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STERKIANA is named after Dr. Victor Sterki (1846-1933) of New Philadelphia, Ohio, famed for his work on the Sphaeriidae, Pupillidae, and Valloniidae. It is fitting that this serial should bear his name both because of his association with the Midwest and his lifelong interest in non-marine Mollusca.

The purpose of STERKIANA is to serve malacologists and paleontologists interested in the living and fossil non-marine Mollusca of North and South America by disseminating information in that special field. Since its resources are modest, STERKIANA is not printed by conventional means. Costs are kept at a minimum by utilizing various talents and services available to the Editor. Subscription and reprint prices are based on cost of paper and mailing charges.

STERKIANA accepts articles dealing with non-marine Mollusca of the Americas in English, French, or Spanish, the three official languages of North America. Contributors are requested to avoid descriptions of new species or higher taxa in this serial as the limited distribution of STERKIANA would probably prevent recognition of such taxa as validly published. Papers on distribution, ecology, and revised checklists for particular areas or formations are especially welcome but those on any aspect of non-marine Mollusca will be considered.

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STERKIANA es una coleccion de trabajos sobre los Moluscos extra-marinos viventes y fosiles de las dos Americas, editada por un grupo de malacólogos de los Estados Unidos centrales. Contenirá en el porvenir trabajos en inglés, francés, y español que serán acceptados por la mesa directiva. La correspondencia deberá ser dirigida al Editor.

PRECIO: 50¢ el número.

FOSSIL GASTROPODS FROM A PALEO-INDIAN ARCHAEOLOGICAL SITE IN CALGARY, ALBERTA, CANADA: LOCAL AND REGIONAL SIGNIFICANCE

Michael Wilson* and Aurèle La Rocque**

INTRODUCTION

In November, 1968 salvage archaeological excavations were conducted at the Mona Lisa site (EgPm-3 in the Canadian site numbering system) in Calgary, Alberta, Canada. Excavations for the basement of an art gallery encountered an extensive bison bone bed underlying the Mazama volcanic ash; and associated crude artifacts indicated that man was the predatory agent involved (Wilson, 1969b).

Bison bones constitute nearly the entire faunal sample from the site; these have been tentatively identified as a small form of *Bison bison occidentalis* (Wilson, 1969a, discussion: 208; Wilson, 1972; Wilson, n. d.). However, a small sample of gastropods was recovered during the preparation of the bone material. The semi-frozen nature of the soil and the necessarily brief nature of the salvage excavations limited sampling possibilities.

Gastropods were submitted to the junior author in 1972, and the results of detailed comparison are reported below. The

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TOPOGRAPHY

The Mona Lisa site is situated in southwest Calgary (51° 02' N. lat., 114° 05' W. long.), near the southern margin of the broad prehistoric floodplain of the Bow River. The altitude of the site is approximately 3445 feet above sea level. The present controlled river level at a point one mile north of the site is about 25 feet lower than the plain surface. Two-tenths of a mile south of the site an abrupt topographic rise to Mount Royal (3550 feet above sea level) delineates the prehistoric floodplain.

STRATIGRAPHY

Deposits in the site area are floodplain alluvium, ranging from cobble-size gravels to fine overbank silts and clays. To the south, Mount Royal is capped with stratified drift or outwash (Meyboom, 1961; Rutter and Wyder, 1969). The section at the site (measured by N. W. Rutter and B.O.K. Reeves) is summarized in Figure 2. A fourfold division of the section is made, based upon unconformities and changes in parent material.

During deposition of the cobbly to pebbly gravels of Unit A, the Bow River evidently flowed near the site, perhaps with

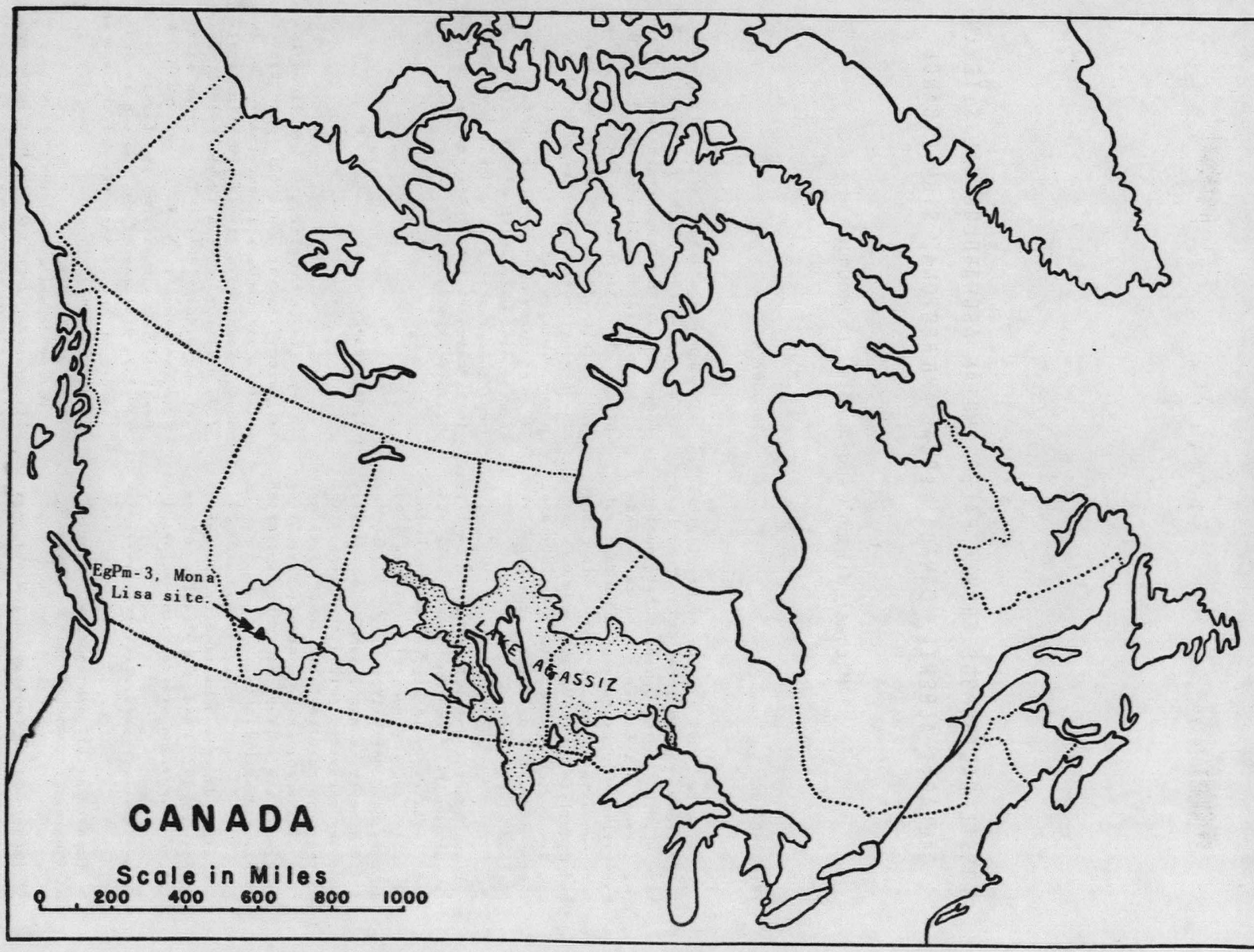

Fig. 1. The Mona Lisa site in relation to Lake Agassiz and postglacial drainage.

a meander or braid channel against the base of Mount Royal. This gravel is clearly derived from the west, and may include reworked materials from the high-terrace Morley Gravels of late Wisconsin age (Tharin, 1960; Meyboom, 1961), as well as outwash directly derived from latest Wisconsin valley glaciers to the west, receding from the Eisenhower readvance. This advance occurred more than 9300 radiocarbon years ago (Rutter, 1966a; 1966b). Unit A terminates in a well-developed black paleosol. A thickness of 3 to 5 cm. for its surface component falls far short of the requirements of the Mollic epipedon (Soil Survey Staff, 1960), although its darkness suggests the incipience of such development. The surface component may be referred to an Ochric epipedon, with a thin (5 to 7 cm.) gray Cambic subsurface horizon. A detailed study of this paleosol has yet to be performed.

Unit B marks renewed depositional activity; this time, however, in the form of overbank silts and clays with occasional pebbles of quartzite. Faint carbonaceous streaks suggest intermittent pedigenesis on the floodplain during this period. The bone bed is situated in the middle of Unit B and is not accompanied by any changes in parent material or grain size of sediments. A large sample of bone material including ribs and tibiae was submitted to the Geological Survey of Canada laboratories by Dr. N. W. Rutter for C-14 analysis, and a date of 8080 ± 150 radiocarbon years B.P. (G.S.C. 1209) was obtained (Lowdon, Robertson and Blake, 1971). A 2 σ range of 8080 ± 300 C-14 years almost certainly brackets the correct age, in view of age estimates for the underlying gravels and the overlying Mazama ash. Unit B thus falls within Late Pinedale times (=Valderan substage), or before the Hypsithermal interval (Richmond, 1965).

Unit C is a thin deposit of a grain size distribution comparable with that of Unit B. However, Unit C differs in origin, as it is made up of a large component of volcanic ash in addition to the silt loam. Samples from this unit were submitted to Mrs. Rose Okazaki and Dr. Henry W. Smith of the Department of Agronomy (Soils), Washington State University, for analysis. The samples were all identified as Mazama

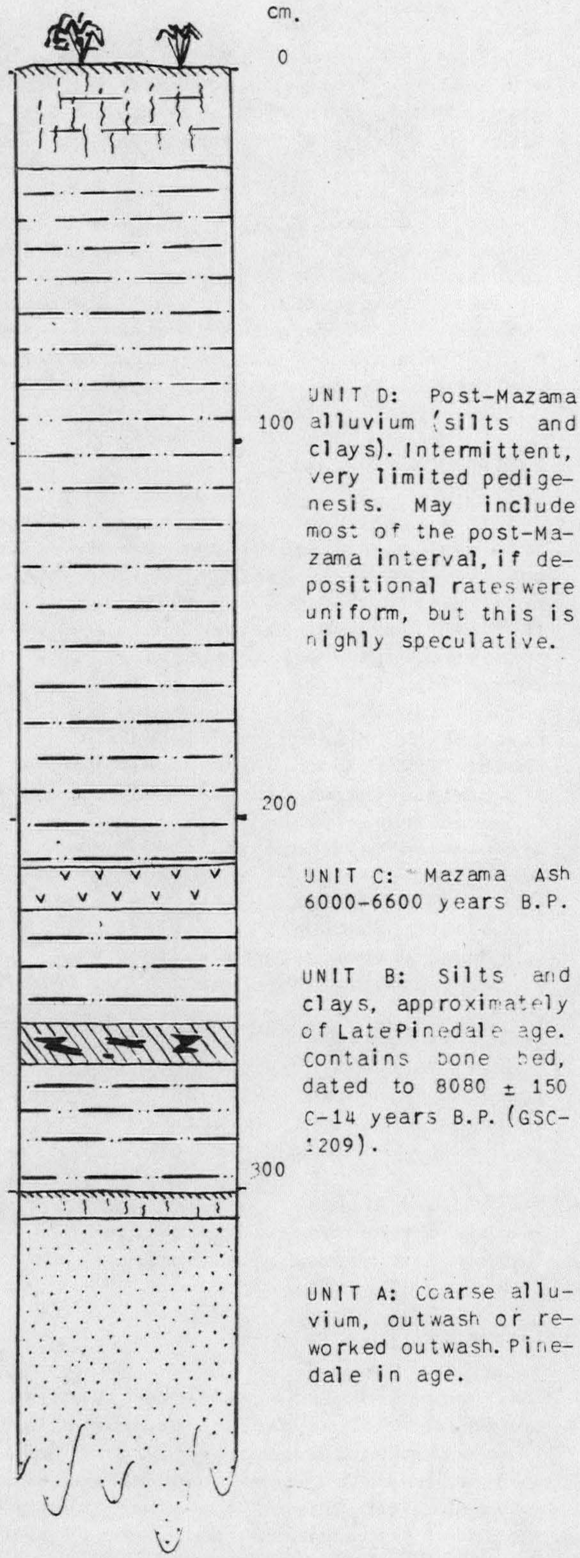

Fig. 2. The stratigraphic column at EgPm-3, Mona Lisa Site.

ash, derived from a widespread ash fall dating within theperiod 6600 to 6000 years B.P. (Fryxell, 1965; Westgate and Dreimanis, 1967; David, 1970).

Unit D includes all of the post-Mazama deposits at the site. Similar in nature to Unit B, this final deposit is composed of fairly homogeneous silts and clays with intermittent carbonaceous horizons a few millimeters thick. The duration of time represented by this unit is not known.

GASTROPODS FROM UNIT B

A small gastropod sample was recovered from Unit B. All gastropods came from the bone bed and thus the date of 8080 ± 150 C-14 years B. P. (G.S.C. 1209) is applied to them. In all, twelve specimens were submitted and two additional fragments were noted. They are identified as follows:

	N
Family PLANORBIDAE H. and A. Adams	
Subfamily PLANORBINAE H.A. Pilsbry	
Genus *Gyraulus* Agassiz	
Subgenus *Torquis* Dall	
Gyraulus parvus (Say) 1817	1
Family ENDODONTIDAE Pilsbry	
Subfamily ENDODONTINAE Pilsbry	
Genus *Discus* Fitzinger	
Discus cronkhitei (Newcomb)	1
Family VALLONIIDAE Pilsbry	
Genus VALLONIA Risso	
Vallonia pulchella (Müller)	5
Vallonia sp., cf. *V. excentrica* Sterki	5
Family ?LYMNAEIDAE	
Genus and species indeterminate	
?Lymnaeid body fragments (not saved)	2

INTERPRETATIONS

Although limited in diversity, this gastropod fauna allows preliminary assessment of environmental implications, in addition to considerations of gastropod paleogeography. The fragility of the forms involved precludes transport or redeposition with the possible exception of the ?Lymnaeid fragments; thus the fauna is considered autochthonous.

Gyraulus parvus (Say) has an extensive modern distribution across 'eastern North America east of the Rocky Mountains from Florida to Alaska and northern Canada' (La Rocque, 1968: 491). Modern *G. parvus* has been collected in Alberta, Saskatchewan, and Manitoba (Ibid.: 492; Tuthill, 1967: 301; Taylor, 1895: 176; Anonymous, 1896). The species appears in Illinoian, Sangamon and Wisconsin deposits of Kansas (Taylor and Hibbard, 1955: 7, 10) but early northern plains records seem to be lacking. The earliest record from our area is from Woodfordian and other late Wisconsin deposits of North Dakota (Clayton, 1961; Tuthill, 1961). Upper Lake Agassiz deposits (Upper Norcross, Campbell, and Gladstone beaches) contain abundant *G. parvus* (Tuthill, 1963; Tuthill, Laird and Kresl, 1964; Upham, 1895; Tuthill, 1967). The Gladstone record is slightly older than the Mona Lisa site material. *G. parvus* from post-Campbell beach deposits at Lavenham, Manitoba (Mozley, 1934) may also be of this age (approximately 9,000 years B. P.) but the evidence is far from conclusive. Zoltai (1969) recovered the species at several post-Upper Campbell, pre-McCauleyville deposits (approximately 10,000 years B. P.) in the Rainy River district of western Ontario. *G. parvus* occurs quite regularly in post-Lake Agassiz deposits (Mozley, 1934; Tuthill, 1967).

The wide North American distribution of *G. parvus*, a pulmonate snail, implies considerable ecological amplitude. La Rocque (1968:491) notes that the species is

> Generally found in quiet bodies of water, mainly those of small size, on mud, sandy mud, sand, gravel, or boulder bottom; also on logs and vegetation, in shallow water a foot or more, up to 4 feet deep. Its ideal habitat seems to be vegetation, in protected situations.

In North Dakota, the species evidently occurred in close proximity to a receding glacial front (Tuthill, 1961; Clayton, 1961). Tuthill (1966) found *G. parvus* in Alaskan waters with surface temperatures ranging from 12.8° C to 18.2° C.

O'Donoghue (1921) collected the species in storm deposits on a sand spit on Berens Island in Lake Winnipeg, Manitoba. O'Donoghue noted that the area has a long and severe winter, the temperature dropping to -40° F on occasion. The lake freezes for approximately five months each year.

Batchelder (1970) used the appearance of *G. parvus* in a California site section to indicate 'a change to water surface of small size, and the development of marsh-like conditions.' Clifford (1969) collected living *G. parvus* in a slowly moving muskeg or brown-water stream (the Bigoray River) in west-central Alberta.

