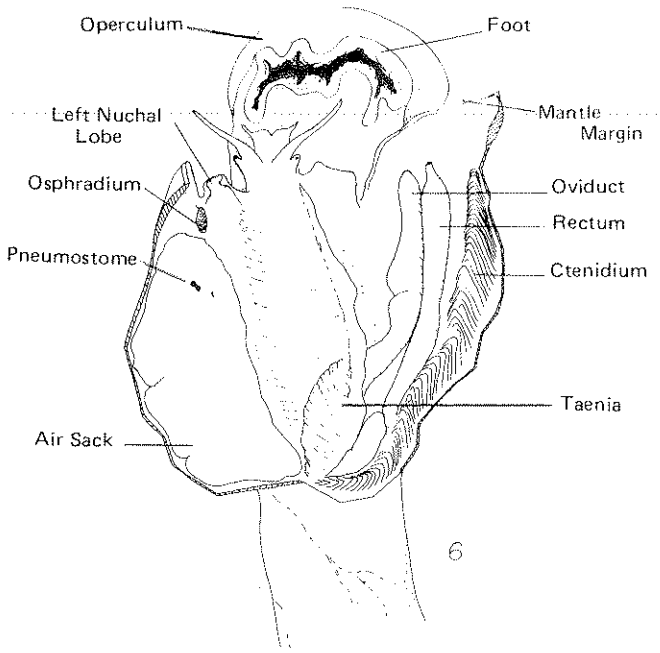

Figure 6. The prosobranch, *Marisa cornuarietis* (Linne, 1758) with mantle cavity opened, to show air sack and pneumostome remote from mantle margin. Specimen from Puerto Rico. Diameter of this planispiral shell, 30 mm. See also Demian, 1965, Fig. 2.

gastropoda), the tubular extensions of the reproductive system through the median dorsal mantle cavity lie along the rectum, which is also prolonged into that cavity. Both the rectum and the reproductive tube are on the opposite side of the body from the pneumostome in Pilidae and Helicinidae. In prosobranchs, the renopore is near the apex of the median mantle cavity, and not extended as a ureter through the wall of this cavity, in contrast to many pulmonates. The renopore is shown in Figure 2, but not in Figure 6.

There are thus four types of pneumostomal mechanisms among air breathing snails. Whether other terrestrial prosobranchs have a pneumostome remains to be determined, and studies on the living animals may be necessary to elucidate the point.

LITERATURE CITED

Baker, H. Burrington 1925 Anatomy of *Hendersonia*: a primitive helicinid mollusk. Academy of Natural Sciences of Philadelphia Proceedings 77: 273-303, Pls. 7-10.

Baker, H. Burrington 1926 Anatomical notes on American Helicinidae. Academy of Natural Sciences of Philadelphia Proceedings 78: 29-56, Pls. 5-8.

Baker, H. Burrington 1928 Mexican mollusks collected for Dr. Bryant Walker in 1926, I. Occasional Papers of the Museum of Zoology, University of Michigan No. 193: 1-64, 6 Pls.

Bourne, Gilbert C. 1911 Contributions to the morphology of the group Neritacea of the Aspidobranch gastropods Pt. II. The Helicinidae. Zoological Society of London, Proceedings, 54: 759-809, Pls. 30-42.

Demian, Emil S. 1965 The respiratory system and mechanism of respiration in *Marisa cornuarietis* (L). Arkiv For Zoologi Ser. 2, 17(8): 539-560.

Harry, Harold William 1964 The anatomy of *Chilina fluctuosa* Gray reexamined, with prolegomena on the phylogeny of the higher limnic Basommatophora (Gastropoda, Pulmonata). Malacologia 1(3): 355-385.

UNIONACEAE OF ARKANSAS: HISTORICAL REVIEW, CHECKLIST, AND OBSERVATIONS ON DISTRIBUTIONAL PATTERNS

M.E. Gordon, L. Russert Kraemer, and A.V. Brown
Department of Zoology, University of Arkansas
Fayetteville, AR 72701

INTRODUCTION

The occurrence and distribution of the Unionacea in Arkansas has not been intensively studied, as noted by LaRocque (1962). The available literature is summarized in Table 1. An indication of the degree of development of the fauna is given by Coker (1919). He reported that between 1912 and 1914 the freshwater mussel industry in Arkansas was responsible for half the yearly production from the Interior Basin south of the Missouri River including the Ohio River and Gulf drainages. Also, the White River was the fourth most productive river in the United States, receiving the second highest yearly price per ton of shells.

Currently, several Arkansas drainages are being studied by the authors. Additional information has been obtained from personal collections of the authors and examination of over 1300 lots of Arkansas unionaceans at the University of Michigan Museum of Zoology, Harvard University Museum of Comparative Zoology, U.S. National Museum of Natural History, University of Colorado Museum, and University of Arkansas Museum.

