H. H. Smith letters to Bryant Walker, there are only a few mollusk papers that have special bearing on the studies of the mollusks of the Tombigbee drainage. They are, as follows:

Goodrich, Calvin. 1941. Distribution of the gastropods of the Cahaba River, Alabama. Occ. Pap. Mus. Zool., Univ. Mich., 428: 1-30.

Hinkley, A. A. 1906. Some shells of Mississippi and Alabama. The Nautilus, 20: 34-36; 52-55.

Neel, Joe K. 1941. A taxonomic study of *Quadrula quadrula* (Rafinesque). Occ. Pap. Mus. Zool., Univ. Mich., 448: 1-8, 1 plate.

van der Schalie, Henry. 1938. The Naiades (fresh-water mussels) of the Cahaba River in Northern Alabama. Occ. Pap. Mus. Zool., Univ. Mich., 392: 1-29.

_____ . 1939. *Medionidus mcglameriae*, a new naiad from the Tombigbee River, with notes on other naiads of that drainage. Occ. Pap. Mus. Zool., Univ. Mich., 407: 1-6, 1 plate.

For a more comprehensive understanding of the many interesting aspects of the biology of the mussel and snail fauna of the Alabama drainage and its relation to the Tennessee system to which it will be connected, there would be a host of important studies to which reference should be made. Some of these are:

Hayes, C. W. and M. R. Campbell. 1900. The relation of biology to physiography. Science, 12(291): 131-133.

Simpson, Charles T. 1900. On the evidence of the Unionidae regarding former courses of the Tennessee and other southern rivers. Science, 12(291): 133-136.

van der Schalie, Henry. 1938. The naiad fauna of the Huron River, in Southeastern Michigan. Misc. Pub., Mus. Zool., Univ. Mich., 40: 1-83; 12 plates, 1 map.

_____ . 1939. Additional notes on the Naiades (freshwater mussels) of the Lower Tennessee River. Amer. Midl. Nat., 22: 452-457.

_____ . 1940. The naiad fauna of the Chipola River, in Northwestern Florida. Lloydia, 3: 191-205, 3 plates.

_____ . 1945. The value of mussel distribution in tracing stream confluence. Mich. Acad. Sci. Arts and Letters, 30: 355-373.

_____ . 1950. The mussels of the Mississippi River (with Annette van der Schalie). Amer. Midl. Nat., 44: 448-466.

_____ . 1951. Arnold Edward Ortmann as revealed by his letters. Nautilus, 65: 134-141; 23-26.

_____ . 1952. An old problem in naiad nomenclature. Nautilus, 65: 93-99.

_____ . 1969. Two unusual unionid hermaphrodites. Science, 163: 1333-34.

_____ . 1970. Hermaphroditism among North American freshwater mussels. Malacologia, 10: 93-112.

_____ . 1973. The mollusks of the Duck River drainage in Central Tennessee. Sterkiana, 52: 45-55.

_____ . 1975. An ecological approach to rare and endangered species in the Great Lakes region. Mich. Acad. Sci. Arts and Letters, 8: 7-22, 5 plates.

van der Schalie, H. and Guy C. Robson. 1963. Bivalve. Encyclopedia Britannica, 1963: 8 pages.

SOME MALACOLOGICAL JOURNAL NOTES AND CORRESPONDENCE OF E.S. MORSE

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I. Introduction

Edward Sylvester Morse (1838-1925) was born and raised in Portland, Maine. As a boy he collected shells and minerals for a hobby; as a young man he was a draftsman, but in 1859 went to Harvard University to study under Louis Agassiz where he remained for three years. He was especially interested in mollusks and brachiopods. For a time he was curator of the Portland Society of Natural History, but in 1866 went to Salem, Mass., to become one of the founding curators at the Peabody Academy of Science. Between 1877-79 he went to Japan to conduct research on brachiopods and mollusks and to teach at the Imperial University of Tokyo. A second visit was made in 1882. He was the first president and one of the organizers of the Boston Malacological Club, founded in 1910.

Below are selected excerpts from his journal entries and his correspondence which illustrate his concern with malacology. For biographical details on Morse, see Howard (1935), Champion (1947), and Wayman (1942). I am indebted to Dr. Ernest S. Dodge, Director, Peabody Museum of Salem, Mass., and to Dr. Ladd Heldenbrand and William J. Ginn, Maine Audubon Society, for permission to quote from the Morse papers on file at their institutions.

II. Selected Passages from Morse Diary Concerning Malacology (1858-1865)

Morse first collected shells by the age of 13. He read his first paper to the Boston Society of Natural History before the age of 20. During his early life, he maintained a journal. A typescript for the years 1858-1863 is deposited in the Peabody Museum of Salem, Mass. (The Wayman Collection). Following are some excerpts which deal with Morse's interest in malacology.

1858

Jan. 18-- "Mon. eve. I read with much embarrassment an article on the progress of conchology in science before the Nat. Hist. Soc. [Boston Society of Natural History] evening meeting."

Jan. 25-- "The *Daily Advertiser* this morning published my article on conchological investigations in Maine."

Feb. 1-- "One-twelfth of the year has gone and though not much, still I have accomplished a little towards arranging my cabinet [of shells], and if I do as much and as promptly every day as I have done today, I shall accomplish much."

Feb. 13--"I have labelled a lot of my shells today, mostly Helicies. Rec'd a box of shells from Mr. Thompson, N.B. [New Bedford] with picture enclosed. I like the looks of him. His shells he sent me were very nice. John [Gould] came up tonight and we struck into a new train of ideas and that is the exploration of the islands noting the number of species of land shells discovered in each island."

Feb. 15--"Looking over my shells today I found a few that I collected last summer a 'Black Strap' and among them a little Helix that attracted my attention at the time, but I forgot all about it. -Today I made drawing and description of it. Examined it carefully under the microscope and am positive it is new [*Helix milium* n. sp.]. If I can find more, it will prove it. I have only one specimen, but shall go there next summer and search carefully."

Feb. 16--"Wrote 6 or 7 pages on Bulimus. If I can write a decent article I will read it at the next meeting [Portland Soc. Nat. Hist. Read Mon. eve. 1 Mar. 1858]. This eve. John [Gould] and I went down to Fullers. I carried down 22 species of fossils from Ohio that I had labeled nicely for him. ····He gave me young specimens of *Alasmodea undulata* Say which he took from the animal itself. Under the glass they look singular. He also gave me specimens of a Vincula from Saco [Me.] which looks new. It may be the young of *M. portlandica.* Also specimen of a Vincula which I am positive is new."

Feb. 18--"This forenoon I made a colored drawing of the *Tritonium decemcostatum* Luddendorff. ····I wish I had time to make drawings of all the shells of Me. and color them up as I did the ones I drew today."

Mar. 1-- "At Natural History Society....I read an article on the Bulimus. Did not feel embarrassed."

Mar. 6-- "Found description of rare Unio bought the other day. It is the *Unio greyii* Lea. A very rare shell."

Apr. 1-- "This morning I took my Pisidium net and started for Pownal. Rode in the engine [R.R.] and dredged in every brook around the depot. ···· Rode on the engine back to Portland and immediately started for Cape Elizabeth and found in the marsh near the Fort a species of Pisidium very small and pretty which looks new to me."

Apr. 10--"How I enjoy showing my cabinet [of shells] to persons who appreciate looking at them and are gifted wich a taste in their observations."

Apr. 13--"I wish I had money. How much I might do towards developing the shells of Maine."

Apr. 15--"John Gould, John Dow, and myself after shells at the Verandah-found for the first time in this state one specimen of *H.* [Helix?] *minuscular* B."

Apr. 19--"At low tide this forenoon I went down on the rocks near the Portland Co wharf and found some beautiful specimens of Eolis. I must have an aquarium and then I can have everything in the sea to admire."

May 13-- "This forenoon I went up back of the house and found some very good shells. *Pupa pentocton, P. simplex, Helix sayi, Monodon alternata, Milium minutissima, Annulata labyrinthica, Chersina indentata* and others, common."

June 18--"My 20th birthday····it is a comfort to look back and see what I have done and what I have got to begin my common and conchologic life with. A trade, a fine cabinet of shells, some very good con-

chological works, and numerous correspondents, and what is far more valuable than all, a friend [John Gould]."

July 15--"[Judge Cooper of Hoboken, N.J.] informed me that [William] Stimpson was down this way. Had left conchology because the synonyms were so perplexing and had gone into Crustacea, Annelida, etc. What a man Stimpson must be to step in as he has and overload the already cumbersome load of synonymy by publishing a new name to every N. E. shell taking all the credit to himself and then step out again without settling his accounts declaring that conchology is perplexing!"

Morse's attitude soon changed with better knowledge of Stimpson and the problems he faced. William Stimpson of the Smithsonian Institution, from roxbury, Mass., studied under Agassizas did Morse. Stimpson praised Morse to W. G. Binney who invited Morse to correspond, resulting in a long term friendship. Soon Stimpson called on Morse who proved to be a good friend. Morse records the following in his journal.

July 20--"I was exceedingly glad to see him.····[He] looked over my shells, pronounded a long....chemintizee 'new', and also my Leda at landslide 'new', Fuller's Pecten, and also the Yoldia of Fuller's."

Aug. 4-- "Mr. Stimpson came to the house this eve. and I went down to Fullers with him.···· He labeled most of Fuller's specimens and told him some were new."

Aug. 17--"Received letter from John [Gould] today giving great account of Fullers and himself reaping fabulous piles of land shells *Helix hortensis* and *albolabris* on an island in Casco Bay--Brown Cow Is. or near it."

Sept. 2-- "Saw this fellow Verrill[A. E. Verrill] and had a nice time in conversation with him. We went down on the meadow and found some good Cyclas. He gave me some very nice *Planorbis trivolvis.*"

Oct. 20--"This evening attended meeting of Boston Society of Natural History and enjoyed myself very much. Saw Prof. Agassiz for the first time.···· Dr. [A. A.] Gould gave an interesting account of his tour through Europe and his visits in different collections there."

Dec. 16--"I called in to Dr. Gould's and showed him my shell drawings. He said they were 'remarkably well done' and thought I might be the man he wanted."

Dec. 27--"Saw Stimpson. Shall get a job of drawing shells, I think."

Dec. 28--"At Dr. Gould's this afternoon. Showed him drawing of *H. [Helix] milium* and carried down a lot of shells for him to look at. He says he is bound to devote his whole time to American conchology as soon as he gets rid of the foreign stuff he is at work on."

1859

Feb. 8-- "Saw Ad [Addison E.] Verrill. He then accompanied me to a house opposite where I was introduced to Dr. Mighels, a fine looking old man. Talked with him some time on shells."

Feb. 18--"Wrote and drew descriptions of animal *Lacuna neritoidea*. This afternoon found more specimens. I have got about 283 specimens. This shell has heretofore been found very rare, but now we have any quantity of specimens. It is a fine species district I think from *L. pallidula* of England."

Apr. 4-- "Very full meeting of the Society [Portland Soc. Nat. Hist.] tonight.····I proposed A. E. Verrill of Norway, Me., as a corresponding member of the Society."

Apr. 18--"Rec'd letter from Mr. A. S. Packard, Jr., Bowdoin College, asking if a collection of Insects would be acceptable to the Society, asking also information in regard to fossil shells, etc."

May 3-- "Ad Verrill [later, Prof. Yale] and Syd [Sydney] Smith of Norway [Me.] and I started for the Cape [Cape Elizabeth] this morning. Syd Smith is a young fellow Ad has interested in shells. He appears to be a first rate fellow. We found a lot of *Helix harpa.*"

May 8-- "Mr. [P. P.] Carpenter of England at the house this forenoon to see my cabinet. Singular man."

May 9-- "He [Carpenter] labelled and relabelled many of my foreign shells.····He showed me an immense number of drawings of the Matzatlan shells on which he published a long article. Showed me also a drawing of Caecums which he is preparing for a monograph. He told me he collected them from sponges. This eve. went down to Dr. Lunt's and got the sand from some sponge draws. Examined it and found any quantity of caecums."

May 23--"Rec'd letters from [A. S.] Packard and [W. G.] Binney. Packard corrects his mistake about *Helix hirsuta* being found near Brunswick, but is positive *Helix aspersa* is found on Whaleboat Is.····Binney sent on a shell which we wants drawn. I drew it on wood for him."

May 26--"Today I received a letter from Mr. P. P. Carpenter who has seen Agassiz and told him of my taste in Science and talent for drawing. Mr. Agassiz wishes to see me. Shall go to Boston tonight."

Nov. 1-- "Went to the laboratory [Agassiz's] and saw [Alpheus] Hyatt who went round with me to find a room. Could not find one.····Was astonished to see the progress they had made in the building [M.C.Z.] in 4 weeks."

Nov. 2-- "Over to Cambridge again this morning and Hyatt at last found a nice place for me and Ad Verrill when he comes. Mrs. Cleveland, Winthrop Square, appears to be a nice woman. Fixed my room and got everything ready to do to work in the morning. This afternoon Prof. Agassiz went with me to Boston and introduced me to Cutting at the Aquarial Gardens. Prof. A. wishes me to make drawings of the Gastropods and Acephala [bivalves] in their live state."

Nov. 3-- "At Boston this morning made drawings of *Buccinum undatum* animal while clinging to the side of the glass. This afternoon he [Agassiz] set me at work drawing the *Mya arenaria* with the syphon extended."

Nov. 29--"Prof. [Agassiz] set me at work on Florida shells."

Dec. 1-- "Prof. Agassiz told me this morning to make a complete series of shells representing their varieties, form, growth, etc. Commended on it at once. This week we have worked in the cellar of the new building [M.C.Z.] "

1860

Jan. 7-- "Discovered a pretty property in *Pecten concentricus* tonight. The width of the ears would go round the circumference of the shell just exactly five times."

In a letter to his mother written 15 Jan. 1860 and in several journal entries over the succeeding two months,

Morse mentions the following as fellow students under Agassiz: Barnard, Lyman, Scudder, Hyatt, Putnam, Wheatland, Ordway, Verrill, Emerton, Clark, Shaler, Foley, Cooke, Bowditch, and Bickmore.

Feb. 1-- "Have separated the so-called genus Ceritheum into a half dozen distinct genera. Here is what Prof. says in regard to families, genera, species. 'Family is a form determined by structure. Genus depends on the ultimate details of structure. Species [on] ornamentation, distribution, form, etc.' "

(The writer has recently published a paper on "Historical Aspects of Louis Agassiz's Lectures on the Nature of the Species." Bios 48: 12-19. 1977).

On 1 Feb. 1860 he wrote again to his mother that "I have been engaged for the past two weeks in Genera. That is I have taken for example the genus Ceritheum and detected 7 or 8 genera from it. It is a great work and Prof. is highly pleased with manner and zeal with which I do it. He hinted to me tonight that he was going to keep he a whole year on it."

Mar. 22--"Meeting of the club [Agassiz Zoological Club] tonight. Hyatt read an interesting paper on Ammonites."

Mar. 28--"It is surprising how poorly and artificially shells are grouped together in families and genera. Many genera such as Buccinum and Cytherium contain at least half a dozen genera apiece."

Mar. 30--"I am getting deeply interested in grouping together different forms constituting genera. I find in the so-called Genus Buccinum, of which there are so many species, only 3 or 4 true Buccinum."

Apr. 2-- "Prof. [Agassiz] spoke this morning of species describers and that such work was poor."

On 1 April 1860 he wrote to his mother, "Now I have under my charge Horace Mann a young student, son of the immortal Horace Mann. I am teaching him how to group together shells." And a week later wrote again that, "He [Agassiz] told me that he was going to put me on to dissecting shortly. He wants me to determine the families in Mollusca which are now made out very poorly."

May 16--"Dissected out lingual ribbon of *Tritonium decemcostatum* and *Tectura testudinalis*. Made drawings of both. Found our Tectura to differ entirely from drawings of the English one in 'Grey's Guide to Mollusca'. The Tritonium resembles the Buccinum very much."

May 17--"Dissected out linguals of *Tritonium islandicum*, *Buccinum undatum* and *Natica heros*. Found Buccinum teeth differing also from drawing of English one figured in Grey's 'Guide to Mollusca'. The study of these ribbons or tongues is extremely fascinating. Would like to have time to get all of our shells and make preparations of the tongues."

May 18--"Made some minute dissections today. In finding the tongue of *Lymnea elodes* and *L. columella*. I was very successful and mounted them both. They bear good deal resemblance to Helices drawings of which are in Binney."

In the summer of 1860, the first serious break between Agassiz and his students took place.

Aug. 20--"Letter from Binney saying he would arrange our land shells at Museum and also that he had secured a copy of his father's work."

Sept. 28--"Prof. introduced me to Prof. [Joseph] Henry of Smithsonian Institute. 800 shells all arranged in Shell Room."

Sept. 29--"Prof. told us today that Prof. Henry had promised to give us everything we wanted from the Smithsonian Institute. Prof. Henry was so deeply impressed with the manner in which we are doing things here that he is going to give us what we wish from the Smithsonian."

Sept. 30--"W. G. Binney here this afternoon. He looked over Helicidae with me at the Museum. He made me an elegant present being a copy of his father's work, a work I have been long desirous of obtaining. He told me that he had observed that the operculum of *Paludina subcasinata* had an orbicular operculum. If such is the case that shell shows an affinity to Valvata and the extreme young is strongly cornated like a Valvata. He drew Prof. [Agassiz] and myself maps of U.S. with distribution of some species of Helices marked over on them. The distribution of the so-called *Helix alternata* was remarkable. The common form, smooth, ranged over a wide district north. The strongly ribbed variety, so-called, formed a band along the Gulf of Mexico while a cornated form occupied a space in Tennessee including the Cumberland Mts. Prof. suggested that the [*H.*] *alternata* might be generically distinct from [*H.*] *albolabris* and that these varieties might be species of this genus occupying the range above named. He wished me to make a microscopical examination of the epidermis as there were strong generic marks in this part of the shell."

In the fall of 1860, dissention between Agassiz and his students was increasing.

Dec. 10--"Finished catalogue copying. We have over 26,500 specimens of Mollusca in alcohol in the Museum, not including the cephalopods and Naiades, and many still to be catalogued. These figures represent about 600 species, 400 of which are Gastropods and 200 Conchifera [Bivalves]."

Dec. 28--"Prof. gave me on Wed. four species of Unios included in the genus Metaptera of Rafinesque and wished me to find out the generic features from the shell. I have been busily engaged on them since then. Have made drawings of the hinge of the *M. leptodon, ohioensis, gracilis* and *alata*. I find strong generic characters specializing this genus though I am puzzled to know what to do with *Alasmodonta complanata* which shows many of the features of the genus Metaptera."

Dec. 31--"My feelings through the year have [been] happy. My studies have progressed as well as I could wish though most of my labors in the Museum have been in arranging the collection of Shells and Mollusks."

1861

Jan. 1-- "Prof. [Agassiz] told me today that the strong line of growth noticeable a little way from the beaks of Unionidae indicated their first spawning season."

Jan. 2-- "Dr. Gould was out here this morning. He told me that next month he should commence on the North American coast shells with the determination of publishing a second edition of his 'Invertebrata of Massachusetts'.

N. Ferrand was out here this afternoon bringing with him 42 species of Cape Palma's shells. We exchanged with him giving in return American helices. Very interesting meeting at the Boston Soc. Nat. Hist. Ordway read a paper showing the

difference between *Paradoxides spinosa* and *P. parlani* showing them distinct species while they have been considered identical by Rogers and Jackson. Door Dr. Jackson was severely handled by Ordway and Prof. [Agassiz] much to our delight and his disgust."

Jan. 4-- "Made out my report to Prof. of the collections in my department since Jan. 1860. We have received about 4,000 species and 30,000 specimens."

Jan. 10-- "Examined animals of *Metaptera ohioensis*. The generic differences are obvious and striking in the animals as in the shell. The mantle and foot are situated at the posterior end and close the gill cavity from the upper cavity. The outer gill reaches down and behind the inner gill. During impregnation the young are developed in the posterior part of this outer gill. The palpi are connected partially on the posterior edge."

