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THE MUSSEL FAUNA OF THE CLINCH RIVER, TENNESSEE AND VIRGINIA

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ABSTRACT

Intensive studies of the Clinch River during the years 1972-1975 have documented the persistence of viable mussel populations at several localities within an approximate 35 kilometer reach of the river (Clinch River Miles 189-211). This restricted area represents approximately 7% of the original river habitat which supported mussels.

Of 33 sites intensively sampled, the shoals at Kyles Ford, Tennessee, and Speer's Ferry, Virginia, were the most productive, yielding 33 and 27 species respectively. This does not enumerate subspecies. While this rich fauna closely approximates that recorded by A. E. Ortmann in 1918, the total number of species recorded for the river has significantly decreased. Ortmann's records indicate 57 species; including subspecies this total becomes 71. The authors' records indicate 43 species, 5 of these being post-impoundment invaders of the lower river. Nineteen species thus appear to have been extirpated from the river; this represents one-third of the original species assemblage. It is of especial note that 12 of these extirpated species are of unique Cumberlandian origin; their continued survival in other rivers is tenuous.

The authors express concern for the continued survival of this unique faunal assemblage; adverse environmental impingements pose constant threats. Emphasis must be placed on the preservation of habitats that continue to support these unique mussel assemblages; the Clinch River is certainly one of the most important of these.

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INTRODUCTION

The Tennessee River drainage above Walden Gorge, defined as the Upper Tennessee River System, historically supported one of the richest freshwater molluscan faunas in the world. Habitat destruction, particularly in the Holston, French Broad, and Powell Rivers, has reduced this once rich fauna to a few scattered populations. Concern for the remaining fauna, particularly those species endemic to the Cumberland Plateau, prompted this study of the Upper Clinch River. The authors have defined the 'Upper Clinch River' as the reaches of this drainage above the direct influence of impoundment. This study thus deals primarily with the mussel fauna of the Clinch River from Clinch River Mile (CRM) 152 to approximately CRM-340. Information has been included in the limited fauna of the downstream impoundments ('Lower Clinch River').

This evaluation of the mussel fauna covers the time period from 1972 to 1975. A total of 33 sites were intensively examined yielding a total of 36 living species of freshwater mussels remaining in the Upper Clinch River. During this study, an attempt was made to examine all existing records for the Clinch River. These records have been incorporated into this report and form a basis for evaluating the magnitude and direction of ecological shift over the past 50 years.

While an invasion by the Asiatic Clam, *Corbicula* cf. *manilensis*, has taken place in the Clinch River within the past few years, that problem is not dealt with in this report. Additionally, data on gastropod distribution are not included here.

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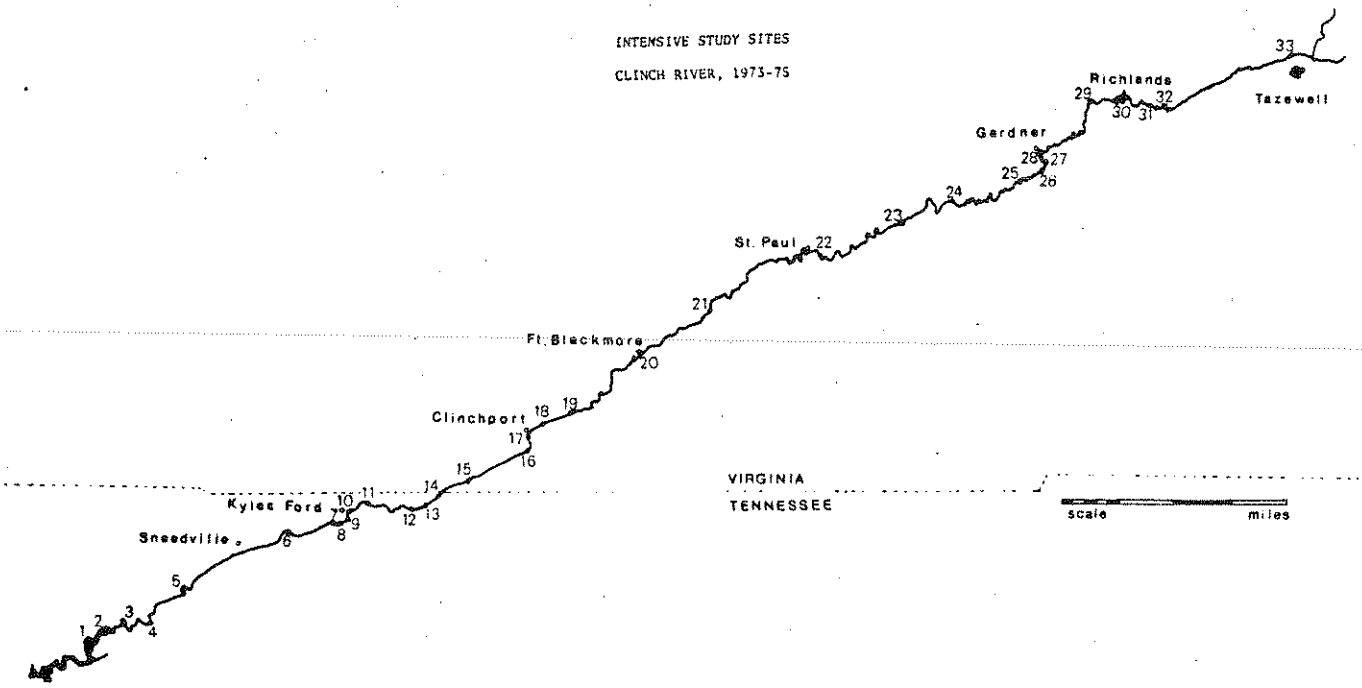
FIGURE 1

INTENSIVE STUDY SITES

CLINCH RIVER, 1973-75



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HISTORIC BACKGROUND

The Clinch, with the Powell, French Broad, and Holston Rivers, forms the headwaters of the Tennessee River System. The Clinch River flows through the Valley and Ridge Province of the Appalachian Region, an area characterized by fold mountains with formations of shale and limestone formed during the Paleozoic Era (Hunt, 1974).

This Upper Tennessee River System has developed a very diverse aquatic fauna, especially freshwater mussels. The fauna here contains species endemic to the Cumberland Plateau. This region includes the Clinch, Powell, Holston, Cumberland, French Broad, and Upper Duck Rivers. These Cumberlandian species are indicated on Tables II and V. Within the past 50 years, man's alteration of the environment (i. e. impoundment, pollution, siltation) has resulted in destruction of much of this fauna.

While certain mussel species have adapted to impoundment of the mainstream Tennessee River, the diversity of species within this system has been drastically reduced (Bates, 1962, 1975). The habitat necessary for support of this rich fauna has been reduced to a few isolated locations in the Upper Clinch, Powell, and Duck Rivers. The richest of these remnant populations is located within an approximate 35 kilometer reach of the Clinch River from Speer's Ferry, Virginia, to Kyles Ford, Tennessee.

While there is a general paucity of significant publications dealing with the mussels of this Upper Tennessee River region, there is one excellent account published by A. E. Ortmann in 1918. This work forms the basis for an evaluation of changes in this fauna which have occurred over approximately the past 50 years (Tables I and II). The work of C. C. Adams (1900) on snails of the genus *Io* provides invaluable background information for interpretation of habitat changes within this drainage. The works of Cahn (1936) and Hickman (1936) document the existence of that rich mussel fauna in the Lower Clinch River prior to the construction of Norris Dam. Cahn's records are summarized in Table III. A more recent report by Stansbery (1972) lists species from the Clinch River but, unfortunately, does not provide locality data or indication of live versus dead status of species reported. Other literature has been cited where pertinent.

In making nomenclatural judgments, the authors have relied on the classic work of Ortmann and Walker (1922). The authors feel strongly that the '50 year rule' of zoological nomenclature be adopted by malacologists, and have adhered to this principle in this report.