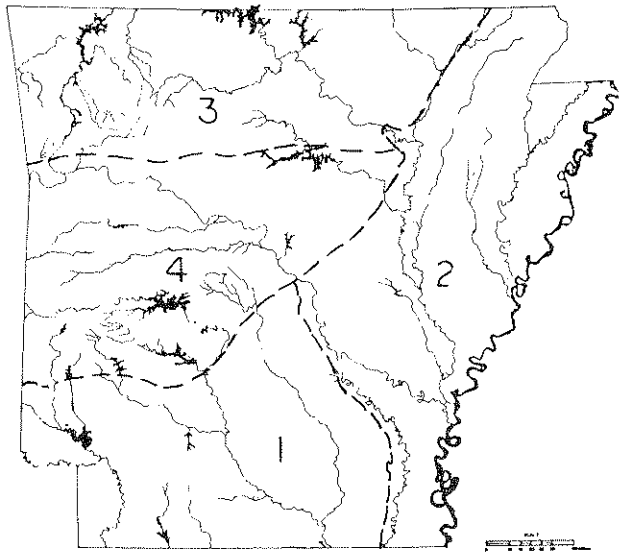

Figure 1. Physiographical regions and major drainages of Arkansas. 1—West Gulf Coastal Plain, 2-Mississippi Aluvial Valley, 3—Ozark Plateaus, 4—Ouachita Mountains

PHYSIOGRAPHY OF ARKANSAS

Geomorphologically, Arkansas can be generally classified as Gulf Coastal Plain, comprised of the West Gulf Coastal Plain and the Mississippi Alluvial Valley in the south and east, respectively, and the Interior Highlands, which includes the Ozark Plateaus and the Ouachita Mountains in the north and west, respectively (Figure 1). The Ozarks can be characterized as a "dome" with a radial drainage pattern. The Boston Mountains form a barrier between the drainages of the more northern Ozark plateaus and the Arkansas River. The Arkansas River approximates the division between the Ozarks and the Ouachitas, which form east-west ridges (Thornbury, 1965; State of Arkansas, 1974).

Table 1. Literature pertaining to Arkansas Unionidae.

A. Type descriptions.

	Subject
T.A. Conrad (1836)	*Unio occidentalis*
I. Lea (1852)	*U. lamarckianus, U. powellii, U. reeveianus, Anodonta opaca*
I. Lea (1862)	*U. grandidens, U. arkansasensis*
W.A. Marsh (1891)	*U. pilsbryi, U. pleasii*
C.T. Simpson (1900a)	*Ptychobranchus clintonensis, Pleurobema brevis subelliptica, P. argentea pannosa*
C.T. Simpson (1900b)	*U. gibbosus delicatus*
J.H. Ferriss (1900)	*Lampsilis simpsoni*
A.E. Ortmann and B. Walker (1912)	*Arkansia wheeleri*
H.E. Wheeler (1914)	*Fusconaia selecta*
L.S. Frierson (1927, 1928)	*Lampsilis rafinesqueana, L. streckeri*

B. Species lists and distributional surveys in Arkansas.

R.E. Call (1895)	Arkansas in general
S.E. Meek (1896)	St. Francis River
E.G. Vanatta (1910)	Ouachita River
S.E. Meek and H.W. Clark (1912)	Buffalo River
H.E. Wheeler (1914)	Cache River
A.A. Hinkley (1916)	White River, North Fork White River, Black River, Spring River
H.E. Wheeler (1918)	Clark County
B.A. Branson (1966)	White River, Kings River
M.E. Gordon, et al. (in press)	Illinois River

C. Benthic faunal surveys including unionaceans

Babcock and MacDonald (1973)	Buffalo River
Kittle, et al. (1974)	Illinois River
Arkansas Eastman Company (1974)	White River
M.E. Cather and G.L. Harp (1975)	Northeastern Arkansas creeks
C.J. Latimer (1975)	Cache River
L.R. Kraemer (1976)	Arkansas River Navigation System
J. Rickett (in press)	Flat Bayou

D. Miscellaneous studies.

R.E. Call (1885)	Mississippi Valley
C.T. Simpson (1900)	U.S. in general
A.E. Ortmann (1912)	Systematics
A.E. Ortmann (1913-1916)	Unionidae in general
C.T. Simpson (1914)	Unionidae in general
A.E. Ortmann (1917)	Systematics
B. Walker (1918)	Systematics
A.E. Ortmann (1918)	Systematics
A.E. Ortmann (1919)	Systematics
R.E. Coker (1919)	Freshwater mussel industry
T.K. Chamberlain (1934)	Anatomy-biochemical
W.P. Brann (1950)	Freshwater mussel industry
A. LaRocque (1962)	References
D.H. Stansbery (1970)	Endangered species
L.R. Kraemer (1970)	Behavior
B.D. Valentine and D.H. Stansbery (1971)	Lake Texoma
R.I. Johnson (1978)	*Plagiola* (= *Dysnomia*)

CHECKLIST

Sixty-two species and six ecophenotypes with subspecific classification have been recorded from Arkansas (Table 3). These records have been confirmed by specimens in the authors' personal collections or the collections of the previously mentioned museums. Another seven species are suspected of occurring, presently or formerly, in Arkansas (Table 2). These species either have been listed in the literature without a voucher specimen being located, have a questionable taxonomic status, or have been listed as possible elements of the Arkansas fauna by previous authors (e.g. Call, 1895). Nomenclature used is generally consistent with that of Ortmann and Walker (1922).

Table 2. Unionid species suspected of occurring in Arkansas.