Feb. 2-- "Went into Boston this afternoon. Went to Dr. Gould's and saw engraving of lingual ribbon of many northern shells. Some of them did not agree with lingual ribbons of what is called the same shells on our coast. He had some Buccinum from the North which resembled the fossil Buccinum found on our coast in Portland. He showed me some large Littorinas from Halifax which resembled very strongly a Littorina from England [L. littorea?]."

[Morse (1880) published a paper on the spread of this species down the Atlantic Coast, following the report by Gray (1879). A further note was added by Dexter (1961)].

Feb. 6-- "Into meeting of the Boston Society tonight carried in some of my drawings and Prof. showed them to the assembly as illustrating the age of Unios. What had been commonly supposed to be a young shell he thought was at least 7 or 8 years old. Dr. Gould hardly believed it, but Prof.'s reasons were apparently correct."

Feb. 16--"Bowditch, [Harry] Rice, and I reached Chelsea Beach after riding in horse cars, omnibus, and footing it through mud some four miles. There was not so much washed up as I expected. Found many Limnaeas on the beach. Did not save any. I collected a good number of *Solemya velum* with animal. Also, *Natica duplicata*. I was not aware that they were found north of Cape Cod, but in looking in Gould's found that they were."

Feb. 27--"A letter from Mr. John G. Anthony of Cincinnati wishing to exchange. Prof. also gave me a letter from Mr. Anthony which he wished me to answer. [Anthony became successor to Morse as Curator of Mullusca at M.C.Z. See biog of Anthony by Ruth Turner in Occasional Papers, Dept. Mollusks, M.C.Z.]

Mar. 1-- "I have made considerable progress in my investigations of the Metapterae. Can make further advancement when I have compared the anatomy of the Metaptera with another allied genus. This far I have only examined the animal of *M. alatus*."

Mar. 5-- "Accompanied Mr. Bartlett to his brother in Newbury to see a lot of Unios which have been varnished for 15 years. We were to have ours fixed in the same way."

Mar. 21--"Found the outlet to cavity immediately above Bujunus organ today. It is a posterior opening with top of cavity on inner site. The cavity is undoubtedly for the free ingress of water."

Mar. 23--"Opened some *Unio phosculeus* for the purpose of making a drawing of the animal. The gills are filled in entirely different way from Metaptera. In the *Unio phoscula* the whole margin of the outer gill or rather the lower half of the outer gills are filled with eggs and the gill takes on a beautiful appearance, ruffled like a frill."

Mar. 26--"Examined *Helix pulchella* of Europe to determine if they were like ours and I think they are different. I examined specimens of the Helix from Heidelberg, Verona, and England, and I found the differences quite striking compared with the American ones from Maine and Ohio."

Apr. 5-- "Prof told me yesterday that he should want me to go to Cincinnati this summer for the purpose of making drawings of the animals of Unios while yet alive."

Apr. 6-- "Made an examination of the animal of *Alasmodonta complanata*. Find tremendous differences between this and the *M. [Metaptera] alata*."

Apr. 8-- "Re-examined section of gills of *Metaptera alata* and *Alasmondonta complanata*. Found the most striking structural differences existing between them. Made longitudinal section through animal of *M. fascolaris* water system. Entrance is in foot and other differences which I wish to confirm."

Apr. 13--"[Agassiz] said that those who sought Nature always found relief if their minds were distressed." [War news was disturbing].

May 21--"At work on species *Alasmodonta edentula* Say. It is the most perplexing shell I ever came across to determine the limits of a species."

May 23--"Cannot make head or tail of the *Alasmodonta edentula*."

May 30--"Prof. showed me a lot of generic distinctions in the Unionidae. It will be splendid to work these all up and I hope to be able to do it."

July 3-- "[Prof. Agassiz] has received a new work on the genera of Helices. The *H. pulchella* belongs to the family Verronica and is the only species known to the author."

Sept. 17--"Made a cast of shell of *Alasmodonta arcuata*. Then I sawed the cast in sections corresponding with the transverse cuts I made of the animal. I shall now be able to get an accurate outline of the interior of the shell."

Oct. 2-- "Prof. [Agassiz] was delighted with the collection I brought back which arrived safely [Mollusks collected in Maine during the summer vacation]. I commenced work this A.M. on the Unios."

Nov. 19--"Club meeting tonight [Agassiz Zool. Club]. I am at work now in my room preparing a paper to read before the club showing my reasons for considering the articulates as a class assume a higher position than the Mollusca." [Paper read Nov. 26 and well received].

In Dec., 1861, Morse left Agassiz and the M.C.Z. Some of his fellow students went into war service. Morse, however, was rejected and prepared for a career as a zoological draftsman (see Dexter, 1967). From this time on, there is a long gap in his journal. Beginning in 1865, he simply prepared a summary for the year. The last entry of malacological interest is for 31 Dec. 1865 when he wrote "A paper on the Classification of Mollusca published in the Essex Institute has received the warmest praise from Prof. Dana and others in high authority. Prof. Dana has solicited the plates illustrating it, to publish the paper entire in the

Amer. Jour. Sci. and Arts.···I have also described new species of Vertigo in the Annals of N.Y. Lyceum of Nat. Hist."

III. Selected Correspondence of E. S. Morse Concerning Malacology (1858-1918)

As a student of Louis Agassiz, Morse wrote to his mother on New Year's Day, 1860, "Prof. [Agassiz] has given me the most unlimited control over the shells in the Museum [M.C.Z.]. My arrangement of fossil shells last week appeared to have pleased him very much."

S. H. Scudder at the Boston Society of Natural History wrote 10 May 1865 characterizing Morse "As a writer and a speaker he exhibits a happy faculty of placing the subjects he presents in a vivid manner before his audience; from no source have I myself received explanations so satisfactory and simple of the structure of Mollusca, the special subject of his investigations, as from him." Temple Prime, having engaged Morse to prepare drawings of shells, wrote to him 5 December 1864 that "I am very much pleased indeed with the execution of the drawings, which are not only very correct but seem to embody the spirit of the species," and again on 28 March 1868, "The drawings and shells have come to hand. I am very much pleased with the execution of the figures, etc. I have still to thank you for the original drawings of some of my shells which you sent a few weeks since. I value them much." Dr. William H. Dall, Curator of Mollusks at the U.S. National Museum, was also impressed by Morse's drawings and wrote to Dr. Victor Sterki 13 March 1896, "As to drawings I do not think anything can be better than such figures as those of Morse."

A. E. Verrill, a fellow student of Morse, suggested that he prepare a guide to the shells of Maine with profit. Verrill wrote 16 January 1862, "Ned, I have been thinking that you might do well to get up a work on the shells of Maine, written so as to be at the same time an advance in science and useful to those who are merely amateurs. It would be well illustrated with wood engravings which would cost *you* but little, and are very useful and would make it sell. It need not cost more than $1.50 or $2.00 and you could make money on it at that! You could work up the shells a family at a time and make communications on them to the Portland Society or some other one, and so have them all ready when you wished to start your book. I *know* that such a book would take. I believe I could get you 50 subscribers myself, even in these hard times." When Morse issued a report on land snails of Maine, he received the following letter from Theodore Gill at the Smithsonian Institution, 1 August 1864--"A copy of your recently issued brochure on the land Pulmonates of Maine has been received here today for Dr. Stimpson and its examination has excited in me a strong desire to possess a copy myself. I have read it with much pleasure and instruction, and find myself in accordance with almost all your views respecting the generic relations of the species and fully appreciation of the great advance made towards the knowledge of our Molluscous Fauna. You seem to me to have preserved a very happy mean in the value conferred on the buccal plate, giving to it full value, but refusing the extravagant estimate placed on it by Mörch. Your views would thus more nearly coincide with those of Busch, whose sections partly correspond with your subfamilies. I think somewhat of reviewing Bloud's recent memoir and in connection with it your own if I can spare the time this summer. Thank God we are beginning now to tear ourselves from the influences of the genera-hating amateurs who look only to the convenience of the memory and become guiled somewhat by nature and science."

When F. W. Putnam, Superintendent of the Essex Institute, learned that Morse was being considered for a position at Bowdoin College, he wrote to Morse offering to exchange specimens. Putnam wrote from Salem, Mass., 11 May 1865, "Having heard that your name has been mentioned in connection with the proposed professorship of Natural History at Bowdoin College, I wish to inform you that should you obtain the situation it will give me pleasure to aid you in the formation of a collection, and in the name of Essex Institute I offer you a full series of all our duplicates, which would, I should judge, number about 1000 species of animals of various classes. Feeling that the College could not select a better person than yourself, from among the young naturalists of the country and hoping that you will receive the appointment, I remain."

George W. Tryon, Jr. at the Academy of Natural Sciences of Philadelphia attempted to attract Morse to his institution. He wrote to Morse 19 November 1866, "We are now organizing the Conchological Dept. of the Acad. of Nat. Sci. [of Phila.] and would like to know whether you are disposed to enter into arrangements with us. We think that that we can offer about $1200 per annum to start with, with a fair prospect of increase in the future." Morse, however, did not accept his invitation, and he likewise refused an offer from the Boston Society of Natural History in order to join the newly organized Peabody Academy of Science at Salem, joining his former fellow students F. W. Putnam, Alpheus Hyatt, and A. S. Packard, Jr.

Morse was attracted to the study of brachiopods, which at first were thought to be mollusks. His researches and publications demonstrated that brachiopods are related to the annelids rather than mollusks (Dexter, 1966). Upon reaching these conclusions, Morse wrote to Dr. William Wood, 31 May 1870, that "I have just returned from these [North Carolina] and bring with me live specimens [of lingula] besides specimens in alcohol and I have the most startling things to show that they are worms and tubicolous worms. You will see by sketches on the other side their worm characters, but they move by setae as a worm moves. They move their valves upon each other as a worm moves its scales, they build a sand tube as many of the tubicolous worms do, and above all they have red blood!! I am hard at work putting the data in proper shape for publication."

Henry A. Pilsbry at the Academy of Natural Sciences of Philadelphia shared with Morse an interest in land shells, and they exchanged specimens and records. Pilsbry wrote to Morse 6 October 1913, "Very glad to have your Adirondack record for *Planogyra asteriscus*. Better by all means send the State Musewum some of them, or send to me, for the State Museum. If you find anything else ther—*even the commonest species,* I would much like a list of them, as Adirondack records are a good deal like the snakes of Ireland, at present." In a letter written 9 December 1918, Pilsbry relates his first interest in land shells written to Morse 9 December 1918, "I am on the lookout for that paper you started in 1855. I found my first land shell in 1875, the old *Pupa fallax,* which I found on the trunks of apple trees in my father's orchard."

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A NON-OBLIGATE ASSOCIATION BETWEEN THE RED ALGA, *BOLDIA,* AND PLEUROCERID SNAILS

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ABSTRACT

An unusual freshwater red alga, *Boldia,* inhabits certain streams of the Southern Appalachians often growing upon the shells of three species of pleurocerid snails. While this alga-snail association is not obligate in all habitats, evidence suggests a long-term evolution of a protocooperative or commensalistic type bound to the seasonal reproductive cycles, development, and survival of the two organisms in simlar riffle habitats of Appalachian streams. The relatively high manganese content of both the snail periostracum and rocks to which *Boldia* was found attached, as well as other environmental features (i.e., photoperiod, water chemistry, and flow regime) suggest explanations for the habitat requirements and present distribution of this red alga.

Boldia is an unusual freshwater red algal genus which frequently develops on the shells of three species of snails, *Leptoxis (Mudalia) dilatata, L. cranata,* and *Oxytrema laqueata.*[1] During a three-year seasonal investigation of the systematics, distribution, and ecology of *Boldia* (Howard, 1977), the association of *Boldia* with various pleurocerid snails was often observed (Figure 1). While no obligate form of symbiosis was observed, it seemed unlikely that this polymorphic red alga would be able to maintain a population in streams without the snail association. Apparently, the alga-snail association is beneficial to one, if not both, organisms, and the association probably had a long evolutionary history within streams of the southern Appalachian Mountains.

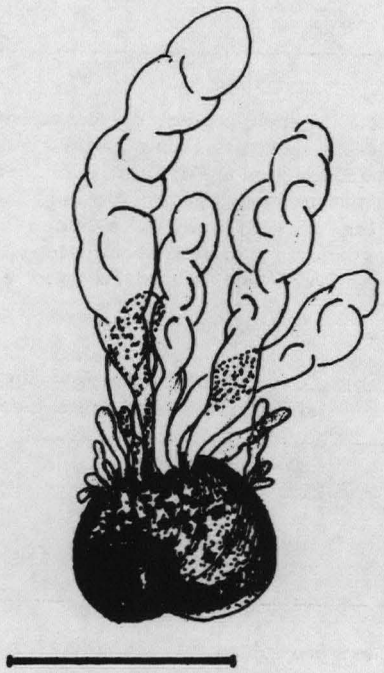

Figure 1. Ink drawing of *Boldia erythrosiphon* growing attached to *Leptoxis (Mudalia)* (bar-1 cm).

Presented here is a review of the current knowledge of this *Boldia* - pleurocerid snail association, including ideas on its origin and development. For brevity, relatively few methods which have been detailed in Howard (1977) are described in this paper. Other special methods will be noted in the results and discussion.

[1]The nomenclature of the Pleuroceridae is confusing. Van der Schalie (pers. comm.) refers to the two genera associated with Boldia habitats as Nitocris and Goniobasis; Rosewater (pers. comm.) identified these as Mudalia and Oxytrema, while the Philadelphia Academy uses the names Mudalia and Goniobasis. We shall use Leptoxis (Mudalia) Rafinesque (1819) and Oxytrema Rafinesque (1819) respectively, based on the rule of strict priority as discussed by Parodiz (1956).

Habitat Description

Twelve known habitats from which *Boldia* has been collected since its first discovery in Big Walker Creek, Giles County, Virginia in 1958 (Herndon, 1964) are depicted in Figure 2. The North River, Tuscaloosa County, Alabama habitat has since been destroyed by impoundment. The Rain Bow Springs, Missouri habitat was discovered by Rufus Thompson (pers. comm.) and has not been visited during these investigations.

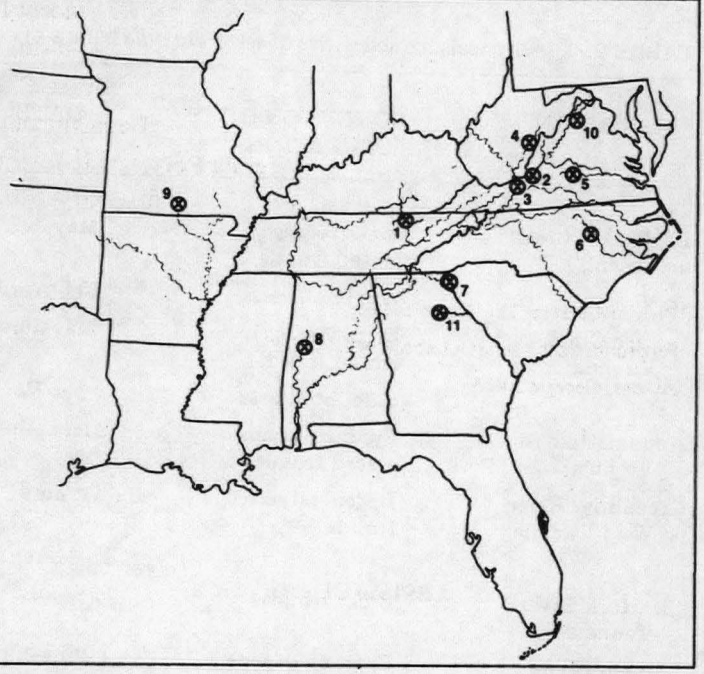

Figure 2. Map of southeastern U.S. showing locations of *Boldia* habitats and approximate % of observed fronds attached to snails (?% = insufficient collections).

(1) Clearfork R., Scott County, Tenn. (100%);
(2) Craig Cr. (80%) and Johns Cr. (10%), Craig County, Va.;
(3) Big Walker Cr., Giles County, Va. (75%);
(4) Greenbrier R., Greenbrier County, W. Va. (50%);
(5) Appomattox R., Buckingham - Prince Edward County Line, Va. (25%);
(6) Lower Barton Cr., Wake County, N.C. (5%);
(7) Ramsey Cr., Oconee County, S.C. (0%);
(8) North R., Tuscaloose County, Ala. (?%, site destroyed by inundation, not collected in this study);
(9) North Fork R., Texas County, Missouri (?%, not collected in this study);
(10) Passage Creek, Shenandoah County, Va. (5%);
(11) Cloud's Creek, Oglethorpe - Madison County Line, Georgia (5%).

The 12 habitats represent unglaciated streams which flow over rocks of lower Cambrian to Pennsylvanian age. While the surficial geology of these habitats often differed, a common feature was high calcium and magnesium content of the rocks. Analyses included routine water chemistry, plasma emission spectroscopy, and neutron activation analysis. The habitats showed widely variable $CaCO_3$ alkalinty, pH ranges of 7.0 - 8.5, and universal presence of Na, Ni, Sn, Al, Mn, Be, and Cu. Numerous streams lacking *Boldia* had either slightly acidic pH or lower levels of Ca, Mg, Na and Cu, with no detectable Ni. The *Boldia* streams were rich in aluminum, an element found to be abundant in the algal thallus by X-ray energy dispersive analysis (Table 1).

TABLE 1. X-ray energy dispersive analysis of *Boldia* and associated stream substrates showing the dominant, subdominant and trace elements detected in order of abundance.

SAMPLE	LOCATION	ELEMENT COMPOSITION	
		Dominant Element	Subdominant & Trace Elements
B. erythrosiphon	Lower Barton Creek North Carolina	S	Ca, Fe, Al, Si, Mg, P, K, Cl
B. erythrosiphon	Ramsey Creek South Carolina	S	Ca, Al, Si, Fe, Mg, P, K
Leptoxis (Mudalia) (periostracum)	Big Walker Creek Virginia	Mn	Ca, Si, Mg, Al, S, P, K, Na, Cl
Leptoxis (Mudalia) (inner surface of shell)	Big Walker Creek Virginia	Ca	Al, Si
Quartz (surface coating)	Appomattox River Virginia	Mn	Fe, Al, Si, Ca, S, K, Cl, Na
Mica-Schist (surface coating)	Lower Barton Creek North Carolina	Mn	Fe, Al, Si, Ca, S, K, Ti

Water temperatures varied seasonally among the habitats (Table 2) and values above 25 C were generally associated with growth cessation and degradation of *Boldia* thalli. Lower Barton Creek represented an exception to the seasonal development of the alga in that water temperatures were less extreme and *Boldia*, although reduced in abundance, was collected throughout the year.

TABLE 2. Physical characteristics of select *Bolodia* habitats (1975-1977).

LOCATION	CONDITION OF POPULATION	DATE	TEMPERATURE (C^O)	pH	DISSOLVED OXYGEN (ppm)
Big Walker Creek Virginia	Erect to degenerated fronds	May-July	21.0-23.0	8.3-8.5	13.0
	Basal holdfasts	Feb-April	11.5-21.0	7.9-8.2	13.0
Passage Creek Virginia	Erect to degenerated fronds	May-July	17.0-22.5	8.0	14.0
	Basal holdfasts	Oct-Nov		7.1-7.2	
Appomattox River[1] Virginia	Erect to degenerated fronds	March-July	12.5-24.0	7.0-7.3	10.0-13.0
Greenbriar River West Virginia	Degenerated fronds	July	24.0-26.0	7.8	13.0
		March	9.5	7.2	
Clearfork River Tennessee	Erect fronds	July	22.0		15.0
Ramsey Creek South Carolina	Erect to degenerated fronds	June-July	18.5-22.0	7.1-7.4	13.0
	Basal holdfasts	March	8.0-11.0	7.1	
Lower Barton Creek North Carolina	Erect fronds	Feb-April	13.0-16.5	7.1-7.5	13.0
	Erect fronds	June	22		13.0
	Erect fronds	September	17.5		
Total Range			8.0-26.0	7.0-8.5	13.0-15.0

[1]Includes data from Dickson & Abbott, 1976.