> The stream was completely ice-covered for 5 months of the year and water temperatures were near 0° C for about 6 months of the year .... Air temperatures frequently drop to -30 or -40 C in winter, but the complete and rapid freeze-over in late autumn furnishes insulation from these temperatures ....Water temperatures.... rose rapidly in late spring and approached 20 C during the summer; but daily fluctuations were small .... the pH of the water was above 7.0 .... (Ibid.:580)

Clifford notes that 'the stream bed consists mainly of mud, silt and small gravel particles .... large growths of filamentous algae .... occur during late summer' (Ibid.: 579-580).

Tuthill (1963:99) contends that *G. parvus* 'can suceed in adverse conditions of high turbidity, high dissolved solids, and seasonal drying' if necessary. It is clear from this discussion that *G. parvus* could have existed with equal success both in quiet areas of the Bow River and in seasonal overbank ponds. O'Donoghue's (1921) record from Lake Winnipeg may not indicate success in a large open lake, since the sample contained elements derived locally from a nearby closed and protected embayment.

A final note concerning identification is in order. La Rocque (1968:491) observes,

> The temptation to identify all small unangulated forms of *Gyraulus*, whether living or fossil, as this species should be resisted until the specimens have been compared with other species of the genus .... Because of the tendency to lump everything under *G. parvus*, the distribution records are not as reliable as might be desired and careful comparisons are in order even when dealing with identified material.

It is interesting to note that all of the North Dakota material (and some from related areas) identified by S.J. Tuthill in the reports considered (Clayton, 1961; Tuthill, 1961; Tuthill, 1963; Tuthill, Clayton and Laird, 1964; Sherrod, 1963) is either *G. parvus* or, less commonly, *Gyraulus* sp. Clayton states, 'Because original descriptions or type specimens of most of the species were not examined, some of the identifications are tentative' (1961:12). In striking contrast, most of the western Canadian studies include species other than *G. parvus*: *G. deflectus* (Stalker, 1969 and Kahn, 1970; identified by C. H. D. Clarke); *G. cyclostomus* (Russell, 1934, identified by F.C. Baker and L. S. Russell; Westgate, 1968, identified by R. Green); *G. altissimus* (Russell, 1934, identified by Russell; Westgate, 1968, identified by R. Green); and *G. hornensis* (Trylich and Bayrock, 1966, identified by R. Green). We do not imply inconsistency, but it is interesting that certain species have specific identifiers. This is, at least in the North Dakota case, in part due to a paucity of comparative material (Clayton, 1961); therefore, the fossil distribution of '*G. parvus*' and perhaps some of the other species should be considered somewhat tentative. The distinctive characters enumerated by Baker (1934a; 1934b) for *G. cyclostomus*, *G. arcticus* and *G. hornensis* are extremely difficult to work with unless good comparative specimens are available. *G. altissimus* is apparently a composite species (Baker, 1934b). Monographic revision here is needed.

Discus cronkhitei (Newcomb), a terrestrial species, is also widely distributed: it is of almost ubiquitous occurrence in North America (La Rocque, 1970: 678, fig. 534). Modern *D. cronkhitei* are found throughout the northern plains area. The species is known from Kansan, Illinoian and Wisconsin deposits of the southern High Plains (Hibbard and Taylor, 1960: 143). The present record from the Mona Lisa site appears to be the earliest record from the northern plains, since other published records are from late stages of Lake Agassiz drainage (Mozley, 1934) and post-Hypsithermal deposits (Mozley, 1934; Tuthill, 1967).

La Rocque (1970:677) notes *D. cronkhitei* to be 'a species of wooded areas that lives in leaf litter or under logs and bark in wooded spots.' However, it has also been found under litter in more open, usually damp situations (Ibid.). Taylor (1895: 175) reported the occurrence of the species *('Patula striatella')* in a collection from 30 to 35 miles east of Red Deer, Alberta. A.O. Wheeler made this collection, of which Taylor says '.... the land shells .... were mostly collected in dried-up sloughs.' Our only suggestion regarding the occurrence of this species at the Mona Lisa site is that some tall vegetative cover, possibly quite dense, was present at places on the floodplain.

Vallonia pulchella (Müller), a terrestrial species, is quite widely distributed over North America east of the Rocky Mountains. It occurs south at least to Colorado and perhaps farther, but the possibility of introduction southward is strong. The species has been recorded for Manitoba and adjacent areas to the south (La Rocque, 1970: 758, fig. 614). Taylor (1895: 177) recorded *'Vallonia pulchella* Mueller sp. form *gracilicosta,* Reinh.' in his table; hoeever, he elsewhere referred to it (Ibid.: 175) as *'Vallonia costata* form *gracilicosta)'*. The latter reference appears to be the correct one.

As a fossil *V. pulchella* is known from Yarmouth to Recent times in the Midwest and central plains (La Rocque, 1970:758). In our area, the present occurrence appears to be the only fossil record thus far.

We take the opportunity here of correcting an error in the stated range of this species by one of us. La Rocque (1970: 757) states that the species occurs from '.... west to Manitoba and Alaska ....' in Canada. This is an error which came about from listing Dall's records of the species as though it occurred in Alaska. A search of available records and the literature shows that it does not in fact occur in Alaska unless it has been listed under some other name. Since it is found in Siberia only east to the Amur it is possible that its distribution has a large gap in the Holarctic region. The map showing the distribution of the species in La Rocque (1970: 758) shows no record of the species for Alaska, Yukon Territory, British Columbia, and Alberta. The nearest record to Alberta is that of Hanham for Manitoba (1899: 1-6) in which he gives three localities: Holland, about 98° 52'W and 49° 35' N which is the only one we have been able to locate on the map; and the Pembina Mts. of earlier records which are farther to the east. The possibility remains that *V. pulchella* may yet be found in Alberta but that province can not at present be included in its range except as a fossil as recorded above for the Mona Lisa site.

V. pulchella 'is found occasionally in drier more open woods and fields .... but also occurs in wetter locations' (La Rocque, ibid.:757; after Oughton, 1948). The species can tolerate dry forest litter and can be quite abundant in leaf mold (La Rocque, ibid.).

Several specimens from the Mona Lisa site closely resemble *Vallonia excentrica,* a third terrestrial species. If this is the case, this would be the first fossil record of the species in North America.

Modern North American occurrences of *V. excentrica* range through the northeastern United States as well as adjacent Ontario, Quebec, Nova Scotia, and Newfoundland. Other occurrences are in Colorado and on the west coast; these have been interpreted as introductions (La Rocque, 1970:759-760, fig. 616). If the present specimens are indeed *V. excentrica,* the possibility remains that the Colorado population is relict.

V. excentrica ranges in habitat from 'damp to dry: damp protected places or relatively dry exposed habitats. This species is more tolerant of drouth than others and requires little cover' (La Rocque, ibid.:759).

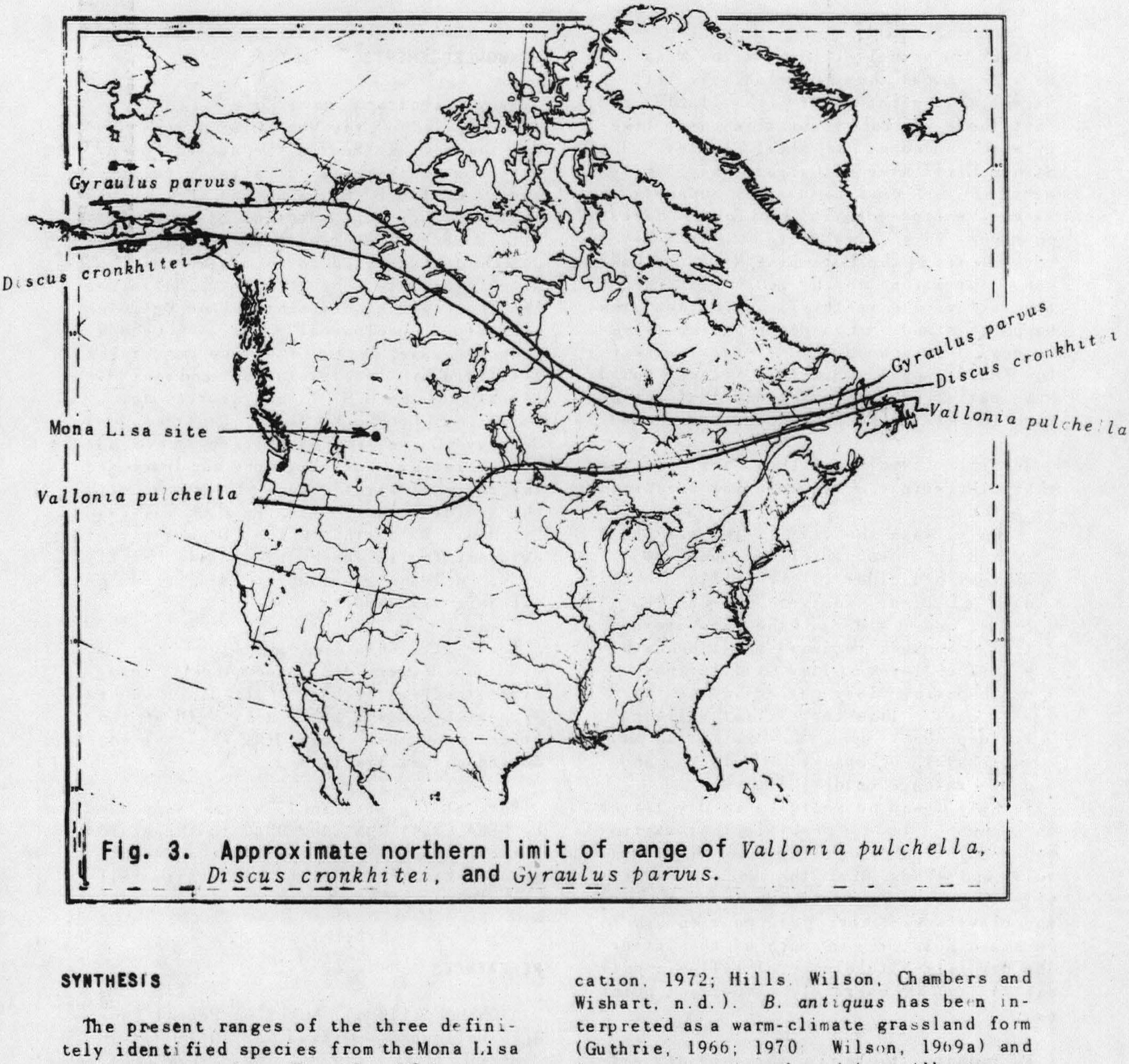

Fig. 3. Approximate northern limit of range of *Vallonia pulchella, Discus cronkhitei,* **and** *Gyraulus parvus.*

SYNTHESIS

The present ranges of the three definitely identified species from the Mona Lisa site are mapped in Fig. 3. Of interest is the apparent southward restriction of *Vallonia pulchella* (and possibly *V. excentrica)* since 8080 C-14 years B. P., this may indicate that conditions at the site were rather comparable to those 200 to 300 miles to the south today.

Interestingly enough, the only dated occurrence of *Bison antiquus* in Alberta, also from Calgary, is chronologically close: 8145 ± 320 C-14 years B. P. (bone date) (Gx-2104; B.O.K. Reeves, personal communication, 1972; Hills, Wilson, Chambers and Wishart, n.d.). *B. antiquus* has been interpreted as a warm-climate grassland form (Guthrie, 1966; 1970; Wilson, 1969a) and its movement northward into Alberta may have been in response to climatic fluctuations. *Bison bison occidentalis* is well documented in Alberta during the period 12,000 to 10,000 years B.P. (Trylich and Bayrock, 1966; Churcher, 1968; and others). Bison from the Mona Lisa site have been referred to *B. bison occidentalis* but the two 'species' are extremely difficult to distinguish in the absence of adult male horn cores. Very likely the two are merely ecological variants of the same species, significant only at the subspecies level.

About the actual ecology of the Mona Lisa site we can thus say relatively little, except that quiet water was available, and that there was tall vegetative cover, likely with abundant dry leaf litter. The Spruce Cliff area of Calgary, only 3 miles west of the Mona Lisa site, supports an extensive topo-edaphic coniferous forest on slopes in an area where the Bow River cuts cliffs in the Porcupine Hills and Paskapoo formations on the southwest side of the valley. The valley floor in that area supports stands of aspen *(Populus tremuloides)*, cottonwood *(P. deltoides)* and willow *(Salix* spp.). Similar stands would have satisfied the cover and leaf litter requirements of the gastropods considered.

Tuthill (1966) describes leaf litter characteristics in a proglacial situation in Alaska:

> On outwash the leaf litter was observed to be completely dry under 15-25-year-old alder in as little as 2 days of clear weather, whereas leaf litter under alders of the same age on till or bedrock remained moist beneath a surface layer of four or five leaves depth during clear periods of as long as 8 days. Thus terrestrial Mollusca are dependent upon a combination of successful occupancy by alders and poor drainage conditions.

Tuthill found no molluscs in dry litter on outwash. It is possible that gastropod populations in litter on river gravels and sands near the Mona Lisa site were low; however, drainage through silts and clays would have been poor enough to maintain moisture in much of the litter. The dry litter tolerance of *Vallonia pulchella* is an extremely important point here.

In summary, there is very slender evidence from gastropod distributions that temperatures may have been slightly warmer or conditions slightly drier 8000 years ago than at present, at the Mona Lisa site. However, the complexity of the problem involved restricts our speculation in this regard. There is no clear evidence for major climatic fluctuations.

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Many scientists gave freely of their time in aid of the Mona Lisa site study. Dr. Brian O. K. Reeves, Department of Archaeology, University of Calgary, Calgary; and Dr. Leslie B. Davis, now of the Department of Sociology, Montana State University, Bozeman, devoted long hours throughout the field period to excavation and on-site interpretations. Dr. N. W. Rutter of the Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, Calgary, gave detailed advice concerning stratigraphic interpretations and sent material to the G.S.C. laboratories for C-14 dating. Dr. L. V. Hills, Department of Geology, University of Calgary, gave advice relating to stratigraphy and discussed the regional stratigraphy of the area with the senior author. Mrs. Rose Okazaki and Dr. Henry W. Smith of the Department of Agronomy (Soils), Washington State University, Pullman, generously identified the volcanic ash samples.

Above all, our deep gratitude goes to Mr. John Beeger, Jr., who quickly recognized the significance of the finds on his property, and who graciously held up construction of the new building while we conducted our excavations.

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THE LAND SNAILS OF TENNESSEE

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This paper lists the land snails of Tennessee as represented by specimens in the collection of the author. Most of the records are from the eastern half of the State, with only scattered records from the western part. As in previous papers of this series, only the counties are listed for the records.

Polygyra pustuloides (Bland). Coffee, DeKalb, Hamilton, Monroe, Sequatchie, Warren.

Polygyra plicata Say. Anderson, Bledsoe, Blount, Bradley, Campbell, Claiborne, Cumberland, Fentress, Franklin, Grundy, Hamilton, Hardin, Knox, Loudon, Marion, Monroe, Montgomery Overton, Polk, Putnam, Rhea, Roane, Sequatchie, Sevier, Union, Van Buren, Warren, White.

Polygyra fatigiata Say. Montgomery.

Polygyra troostiana Lea. Bedford, Cannon, Davidson DeKalb, Hickman, Jackson, Maury, Pickett, Rutherford, Smith, Sumner, Trousdale, Williamson, Wilson.

Stenotrema spinosum (Lea). Claiborne, Franklin, Grainger, Grundy, Hamilton, Knox, Marion, Monroe, Perry.

Stenotrema edgarianum (Lea). Cumberland, Marion, Sequatchie.

Stenotrema barbigerum (Redfield). McMinn, Polk.

Stenotrema edvardsi (Bland). Claiborne, Carter, Fentress, Johnson, Morgan, Scott, Sullivan.

Stenotrema waldense Archer. Campbell, Claiborne.

Stenotrema altispira (Pilsbry). Carter, Sevier.

Stenotrema depilatum (Pilsbry). Monroe, Sevier.

Stenotrema calvescens Hubricht. Bledsoe, Bradley, Franklin, Grundy, Hamilton, Marion, Sequatchie.

Stenotrema barbatum (Clapp). Cumberland, Hamilton, White.

Stenotrema angellum Hubricht. Clay, Fentress, Jackson.