Plethobasis cyphyus	*Glebula rotundata*
Elliptio crassidens	*Dysnomia florentina*
Obovaria subrotundata	*Proptera alata*
Pleurobema cf. *clava*	

DISCUSSION

Distribution of the Unionacea in Arkansas when compared to general distribution within the Interior Basin reflects four distinct faunal affinities. These can be characterized as species from the southern Interior Basin-Gulf drainage, northern Interior Basin, the endemic Interior Highlands fauna ("Ozark" of H. and A. van der Schalie, 1950), and those that seem to occur throughout the Interior Basin. The occurrence of these faunal assemblages can be correlated with the geological history of the Interior Highlands, the periodic isolation of these highlands, and their function as biological refugia.

Certain species (e.g. *Proptera purpurata, Villosa lienosa*) which are typically distributed through the southern Interior Basin and Gulf drainages range north into the Ozarks. Their distributional limits approximate the shorelines of the Cretaceous and Tertiary embayments over the Gulf Coastal Plains (Thornbury, 1965; State of Arkansas, 1974). The Interior Highlands may have functioned as refugia for these southern species during these embayments. The disjunct distribution of *Lampsilis streckeri* may be a result of these embayments. The curious distribution of Arkansas Oak (*Quercus arkansana*) reflects the same geomorphological history. Found only very locally in Arkansas, Alabama, Georgia, and Florida, this primitive species is restricted to areas along the former Cretaceous shoreline (State of Arkansas, 1974).

Relict populations of species normally associated with the Cumberland region (e.g. *Cumberlandia monodonta, Dysnomia* spp.) have been found in the Interior Highlands. Johnson (1978) postulates that *Dysnomia* may have inhabited the region prior to the Cretaceous. The Interior Highlands and Cumberland regions are similar geologically and physical connections may have existed (Walker, 1917; Thornbury, 1965). Faunal evidence for such connection has been given by H. and A. van der Schalie (1950) and Johnson (1978). Embayments may have served as an isolating mechanism between the two regions by inundating their connection via the lower Ohio River (Walker, 1917).

Some species characteristic of the northern Interior Basin assemblage (e.g., *Lasmigona complanata, Proptera alata*) presently range as far south as the Interior Highlands. These may represent refugial populations that have persisted since glaciation. Johnson (1978) notes that the Interior Highlands were probably a Pleistocene refugium which was a source for recolonization of the upper Mississippi drainages and portions of the Great Lakes drainages (Walker, 1913; van der Schalie, 1945). During the extent of maximum glaciation, the Ohio River may have been unsuitable as a corridor between the Interior Highlands and the Cumberland due to ice, temperature, or silt-load.

Pre- and postglacial channels of the Mississippi and Ohio rivers were quite different from the present. Through Arkansas, the postglacial Mississippi River has flowed west of Crowley's Ridge, skirting the base of the Ozark Plateaus, and occupying portions of the following present drainages: Black, Cache, St. Francis, L'Anguille, Little, Tyronza, and Arkansas rivers and LaGrue and DeView bayous. The Ohio River flowed through Arkansas, occupying the present channels of the St. Francis and Mississippi rivers, into Louisiana, entering the Mississippi River below the confluences of the Arkansas and Ouachita rivers (Fisk, 1944; Thornbury, 1965). These former channels may explain the presence of species as *Proptera capax, Lampsilis higginsii, L. orbiculata*, and *Dysnomia* species in the St. Francis, Black, and White rivers' drainages and a possible means of dispersal for some species found in the Ouachitas (e.g. *Cumberlandia, L. higginsii, L. orbiculata*).

Portions of the Interior Highlands have persisted since the Pre-cambrian (St. Francois Mountains in Missouri), never having been completely base-leveled or entirely inundated (Thornbury, 1965; State of Arkansas, 1974). Due to the age, isolation, and refugial function, an endemic unionid fauna has developed (H. and A. van der Schalie, 1950). These species may have evolved within the region as they share a preference for smaller rivers and headwater situations. Alternatively, these species may represent relict populations of refugial species that were not able to recolonize their former habitat. In contrast to the diverse, endemic Cumberland fauna (Ortmann, 1924; van der Schalie, 1973), the endemic Interior Highlands fauna appears to be composed of only seven species. Three of these are restricted north of the Boston Mountains divide between the White and Arkansas drainages, and two are found only in the Ouachitas (Table 3). Other supposed species have been relegated to synonymy. This may reflect the general trend toward fewer species west of the Mississippi River. Alternatively, the fauna may have been depleted fairly recently. Following the last glacial advance, the Interior Highlands became increasingly arid with desert conditions existing possibly as late as 3000 years ago (State of Arkansas, 1974). This may have had a profound effect upon the unionid fauna, with possible extinctions, necessitating the recolonization of smaller streams and former headwaters.

Species widely distributed through the Interior Basin (e.g., *Ligumia recta, Anodonta grandis*) have been affected by the same factors as the other groups discussed, but have been more successful at recolonization. These species have been found throughout most of Arkansas.