Figure 2 presents the percentage of mature *Boldia* thalli attached to snails within the particular habitat, based on visual estimates. The alga-snail association was predominant in Clearford River (100 percent) and Big Walker Creek (75 percent), while in Lower Barton Creek and Passage Creek snails were rarely found with attached algal thalli. Of interest was the observation that *Boldia* in Craig Creek, Craig County, Virginia grew predominantly (80 percent) on smails with most of the remaining population attaching to relatively sparcely distributed rocks always having a black mineral coating. In contrast, nearby John's Creek contained numerous black mineral-coated rocks, upon whihc 90 percent of the resident algal population grew. X-ray energy dispersive analyses revealed that both the rock coatings and the periostracum of *Leptoxis (Mudalia) dilalata* contained manganese as the major elemental component.

Seasonal development of *Boldia* fronds occusrred in all streams esxcept in Lower Barton Creek, North Carolina, where fronds were collected on a year-round basis (Figure 3). Table 3 summarized the parallel development of alga and snail which seems to involve the attachment of monospores to the shells of young snails; *Leptoxis (Mudalia) dilatata* represents the predominant species. An account by Flint (1970) of the

TABLE 3. Seasonal development of snail and alga.

APPROXIMATE TIME OF YEAR	*LEPTOXIS (MUDALIA)**	*BOLDIA*
October-November	Mating Peak	---
March	Oviposit Peak	---
April-June	Young Snails	Frond Production Commences
June - July	Immature Snails	Peak Monospore Production
July-August	Immature Snails	*Boldia* Frond Degeneration
October-November	Mating Peak	*Boldia* Basal System Developing
April-July	Immature Snails	*Boldia* Frond Developing

*Approximate times based on our observations and taken from Van Cleave (1932) and Dazo (1965) for *Pleurocera acuta* and *Goniobasis livescens.*

Boldia holdfast dissolving a hole in the shell of the associated snail *(Viviparus),* followed by development of snail larvae within the algal thallus was never observed during these investigations. To our knowledge, the holdfast develops only on the manganese-rich periostracum of the three pleurocerid snail species mentioned earlier, not *Viviparus.* Furthermore, snails inside *Boldia* saccate thalli have never been observed during these investigations.

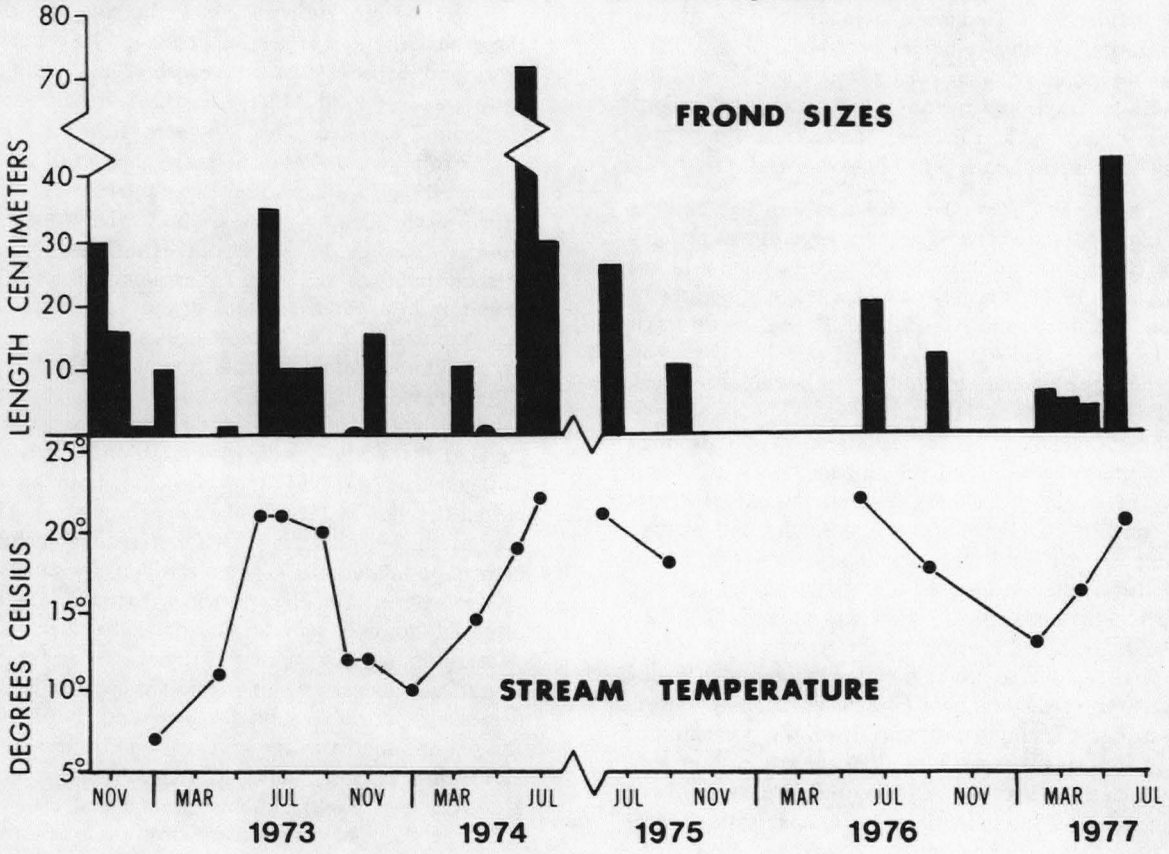

Figure 3. Relationship of *Boldia* frond length to water temperature in Lower Barton Creek, N.C. (semicircles designates occurrence of basal structure without erect fronds).

DISCUSSION

No evidence has been obtained to indicate a benefit to the snail resulting from its association with the alga. However, the apparent affinity of *Boldia* monospores for manganese-rich substrates may be a key to the development and perpetuation of this assocition. Parker *et al* (1973) reported an obligate association between a freshwater green alga *(Monostroma)* and black rocks rich in iron and manganese.

The evolution of the *Blodia*-snail association described herein is speculative; however, we have noted that the habitat requirements of the snails, *Leptoxis (Mudalia)* and *Oxtrema,* are very similar to those of *Boldia. Leptoxis* is restricted to flowing water saturated with oxygen, as is *Boldia. Oxytrema* can inhabit water of lower oxygen content, but *Boldia* has never been found under these conditions which may explain the preference of *Boldia* for the *Leptoxis (Mudalia) dilatata* and *L. carinata* complex.

Snails of the Pleuroceridae have left a fossil record dating to the lower Cretaceous Period with approximately 55 genera known through the Tertiary Period. *Oxytrema* is well represented from this period (Henderson, 19350; however, *Leptoxis (Mudalia)* is not know from the fossil record (D.W. Taylor, Pacific Marine Station, Dillion Beach, pers. comm.).

The red algae are an ancient group of plants based on the presence of phycobilin pigments, the absence of flagellated reproductive cells, and their presence in the marine fossil record (Smith, 1933; Dixon, 1973). It is not surprising that *Boldia* is not known in the fossil record because of its delicate, emphemeral frounds, which make fossilization unlikely.

The southern Appalachian and Ozark Mountains have existed as continously exposed land masses since the close of the Paleozoic Era. As such, they represent the oldest areas of North America with the possibility of a constant habitat. Steyermark (1959) stated that most endemic plant species of North America are restricted to geographic regions free from continental flooding or glaciation. Consequently, the abundance of endemic plants in the southern Appalachians, Cumberland Plateau, and the Ozarks is understandable. *Boldia* represents another example of this distributional pattern.

We hypothesize that *Boldia* represesnts an ancient form of Rhodophyta comparable to ancestral forms which have inhabited headwater streams of the southern Appalachians since Lower Cretaceous time. With similar environmental requirements as represented by present snail-algal associtions, and these conditions constantly satisfied by souther Appalachian streams, it is assumed that ancestral *Boldia* utilized shells of ancient pleuroceried snails as substrates fro the at-

tachment and development of monospores. This substrate associtions may have been accidental initially; however, if an alga with stream habitat requirements attached to a snail with similar requirements, its chances of remaining in headwater locations and thus within a refugium would be improved. The relationship apparently narrowed from snails of the Pleuroceridae to *Oxytrema* is known from the fossil record prior to the Pleistocene and because of the more compatible present day habitat requirements of *Leptoxis (Mudalia)*.

During the Eocene Epoch, the Mississippi Embayment was reduced and the coastal plains began to emerge. It was perhaps because of changes in the drainage systems beginning in the Eocene (Ross, 1971) that *Boldia* exists in its present distribution. The Teays and Appalachian Rivers, ancestors of the New, Tennessee, and Alabama Rivers, were involved in an intricate exchange of streams to produce the present drainages, as detailed by Ross (1969, 1971).

Migration of divides and subsequent stream capture resulted from differential weathering of the Appalachian Mountains. The uplift of the Appalachians resulted in eastern slopes generally consisting of limestone and dolomite and western slopes composed of sandstones and quartizites. Downward weathering accelerated erosion of the eastern slopes, causing the divide to migrate westward as it was reduced in height (Hack, 1969). Erosional changes of the Appalachian Mountains resulted in an altered drainage system as westerly flowing streams were captured by the enlarging eastern drainage basin.

Stream capture, resulting primarily from the breaching of divides and subsequent reversal of drainage patterns, is thus the most plausible way to explain the present isolated populations of *Blodia*. Such chnges in drainage systems were primarily occurrences of the Cenozoic Era (Hack, 1969; Ross, 1967, 1971). Numerous regions of the southern Appalachians exist where divide migration and stream capture may have been instrumental in expending the range of *Boldia*. The Montgomery, Giles, and Craig County area of Virginia contains headwater streams of the New, Roanoke, and James Rivers and may have been a central point for distributing the alga about the state. The Boone region of North Carolina is surrounded by interlacing headwaters of the New, Yadkin, and Tennessee Rivers which flow in various directions to different drainages. In northern Georgia, headwater streams of the Tennessee, Alabama, and Savannah River systems are in close proximity to one another and stream piracies among them have occurred frequently (Ross, 1971).

The advance of Pleistocene glaciers never reached the locations of present day *Boldia* populations, and the alga may have inhabited streams of the northern Appalachians prior to glaciation. The use of the southern Appalachians as a botanical refugium during glacial advances has been noted by Braun (1951) and the similar condition of the Ozarks has been discussed by Steyermark (1959). Erosion following the Pleistocene glaciation resulted in the transfer of western drainage streams to the atlantic system (Ross, 1969). The modern drainage of southern Appalachian rivers and the present distribution of snail-algal associations probably date to the late Pleistocene.

A central location for the distribution of *Boldia* may have been the upper reaches of the Tennesee and New River drainages in southwestern Virginia and eastern Tennessee. The algal population in Scott County, Tennessee best represents a relic population because of the continous habitat offered by the Cumberland Plateau and the Association at this site of *Boldia* with the older snail genus *Oxytrema*.

Waterfowl are known to contribute to the dispersal of numerous genera of algae (Schlichting, 1958). Various ducks, coots and herons have been observed at *Boldia* habitats; however, it is doubtful that, if ingested, the alga could remain viable until excreted. The prostrate nature of *Boldia* during much of the year makes dispersal by the feet of birds unlikely, as does the alga's lack of desiccation resistant reproductive structures (Schlichting, pers. comm.). Therefore, while spores are easily washed downstream, it is difficult to envision any mechanism other than snails for explaining the alga's ability to remain in headwater locations or move upstream to establish new populations. The habitat in South Carolina at Ramsey Creek did not contain snails during our study. It receives 2.5 - 5.0 cm more precipitation per month than any other *Boldia* habitat (Smith, 1968). The original collection site in Ramsey Creek (Dillard, 1967) presently lacks *Boldia;* however, *Boldia* was collected one-half mile downstream in an area which lacked the alga in 1967 (Dillard, pers. comm.). These observations suggest that *Boldia* cannot readily maintain a permanent population site in streams which lack snails.

Monospores are the principal method of downstream dispersal; however, as spores or thallus fragments move downstream, dissolved oxygen tends to decrease as depth increases. Runoff also increases with a resultant increase in siltation and decrease in available sunlight. Increased runoff often lowers the pH and increases the nutrient load, especially in lowland agricultural areas; under such conditions green algae, bluegreen algae, and diatoms abound and usually eliminate red algae. Also, lowland stream locations are more susceptible to floodng and water temperatures are often higher than in upland streams. These conditions are less favorable for downstream expansion by *Boldia*.

The impoundment of rivers and steams not only limits acceptable habitats of *Boldia* but makes existence in mountain refugia difficult for both snail and alga. Notable was the impoundment of the North River in Alabama and the elimination of the *Boldia* population reported by Deason and Nichols (1970). Although human activities contribute to a decrease in potential habitats, the environmental requirements of *Boldia* are naturally limiting. Locations which satisfied the habitat requirements of *Boldia* are naturally limiting. Locations which satisfied the habitat requirements of *Boldia* may have existed to a greater extent in the past, but dramatic changes in lowland habitats outside the refugia of mountain streams have kept more extensive distributons in check.

The preceding discussion of the evolution and present distribution of the *Boldia*-snail association is admittedly speculative. However, we hope that this information will stimulate subsequent studies, including physiological culture studies to further identify the ecological characteristics of the *Boldia*-snail association.

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PERSPECTIVE ON NORTH AMERICAN MALACOLOGY I. MOLLUSKS IN THE ALABAMA RIVER DRAINAGE; PAST AND PRESENT

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Introduction

The rapid loss of the biota in many drainage systems has been of great concern, especially as it relates to such benthic animals as the very rich and unique mussel fauna of the Alabama River drainages. Modern developments potentially affecting such rivers have now become of immediate concern. To understand the impact of these changes this assessment is given, based in part on the excellent collections made by Herbert Huntington Smith. He was employed by the Alabama Museum of Natural History at Tuscaloosa. For about twenty years he and his wife, Daisy, were sponsored by a "Syndicate" organized and encouraged largely by Dr. Bryant Walker, a Detroit lawyer, who had a private mollusk museum. The collaboration of Bryant Walker with Dr. Arnold Edward Ortmann of the Carnegie Museum in Pittsburgh was unusually close. Much of what is known about the systematics of mussels is due to their collective efforts. The historical records that follow are a tribute to their work and these data should serve as a basis for assessing the changes that have come about in this river system since the turn of the century.

The late Henry A. Pilsbry, for many years recognized as the dean of American malacology, stated in a review of Bryant Walker's book entitled, *The Terrestrial Shell-Bearing Mollusca of Alabama (1930: 105):*

> "I doubt whether any state in the Union has been worked more thoroughly and systematically than Alabama, by Mr. Smith's assiduous collecting. He not only personally collected over a very large part of the state, both north and south, but through local collectors, many of them trained by him, he reached into many localities that he did not personally visit."

In this book Bryant Walker gave the following information on what was known as the "Syndicate" - a group formed by Dr. Walker and supported by him to sustain H. H. Smith over a twenty-year period as a professional collector responsible for collecting an amazing amount of mollusk specimens. Walker (1928) wrote:

> "Mr. Smith began to collect for Dr. Clapp in 1903. In 1904 he organized a 'Syndicate' for the systematic prosecution of the work. This at first consisted of Mr. T. H. Aldrich, Dr. George H. Clapp, Dr. H. A. Pilsbry, and the writer. Dr. Pilsbry dropped out in 1906 and his place was taken by the late John B. Henderson, Jr. In 1908, Mr. Aldrich retired and the work for that year was carried on by Clapp, Mr. Henderson and myself. The Syndicate ceased to function at the end of that year and after that time Mr. Smith collected land shells for Dr. Clapp and the Alabama State Museum until his death in 1920."

The results of the work on mussels by key people in the Syndicate as reported here are essentially the efforts of Bryant Walker, who financed and encouraged Mr. Smith, A. E., Ortmann who collaborated with Walker until the time of his death in 1927, and George H. Clapp, the recipient and student of the land snails. We are indebted to Dr. Clapp (1920) for the following evaluation of the excellent surveys made in Alabama by H. H. Smith:

> "The sudden death of Herbert Huntington Smith on March 22nd, at University, Alabama, meant more, perhaps, to the conchologists of the United States than we now realize, although the collecting and serious study of shells was the work of the later years of his life."
>
> " . . .In 1903 his health still being poor, he gave up the fight, and resolved to go to the South to live. He settled in Wetumpka, Ala., and at once started after shells. His first collecting there, so different from work in the tropics, was rather disheartening, and he wrote that there were no shells in that region. A little later he began to get results, and then he wrote, 'I didn't know how to collect,' and when the first lot came in, it was seen that he had struck a remarkably rich region. Than a 'Syndicate' was formed of T. H. Aldrich, of Washington, D. C., Mr. Bryant Walker, of Detroit, Dr. H. A. Pilsbry, of the Acadamy of Natural Sciences, Philadelphia, Pa., and the writer, and the work was carried on steadily over six years. Dr. Pilsbry dropped out in 1906, and he was replaced by Mr. John B. Henderson, of Washington, D. C."
>
> "The naming and distribution of thousands of land shells collected in all parts of Alabama, fell to the part of the writer, and the new species have all been described by him; 13 species and 4 varieties up-to-date, with probably several more to follow, as the material is more carefully studied. After the regular work of the 'Syndicate' was stopped. Mr. Smith continued collecting freshwater shells for Mr. Walker, and land shells for the writer, while collecting Tertiary fossils for the Geological Survey of Alabama, by which he was employed as Curator of the Museum at the University of Alabama. The sorting, naming and distributing of the fresh-water shells, was done by Mr. Walker, and I cannot do better than quote from a letter from him, on this subject:
>
> 'I enclose the meager list of n. sp. and vars. that have been described from Mr. Smith's material. But that does not begin to show the enormous amount of work that he did in developing the fauna of Alabama. Besides going the whole length of the Coosa from Gadsden to Wetumpka by boat, he did the Black Warrior thoroughly before it was spoiled by the Government improvements (?) and spent the season on the Mussel Shoals of the Tennessee. Two or three summers were spent on the Connasauga and other head-waters of the Coosa, in numerous side trips he had covered practically the whole state. Then, too, through

local collectors, many of them trained by him, he had reached into many localities that he did not personally visit. By these means he collected an enormous amount of material, practically none of which has been worked up.'

'While he worked for the 'Syndicate' he collected everything; but when that arrangement ceased, he specialized in the Unionidae and Pleuroceridae. I have not any very accurate figures on the number of specimens of Unionidae that he collected, but I think that from 40,000 to 50,000 would not be an overestimate. His Black Warrior collection alone he reported as 10,000. No report of this material has ever been made, and a very large proportion of it still remains to be worked over. This I shall do as rapidly as I have time. I also have on hand many thousands of specimens of Amnicolidae that have not yet been sorted out. And the same is true of a very large amount of Ancylidae from the Coosa and its tributaries.'

'But it was especially in the *Pleurocridae* that he put in his best work. He became exceedingly interested in that family and the many perplexing problems that its protean species presented, and it was his expectation to work it up himself. The enormous collection, thousands upon thousands of specimens, and the familiarity that he had acquired in his many years of field work, especially fitted him for the work. But unfortunately the multitude of duties pressed upon him, as Curator of the State Museum, prevented him from carrying his plan to execution. He had planned to publish a paper on the *Anculosae* of the Coosa for some time, and expected to write it up this last spring. He had gone so far as to arrange a series of the species in the order that he intended to present them, but his untimely death prevented the completion of the work. Beyond this, and a somewhat similar arrangement of the *Gyrotomas,* nothing has been done and, except the manuscript names attached to many species that he believed to be new, and which he intended to describe, there is absolutely nothing left to show the vast knowledge that he had acquired of that marvelous fauna. He had it all in his brain, and it all perished with him. I do not suppose that any other man ever had such an intimate knowledge of the variation in that family, and to think that it it all gone, is truly pitiful.'

Clapp, in this article, gave a list of the species described by him and others which were collected in Colombia and Alabama.