For a detailed history of nomenclatural synony-

TABLE I
MUSSEL RECORDS: CLINCH RIVER, ORTMANN, 1918 (Synonymized Names)

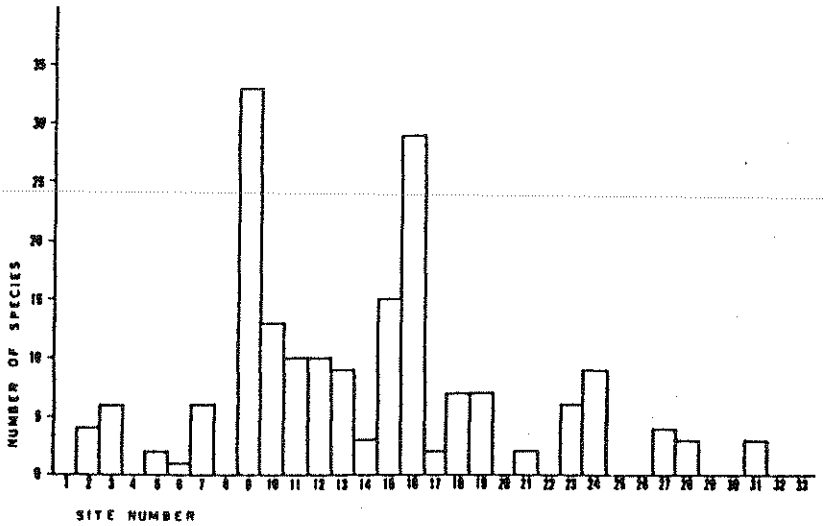
	Tazewell Co., Va.	Cedar Bluff Tazewell Co., Va.	Richland Tazewell Co., Va.	Raven Tazewell Co., Va.	Cleveland Russell Co., Va.	St. Paul Wise Co., Va.	Dungannon Scott Co., Va.	Clinchport Scott Co., Va.	Speer's Ferry Scott Co., Va.	Horton Ford Hancock Co., Tn.	Kyles Ford Hancock Co., Tn.	Sneedville * Hancock Co., Tn.	Lower Clinch **
Present Site No.	33	31	30	29	23	22	21	18	16	12	9		
Margaritanidae													
Cumberlandia monodonta	-	-	-	-	-	-	-	-	-	-	-	-	X
Unioninae													
Amblema costata	-	-	-	-	X	X	X	X	X	-	-	-	X
Cyclonaias tuberculata	-	-	-	-	-	-	-	X	X	X	-	-	X
Elliptio crassidens	-	-	-	-	-	-	-	X	-	-	-	-	X
Elliptio dilatatus	-	X	X	X	X	X	-	X	X	-	X	X	X
Fusconaia barnesiana	X	X	X	X	-	X	-	X	-	-	X	-	X
Fusconaia cuneolus	-	-	-	-	-	-	-	X	X	X	-	-	X
Fusconaia edgariana	-	-	-	-	X	X	-	X	X	-	-	X	X
Fusconaia pilaris	-	X	X	X	X	X	-	X	X	X	X	X	X
Lastena lata	-	-	-	-	X	X	-	X	-	-	-	-	X
Lexingtonia dolabelloides	-	X	X	X	X	X	-	X	-	-	-	-	X
Plethobasus cooperianus	-	-	-	-	-	-	-	-	-	-	-	-	X
Plethobasus cyphyus	-	-	-	-	-	-	-	X	-	-	-	X	X
Pleurobema cordatum	-	-	-	-	X	-	-	X	-	-	-	-	X
Pleurobema oviforme	-	X	X	X	X	X	-	X	X	-	X	-	X
Quadrula cylindrica	-	X	X	X	X	-	-	X	X	-	-	-	X
Quadrula intermedia	-	-	-	-	X	-	-	X	-	-	-	-	-
Quadrula pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	X
Anodontinae													
Alasmidonta marginata	-	-	X	-	X	X	-	X	X	-	-	-	X
Alasmidonta minor	X	X	X	-	X	X	-	-	X	-	-	-	-
Lasmigona costata	-	X	X	X	X	X	-	X	X	X	-	-	X
Lasmigona holstonia	X	X	X	-	-	-	-	-	-	-	-	-	-
Strophitus rugosus	-	X	X	X	X	X	-	-	-	-	-	-	X
Lampsilinae													
Actinonais carinata	-	-	-	-	-	X	-	X	-	X	-	-	X
Actinonais pectorosa	-	-	-	-	X	X	-	X	X	X	-	-	X
Carunculina moesta	-	-	-	-	-	-	-	-	X	-	-	-	-
Conradilla caelata	-	-	-	-	-	X	-	-	-	-	-	-	X
Cyprogenia irrorata	-	-	-	-	-	-	-	-	-	-	-	-	X
Dromus dromas	-	-	-	-	-	-	-	-	-	-	-	-	X
Dysnomia arcaeformis	-	-	-	-	-	-	-	-	-	-	-	-	X
Dysnomia capsaeformis	-	X	-	X	X	X	-	X	X	X	-	-	X
Dysnomia haysiana	-	-	-	X	-	-	-	-	-	-	-	-	X
Dysnomia brevidens	-	-	-	-	-	-	-	X	X	-	-	-	X
Dysnomia lenior	-	-	-	-	-	-	-	-	X	-	-	-	-
Dysnomia propinqua	-	-	-	-	-	-	-	-	-	-	-	-	X
Dysnomia stewardsoni	-	-	-	-	-	-	-	-	-	-	-	-	X
Dysnomia torulosa gubernaculum	-	-	-	-	-	-	X	X	-	-	X	-	X
Dysnomia triquetra	-	-	-	-	-	-	-	X	X	X	-	-	X
Lampsilis fasciola	-	X	X	X	X	X	-	X	-	-	-	-	X
Lampsilis orbiculata	-	-	-	-	-	-	-	-	-	-	-	-	X
Lampsilis ovata	-	X	X	X	X	X	-	X	X	-	-	-	X
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	X
Leptodea leptodon	-	-	-	-	-	-	-	-	-	-	-	-	X
Ligumia recta latissima	-	-	-	-	-	X	-	X	-	-	-	-	X
Medionidus conradicus	-	X	X	X	X	X	-	X	X	-	X	-	X
Micromya fabalis	-	-	-	-	X	X	-	-	X	-	-	-	X
Micromya nebulosa	X	X	X	X	X	X	-	X	X	-	-	-	-
Micromya perpurpurea	-	X	X	X	X	X	-	X	X	-	-	-	-
Micromya trabalis	-	-	-	-	-	-	-	-	X	-	-	-	-
Micromya vanuxemensis	-	-	-	-	-	-	-	-	X	-	-	-	X
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	X
Obovaria retusa	-	-	-	-	-	-	-	-	-	-	-	-	X
Plagiola lineolata	-	-	-	-	-	-	-	-	-	-	-	-	X
Proptera alata	-	-	-	-	-	-	-	X	-	-	-	-	-
Ptychobranchus fasciolaris	-	-	-	-	X	X	-	X	X	-	-	-	X
Ptychobranchus subtentum	-	X	X	X	X	X	-	X	-	-	X	X	X
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-	-	X
Totals	4	17	17	16	24	25	2	32	18	8	7	7	50

Total Number of Species--All Sites: 57

* Not sampled due to lack of suitable habitat.

** Stations now impounded by Norris Reservoir.

Figure II. Numbers of species per site 1973-75



mies, the works of Binney (1863), Call (1898), and Simpson (1900) are recommended. An excellent bibliography of the zoology of the Tennessee Valley Region has been prepared by Shoup (1974).

METHODS AND MATERIALS

Preliminary sampling for mussels in the Clinch River was begun in 1972, with additional sites sampled during 1973, 1974, and 1975. Of the many sites visited, thirty-three were selected for intensive study. When feasible, sampling was done during periods of low flow. Since schedules occasionally dictated sampling under adverse conditions, attempts were made to visit all sites more than once.

Sampling was carried out employing techniques developed and proven effective during earlier investigations by Bates, Dennis, and van der Schalie. Collecting methods included handpicking, raking, use of a Needham Scraper, exployment of SCUBA, and examination of muskrat middens.

Shells collected were cleaned, labeled, and placed in cloth bags for storage. Representative living specimens were relaxed using propylene phenoxytol, fixed in Bouin's Solution or formelin, and stored in 70% ethyl alcohol for future anatomical and histological study. Selected soft parts have been frozen and retained for future chemical analyses. All collections are deposited at the Forestry, Fisheries, and Wildlife Development unit, Tennessee Valley Authority, Norris, Tennessee. Most specimens were returned to the river after identification.

All records are based upon the collection of living and/or freshly dead material unless otherwise noted. 'Freshly dead' is defined as a specimen having the hinge ligament intact, with the nacre exhibiting some luster, indicating that the animal had recently died.

DESCRIPTION OF AREA SAMPLED

The Clinch River is a high gradient stream characterized by a series of shoals and pools from its headwaters near Tazewell, Virginia, to the upper reaches of Norris Lake, a distance of approximately 306 km (190 mi). The substrate consists mainly of rocks and gravel contained between outcrops of bedrock. The flow varies from a minimum of approximately 250 cfs in the fall to a maximum of approximately 35,000 cfs in the winter. Annual temperatures range from 2° to 26° C. (Water Resources Data for Tennessee, U.S. Department of the Interior, Geological Survey). The apparent high turbidity during most of the year (average 20 JTU), produces little deposition of silt in the shoal areas except at times of extreme low flow. Pool areas, however, contain considerable amounts of mud and sand. The uppermost sample site was at Tazewell, Virginia, the lowest in the headwaters of Norris Lake. The term 'shoal' is used to designate an area of shallow water over a uniform substrate, while 'riffle' refers to a shallow area of turbulence characterized by the presence of large rocks or bedrock outcrops. Designation of small, medium and large river faunal assemblages is based on the works of Ortmann, van der Schalie, and personal observation.

RESULTS

Sample sites have been separated into three categories: upper, middle, and lower. Sample sites are numbered consecutively from lowermost station to headwaters. Table IV lists the sites and the map (Figure 1) locates them. The upper sites (17–33) represent an area which has been seriously influenced by pollution. The middle sites (9–16) represent the most productive area of the river. The lower sites (1–8) support mussels, but in less abundance than the middle sites. The distribution data which follow are summarized in Table V.