The geomorphological history of Arkansas has apparently produced a diverse unionid fauna, that is comparable only to Missouri (60 species, 6 subspecies; Buchanan, personal communication) in numbers of species for states west of the Mississippi River (sufficient data is lacking from Louisiana). Additional studies of the unionacean fauna of Arkansas are necessary to adequately portray the current assemblage of species. The fauna from southeastern Arkansas is poorly known due to the paucity of studies. With water resources development (U.S. Army, 1965) and modification from other sources, the fauna may be considerably reduced before it is totally known.

for revised list of species, see Gordon (1981) Recent Mollusca of Arkansas

Table 3. Checklist of Arkansas Unionacea: Synoptic table showing distribution by river drainage.

[1]Endemic Interior Highlands species restricted to Ozark Plateaus.

[2]Endemic Interior Highlands species restricted to Ouachita Mountains.

[3]Endemic Interior Highland species.

[4]Based on or confirmed by information from John L. Harris (personal communication).

	Illinois River	White River	Buffalo River	North Fork White River	Black River	Spring River	Little Red River	Cache River	St. Francis River	Arkansas River	Bartholomew Bayou	Ouachita River	Saline River	Little Missouri River	Caddo River	Red River	Little River
Cumberlandia monodonta												X					
Fusconaia flava	X	X	X	X			X		X	X		X	X	X	X	X	X
F. flava undata		X		X	X	X	X		X			X					
F. ebena		X		X	X	X	X		X			X					
F. ozarkensis[1]		X	X	X	X	X				?							
Megalonaias gigantea	X	X							X	X	X	?					
Amblema plicata	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Quadrula pustulosa	X	X	X		X	X	X	X	X	X		X	X		X		X
Q. quadrula	X	X							X			X	X				
Q. nodulata		X							X				X				
Q. metanerva		X			X	X			X			X	X				
Q. cylindrica	X	X	X	X	X	X	X		X			X	X				
Tritogonia verrucosa	X	X	X	X	X	X	X	X	X	X		X	X		X		
Plectomerus dombeyanus		X			X	X		X	X		X	X	X		X		
Cyclonaias tuberculata		X	X	X	X	X				X						X	
Pleurobema cordatum coccineum	X	X	X		X	X	X			X		X	X	X			
P.c. catillus				X	X	X	X					X					
P.c. plenum						X			X			X	X				
P.c. pyramidatum		X			X	X			X		X	X	X				
Elliptio dilatatus	X	X	X	X	X	X	X	X	X			X	X	X			
Uniomerus tetralasmus		X			X			X	X			X	X		X		
Alasmidonta calceolus		X	X														
A. marginata	X	X	X	X	X	X	X					X	X		X		
Lasmigona costata	X	X	X	X	X	X	X			X		X	X		X		
L. complanata		X		X			?										
Arcidens confragosus					X			X	X								
Arkansia wheeleri[2]												X					X
Anodonta grandis	X	X					X	X	X	X	X	X	X		X	X	X
A.g. corpulenta	X	X					X		X	X	X	X					
A. imbecilis	X	X		X	X			X	X			X	X				
A. suborbiculata						X			X			X					

Anodontoides ferrussacianus							X		X													
Strophitus undulatus	X	X	X	X	X	X	X		X	X		X	X									
Simpsoniconcha ambiqua							X															
Ptychobranchus occidentalis[3]	X	X	X	X		X	X					X	X		X			X				
Obliquaria reflexa		X		X	X	X		X	X		X											
Cyprogenia aberti[3]		X	X	X	X	X	X		X	X		X	X		X							
Obovaria olivaria		X		X	X	X	X	X	X		X	X										
Actinonaias carinata	X	X	X	X	X	X	X		X	X		X	X		X							
A.c. gibba					X							X										
A. ellipsiformis	X	X	X	X		X									?							
Truncilla truncata		X		X	X	X	X		X	X		X	X									
T. donaciformis					X				X			X										
Plagiola lineolata		X		X	X	X			X			X			X							
Leptodea fragilis		X			X	X	X	X	X	X	X	X	X									
L. leptodon		X		X		X						X										
L. laevissima					X				X	X											X	
P. purpurata	X	X	X		X	X	X	X	X	X	X	X	X	X							X	
P. capax		X			?		?		X	?		?	?				?					
Carunculina parva	X	X	X				X	X	X			X	X	X	X	X	X	X				
C. texasensis[4]							X		X			X			X							
C. glans	X	X	X			X	X					X	X	X	X							
Villosa iris		X	X	X			X															
V. lienosa	?	X	X	X	X	X	X	X	X	X		X	X		X							
V. arkansasensis[2, 4]							?					X	X	X	X							
Ligumia subrostrata	X	X	X					X	X			X	X									
L. recta		X	X	X	X	X	X		X	X		X	X	X								
Lampsilis anodontoides	?	X			X			X	X	X	X	X	X									
L. radiata siliquoidea	X	X	X		X	X			X	X	X	X	X		X							
L. hydiana							X	X	X	X	X	X	X	X	X	X	X					
L. reeveiana[1]		X	X	X		X	X															
L. streckeri							X															
L. rafinesqueana[1]	X																					
L. ovata ventricosa	X	X	X	X	X	X	X		X	X		X	X	X								
L. orbiculata[4]									X			X										
L. higginsii		?		X	X	X						X									X	
Dysnomia triquetra		X																				
D. turgidula						X																