The life and work of H. H. Smith was also the subject of an article by Dr. W. J. Holland. George Clapp reviewed it, as follows:

"Dr. W. J. Holland, Director of the Carnegie Museum, Pittsburgh, has written a very appreciative article on the life and work of Mr. Smith, in Science, N. S. Vol. XLIV, No. 1273, pages 481-483, May 23, 1919, where other fields of activity are touched upon; but to cover the whole subject whould demand a volume. It is to be regretted that Mr. Smith was not able to carry out a plan he long had in mind, of working up his extensive series of notebooks into a story of his life as a collector, at it would have been an inspiration to future collectors, and would, I feel sure, have been worthy to place alongside of the classic works of Bates and Wallace, He was a remarkably keen observer, as shown by his letters, so his notebooks undoubtedly contained a vast amount of most valuable observations. Even when feeling 'down in his luck,' he always saw the funny side of life, and had a large stock of humerous stories, which he would frequently insert in his letters, for no other reason, apparently, than that he just happened to think of them."

Pilsbry (1930) in reviewing Walker's "The Terrestrial Shell-Bearing Mollusca of Alabama" also gave an excellent appraisal of Smith's work, as follows:

"Herbert H. Smith, assisted by his talented wife, collected mollusks in Alabama from 1903 until his death in 1920. In this rich field, which had been worked over in places by Conrad and Showalter and other correspondents of Dr. Isaac Lea, Smith covered the ground much more effectively, collecting not only copious materials for elucidating the old species, but also many new forms of the greatest interest. Many of the discoveries were published from time to time in the Nautilus and elsewhere, by Walker and G.H. Clapp, and Goodrich has worked on the Pleuroceridae. Now we have a treatise on the land shells of the state from Bryant Walker's capable pen."

While Dr. Bryant Walker did publish a monumental work on the land shells of Alabama, he did not complete a study of longstanding on the mussels which he planned to publish later as is evident in voluminous notes he left in manuscript form. That he had a thorough understanding and was prepared to publish what he knew about the naiades of the state is shown in the abstract (Walker, 1918 20th Mich Aead Sci Rept.)*

*Editors Note: This paper will be reprinted in the next issue of Sterkina, as it is generally unavailable.

Bryant Walker was without question one of the most outstanding among American malacologists. He was a lawyer by profession but spent much of his time working in his private museum in Detroit on mollusks. He was outstanding in civic affairs and was able to build his museum by amassing large collections from others. His holdings, when they came to the Museum of Zoology at the University of Michigan in 1936, contained more than a hundred thousand lots — twice in size to that in the Museum's Mollusk Division at that time. In addition to his 155 publications he was instrumental in sponsoring and publishing Charles Torrey Simpson's Descriptive Catalog of the Naiades in 1914. Simpson brought this manuscript to a close in 1902 and the many changes and additions that were made to it later were made by Bryant Walker. Simpson requested that Walker "attach his name as one of the authors, but this he was unwilling to do, so the thing came out under my name."

Bryant Walker (1918) did make available in broad context the relation of the Alabama mollusk fauna to that of North America in a monumental work with the title: "Synopsis of the Classification of the Fresh Water Mollusca of North

America, North of Mexico, and A Catalogue of the More Recently Described Species, with Notes."

H. A. Pilsbry (1919) reviewed this work indicating its timeliness by way of bringing together much loose material from old manuals and the importance of such a handbook as a concise and valuable reference. He stated:

"Students of North American fresh-water mollusks of this generation have had as a basis the invaluable manuals by W. G. Binney, Prime and Tryon, issued by the Smithsonian Institution, 1865-73, and the works of Lea on Unionidae, of about the same date. Some single groups have been elaborately treated since, the Uniones by Simpson, the Lymnaeidae by Baker; but most of the progress in the last fifty years has been recorded in a host of papers, by many authors and in many journals. To systematize this material and make it readily accessible, Dr. Walker has prepared this synopsis of the classification as understood today, giving definitions of families, genera and minor groups, with figures of types or typical species of each, frequently also of anatomical structures important in classification."

"The second paper is devoted to species published since the appearance of the monographic works alluded to above, together with those omitted, formerly misunderstood, or concerning which there had been diversity of opinion. The great utility of such a catalogue will be apparent."

"Together, these papers give a most interesting epitome of the progress made by the present generation in the study of our fresh-water mollusks, so far as classification and description are concerned. Dr. Walker's long familiarity with the subject enables him to present it lucidly and completely."

In addition to Walker's important role in gaining knowledge of the mollusks of Alabama, the work of A.E. Ortmann is foremost particularly in relation to his studies of the mussel there. Ortmann and Walker collaborated in an exemplary way as is evident in an article with the title, "Arnold Edward Ortmann as Revealed by His Letters" (van der Schalie, 1951). Pilsbry (1927) gave a good appraisal of Ortmann's work with the Unionidae, as follows:

"American science has suffered a serious loss in the death at Pittsburgh of Dr. Arnold E. Ortmann, January 3 of this year, in his sixty-fourth year of his age."

"In Ortmann's work on zoogeography he left aside the birds and the mammals which had served for the greater part of previous works, and devoted himself to the evidence of aquatic invertebrates. An intimate and exact knowledge of several great groups, and logical marshaling of the facts characterize his papers on this subject . . . His investigations extended from the Ohio system to all the riviers of the eastern United States from New England to the Carolinas and a partial exploration of the rivers of Georgia, Alabama and Mississippi. His researches have thrown a great deal of light upon the geology and transformations of the rivers of the eastern half of the United States. In the morphology and classification of Unionidae he was soon recognized as the chief American authority. He continued and greatly extended the system, which he took up where Simpson's great work left it; and he has set a high standard for future workers on this subject. One of his great services was the work on unionid gill structure."

". . . His enthusiasm for natural history was contagious, and contributed larely to his success as a teacher. He possessed the ability in an unusual degree of concentrating all of his powers on the subject on hand. In the field he was indefatigable, never sparing himself, deterred by neither exposure or fatigue in the quest for specimens for his researches."

"The thorough acquantaince of both authors with the subject, their fair and comprehensive consideration of each case, with due reference to the International Rules of Nomenclature, should entitle their conclusions to general acceptance. It is to be hoped that this essay will tend to uniformity in matters of mere nomenclature, so that the energies of our Unio students can be more fully devoted to the many unsolved questions of structure, development and distribution of these most interesting mollusks."

Mussel Systematics. Even a cursory examination of modern lists of mussel species given for river systems will reveal inconsistencies in the use of the names applied to some of the species. For example, in the list by Yokley (herewith appended) *Toxolasma* is used rather than *Carunculina; Potamilus* replaces *Proptera; Epioblasma* represents *Dysnomia.* This apparent inconsistency is not new and the history of the difficulty was reviewed by van der Schalie (1952) in an article with the title, "An Old Problem in Naiad Nomenclature." A.E. Ortmann and Bryant Walker (1922) produced a monumental study to clarify the use of poorly described Rafinesque species. Unless modern systematice workers are willing to accept their scholarly and painstaking efforts it is not likely that those not familiar with mussel systematics can fully understand that species they earlier knew under a given name are now suddenly appearing as something under another label. In this report the work of Ortmann and Walker (1922) will be followed and the changes suggested elsewhere will not be considered as valid, particularly since the use of the names substituted have usually not been justified by documented evidence as were those in the Ortmann and Walker revision. As to the importance of their work, the following brief review (Anonymous, 1922) clearly indicates a course that would be most helpful in this time when coordination of efforts is so much needed:

On the species level *Lampsilis anodontoides* may appear in lists as *Lampsilis teres; Actinonaias carinata* as *A. ligamentina; Lampsilis siliquoidea* as *L. luteola; Amblema costata* as *A. plicata;* etc. Some of these names were adopted from the revision published by L. S. Frierson (1927) in which he avoids any mention of the earlier work of Ortmann and Walker (1922). It was shown (van der Schalie, 1952) that Ortmann and Walker tried to have Frierson work with them in resolving the difficulties posed by Rafinesque's poor descriptions, but Frierson's published check list where adopted will continue to introduce other names.

TABLE I

A list of the Naiads in the Tombigbee River exclusive of its tributaries (from Yokley, 1975)

Species	Hinkley 1906	Van der Schalie 1939	Yokley & Gooch 1974
Strophitus tombigbeensis Lea	Yes	Yes	Yes
Arcidens confragosus Say	Yes	Yes	Yes
Lasmigona complanata Barnes	Yes	No	Yes
**Megalonaias gigantea* Barnes	No	Yes	Yes
**Plectomerus dombeyana* Val.	Yes	Yes	Yes
**Tritogonia verrucosa* Raf.	No	Yes	Yes
**Quadrula aspera* Lea	Yes	Yes	Yes
**Quadrula rumphiana* Lea	Yes	Yes	Yes
**Quadrula metanevra* Raf.	Yes	Yes	Yes
**Quadrula stapes* Lea	Yes	Yes	Yes
**Quadrula asperata* Lea	Yes	Yes	Yes
**Amblema plicata perplicata* Conrad	Yes	Yes	Yes
**Fusconaia ebena* Lea	Yes	Yes	Yes
**Fusconaia rubida* Lea	Yes	Yes	Yes
Pleurobema decisum Lea	Yes	No	Yes
Pleurobema marshalli Frierson	No	Yes	Yes
Pleurobema nucleopsis Conrad	Yes	No	Probably
Pleurobema bulbosum Lea	Yes	No	Yes
Pleurobema nux Lea	Yes	No	Yes
Pleurobema taitianum Lea	Yes	No	Yes
Pleurobema curtum Lea	Yes	No	Yes
**Elliptio crassidens* Lam.	Yes	Yes	Yes
Elliptio arctatus Conrad	Yes	Yes	Yes
Elliptio dilatatus Raf.	Yes	Yes	Yes
**Obliquaria reflexa* Raf.	Yes	Yes	Yes
**Plagiola lineolata* Raf.	Yes	Yes	Yes
**Obovaria unicolor* Lea	Yes	Yes	Yes
Obovaria sp.	Yes	Yes	Yes
Truncilla truncata Raf.	Yes	Yes	No
**Truncilla donaciformis* Lea	Yes	Yes	Yes
**Leptodea fragilis* Raf.	Yes	Yes	Yes
Potamilus inflatus Lea	No	Yes	No
**Potamilus purpuratus* Lam.	No	Yes	Yes
Toxolasma parva Barnes	Yes	No	No
Medionidus acutissimus Lea	Yes	No	Yes
Medionidus meglameriae van der Schalic	No	Yes	No
**Ligumia recta* Lam.	Yes	Yes	Yes
Villosa lienosa Conrad	Yes	Yes	Yes
**Lampsilis anodontoides* Lea	Yes	Yes	Yes
**Lampsislis radiate claiborneusis* Lea	Yes	Yes	No
Lampsilis affinis Lea	Yes	No	No
Lampsilis apicina Lea	Yes	Yes	Yes
**Lampsilis excavata* Lea	Yes	Yes	Yes
Epioblasma penita Conrad	No	No	Yes
Epioblasma metastriata Conrad	No	Yes	No
Anodonta imbecillis Say	No	No	Yes
Total Number of Species	37	34	40

*Species collected alive

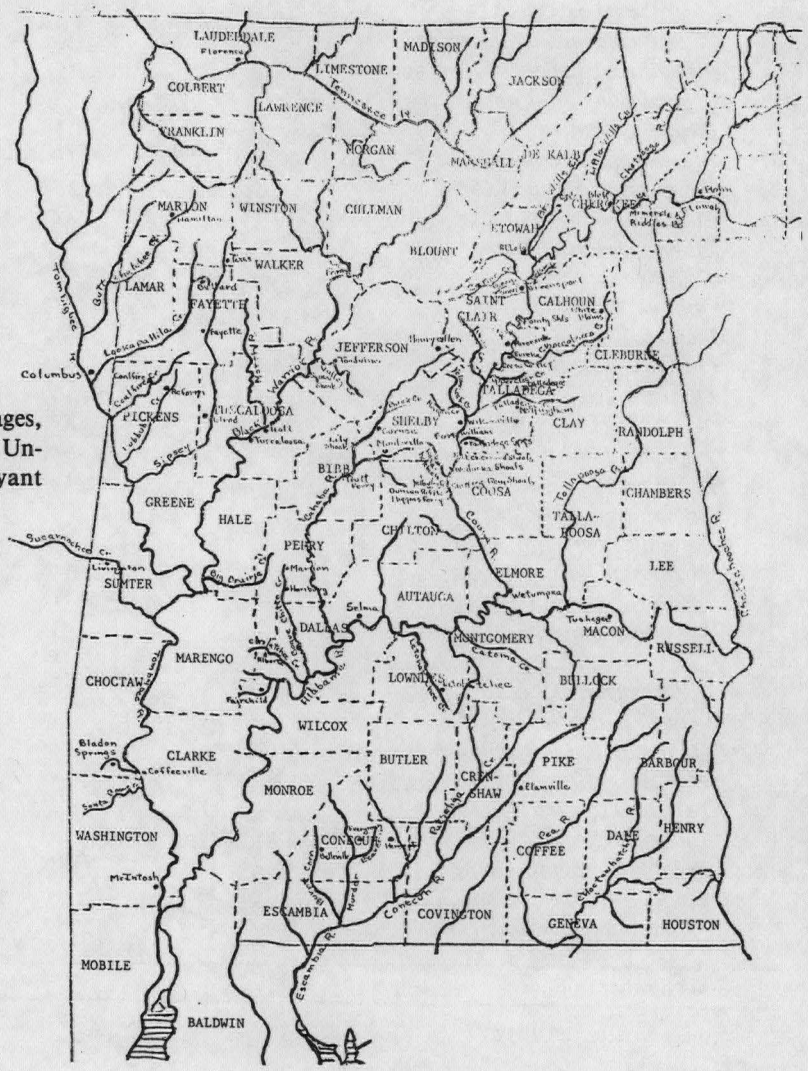
I. Tombigbee River.

Collections from the Tombigbee River made by H. H. Smith (Map I) were largely in its tributaries. A list of the mussels from a series of stations in the main river as compiled by Yokley and Gooch in 1975 (Table I) also contains the records given by A. A. Hinkley in 1906 for the Tombigbee at Columbus. In 1931 Calvin Goodrich and the writer also visited the Tombigbee at Columbus. That collection is compared to Hinkley's 1906 records (Table II) and as stated by van der Schalie (1939:3): "Hinkley apparently arrived at this station at a more favorable time for collecting than we did. Accumulated silt, turbidity, and high water made it impossible to collect adequate series." In this same table the two lists given for 1933 and 1935 represent collections at Epes - the 1933 list by W. J. Clench and van der Schalie; the better collection by the late Winnie McGlamery in 1935. She discovered a new species of *Medionidus* which was named in her honor.

The recent comparative table based on the collections of Yokley and Gooch (Table I) indicated that this drainage has about the same number of mussel species as the other major tributaries in the Alabama system - about 40 species.

It will be noted that some of the best collections in the tributaries of the Tombigbee as made by H. H. Smith came from the Sipsey River. The kinds of difficulties that collectors encounter are given by Smith (1911):

"Since writing last I have made several excurisons to the Sipsey. You will remember that, after my work at the Forks, we considered it rather a poor stream for *Unionidae*. My present impression is that it is going to turn out one of the richest in Alabama, and decidely peculiar. It is, in fact, very different from other rivers which I have explored. Most of it is 'dead water,' with a steady, pretty strong current and three or four feet deep; it is very crooked and choked with drift logs. Now and then there are gravel shoals, shallow, with an even, strong current, and these are the places for the mussels, especially *Pleurobemas*. These gravel shoals are altogether peculiar in my experience. The bottom is a layer of gravel, a foot or so thick, cemented so that it is quite hard; under this there is loose gravel, in which the mussels generally live. At the Forks I used to wonder why the muskrats left so many shells and I found so few. A farmer there, who had taken out river gravel for a road, gave me the explanation, which I have verified: only a few mussels are in the top layer, but great numbers of them under the cemented portion; the muskrats get them through small crevices. The proper way to work these shoals will be to have a man dig away the cemented part, which is not very hard, and get the layer beneath."



MAP I. A. E. Ortmann's map of Alabama River drainages, showing mainly stations established by H. H. Smith. Unpublished correspondence, A. E. Ortmann to Bryant Walker, from personal files of author.

TABLE II

A list of the Naiades in the Tombigbee River, exclusive of its tributaries (from van der Schalie, 1939)

Species	Columbus		Epes	
	1906	1931	1933	1935
Fusconaia rubida	—	X	X	93
Fusconaia ebenus	X	—	—	91
Fusconaia cerina	X	—	—	—
Megalonaias gigantea	—	X	X	66
Plectomerus trapezoides	X	—	—	1
Amblema perplicata	X	X	—	16
Quadrula pustulosa	X	X	X	89
Quadrula aspera	X	—	—	18
Quadrula forsheyi	—	—	X	—
Quadrula rumphiana	X	X	—	2
Quadrula metanevra	X	X	X	17
Quadrula stapes	X	—	X	—
Tritigonia verrucosa	—	—	—	44
Pleurobema cordatum plenum	X	X	X	4
Pleurobema marshalli	—	—	—	2
Pleurobema tombigbeanum	—	—	X	—
Pleurobema nucleopsis	X	—	—	—
Pleurobema bulbosum	X	—	—	—
Pleurobema nux	X	—	—	—
Pleurobema taitanum	X	—	—	—
Pleurobema curtum	X	—	—	—
Pleurobema decisum	X	—	—	—
Elliptio crassidens	X	X	X	10
Elliptio dilatatus	X	—	X	19
Elliptio arctatus	X	—	—	4
Strophitus tombigbeensis	X	—	—	2
Lasmigona complanata	X	—	—	—
Arcidens confragosus	X	X	—	—
Obliquaria reflexa	X	X	—	12
Obovaria unicolor	X	X	—	7
Obovaria castanea	X	X	X	—
Plagiola lineolata	X	X	X	26
Leptodea fragilis	X	X	—	1
Leptodea alabamensis	—	—	—	1
Proptera purpurata	—	X	—	8
Carunculina parva	X	—	—	—
Medionidus acutissimus	X	—	—	—
Medionidus meglameriae	—	—	—	2
Ligumia recta latissima	X	—	—	1
Micromya lienosa	X	X	—	3
Micromya concestator	X	—	—	7
Lampsilis anodontoides	X	X	—	52
Lampsilis excavata	X	X	X	25
Lampsilis straminea	—	X	—	—
Lampsilis hydiana	X	—	—	—
Lampsilis affinis	X	—	—	—
Lampsilis apicina	X	—	—	—
Dysnomia metastriata	—	—	—	4
Truncilla donaciformis	X	—	—	1
Truncilla truncata	—	X	—	—
Total number of species (50)	39	21	14	30

Tombigbee Drainage:
Tombigbee River, Alabama (Hartman Collection)
Quadrula aspersa
Micromya (Villosa) lienosa
Lampsilis claibornensis

Tombigbee, McIntosh, Washington Co., Alabama (L. H. McNeill Collection)
Fusconaia ebenus
Megalonaias gigantea
Quadrula asperata
Quadrula aspera

Columbus, Lowndes Co., Mississippi (probably Tombigbee River)
Fusconaia rubida
Obovaria subrotunda (?)