Upper Sites (17–33)

The headwaters of the Clinch River, from Blackford, Virginia to Tazewell, Virginia (sites 25–33) have been influenced by pollution from many sources including siltation from construction, and wastes from the developed areas of Tazewell, Cedar Bluffs, Richlands, and Raven. Considerable siltation was evident in this stretch of the river when collected, and mussels were few. One live mussel, *Micromya nebulosa*, was found at Cedar Bluff (site 31) with relics of a few additional species. Three species were recorded from Gardners Mill (site 28) and four from below Gardner (site 27). While some relic shells were present, no live or freshly dead mussels were found at any of the remaining six sites (25, 26, 29, 30, 32, 33). This headwater fauna included a total of six species, all of which can be considered small stream forms. These were *Fusconaia barnesiana* and its form *bigsbyensis*, *Lampsilis fasciola*, *Medionidus conradicus*, *Micromya nebulosa*, and *Ptychobranchus fasciolaris*.

Approximately seven miles above Cleveland, at Nash's Ford (site 24), eight species were taken. Midden material was abundant at these sites but live mussels were rare. Several species characteristic of medium sized streams (i. e. *Actinonaias carinata*, *A. pectorosa*, *Lampsilis ovata*) increased in abundance with stream size from Cleveland to above Clinchport, Virginia (sites 20–22) where most of the fauna was destroyed as a result of two industrial spills which occurred on June 10, 1967 (fly ash), and June 19, 1970 (acid) at Carbo, Virginia (Cairns, Crossman, *et al.*, 1970, 1971), mussel species not reported. Silt accumulation was noted in this area, and only two mussel species were recorded.

Just above Clinchport, (sites 18, 19), mussels increased in abundance and numbers of species present. These two sites produced a combined total of 13 species. Immediately below Clinchport (site 17), mussels were scarce and only two species were collected.

Middle Sites (9–16)

The highest recorded concentrations of mussels were found in the stretch of river from Speers Ferry, Virginia (site 16) to Kyles Ford, Tennessee (site 9), a distance of approximately 35 kilometers (22 miles).

At Speers Ferry, there is a long shoal area (approximately 200 m), terminating at a riffle area formed by bedrock outcrops. Depth at low water varies from one-third to one meter. Mussels were abundant in numbers and diversity within the shoal area and at the riffle. This is one of the richest mussel habitats in the river, second only to Kyles Ford in population density. Twenty-nine species were taken at this site.

While the area between Speers Ferry and Kyles Ford supports many mussels, no shoal areas were found within this stretch of river (sites 11–15) which supported the abundance of mussels found at sites 9 and 16. The river in this area was generally slow moving and deep, broken by occasional bedrock outcrops and short shoal areas. There were no extensive productive shoals. Most records for these sites are based on freshly dead shell material taken from muskrat middens. Site 11 was a shoal area similar to Speers Ferry. Shells were abundant in middens along the banks but live specimens were scarce.

Site 10 is at State Highway 70 bridge crossing at Kyles Ford, Tennessee. Due to deep water (2–4 m), this site was collected employing SCUBA. The species found here are those characteristic of medium to large river faunas (i. e., *Proptera alata*, *Amblema costata*). Characteristic riffle species (i. e., representatives of *Dysnomia* and *Micromya*) were absent from this area.

Site 9, downstream from the bridge at Kyles Ford, is undoubtedly the area of greatest mussel density in this river and probably the entire Tennessee Valley. The river at this station is a series of long shoal areas interspersed with riffles and shallow pools (1–2 m deep). At low water, some bedrock ledges are exposed. Mussels were abundant in the gravel substrate of the shoals and pools, and wedged between rocks along the ledges. Mussel distribution here was limited to the north side of the river, the south bank being characterized by shifting sand and gravel substrate.

Lower Sites (1–8)

Several downstream areas (sites 2, 3, 5, 6, and 7) are similar in appearance to the shoal at Kyles Ford but support only limited numbers of mussels. Mussels found in this stretch of river include species characteristic of medium to large rivers. The most abundant species was *Actinonaias carinata*. Notably absent were representatives of the genera *Dysnomia* and *Micromya*. The lowermost site, at the bridge crossing of U. S. Highway 25E, is in the headwaters of Norris Lake and is influenced by changing lake levels. When sampled the water was slow moving, with a substrate composed mainly of bedrock; only relic shells were found.

DISCUSSION OF SPECIES

Of the numerous mussel species historically recorded from the Clinch River, many no longer occur in the drainage; others have been included in synonymy (Tables II and III). The authors' distribution records are presented in Table V.

TABLE II

MUSSEL RECORDS - ORTMANN, 1918
(Synonyms Indicated)

Margaritanidae		
Cumberlandia monodonta	=	Cumberlandia monodonta
Unionidae		
Unioninae		
* Amblema plicata costata	=	Amblema costata
* Rotundaria tuberculata	=	Cyclonaias tuberculata
* Elliptio niger	=	Elliptio crassidens
* Elliptio dilatatus	=	Elliptio dilatatus
*Fusconaia barnesiana * Fusconaia barnesiana bigbyensis Fusconaia barnesiana tumescens	=	Fusconaia barnesiana
*Fusconaia cuneolus Fusconaia cuneolus appressa	=	Fusconaia cuneolus
*Fusconaia cor *Fusconaia cor analoga	=	Fusconaia edgariana
*Fusconaia pilaris * Fusconaia pilaris bursa-pastoris * Fusconaia pilaris lesueriana	=	Fusconaia pilaris
* Lastena lata	=	Lastena lata
*Lexingtonia dolabelloides * Lexingtonia dolabelloides conradi	=	Lexingtonia dolabelloides
Plethobasus cooperianus	=	Plethobasus cooperianus
* Plethobasus cyphyus	=	Plethobasus cyphyus
Pleurobema obliquum * Pleurobema obliquum coccineum Pleurobema obliquum cordatum Pleurobema obliquum catillus Pleurobema obliquum rubrum	=	Pleurobema cordatum
*Pleurobema oviforme * Pleurobema oviforme argenteum Pleurobema oviforme holstonense	=	Pleurobema oviforme
* Quadrula cylindrica * Quadrula cylindrica strigillata	=	Quadrula cylindrica
*Quadrula intermedia	=	Quadrula intermedia
Quadrula pustulosa	=	Quadrula pustulosa

TABLE II (cont.)
MUSSEL RECORDS - ORTMANN, 1918
(Synonyms Indicated)

Anodontinae		
*Alasmidonta marginata	=	Alasmidonta marginata
*Alasmidonta minor	=	Alasmidonta minor
*Lasmigona badia	=	Lasmigona holstonia
*Lasmigona costata	=	Lasmigona costata
*Strophitus edentulus	=	Strophitus rugosus
Lampsilinae		
*Nephronoias ligamentina gibba	=	Actinonaias carinata gibba
*Nephronoias pectorosa	=	Actinonaias pectorosa
*Toxolasma lividum	=	Carunculina moesta
*Lemiox rimosus	=	Conradilla caelata
Cyprogenia stegaria	=	Cyprogenia irrorata
*Dromus dromas caperatus	=	Dromus dromas
*Truncilla arcaeformis	=	Dysnomia arcaeformis
*Truncilla capsaeformis	=	Dysnomia capsaeformis
*Truncilla haysiana	=	Dysnomia haysiana
*Truncilla interrupta	=	Dysnomia brevidens
*Truncilla lenior	=	Dysnomia lenior
*Truncilla propinqua	=	Dysnomia propinqua
*Truncilla stewardsoni	=	Dysnomia stewardsoni
*Truncilla torulosa gubernaculum	=	Dysnomia torulosa gubernaculum
*Truncilla triquetra	=	Dysnomia triquetra
*Lampsilis fasciola	=	Lampsilis fasciola
Lampsilis orbiculata	=	Lampsilis orbiculata
*Lampsilis ovata *Lampsilis ovata ventricosa	=	Lampsilis ovata
*Eurynia recta	=	Ligumia recta latissima
*Medionidus plateolus	=	Medionidus conradicus
*Eurynia fabalis	=	Micromya fabalis
*Eurynia nebulosa	=	Micromya nebulosa
*Eurynia perpurpurea	=	Micromya perpurpurea
*Eurynia trabalis	=	Micromya trabalis
*Eurynia vanuxemensis	=	Micromya vanuxemensis
Paraptera fragilis	=	Leptodea fragilis
Paraptera leptodon	=	Leptodea leptodon
Obliquaria reflexa	=	Obliquaria reflexa
Obovaria retusa	=	Obovaria retusa
Plagiola lineolata	=	Plagiola lineolata
*Proptera alata	=	Proptera alata
*Ellipsaria fasciolaris	=	Ptychobranchus fasciolaris
*Ellipsaria subtenta	=	Ptychobranchus subtentum
Amygdalonias truncata	=	Truncilla truncata

~~*Cumberlandian Species~~; forms not designated separately.

* Collected in Virginia

Following is a discussion of species recorded from the Clinch River, arranged by genera. Within the treatment of each genus is included a discussion of current taxonomic status and distributional information. For simplicity, species have been arranged alphabetically within each subfamily; this does not follow phylogenetic order used by some authors; however, the authors feel this arrangement will facilitate use of information presented here. A discussion of common names and their use is presented in a later section of this report.