ACKNOWLEDGEMENTS

Appreciation is expressed to the following for their help, advice, and use of facilities at their respective institutions: Dr. Henry van der Schalie and Dr. Alan P. Tompa, University of Michigan Museum of Zoology; Mr. Richard I. Johnson, Harvard University Museum of Comparative Zoology; Dr. Arthur H. Clarke, U.S. National Museum of Natural History; Dr. Nancy G. McCartney, University of Arkansas Museum; and Dr. Shi-Kuei Wu, University of Colorado Museum. Also, we would like to thank Mr. Alan Buchanan, Missouri Department of Conservation; Mr. Ronald Oesch, Glendale, Missouri; Mr. John L. Harris, Department of Zoology, University of Tennessee; Dr. John Rickett, Biology Department, University of Arkansas – Little Rock; and Dr. George L. Harp, Department of Biological Sciences, Arkansas State University for information they provided. A grant from the University of Arkansas Foundation, Inc., financed a trip to the first three institutions listed above. The manuscript was typed by Ms. Jackie Griffin.

LITERATURE CITED

Arkansas Eastman Company. 1974. Environmental impact assessment report. Batesville, Arkansas. 120 p.

Arkansas, State of. 1974. Arkansas natural area plan. Arkansas Department of Planning, Little Rock, 248 p.

Babcock, R.E., and H.C. MacDonald. 1973. Preliminary reconnaissance water quality survey of the Buffalo National River. U. Ark. W.R.R.C. Pub. 19: 1-147.

Brann, W.P. 1950. A proposal for business research and education relevant to problems of the economic development of Arkansas. Institute of Science and Technology, Fayetteville.

Branson, B.A. 1966. Unionid records from Kansas, Arkansas, and Louisiana. Sterkiana 23: 7-8.

Call, R.E. 1885. Geographical catalogue of the Unionidae of the Mississippi Valley. Bull. Des Moines Acad. Sci. 1: 5-57.

Call, R.E. 1895. A study of the Unionidae of Arkansas, with incidental references to their distribution in the Mississippi Valley. Trans. Acad. Sci. St. Louis 7: 1-65.

Cather, M.E., and G.L. Harp. 1975. The aquatic macroinvertebrate fauna of a Ozark and a deltaic stream. Proc. Ark. Acad. Sci. 29: 30-35.

Chamberlain, T.K. 1934. The glochidial conglutinates of the Arkansas Fanshell, *Cyprogenia aberti* (Conrad). Bio. Bull. 66: 55-61.

Coker, R.E. 1919. Freshwater mussels and mussel industries of the United States. Bull. U.S. Bus. Fish. 36: 13-89.

Conrad, T.A. 1836. Monography of the family Unionidae, or naiades of Lamarck (freshwater bivalve shells of North America). J. Dodson, Philadelphia. 118 p.

Ferriss, J.H. 1900. A new *Lampsilis* from Arkansas. Nautilus 14: 38-39.

Fisk, H.N. 1944. Geological inverstigation of the alluvial valley of the lower Mississippi River. Mississippi River Commission, Vicksburg. 78 p.

Frierson, L.S. 1927. A classified and annotated check list of the North America naiades. Baylor University Press, Wisc. 111 p.

Frierson, L.S. 1928. Illustrations of Unionidae, Nautilus 41: 138-139.

Gordon, M.E., A.V. Brown, and L. Russert Kraemer. Mollusca of the Illinois River, Arkansas. Proc. Ark. Acad. Sci. for 1979.

Hinkley, A.A. 1916. New fresh-water shells from the Ozark Mountains. Proc. U.S. Natl. Mus. 49: 587-589.

Johnson, R.I. 1978. Systematics and zoogeography of *Plagiola* (= *Dysnomia* = *Epioblasma*), an almost extinct genus of freshwater mussels (Bivalvia: Unionidae) from middle North America. Bull. Mus. Comp. Zool. 148: 239-321.

Kittle, P., E. Short, and R. Rice. 1974. A preliminary study of water quality of the Illinois River in Arkansas. University of Arkansas, Fayetteville. 158 p.

Kraemer, L.R. 1970. The mantle flap in three species of *Lampsilis* (Pelecypoda: Unionidae). Malacologia 10: 225-282.

Kraemer, L.R. 1976. An evaluation of the effects of dredging within the Arkansas River Navigation System, IV. The effects upon the benthic associations. Univ. Ark. W.R.R.C. 46: 1-357.

LaRoque, A. 1962. Key references to the Mollusca of Arkansas. Sterkiana 6: 39.

Latimer, C.J. 1975. The effects of channelization on the benthic macroinvertebrates of Cache River and Bayou DeView. Unpublished M.S. thesis, Arkansas State University. 64 p.

Lea, I. 1852. Observations on the genus *Unio*, etc. vol. 5. Philadelphia.

Lea, I. 1862. Observations on the genus *Unio*, etc. vol. 9. Philadelphia.

Marsh, W.A. 1891. Description of two new species of *Unio* from Arkansas. Nautilus 5: 1-2.

Meek, S.E. 1896. A list of fishes and mollusks collected in Arkansas and Indian Territory in 1894. Bull. U.S. Fish. Comm. 1895. 15: 341-349.