Tributaries:
Coffee Creek, Alabama (possibly near Coffeeville, Clarke Co., Alabama ?) (Hartman Collection)
Ligumia subrostrata
Santa Bogue Creek, Washington Co., Alabama
Fusconaia rubida
Bladon Springs, Choctaw Co., Alabama (Showalter Collection(
Pleurobema interventum
Sucarnochee Creek, pool on floodplain, Livingston, Sumter Co., Alabama (H. H. Smith, April 18, 1914)
Uniomerus telralasmus
Anodonta grandis

Tributaries of Upper Tombigbee:
Sipsey River, Elrod, Tuscaloosa Co., Alabama (H. H. Smith, 1911, 1912)
Fusconaia rubida
Tritogonia verrucosa
Elliptio dilatatus
Obovaria subrotunda (?)
Micromya (Villosa) lienosa
Lampsilis anodontodies
Lampsilis caibornensis
Lampsilis excavata
Lampsilis clarkiana

Sipsey River, 5 mi n of Fayette, Fayette Co., Alabama (H. H. Smith)
Fusconaia rubida
Amblema perplicata
Tritogonia verrucosa
Pleurobema decisum
Pleurobema interventum
Pleurobema flavidulum
Elliptio arctatus
Uniomerus tetralasmus
Strophitus spillmani
Obovaria nux
Carunculina cromwelli
Micromya (Villosa) vibex
Micromya (Villosa) lienosa
Lampsilis anodontoides
Lampsilis claibornensis
Lampsilis clarkiana

Sipsey River, The Forks, Texas, Marion Co., Alabama
Fusconaia rubida
Tritogonia verrucosa
Quadrula metanevra
Pleurobema interventum
Pleurobema flavidulum
Elliptio arctatus
Strophitus spillmani
Strophitus subvexum
Obovaria nux
Obovaria subrotunda
Carunculina cromwelli
Micromya (Villosa) vibex
Micromya (Villosa) lienosa
Medionidus acutissimus
Lampsilis claibornensis

Lubbub Creek, Reform, Pickins Co., Alabama (H. H. Smith, 1912)
Strophitus spillmani
Lampsilis claibornensis

Coalfire Creek, Coalfire, Pickins Co., Alabama (H. H. Smith, 1914)
Fusconaia rubida
Pleurobema flavidulum
Strophitus spillmani
Carunculina cromwelli
Micromya (Villosa) vibex
Micromya (Villosa) lienosa
Lampsilis claibornensis

Ballard Creek, Fayette Co., Alabama (H. H. Smith)
Carunculina cromwelli
Micromya (Villosa) lienosa
Lampsilis claibornensis

Buttahatchee River, Hamilton, Marion Co., Alabama (H.H. Smith)
Fusconaia rubida
Quadrula paupercula
Tritogonia verrucosa
Pleurobema concolor
Elliptio dilatatus
Elliptio arctatus
Strophitus spillmani
Stophitus tombigbeensis
Obovaria nux
Leptodea fragilis
Micromya (Villosa) vibex
Micromya (Villosa) lienosa
Lampsilis claibornensis
Lampsilis excavata
Lampsilis clarkiana

II. Alabama River

Perhaps because of its large size, few records are available on the mussels of the main river in lower Alabama. both of those given are from the Hartman and Call collections. H. H. Smith seems to have concentrated more on the fauna of the tributaries in lower Alabama. To survey properly such a large river would require large equipment not available to persons involved with pioneering work.

Alabama River, Alabama (Hartman Collection)
Quadrula asperata
Quadrula aspera
Quadrula metanevra
Pleurobema lewisi
Obliquaria reflexa
Lampsilis claibornensis
Lampsilis excavata

Alabama River, Selma, Dallas Co., Alabama (R. E. Call)
Quadrula asperata
Pleurobema lewisi
Pleurobema taitianum
Pleurobema tombigbeanum
Proptera purpurta

Small Tributaries in Lower Alabama:

Cub Creek, Pine Hill, Wilcox Co., Alabama (H. H. Smith)
Fusconaia rubida
Quadrula cahabensis
Tritogonia verrucosa
Strophitus elliotti
Strophitus spillmani
Carunculina cromwelli
Micromya (Villosa) lienosa
Lampsilis straminea

Beaver Creek, Pine Hill, Wilcox Co., Alabama (H. H. Smith)
Fusconaia rubida
Uniomerus tetralasmus
Crunculina cromwelli
Micromya (Villosa) lienosa
Lampsilis straminea

Cholatchee Creek, Alberta, Wilcox Co., Alabama (H. H. Smith)
Carunculina cromwelli
Lampsilis straminea

Bogue Chitto Creek, Perry Co., Alabama (E. R. Schowalter)
Lampsilis straminea

Bogue Chitto Creek, Hamburg, Perry Co., Alabama (H. H. Smith)
Fusconaia rubida
Strophitus elliotti
Carunculina cromwelli
Micromya (Villosa) lienosa
Lampsilis straminea

Letohatchee Creek, 1 mi from Depot, Lowndes Co., Alabama (Hartman Coll.)
Anodonta grandis

Catoma Creek, Montgomery Co., Alabama (E. Rustston)
Amblema latecostata

III. Black Warrior River

Most of the records herewith appended were from collections made by H. H. Smith. In a letter to Calvin Goodrich (March 22, 1920), Ortmann made a significant statement (van der Schalie, 1951: 23):

> "One thing is clear: when we begin to study the development of the fauna of a river-system, **our knowledge of the distributional facts must be complete.** There must be no large areas, like the uppermost Black-Warrior basin, of which we do not know anything. H. H. Smith has done wonderful work in the Alabama-drainage, but his work has not been completed - so much more is his untimely death to be regretted."

Black Warrior System of Tombigbee Drainage:

Black Warrior River, Lock 11, Tuscaloosa, Tuscaloosa Co., Alabama (H. H. Smith, November,1910)
Anodonta imbecillis
Leptodea fragilis
Proptera purpurata
Micromya (Villosa) lienosa

Black Warrior River, Squaw Shoals, Jefferson co., Alabama (Hartman, R. E. Call, H. H. Smith)
Fusconaia rubida
Amblema perplicata
Quadrula aspera
Tritogonia verrucosa
Pleurobema rubellum
Elliptio crassidens
Elliptio arctatus
Ptychobranchus greeni
Leptodea fragilis
Proptera purpurata
Carunculina corvunculus
Micromya (Villosa) vibex
Micromya (Villosa) lienosa
Lampsilis altilis
Dysnomia metastriata

Forks of Black Warrior River, Walker Co., Alabama (H. H. Smith)
Tritogonia verrucosa
Ptychobranchus greeni
Obliquaria reflex
Lampsilis excavata

Tributaries:

Big Prairie Creek, Hale Co., Alabama (Hartman and Schowalter)
Fusconaia rubida
Amblema "latecostata"

Amblema perplicata
Quadrula forsheyi
Pleurobema concolor
Elliptio arctatus
Lasmigona complanata
Anodonta grandis
Anodontoides showalteri
Proptera purpurata
Micromya (Villosa) lienosa
Lampsilis straminea

Pool at Holt, Tuscaloosa Co., Alabama (H. H. Smith, 1911)
Anodonta imbecillus

North River, Hagler's Mill, Tuscaloosa Co., Alabama (H. H. Smith, 1911)

North River, Hagler's Mill, Tuscaloosa Co., Alabama (H. H. Smith, 1911)
Tritogonia verrucosa
Pleurobema hagleri
Elliptio arctatus
Ptychobranchus greeni

Valley Creek, Toadvine, Jefferson Co., Alabama (H. H. Smith, 1912 and 1913)
Fusconaia rubida
Amblema costata
Tritogonia verrucosa
Pleurobema hagleri
Elliptio arctatus
Leptodea fragilis
Lampsilis excavata

IV. Cahaba River

The earlier lists given here include collections made by Call, Hartman and Smith. As stated by van der Schalie (1938), the Cahaba evidently had not been as thoroughly explored as was the Coosa. Two extensive surveys were made later (see Map 2): in 1933, W. J. Clench of the Museum of Comparative Zoology at Harvard and the author collected in the lower reaches of the river; in 1935, Calvin Goodrich and the author revisited the Cahaba and added greatly to collections from the headwaters. The 48 species listed in Table III are considered both in regard to general distribution and to ecology so that assemblages can be characterized as being common to creeks, small river, medium-sized river or large river. The zones delineated ecologically for the several species agree with geological zones as indicated by the late Dr. Walter B. Jones of the Alabama Geological Survey. J. J. Jenkinson (1974) also indicated that a geological feature such as the "fall line" influences the distribution pattern of mussels.

The collections made at Lily Shoals were unbelievably rich (Table III). Hopefully this section of the river, if it is still pristine, can be maintained as a "wild river" preserve. The species list for the Cahaba is quite similar to that reported here for the Coosa; both streams seem to share in the richness of their molluscan fauna, as well as in the potential for harboring certain unusual endemic species (see Bash, 1959).

Cahaba River Drainage:

Cahaba river, Perry Co., Alabama (Hartman Collection)
Dysnomia penita
Pleurobema brumbyanum

Cahaba river, Bibb Co., Alabama (Hartman; Schowalter)
Pleurobema decisum
Pleurobema interventum
Pleurobema instructum
Pleurobema nux
Pleurobema stabile
Pleurobema brumbyanum
Medionidus parvulus
Micromya (Villosa) nebulosa

Cahaba River, Pratt Ferry, Bibb Co., Alabama (H. H. Smith)
Fusconaia rubida
Quadrula aspera
Pleurobema decisum
Elliptio crassidens
Lampsilis excavata

Cahaba River, Lily Shoals, Bibb Co., Alabama (Hartman; R. E. Call)
Pleurobema interventum
Pleurobema brumbyanum
Ptychobranchus greeni
Medionidus parvulus
Micromya (Villosa) nebulosa
Dysnomia metastriata

Cahaba river, Gurnee, Shelby Co., Alabama (H. H. Smith)

Fusconaia rubida
Amblema perplicata
Quadrula cahabensis
Quadrula rumphiana
Tritogonia verrucosa
Pleurobema interventum
Elliptio crassidens
Elliptio dilatatus
Elliptio arctatus
Lasmigona complanata
Ptychobranchus greeni
Proptera purpurata
Medionidus acutissimus
Micromya (Villosa) vibex
Micromya (Villosa) lienosa
Lampsilis anodontoides
Lampsilis excavata
Dysnomia metastriata

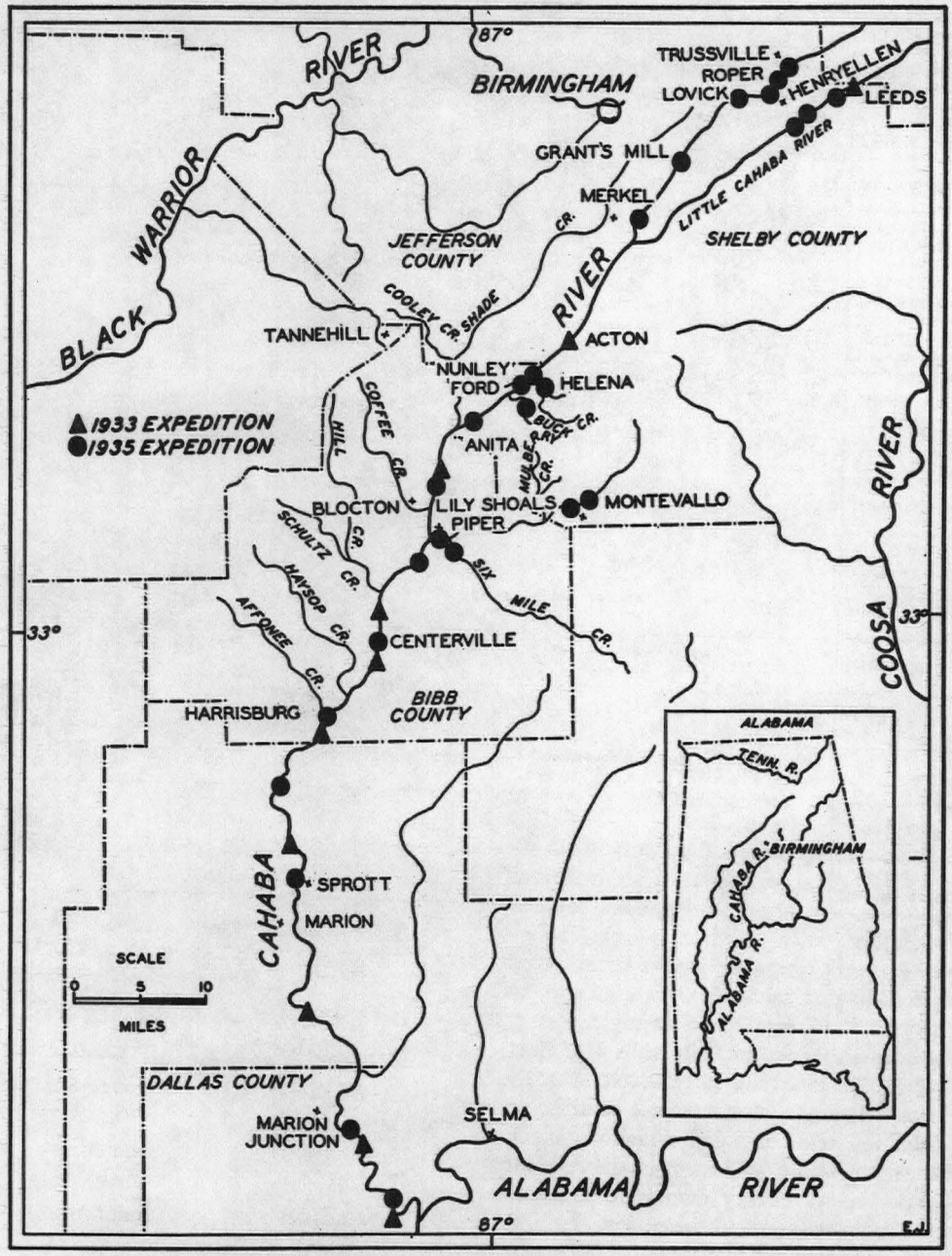
Cahaba River, Henryellen, Jefferson Co., Alabama (H. H. Smith)
Elliptio arctatus

Tributaries:

Shoal Creek, tributary to Little Cahaba, Montevallo, Shelby Co., Alabama (R. E. Call)
Elliptio tuomeyi

Buck Creek, Shelby Co., Alabama (Hartman Collection)
Micromya (Villosa) vibex

MAP 2
NAIADES OF THE CAHABA RIVER
(from van der Schalie, 1938)



Map 2. Cahaba River

TABLE III
(van der Schalic, 1938)

SYNOPTIC TABLE SHOWING DISTRIBUTION OF NAIADES BY COLLECTING STATIONS IN THE CAHABA RIVER

	CREEKS						MAIN RIVER HEADWATERS TO MOUTH																			
							SMALL RIVER					MEDIUM-SIZED RIVER								LARGE RIVER						
	2 miles north of Leeds	1 mile south of Leeds	4 miles south of Leeds	6 miles south of Leeds	Buck Creek, Helena	Beaverdam Creek, Helena	Near Roper	Henryellen	Lovick	Grants Mill	East of Merkel	Acton	Nunley Ford	Anita	Lily Shoals	10 miles above Centerville	7 miles above Centerville	1 mile above Centerville	At Centerville	7 miles below Centerville	2 miles east of Harrisburg	8 miles north of Sprott	5 miles northeast of Marion	West of Sprott	½ mile west of Felix	10 miles west of Selma	Near Beloit
Unioninae																										
Fusconaia rubida	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	23	103	15	26	1	.....	7	9	18	6	2	.....	19	.....
Fusconaia cerina	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
Fusconaia ebenus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	23	5	.....	1	12	1
Amblema perplicata	.....	.....	.....	.....	.....	.....	1	65	20	40	4	10	31	21	26	1	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....
Megalonaias gigantea	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	.....	.....	.....	.....	.....	.....
Quadrula pustulosa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	6	20	17	17	1	1	27	12	58	50	17	2	125	9
Quadrula cahabensis	.....	.....	.....	.....	.....	.....	.....	30	10	3	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Quadrula vallata	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Quadrula aspera	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	8	17	.....	.....	.....	.....	1	1	1	.....	.....	1	5	1
Quadrula rumphiana	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	1	.....	1	2	3	.....	.....	.....	.....	4	.....	.....	.....	.....	.....
Quadrula metanevra	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	12	22	2	.....	20	1
Tritigonia verrucosa	.....	.....	.....	.....	.....	.....	1	15	34	6	2	.....	10	12	29	6	5	1	.....	3	2	7	2	.....	3	12	6
Pleurobema simulans	.....	.....	.....	.....	5	.....	.....	2	.....	.....	.....	.....	.....	.....	68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pleurobema nux	.....	.....	.....	.....	.....	.....	.....	1	.....	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	2	.....
Pleurobema rubellum	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Pleurobema decisum	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	1	5	7	4	.....	.....	1	.....	1	.....	.....	.....	.....	.....
Pleurobema instructum	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	1	1	3	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....
Pleurobema cordatum	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	.....
Elliptio crassidens	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	62	3	5	19	37	6	7	12	15	20	6	1	1	10	6
Elliptio arctatus	.....	.....	.....	.....	1	.....	.....	137	90	15	.....	.....	41	10	25	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Elliptio dilatatus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anodontinae																											
Lasmigona holstonia	2	33	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lasmigona complanata	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	3	.....	.....	.....	.....	1	.....	1	.....	.....	.....	.....	.....
Anodonta imbecillis	.....	.....	.....	20	.....	.....	.....	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Strophitus spillmanii	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Strophitus subvexus	.....	.....	.....	.....	.....	.....	.....	5	6	5	2	.....	1	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lampsilinae																											
Ptychobranchus greeni	.....	.....	.....	.....	.....	.....	.....	5	3	7	4	.....	23	20	9	1	2	.....	1	1	.....	.....	.....	.....	.....	.....	.....
Obliquaria reflexa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	2	1	.....	.....	2	2	4	10	3	.....	8	.....
Obovaria subrotunda	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	40	10	53	80	31	3	150	7
Plagiola lineolata	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	7	1	.....	.....	1	.....
Leptodea fragilis	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13	2	45	1	.....	.....	.....	3	2	.....	.....	1	.....	1	4
Proptera purpurata	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	4	.....	38	2	2	1	2	.....	2	1	3	.....	.....	1	.....
Carunculina corvunculus	.....	.....	.....	.....	.....	.....	.....	2	3	.....	.....	.....	.....	.....	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Carunculina cromwelli	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Medionidus parvulus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	x	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Medionidus acutissimus	.....	.....	.....	.....	.....	.....	.....	1	.....	4	1	.....	28	22	15	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	3	.....
Micromya vanuxemensis	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	70	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	.....
Micromya nebulosa	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Micromya lienosa	4	1	2	1	.....	1	.....	5	18	2	4	.....	3	5	65	.....	.....	.....	.....	1	1	2	.....	.....	1	1	.....
Micromya vibex	1	5	9	17	.....	.....	.....	31	31	1	.....	.....	3	4	16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ligumia recta latissima	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	3	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
Lampsilis claibornensis	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	1	.....	6	.....	.....	.....	.....	.....	2	8	2	.....	.....	.....	.....
Lampsilis clarkiana	.....	.....	.....	3	2	.....	1	20	14	.....	1	.....	5	3	6	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lampsilis anodontoides	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	.....	1	2	22	.....	3	1	1	7	18	3	10	.....	4	8	3
Lampsilis excavata	.....	.....	.....	.....	1	.....	.....	16	24	3	2	.....	1	11	10	20	14	.....	1	8	.....	20	60	1	2	30	3
Dysnomia metastriata	.....	.....	.....	.....	1	.....	.....	49	35	26	2	.....	38	23	12	6	.....	.....	.....	.....	.....	8	1	3	.....	.....	.....
Dysnomia othcaloogensis	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Truncilla donaciformis	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	.....	.....	.....	.....	.....	4	1	20	1

V. Coosa River

The mussels of the Coosa drainage as here reported are those collected by H. H. Smith as a part of the Syndicate material given to Dr. Clapp at the Carnegie Museum in Pittsburgh. These collections were organized and tabulated by Dr. Ortmann. Since the Coosa with its many fine shoals has perhaps been changed more than any of the other streams in the Alabama system, this tabulation represesnts the best survey ever made of that river in its earlier unaltered state. A clear and concise statement (Anonymous, 1913) as to the nature of the great work accomplished by Herbert Smith follows:

> "Mr. Herbert H. Smith, Curator of the Museum of the Alabama Geological Survey, has recently brought back from the Coosa River the largest and finest collection of fresh-water shells ever made by him. There are about 25,000 selected specimens, including a very large number of species, some of them new to science. The principal locality worked was Weduska Shoals, between Shelby and Coosa Counties, believed to be the richest place on this very productive river. The Shoals will soon be covered with 20 feet of water by the great dam of the Alabama Power Company, now nearly completed. Mr. Smith's expedition was planned in order to obtain large series of the shells while they are still accessible. In all probability some of the Weduska species will not be found elsewhere; many Coosa mollusca are extremely local, even restricted to a small part of one shoal. These Weduska species, if not collected now, would have been forever lost to science; in fact, they are likely to become extinct under the changed conditions. Special efforts are made to secure a full set of the animals of *Pleuroceridae* for anatomical purposes, and about 5,000 of these were preserved."