FAMILY MARGARITANIDAE, Ortmann, 1911

Cumberlandia Ortmann 1912

This monotypic genus, represented by *Cumberlandia monodonta* (Say, 1829) was found at several locations in the Clinch River, and was abundant at Kyles Ford, Tennessee (site 9). While this species is generally considered rare, recent records from the Tennessee River and other rivers of the Interior Basin indicate that it continues to be widespread and occasionally locally abundant.

FAMILY UNIONIDAE, Ortmann, 1911

Subfamily UNIONINAE, Ortmann, 1910

Amblema Rafinesque, 1819

Amblema costata Raf., 1820, is a typical Ohioan form which is presently widely distributed through the Tennessee River system. Its present distribution in the Clinch River is from Cleveland, Virginia, downstream to Speers Ferry, Virginia, where it occurs in fair abundance. According to Ortmann's records (1918), it represented an important component of the fauna of the Lower Clinch River prior to impoundment. The authors question the listing of *A. plicata plicata* (Say, 1817) by Stansbery (1972) from the Clinch River. The type locality of *A. plicata* is Lake Erie and the use of *plicata* has been properly restricted to description of the lake form of this species just as *peruviana* should be restricted to use for the greatly inflated large river form (Ortmann and Walker, 1922). The development of characteristic lake forms is well summarized by van der Schalie (1941). Stansbery's records of *A. plicata* should therefore be synonymized with *A. costata*, reported in the present survey.

Cyclonaias Pilsbry, 1922

This monotypic genus is well represented throughout the Tennessee System and is locally abundant at several sites in the Clinch River. All collections cited record this species as *Cyclonaias tuberculata* (Raf., 1820). Ortmann's 1918 listing records this species as *Rotundaria tuberculata* (Raf., 1820); however, the nomenclatural revision of Ortmann and Walker (1922) resulted in the designation of the genus *Cyclonaias* which is the present designation.

Elliptio Rafinesque, 1819

This genus, so abundantly represented in East Coast drainages, is represented in the Tennessee System by two wide ranging species, *Elliptio crassidens* (Lamarck, 1819) and *E. dilatatus* (Raf. 1820). Both of these species remain common and sometimes locally abundant throughout the Interior Basin. *Elliptio dilatatus* is well represented in collections throughout the Clinch River; *E. crassidens* is found at several of the lower stations.

Fusconaia (Simpson, 1900)

The genus *Fusconaia* presents many difficult systematic and taxonomic problems, particularly in attempting to deal with headwater forms. While as many as 20 different taxonomic names could be applied to the *Fusconaias* of the Clinch River, for the purpose of this paper prime importance will be given the identification of major species complexes that remain extant. Discussions of problems with this genus can be found in Simpson (1900, 1914) and Ortmann (1918, 1925), Ortmann and Walker (1922).

Four major species complexes are considered to be indigenous to the Clinch River; two of these clearly remain extant while the others are of uncertain status.

The group of *F. cuneolus* (Lea, 1840) is not represented in the present collections. Three years of intensive collecting have failed to produce specimens that the authors feel clearly belong to this complex. Ortmann (1918) records this form from several localities in the Clinch River; Cahn (1936) records it from below Norris Dam. Cahn's list of species includes *F. tuscumbiensis* (Lea, 1871) which is a Clinch River form of *F. cuneolus* (Ortmann, 1918) and should not be listed as a separate species.

Present collections contain large numbers of individuals representing the *F. barnesiana* (Lea, 1838) complex and substantiates the continued existence of both the typical *barnesiana* and *bigbyensis* (Lea, 1841) forms of this species.

The complex characterized by *Fusconaia edgariana* (Lea, 1840), is well represented in present collections. The authors have included in this designation *F. cor* (Conrad, 1834) and *F. cor analoga* (Ortmann, 1918).

The complex of *F. subrotunda* (Lea, 1831) presents some difficulty. The specific name *F. pilaris* (Lea, 1840) has been used to describe the Upper Tennessee drainage analog of the typical Ohio River *F. subrotunda*. Additionally the subspecific names *lesueuriana* (Lea, 1840) and *bursa-pastoris* (Wright, 1896) have been added to *F. pilaris*. The rather indiscriminate use of various combinations of these taxonomic designations has only led to confusion. Records of Ortmann and Cahn indicate the early existence of *F. pilaris* forms in the Clinch River; the authors' collections indicate no recent records.

Fusconaia edgariana, *F. barnesiana*, and *F. bar-*

nesiana bigbyensis clearly remain viable members of the mussel fauna of a portion of the Clinch River; continued existence of other forms of *Fusconaia* is questionable.

Lastena Rafinesque, 1820

This rare monotypic species *Lastena lata* (Raf. 1820) was taken from three sites (3, 9, 16) during the course of this study. This species was reported as rare by Ortmann (1918) and indeed remains very rare at the present time. It appears that the only recent live records of this species are those reported here from the Clinch River.

Lexingtonia Ortmann, 1914

Extensive collecting of the Clinch River has failed to produce any specimen which can be definitely assigned to this genus. Ortmann (1918) records *Lexingtonia dolabelloides* (Lea, 1840) from the Lower Clinch River 'up to Agee, Campbell Co. where it intergrades with *conradi*.' This area of the Clinch River has been inundated by Norris Lake and no longer supports mussel populations.

Collections taken from the Upper Clinch contain many individuals that in shell morphology approach *L. dolabelloides conradi* (Vanatta, 1915). The authors are hesitant to assign these specimens to this taxon without adequate soft parts for study; it must be borne in mind that when Ortmann erected the genus *Lexingtonia* he did so on the basis of his studies of soft-part morphology and particularly on morphology of the marsupium and placentae. Gravid material is thus necessary for definite generic determination. Ortmann and others clearly recognized the close systematic affinities between *Lexingtonia* and the group of *Pleurobema oviforme*.

Specimens in recent collections which approach the *conradi* form of *Lexingtonia* have been tentatively assigned to the group of *P. oviforme*.

Plethobasus Simpson, 1900

This genus is presently represented in the Clinch River by *Plethobasus cyphyus* (Raf., 1820); it is present in recent collections from sites 9 and 16. This species remains widespread throughout the Interior Basin.

The form of *P. cyphyus compertus* (Frierson, 1911) has been described from the Clinch and Holston Rivers which represent the probable type locality for this form. The authors have not attempted to separate this form from *P. cyphyus*.

While Ortmann (1918) lists *P. cooperianus* (Lea, 1834) from the Lower Clinch River, there is no recent evidence for considering this species as a member of the Clinch River assemblage. While this species has been occasionally taken by Bates and Isom from locations in the Lower Tennessee River, it is undoubtedly a species of rare occurrence.

Pleurobema. Rafinesque, 1818

The authors recognize two species complexes representing this genus in the Clinch River, that of *Pleurobema cordatum* (Raf., 1820) and *P. oviforme* (Conrad, 1834). Both are represented in present collections but must be considered rare in the Clinch River.

Ortmann (1918) summarized the problems relating to the *P. cordatum (obliquum)* comp'ex as follows:

> 'This consists of a group of forms very variable in shape, which has been divided into a number of 'species.' In the Upper Tennessee region several of the latter are found, but they all intergrade with each other, and there is very little indication of their separation into geographical or ecological races. Mostly, the various forms are found associated, so that they are hardly more than individual variations.'

The group of *P. cordatum* is taken to include several forms associated with the complex of *P. obliquum* (Lamarck, 1819) including for the Clinch River: *P. coccineum* (Conrad, 1836), *P. pyramidatum* (Lea, 1831), *P. plenum* (Lea, 1840), *P. catillus* (Conrad, 1836), and *P. rubrum* (Raf., 1820). Specimens which were collected during this survey could be ascribed to all of the above mentioned forms. Ortmann (1918) records *P. cordatum, coccineum, catillus,* and *rubrum,* while Cahn (1936) records *P. cordatum, pyramidatum,* and *plenum,* and Stansbery (1972) records *P. coccineum, pyramidatum,* and *plenum.* For the present the authors feel it is sufficient to indicate that this complex remains extant in the middle section of the Clinch River.

The species complex of *Pleurobema oviforme* is represented only in collections from Speers Ferry, Virginia. While the forms *P. clinchensis* (Lea, 1867), *P. ravenelianus* (Lea, 1834), and *P. holstonense* (Lea, 1840) have been described from the Clinch River, no attempt has been made to separate these forms from *P. oviforme s. s.* Ortmann (1918) found *P. oviforme* widely distributed in the Clinch (see Table II) thus indicating considerable restriction in its range and concern for its continued existence. This species complex probably represents a southern analog of the *P. clava* group of the Upper Ohio drainage.

Quadrula Rafinesque, 1820

Present collections indicate the continued existence of *Quadrula cylindrica* (Say, 1817) and *Q. pustulosa* (Lea, 1831) in the Clinch River.

Q. pustulosa was taken from Kyles Ford and Horton Ford, Tennessee, and Speers Ferry, Virginia. It remains widespread throughout the Tennessee River System although apparently absent from the Lower Clinch. *Quadrula cylindrica* (Say, 1817) was collected from Kyles Ford and Swing Bridge (site 15); Ortmann's records indicate a wider original distribution. The authors do not recognize *Q. cylindrica*

strigillata (Wright, 1898) as a distinct species but rather as a headwater form of the typical *cylindrica*. Present collections failed to yield recent specimens of *Quadrula intermedia* (Conrad, 1836) in the Clinch River. This species, which is listed as endangered *(Fed. Register,* June 14, 1976), was reported from the Middle and Upper Clinch by Ortmann (1918).