Meek, S.E., and H.W. Clark. 1912. The mussles of the Big Buffalo fork of White River, Arkansas. U.S. Bur. Fish. Doc. 759: 1-20.

Ortmann, A.E. 1912. Notes upon the families and genera of the najades. Ann. Carnegie Mus. 8: 222-364.

Ortmann, A.E. 1913-1916. Studies in najades. Nautilus 27: 88-91: 28: 20-22, 28-34, 41-47, 65-69, 106-108, 129-131, 141-143: 29: 62-67: 30: 54-57.

Ortmann, A.E. 1917. A new type of the nayad-genus *Fusconaia*. Group of *F. barnesiana* Lea. Nautilus 31: 58-64.

Ortmann, A.E. 1918. The systematic position of two species of mussels from the Ozarks. Nautilus 32: 13-15.

Ortmann, A.E. 1919. A monograph of the naiades of Pennsylvania. Pt. III Systematic account of the genera and species. Mem. Carnegie Mus. 8: 1-385.

Ortmann, A.E. 1924. The naiad fauna of the Duck River in Tennessee. Am. Midl. Nat. 9: 1-47.

Ortmann, A.E., and B. Walker. 1912. A new North American naiad. Nautilus 25: 97-100.

Ortmann, A.E. and B. Walker. 1922. On the nomenclature of certain North American naiades. Occ. Pap. Mus. Zool. Univ. Mich.

Rickett, J.D. Abundance, diversity, and distribution of benthic macroinvertebrates, in the Flat Bayou drainage area, Jefferson County, Arkansas. Proc. Ark. Acad. Sci. for 1979.

Simpson, C.T. 1900a. New and unfigured Unionidae. Proc. Acad. Nat. Sci. Philad. 52: 74-86.

Simpson, C.T. 1900b. Synopsis of the naiades or pearly freshwater mussels. Proc. U.S. Natl. Mus. 22: 501-1044.

Simpson, C.T. 1914. A descriptive cataolgue of the anaides or pearly freshwater mussels. Bryant Walker, Detroit. 1540 p.

Stansbery, D.H. 1970. Symposium on the rare and endangered mollusks of North America, 2. Eastern freshwater mollusks. (1) The Mississippi and St. Lawrence river systems. Malacologia 10: 9-22.

Thornbury, W.D. 1965. Regional geomorphology of the United States. John Wiley and Sons, New York. 609 p.

U.S. Army. 1965. Water resources development in Arkansas.

Engineer Division Lower Mississippi Valley, Vicksburg. 90 p.
Valentine, B.D., and D.H. Stansbery. 1971. An introduction to the naiads of the Lake Texoma region, Oklahoma, with notes on the Red River fauna (Mollusca: Unionidae). Sterkiana 42: 1-40.
Vanatta, E.G. 1910. Unionidae from southeastern Arkansas and northeastern Louisiana. Nautilus 23: 102-104.
van der Schalie, H. 1945. The value of mussel distribution in tracing stream confluence. Pap. Mich. Acad. Sci. Arts Let. 30: 355-372.
van der Schalie, H. 1973. The mollusks of the Duck River drainage in central Tennessee. Sterkiana 52: 45-55.
van der Schalie, H., and A. van der Schalie. 1950. The mussels of the Mississippi River. Am. Midl. Nat. 44: 448-466.
Walker, B. 1913. The unione fauna of the Great Lakes. Nautilus 27: 18-23, 29-34, 40-47, 56-59.
Walker, B. 1917. The method of evolution in the Unionidae. Occ. Pap. Mus. Zool. Univ. Mich. 45: 1-10.
Walker, B. 1918. A synopsis of the classification of the freshwater Mollusca of North America, north of Mexico, and a catalogue of the more recently species, with notes. Misc. Pub. Mus. Zool. Univ. Mich. 6: 1-213.
Wheeler, H.E. 1914. The unione fauna of Cache River, with descriptions of a new *Fusconaia* from Arkansas. Nautilus 28: 73-78.
Wheeler, H.E. 1918. The Mollusca of Clark County, Arkansas. Nautilus 31: 109-125.

MOLLUSCAN COMMUNITIES OF THE WEST FLORIDA SHELF

William G. Lyons
Florida Dept. of Natural Resources Marine Research Laboratory
St. Petersburg, FL 33701

The West Florida Shelf (Figure 1) is an area encompassing more than 30,000 square miles of the Eastern Gulf of Mexico, beginning just north of the Florida Keys but including the Dry Tortugas, then extending northward to Cape San Blas. Inshore, the fauna varies from primarily tropical Caribbean species in the south to warm-temperate continental species in the north. Several communities defined by temperature, salinity, and substrate are discernible.

The Dry Tortugas consists of a group of seven small islands in the extreme southeastern Gulf approximately 80 miles west of Key West but separated from the Keys by Rebecca Channel. The fauna consists almost entirely of hardier, more tolerant, shallow water tropical species. Substrate is entirely tropical carbonate and salinities almost always exceed 35 o/oo. The Tortugas are situated somewhat north of the moderating temperatures of the Florida Current, and the fauna is severely reduced in some years by extreme cold fronts from the north. Low salinities from freshwater Everglades run-off and toxicity from southwest Florida red tides have also been implicated in faunal damage.