Stenotrema stenotrema stenotrema (Pfeiffer). Anderson, Bedford, Bledsoe, Blount, Bradley, Campbell, Carter, Cheatham, Claiborne, Clay, Cocke, Cumberland, Davidson, DeKalb, Fentress, Franklin, Grainger, Greene, Grundy, Hamblin, Hamilton, Hancock, Hardin, Hawkins, Hickman, Jackson, Johnson, Knox, Loudon, Macon, Marion, Meigs, Monroe, Montgomery, Moore, Morgan, Overton, Pickett, Polk, Putnam, Rhea, Roane, Rutherford, Scott, Sevier, Sequatchie, Smith, Sullivan, Sumner, Trousdale, Unicoi, Van Buren, Warren, Washington, White, Wilson.

Stenotrema stenotrema voluminosum (Clench & Banks). Polk, Sevier.

Stenotrema stenotrema nudum (Pilsbry). Wilson.

Stenotrema magnifumosum (Pilsbry). Monroe, Polk, Sevier, Van Buren.

Stenotrema pilula (Pilsbry). Bledsoe, Blount, Cumberland, Sequatchie, Sevier, Van Buren, White.

Stenotrema hirsutum (Say). Bledsoe, Cumberland, Fentress, Humphreys, Jackson, Madison, Marion, McMinn, Morgan, Overton, Pickett, Scott, Wayne, White.

Stenotrema turbinella (Clench & Archer). Franklin, Marion.

Stenotrema deceptum (Clapp). Franklin, Marion.

Stenotrema cohuttense (Clapp). Polk.

Stenotrema leai aliciae (Pilsbry). Bedford, Coffee, Franklin, Hardin, Shelby, Wilson.

Stenotrema fraternum fraternum (Say). Cumberland, Grainger, Greene, McMinn, Rutherford, Sullivan.

Mesodon thyroidus (Say). Anderson, Bledsoe, Blount, Bradley, Campbell, Cannon, Carter, Claiborne, Cocke, Cumberland, Davidson, DeKalb, Fentress, Grainger, Greene, Grundy, Hardeman, Hamblin, Hamilton, Hawkins, Hickman, Jackson, Knox, Lawrence, Marion, McMinn, Monroe, Morgan, Overton, Polk, Putnam, Roane, Ruth[illegible] Scott, Sevier, Shelby, Smith, St[illegible]wart, [illegible]nicoi, Warren, Washington, White, Wi[illegible]

Mesodon clausus clausus (Say). Blount, Campbell, Carter, Claiborne, Coffee, Cocke, Cumberland, Hamilton, Hancock, Hickman, Johnson, McMinn, Monroe, Sevier, Smith, Sullivan, Warren, Washington.

Mesodon sanus (Clench & Archer). Franklin, Marion.

Mesodon downianus (Bland). Grundy, Marion.

Mesodon kalmianus Hubricht. Morgan, Overton, Scott.

Mesodon andrewsae W. G. Binney. Carter, [illegible]

Mesodon normalis (Pilsbry). Blount, Carter, Greene, Johnson, Monroe, Polk, Sevier, Unicoi. The record for this species from near Pikeville, Bledsoe Co. (Pilsbry, LMNA 1:720) is based on a slightly immature specimen of *Mesodon zaletus* (Binney).

Mesodon zaletus (Binney). Blount, Campbell, Carter, Cheatham, Cocke, Cumberland, Davidson, DeKalb, Fentress, Franklin, Grundy, Hamilton, Hickman, Jackson, Knox, Macon, Marion, Maury, Monroe, Montgomery, Morgan, Pickett, Putnam, Roane, Robertson, Rutherford, Scott, Sequatchie, Sevier, Smith, Sullivan, Van Buren, Warren, White, Wilson.

Mesodon elevatus (Say). Claiborne, Clay, Cocke, Davidson, Franklin, Grainger, Jackson, Knox, Macon, Marion, Maury, Monroe, Montgomery, Rutherford, Smith, Sumner, White, Wilson.

Mesodon clarki clarki (Lea). Blount, Monroe, Sevier.

Mesodon christyi (Bland) Blount, Monroe, Sevier.

Mesodon wheatleyi (Bland). Carter, Monroe, Sevier.

Mesodon ferrissi (Pilsbry). Sevier.

Mesodon laevior Hubricht. Cheatham, Davidson, Franklin, Hamilton, Hickman, Jackson, Macon, Marion, Maury, Montgomery, Overton, Pickett, Roane, Robertson, Smith, Warren.

Mesodon appressus (Say). Anderson, Campbell, Carter, Claiborne, Cocke, Grainger, Greene, Hamblin, Knox, Macon, Morgan, Putnam, Rhea, Roane, Scott, Washington, White.

Mesodon perigraptus (Pilsbry). Blount, Bradley, Cocke, Davidson, DeKalb, Franklin, Grundy, Hamilton, Marion, Monroe, Overton, Polk, Putnam, Roane, Sevier, Smith, Trousdale, Unicoi, Van Buren, White.

Mesodon wetherbyi (Bland). Anderson, Campbell, Cumberland, Fentress, Morgan.

Mesodon jonesianus (Archer). Sevier.

Mesodon subpalliatus (Pilsbry). Carter.

Mesodon sayanus (Pilsbry). Washington.

Mesodon chilhoweensis (Lewis). Blount, Campbell, Cumberland, Morgan, Sevier.

Mesodon rugeli (Shuttleworth). Anderson, Bledsoe, Blount, Bradley, Campbell, Claiborne, Clay, Cocke, Cumberland, Fentress, Franklin, Grainger, Greene, Grundy, Hamblin, Hamilton, Hawkins, Jackson, Johnson, Knox, Marion, McMinn, Monroe, Morgan, Overton, Pickett, Polk, Putnam, Rhea, Roane, Scott, Sequatchie, Sevier, Smith, Sullivan, Unicoi, Van Buren, Washington, White.

Mesodon smithi (Clapp). Franklin.

Mesodon inflectus (Say). Anderson, Bedford, Bledsoe, Blount, Bradley, Cannon, Campbell, Carter, Cheatham, Chester, Claiborne, Coffee, Crockett, Davidson, DeKalb, Franklin, Gibson, Grainger, Greene, Grundy, Hamilton, Hardeman, Hardin, Hickman, Humphreys, Jackson, Jefferson, Knox, Lawrence, Loudon, Macon, Marion, McMinn, McNairy, Monroe, Montgomery, Moore, Polk, Putnam, Rhea, Roane, Rutherford, Sevier, Shelby, Smith, Sumner, Trousdale, Unicoi, Union, Warren, Washington, Wayne, White, Wilson.

Triodopsis rugosa Pilsbry. Carter.

Triodopsis tridentata (Say). Anderson, Bledsoe, Blount, Bradley, Campbell, Cannon, Carter, Cheatham, Chester, Claiborne, Coffee, Crockett, Davidson, DeKalb, Franklin, Gibson, Grainger, Greene, Grundy, Hamilton, Hardeman, Hardin, Hickman, Humphreys, Jackson, Jefferson, Knox, Lawrence, Loudon, Macon, Marion, McMinn, McNairy, Monroe, Montgomery, Moore, Polk, Putnam, Rhea, Roane, Rutherford, Sevier, Shelby, Smith, Sumner, Trousdale, Unicoi, Union, Warren, Washington, Wayne, White, Wilson.

Triodopsis rugosa Pilsbry. Carter.

Triodopsis tridentata (Say). Anderson, Bledsoe, Blount, Bradley, Campbell, Cannon, Carter, Cheatham, Claiborne, Cocke, Cumberland, DeKalb, Dickson, Fentress, Franklin, Grainger, Greene, Grundy, Hamilton, Hamblin, Hancock, Hawkins, Jackson, Johnson, Knox, Lawrence, Lincoln, Macon, Marion, McMinn, Morgan, Overton, Pickett, Polk, Putnam, Roane, Robertson, Scott, Sequatchie, Sevier, Unicoi, Union, Van Buren, Warren, Washington, White.

Triodopsis tennesseensis (Walker). Campbell, Cocke, Fentress, Grainger, Hamilton, Roane, Scott, Smith, Sullivan.

Triodopsis complanata. (Pilsbry). Jackson.

Triodopsis vulgata Pilsbry. Anderson, Bedford, Bradley, Carter, Claiborne, Cumberland, Franklin, Fentress, Grainger, Grundy, Hamilton, Jackson, Johnson, Knox, Lincoln, Marion, Monroe, Putnam, Roane, Rutherford, Scott, Stewart, Unicoi, Van Buren, Wilson.

Triodopsis clairbornensis Lutz. Campbell, Claiborne.

Triodopsis fallax fallax (Say). Blount.

Triodopsis alabamensis (Pilsbry). Grundy, McMinn.

Triodopsis hopetonensis (Shuttleworth). Anderson, Campbell, Hamilton, Marion, McMinn, Rhea.

Triodopsis obstricta (Say). Cheatham, Davidson, Dyer, Fentress, Franklin, Hamilton, Hickman, Macon, Marion, Smith, Van Buren, Warren.

Triodopsis denotata (Férussac). Anderson, Greene, Grundy, Hamilton, Hardin, Knox, Polk, Sullivan, Union.

Triodopsis caroliniensis (Lea). Franklin, Polk.

Triodopsis fosteri fosteri (F. C. Baker). Shelby.

Triodopsis albolabris (Say). Anderson, Blount, Campbell, Carter, Cumberland, Grainger, Greene, Marion, Pickett, Roane, Rutherford, Scott, Sevier, Unicoi, Union, Washington, White.

Triodopsis alleni (Wetherby). Franklin.

. *Triodopsis major* (Binney). Blount, Bradley, DeKalb, Franklin, Hamilton, Marion, McMinn, Monroe, Polk.

Allogona profunda (Say). Carter, Clay, Smith.

Rabdotus dealbatus dealbatus (Say). Davidson, Rutherford, Sumner, Wilson.

Opeas pyrgula Schmacker & Boettger. Hamilton.

Haplotrema concavum (Say). Anderson, Blount, Bradley, Campbell, Carter, Cheatham, Claiborne, Cocke, Cumberland, Davidson, Fentress, Franklin, Grainger, Greene, Grundy, Hamblin, Hamilton, Hickman, Jackson, Johnson, Knox, Lawrence, Macon, Marion, Maury, Meigs, Monroe, Montgomery, Overton, Polk, Putnam, Rhea, Roane, Scott, Sevier, Smith, Sullivan, Unicoi, Union, Van Buren, Warren, Washington, White.

Haplotrema kendeighi Webb. Blount, Sevier.

Euconulus chersinus chersinus (Say). Anderson, Bledsoe, Blount, Campbell, Cannon, Claiborne Cocke, Coffee, Fentress, Franklin, Grainger, Greene, Grundy, Hamilton, Hawkins, Knox, Loudon, Maury, Monroe, Overton, Roane, Rutherford, Sequatchie, Sevier, Shelby, Warren, White, Wilson.

Euconulus dentatus (Sterki). Macon.

Guppya sterkii (Dall). Blount, Cocke, Franklin, Grainger, Knox, Monroe, Roane, Unicoi, White, Wilson.

Glyphyalinia burringtoni (Pilsbry). Blount, Carter, Cocke, DeKalb, Hawkins, Sevier.

Glyphyalinia cumberlandiana (Clapp). Franklin, Lincoln, Marion, Monroe, Polk.

Glyphyalinia roanensis (H. B. Baker). Anderson, Carter, Grundy, Marion, Monroe, Unicoi.

Glyphyalinia wheatleyi (Bland). Anderson, Blount, Cannon, Claiborne, Cumberland, Knox, Macon, Moore, Morgan, Overton, Pickett, Roane, Rutherford, Scott, Sevier, White.

Glyphyalinia lewisiana (Clapp). Franklin, Wilson.

Glyphyalinia specus Hubricht. Bedford, Cannon, Grundy, Jackson, Sullivan, Van Buren.

Glyphyalinia pentadelphia (Pilsbry). Blount, Monroe, Polk, Sevier.

Glyphyalinia rhoadsi (Pilsbry). Blount, Sevier.

Glyphyalinia indentata (Say). Anderson, Bedford, Bledsoe, Blount, Bradley, Campbell, Cannon, Carter, Cheatham, Claiborne, Clay, Cocke, Coffee, Crockett, Cumberland, Davidson, DeKalb, Dickson, Fentress, Franklin, Grundy, Hamblin, Hamilton, Hawkins, Johnson, Lincoln, Macon, Marion, Maury, Monroe, Montgomery, Moore, Morgan, Overton, Perry, Pickett, Polk, Rhea, Roane, Robertson, Rutherford, Scott, Sequatchie, Sevier, Shelby, Sumner, Van Buren, Warren, White, Wilson.

Glyphyalinia caroliniensis (Cockerell). Campbell, Carter, Claiborne, Cocke, Greene, Polk, Sevier.

Glyphyalinia cryptomphala (Clapp). Anderson, Claiborne Cumberland, Davidson, DeKalb, Franklin, Hardin, Knox, Madison, Marion, Roane, Sevier, Smith, Van Buren, Warren.

Glyphyalinia solida (H. B. Baker). Bledsoe, Claiborne, DeKalb, Humphreys, Macon, Marion, Maury, Monroe, Montgomery, Overton, Sequatchie, Smith, Sumner, Van Buren.

Glyphyalinia praecox (H.B. Baker). Anderson, Blount, Carter, Cocke, Fentress, Grainger, Hamilton, Hawkins, Marion, Monroe, Morgan, Perry, Rhea, Roane.

Glyphyalinia rimula Hubricht. Cannon, Clay, Jackson, Overton, Scott.

Glyphyalinia sculptilis (Bland). Blount, Cocke, Cumberland, Fentress, Hardeman, Marion, Monroe, Moore, Polk.

Mesomphix inornatus (Say). Claiborne, Fentress, Grainger, White.

Mesomphix andrewsae (Pilsbry). Blount, Monroe, Sevier.

Mesomphix subplanus (Binney). Sevier.

Mesomphix rugeli (W.G. Binney). Carter, Sullivan, Unicoi.

Mesomphix vulgatus H. B. Baker. Clay, Macon, Pickett, Robertson, Sumner.

Mesomphix anurus Hubricht. Campbell, Cannon, Cheatham, Davidson, DeKalb, Dickson, Fentress, Franklin, Grundy, Hamilton, Hickman, Jackson, Macon, Marion, Maury, Montgomery, Smith, Sumner, Warren.

Mesomphix perlaevis (Pilsbry). Anderson, Bedford, Blount, Bradley, Campbell, Cannon, Carter, Claiborne, Cocke, Cumberland, Grundy, Hamilton, Lincoln, Marion, McMinn, Monroe, Morgan, Polk, Putnam, Rhea, Roane, Scott, Sevier, Unicoi, Union, Van Buren, Warren, White.

Mesomphix latior (Pilsbry). Bledsoe, Blount, Bradley, Monroe, Polk, Sevier, Washington.

Mesomphix globosus (MacMillan). Obion, Shelby, Williamson.

Mesomphix ruidus Hubricht. Montgomery, Rutherford.

Mesomphix cupreus (Rafinesque). Blount, Carter, Claiborne, Cocke, DeKalb, Fentress, Grainger, Greene, Grundy, Hawkins, Knox, Monroe, Roane, Scott, Sevier, Sullivan, Union, Van Buren, Washington, White.

Mesomphix capnodes (W. G. Binney). Anderson, Bledsoe, Campbell, Cheatham, Claiborne, DeKalb, Franklin, Greene, Grundy, Hamilton, Johnson, Macon, Marion, Sequatchie, Van Buren, Warren, White, Wilson.

Vitrinizonites latissimus (Lewis). Carter, Monroe, Sevier, Unicoi.

Paravitrea multidentata (Binney). Campbell, Carter, Claiborne, Fentress, Grainger, Hawkins, Macon, Monroe, Morgan, Polk, Robertson, Scott, Sevier, Unicoi.

Paravitrea walkeri (Pilsbry). Blount, Monroe.

Paravitrea variabilis H.B. Baker. Bledsoe, Sequatchie.

Paravitrea andrewsae (W.G. Binney). Carter.

Paravitrea reesei Morrison. Johnson.

Paravitrea tridens Pilsbry. Carter, Cocke, Unicoi.

Paravitrea petrophila (Bland). Cocke, Knox, Marion.

Paravitrea placentula (Shuttleworth). Bradley, Cocke, Franklin, Knox, Polk, Sevier, Unicoi.

Paravitrea metallacta Hubricht. Cannon, DeKalb, Smith, Warren, White.

Paravitrea blarina Hubricht. Anderson, Claiborne, Grainger, Hawkins, Jackson, Knox.