The systematic status of *Q. sparsa* is poorly understood. While it is clear that the *Q. sparsa* of Lea (1841) is in the group of *Q. metanevra* (Simpson, 1914), it also appears to have close affinities with *Q. intermedia* (Ortmann, 1918). The authors favor considering *Q. sparsa* as an ecomorph of *Q. metanevra*. After examination of recent collections from the Cumberland River and headwaters of the Tennessee River the authors have reservations as to the proven systematic affinities of this taxon. While it does not appear to exhibit a clinal relationship with either *Q. metanevra* or *Q. intermedia*, its close affinities with the group of *Q. metanevra* are clear. This form has been taken in recent TVA collections with both *Q. metanevra* (Cumberland River) and *Q. intermedia* (Powell River). As in so many instances, present judgments must be based on the very limited availability of specimens for study. While Cahn (1936) reports this species from the Lower Clinch, Ortmann (1918) does not recognize this form and present collections do not indicate its existence in this river. Stansbery (1972) lists this species from the Clinch River but without documentation. Subsequently (1977) he reports one specimen found in 1963 and states 'repeated efforts since 1963 to obtain evidence of the continued existence of this species in the Clinch River have failed.' The listing of the species as endangered in the Clinch River *(Fed. Reg.,* June 14, 1976) is thus questionable. Recent TVA surveys have revealed only one significant remaining population of this form in the Powell River (Dennis, unpublished, 1976).

SUBFAMILY ANODONTINAE Ortmann, 1910

Alasmidonta Say, 1818

Two species of this genus are reported from the Clinch River by Ortmann (1918), *Alasmidonta minor* (Lea, 1845) and *A. marginata* (Say, 1819). Present collections indicate continued existence of *A. marginata* but complete absence of *A. minor*. *Alasmidonta marginata* remains widespread throughout the Interior Basin; while generally most abundant in small to medium sized streams, it does occur in many large rivers. Efforts to find *A. minor* in the Clinch River above the Tennessee-Virginia border, where it was reported by Ortmann (1918), proved futile. This characteristic small stream form should be considered a species analog of *A. calceolus* (Simpson, 1914) and may continue to exist in some small tributary streams. Stansbery's listing (1972) of *A. viridis* (Raf., 1820) has apparently resulted from synonymizing Ortmann's *A. minor* with *A. viridis*.

Lasmigona Rafinesque, 1831

Historically two species of *Lasmigona* are known from the Clinch River, *L. costata* (Raf., 1820) and *L. holstonia* (Lea, 1838); Ortmann, 1918). Results of this survey would indicate the continued widespread distribution of *L. costata* in the Clinch River; it additionally continues to be common throughout the Interior Basin. Intensive efforts failed to produce a single specimen of *L. holstonia*. Ortmann (1918) reporting this species as *L. badia*, recorded it as widespread throughout small streams in the Tennessee headwaters. Intensive collecting of the North Fork Holston River (Dennis, unpublished, 1976) has failed to produce living specimens of this species. It may still occur in some areas of the Holston River, but no recent records are known. While Stansbery (1972) records this species from the Clinch River, his record does not give specific locality data or indicate if the specimen was living. It is questionable that this species remains extant in this drainage.

Pegias Simpson, 1900

Pegias fabula (Lea, 1836), the type and only species of the genus, was not reported by Ortmann (1918) from the Clinch River and is not represented in present collections. This rare, small stream form has not been taken live in any recent collections known to the authors.

Strophitus (Raf., 1820)

Ortmann (1918) reported *Strophitus edentulus* (Say, 1828) from several localities in the Clinch River (Table II). The authors have chosen to retain the specific taxonomic designation of *S. rugosus* (Swainson, 1822) for the forms of this genus found in the Tennessee River System (as well as the Great Interior Basin). Stansbery (1972) has listed *S. undulatum shefferianus* (Lea, 1852) as a Cumberlandian form from the Clinch River. Present collections produced one freshly dead shell from this river indicating that it is present, but rare. The authors prefer that this form be given the specific name *S. rugosus*.

SUBFAMILY LAMPSILINAE Ortmann, 1910

Actinonaias Fischer and Crosse, 1893

This genus was taken in large numbers from most collecting sites in the Clinch River. *A. carinata* (Barnes, 1823) along with the form *A. carinata gibba* (Simpson, 1900) is presently the most common large species in the Clinch River. This species remains common and widespread throughout the Interior Basin. While in some areas there is gradation between *carinata* and the form *gibba* (*i. e.* Cumberland River), most of the specimens collected in the Clinch appear to be the *gibba* form.

Actinonaias pectorosa (Conrad, 1834), the dis-

TABLE III

MUSSEL RECORDS - A. R. CAHN, 1936

(Synonyms Indicated)

Margaritanidae:		
Margaritana monodonata	=	Cumberlandia monodonta
Unionidae:		
Amblema costata	=	Amblema costata
Cyclonaias tuberculata	=	Cyclonaias tuberculata
Elliptio crassidens	=	Elliptio crassidens
Elliptio dilatatus Elliptio dilatatus subgibbosus	=	Elliptio dilatatus
Fusconaia tuscumbensis Fusconaia cuneolus	=	Fusconaia cuneolus
Fusconaia edgarianum	=	Fusconaia edgariana
Fusconaia pilaris lesueriana	=	Fusconaia pilaris
Pleurobema cordatum Pleurobema cordatum pyramidatum Pleurobema plenum	=	Pleurobema cordatum
Quadrula cylindrica	=	Quadrula cylindrica
Quadrula metanevra	=	Quadrula metanevra
Quadrula pustulosa	=	Quadrula pustulosa
Anodontinae:		
Alasmidonta holstonia	=	Lasmigona Alasmidonta holstonia
Alasmidonta marginata	=	Alasmidonta marginata
Lasmigona costata	=	Lasmigona costata
Lampsilinae:		
Actinonaias carinata	=	Actinonaias carinata
Carunculina glans Carunculina parva	=	Carunculina moesta
Cyprogenia alberti Cyprogenia irrorata	=	Cyprogenia irrorata
Dromus dromas caperatus	=	Dromus dromas
Dysnomia brevidens	=	Dysnomia brevidens
Dysnomia capsaeformis	=	Dysnomia capsaeformis
Dysnomia florentina	=	Dysnomia florentina
Dysnomia haysiana	=	Dysnomia haysiana
Dysnomia triquetra	=	Dysnomia triquetra
Lampsilis fasciola	=	Lampsilis fasciola
Lampsilis orbiculata	=	Lampsilis orbiculata
Lampsilis ovata Lampsilis ovata ventricosa	=	Lampsilis ovata
Ligumia recta latissima	=	Ligumia recta latissima
Medionidus conradicus	=	Medionidus conradicus
Ligumia iris Micromya nebulosa	=	Micromya nebulosa
Obliquaria reflexa	=	Obliquaria reflexa
Proptera alata megoptera	=	Proptera alata
Ptychobranchus phaseolus	=	Ptychobranchus fasciolaris
Truncilla truncata	=	Truncilla truncata

tinctive Cumberlandian representative of this genus, remains as a common member of the Clinch faunal assemblage. As with all Cumberlandian species, its range has in recent years been progressively restricted.

Carunculina Baker, 1898

No living specimens representing this genus were taken during this survey. Ortmann (1918) records *Carunculina (Toxolasma) lividum* (Raf., 1831) from the Clinch River. As later pointed out by Ortmann and Walker (1922) the type of this species from the Rock Castle River, Kentucky, is not recognizable and should be discarded in favor of *C. moesta* (Lea, 1841). Further, Ortmann and Walker point out that the generic name *Toxolasma* must also be discarded.

Examination of material collected by Bates, Isom, Gooch, and Neill clearly establishes the scattered but often locally abundant distribution of *C. moesta* and *C. parva* (Barnes, 1823) within the main stem Tennessee system. *Carunculina parva* as reported by Bates (1962) has become a locally important member of the post-impoundment overbanks molluscan assemblage (see also Bates, 1975).

The Interior Basin analog of *C. moesta*, *C. glans* (Lea, 1841), has not been taken in its typical form from the Tennessee River system. Its occurrence in the lower stretches of the Tennessee would, however, not be surprising. The exact systematic relationship of *C. glans* and *C. moesta* is not presently clear and needs further critical investigation.

One easily could mistake small specimens of *Micromya (Villosa) vanuxemensis* (Lea, 1838) for *C. moesta* or possibly *C. glans* (see Ortmann and Walker, 1922). This would be particularly true if one did not have female soft parts available for study, since the occurrence of caruncles on the inner mantle margins of the female is perhaps the most distinctive characteristic of the genus.

Conradilla Ortmann, 1921

Conradilla caelata (Conrad, 1834), the species monotype of this genus, is presently rare in the Clinch River. Collecting efforts yielded only one freshly dead shell from Kyles Ford.

This species which historically had a fairly wide distribution within the Tennessee-Cumberland system now appears to be severely restricted in its distribution; one location in the Duck River, limited numbers in the Powell River, and possibly a few individuals in the Clinch River. It is undoubtedly deserving of its endangered status.