Farther north, a strong tropical influence is exerted by the Loop Current, which passes on its downward swing over the outer portion of the shelf and occasionally releases eddies of Caribbean water to wash onto the shelf. Certain tropical species are doubtlessly recruited by this means. The Florida Middle Ground, a group of reefs rising to perhaps 20 m below the surface from depths of 30-40 m, provides a unique feature in the northeastern Gulf (Hopkins et al., 1977a, b). Many tropical species characterizing the fauna are rare or absent elsewhere on the West Florida Shelf (Lyons, 1976; Turgeon and Lyons, 1977).

Estuaries dominate the coastline from Cape Sable to Cape San Blas. Vegetation varies from vast mangrove forests in the south to *Spartina-Juncus* marshes in the north, and several species of seagrasses are common throughout the region. Sediments are primarily terrigenous quartz sands, but oyster reefs provide some hard substrate. Salinities vary from near zero to about 34 o/oo and temperatures fluctuate greatly (e.g., Taylor et al., 1970). Macronutrients are generally high. Molluscan diversity is high, especially in seaward portions of estuaries. I have recorded nearly 350 species in Tampa Bay. The southern Ten Thousand Islands and northern Big Bend areas are actually huge estuaries gradually merging seaward with offshore shelf communities. However, between these and to the far north, estuaries such as Charlotte Harbor, Tampa Bay, and St. George Sound are separated from the Gulf by a series of barrier islands with sandy, seaward beaches.

At least three vertical zones of faunal distribution occurring seaward from estuaries along the west coast of Florida have become apparent during analysis of material collected during the

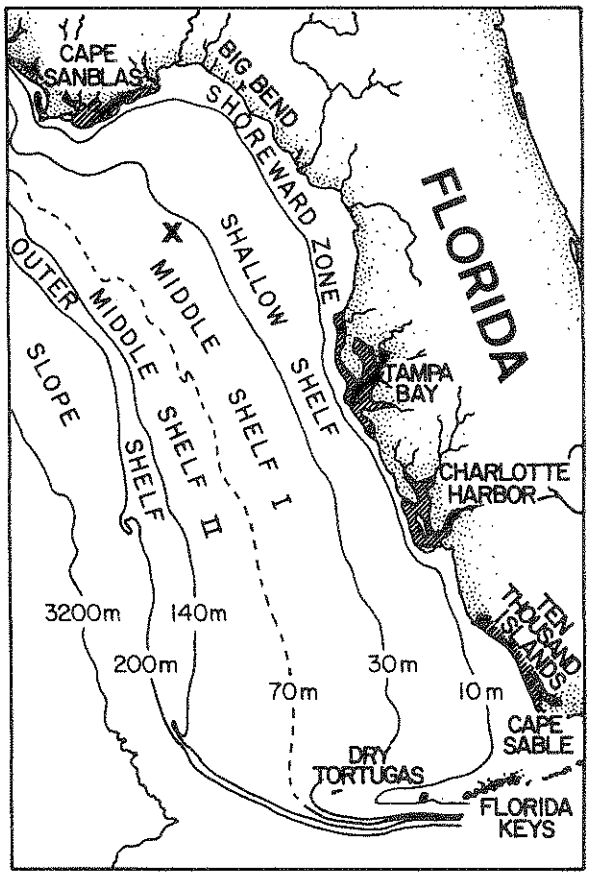

Figure 1. West Florida Shelf, showing subdivisions based upon faunal differences. Florida Middle Ground (x) and major estuaries (slanted shading) indicated.

Hourglass Cruises, a series of some 700+ dredge and trawl tows made by the R/V Hernan Cortez at 10 stations in depths from 6 to 73 m during 1965 through 1967 (Joyce and Williams, 1969). Distributional patterns indicating these zones have been discerned in analyses of several groups, including stomatopod, amphipod, isopod, and decapod crustaceans, mollusks, echinoids, and several families of benthic fishes.

The "nearshore," or "shoreward" zone (Lyons and Collard, 1974) occurs from the beach out to depths of approximately 10 m. Sediments are quartz sands, with little hard substrate except that provided by dead shells of large mollusks. Annual temperature fluctuations are considerable (Figure 2), and salinities usually range from 31-34 o/oo (Joyce and Williams, 1969). The fauna is characterized by warm-temperate bivalves. *Donax variabilis* is abundant along beaches. The nearshore fauna is dominated by large and moderately sized, warm-temperate bivalves; such species as *Anadara transversa, Noetia ponderosa, Atrina rigida, A. seminuda, Dinocardium robustum, Trachycardium egmontianum,* and *Merceneraria campechiensis* are common, as are large, predatory gastropods such as, *Polinices duplicatus, Busycon contrarium, Fasciolaria hunteria,* and *Pleuroploca gigantea.*