Paravitrea tantilla Hubricht. Fentress, Grainger, Grundy, Hawkins, Lincoln, Overton, Van Buren, Warren, White.

Paravitrea lapilla Hubricht. Davidson.

Paravitrea capsella (Gould). Anderson, Blount, Campbell, Cannon, Clay, Cocke, Cumberland, DeKalb, Fentress, Franklin, Hamblin, Hamilton, Hancock, Hardin, Jackson, Macon, Marion, Monroe, Montgomery, Overton, Polk, Roane, Robertson, Scott, Sevier, Smith, Sullivan, Sumner, Wilson.

Paravitrea calcicola H.B.Baker. Blount, Marion, Polk.

Paravitrea smithi (Walker). Marion.

Pilsbryna castanea H.B. Baker. Marion.

Pilsbryna aurea H. B. Baker. Unicoi.

Hawaiia minuscula minuscula (Binney). Clay, Greene, Marion, Moore, Morgan, Montgomery, Roane, Sequatchie, Shelby, Smith, Trousdale, Wilson.

Gastrodonta interna interna (Say). Bledsoe, Bradley, Cannon, Clay, Coffee, Cocke, Cumberland, DeKalb, Fentress, Franklin, Grundy, Hamilton, Hardin, Jackson, Jefferson, Lawrence, Lincoln, Macon, Marion, Marshall, McMinn, Meigs, Monroe, Morgan, Overton, Perry, Pickett, Polk, Putnam, Rhea, Roane, Scott, Sequatchie, Sevier, Smith, Stewart, Sumner, Trousdale, Unicoi, Van Buren, Warren, Wayne, White.

Ventridens gularis (Say). Anderson, Blount, Bradley, Campbell, Cocke, Grainger, Grundy, Hamilton, Johnson, Knox, Marion, Morgan, Polk, Rhea, Roane, Scott, Sequatchie, Sevier, Union, Warren.

Ventridens collisella (Pilsbry). Anderson, Blount, Campbell, Claiborne, Cumberland, Grainger, Hamilton, Hawkins, Jefferson, Knox, Marion, McMinn, Rhea, Roane, Sevier, Sullivan, Union, Washington.

Ventridens decussatus (Walker & Pilsbry). Carter, Monroe, Unicoi.

Ventridens pilsbryi Hubricht. Bledsoe, Blount, Bradley, Campbell, Carter, Claiborne, Cocke, Cumberland, Fentress, Franklin, Greene, Grundy, Hamilton, Hawkins, Marion, McMinn, Meigs, Monroe, Polk, Rhea, Roane, Scott, Sequatchie, Sevier, Unicoi, Van Buren, Washington.

Ventridens theloides (Walker & Pilsbry). Bledsoe, Campbell, Cumberland, DeKalb, Fentress, Grainger, Greene, Grundy, Hawkins, Macon, Meigs, Morgan, Overton, Pickett, Polk, Rhea, Roane, Scott, Sequatchie, Van Buren, Warren, White.

Ventridens lawae (W.G. Binney). Anderson, Bradley, Campbell, Cannon, Claiborne, Clay, Cocke, Cumberland, DeKalb, Fentress, Grainger, Grundy, Hamblin, Hamilton, Knox, Loudon, Macon, Marion, Monroe, Morgan, Overton, Polk, Rhea, Roane, Scott, Sevier, Union, Van Buren, Warren.

Ventridens coelaxis (Pilsbry). Carter, Johnson.

Ventridens lasmodon (Phillips). Claiborne, Greene, Hawkins, Knox, Monroe, Roane, Sevier, Union.

Ventridens demissus (Binney). Anderson, Bedford, Campbell, Cannon, Carter, Cheatham, Claiborne, Coffee, Cumberland, Fentress, Grundy, Hawkins, Hickman, Humphreys, Lincoln, Macon, Monroe, Montgomery, Moore, Morgan, Overton, Rhea, Roane, Rutherford, Scott, Smith, Trousdale, Union, Warren, Wilson.

Ventridens percallosus (Pilsbry). Anderson, Campbell, Davidson, Rutherford.

Ventridens acerra (Lewis). Blount, Carter, Claiborne, Cumberland, Franklin, Hawkins, Marion, Monroe, Sevier.

Ventridens ligera (Say). Anderson, Clay, DeKalb, Hamilton, Lauderdale, Macon, Marion, Meigs, Perry, Roane, Shelby.

Ventridens intertextus (Binney). Blount, Bradley, Claiborne, Coffee, DeKalb, Fentress, Hamilton, Marion, Monroe, Polk, Rhea, Roane, Sequatchie, Sevier.

Ventridens eutropus Pilsbry. Cheatham, DeKalb, Macon, Putnam.

Ventridens elliotti (Redfield). Blount, Cocke, Cumberland, Polk, Sevier.

Zonitoides arboreus (Say). Anderson, Bedford, Bledsoe, Blount, Bradley, Claiborne, Cocke, Coffee, Cumberland, Davidson, DeKalb, Franklin, Greene, Grundy, Hamilton, Jackson, Knox, Loudon, Marion, McMinn, Monroe, Morgan, Montgomery, Overton, Pickett, Polk, Rhea, Roane, Scott, Sequatchie, Sevier, Shelby, Sumner, Van Buren, Warren, White, Wilson.

Zonitoides lateumbilicatus (Pilsbry). Marion.

Striatura meridionalis (Pilsbry & Ferriss). Anderson, Bledsoe, Blount, Coffee, Fentress, Franklin, Grainger, Greene, Hawkins, Knox, Marion, Monroe, Montgomery, Morgan, Overton, Putnam, Roane, Sequatchie, Smith, Sumner, Unicoi, White, Wilson.

Striatura ferrea Morse. Monroe, Sevier.

Anguispira alternata alternata (Say). Bedford, Coffee, Cumberland, DeKalb, Fentress, Franklin, Hamilton, Hardin, Jackson, Knox, Macon, Montgomery, Pickett, Polk, Roane, Shelby, Smith, Sullivan, Sumner, Trousdale, Unicoi, Washington.

Anguispira alternata jessica Kutchka. Carter, Monroe.

Anguispira knoxensis (Pilsbry). Knox.

Anguispira strongylodes (Pfeiffer). Bradley, Cumberland, DeKalb, Fayette, Franklin, Greene, Grundy, Marion, Polk, Rutherford, Shelby, Smith, Sumner, Wilson.

Anguispira mordax mordax (Shuttleworth). Campbell, Davidson, DeKalb, Fentress, Franklin, Grundy, Hickman, Knox, Marion, Sevier, Smith, Warren.
Anguispira mordax mordax and *A. strongylodes* hybridize where their ranges overlap. Hybrid populations have been named *smithi*, *columbo*, and *lawae*. *Anguispira mordax paucicostata* Kutchka is a high altitude form.

Anguispira cumberlandiana (Lea). Franklin, White.

Discus patulus patulus (Deshayes). Anderson, Bledsoe, Blount, Bradley, Campbell, Carter, Cheatham, Claiborne, Clay, Cocke, Cumberland, Davidson, DeKalb, Fentress, Franklin, Grundy, Hamilton, Hickman, Jackson, Jefferson, Knox, Lauderdale, Macon, Marion, Meigs, Monroe, Montgomery, Moore, Morgan, Obion, Overton, Perry, Polk, Rhea, Roane, Rutherford, Scott, Sequatchie, Sevier, Shelby. Stewart, Sullivan, Sumner, Tipton, Unicoi, Union, Van Buren, Warren, Washington, White, Wilson.

Discus nigrimontanus (Pilsbry). Anderson, Claiborne, Fentress, Franklin, Loudon, Overton, Putnam, Sevier, Van Buren, Warren, White.

Discus bryanti (Harper). Carter, Unicoi.

Discus clappi (Pilsbry). Franklin.

Helicodiscus enneodon Hubricht. Anderson, Cocke, Unicoi.

Helicodiscus multidens Hubricht. Anderson, Claiborne, DeKalb, Putnam, Smith.

Helicodiscus fimbriatus (Wetherby). Blount, Monroe, Polk.

Helicodiscus hexodon Hubricht. Bledsoe.

Helicodiscus aldrichianus (Clapp). Franklin, Overton.

Helicodiscus notius notius Hubricht. Anderson, Bledsoe, Campbell, Clay, Cocke, Coffee, DeKalb, Fentress, Franklin, Grainger, Hamilton Jackson, Knox, Lawrence, Marion, Montgomery, Moore, Overton, Rhea, Rutherford, Scott, Sevier, Smith, Sumner, Trousdale, Union, Warren, White, Wilson.

Helicodiscus notius specus Hubricht. Sullivan.

Helicodiscus parallelus (Say). Coffee, Franklin, Hamilton, Hawkins, Jackson, Marion, McMinn, Overton, Roane, Shelby.

Helicodiscus barri Hubricht. Anderson, Davidson, Dickson.

Helicodiscus hadenoecus Hubricht. DeKalb, Jackson, Van Buren, White.

Helicodiscus inermis H.B. Baker. Franklin, Grundy, Marion, Van Buren.

Punctum minutissimum (Lea). Rutherford, Sevier, Shelby.

Punctum blandianum Pilsbry. Anderson, Blount, Franklin, Grainger, Hawkins, Knox, Marion, Monroe, Rutherford, Sevier, Unicoi.

Punctum vitreum H. B. Baker. Carter.

Punctum smithi Morrison. Fentress, Macon, Sequatchie, White.

Arion fasciatus (Nilsson). Carter, Johnson.

Philomycus carolinianus (Bosc). Anderson, Bledsoe, Blount, Campbell, Coffee, Cocke, Cumberland, Davidson, DeKalb, Fentress, Hardeman, Haywood, Knox, Lauderdale, Macon, Marion, Monroe, Perry, Polk, Rhea, Roane, Rutherford, Scott, Sequatchie, Sevier, Shelby, Sumner, White, Wilson.

Philomycus togatus (Gould). Johnson, Morgan.

Philomycus sellatus Hubricht. Franklin, Grundy, Marion.

Philomycus flexuolaris (Rafinesque). Carter, Monroe, Polk, Sevier.

Philomycus venustus Hubricht. Carter, Sevier, Sullivan.

Pallifera mutabilis Hubricht. Anderson, Campbell, Carter, Davidson, Franklin, Macon, Marion, Rhea, Roane, Sevier, Shelby.

Pallifera wetherbyi W. G. Binney. Fentress, Marion, Putnam, White.

Pallifera hemphilli (W. G. Binney). Sevier.

Pallifera marmorea (Pilsbry). Sumner.

Pallifera secreta (Cockerell). Anderson, Campbell, Claiborne, Cocke, Fentress, Hawkins, Johnson, Roane, Sevier, Unicoi, Union, Washington.

Pallifera fosteri F.C. Baker. Anderson, Bledsoe, Blount, Bradley, Carter, Cumberland, Greene, Jefferson, Monroe, Polk, Rhea, Sevier, Sullivan.

Succinea ovalis Say. Dyer, Johnson, Shelby, Sevier.

Succinea greeri Tryon. White.

Catinella vermeta (Say). Campbell, DeKalb, Hamilton, Hickman, Jackson, Johnson, McMinn, Montgomery.

Catinella texana Hubricht. Shelby.

Catinella oklahomarum (Webb). Cannon, Claiborne, Cocke, Cumberland, Greene, Macon, Marion, Sequatchie.

Strobilops labyrinthica (Say). Anderson, Bradley, Franklin, Grainger, Hamilton, Hawkins, Lawrence, Marion, Montgomery, Moore, Rutherford, Scott, Sequatchie, Sumner, Wilson.

Strobilops texasiana Pilsbry. Marion, Rutherford, Trousdale, Wilson.

Strobilops aenea Pilsbry. Bledsoe, Bradley, Coffee, Cocke, DeKalb, Franklin, Grundy, Marion, Maury, Monroe, Moore, Putnam, Roane, Rutherford, Sevier, Shelby, Van Buren.

Gastrocopta armifera (Say). Bedford, Campbell, Coffee, Davidson, DeKalb, Franklin, Greene, Hamilton, Hawkins, Johnson, Marion, Maury, McMinn, Moore, Roane, Rutherford, Sumner, Williamson, Wilson.

Gastrocopta clappi (Sterki). Anderson, Moore, Rutherford, Trousdale, Wilson.

Gastrocopta contracta (Say). Bledsoe, Cocke, Coffee, Franklin, Greene, Grundy, Hawkins, Johnson, Macon, Moore, Putnam, Rutherford, Sevier, Shelby, Smith, Sumner, Washington, Wilson.

Gastrocopta pentodon (Say). Bledsoe, Grainger, Hamilton, Hawkins, Rutherford, Sequatchie, Sevier, Sumner, Wilson.

Gastrocopta tappaniana (C. B. Adams). Carter, Grundy, Hamilton, Rutherford, Wilson.

Gastrocopta corticaria (Say). Blount, Franklin, Knox.

Gastrocopta procera (Gould). Franklin, Hamilton, Marion, Rutherford, Shelby, Wilson.

Vertigo milium (Gould). Knox.

Vertigo oscariana Sterki. Hawkins, Rutherford, Sevier.

Vertigo rugosula Sterki. Rutherford.

Vertigo tridentata Wolf. Carter, Hawkins.

Vertigo gouldi gouldi (Binney). Greene.

Vallonia excentrica Sterki. Campbell.

Cionella morseana Doherty. Blount, Campbell, Carter, Cheatham, Claiborne, Cocke, Cumberland, Fentress, Franklin, Grainger, Hancock, Johnson, Knox, Marion, Monroe, Morgan, Overton, Roane, Sevier, Union, White.

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Carychium exile H. C. Lea. Anderson, Blount, Carter, Cocke, Coffee, DeKalb, Franklin, Fentress, Grainger, Grundy, Hamilton, Jackson, Johnson, Knox, Marion, Morgan, Overton, Perry, Putnam, Roane, Rutherford, Sequatchie, Union, Warren, White.

Carychium floridanum Clapp. Blount.

Carychium stygium Call. Sumner.

Carychium clappi Hubricht. Anderson, Blount, Carter, Coffee, Franklin, Grainger, Grundy, Hawkins, Knox, Macon, Marion, Monroe, Montgomery, Overton, Roane, Sevier, Sumner, Trousdale, Unicoi, Wilson.

Carychium nannodes Clapp. Anderson, Claiborne, Cocke, Cumberland, Franklin, Grainger, Grundy, Knox, Macon, Marion, Overton, Pickett, Polk, Roane, Sevier, Unicoi.

Hendersonia occulta (Say). Claiborne, Sullivan, Unicoi.

Helicina orbiculata orbiculata (Say). Bledsoe, Cannon, Cheatham, Davidson, DeKalb, Franklin, Grundy, Hamilton, Hardin, Jackson, Macon, Marion, Montgomery, Overton, Pickett, Putnam, Rutherford, Smith, Sumner, Van Buren, Warren, White, Wilson.

Pomatiopsis cincinnatiensis (Lea). Clay, Warren.

Pomatiopsis lapidaria (Say). Blount, Bradley, Campbell, Cheatham, Claiborne, Clay, Cumberland, DeKalb, Fentress, Franklin, Grainger, Grundy, Hamilton, Hawkins, Knox, Macon, Marion, Maury, Monroe, Montgomery, Overton, Polk, Roane, Sevier, Smith, Sullivan, Unicoi, Union.

CRITIQUE 'PROCEEDINGS OF A SYMPOSIUM ON RARE AND ENDANGERED MOLLUSKS (NAIADS) OF THE U. S. COLUMBUS, OHIO 1971'

Billy G. Isom[1]

There is no disagreement with the purpose of the symposium on rare and endangered freshwater mollusks, but there is disagreement with the content of the proceedings and the fact that available expertise was not brought to bear on the problem. Correspondence with several eminent malacologists, including Dr. Henry van der Schalie, University of Michigan, revealed that none was invited to contribute to the symposium.

The title of the proceedings indicates that the symposium was dedicated to discussions of rare and endangered naiads or mussels. However, the principal paper by Stansbery dealt with both mussels and snails and was primarily a recapitulation of Stansbery (1970) except that numerous resurrected names were introduced.

Stansbery's papers (1970; 1971) need further discussion; for example, neither van der Schalie (1939) nor Isom (1968), Isom and Yokley (1968), and Isom and Yokley (1968a) were referred to in the discussion on the mussel fauna of **Muscle Shoals**, Alabama. The latter papers deal with the historical and present status of Cumberlandian and other endemic species of some tributaries of the lower Tennessee River. Two of the papers have specific references to fauna of the Muscle Shoals area. Another significant omission was the paper by Isom (1969) which was an attempt to classify objectively the causes of the decline in mussel populations of the Tennessee River and which includes records of species not only for Kentucky Reservoir, which Stansbery discussed, but also information on Muscle Shoals.