The generic designation *Lemiox* has recently been resurrected for this monotypic genus (Burch, 1975). Ortmann and Walker (1922), with Henry A. Pilsbry as arbitrator, resolved the *Unio (Lemiox) rimosus* (Raf., 1831) - *U. caelata* (Conrad, 1834) controversy. In that *U. rimosus* was deemed 'not identifiable' the specific name *rimosus* was discarded and with it the generic designation *Lemiox*. The authors thus accept *Conradilla caelata* (Conrad, 1834) as the only proper designation for this taxon.

Cyprogenia Agassiz, 1852

This genus is presently represented in the Clinch River by *C. irrorata* (Lea, 1828). Ortmann (1918) referred to this form as *C. stegaria* (Raf., 1820). Subsequently, Ortmann and Walker (1922) determined the validity of using the specific designation *irrorata* and thus the present name stands. All collections cited record this species. Cahn (1936) additionally lists *C. aberti* (Conrad, 1850) from the Lower Clinch. As the distribution of *C. aberti* appears to be restricted to drainages west of the Tennessee River, this identification must be considered in error. It is likely that the specimens in question were *C. irrorata*. While not occurring in large numbers, this species has consistently been present in collections from Speers Ferry, Virginia, and Kyles Ford, Tennessee.

Dromus (Simpson, 1900)

Dromus dromas (Lea, 1834) is represented in the Clinch River by a small population at Kyles Ford, Tennessee; a few fresh shells were additionally taken at site 13. At one time this species was very abundant in the mainstream Tennessee River as evidenced from Indian midden collections (Bates, personal observation; Warren, 1975). The authors presently know of only one other viable population of this species occurring in the Powell River. *Dromus dromas* and the form *D. dromas caperatus* (Lea, 1845) with type locality designated as the Clinch River, must be considered endangered.

Dysnomia Agassiz, 1852

Numerous nomenclatural difficulties have been associated with this genus. Ortmann and Walker (1922) clearly established *Dysnomia* as the proper generic designation, thus exempting the use of *Truncilla* or *Epioblasma*. A recent discussion of the *Dysnomia* versus *Epioblasma* problem has been published by van der Schalie (1973).

This large genus, containing more than twenty-five described species, is known from historic records to have been widespread and well represented throughout the Tennessee River System. Since many species of this genus are characteristic of shallow water, riffle habitats, destruction of these habitats has resulted in extinction of some members of this genus. Species recorded by Ortmann (1918) which the authors now believe may be extinct include: *D. arcaeformis* (Lea, 1831), *D. haysiana* (Lea, 1834), *D. lenior* (Lea, 1843), *D. propinqua* (Lea, 1857), and *D. stewardsoni* (Lea, 1852). Thus, five of the nine species recorded by Ortmann from the Clinch River have probably been extirpated from this drainage.

Present collections indicate the continued sur-

SAMPLE SITES - CLINCH RIVER
1972 - 1975

Site Number	Description	
1	U.S. Highway 25E Bridge	CRM 152.0
2	Below Grissom Island	CRM 154.2
3	Above Grissom Island	CRM 160.0
4	At Big War Creek	CRM 164.4
5	Lawson Mill	CRM 170.6
6	Brooks Island, lower end	CRM 183.0
7	Webb Island, lower end	CRM 187.3
8	Above Webb Island	CRM 188.0
9	Kyles Ford, above Tenn. St. Hwy. 70 bridge	CRM 189.5
10	Kyles Ford, under Tenn. St. Hwy. 70 bridge	CRM 189.8
11	Island at Wallens Bend	CRM 192.6
12	Horton Ford	CRM 199.0
13	Above Horton Ford	CRM 200.2
14	New bridge near Tenn.-Va. State Line	CRM 201.8
15	At Spring House	CRM 205.0
*16	Speer's Ferry, Virginia	CRM 211.8
17	Below Clinchport, Virginia	CRM 212.9
18	Above Clinchport, Virginia	CRM 214.0
19	Swing Bridge above Clinchport	CRM 216.3
20	Fort Blackmore, Virginia	CRM 227.3
21	Dungannon, Virginia	CRM 236.8
22	Above St. Paul, Virginia	CRM 256.0
*23	Cleveland, Virginia	CRM 271.6
24	Nash Ford	CRM 279.5
25	Blackford, at Virginia State Hwy. 80	CRM 296.0*
26	Below Little River	CRM 298.0
27	Ford below Gardner (Hale Hollow)	CRM 302.0
28	Gardner Mill	CRM 303.0
29	Above Raven, Virginia	CRM 315.0
30	Richlands, Virginia	CRM 317.0
31	Ford below Cedar Bluff	CRM 319.0
32	Above Cedar Bluff at old mill	CRM 320.0
33	North Tazewell, off Va. State Hwy. 61	CRM 340.0

*Mile points have been approximated from United States Geological Survey Topographic maps. Sites #25-33.

vival of four species of *Dysnomia* in the Clinch River: *D. brevidens* (Lea, 1831), *D. capsaeformis* (Lea, 1834), *D. torulosa gubernaculum* (Reeves, 1865), and *D. triquetra* (Raf., 1820).

Two of these species (*D. capsaeformis* and *D. brevidens*) occur in fair abundance at several localities. *Dysnomia triquetra* is of occasional occurrence while *D. torulosa gubernaculum* is very rare in the Clinch River.

Stansbery (1972) lists as a new record from the Clinch River *Epioblasma (=Dysnomia) walkeri* (Wilson and Clark, 1914). In a recent report prepared for U. S. Department of Interior, Fish and Wildlife Service, Stansbery (1977) duscusses the status of this species as an endangered mollusk. He states:

> 'A check of the distribution map reveals evidence of populations in the Clinch, Middle Fork Holston, and Duck Rivers of the Tennessee system and in the Red and Stones Rivers in the Cumberland System. The Clinch River record is based, however, upon a single valve taken in 1965, and all efforts to find additional evidence in this river have failed.'

Based on this documentation the authors do not consider *D. walkeri* a part of the Clinch River fauna.

Lampsilis Rafinesque, 1820

Present collections from the Clinch River produced two species representing this genus: *Lampsilis ovata* (Say, 1817) and *L. fasciola* (Raf., 1820).

Lampsilis fasciola is clearly recognizable, presenting no taxonomic difficulty. *L. ovata* has been described by Ortmann (1918) as intergrading in the extreme headwaters with the form *L. ovata ventricosa* (Barnes, 1823). While present collections indicate considerable variability in this species all specimens have been designated *L. ovata*. This group of the genus *Lampsilis* exhibits pronounced clinal variation. A detailed discussion of this problem is presented by Ortmann (1913, 1920) and Cvancara (1963). Both *L. ovata* and *L. fasciola* were found to be widely distributed and well represented in present collections.

The endangered species *L. orbiculata (Fed. Reg.*, 1976) has been reported from the Lower Clinch River by Ortmann (1918), and Cahn (1936). The authors found no evidence of this species occurring in the Clinch River above the Norris impoundment and therefore have not included it as a part of the Clinch River fauna.

Leptodea Rafinesque, 1820

Two members of this genus are reported from the Clinch River by Ortmann (1918), *L. leptodon* (Raf., 1820) and *L. fragilis* (Raf., 1820). This genus was previously designated *Paraptera* (Ortmann, 1911) but subsequently revised (Ortmann and Walker, 1922) to *Leptodea*.

Leptodea leptodon was not collected during the present investigation; the authors have no knowledge of any recent collection of this species. Reported by Ortmann as 'rare,' this species may be close to extinction.

Leptodea fragilis was collected from three sites (9, 10, 16) during the present study. While this species remains common throughout most of the mainstem Tennessee River, it is a rare component of the Clinch River fauna.

Ligumia Swainson, 1840

This genus is well represented in present collections by a single wide-ranging form *Ligumia recta latissima* (Raf., 1820). It is common at Speers Ferry and Kyles Ford.

The authors have adhered to the decision of Ortmann and Walker (1922) to reserve *Ligumia recta* (Lamarck, 1819) for designation of the main species, with the type locality Lake Erie, and retain *latissima* for the typical river form found throughout the Interior Basin (van der Schalie, 1941).

Medionidus Simpson, 1900

The single Cumberlandian representative of this genus *Medionidus conradicus* (Lea, 1834), is well represented in present collections from the Clinch River. While the authors have noted this species in recent collections from the Duck, Powell, and North Fork Holston Rivers, it is apparent that a marked restriction of its past range has occurred and thus its future must be deemed tenuous.

Micromya Agassiz, 1852

For present listings, the authors have retained the generic designation *Micromya* for this extremely confusing group of Lampsilinae. Recognition of *Villosa* as the generic designation (Stansbery, 1972; Burch, 1975) is based on acceptance of Frierson's work (1927). Ortmann (1918) treats this group as a subgenus of *Eurynia;* until this group is definitively monographed, the authors prefer to accept the '50 year rule' and retain *Micromya*.

Ortmann (1918) records five species representing this group from the Clinch River (Table II), two of which he described as rare, *M. fabalis* (Lea, 1831) and *M. trabalis* (Conrad, 1834). Neither of these species are represented in present collections.