Of great interest among the mollusks of the Coosa River are some of the rare and endemic snails. Both H. H. Smith and A. A. Hinkley were able to discover some of them. Walker (1908: 128) in describing new species of Ancylidae stated, as follows:

> "All these species of *Neoplanorbis* were discovered by Mr. Herbert H. Smith in the fall of 1907. They live on the under sides of stones in the more or less rapid current and in suitable locatlities are very abundant. Mr. Smith took 50 from one small stone. *Neoplanorbis* seems very local in distribution. It may be abundant on one shoal and not found at all on another. And on the same shoal, it is frequently restricted to one side of the river or the other."

In 1959, Dr. Paul F. Basch attempted to rediscover these rare genera but in a brief account entitled, "The Coosa Rivisited," he stated:

> "The Coosa River in east central Alabama has been famous for its many endemic species of mollusks for half a century. Since the early collections were made, the river has been greatly altered by the construction of power dams. In, June, 1959, the author and Dr. J. B. Burch visited the Coosa in search of *Amphigyra* and *Neoplanorbis,* but no specimens of these genera could be found."
>
> "The adjacent Cahaba Rier near Helena, Shelby County, Alabama, did provide a number of specimens of *Rhodacmea cahawbensis* Walker 1917, and the anatomy of this species was studied and reeported upon. . . ."

In addition to H. H. Smith, Anson A. Hinkley was another of the important early collectors to visit the Coosa. Bryant Walker (1920) gave in summary form the importance of Hinkley's work, as follows:

> "In 1903 he began the series of collecting trips which have given him a permanent place in the history of American Conchology. In the winter of that year he explored the Coosa and Black Warrior rivers of Alabama. Two remarkable new genera, *Amphigyra* Pils, and *Neoplanorbis* Pils., and many new species of *Somatogyrus, Ancylus* and *Quadrula* were discovered. Mr. Hinkley was the first to develop the minute species of Alabama, which had been almost entirely overlooked by the earlier collectors in that state, whose attention had been wholly absorbed with the wonderful fauna of *Unionidae* and *Pleuroceridae* in that region."

While Smith and others assembled large quantities of snails belonging to the family Pleuroceridae, it fell to Calvin Goodrich to work out the systematics of this difficult group. Pilsbry (1937) gave a very favorable review of Goodrich's revision of the *Goniobasis* of the Coosa River, as follows:

> "In this third paper discussing Coosa River pleurocerids the stout, cylindric Goniobases are revised. The group has been the terror of conchologists for a generation. Though a few, such as *capillaris, impressa* and *caelatura* were generally recognized, most of the species were submerged in such a sea of synonyms, about 90 in all, that one sank back discouraged by the task of identification. 24 species are now admitted, three of them new, two other names substituted for named preoccupied. The opercula and dentition are considered, and all of the species are illustrated by excellent figures."

Calvin Goodrich retired in 1944. It was fortunate that he completed several studies on the mollusks of the Coosa River. In 1941 he published an account on the Pleuroceridae of the small streams of the Alabama system; this report was followed in 1944 by papers dealing with the Pleurocerids of the Coosa itself, as well as the results of his studies on the freshwater pulmonates and Sphaeriids.

The H. H. Smith mussel collections are the most extensive made in the preimpoundment stage of the Coosa drainage. The number of stations recorded here are impressive both in the river itself and in its tributaries. Table IV lists the species in a synoptic arrangement to show their ecology and distribution. The table reflects in many ways the same patterns previously shown for the Cahaba drainage.

VI. Tallapoosa River

The only Smith record available for this river is the one listed for the branch of Uphapee Creek. J. J. Jenkinson (1979), in his Master's thesis published at Auburn University in 1973, reported on unionids taken in the Saugahatchee and Uphapee creeks in the Tallapoosa drainage. From his map (1979: 150) it appears that he collected naiades from about a dozen stations. The thesis seems to be unpublished but would provide useful information on the mussels of that drainage system.

Coosa River, Weduska Shoals, Shelby Co., Alabama (H.H. Smith, 1913)
Fusconaia ebenus
Megalonaias triumphans
Amblema perplicata
Quadrula asperata
Quadrula kieneriana
Quadrula rumphiana
Tritogonia verrucosa
Pleurobema chattanoogaense
Pleurobema decisum
Pleurobema hartmanianum
Pleurobema showalteri
Pleurobema stabile
Elliptio crassidens
Elliptio dilatatus subgibbosus
Elliptio arctatus
Strophitus connasaugaensis
Ptychobranchus greeni foremanianum
Obliquaria reflexa
Truncilla donaciformis
Plagiola lineolata
Leptodea fragilis
Proptera purpurata poulsoni
Carunculina corvunculus
Medionidus acutissimus
Medionidus parvulus
Micromya (Villosa) vibex
Lampsilis anodontoides
Lampsilis excavata
Lampsilis perovalis
Dysnomia metastriata

Coosa River, Peckerwood Shoals, Shelby Co., Alabama (H.H. Smith)
Fusconaia ebenus
Quadrula asperata
Quadrula kieneriana
Pleurobema chattanoogaense
Elliptio crassidens
Elliptio dilatatus subgibbosus
Elliptio arctatus
Ptychobranchus greeni foremanianum
Leptodea fragilis
Proptera purpurata poulsoni
Dysnomia metastriata

Coosa River, Fort William Shoals, Shelby Co., Alabama (H.H. Smith)
Amblema perplicata
Pleurobema chattanoogaense
Pleurobema decisum
Ptychobranchus greeni foremanianum
Lampsilis perovalis

Coosa River, Three Island Shoals, Wilsonville, Shelby Co., Alabama (H.H. Smith)
Fusconaia ebenus
Megalonaias triumphans
Quadrula asperata
Quadrula metanevra
Quadrula rumphiana
Pleurobema chattanoogaense
Pleurobema decisum
Elliptio crassidens
Elliptio dilatatus subgibbosus
Ptychobranchus greeni foremanianum
Obliquaria reflexa
Plagiola lineolata
Ligumia recta latissima
Lampsilis excavata
Lampsilis perovalis
Dysnomia metastriata

Coosa River, near Upper Clear Creek, Talledega Co., Alabama (H.H. Smith)
Quadrula asperata
Elliption dilatatus subgibbosus
Ptychobranchus greeni foremanianum
Medionidus parvulus
Dysnomia metastriata

Coosa River, Coosa Valley, St. Clair Co., Alabama (H.H. Smith)
Quadrula asperata
Fusconaia ebenus
Megalonaias triumphans
Pleurobema chattanoogaense
Pleurobema lewisi
Elliptio crassidens
Elliption dilatatus subgibbosus
Ptychobranchus greeni foremanianum
Obliquaria reflexa
Leptodea fragilis
Proptera purpurata poulsoni
Lampsilis excavata
Lampsilis clarkiana
Dysnomia metastriata

Coosa River, Eureka, Talladega Co., Alabama (Goodrick Collection)
Pleurobema decisum

Coosa River, Riverside, St. Clair Co., Alabama (H.H. Smith)
Fusconaia ebenus
Amblema perplicata
Quadrula asperata
Quadrula kieneriana
Quadrula metanevra
Quadrula rumphiana
Tritogonia verrucosa
Pleurobema chattanoogaense
Pleurobema decisum
Elliptio dilatatus
Elliptio dilatatus subgibbosus
Ptychobranchus grenni foremanianum
Obliquaria reflexa
Leptodea fragilis
Proptera purpurata poulsoni
Medionidus parvulus
Micromya (Villosa) vibex
Ligumia recta latissima
Lampsilis excavata
Lampsilis perovalis
Dysnomia metastriata

Coosa River, Lock 4, St. Clair Co., Alabama (H.H. Smith)
Obliquaria reflexa

TABLE IV

DISTRIBUTION OF NAIADS AT SMITH'S COOSA RIVER STATIONS

		CREEKS: Chattooga River, 2 mi n of Cedar Bluff	Little Wills Creek, Attala	Big Wills Creek, Attala	Canoe Creek	Greens Creek	Beaver Creek	Shoal Creek	Choccolocco Creek, White Plains	Choccolocco Creek, Jackson Shoals	Choccolocco Creek, Eureka	Kelly Creek	Talladega Creek, Talladega	Talladega Creek, Nottingham	Talladega Creek	Morgan Creek, branch of Yellow Leaf	Yellow Leaf Creek	Cedar Creek, Talladega Springs	Spring Creek, Kewatchee Springs	Mill Creek, branch of Waxahatchee	MAIN RIVER: Mimerota Bend	Riddles Bend	Leoto Shoals, Greensport	Fomby Shoals	Lock 4	Riverside	Eureka	Coosa Valley	nr Upper Clear Creek	Three Island Shoals, Wilsonville	Fort William Shoals	Peckerwood Shoals	Weduska Shoals	nr Waxahatchee Creek	nr Yellow Leaf Creek	Butting Ram Shoals	Duncan Riffle	Higgins Ferry	Wetumpka
Unioninae:	Fusconaia ebenus																				x					x		x		x		x	x						
	Amblema perplicata			x																		x				x					x		x						x
	Amblema perplicata elliotti	x																																					
	Megalonais triumphans																											x		x			x						
	Quadrula aspera																																						x
	Quadrula asperata									x											x	x				x		x	x	x		x	x						x
	Quadrula kieneriana																									x						x	x		x				x
	Quadrula metanevra																									x				x									
	Quadrula rumphiana																					x	x			x				x			x						
	Tritigonia verrucosa									x																x							x						x
	Pleurobema chattanoogaense				x			x																		x		x		x	x	x	x		x	x			x
	Pleurobema decisum																x									x	x			x	x		x	x	x				x
	Pleurobema georgianum							x																															
	Pleurobema hartmanianum																																x						
	Pleurobema johannis						x																																
	Pleurobema lewisi																											x											
	Pleurobema showalteri																																x						
	Pleurobema stabile																																x						
	Elliptio arctatus									x																						x	x			x			x
	Elliptio crassidens	x								x																		x		x		x	x						x
	Elliptio dilatatus									x																x													
	Elliptio dilatatus subgibbosus									x											x		x			x		x	x	x		x	x		x				
Anodontinae:	Lasmigona holstonia																	x		x																			
	Anodonta grandis				x		x																																
	Anodonta imbecillis				x		x																																
	Strophitus connasaugaensis																																x						
Lampsilinae:	Ptychobranchus greeni foremanianum	x								x													x	x		x		x	x	x	x	x	x				x		x
	Obliquaria reflexa																				x		x	x	x	x		x		x			x						x
	Plagiola lineolata																				x				x					x			x						x
	Leptodea fragilis																				x					x		x				x	x		x				x
	Proptera purpurata																																						x
	Proptera purpurata poulsoni									x																x		x				x	x						x
	Carunculina corvunculus						x		x	x		x					x																x						
	Medionidus acutissimus									x					x																		x						
	Medionidus parvulus									x																x			x				x						
	Micromya (Villosa) lienosa																																						x
	Micromya (Villosa) nebulosa		x			x		x		x				x					x																				
	Micromya (Villosa) vanuxemensis		x				x	x								x	x						x																
	Micromya (Villosa) vibex				x				x		x															x							x			x			
	Ligumia recta latissima	x																								x				x									
	Lampsilis anodontoides																																x						x
	Lampsilis claibornensis																																						x
	Lampsilis clarkiana									x			x		x													x											
	Lampsilis excavata									x																x		x		x			x						x
	Lampsilis perovalis																									x				x			x					x	
	Dysnomia metastriata									x															x	x		x	x	x	x	x	x		x			x	
	Truncilla donaciformis																					x											x						
		4	2	1	1	1	5	4	2	15	1	1	1	1	2	1	3	1	1	1	6	4	5	2	3	21	1	14	5	16	5	11	30	1	5	4	1	2	19

Plagiola lineolata
Dysnomia metastriata

Coosa River, Fomby Shoals, Calhoun Co., Alabama (H.H. Smith)
Ptychobranchus greeni foremanianum
Obliquaria reflexa

Coosa River, Leoto Shoals, Greensport, St. Clair Co., Alabama (H.H. Smith)
Quadrula rumphiana
Elliptio dilatatus subgibbosus
Ptychobranchus greeni foremanianum
Obliquaria reflexa
Micromya (Villosa) vanuxemensus

Coosa River, Riddles Bend, Cherokee Co., Alabama (H.H. Smith)
Quadrula asperata
Quadrula rumphiana
Amblema perplicata
Truncilla donaciformis

Coosa River, Mimerota Bend, Cherokee Co., Alabama (H.H. Smith)
Fusconaia ebenus
Quadrula asperata
Elliptio dilatatus subgibbosus
Obliquaria reflexa
Plagiola lineolata
Leptodea fragilis

Coosa River Drainage - Tributaries:

Mill Creek, branch of Waxahatchee Creek, Shrader Mill, Shelby Co., Alabama (H.H. Smith)
Lasmigona holstonia

Spring Creek, Kewatchee Springs, Shelby Co., Alabama (H.H. Smith)
Micromya (Villosa) nebulosa

Cedar Creek, Talladega Springs, Talladega Co., Alabama (E.R. Showalter)
Lasmigona holstonia

Yellow Leaf Creek, Shelby Co., Alabama (H.H. Smith)
Pleurobema chattanoogaense
Carunculina corvunculus
Micromya (Villosa) vanuxemensus

Morgan Creek, branch of Yellow Leaf Creek, Shelby co., Alabama (H.H. Smith)
Micromya (Villosa) vanuxemensis

Talladega Creek, Talladega Co., Alabama (Hartman Collection)
Medionodus acutissimus
Lampsilis clarkiana

Talladega Creek, Nottingham, Talladega Co., Alabama (H.H. Smith)
Micromya (Villosa) nebulosa

Talladega Creek, Talladega, Talladega Co., Alabama (Hartman Collection)
Lampsilis clarkiana

Kelly Creek, St. Clair Co., Alabama (H.H. Smith)
Carunculina corvunculus

Choccolocco Creek, Eureka, Talladega Co., Alabama (H.H. Smith)
Micromya (Villosa) vibex

Choccolocco Creek, Jackson Shoals, Talladega Co., Alabama (H.H. Smith)
(most likely in lowermost part of creek)
Quadrula asperata
Tritogonia verrocosa
Elliptio crassidens
Elliptio dilatatus subgibbosus
Elliptio arctatus
Ptychobranchus greeni foremanianum
Proptera purpurata poulsoni
Carunculina corvunculus
Medionidus acutissimus
Medionidus parvulus
Micromya (Villosa) nebulosa
Micromya (Villosa) vanuxemensis
Lampsilis excavata
Lampsilis clarkiana
Dysnomia metastriata

Choccolocco Creek, White Plains, Calhoun Co., Alabama (H.H. Smith)
Carunculina corvunculus
Micromya (Villosa) vibex

Shoal Creek, St. Clair Co., Alabama (H.H. Smith)
Pleurobema chattanoogense
Pleurobema georgianum
Micromya (Villosa) nebulosa
Micromya (Villosa) vanuxenmensis

Beaver Creek, St. Clair Co., Alabama (H.H. Smith)
Pleurobema johannis
Anodonta imbecillis
Anodonta grandis
Carunculina corvunculus
Micromya (Villosa) vanuxemensis

Greens Creek, Etowah Co., Alabama (H.H. Smith)
Micromya (Villosa) nebulosa

Canoe Creek, St. Clair Co., Alabama (H.H. Smith)
Pleurobema chattanoogaense
Anodonta imbecillis
Anodonta grandis
Micromya (Villosa) vibex

Big Wills Creek, Attala, Etowah Co., Alabama (H.H. Smith)
Amblema perplicata

Little Wills Creek, Attala, Etowah Co., Alabama (H.H. Smith)
Micromya (Villosa) nebulosa
Micromya (Villosa) vanuxemensis)

Chattooga River, 2 mi n of Cedar Bluff, Cherokee Co., Alabama (H.H. Smith)
- *Amblema perplicata elliotti*
- *Elliptio crassidens*
- *Ptychobranchus greeni foremanianum*
- *Ligumia recta latissima*

Chattooga River, Trion, Chattooga Co., Georgia (A.E. Ortmann)
- *Lasmigona hostonia*
- *Strophitus connasaugaensis*
- *Medionidus acutissimus*
- *Micromya (Villosa) vanuxemensis*
- *Lampsilis clarkiana*

Chattooga, Lafayette, Walker Co., Georgia (Hartma Collection)
- *Micromya (Villosa) vanuxemensis*

Little River, Cherokee Co., Alabama (H.H. Smith)
- *Lasmigona hostonia*
- *Micromya (Villosa) vibex*

Spring Creek, Teloga, Chattooga Co., Georgia (Sterki Collection)
- *Micromya (Villosa) vanuxemensis*

Cowans Creek, Cherokee Co., Alabama (H.H. Smith)
- *Pleurobema georgianum*
- *Carunculina corvunculus*
- *Micromya (Villosa) nebulosa*
- *Micromya (Villosa) vanuxemensis*

Tributaries of the Coosa River in its headwaters, above Rome, Georgia:

Oostanaula River, Rome, Floyd co., Georgia (H.H. Smith)
- *Quadrula asperata*
- *Tritogonia verrucosa*
- *Pleurobema decisum*
- *Elliptio crassidens*
- *Proptera purpurata poulsoni*
- *Lampsilis excavata*

Dry Creek, Rome, Floyd Co., Georgia (R.E. Call)
- *Lasmigona holstonia*
- *Micromya (Villosa) vanuxemensis*

Oothcalooga Creek, Calhoun, Gordon Co., Georgia (H.H. Smith)
- *Amblema perplicata elliotti*
- *Anodonta imbecillis*
- *Carunculina corvunculus*
- *Micromya (Villosa) vanuxemensis*

Millpond on Oothcalooga Creek, Calhoun, Gordon Co., Georgia (H.H. Smith)
- *Anodonta grandis*

"Buckhout Spring Branch," 3 mi e of Calhoun, Gordon Co, Georgia (H.H. Smith)
- *Lasmigona holstonia*

Conasauga Drainage to the Coosa River:

Conasauga River, Whitfield Co., Georgia (H.H. Smith)
- *Amblema perplicata elliotti*
- *Quadrula asperata*
- *Quadrula rumphiana*
- *Tritogonia verrucosa*
- *Pleurobema chattanoogaense*
- *Pleurobema decisum*
- *Elliptio arctatus*
- *Ptychobranchus greeni foremanianum*
- *Micromya (Villosa) vanuxemensis*
- *Lampsilis excavata*

Conasauga River, Dalton, Whitfield Co., Georgia (Goodrich Collection)
- *Lampsilis excavata*

Conasauga River, Campbell's Mill, 5 mi sw of Tennga. Murray Co., Georgia (H.H. Smith)
- *Pleurobema georgianum*
- *Carunculina corvunculus*

Conasauga River, Conasauga, Polk Co., Tennessee (A.E. Ortmann)
- *Pleurobema georgianum*
- *Pleurobema johannis*
- *Strophitus connasaugaensis*
- *Medionidus parvulus*
- *Micromya (Villosa) nebulosa*
- *Micromya (Villosa) vibex*
- *Micromya (Villosa) vanuxemensis*
- *Lampsilis clarkiana*

Swamp Creek, s of Dalton, Whitfield Co., Georgia (Hartman Collection)
- *Micromya (Villosa) nebulosa*

Holly Creek, Murray Co., Georgia (H.H. Smith)
- *Quadrula asperata*
- *Quadrula rumphiana*
- *Elliptio tuomeyi*
- *Micromya (Villosa) vibex*
- *Micromya (Villosa) vanuxemensis*
- *Lampsilis claibornensis*
- *Lampsilis excavata*

Coahulla Creek, Herndons Mill, Whitfield Co., Georgia (H.H. Smith)
- *Amblema perplicata elliotti*
- *Quadrula rumphiana*
- *Micromya (Villosa) vanuxemensis*

Etowah River, Georgia (Hartmann Collection)
- *Elliptio crassidens*
- *Ptychobranchus greeni foremanianum*
- *Proptera purpurata poulsoni*
- *Dysnomia metastriata*

Etowah River, Rome, Floyd Co., Georgia (R.E. Call)
- *Elliptio crassidens*

VI. Tallapoosa River

The only Smith record available for this river is the one listed for the branch of Uphapee Creek. J.J. Jenkinson (1979), in his Master's thesis published at Auburn University in 1973, reported on unionids taken in the Saugahatchee and Uphapee creeks in the Tallapoosa drainage. From this map (1979:150) it appears that he collected naiades from about a dozen stations. The thesis seems to be unpublished but would provide useful information on the mussels of that drainage system.