The continued reference to Muscle Shoals, Alabama, as 'Mussel Shoals' is contrary to historical documentation (Dexter, 1961 and 1967; Isom, 1971).

Captions for figures 22 through 50 listed by Stansbery (1971) are totally inadequate since they are based on limited records. Many people are looking to these annotations and records for support in evaluating possible impact of proposed projects on mollusks. The material compiled, while a beginning, is based on such limited information that it should be considered only provisionally authoritative.

Stansbery (1971, p. 7) discussed *Plethobasus cooperianus* but does not include the information of Isom and Yokley (1968). While the new record of *P. cooperianus* from Duck River probably means little to the survival of this species, it should be noted.

Stansbery (1971) incorrectly states that unionids do not successfully reproduce in the New Johnsonville area, Kentucky Reservoir, Tennessee River. Isom (1969) re-

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1 Environmental Biology Branch, Division of Environmental Research and Development, Tennessee Valley Authority, Muscle Shoals, Alabama.

ported that *Fusconaia ebena* was successfully reproducing in the main channel of Kentucky Reservoir. Numerous other species of Unioninae have adapted to the environment of Kentucky Reservoir.

Stansbery's evaluation of the Gastropoda is extremely unsatisfactory. He indicates that there are insufficient data for evaluating species status of Physidae, Lymnaeidae, and Planorbidae which is a personal opinion since there are authoritative sources of information on these families. Further, the names applied to the Pleuroceridae are extremely confusing since, as Rosewater (1960) noted, 'It does matter which genus is called *Pleurocera*, because what has been called by that name has been recognized for so long and is still being used in this sense by most workers in North America. To call *verrucosa* and its allies *Pleurocera* would change a nomenclatorially-linked generic concept of long standing..' Practical evidence for retention of *Pleurocera acuta* Rafinesque, 1831, as the type species of *Pleurocera* Rafinesque, 1818, rather than *Pleurocera verrucosa* Rafinesque, 1820, as Stansbery has done, is overwhelming.

Another contributor, Stein (1971), does not give full credit for resource material used in her presentation which appears, in part, to be a review of the literature.

Clark (1971) gives an interesting account of the historical and current management of naiad populations in Ohio that will be of interest for generations. His question or conjecture about the value of dams to management of mussels on the Muskingum River in Ohio is indeed interesting.

Fikes and Tubb (1971) best summarize their article with the statement that, 'Variability in the tests is quite large and a statistical test is probably meaningless.'

Imlay (1971) incorrectly states that, 'The commercial mussel harvest from Green River in Kentucky has been ruined for many years because of petroleum brine waste.' There was some active mussel harvesting on the lower Green River in 1965, about 5 years after the problem of brine waste was reportedly terminated. It is known from personal work in 1971 and work by Stansbery (1965) and Williams (1969) that there is a substantial and diverse mussel fauna in the lower Green River. Reduction in the number of mussels is more likely due to overharvesting than to 'brine waste.'.

Van der Schalie (personal communication) noted, with reference to Imlay's (1971) statements that *Lampsilis higginsi* was '.... once widely distributed ....' and 'It was a valuable commercial species in Lake Pepin ....' that '*L. higginsi* and *L. orbiculata* may be conspecific but surely neither of them is common and widely distributed ....'

In conclusion, it is my opinion and that of others, substitution of resurrected generic or specific trivial names for those long in general use is a disservice to the aim of better informing our colleagues, administrators, other non-malacologists, and the public. I think one can say that vacillation of mollusk taxonomists is a challenge to the credibility of all malacologists. In fact, because of the vacillation of our taxonomists, the information presented is of limited value to laymen who need such information for making decisions. This statement applies to taxonomists in general and is not specific to malacology. Very recent experience showed that some resurrected generic names in Stansbery (1971) have hindered synthesis of lists of endangered species. For additional arguments for conservatism in taxonomy, Cole (1941 and 1941a) and van der Schalie (1952) should be consulted.

A meeting of national stature should be held to bring together all available expertise to determine endangered mollusk species and attempt to stabilize nomenclature. A really authoritative compilation could result from such a meeting.

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EDITOR'S NOTE

With permission of the author of this paper, it has been shown to Dr. David H. Stansbery in case he should wish to prepare a reply for publication in this number of Sterkiana. Pressure of other duties has prevented Dr. Stansbery from doing so in time but his reply will be published in Sterkiana as soon as it is ready and space is available.

Publication of this paper in Sterkiana is not to be construed as approval or disapproval by the editor of the ideas expressed; sole responsibility for the latter rests with the author of the paper.

A CHECKLIST OF THE LAND AND FRESHWATER MOLLUSKS OF VIRGINIA

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Topographically, Virginia is divided into three regions; the Appalachian mountains which form its western spine, the central Piedmont plateau of rolling hills cut by narrow stream valleys, and the sandy coastal plain with its drowned valleys.

Almost all of the rivers rise on the eastern slopes of the mountains and flow in a southeasterly direction into the Atlantic Ocean. Only in the extreme southwest corner of the state is the drainage pattern altered. Rivers there are part of the vast Mississippi River system. They include the Holston, Clinch, and Powell which drain into the Tennessee River, and the Russell, Pound, and New which drain into the Ohio River. Heavy pollution of these rivers renders the continued existence of some previously reported species doubtful.

Previous molluscan checklists of Virginia material have been limited to certain counties and have been based on material in private collections. The following checklist attempts to bring together all published county records and locality records from the collections of the United States National Museum, the Museum of Comparative Zoology at Harvard, the American Museum of Natural History, the Museum of Zoology of the Ohio State University, and material in private collections.

* Present address: Norwood City Schools Planetarium, Norwood, Ohio 45212

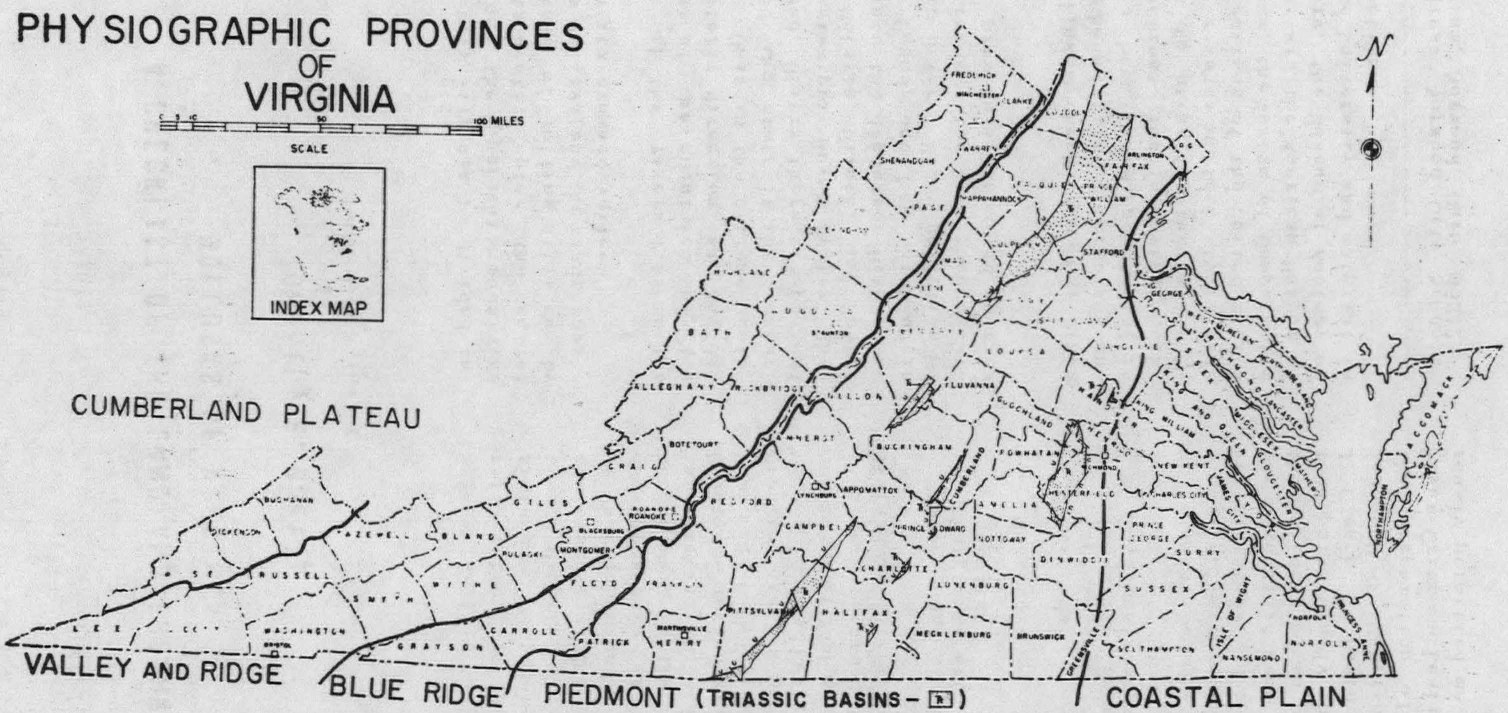
Some locality records must be altered to reflect boundary changes. Cities in Virginia may be independent political entities. Hampton, Richmond, and Alexandria are examples. Old Norfolk County records are now found under the cities of Norfolk and Chesapeake. Princess Anne County has become part of the huge area incorporated into the city of Virginia Beach. Warwick County is included in the city of Newport News. For the location of counties, see Figure 1.

A total of 373 species and varietal forms is herein recorded for Virginia. They are divided as follows:

Pelecypoda	86
Margaritiferid	1
Unionids	70
Sphaeriids	14
Mactrid	1
Gastropoda	287
Freshwater Operculates	35
Freshwater Pulmonates	29
Land Gastropods	223

The author would appreciate having omissions and errors in this list brought to her attention. A question mark preceding the scientific name indicates doubt about the validity of an occurrence in Virginia. I am particularly indebted to Dr. William J. Clench, Dr. David H. Stansbery, and Dr. Joseph P. E. Morrison for their help in the preparation of this checklist. F. Wayne Grimm and Leslie Hubricht have generously permitted me to use all their Vir-

FIGURE 1:



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ginia records andhave advised me concerning relationships within the genus *Triodopsis*.

PELECYPODA

Family Margaritiferidae

Cumberlandia monodonta Say. Lee, Scott.

Family Unionidae

Anodonta cataracta Say. Augusta. Fairfax, Fluvanna, Goochland, Halifax, Hampton, Mecklenburg, Newport News, Orange, Prince William, Rockbridge, York.

Anodonta imbecillis Say. Nottoway.

Strophitus undulatus Say. Augusta, Brunswick, Culpepper, Cumberland, Fairfax, Fauquier, Fluvanna, Goochland, Lee, Orange, Powhattan, Prince William, Roanoke, Rockbridge, Rockingham, Shenandoah.

Strophitus undulatus shaefferianus Lea. Smyth.

Alasmidonta heterodon Lea. Culpepper, Fluvanna, Lee, Orange.

Alasmidonta marginata Say. Rockbridge, Smyth.

Alasmidonta undulata Say. Augusta, Brunswick, Fairfax, Fauquier, Fluvanna, Goochland, Orange, Prince William, Rockbridge, Rockingham.

Alasmidonta varicosa Lamarck. Fairfax, Lee, Prince William, Scott, Shenandoah, Warren, Wise.

Alasmidonta viridis Rafinesque. Lee, Smyth.

Pegias fabula Lea. Scott, Smyth, Tazewell.

Lasmigona costata Rafinesque. Lee, Scott.

Lasmigona holstonia Lea. Tazewell, Washington.

Lasmigona subviridis Conrad. Cumberland, Culpepper, Dinwiddie, Fairfax, Fauquier, Fluvanna, Goochland, Loudoun, Orange, Powhattan, Rockbridge, Shenandoah, Spotsylvania.

Tritogonia verrucosa Rafinesque. Lee.

Quadrula cylindrica strigillata Wright. Lee, Russell, Scott, Twzewell, Wise.

Quadrula sparsa Lea. Wise, Scott.

Quadrula intermedia Conrad. Lee, Wise.

Quadrula pustulosa Lea. Scott, Wise.

Amblema plicata Say. Russell, Scott, Wise.

Fusconaia subrotunda lesueuriana Lea. Russell, Scott, Tazewell, Wise.

Fusconaia cuneolus Lea. Scott.

Fusconaia edgariana Lea. Russell, Scott, Washington, Wise.

Fusconaia barnesiana Lea. Lee (as Pleurobema bigbyensis Lea), Russell, Scott, Tazewell, Wise.

Cyclonaias tuberculata Rafinesque. Giles, Lee, Montgomery, Russell, Scott, Wise.

Lexingtonia dolabelloides Lea. Russell, Scott, Tazewell, Washington, Wise.

Lexingtonia subplana Conrad. Buckingham, Cumberland (as Pleurobema masoni Conrad, which does not occur north into Virginia), Brunswick, Cumberland, Fluvanna, Goochland, Henrico, Powhattan, Rockbridge.

Plethobasus cyphyus Rafinesque. Scott.

Pleurobema oviforme Conrad. Scott, Wise.

Pleurobema coccineum Conrad. Scott.

Pleurobema pyramidatum Lea. Scott.

Canthyria collina Conrad. Botetourt, Fluvanna, Goochland, Powhattan, Rockbridge.

Elliptio crassidens Lamarck. Lee, Scott.

Elliptio congaraea Lea. Franklin.

Elliptio complanata Lightfoot. All river systems of Atlantic Slope drainage.

Elliptio dilatata Rafinesque. Lee, Montgomery, Russell, Scott, Tazewell, Washington.

Elliptio lanceolata Lea. Buchanan, Campbell, Culpepper, Cumberland, Fairfax, Fauquier, Fluvanna, Goochland, Halifax, Hanover, Louisa, Orange, Powhattan, Prince William, Rockbridge.

Lastena lata Rafinesque. Russell, Scott, Wise.

Uniomerus obesus Lea. Shenandoah.

Uniomerus tetralasmus Say. Nottoway River.

Ptychobranchus fasciolare Rafinesque. Russell, Scott, Smyth, Wise.

Ptychobranchus subtentum Say. Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise.

Cyprogenia stegaria Rafinesque. Scott.

Dromus dromas Lea. Scott.

Actinonaias ligamentina Lamarck. Lee, Scott, Wise.

Actinonaias pectorosa Conrad. Lee, Russell, Smyth, Washington, Wise.

Potamilus alatus Say. Lee, Scott.

Toxolasma lividum Rafinesque. Lee, Scott, Smyth, Washington (as *Carunculina glans*, a species of the interior basin only).

Medionidus conradicus Lea. Russell, Scott, Smyth, Tazewell, Washington, Wise.

Ligumia nasuta Say. James River.

Ligumia recta Lamarck. Lee, Scott, Wise.

Conradilla caelata Conrad. Russell, Scott, Washington, Wise.

Villosa fabalis Lea. Lee, Russell, Scott, Smyth, Washington, Wise.

Villosa perpurea Lea. Lee, Russell, Scott, Tazewell, Wise.

Villosa iris nebulosa (Conrad). Lee, Russell, Scott, Smyth, Tazewell (as old female *Lampsilis picta* Lea), Washington, Wise.

Villosa vanuxemi Lea. Lee, Scott, Smyth, Washington, Wise.

Villosa constricta Conrad. Alleghany, Amherst, Arlington (as *V. vibex amygdala* Lea), Botetourt, Brunswick, Campbell, Cumberland, Fluvanna, Goochland, Henrico, Nottoway, Powhattan, Roanoke, Rockbridge.

Lampsilis cariosa Say. Brunswick, Fairfax, Hanover.

Lampsilis ventricosa Barnes. Clarke, Giles, Lee, Loudoun, Russell, Scott, Shenandoah, Smyth, Tazewell, Wise.

Lampsilis cohongoronta Ortmann (cf. *L. ventricosa* Barnes). Shenandoah River.

Lampsilis ovata Say. Jefferson (introduced).

Lampsilis fasciola Rafinesque. Lee, Russell, Scott, Smyth, Tazewell, Washington, Wise.

Lampsilis ochracea Say. Dinwiddie, Fairfax, Goochland, King and Queen, King William, Prince George, York River.

Lampsilis radiata Gmelin. Fairfax.

Epioblasma triquetra Rafinesque. Scott.