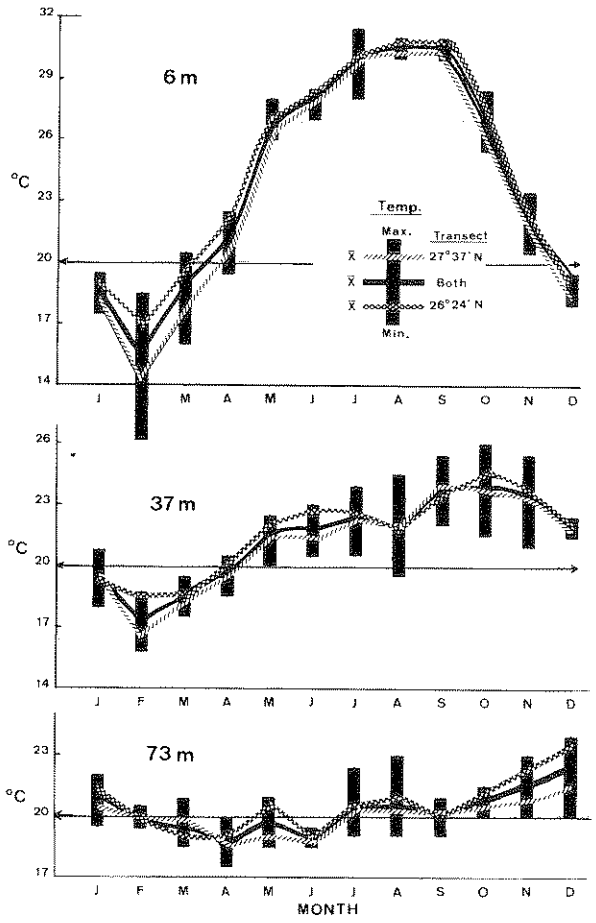

Figure 2. Minimum, maximum, and mean bottom temperatures at three depths (6, 37, and 73 m) each along two transects (26°24'N; 27°37'N) on the West Florida Shelf, August 1965 through November 1967; 37 m station of northern transect sampled bimonthly, all other stations sampled monthly.

The zone may be characterized as a rich, warm-temperate, upper euryhaline fauna, with obvious relationship to the estuary.

The next zone, designated the shallow shelf (Lyons and Collard, 1974), extends seaward to depths of about 30 or 40 m. Shallow depths permit considerable temperature fluctuations and the area is overlain by a mass of green, coastal water with salinities usually about 35-36 o/oo (Joyce and Williams, 1969). Although quartz sands persist, many warm-temperate Carolinean species have disappeared, and scattered limestone outcroppings provide substrate for a number of submerged, shallow water tropical species. As at Dry Tortugas, these are generally species more tolerant of environmental fluctuation.

At depths of about 30-40 m, the shallow shelf fauna intersects a deeper fauna which has been designated middle shelf (Lyons and Collard, 1974). Near the 30 m isobath, green coastal waters intersect with clearer, less enriched, but more stable blue waters of the middle and outer shelf. Salinities remain around 35o/oo and temperatures seldom fluctuate more than 3 or 4 degrees from the 20°C isotherm, stabilizing seaward (Figure 2). Sediments are predominantly calcareous except for a small intrusion of quartz sand off Charlotte Harbor, and limestone outcroppings are fairly common. This area, extending from about 40 m to about 140 m, may actually contain two subdivisions, but sufficient data is not available for the area beyond 73 m depths. That two zones may exist is indicated by an apparent center for abundance for many species between 50 and 60 m, and the rare occurrence of some apparently deeper water species at 73 m. Literature records indicating species whose ranges start at about 70 m and extend to about 140 m suggest that a second zone may exist within the middle shelf. The fauna is tropically derived but generally is distributed only along the more environmentally stable outer shelves of the southeastern United States and Gulf of Mexico. Much of it has descended from former Tertiary stocks of the southeastern U.S. As many as 600 to 800 molluscan species may inhabit the middle shelf, such diversity being allowed by the favorable environmental stability of the zone.

Material from commercial specimen shell dredgers indicates a distinctive fauna near the 200 m isobath. Literature records for many species additionally indicate a molluscan assemblage beginning at about 140 m and extending across the 200 m isobath to perhaps as deep as 400 m. To further illustrate these communities, I analyzed species of Muricidae on the West Florida Shelf. Of 27 species of muricids known within the area bounded by the northern Gulf and Florida Keys in depths 70 m or less, 21 species occurred in Hourglass collections. The six "missing" species include two *Dermomurex, D. elizabethae* and *D. pauperculus*; the latter was reported in the eastern Gulf by Radwin and D'Attilio (1976) but I have not seen specimens. *Trachypollia nodulosa*, a rock dweller seldom occurring deeper than intertidally in the Keys and Dry Tortugas, is absent to the north, and *Hexaplex fulvescens*, the common large, warm-temperate, continental species, is absent except in the extreme northwest corner of the shelf near Cape San Blas. *Favartia alveata*, a tropical species of the Florida Keys and Dry Tortugas, has been collected at the Florida Middle Ground and may further indicate the more tropical nature of that fauna. The sixth species, *Urosalpinx tampaensis*, is a west Florida endemic so restricted to estuaries that Hourglass sampling began seaward of its range.

Table 1 shows the number of samples containing a particular species at each depth in the Hourglass collections. Greatest incidence of occurrence for each species is underlined. Six species occurred at the 6 m stations, and three of these characterize the nearshore fauna. *Urosalpinx perrugata* is a west Florida endemic