Tallapoosa River Drainage:

Branch of Uphapee Creek, 4 mi se of Tuskegee, Macon Co., Alabama (H.H. Smith)
Lampsilis straminea

Conclusions

The construction of the Tenn-Tom Seaway will have a great impact on the biota of the Tombigbee River and the degree of the changes will have to be measured against these lists of species inhabiting the main stream and its tributaries. It is known that some of the mussel species are now threatened or endangered. It would appear in the several interests concerned with those changes that surveys such as were undertaken by H. H. Smith should again be sponsored and parts of the river system still relatively pristine be set aside as preserves.

With the earlier great alterations in the Coosa River due to dam construction these locality data represent largely preimpoundment conditions. They can be very useful for seeking remedial ways for maintaining what may still be left at some of the sites not yet altered. Such surveys need immediate sponsorship.

The failure in obtaining comparable data in richness of naiades in the Tallapoosa drainage remains unexplained. It may be related to the nearness to a schistose formation that cuts across Alabama and Georgia providing too little lime for the production of a large mussel fauna; it may also have stream confluence significance.

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A SURVEY OF THE MUSSELS (UNIONIDAE) of the UPPER TENNESSEE RIVER - 1978

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This account of the mussels of the upper Tennessee River includes portions of the mainstream Tennessee River from Walden Gorge, west of Chattanooga, Tennessee, to Fort Loudoun Dam, south of Knoxville, Tennessee. Collections were made downstream from each of the three mainstream dams (Fort Loudoun, Watts Bar, Chickamauga) for varying distances depending on the quality of the substrate. Eighty-six stations were sampled which yielded a total of only 21 extant species as compared to 57 species reported by Ortmann (1918). Slight changes in faunal composition have occurred since Scruggs' survey (1960). Most notable of the changes are (1) invasion of typical post-impoundment species (6 of the 21 extant species) and (2) the occurrence of *Dromus dromas* (lea, 1834), a Cumberlandain species not reported from the Tennessee River since Ortmann (1918).

Introduction

The Tennessee River has long been noted for its indigenous mussel fauna. Within the Tennessee River, species originating in the upper Tennessee or Cumberland River basins (Cumberlandian) are merged with species originating in the lower Ohio River basin (Ohioan) together with species of undetermined origin.

This account of the mussels of the upper Tennessee River includes portions of the mainstream Tennessee River from Walden Gorge, west of Chattangooa, Tennessee, to Fort Loudon Dam, south of Knoxville, Tennessee (Figure I). Collections were made downstream from each of the three mainstream dams (Fort Loudon, Watts Bar, Chickamauga) for varying distances depending on the quality of the substrate. Eighty-six stations were sampled which yielded a total of 21 extant species as compared to 57 species by Ortmann (1918).

The classical work by Ortmann and Walker (1922) has formed the basis for nomenclatural decisions in this paper. Historical records have been synonymized following the recent publication by Bates and Dennis (1978). The "50 year rule" of zoological nomenclature has been adhered to in this publication. Voucher specimens for most species are deposited with the Museum of Zoology, Mollusk Division, University of Michigan, Ann Arbor, Michigan, 48104. Vouchers are not available for those species which are protected as endangered species or those species which the author deems "rare" in the upper Tennessee River.

Acknowledgements

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Historic Background

The Tennessee River proper is formed east of Knoxville, Tennessee, at the confluence of the Holston and French Broad Rivers (Figure 1). It flows generally southwesterly to Guntersville, Alabama, westward through Muscle Shoals, Alabama, to the Alabama-Mississippi state line, then northward through Tennessee to Paducah, Kentucky, where it joins the Ohio River.

Ortmann (1918) provides the basic reference to the mussel fauna of the upper Tennessee River prior to the major impoundment projects on the Tennessee River which began in 1936. In his account, he provides baseline for all of the upper Tennessee River drainage, including the Clinch, Powell, Holston, and French Broad rivers. In reports his collections along with the records of Lewis (1872), Pilsbry and Rhoads (1896), the Bryant Walker collection (Adams, 1901), the Carnegie Museum (Hartman collection (H.), Smith collection (S.), and Juny collection, Ortmann lists 66 species (57 in synonymy from the Tennessee River between Chattanooga and Knoxville, Tennessee (Table I).

Cahn (1936) collected mussels from the Clinch River downstream from Norris Dam upon the closure of that structure. His collections (34 species in synonomy) are one of the last records of the mussel fauna prior to the major impoundment projects on the Tennessee River. Three species, *Quadrula metanevra, Alasmidonta holstonia (Lea)* and *Dysnomia florentina* (Lea, 1857) were not reported by Ortmann (1918).

Scruggs (1960) provides post impoundment data on the fauna of Tennessee River. He collected in Chickamauga Reservoir between Tennessee River Mile (TRM) 498.0-519.0 and recorded 17 species (Table 1). In evaluating the status of the mussel stocks, Scruggs suggested that overharvesting (by commercial fishermen), rapid deterioration of suitable habitat, and water quality were responsible for the declining mussel fauna. Isom (1969) concurred with Scruggs' assessment regarding overharvesting and reduction in suitable habitat; however, water quality was considered generally good, with prospects for continued improvement. In conducting post impoundment mussel surveys in the upper Tennessee River, Isom (1969) recorded 15 species, five of which constituted new records for the upper Tennessee River. These species are widely distributed on overbanks throughout the mainstream reservoir.

Bates (1975) conducted tailwater and overbank mussel surveys in the Tennessee River. He collected a total of eight species. Three of these, *Anodonta grandis, A. corpulenta,* and *Proptera laevissima* are definitely post impoundment species.

Methods and Materials

Sampling was conducted during 1978. Eighty-six stations were sampled, 21 downstream from Fort Loudon Dam (Watts Bar Reservoir), 55 downstream from Watts Bar Dam

FIG.—1 UPPER TENNESSEE RIVER INCLUDING MAJOR TRIBUTARIES

(Chickamauga Reservoir), and 10 downstream from Chickamauga Dam (Nickajack Reservoir).

All samples were collected by biologists who are also certified scuba divers. At each station visited, divers collected every mussel encountered during timed random searches. Mussels were placed in nylon mesh bags and brought to the surface for identification and enumeration. Each specimen was identified, using voucher specimens as necessary, and returned to the river. Only the number of each species was recorded, i.e., no determinations of age, class, or size were made. Type of substrate, water depth, and any unusual conditions were recorded at each station.

Results

Overall Chickamauga Reservoir provides the most productive mussel habitat. Species composition estimates (Table 2) indicate that *Elliptio crassidens* and *Pleurobema cordatum* are the most common species collected.

Watts Bar Reservoir

The range of sampling stations covered 24.4 river miles from TRM 576.4-600.8. The most upstream stations (TRM 597.4-600.8) were relatively unproductive in terms of the mussel fauna. Only two species, *Proptera alata* and *Elliptio crassidens*, are represented in this reach. The substrate is characterized by large rocks with scattered pockets of cobble and sand, thus suitable habitat is minimal.

From TRM 597.3 downstream to TRM 588.4, two areas were located which supported 11 species. Mussels were found primarily in areas characterized by a cobble, gravel, sand mixture with only moderate siltation. Downstream from TRM 588.0 the substrate becomes decreasingly suitable for most riverine species of mussels with areas of heavy siltation evident and large areas of shifting sand. The distribution of mussel species found in upper Watts Bar Reservoir is provided in Table 3.

Chickamauga Reservoir

Sampling stations were located within a 15 mile reach of river downstream from Watts Bar Dam (TRM 528.9-514.2). The most productive areas (no. species 10) were TRM 528.1-527.4, TRM 525.0, and TRM 521.3-520.3. Downstream from TRM 520.3 to TRM 514.2 the faunal assemblage is substantially reduced, and the species found are those typically (within the Tennessee River) found in area of moderate sediment deposition. General substrate characteristics are indicated in. The most productive area, as indicated by the number of species, occurs on the east side of the river between TRM 521.3 and TRM 520.3. Twenty of the twenty-one species recorded from this reservoir are reported from this area. Most notable among these species is the presence of *Dromus dromas*. This record is the first reported occurrence for this species in the mainstream upper Tennessee River since Ortmann (1918). The distribution of all species found in upper Chickamauga is provided in Table 4.

Nickajack Reservoir

The reach of the river between Chickamauga Dam and Walden Gorge is influenced considerably by urban runoff and industrial discharges from the Chattanooga, Tennessee, area. Ten sampling stations from TRM 468.3-454.0 were surveyed. The mussel fauna is generally depauperate with the exception of one station (TRM 468.0) where 11 species were found. Substrate does not seem to be an obvious limiting factor since extensive areas of silt free cobble and gavel were observed. The distribution of all species found in this reach is provided in Table 5.

FAMILY UNIONIDAE, Ortmann, 1911
SUBFAMILY UNIONINAE, Ortmann, 1919

Fusconaia (Simpson, 1900)

The *Fusconaia subrotunda* (Lea, 1831) complex presents some taxonomic difficulties in the headwater forms (see Bates and Dennis, 1978). However, the *F. subrotunda* specimens collected from the upper Tennessee River do not appear similar to headwater forms but rather to the lower Tennessee River *F. subrotunda*. Very few specimens of this taxa were collected and its continued existence in the upper Tennessee is questionable.

Megalonaias Utterback, 1915

Megalonaias gigantea (Barnes, 1823) belongs to the Ohioan faunal (Interior Basin) group. *Megalonaias gigantea* was not reported from the upper Tennessee by Ortmann (1918) nor by more recent workers. It has now been collected from one station in Nickajack Reservoir (at Chattanooga, Tennessee) and from three stations in chickamauga Reservoir. Impoundment has apparently facilitated the expansion of the range of *M. gigantea*. If it has not already done so, it will certainly expand its range into Watts Bar Reservoir and Fort Loudoun Reservoir.

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Amblema Raf., 1819

Amblema costata Raf., 1820, belongs to the Ohioan faunal group. It has been reported from the upper Tennessee River by Ortmann (1918) and by Scruggs (1960). Presently, it is a relatively common species in each of the reservoirs surveyed.

Quadrula Raf., 1820

Of the four species of this genus reported by Ortmann (1918), only two species were found, *Q. pustulosa* (Lea, 1831) and *Q. metanevra* (Raf., 1820). *Quadrula cylindrica* (Say, 1817) and *Q. intermedia* (Conrad, 1836) still occur in the Powell and Duck Rivers but have apparently been extirpated from the upper Tennessee. *Quadrula cylindrica* has been recently collected (Neill and Pardue, 1978, unpublished) from the tailwater area of the Tennessee River downstream from Kentucky Dam and from the Clinch River (Bates and Dennis, 1978).

Quadrula pustulosa is one of the frequently collected species in the upper Tennessee River with estimates of abundance ranging from 4.0 to 11.1 percent of the fauna. It occurs in each of the three reservoirs surveyed. *Quadrula metanevra* is somewhat less common than *Q. pustulosa* but is not considered rare in the upper Tennessee River.

***Tritogonia* Agassiz, 1852**

This monotypic genus of uncertain faunal origin was reported by Scruggs (1960). It has been collected from the same general area as that visited by Scruggs and within 2-4 miles downstream from Watts Bar Dam. It is frequently collected from the lower Tennessee River but is presently know only from Chickamauga Reservoir in the upper Tennessee River.

***Cyclonaias* Pilsbry, 1922**

Cyclonaias tuberculata has been reported from the upper Tennessee by Ortmann (1918), Scruggs (1960), and Isom (1969). It remains a very common component of the upper Tennessee River fauna and is reported from each of the three reservoirs surveyed.

***Plethobasus* Simpson, 1900**

Plethobasus cooperianus (Lea, 1934) has been reported from the upper Tennessee River by Ortmann (1918) and Scruggs (1960). Ortmann, reporting the work of Pilsbry and Rhoads, records *P. cooperianus* from the Tennessee River at and below Knoxville, Tennessee, to Chattanooga, Tennessee. Scruggs records it from the Washington Ferry area of the Tennessee River (Chickamauga Reservoir). The author failed to collect any specimens of *P. cooperianus* from either Chickamauga or Nickajack Reservoirs; however, a single specimen was collected from Watts Bar Reservoir (TRM 595.0). Recent studies (Bates and Dennis, 1978, Tennessee Valley Authority, 1979, unpublished) have failed to document this species from either the Clinch or Powell Rivers. This member of the Ohioan faunal group is certainly very rare in the upper Tennessee River.

***Pleurobema* Raf., 1818**

Pleurobema cordatum, which was collected from each of the reservoirs surveyed, was the only species of this genus represented in the upper Tennessee River fauna. However, it was the second most abundant species present in the collections. Once very abundant in Chickamauga Reservoir, this species has declined progressively since Scruggs' (1960) survey. Improving water quality and the establishment of a mussel sanctuary in upper Chickamauga Reservoir should aid in the recovery of this species to near its former abundance.

***Elliptio* Raf., 1820**

Elliptio crassidens (Lamarck, 1819) is by far the most abundant species in the upper Tennessee River. Estimates of abundance indicate that it comprises from 53 to 85 percent of the fauna. Ortmann (1918) reported it extremely abundant in the Tennessee River between Knoxville and Chattanooga, Tennessee.

Elliptio dilatatus (Raf. 1820) is considerably less abundant than *E. crassidens* and was collected only from Chickamauga and Watts Bar Reservoirs. No specimens were collected from Nickajack Reservoir. Similarly, Isom (1969) did not report *E. dilatatus* from Nickajack Reservoir. Based on Ortmann's (1918) discussion, *E. dilatatus* is apparently less abundant than it was prior to impoundment. Isom (1969) reported a density of 0.011 per square yard which is probably not substantially different than that today.

SUBFAMILY ANODONTINAE

***Anodonta* Lamarck, 1799**

Three species of this genus were collected from the upper **Tennessee River.** *Anodonta imbecillis* Say, 1829; *A. corpulenta* Cooper, 1834; and *A. grandis* Say, 1829. Members of this genus were first reported from the upper Tennessee River by Isom (1969). These typical impoundment species occur throughout the mainstream of the Tennessee River, being most abundant on the overbank areas.

SUBFAMILY LAMPSILINAE

***Obliquaria* Raf., 1820**

Obliquaria reflexa Raf., 1820, has been reported from the upper Tennessee River since Ortmann (1918). It occurs in each of the three reservoirs surveyed, and has adapted reasonably well to impoundment since it is frequently collected from overbank areas. It also occurs throughout the mainstream of the lower Tennessee River.

***Cyprogenia* Agassiz, 1852**

Cyprogenia irrorata (Lea, 1828) was collected from four stations in upper Chickamauga Reservoir. These collections are the first reported from the upper Tennessee since Ortmann (1918) recorded *C. stegaria* (Raf., 1820). Ortmann indicated that it was quite abundant in the lower Clinch. Recently the author has collected *C. irrorata* also from Guntersville Dam tailwater and Kentucky Dam tailwater while Gooch and Wade (1978, unpublished) record it from Kentucky Reservoir. In each of these localities it must be considered among the rare shells collected.

***Dromus* (Simpson, 1900)**

Dromus dromas (Lea, 1834) was collected from three stations in Chickamauga Reservoir, all within one mile of each other. This Cumberlandian species has not been reported from the Tennessee River since Ortmann (1918) reported it, three miles below Knoxville, Tennessee. Based on the number of shells in the Indian middens, this species was once very common in the upper Tennessee River. However, despite extensive surveys throughout the mainstream Tennessee River, these most recent collections are the only known localities for this species in the Tennessee River proper. It has been collected from the Cumberland River (TVA, unpublished, 1976) and the Clinch River (Bates and Dennis, 1978). Bates and Dennis (1978) also report it from the Powell River; however, recent surveys (TVA, unpublished, 1979) recorded only the headwater subspecies *Dromus dromas caperatus* (Lea, 1845). In any instance it must be considered very rare.

***Plagiola* Lea., 1829**

This monotypic genus is represented by *P. lineolata* (Lea. 1829) and occurs in each of the three reservoirs surveyed. It is a large river species historically occurring in the upper Tennessee River. It is relatively common in Nickajack and Chickamauga Reservoirs but somewhat more rare in Watts Bar Reservoir.

***Leptodea* Raf., 1820**

Leptodea fragilis (Raf., 1820) was collected from only one

station in Chickamauga Reservoir. It was reported by Ortmann (1918) from a pond in the area but not from the river. Although not generally considered rare, recent surveys in the lower Tennessee River have yielded only a few specimens.

***Proptera* Raf., 1819**

Proptera alata (Say, 1817) was frequently collected from each of the reservoirs surveyed and especially abundant in Nickajack Reservoir (13.7 percent of the total collected). This species is historically a member of the upper Tennessee River fauna. *Proptera alata* seems to be well adapted to survival in the impoundments as evidenced by the number of specimens which the author and others have collected from overbanks and other areas with significant silt deposition.

***Ligumia* Swainson, 1840**

Ligumia recta latissima (Raf., 1820) was collected in each of the reservoir survyed. It has historically been recorded from the upper Tennessee by Ortmann (1918) and Scruggs (1960). *L. recta lattissima* occurs throughout the mainstream of the Tennessee River but never in large numbers.

***Lampsilis* Raf., 1820**

This genus is represented by two species in these most recent collections, *L. ovata* (Say, 1817) and *L. orbiculata* (Hildreth, 1828). Both species occur in Chickamauga and Watts Bar Reservoirs. *Lampsilis orbiculata* was collected from 13 stations in chickamauga Reservoir and 2 stations in Watts Bar Reservoir. *Lampsilis ovata* has been reported by Ortmann (1918) and Scruggs (1960) while *L. orbiculata* was reported only by Ortmann (1918). *Lampsilis orbiculata,* though generally not occurring in large numbers, is widely distributed throughout the mainstream Tennessee River.

SUMMARY AND CONCLUSIONS

The fauna of the upper Tennessee River is obviously quite reduced from Ortmann's list of 57 species (synonymized names). Chickamauga Reservoir apparently provides the best environmental conditions for the survival of the mussel fauna. Part of this area is protected from commercial musseling by the State of Tennessee. This fact in conjuntion with improving water quality should result in enhancement of the diversity and abundance of the mussel fauna in this reach of the river.

Pollution and a lack of sources for recolonization apparently continue to be a limiting factor restricting the diversity and abundance of mussels in Nickajack Reservoir. The extent and potential sources of pollution in this reach of river will probably preclude the development of increased mussel diversity for years to come.

Isolated areas exist in Watts Bar Reservoir where mussels continue to survive. Low dissolved oxygen releases from Fort Loudoun Dam may partially account for the lack of any significant fauna in the immediate tailwater area. However, even in downstream areas, assuming dissolved oxygen has been replenished, the substrate rapidly becomes comprised of increasing percentages of silt.