Epioblasma brevidens Lea. Scott.

Epioblasma haysiana Lea. Tazewell.

Epioblasma lenior Lea. Scott (extinct).

Epioblasma capsaeformis Lea. Russell, Scott, Tazewell, Wise.

Epioblasma torulosa gubernaculum Reeve. Scott.

Epioblasma walkeri Wilson & Clark. Scott.

Family Sphaeriidae

Pisidium adamsi Prime. Dinwiddie.

Pisidium aequilaterale Prime. Shenandoah.

Pisidium casertanum Poli. Goochland, Newport News, Virginia Beach, York.

Pisidium compressum Prime. Goochland, Virginia Beach.

Pisidium dubium Say. Goochland.

Pisidium nitidum Jenyns. Chesapeake, Virginia Beach.

Pisidium punctiferum Guppy. Albemarle.

Pisidium walkeri Sterki. Virginia (H. B. Herrington.

Sphaerium fabale Prime. Nelson.

Sphaerium lacustre Müller. Accomack.

Sphaerium occidentale Prime. Hampton, Newport News, Virginia Beach.

Sphaerium partumeium Say. Culpepper, Hampton, Newport News.

Sphaerium securis Prime. Northampton.

Sphaerium simile Say. Virginia (H.B. Herrington).

Family Mactridae

Rangia cuneata Gray in Sowerby. Charles City, Isle of Wight, James City, Newport News, Stafford, Surrey, Virginia Beach.

GASTROPODA: FRESHWATER OPERCULATES

Family Viviparidae

Viviparus georgianus Lea. Fairfax.

Campeloma decisum Say. Cumberland, Fairfax, Fluvanna, Goochland, Hanover, Lee, Louisa, Newport News, Powhattan, York.

Lioplax subcarinata Say. Chesterfield, Cumberland, Fairfax, Fluvanna, Powhattan.

Family Valvatidae

Valvata tricarinata Say. Fairfax.

Valvata tricarinata perconfusa Walker. Fairfax.

Family Hydrobiidae

Hydrobia jacksoni Bartsch. Norfolk.

Hydrobia truncata Vanatta. Northumberland.

Hydrobia sp. Westmoreland.

Fontigens nickliniana Lea. Bath.

Fontigens attenuata Haldeman. Montgomery.

Fontigens orolibas Hubricht. Albemarle, Augusta, Greene, Madison, Page, Rappahannock, Rockingham, Warren.

Fontigens sp. Alleghany, Augusta, Bath, Craig, Frederick, Giles, Madison, Montgomery, Page, Pittsylvania, Rockbridge, Rockingham, Russell, Shenandoah, Smyth, Wythe.

Lartetia sp. Warren, possibly extinct. (Morrison, personal communication).

Littoridinops cf. *L. tenuipes* Cooper. Hampton, King George, Newport News, Norfolk, Northampton.

Lyogyrus granum Say. Fairfax, Hanover, Henrico, New Kent, Norfolk.

Amnicola limosa Say. Clarke, Fairfax, Goochland, Hampton, Henrico, Newport News, Norfolk, Page, Sussex.

Cochliopa decisa Haldeman. Goochland.

Cochliopa virginica Walker. Fairfax, Fauquier, Fluvanna, Goochland, Orange, Prince William, Wythe.

Gillia altilis Lea. Alexandria, Campbell, Cumberland, Dinwiddie, Fairfax, Fluvanna, Frederick, Goochland, Lee, Powhattan.

Pomatiopsis cincinnatiensis Lea. Lee, Scott.

Pomatiopsis lapidaria Say. Arlington, Buchanan, Fairfax, Giles, Grayson, Lee, Mecklenburg, Montgomery, Newport News, New Kent, Patrick, Prince William, Scott, Smyth, Washington, Wythe.

Bithynia tentaculata Linné. Fairfax, Rockbridge.

Family Pleuroceridae

Pleurocera canaliculatum Say. Lee, Scott, Smyth, Washington, Wise.

Goniobasis uncialis Haldeman. Scott.

Goniobasis arachnoidea Anthony. Lee.

Goniobasis carinifera Lamarck. Tazewell.

Goniobasis clavaeformis Lea. Lee, Scott, Washington.

Goniobasis simplex Say. Lee, Smyth, Wise.

Goniobasis spinella Lea. Lee, Scott.

Goniobasis virginica Gmelin. Botetourt, Cumberland, Fairfax, Fauquier, Fluvanna, Goochland, Loudoun, Powhattan, Roanoke, Rockbridge, Stafford.

Io fluvialis Say. Lee, Scott, Washington, Wise.

Spirodon carinata Bruguière. Botetourt, Brunswick, Buchanan, Cumberland, Fairfax, Fluvanna, Frederick, Goochland, Madison, Montgomery, Nelson, Orange, Powhattan, Pulaski, Roanoke, Rockbridge, Rockingham, Shenandoah, Wythe.

Spirodon dilatata Conrad. Alleghany, Amherst, Carroll, Grayson, Rockbridge.

Anculosa praerosa Say. Lee.

Anculosa subglobosa Say. Lee, Scott, Smyth, Tazewell, Washington, Wise.

GASTROPODA: FRESHWATER PULMONATES

Family Physidae

Aplexa hypnorum Linné. Greene.

Physa ancillaria Say. Fairfax.

Physa acuta Draparnaud. Hampton, Newport News, Fairfax, Virginia Beach, York (introduced. W. J. Clench, personal communication).

Physa aurea Lea. Augusta, Bath, Botetourt, Cumberland, Fluvanna, Goochland, Lee, Loudoun, Rockbridge, Shenandoah, Smyth, Tazewell, Washington.

Physa goodrichi Clench. Smyth, Tazewell, Wise.

Physa heterostropha Say. Albemarle, Culpepper, Fairfax, Hampton, Loudoun, Newport News, Page, Prince William.

Fossaria dalli Baker. Frederick.

Fossaria humilis Say. Hampton, Newport. News, Prince William, Virginia Beach, York.

Fossaria modicella Say. Arlington, Clarke, Northumberland, Rockbridge, Shenandoah.

Fossaria obrussa Say. Scott, Warren, Wise, Wythe.

Fossaria obrussa exigua Lea. Newport News, York.

Fossaria parva Lea. Augusta, Frederick, New Kent.

Stagnicola caperata Say. Fairfax, Page, Shenandoah.

Pseudosuccinea columella Say. Albemarle, Culpepper, Fairfax, Hampton, New Kent, Newport News, Surrey, Virginia Beach.

Radix auricularia Linné. Giles (Introduced).

Family Planorbidae

Helisoma anceps Menke. Alleghany, Arlington, Fairfax, Fluvanna, Giles, Goochland, Hanover, Newport News, Spotsylvania, Smyth, York.

Helisoma trivolvis Say. Fairfax, Newport News, Smyth.

Planorbula armigera Say. Fairfax, Hampton, Newport News (Fairfax as *P. jenksii* H. F, Carpenter).

Planorbula wheatleyi Lea. Virginia Beach.

Gyraulus deflectus Say. Fairfax.

Gyraulus parvus Say. Augusta, Frederick, Giles, Newport News, Rockbridge, Shenandoah, Wythe, York.

Menetus brongniartianus Lea. Newport News, Surrey.

Menetus dilatatus Gould. Culpepper, Fairfax, Hampton, New Kent, Newport News, Prince William.

Menetus dilatatus buchanensis Lea. Newport News, Page.

Promenetus exacuous Say. Dinwiddie, Prince George.

Family Ancylidae

Ferrissia fragilis Tryon. Rockbridge.

Ferrissia parallela Haldeman. Fairfax.

Ferrissia rivularis Say. Fairfax, Washington, Wise.

Laevapex fuscus C. B. Adams. Hampton, Newport News, Norfolk, Virginia Beach.

GASTROPODA: LAND

Family Helicinidae

Helicina orbiculata Say. Norfolk (Introduced. W. E. Old, Jr. !).

Hendersonia occulta Say. Augusta, Giles, Montgomery, Patrick, Pulaski, Rockbridge, Smyth, Warren, Washington, Wythe.

Family Carychiidae

Carychium exiguum Say. Fairfax, Giles, Rockbridge.

Carychium nannodes Clapp. Alleghany, Bath, Bland, Botetourt, Buchanan, Giles, Halifax, Patrick, Pittsylvania, Pulaski, Scott, Smyth.

Carychium clappi Hubricht. Bath, Bland, Botetourt, Buchanan, Giles, Patrick, Pittsylvania, Pulaski, Rockbridge, Scott, Smyth, Washington.

Carychium exile H. C. Lea. Alleghany, Augusta, Bath, Bedford, Botetourt, Craig, Franklin, Giles, Halifax, Henrico, Highland, Madison, Page, Pittsylvania, Prince William, Pulaski, Rockbridge, Rockingham, Smyth, Washington.

Carychium costatum Hubricht. Patrick, Pittsylvania, Pulaski, Washington.

Family Cionellidae

Cionella lubrica Müller. Alleghany, Augusta, Bath, Clark, Fauquier, Frederick, Highland, Loudoun, Norfolk, Page, Prince William, Pulaski, Rappahannock, Rockingham, Shenandoah, Warren, Wythe.

Cionella morseana Doherty. Alleghany, Augusta, Bath, Bedford, Bland, Botetourt, Craig, Giles, Grayson, Madison, Page, Patrick, Pittsylvania, Pulaski, Rappahannock, Rockbridge, Rockinghwm, Shenandoah, Smyth, Tazewell, Warren, Washington, Wythe.

Cionella lubricella Porro. Alleghany, Bath, Bland, King George, Tazewell.

Family Valloniidae

Vallonia pulchella Müller. Accomack, Alleghany, Chesapeake, Franklin, Frederick, Lancaster, Newport News, Norfolk, Northhampton, Northumberland, Roanoke, Rockbridge, Tazewell, York.

Vallonia excentrica Sterki. Accomack, Alleghany, Chesapeake, Highland, King George, Lancaster, Newport News, Norfolk, North-Hampton, Orange, Pittsylvania, Rockbridge, Russell, Smyth, Washington, Wythe.

Vallonia costata Müller. Alleghany, Augusta, Bland, Bath, Campbell, Craig, Fairfax, Frederick, Henrico, Highland, Newport News, Norfolk, Roanoke, Rockbridge, Russell, Shenandoah, Tazewell, Wythe, York.

Vallonia perspectiva Sterki. Clarke, Frederick, Loudoun Montgomery, Newport News, Page, Patrick, Southampton, Warren.

Family Pupillidae

Pupilla muscorum Linné. Carroll, Frederick.

Pupoides albilabris C. B. Adams. State wide.

Gastrocopta cristata Pilsbry & Vanatta. Accomack, Alleghany, Charles City, Chesapeake, Fairfax, Franklin, Frederick, Lee, Loudoun, New Kent, Newport News, Northampton, Orange, Page, Pittsylvania, Pulaski, Rockbridge, Russell, Scott, Smyth, Sussex, York.

Gastrocopta pellucida hordeacella Pilsbry. Norfolk.

Gastrocopta procera Gould. Alleghany, Charles City.

Gastrocopta armifera Say. State wide.

Gastrocopta armifera clappi Sterki. Lee, Washington, Russell.

Gastrocopta contracta Say. State wide.

?*Gastrocopta holzingeri* Sterki. Giles.

Gastrocopta pentodon Say. State wide.

Gastrocopta tappanniana C. B. Adams. Accomack, Franklin, Frederick, King George, Orange, Pittsylvania, Rockbridge, Rockingham, York.

Gastrocopta corticaria Say. Arlington, Montgomery, New Kent, Orange, Page, Roanoke.

?*Vertigo elatior* Sterki. Frederick, Montgomery.

Vertigo ovata Say. Accomack, Chesapeake, Clarke, Franklin, King George, New Kent, Norfolk, Orange, Pittsylvania, Rockbridge, Virginia Beach.

Vertigo oralis Sterki. Chesapeake, Norfolk.

Vertigo teskeyae Hubricht. Chesapeake, Norfolk.

Vertigo ventricosa Morse. Pulaski, Rockbridge.

Vertigo pygmaea Draparnaud. Bland, Northhampton, Rockbridge.

Vertigo parvula Sterki. Augusta, Pulaski, Rappahannock, Rockbridge, Warren.

Vertigo tridentata Wolf. Alleghany, Bath, Giles, Pulaski, Russell, Tazewell.

Vertigo bollesiana Morse. Chesapeake.

Vertigo gouldi Binney. Augusta, Clarke, Loudoun, Middlesex, New Kent, Pulaski, Rockbridge, Shenandoah, Warren.

Vertigo milium Gould. Accomack, Chesapeake, Fairfax, Frederick, Loudon, New Kent, Norfolk, Pittsylvania, Prince William, Rockbridge, Tazewell, Virginia Beach.

Vertigo oscariana Sterki. Bedford, Newport News, Pittsylvania.

Columella edentula Draparnaud. Augusta, Giles, Henrico, Loudoun, New Kent, Page, Patrick, Pittsylvania, Pulaski, Rappahannock, Rockbridge, Warren, Washington.

Family Strobilopsidae

Strobilops aenea Pilsbry. Accomack, Augusta, Charles City, Fairfax, Gloucester, Henrico, Louisa, Loudoun, Middlesex, Montgomery, Northampton, Page, Pittsylvania, Prince Edward, Pulaski, Rappahannock, Rockbridge, York.

Strobilops labyrinthica Say. State wide.

Strobilops texasiana Pilsbry & Ferriss. Virginia (J. B. Burch).

Family Succineidae

Succinea aurea Lea. Accomack, Henrico.

Succinea ovalis Say. Alleghany, Craig, Essex, Giles, Rockbridge, Scott, Smyth, Tazewell, Washington.

Succinea wilsoni Lea. Accomack, King, George, Mathews, Nansemond, Northampton.

Succinea avara Say. Augusta, Clarke, Culpepper, Page, Shenandoah.

Succinea pyrites Hubricht. Accomack.

Catinella vermeta Say. Accomack, Bedford, Bland, Essex, Frederick, James City, King George, Lee, Norfolk, Scott, Smyth.

Catinella oklahomarum Webb. Accomack, Bedford, Chesapeake, King William, Middlesex, Northampton, Pittsylvania, Virginia Beach, Westmoreland.

Catinella hubrichti Grimm. Accomack, James City.

Oxyloma decampi gouldi Pilsbry. Campbell.

Oxyloma effusa subeffusa Pilsbry. Charles City, Nansemond.

Family Philomycidae

Philomycus carolinianus Bosc. Accomack, Essex, Fairfax, Gloucester, Halifax, Hanover, James City, King William, Lancaster, Mathews, Mecklenburg, Middlesex, Nansemond, New Kent, Newport News, Northampton, Patrick, Pittsylvania, Prince Edward, Prince George, Sussex, Virginia Beach, Westmoreland.

Philomycus caroliniwnus flexuolaris Rafinesque. Alleghany, Bedford, Campbell, Fairfax, Giles, James City, Newport News, Patrick, Pittsylvania, Rownoke, Smyth, Washington, Wythe, York.

Philomycus togatus Gould. Bedford, Buchanan, Campbell, Fluvanna, Franklin, Halifax, Henrico, Henry, Lee, Patrick, Pittsylvania, Pulaski, Rappahannock, Washington, Wise.

Philomycus bisdosus Branson. Buchanan.

Philomycus virginicus Hubricht. Alleghany, Bedford, Madison, Patrick, Pittsylvania, Scott.

Philomycus venustus Hubricht. Grayson, Roanoke, Smyth, Washington, Wise, Wythe.

Pallifera dorsalis Binney. Amherst, Augusta, Campbell, Charlotte, Craig, Franklin, Giles, Grayson, Greene, Patrick, Pittsylvania, Roanoke, Rockbridge, Washington, Wise, Wythe.

Pallifera fosteri Baker. Clark, Nansemond, Newport News, Sussex, Virginia Beach.

Pallifera hemphilli W.G. Binney. Giles, Grayson, Smyth.

Pallifera hemphilli secreta Cockerell. Bath, Essex, Grayson, Patrick, Pittsylvania, Pulaski, Warren, Washington.

Pallifera mutabilis Hubricht. Alleghany, Campbell, Giles, Halifax, Hanover, Mecklenburg, Montgomery, Nansemond, Northampton, Pittsylvania, Rockbridge, Wise, Wythe.

Pallifera megaphallica Grimm. Accomack, Bedford, Campbell, Charles City, Charlotte, Craig, Franklin, Halifax, James City, King George, Louisa, Mecklenburg, Middlesex, Nansemond Newport News, Norfolk, Northhampton, Pittsylvania, Richmond, Virginia Beach, Washington, York.