The authors presently recognize two species complexes of this group from the Clinch River, *M. nebulosa* (Conrad, 1834) and *M. vanuxemensis* (Lea, 1838). While *M. vanuxemensis* appears to be quite distinctive, *M. nebulosa* exhibits extreme variability and may actually represent several species. Present collections of *M. nebulosa* include forms exhibiting a broad spectrum of morphological variation. All of these variants have been grouped under the designation *M. nebulosa*. This taxon exhibits close systematic affinities with *M. iris* (Lea, 1830), and may be the southern analog of this

form. This group clearly needs further critical systematic study.

Obliquaria Rafinesque, 1820

Obliquaria reflexa Raf., 1820, the type of this genus, is not presently known from the Clinch River above Norris Dam. This is a typical large river form, presently common in the Tennessee River and other rivers of the Interior Basin. In the Lower Clinch River it has adapted to conditions of impoundment and colonized overbank areas (Bates, 1975).

Obovaria Rafinesque, 1819

Present collections have yielded no specimens belonging to this genus. Ortmann (1918) reports taking 'a young specimen' of *Obovaria retusa* (Lamarck, 1819) from the Clinch River at Clinton, Anderson County, Tennessee. It would appear that this genus is no longer represented as part of the Clinch River fauna.

Plagiola Rafinesque, 1820

The single species in this genus, *Plagiola lineolata* (Raf., 1820) is a typical large river form, not presently a part of the Clinch River fauna. Ortmann's records (1918) are from downstream areas now inundated.

Proptera Rafinesque, 1819

Proptera alata (Say, 1817), the common widespread representative of this genus, is presently common at several stations on the Clinch River. This species appears to have adapted well to impoundment; it has become a common member of the overbank fauna of the Tennessee River (Bates, 1975) and might be expected to colonize impounded portions of the Clinch River.

Ptychobranchus Simpson, 1900

Present collections indicate the continued existence of both *P. fasciolaris* (Raf., 1820) and *P. subtentum* (Say, 1825) in the Clinch River. *Ptychobranchus fasciolaris* is wide ranging and of common occurrence throughout the Interior Basin. *Ptychobranchus subtentum* is a Cumberlandian form presently restricted in its distribution to the Clinch, Powell, and North Fork Holston Rivers while locally it is sometimes abundant, its previous range has been significantly reduced.

Truncilla Rafinesque, 1819

Present records indicate occasional occurrences of the single species *T. truncata* (Raf., 1820) throughout the middle section of the Clinch River. This species remains widespread throughout the Interior Basin.

DISCUSSION

During this investigation the authors attempted to clarify issues surrounding the present status of the unique naiad fauna of the Clinch River; this report is not intended as a monographic treatment. All recent distribution records reported are represented by material retained in the collections of the Division of Forestry, Fisheries and Wildlife Development, Tennessee Valley Authority, Norris, Tennessee. Representative anatomical material was preserved for future study. During field studies, every effort was made to minimize disturbance of habitats; most specimens were immediately returned to their substrate following data recording. Particular attention was given the immediate replacement of rare forms.

Field and laboratory observation of individuals taken from those yet productive areas would indicate no evidence of extreme stress at the time of this study; age-size class structure, sex ratios, reproductive activity, presence of crystalline style, level of parasitism would all indicate a healthy, viable fauna. Adverse environmental impingement, however, remains a very real threat to the continued existence of this fauna.

Several areas of concern are demanding of further elucidation and thus the following considerations.

NOMENCLATURE

A nomenclatural 'Tower of Babel' has long plagued malacologists; not an exclusive problem. Specific and generic names have been changed so often and generally so indiscriminately that the uninitiated often have difficulty in interpreting current species lists. While this faunistic analysis is not the appropriate place to address all of the current problems in naiad nomenclature, the issues must be recognized. Facetiously one might suggest a specialized course in the 'Art of Taxonomic Vacillation' for success in malacology today. The excellent, succinct papers of Cole (1941, 1941a) and van der Schalie (1952) are apparently unknown to or simply ignored by many current workers. Isom (1973) again raised these questions, with similar lack of apparent impact. As stated earlier in this report, the authors have advocated adherence to the '50 year rule' and have done so in this paper.

Federal enactment of the Endangered Species Act of 1973 has unfortunately given fuel to what should have been a nomenclatural funeral pyre. This mandate to designate species and/or forms as threatened or endangered *with listing of common names* has directly produced the present 'circus atmosphere' in molluscan taxonomy. Common names have been apparently capriciously generated and published in the *Federal Register*. The use of common names is not to be abhorred; however, one must recognize that the vernacular names applied to many species are: (1) in many instances unprintable, except perhaps in modern pornographic periodicals, (2) regional in

TABLE V - MUSSEL SPECIES DISTRIBUTION: CLINCH RIVER, 1973-1975

Species	Site Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
															Va →
Margaritanidae															
/ Cumberlandia monodonta	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-
Unioninae															
/ Amblema costata	-	-	-	-	-	-	-	-	X	X	-	-	-	X	-
/ Cyclonaias tuberculata	-	-	-	-	X	-	-	-	X	X	-	-	-	-	-
Elliptio crassidens	-	-	X	-	-	-	-	-	X	-	X	-	-	-	-
Elliptio dilatatus	-	-	-	-	-	-	-	-	X	-	-	X	X	-	X
* Fusconaia barnesiana**	-	-	-	-	-	-	-	-	X	X	X	X	X	-	X
* Fusconaia b. bigbyensis	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Fusconaia edgariana**	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
Lastena lata	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-
Plethobasus cyphyus	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Pleurobema cordatum	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
Pleurobema oviforme**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula cylindrica	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
Quadrula pustulosa	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-
Anodontinae															
Alasmidonta marginata	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Lasmigona costata	-	-	X	-	-	-	X	-	X	X	-	-	-	-	-
Strophitus rugosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilinae															
* Actinonaias carinata	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
* Actinonaias c. gibba	-	X	X	-	X	-	X	-	X	X	X	X	-	-	X
Actinonaias pectorosa**	-	X	X	-	-	-	X	-	X	-	-	X	X	-	X
Cyprogenia irrorata	-	-	-	-	-	-	-	-	X	X	-	-	-	X	-
Conradilla caelata**	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Dromus dromas**	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-
Dysnomia brevidens**	-	-	-	-	-	-	-	-	X	-	-	-	-	-	X
Dysnomia capsaeformis**	-	-	-	-	-	-	-	-	X	-	X	-	X	-	X
Dysmonia torulosa** gubernaculum	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Dysnomia triquetra	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-
Lampsilis fasciola	-	-	-	-	-	-	-	-	X	-	X	X	-	-	-
Lampsilis ovata	-	-	-	-	-	-	X	-	X	X	-	-	-	-	X
Legumia recta latissima	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-
Medionidus conradicus**	-	X	-	-	-	-	X	-	X	-	X	X	-	X	X
Micromya (Villosa)** nebulosa	-	-	-	-	-	-	-	-	X	-	X	-	-	-	-
Micromya vanuxemensis**	-	-	-	-	-	-	-	-	X	-	X	-	-	-	X
Proptera alata	-	-	X	-	-	-	-	-	X	X	-	-	-	-	-
Ptychobranchus fasciolaris	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X
Ptychobranchus subtentum**	-	X	-	-	-	-	X	-	X	X	X	X	X	-	X
Truncilla truncata	-	-	-	-	-	X	-	-	X	-	X	X	-	-	X
	4	6	2	1	6				33	13	10	10	9	3	13

* these two forms have been counted as one species. **Cumberlandian species.

TABLE V (cont.) - MUSSEL SPECIES DISTRIBUTION: CLINCH RIVER, 1973-1975

Spurs Ferry	Site Number																	
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	
X	X	X	-	-	-	-	-	X	-	-	X	X	-	-	X	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	
X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	-	
X	-	X	X	-	X	-	X	X	-	-	-	-	-	-	-	-	-	
X	-	X	X	-	-	-	X	X	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	X	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	X	-	-	-	-	X	-	-	X	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	X	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	
X	-	-	X	-	-	-	-	-	-	-	X	-	-	-	X	-	-	
X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
27	2	7	7		2		6	8			4	3			3			

application, and (3) multiple, the same species is often known by several designations even within the same geographic area. The common names as reported by Coker (1915) are certainly worthy of consideration but even these have been indiscriminately tampered with in recent listings. Additionally, many of the species discussed in this paper have never had common names. For these reasons, the authors have not attempted to include a listing of common names for the species of the Clinch River. Until such time as an agreed upon list of common names is adopted by some committee of national stature, their employment in *Federal Register* listings must be questioned.

There exists the further problem attendant upon the recognition of subspecies, forms, ecomorphs, and clinomorphs. Every tributary, stream, creek, and ditch may support the recognizable form of a species; is each to be separately treated? When the diagnostic characteristics of a form become so obscure that only the author of the taxon can recognize it, its validity becomes questionable. The credibility of malacology may itself be worthy of endangered listing!