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Table 1

MUSSEL RECORDS: UPPER TENNESSEE RIVER; ORTMANN (1918), SCRUGGS (1960), ISOM (1969), BATES (1975), PARDUE (1980)

	Ortmann (1918)	Scruggs (1960)	Isom (1969)	Bates (1975)	Pardue (1980)
Unioninae					
Cumberlandia monodonta (Say, 1829)	x	-	-	-	-
Fusconaia subrotunda (Lea, 1831)	-	-	-	-	x
Fusconaia barnesiana (lea, 1838)	x	-	-	-	-
Fusconaia pilaris (Lea, 1840)	x	-	-	-	-
Fusconaia cuneolus (Lea, 1840)	x	-	-	-	-
Fusconaia edgariana (Lea, 1840)	x	-	-	-	-
Megalonaias gigantea (Barnes, 1823)	-	-	-	-	x
Amblema costata (Raf., 1820)	x	x	-	-	x
Quadrula pustulosa (Lea, 1831)	x	x	x	x	x
Quadrula metanevra (Raf., 1820)	x	x	x	-	x
Quadrula intermedia (Conrad, 1836)	x	-	-	-	-
Quadrula cylindrica (Say, 1817)	x	-	-	-	-
Tritigonia verrucosa (Raf., 1820)	-	x	-	-	x
Cyclonaias tuberculata (Raf., 1820)	x	x	-	-	x
Plethobasus cyphyus (Raf., 1820)	x	x	-	x	-
Plethobasus cooperianus (Lea, 1834)	x	x	-	-	x
Lexingtonia dolabelloides (Lea, 1840)	x	-	-	-	-
Pleurobema oviforme (Conrad, 1834)	x	-	-	-	-
Pleurobema cordatum (Raf., 1820)	x	x	x	x	-
Elliptio crassidens (Lamarck, 1819)	x	x	x	x	x
Elliptio dilatatus (Raf., 1820)	x	x	x	-	x
Lastena lata (Raf., 1820)	x	-	-	-	-
Anodontinae					
Lasmigona costata (Raf., 1820)	x	-	-	-	-
Lasmigona complanata (Barnes, 1823)	-	-	-	-	x
Anodonta grandis (Say, 1829)	-	-	x	-	x
Anodonta corpulenta (Cooper, 1834)	-	-	x	x	x
Anodonta imbecillis (Say, 1829)	-	-	x	-	x
Anodonta suborbiculata (Say, 1831)	-	-	x	x	-
Alasmidonta marginata (Say, 1819)	x	-	-	-	-
Strophitus rugosus (Swainson, 1822)	x	-	-	-	-
Lampsilinae					
Ptychobranchus fasciolaris (Raf., 1820)	x	-	-	-	-
Ptychobranchus subtentum (Say, 1825)	x	-	-	-	-
Obliquaria reflexa (Raf., 1820)	x	x	x	x	x
Cyprogenia irrorata (Lea, 1828)	x	-	-	-	x
Dromus dromas (Lea, 1834)	x	-	-	-	x
Dromus dromas caperatus (Lea, 1845)	x	-	-	-	-
Obovaria subrotunda (Raf., 1820)	x	-	-	-	-
Obovaria retusa (Lamarck, 1819)	x	-	-	-	-
Obovaria olivaria (Raf., 1820)	-	x	-	-	-

Table 1 (continued)

	Ortmann (1918)	Scruggs (1960)	Isom (1969)	Bates (1975)	Pardue (1980)
Actinonaias carinata (Barnes, 1823)	x	x	-	-	-
Actinonaias pectorosa (Conrad, 1834)	x	-	-	-	-
Plagiola lineolata (Raf., 1820)	x	x	x	-	x
Truncilla truncata (Raf., 1820)	x	-	x	-	-
Leptodea fragilis (Raf., 1820)	x	-	-	-	x
Leptodea leptodon (Raf., 1820)	x	-	-	-	-
Proptera alata (Say, 1817)	x	x	x	-	x
Proptera laevissima (Lea, 1829)	-	-	-	x	-
Carunculina moesta (Lea, 1841)	x	-	-	-	-
Conradilla caelata (Conrad, 1834)	x	-	-	-	-
Medionidus conradicus (Lea, 1834)	x	-	-	-	-
Ligumia recta latissima (Raf., 1820)	x	x	-	-	x
Micromya fabalis (Lea, 1831)	x	-	-	-	-
Micromya nebulosa (Conrad, 1834)	x	-	-	-	-
Micromya vanuxemensis (Say, 1838)	x	-	-	-	-
Lampsilis ovata (Say, 1817)	x	x	-	-	x
Lampsilis fasciola (Raf., 1820)	x	-	-	-	-
Lampsilis orbiculata (Hildreth, 1828)	x	-	-	-	x
Dysnomia triquetra (Raf., 1820)	x	-	-	-	-
Dysnomia arcaeformis (Lea, 1831)	x	-	-	-	-
Dysnomia lenoir (Lea, 1843)	x	-	-	-	-
Dysnomia haysiana (Lea, 1834)	x	-	-	-	-
Dysnomia brevidens (Lea, 1831)	x	-	-	-	-
Dysnomia stewardsoni (Lea, 1852)	x	-	-	-	-
Dysnomia lewisi (Walker, 1910)	x	-	-	-	-
Dysnomia capsaeformis (Lea, 1834)	x	-	-	-	-
Dysnomia torulosa gubernaculum (Reeves, 1865)	x	-	-	-	-
Dysnomia propinqua (Lea, 1857)	x	-	-	-	-

x Denotes presence of taxa
- Denotes absence of taxa

Table 2

SPECIES COMPOSITION OF SAMPLES TAKEN FROM SELECTED AREAS WITHIN EACH OF THE UPPER TENNESSEE RESERVOIRS

	WATTS BAR TRM 576.4 - 600.8 Percent of Total	CHICKAMAUGA TRM 526.4 - 528.1 Percent of Total	CHICKAMAUGA TRM 520.0 - 521.0 Percent of Total	NICKAJACK TRM 454.0 - 468.3 Percent of Total
Fusconaia subrotunda	0.1	-	0.2	-
Megalonais gigantea	-	1.3	0.1	1.0
Amblema costata	0.6	6.2	0.1	1.0
Quadrula pustulosa	4.0	11.1	6.9	4.2
Quadrula metanevra	0.7	0.3	2.6	4.2
Tritigonia verrucosa	-	0.5	0.2	-
Cyclonaias tuberculata	1.1	4.9	8.0	1.0
Plethobasus cooperianus	0.1	-	-	-
Pleurobema cordatum	3.1	21.4	10.2	12.6
Elliptio crassidens	85.2	-	66.9	52.6
Elliptio dilatatus	0.2	-	0.2	-
Anodonta grandis	-	0.5	-	-
Anodonta corpulenta	-	-	<0.01	1.0
Anodonta imbecillis	-	-	-	1.0
Obliquaria reflexa	0.5	3.4	0.2	3.1
Cyprogenia irrorata	-	-	0.1	-
Dromus dromas	-	-	0.2	-
Plagiola lineolata	0.2	2.3	2.3	1.0
Leptodea fragilis	-	0.3	-	-
Proptera alata	3.0	1.8	1.1	13.7
Ligumia recta lattisima	0.8	0.8	0.3	3.1
Lampsilis ovata	0.1	0.3	<0.1	-
Lampsilis orbiculata	0.2	1.5	0.4	-

Table 3

DISTRIBUTION OF MUSSELS IN UPPER WATTS BAR RESERVOIR
TRM 600.8-576.4

	TRM	600.8	598.8	597.4	597.3	597.3	597.2	596.2	595.1	595.0	595.0	594.3	594.1	592.2	592.3	591.5	591.0	598.7	588.4	588.0	584.4	576.4
	*	(50%)	(50%)	(50%)	(75%)	(25%)	(50%)	(25%)	(25%)	(75%)	(25%)	(75%)	(25%)	(25%)	(25%)	(75%)	(75%)	(50%)	(75%)	(75%)	(25%)	(75%)
Unioninae																						
Fusconaia subrotunda		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
Amblema costata		-	-	-	-	-	-	-	-	-	-	x	-	x	x	-	-	-	-	-	-	-
Quadrula pustulosa		-	-	-	x	-	x	-	-	-	x	-	x	x	-	-	-	-	x	-	-	-
Quadrula metanevra		-	-	-	-	-	-	-	-	-	x	-	-	x	-	x	-	-	x	-	-	-
Cyclonaias tuberculata		-	-	-	-	-	-	-	-	-	x	-	-	x	-	-	-	-	x	-	-	-
Plethobasus cooperianus		-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-
Pleurobema cordatum		-	-	-	x	-	x	-	-	-	x	-	x	x	-	-	-	-	x	-	-	-
Elliptio crassidens		-	-	x	x	x	x	-	-	-	x	x	x	x	x	x	-	-	x	x	-	-
Elliptio dilatatus		-	-	-	-	-	-	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-
Lampsilinae																						
Obliquaria reflexa		-	-	-	-	-	-	-	-	-	-	x	-	x	-	-	-	-	x	-	-	-
Plagiola lineolata		-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-
Proptera alata		x	-	-	x	x	x	-	-	-	x	-	x	x	-	-	-	-	x	-	-	-
Ligumia recta latissima		-	-	-	-	-	x	-	-	-	x	-	x	x	-	-	-	-	x	-	-	-
Lampsilis ovata		-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis orbiculata		-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	x	-	-	-
No. Species		1	0	1	5	2	6	0	0	0	8	3	6	11	2	2	0	0	11	1	0	0
Total Collection Time (Min)		24	10	6	32	28	30	6	2	10	56	26	28	30	8	14	4	2	42	10	8	6

* Percent from left bank looking downstream
\- Denotes absence of species
x Denotes presence of species

Table 4

DISTRIBUTION OF MUSSELS IN UPPER CHICKAMAUGA RESERVOIR
(TRM 528.9-514.2)

TRM (% *)	528.9 (25%)	528.9 (75%)	528.4 (75%)	528.2 (25%)	528.1 (25%)	528.0 (25%)	527.4 (25%)	527.2 (75%)	526.5 (75%)	526.4 (75%)	526.1 (75%)	526.0 (75%)	525.8 (75%)	525.0 (75%)	524.9 (75%)	524.0 (25%)	552.8 (75%)	522.1 (25%)	521.6 (25%)
Unioninae																			
Fusconaia subrotunda	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Megalonaias gigantea	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-
Amblema costata	-	x	-	x	x	-	x	x	x	x	-	-	-	x	x	-	-	-	-
Quadrula pustulosa	-	x	-	x	x	x	x	-	x	x	x	-	-	x	x	x	-	-	-
Quadrula metanevra	-	x	-	-	-	-	x	-	-	-	-	-	-	x	-	x	-	-	-
Tritigonia verrucosa	-	-	-	-	x	-	-	-	-	x	-	-	-	x	-	-	-	-	-
Cyclonaias tuberculata	-	x	-	-	x	x	x	-	x	x	x	-	-	x	x	-	-	-	-
Pleurobema cordatum	x	x	-	-	x	x	x	-	x	x	x	-	-	x	x	x	-	-	-
Elliptio crasidens	x	x	-	x	x	x	x	-	x	x	x	x	-	x	x	x	-	x	-
Elliptio dilatatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anodontinae																			
Anodonta grandis	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-
Anodonta corpulenta	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilinae																			
Obliquaria reflexa	-	-	-	-	x	-	x	x	-	x	x	-	-	x	-	-	-	-	-
Cyprogenia irrorata	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-
Dromus dromas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plagiola lineolata	-	-	-	-	x	x	x	-	-	x	x	-	-	-	-	x	-	-	-
Leptodea fragilia	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-
Proptera alata	-	x	-	x	x	x	x	-	x	-	x	x	-	x	-	x	-	-	-
Ligumia recta	-	-	-	-	x	x	x	-	-	-	-	-	-	x	-	x	-	-	-
Lampsilis ovata	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis orbiculata	-	-	-	-	x	x	x	-	-	-	-	-	-	x	-	-	-	-	-
No. Species	2	7	1	4	11	9	13	2	7	9	7	7	0	13	5	7	0	1	0
Total Collection Time (Min.)	10	36	14	18	58	42	42	18	24	50	30	8	3	76	24	40	10	10	4

TRM (% *)	521.4 (75%)	521.3 (50%)	521.2 (25%)	521.0 (75%)	521.0 (50%)	521.0 (25%)	520.8 (25%)	520.7 (25%)	520.7 (50%)	520.5 (25%)	520.5 (50%)	520.4 (25%)	520.4 (50%)	520.3 (25%)	520.2 (25%)	520.2 (50%)	520.0 (25%)	519.8 (25%)
Unioninae																		
Fusconaia subrotunda	-	-	-	-	-	-	-	-	-	-	-	x	-	x	-	-	-	-
Megalonaias gigantea	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-
Amblema costata	-	-	-	-	-	x	-	-	-	-	-	x	-	x	-	-	-	-
Quadrula pustulosa	-	x	x	-	x	x	x	x	x	x	x	x	x	x	x	-	-	x
Quadrula metanevra	-	x	x	-	x	-	x	-	x	x	x	x	x	x	-	-	x	-
Tritigonia verrucosa	-	x	-	-	-	-	-	-	x	-	-	x	x	-	x	x	-	-
Cyclonaias tuberculata	-	x	x	-	x	x	x	x	x	-	x	x	x	x	x	x	-	x
Pleurobema cordatum	-	x	x	-	x	x	x	x	x	x	x	x	x	x	x	-	-	x
Elliptio crasidens	-	x	x	-	x	x	x	x	x	x	x	x	x	x	x	x	x	-
Elliptio dilatatus	-	-	-	-	-	-	-	-	-	-	x	x	-	x	-	-	-	-
Anodontinae																		
Anodonta grandis	-	-	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-
Anodonta corpulenta	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
Lampsilinae																		
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	x	-	-	-	x	-	-	-	-
Cyprogenia irrorata	-	x	-	-	-	x	-	-	-	-	-	-	-	-	x	-	-	-
Dromus dromas	-	-	-	-	-	-	x	-	-	-	x	-	-	-	x	-	-	-
Plagiola lineolata	-	x	x	-	x	x	x	x	x	x	x	-	x	x	-	-	-	x
Leptodea fragilia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proptera alata	-	-	x	-	-	-	x	x	-	x	x	x	x	x	-	-	-	-
Ligumia recta	-	-	x	-	x	x	-	-	-	x	-	-	-	x	x	-	-	-
Lampsilis ovata	-	x	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-
Lampsilis orbiculata	-	x	-	-	x	x	-	-	x	-	-	x	-	x	x	-	-	-
No. Species	0	10	8	0	8	9	9	7	8	8	9	13	8	13	9	3	7	4
Total Collection Time (Min.)	8	40	36	5	52	30	40	46	32	58	76	40	94	114	60	10	30	9

TRM (% *)	519.5 (50%)	519.5 (75%)	519.2 (25%)	519.2 (75%)	518.5 (25%)	518.4 (75%)	518.2 (50%)	518.2 (75%)	518.0 (50%)	518.0 (75%)	517.6 (25%)	517.2 (75%)	517.0 (75%)	516.4 (25%)	516.4 (50%)	516.0 (75%)	514.4 (25%)	514.2 (50%)
Unioninae																		
Fusconaia subrotunda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias gigantea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amblema costata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula pustulosa	x	-	-	-	x	x	x	-	x	x	-	-	x	-	-	x	x	x
Quadrula metanevra	-	-	-	-	x	-	-	-	-	x	-	-	-	-	-	-	-	-
Tritigonia verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-
Cyclonaias tuberculata	-	-	x	-	-	x	x	-	x	x	-	x	x	-	-	x	x	x
Pleurobema cordatum	x	-	x	-	x	x	x	-	x	x	-	-	x	-	x	x	x	x
Elliptio crasidens	x	-	x	-	x	x	x	-	x	x	-	x	x	-	x	x	x	x
Elliptio dilatatus	-	-	x	-	-	-	-	-	x	-	-	-	-	-	x	-	-	-
Anodontinae																		
Anodonta grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anodonta corpulenta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilinae																		
Obliquaria reflexa	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	x	-	x
Cyprogenia irrorata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dromus dromas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plagiola lineolata	-	-	-	-	x	x	-	-	-	x	-	x	-	-	-	x	x	-
Leptodea fragilia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proptera alata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ligumia recta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis orbiculata	-	-	-	-	x	-	-	-	x	-	-	-	-	-	-	-	-	-
No. Species	3	0	3	0	6	5	4	0	7	6	0	3	4	0	2	8	6	5
Total Collection Time (Min.)	6	2	24	2	48	34	30	3	18	51	10	13	14	5	4	45	19	17

* Percent from left bank looking downstream
\- Denotes absence of species
x Denotes presence of species

Table 5

DISTRIBUTION OF MUSSELS IN UPPER NICKAJACK RESERVOIR
TRM 468.3-454.0

	*									
	(25%)	(75%)	(50%)	(50%)	(50%)	(25%)	(25%)	(25%)	(75%)	(25%)
TRM	468.3	468.0	465.5	465.2	465.0	461.3	459.5	455.4	455.2	454.0
Unioninae										
Megalonaias gigantea	-	x	-	-	-	-	-	-	-	-
Amblema costata	x	-	-	-	-	-	-	-	-	-
Quadrula pustulosa	-	x	-	x	-	-	-	-	-	-
Quadrula metanevra	-	x	-	x	x	-	-	-	-	-
Cyclonaias tuberculata	-	x	-	-	-	-	-	-	-	-
Pleurobema cordatum	-	x	x	x	x	-	-	-	-	-
Elliptio crassidens	x	x	-	x	-	-	-	-	-	-
Anodontinae										
Anodonta imbecillis	-	-	x	-	-	-	-	-	-	-
Anodonta corpulenta	-	x	-	-	-	-	-	-	-	-
Lampsilinae										
Obliquaria reflexa	-	x	-	-	-	-	-	-	-	-
Plagiola lineolata	-	x	-	-	-	-	-	-	-	-
Proptera alata	-	x	x	x	x	x	-	-	x	x
Ligumia recta latissima	-	x	-	-	-	-	-	-	-	-
No. Species	2	11	3	5	4	1	0	0	1	1
Time of Search (Min.)	10	30	22	20	18	10	12	6	12	10

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* Percent from left bank looking downstream
- Denotes absence of species
x Denotes presence of species

STERKIANA

John M. Bates
Editor

Box 402
Shawsville, Virginia 24162

Sally D. Dennis
Secretary, Treasurer

December 1, 1981

Dear Readers and former Subscribers;

This mailing of Sterkiana, Number 71, represents a part of our effort to reactivate this journal as a viable publication. Following Aurèle La Rocque's announcement that Sterkiana would cease publication with Number 70, several of us expressed our considerable concern and in subsequent conversations with Aurele, agreed to making an attempt at keeping the journal alive. After long delay and much frustration, Number 71 was printed. From limited distribution during the summer of 1981 (hand delivered copies) and the efforts of Arthur Clarke and others, word spread that the journal had resumed publication.

The response to date has been encouraging; many of you have called or written indicating your interest. This letter will hopefully answer some of the questions raised.

Editorial policy will remain essentially unchanged. While an editorial board has not been listed, many individuals have indicated a willingness to act as reviewers. The next issue will list some of these individuals.

Articles appearing in Sterkiana will continue to be abstracted for Biological Abstracts by Ralph Dexter; this has already been done for Number 71.

We presently anticipate the publication of at least two numbers per year running from 50 to 100 pages each, as available funds permit. It is hoped that subscriptions will cover publication costs which will obviate the "paid publication" mess. Your comments on this problem would be most welcome!

The costs of printing and distributing this issue more than doubled from our original estimate of $650.00 (1979 prices)! As pointed out by Aurèle in 1976, the "greed of the postal service" is alone enough to make one quit.

We are asking for $8.00/yr (minimum 2 numbers) for individual subscriptions and $12.00 for institutional subscriptions. Any profit that might accrue will be credited to your account.

With the mailing of No. 72 (Spring of '82) we will report on the relative success (failure?) of this venture.

Sincerely,

John M. Bates