Pallifera varia Hubricht. Amherst, Augusta, Bedford, Madison, Page, Rappahannock, Rockbridge.

Family Arionidae

Arion hortensis Férussac. Tazewell, Wythe.

Family Endodontidae

Anguispira alternata Say. Alleghany, Bedford, Giles, Halifax, Lee, Madison, Middlesex, Montgomery, Northampton, Page, Patrick, Pittsylvania, Roanoke, Rockingham, Tazewell, Warren, Washington, Wythe.

Anguispira alternata angulata Pilsbry. Augusta, Bath, Clarke, Fairfax, Frederick, Henrico, Lee, Loudoun, Mecklenburg, Northhampton, Rockbridge.

Anguispira alternata fergusoni Bland. Charles City, Charlotte, Chesapeake, Clarke, Fairfax, Halifax, Isle of Wight, Mecklenburg, Middlesex, Nansemond, Norfolk, Northhampton.

?Anguispira alternata strongylodes Pfeiffer. Halifax.

Anguispira alternata jessica Kutchka. Grayson.

Anguispira alternata crassa Walker. Bath.

Anguispira alternata mordax Shuttleworth. Alleghany, Fairfax, Giles, Lee, Montgomery, Pulaski, Wise.

Anguispira alternata knoxensis Pilsbry. Mecklenburg.

Discus cronkhitei Newcomb. Alleghany, Highland, Norfolk, Page, Rappahannock, Scott, Smyth, Washington.

Discus patulus Deshayes. Amherst, Bland, Dickenson, Fairfax, Giles, Grayson, Montgomery, Patrick, Pittsylvania, Pulaski, Roanoke, Rockbridge, Russell, Scott, Shenandoah, Smyth, Washington, Wise, Wythe.

Helicodiscus notius Hubricht. Accomack, Augusta, Charlotte, Giles, Newport News, Pulaski, Scott.

Helicodiscus parallelus Say. State wide.

Helicodiscus diadema Grimm. Alleghany, Rockbridge.

Helicodiscus hadenoecus Hubricht. Pulaski.

Helicodiscus singleyanus Pilsbry. Botetourt, Rockbridge.

Helicodiscus singleyanus inermis H.B. Baker. Alleghany, Augusta, Newport News, Pittsylvania, Pulaski, Rockbridge.

Helicodiscus jacksoni Hubricht. Alleghany, Clarke, Highland, Loudoun, Newport News, Page, Pulaski, Russell, Warren.

Helicodiscus enneodon Hubricht. Scott.

Helicodiscus triodus Hubricht. Botetourt.

Punctum blandianum Pilsbry. Bedford, Botetourt, Giles, Patrick, Pittsylvania, Smyth.

Punctum minutissimum Lea. Buchanan, Charles City, Franklin, Highlwnd, James City, Madison, Page, Pittsylvania, Prince William, Smyth, Virginia Beach.

Punctum vitreum H.B. Baker. Alleghany, Fairfax, Pittsylvania, Pulaski, Rockbridge.

Punctum smithi Morrison. Bedford, Charles City, Middlesex, Pittsylvania.

Punctum lamellatum Hubricht. Bedford, Pittsylvania.

Family Limacidae

Limax flavus Linné. Henrico, Northampton.

Limax maximus Linné. Accomack, Lee, Newport News, Norfolk, Pittsylvania, Scott, Wythe.

Lehmannia poirieri Mabille. Accomack, Henrico, Newport News, Norfolk, Northampton.

Deroceras laeve Müller. State wide.

Deroceras reticulatum Müller. Russell, Wythe, York.

Milax gagates Draparnaud, Accomack, Hampton, Newport News, Norfolk, Northampton, Northumberland, Orange.

Family Zonitidae

Nesovitrea electrina Gould. Bland, Fairfax, Frederick, Norfolk, Scott.

Glyphyalinia burringtoni Pilsbry. State wide.

Glyphyalinia cumberlandiana Clapp. Highland.

Glyphyalinia cumberlandiana roanensis H. B. Baker. Pulaski, Scott.

Glyphyalinia virginica Morrison. Charles City, Clarke, Loudoun, Madison, Page, Prince William, Rockbridge, Rockingham.

Glyphyalinia wheatleyi Bland. Bedford, Campbell, Pittsylvania, Roanoke, Smyth, Rockingham.

Glyphyalinia lewisiana Clapp. Alleghany, Pittsylvania, Pulaski.

Glyphyalinia raderi Dall. Alleghany, Craig, Page, Pulaski.

Glyphyalinia rhoadsi Pilsbry. Augusta, Bedford, Charlotte, Clarke, Craig, Culpepper, Fairfax, Fauquier, Frederick, Greene, Loudoun, Montgomery, Orange, Page, Pittsylvania, Pulaski, Rappahannock, Roanoke, Rockingham, Scott, Smyth, Warren, Washington.

Glyphyalinia rhoadsi austrina H.B. Baker. Amherst, Rockbridge.

Glyphyalinia carolinensis Cockerell. Alleghany, Giles, Grayson, Patrick, Pulaski, Rockbridge, Washington, Wythe.

Glyphyalinia cryptomphala solida H. B. Baker. Charles City, Essex, Henry, Lee, Newport News, Northampton, Patrick, Pittsylvania, Prince William, Pulaski, Rappahannock, Smyth, Warren, York.

Glyphyalinia luticola Hubricht. Accomack, James City, Northampton, Tazewell, Wythe.

Glyphyalinia indentata Say. State wide.

Glyphyalinia indentata paucilirata Morelet. James City, Newport News.

Glyphyalinia praecox H.B. Baker. Frederock.

Glyphyalinia sculptilis Bland. Highland, Washington.

Mesomphix perlaevis Pilsbry. Buchanan, Giles, Halifax, Lee, Mecklenburg, Pittsylvania.

Mesomphix perlaevis vulgatus H.B. Baker. Augusta.

Mesomphix inornatus Say. Alleghany, Augusta, Bath, Bedford, Bland, Botetourt, Craig, Giles, Highland, Lee, Pulaski, Roanoke, Rockbridge, Rockingham, Russell, Scott, Smyth, Tazewell, Washington, Wise, Wythe.

Mesomphix rugeli W. G. Binney. James City, Montgomery, Patrick, Washington, Wythe, York.

Mesomphix rugeli oxycoccus Vanatta. Giles, Grayson, Halifax, Mecklenburg, Patrick, Pittsylvania, Pulaski, Smyth, Wythe.

Mesomphix subplanus Binney. Grayson, Patrick, Smythe, Washington.

Mesomphix capnodes W. G. Binney. Bedford, Halifax, Mecklenburg, Pittsylvania, Pulaski, Roanoke, Rockbridge.

Mesomphix cupreus Rafinesque. Alleghany, Augusta, Bath, Buchanan, Campbell, Giles, Grayson, Lee, Montgomery, Pulaski, Rockbridge, Russell, Scott, Smyth, Washington, Wise, Wythe.

Vitrinizonites latissimus Lewis. Grayson, Smyth, Washington, Wythe.

Paravitrea andrewsae W.G. Binney. Buchanan, Washington.

Paravitrea bidens Hubricht. Lee.

Paravitrea capsella Gould. Augusta,

Bedford, Bland, Buchanan, Giles, Lee, Montgomery, Patrick, Pittsylvania, Pulaski, Smyth, Tazewell, Wythe.

Paravitrea reesei Morrison. Giles, Grayson, Montgomery, Pittsylvania, Pulaski, Smyth.

Paravitrea blarina Hubricht. Lee.

Paravitrea seradens Hubricht. Giles.

Paravitrea pontis H. B. Baker. Rockbridge.

Paravitrea grimmi Hubricht. Alleghany, Bath, Botetourt, Highland, Rockbridge.

Paravitrea multidentata Binney. Alleghany, Augusta, Bedford, Bland, Botetourt, Highland, Loudoun, Madison, Page, Patrick, Pittsylvania, Pulaski, Rappahannock, Rockbridge, Smyth, Warren.

Hawaiia minuscula Binney. State wide.

Oxychilus cellarius Müller. Montgomery, Pittsylvania, Roanoke, Rockbridge, Wythe.

Oxychilus draparnaldi Beck. Augusta, Frederick, Norfolk.

Euconulus chersinus Say. Giles, Patrick, Pittsylvania, Sussex.

Euconulus chersinus dentatus Sterki. Amherst, Bedford, Charles City, Page, Pittsylvania, Rockbridge, Virginia Beach, Wythe.

Euconulus chersinus polygyratus Pilsbry. Alleghany, Pulaski.

Euconulus fulvus Müller. Augusta, Bath, Patrick, Pittsylvania, Rappahannock, Rockingham, Warren, Washington.

Guppya sterkii Dall. Bath, Halifax, Patrick, Pittsylvania, Pulaski, Rockbridge, Smyth.

Gastrodonta interna fonticula Wurtz. Scott.

Ventridens cerinoideus Anthony. All coastal plain counties.

Ventridens pilsbryi Hubricht. Roanoke, Smyth, Wythe.

Ventridens coelaxis Pilsbry. Grayson, Washington.

Ventridens collisella Pilsbry. Alleghany, Bedford, Botetourt, Campbell, Giles, Halifax, Lee, Montgomery, Pittsylvania, Pulaski, Rockbridge, Russell, Scott, Smyth, Washington.

Ventridens gularis Say. Alleghany, Botetourt, Charlotte, Fluvanna, Hanover, Halifax, Mecklenburg, Nottoway, Pittsylvania, Prince Edward, Pulaski.

Ventridens gularis theloides Walker & Pilsbry. Patrick, Pittsylvania.

Ventridens lasmodon Phillips. Lee, Patrick, Tazewell.

Ventridens lawae W. G. Binney. Washington.

Ventridens suppressus Say. Alleghany, Arlington, Augusta, Bath, Bedford, Botetourt, Campbell, Craig, Culpepper, Franklin, Frederick, Highland, Madison, Page, Pittsylvania, Pulaski, Roanoke, Rockbridge, Rockingham, Warren, York.

Ventridens suppressus magnidens Pilsbry. Henrico.

Ventridens suppressus virginicus Vanatta. Amherst, Augusta, Charles City, Clarke, Frederick, Page, Rappahannock, Rockbridge, Rockingham, Shenandoah, Warren.

Ventridens acerra Lewis. Alleghany, Bedford, Botetourt, Giles, Grayson, Lee, Pulaski, Roanoke, Rockingham, Russell, Scott, Smyth, Washington, Wythe.

Ventridens demissus Binney. Grayson, Lee, Newport News, Pulaski, Rockbridge, Smyth, Twzewell, Washington, Wise, Wythe.

Ventridens intertextus Binney. Amherst, Campbell, Charles City, Halifax, Pittsylvania, Washington.

Ventridens ligerus Say. State wide.

Ventridens elliotti Redfield. Patrick, Wythe.

Zonitoides arboreus Say. State wide.

Striatura milium Morse. Arlington, Henrico, Loudoun, Prince William.

Striatura exigua Simpson. Augusta, Madison, Page, Rappahannock, Rockbridge.

Striatura meridionalis Pilsbry & Ferriss. State wide.

Striatura ferrea Morse. Patrick, Prince William, Rappahannock.

Family Haplotrematidae

Haplotrema concavum Say. State wide.

Family Subulinidae

Subulina octona Bruguière. Arlington (introduced).

Rumina decollata Linné. Norfolk (introduced).

Lamellaxis gracilis Hutton. Norfolk, Pittsylvania.

Opeas pyrgula Schmacker & Boettger. Clarke, Norfolk.

Cecilioides aperta Swainson. Introduced into Virginia (J. B. Burch).

Family Polygyridae

Polygyra pustuloides Bland. Charles City, Pittsylvania.

Polygyra texasiana Moricand. Norfolk (W. E. Old, Jr.).

Polygyra postelliana Bland. Newport News.

Polygyra plicata Say. Lee.

Stenotrema hirsutum Say. State wide.

Stenotrema barbatum Clapp. Campbell, Caroline, Charlotte, Fairfax, Halifax, Mecklenburg, Newport News, Pittsylvania, Prince George, Pulaski, York.

Stenotrema altispira Pilsbry. Grayson.

Stenotrema stenotrema Pfeiffer. Dickenson, Giles, Grayson, Lee, Montgomery, Patrick, Pittsylvania, Pulaski, Roanoke, Rockbridge, Russell, Smyth, Tazewell, Warren, Washington, Wise, Wythe.

Stenotrema edvardsi Bland. Grayson, Lee, Smyth, Washington, Wise, Wythe.

Stenotrema spinosum Lea. Lee, Scott, Wythe.

Stenotrema fraternum Say. Alleghany, Amherst, Arlington, Bedford, Campbell, Craig, Fairfax, Henry, Lee, Page, Patrick, Pittsylvania, Rappahannock, Rockbridge, Rockingham, Russell, Warren, Washington, Wythe.

Stenotrema fraternum montanum Archer. Tazewell.

Stenotrema burringtoni Grimm. Highland.

Stenotrema leai Binney. Virginia (J. B. Burch).

Stenotrema leai aliciae Pilsbry. Craig.

Mesodon andrewsae Binney. Grayson, Smyth.

Mesodon andrewsae normalis Pilsbry. Bedford, Giles, Grayson, Patrick, Roanoke, Wise, Wythe.

Mesodon clausus Say. Lee, Russell.

Mesodon downieanus Bland. Pittsylvania.

Mesodon thyroidus Say. State wide.

Mesodon zaletus Binney. Buchanan, Highland, Pulaski, Scott, Tazewell, Washington, Wise, Wythe.

Mesodon elevatus Say. Lee, Scott.

Mesodon wheatleyi Bland. Grayson, Smyth.

Mesodon burringtoni Hubricht. Bland, Campbell, Lee, Montgomery, Pittsylvania, Russell, Scott, Smyth, Washington.

Mesodon appressus Say. Bland, Buchanan, Campbell, Charles City, Chesapeake, Dickenson, Giles, Grayson, Halifax, Henrico, Lee, Mecklenburg, Montgomery, New Kent, Orange, Pittsylvania, Prince George, Pulaski, Roanoke, Rockbridge, Russell, Scott, Smyth, Tazewell, Washington, Wise, Wythe.

Mesodon laevior Pilsbry. Pittsylvania.

Mesodon perigraptus Pilsbry. New Kent.

Mesodon sayanus Pilsbry. Buchanan, Grayson, Patrick, Scott, Smyth, Tazewell, Washington, Wise.

Mesodon rugeli Shuttleworth. Buchanan, Dickenson, Giles, Lee, Montgomery, Pulaski, Russell, Scott, Smyth, Tazewell, Washington, Wythe.

Mesodon inflectus Say. Grayson, Lee, Montgomery, Pulaski, Smyth, Washington.

Polygyriscus virginianus Burch. Montgomery, Pulaski.

Triodopsis fallax Say. Albemarle, Appomatox, Brunswick, Buckingham, Campbell, Charles City, Essex, Fairfax, Franklin, Greensville, Gloucester, Halifax, Henry, King & Queen, King George, King William, Lancaster, Louisa, Mathews, Mecklenburg, Middlesex, Nansemond, New Kent, Newport News, Northumberland, Nottaway, Orange, Page, Pittsylvania, Prince George, Prince William, Richmond, Rockbridge, Shenandoah, Southampton, Sussex, Westmoreland, York.

Triodopsis fallax alabamensis Pilsbry. Pittsylvania.

Triodopsis fallax fallax X *t. f. alabamensis*. Pittsylvania.

Triodopsis fallax hopetonensis Shuttleworth. Campbell (introduced), Henrico, Newport News, Norfolk, Virginia Beach, York.

Triodopsis fallax obsoleta Pilsbry. Accomack, King William, Newport News, Northhampton, Norfolk, York.

Triodopsis fallax fallax X *t. f. obsoleta*. Accomack, Chesapeake, Mathews, Norfolk, Northampton, York.

Triodopsis fallax affinis Hubricht. Pittsylvania.

Triodopsis messana Pilsbry. Nansemond.

Triodopsis fraudulenta Pilsbry. Alleghany, Augusta, Bath, Bland, Botetourt, Craig, Giles, Greene, Madison, Page, Rappahannock, Rockbridge, Rockingham, Warren.

Triodopsis vulgata Pilsbry. Giles, Halifax, Lee, Loudoun, Mecklenburg, Page, Pulaski, Roanoke, Russell, Scott, Shenandoah, Washington, Wythe.

Triodopsis rugosa Brooks & MacMillan. Wise.