Species presently endangered

The following nine species are presently listed as endangered from the Clinch River *(Federal Register*, June 14, 1976): *Conradilla caelata, Dromus dromas, Dysnomia (=Epioblasma) torulosa gubernaculum, Fusconaia cuneolus, Fusconaia edgariana, Lampsilis orbiculata orbiculata, Pleurobema plenum, Quadrula intermedia,* and *Quadrula sparsa*. The authors believe that only three of these remain extant in viable numbers in the Upper Clinch River, *Dromus dromas, Dysnomia torulosa gubernaculum*, and *Fusconaia edgariana*. *Conradilla caelata* may possibly continue to exist in very limited numbers and a few specimens of *Fusconaia cuneolus* have been recently taken from the Lower Clinch River. Additional species which have been extirpated from this drainage are discussed in the conclusions. One species, *Lastena lata*, appears to remain only in the Upper Clinch River.

Life History data

Conclusive life history data for the mussel fauna of the Clinch River is lacking! Many fish species, particularly members of the Centrarchidae, have been implicated as potential hosts for the glochidial stage of development. Much of the available information on implicated host fish is based on the early work of the U. S. Bureau. of Fisheries; Lefevre and Curtis (1912), Coker *et al.* (1921). Fuller (1974) has compiled available data on fish species implicated as glochidial hosts. These classic experimental studies yielded a great deal of information on potential host relations as established under artificial conditions. Without field verification these data must be considered inferential and not definitive.

Ellis and Ellis (1926) reported obtaining metamorphosis of the glochidial stage of several species in artificial media. The precise techniques employed were, however, never published and the work has never been duplicated. Their work has left investigators with at least some doubt as to the facultative or obligatory nature of the parasitic stage.

More recent studies by Matteson (1958) and Yokley (1972) leave the same unanswered questions as to applicability of laboratory data to natural systems. Forced exposure of potential hosts to foreign parasites has often led to disastrous ecological consequences. Questions of natural host-parasite relationships and host specificity of mussels with fish remain unanswered.

Lower Clinch River Fauna

The Clinch River from its confluence with Watts Bar Reservoir, Tennessee River upstream to CRM-152, has been defined as the Lower Clinch River in this paper. This stretch of river has been influenced by construction and operation of Melton Hill Dam, CRM-23, Norris Dam, CRM 80, and the backwater effects of Watts Bar Reservoir on the Tennessee River.

The mussel fauna of this area is now apparently reduced to nine species. Five species, *Anodonta corpulenta* (Cooper, 1834), *A. imbecillis* (Say, 1829), *A. suborbiculata* (Say, 1831), *Lasmigona complanata* (Barnes, 1823), and *Leptodea laevissima* (Lea, 1829) are not discussed elsewhere in this paper as prior to the report of Bates (1975) they were not considered members of the Clinch River faunal assemblage. These are characteristic impoundment forms (Bates, 1962) and their occurrence in these downstream impounded areas is not surprising; they do not occur in the river above Norris Dam. *Leptodea fragilis* continues to occur in the Upper Clinch River and historically belonged to this fauna (Ortmann, 1918). *Obliquaria reflexa* was reported by Ortmann (1918) and Cahn (1936) and continues to exist in the river downstream from Norris Dam. These seven species have all become successful members of the overbank fauna of the Lower Clinch River (Bates, 1975).

Two main channel, pre-impoundment species, *Fusconaia cuneolus* and *Lampsilis fasciola* continue to exist in limited numbers in the Lower Clinch River below Norris Dam. Present records for these two species are based on specimens taken by TVA biologists during 1973-1975. *Lampsilis fasciola* is well represented in present collections from the Upper Clinch River but *Fusconaia cuneolus* now is apparently restricted to isolated areas downstream from Norris Dam. Specimens of these two species taken from the Lower Clinch River exhibit extreme age and periostracal erosion indicating tenuous survival. *Fusconaia cuneolus* is presently listed as an endangered species.

This Lower Clinch River, downstream of CRM-152, historically supported the greatest diversity of species known from this drainage. Ortmann (1918) recorded no fewer than fifty species from this area; this contrasts with the forty-two species he reported for the river above areas now impacted by impoundment.

The authors encountered considerable difficulty in attempting to verify the records of Cahn (1936) and Hickman (1936). These authors (Cahn and Hickman) listed essentially the same species for the Clinch River downstream of Norris Dam and thus the one listing by Cahn is here reported (Table III). Since original material from neither of these collections could be located for verification, the

authors felt compelled to take limited license in producing a synonymized species list for the Clinch River immediately downstream of Norris Dam. Certain species reported were clearly out of range and were reduced to known indigenous synonymy. Cahn's list (Table III) after conservative synonymization still indicates no fewer than thirty-four species present in this area. The greatest number of species produced from any one site by Ortmann was thirty-two (Clinchport, Va.); the authors' most productive site (Kyles Ford, Tenn.) yielded the same number. The mussel fauna of the Lower Clinch River has clearly been impacted by development.

Cumberlandian Faunal Elements

Many Cumberlandian species historically associated with the Clinch River Basin have been apparently extirpated. Ortmann's list of 1918 would indicate no fewer than twenty-five species of Cumberlandian origin; inclusion of a minimum of eight recognized forms would raise this total to thirty-three.

The authors can verify the continued existence of thirteen Cumberlandian species in the Upper Clinch River. The continued tenuous existence of *Fusconaia cuneolus* in the Lower Clinch River would raise this total to fourteen. The addition of *Fusconaia barnesiana bigbyensis* to this list would produce a total of recognizable species and forms of fifteen at the present time.

Taxa of Cumberlandian origin which the authors feel have been clearly extirpated from the Clinch River include *Fusconaia pilaris* (and forms), *Quadrula intermedia, Lasmigona holstonia, Dysnomia arcaeformis, D. haysiana, D. lenior, D. propinqua, D. stewardsoni,* and *Micromya (=Villosa) trabalis.*

Many species and forms of Cumberlandian origin are undoubtedly already extinct and others appear to be on the verge of extinction. Further reduction in available habitat and/or adverse environmental impingement could well lead to the eventual total extirpation of these unique species.

Cumberlandian species recorded by Ortmann are indicated on Table II; those believed by the authors to remain extant in the Upper Clinch River are indicated on Table V.

SUMMARY AND CONCLUSIONS

This study made obvious to the authors that an approximately thirty-five kilometer reach of the Upper Clinch River from Speer's Ferry, Virginia, to Kyle's Ford, Tennessee, supports what is probably the most abundant and diverse fresh water mussel fauna remaining in the world. The closest approximation of this unique faunal assemblage occurs in a small section of the Powell River. Historic records clearly indicate that this uniquely rich fauna was once dispersed over most of the Upper Tennessee River System.

The present distribution of mussel species in the Upper Clinch River is graphically presented in the Figure II histogram. It should be apparent that the middle sample sites (9-16) remain the most productive. Upper sites (1-8) and lower sites (17-33) have for many years been subjected to adverse environmental stress. Survival of the fauna at these middle sites is at best tenuous. This short reach of river represents approximately 7% of the original mussel habitat of the Clinch River.

After placing subspecies and forms in synonymy (Table II), Ortmann's records clearly establish a minimal faunal assemblage for the Upper Clinch River of 42 species; present data indicate continued survival of 36. The authors feel this apparent loss of 6 species is extremely conservative. Ortmann's records for the entire Clinch Basin indicate 57 species; including subspecies this total becomes 71. Present records indicate a total of 43 species for the Basin, 7 of these being restricted to the Lower Clinch River. Of these 7 species, 5 have invaded following impoundment. Thus the original Clinch River mussel fauna representing 57 species has been reduced to 38. A total of 19 native species have thus apparently been extirpated from the Clinch River Basin; if subspecies and forms were included in this estimate, the number of taxa extirpated would be much greater. In summary:

Ortmann Records	
Total species and subspecies recorded for the Clinch River	71
Total after placing subspecies in synonymy	57
Upper Clinch River	42
Lower Clinch River	50
Authors' Records (subspecies not separated)	
Total for the Clinch River	43
Upper Clinch River	36
Lower Clinch River	9
Post-impoundment colonizers	5
Native species now restricted to Lower Clinch	2
Cumberlandian Species	
Ortmann: Total	33
Synonymized	25
Authors (Only one species remaining in the Lower Clinch)	13
Species extirpated from the Clinch Basin	
Authors (12 of these Cumberlandian)	19

During this study, the authors have adhered to conservative taxonomic principles; whenever there has been a question as to the taxonomic status of a form, it has been placed in synonymy. Some forms placed in synonymy may well be erected to species status in the future should adequate systematic documentation become available.

There continues to exist the need for life history and broad based ecological studies to provide the basis for the development of intelligent guidelines for the management of this unique resource.

The authors must express concern for the continued survival of this unique faunal assemblage. Adverse environmental impingements pose constant threats. Emphasis must be placed on preservation of the habitats that continue to support this fau-

na. Recent action by the State of Tennessee in setting aside that reach of the Clinch River from the Virginia-Tennessee State Line to Sneedville, Tennessee, as a mussel sanctuary must be lauded as enlightened environmental action.

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CORRIGENDA

Page 6, left hand column, last paragraph, 5th line from the bottom: the sentence beginning 'All collections are ....' should read: 'Representatives of all collections are ....'

Page 7, left hand column, first line: The heading 'RESULTS' should have been inserted after the first paragraph beginning 'Sample results ....' and not above that paragraph.