Triodopsis rugosa anteridon Pilsbry. Pulaski, Rockbridge.

Triodopsis tridentata Say. Alleghany, Amherst, Augusta, Bedford, Bland, Botetourt, Buchanan, Craig, Giles, Grwyson, Henry, Highland, Lee, Monroe, Montgomery, Nelson, Northampton, Page, Patrick, Pittsylvania, Pulaski, Roanoke, Rockbridge, Smyth, Tazewell, Washington, Wythe.

Triodopsis tennesseensis Walker. Pittsylvania, Russell, Scott, Washington.

Triodopsis juxtidens Pilsbry. State wide, but with spotty distribution in southwest corner of the state.

Triodopsis burchi Hubricht. Bedford, Franklin, Henry, Montgomery, Patrick, Pittsylvania, Roanoke.

Triodopsis denotata Férussac. Fairfax, Montgomery, Pittsylvania, Pulaski, Scott, Smyth, Washington, Wythe.

Triodopsis albolabris Say. State wide.

Triodopsis dentifera Binney. Alleghany, Bedford, Botetourt, Giles, Grayson, Wise.

Triodopsis pendula Hubricht. Grayson.

Allogona profunda Say. Alleghany, Grayson, Halifax, Lee, Mecklenburg, Patrick, Pittsylvania, Pulaski, Rockbridge, Russell, Scott, Wise.

Family Helicellidae

Helicella caperata Montagu. Accomack, Norfolk, York.

Helicella striata Müller. Norfolk.

Family Helicidae

Helix aspersa Müller. Chesapeake.

Cepaea nemoralis Linné. Amherst, Augusta, Bath, Bedford, Campbell, Chesapeake, Pittsylvania, Rockbridge, Shenandoah.

Otala lactea Müller. Virginia Beach (F. W. Grimm! - dead).

SYNONYMY

The following names have appeared in various publications as occurring in Virginia. These are synonyms of other species included in the checklist.

Alasmidonta calceola Lea, eq. *Alasmidonta viridis* Rafinesque.
Actinonaias carinata Barnes, eq. *Actinonaias ligamentina* Lamarck.
Actinonaias gibba Simpson, eq. *Actinonaias ligamentina* Lamarck.
Amnicola porata Say, eq. *Amnicola limosa* Say.
Anodon papyracea Anthony, eq. *Strophitus undulatus* Say.
Ancylus haldemani Bourguignat, eq. *Ferrissia rivularis* Say.
Campeloma integra Say, eq. *Campeloma decisum* Say.
Campeloma lima Anthony, eq. *Campeloma decisum* Say.
Campeloma rufa Haldeman, eq. *Campeloma decisum* Say.
Catinella pinicola Say, eq. *Catinella oklahomarum* Webb.
Columella simplex Gould, eq. *Columella edentula* Draparnaud.
Elliptio fisherianus Lea, eq. *Elliptio lanceolata* Lea.
Elliptio insulsus Lea, eq. *Elliptio complanata* Lightfoot.
Elliptio productus Conrad, eq. *Elliptio lanceolata* Lea.
Goniobasis ementa Anthony, eq. *Goniobasis virginica* Gmelin.
Gyraulus deflectus obliquus DeKay, eq. *Gyraulus deflectus* Say.
Gundlachia meekiana Stimpson, eq. *Ferrissia fragilis* Tryon.
Helicodiscus intermedius Morrison, eq. *Helicodiscus singleyanus inermis* H. B. Baker.
Helisoma anceps bartschi Baker, eq. *Helisoma anceps* Menke.
Helisoma trivolvis marshalli Baker, eq. *Helisoma trivolvis* Say.
Helisoma trivolvis holstonense Baker, eq. *Helisoma trivolvis* Say.
Io brevis Anthony, eq. *Io fluvialis* Say.
Io clinchensis C. C. Adams, eq. *Io fluvialis* Say.
Io lyttonensis C. C. Adams, eq. *Io fluvialis* Say.
Io paulensis C.C. Adams, eq. *Io fluvialis* Say.
Io powellensis C. C. Adams, eq. *Io fluvialis* Say.
Io spinosa Lea, eq. *Io fluvialis* Say.
Laevapex fuscus eugrapta Pilsbry, eq. *Laevapex fuscus* C. B. Adams.
Lasmigona badium Rafinesque, eq. *Lasmigona holstonia* Lea.
Ligumia latissima Rafinesque, eq. *Ligumia recta* Lamarck.
Limax marginatus Müller, eq. *Lehmannia poirieri* Mabille.
Lymnaea virginica Say, eq. *Goniobasis virginica* Gmelin.
Margaritana monodonta Say, eq. *Cumberlandia monodonta* Say.

Mesodon appressus sculptior Pilsbry, eq. *Mesodon appressus* Say.
Mudalia dentata Couthouy, eq. *Anculosa carinata* Bruguière.
Musculium rosaceum Prime, eq. *Sphaerium lacustre* Müller.
Musculium truncatum Linsley, eq. *Sphaerium partumeium* Say.
Philomycus carolinianus collinus Hubricht, eq. *Philomycus togatus* Gould.
Physa crocata Lea, eq. *Physa aurea* Lea.
Physa inflata Lea, eq. *Physa aurea* Lea.
Physa microstoma Lea, eq. *Physa aurea* Lea.
Pisidium neglectum Sterki, eq. *Pisidium casertanum* Poli.
Pisidium splendidulum Sterki, eq. *Pisidium nitidum* Jenyns.
Planorbis bicarinatus Say, eq. *Helisoma anceps* Menke.
Pupoides marginatus Say, eq. *Pupoides albilabris* C. B. Adams.
Quadrula tuberculata Rafinesque, eq. *Cyclonaias tuberculata* Rafinesque.
Quadrula verrucosa Rafinesque, eq. *Tritogonia verrucosa* Rafinesque.
Sphaerium flavum Prime, eq. *Sphaerium striatinum* Lamarck.
Sphaerium sulcatum Lamarck, eq. *Sphaerium simile* Say.
Stenotrema monodon Rackett, eq. *Stenotrema leai* Binney.
Strobilops labyrinthica parietalis Pilsbry, eq. *Strobilops labyrinthica* Say.
Strophitus edentulus Say, eq. *Strophitus undulatus* Say.
Strophitus undulatus tennesseensis Frierson, eq. *Strophitus undulatus shaefferianus* Lea.
Succinea pronophobus Pilsbry, eq. *Succinea wilsoni* Lea.
Triodopsis albolabris traversensis Leach, eq. *Triodopsis albolabris* Say.
Triodopsis hopetonensis chincoteagensis, Pilsbry, eq. *Triodopsis fallax obsoleta* Pilsbry.
Triodopsis notata Deshayes, eq. *Triodopsis denotata* Férussac.
Unio planilaterus Conrad, eq. *Elliptio congaraea* Lea.
Valvata tricarinata bicarinata Lea, eq. *Valvata tricarinata perconfusa* Walker.

SPECIES REPORTED IN ERROR

Carunculina glans Lea. An interior basin species reported from Lee County; specimens identified as *Toxolasma lividum* Rafinesque.

Quadrula cylindrica Say. An interior basin species reported from Louisa County.

Quadrula quadrula Rafinesque. An interior basin species reported from Lee County.

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FLUORESCENCE CAUSED BY *PSEUDOMONAS* IN THE MUCUS OF *HELIX ASPERSA* MÜLLER

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The yellow fluorescence observed when mucus from *Helix aspersa* is exposed to ultraviolet light was first reported by Turchini (1926) and later mentioned by Fischer and Saddy (1949); Turchini mentioned in a footnote that Derrien had communicated orally with him regarding the phenomenon. Although the cause of such fluorescence in land snails has been undetermined until recently, Derrien and Turchini (1925) earlier had suggested a bacterial origin. Subsequently, papers by Rawls and Yates (1971) and Rawls and Baum (1971) indicated a relationship between pseudomonad bacteria and fluorescence in the mucus of certain endodontid and polygyrid snails. Most recently, Baum and Rawls (1972) established the role of pseudomonads in the production of fluorescent pigments in the mucus of *Anguispira kochi* (Pfeiffer), and Rawls, Baum and Yates (1972) described fluorescence caused by pseudomonads in the mucus of *Bulimulus inscendens* Binney. We now wish to report that the distinctive fluorescence which is characteristic of the mucus of *Helix aspersa* likewise is caused by the occurrence of specific pigments produced by pseudomonad bacteria.

Through the kindness of a colleague, Barry Roth, a number of specimens of *Helix aspersa* came to us from California for use in our study. Using the technique and procedure devised earlier (Baum and Rawls, 1972), 15 Petri plates containing Pseudomonas-B Medium were strewked with mucus taken from 15 specimens of *Helix aspersa* and stored in the dark at room temperature. Forty eight hours later, 12 of the plates showed bacterial growth, 11 exhibiting a greenish-yellow fluorescence under ultraviolet light. The latter colonies were then isolated in pure culture by re-streaking successively three times on Medium B. With each re-streaking, the color of the fluorescence exhibited ranged from greenish-yellow through blue-green to blue. A final re-streaking, as a check, was made on separate plates of Medium B and Plate Count Agar. The color range on Medium B was essentially the same as before, but the PCA plates showed only a blue fluorescence. A Gram stain of each pure culture was made as a primary test of purity and for gross identification, and Bacto-Dif-

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ferentiation Discs, Oxidase (Difco Labs, 1966), were used to identify the bacteria as pseudomonads.

Spectrophotometric examination of mucus samples from *H. aspersa* reveals absorption peaks at about 282 nm, 330 nm, and 410 nm. Similar examination of pigment from bacterial isolates reveals prominent absorption only at about 278 nm, with slight peaks at about 320 nm and 390 nm. An emission value of 435 nm was obtained at an excitation wavelength of 165 nm. These values are quite comparable in range with those obtained from mucus samples and bacterial isolates taken from other fluorescent snails, and they lead us to the conclusion that fluorescence in *H. aspersa* is caused by the production of specific pigments by pseudomonad bacteria present in the mucus of these snails.

The variations in fluorescent colors observed during re-streaking on Pseudomonas-B Medium suggest that perhaps several pigments of bacterial origin are present in the mucus of living specimens of *Helix aspersa*. At least one of the pigments is golden-yellow pigment which characterizes the fluorescence observed in the mucus of the snail. That some sort of nutritional factor is involved, either on the part of the snail or on the part of the bacteria present, seems indicated by the shift from golden-yellow through blue-green to blue in successive isolates grown on Medium B. This seems substantiated by the production of blue fluorescence in isolates grown on ordinary Plate Count Agar, which lacks the nutritional ingredients present in Pseudomonas-B Medium. Hypothetically, then, something about the physiology of *Helix aspersa* permits pseudomonads present in the mucus to produce several pigments which fluoresce when excited by ultraviolet light. The dominant pigment fluoresces golden-yellow, but blue a d green pigments obviously are present as evidenced by the colors observed in successive bacterial isolates. We are pursuing the idea of a 'physiological factor,' and we hope to be able to report some degree of success in a future paper.

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NOTES AND NEWS

Editorial Policies

There is an old French proverb '*Mon verre est petit mais je bois dans mon verre.*' It has become customary in many fields to drink in other people's glass and to pay handsomely for it. STERKIANA from the start was an experiment in old-fashioned independence, based on all-volunteer work. In a world that believes in bigness, in constant growth and increased profits based on increasing prices, some have found it difficult to understand why STERKIANA's prices have remained the same from the beginning, more than ten years ago, until the present. It is a pleasure to announce that these reactionary policies will continue as long as inflation does not make it impossible to do so.

In order to maintain these policies, it has been necessary to reduce the paper work for STERKIANA to the barest minimum: no complex invoicing (xerox machines should have ended umptuplicate copies of invoices long ago), no delayed billing for institutions whose rules demand credit and months to pay and no participation in sales campaigns of any kind. It is gratifying to find that STERKIANA, like the Hershey bar some years ago, or the man with the better mouse trap, has found malacologists and paleontologists interested in its field and that the majority of active workers in the field know about STERKIANA and read it regularly. STERKIANA hopes to be able to continue for a long time on the same basis.

The original intention was to restrict articles in STERKIANA to non-marine Mollusca of both Americas. It now appears that this rule, which has been seriously bent before, can now be discarded and that in future articles on marine Mollusca will also be considered. The ban on descriptions of new taxa will still be maintained as these are more appropriately published in such journals as the NAUTILUS and MALACOLOGIA.

The following clarifications of policy are now in order for reprint rates and invoicing.

Reprint rates

Authors' reprints for STERKIANA articles are priced on the basis of cost of paper and cost of postage or shipping charges. At this time, cost of paper is $1.00 per hundred sheets whether two pages are reprinted on the sheets or only one. For example, a paper of two pages is printed on both sides of the sheet and cost is therefore $1.00 per hundred copies; a paper of three pages is printed on both sides of one sheet plus one page on another sheet hence the cost is $2.00 per hundred copies. Additional pages are priced on the same basis.

Postage rates vary from time to time (mainly upward) but at this moment rates within the U. S. are 14¢ for the first 8 ounces and 7¢ for each additional pound. Rates to other countries are somewhat higher but there is so much variation that details can not be given here.

Authors of manuscripts submitted for publication in STERKIANA are urged to indicate the number of reprints desired on a note accompanying the manuscript in order to avoid the necessity of further correspondence.

Invoicing policy

Invoices will be supplied for purchase of back numbers only. This publication is available otherwise by subscription or on exchange only. Subscriptions are payable in advance, on notification of expiration of previous subscription. Henceforth, notice will be given on the last page of the last number paid for. Failure to remit payment before issue of the next number will be construed as a termination of subscription. Because of lack of facilities and an effort to maintain dues at the lowest possible price, this is the only notification or invoice that will be given. Subscribers are urged to check the last page of STERKIANA on receipt of each number in order to check the state of their subscription.

A call for ecological data

Some years ago in this periodical, the writer reprinted valuable observations on non-marine Mollusca which had been uncovered during the preparation of *Pleistocene Mollusca of Ohio*. The literature of malacology contains many short observations on the habits, wssociations, abundance, food, enemies, parasites, symbiotes, commensals, of non-marine Mollusca which apparently have never been brought together.

STERKIANA now invites notes on these topics, both short and long, and will publish as many of them as possible. As soon as a sufficient number have appeared, an ecological index will be prepared and published in STERKIANA.

-------IN MEMORIAM-------

All those who knew Louise Clarke, wife of Arthur H. Clarke, Jr., president of the American Malacological Union in 1968, were shocked and grieved to hear of her unexpected death recently. Mrs. Clarke was 51 and is survived by her husband and one son.

Those who attended the AMU meetings in Ottawa, Ontario, will remember Louise Clarke as the unassuming organizer of many functions which made that meeting an outstanding one. We join a host of friends in extending deepest sympathy to our good friend Arthur and his family.

distended into rather conspicuous bulb-like expansions which greatly diminish the openings of the tubes into the suprabranchial chamber, although their edges do not fuse.

As the histological details of the structure of the marsupia in several genera belonging to the Lampsilinæ have been studied by Mr. Carter and will be described in his forthcoming paper, a further account may be omitted here.

PHYLOGENY OF THE MARSUPIUM.

It is not without justification that a phylogenetic significance should have been attached to the several types of the marsupium which occur in the Unionidæ, for it would seem clear that those forms in which the structure characteristic of the respiratory gill is least modified, as in *Quadrula*, are more primitive than those in which the specialization of the marsupium has gone much farther, as in *Anodonta*, *Lampsilis*, and many other genera.

Simpson (1900) has considered these facts in some detail and concludes that the oldest type of marsupium phylogenetically is that occurring in the Endobranchiæ in which the inner gills alone are used as brood chambers. It is a slight transition from this condition to that presented by the Tetragenæ with all four gills functioning for this purpose. Basing his supposition largely upon shell characters and geographical distribution, he further concludes that the Homogenæ marked the next step in marsupial differentiation, while the Heterogenæ and all other groups in which a portion only of the outer gills is modified for receiving the eggs are the latest product of the evolution of the Unionidæ.

That this series correctly represents the phylogenetic sequence in the appearance of the marsupial modifications would seem to be borne out by the structural conditions existing in the several types so far as we have examined them, provided that we assume, with respect to the Homogenæ, that genera like *Pleurobema* and *Unio*, in which the marsupium is less specialized, are more primitive and therefore stand nearer the *Tetragenæ* than such genera as *Anodonta*, *Symphynota*, and others, which, as Ortmann has shown, exhibit certain modifications evidently in advance over the marsupium of the former.

Ortmann (1911), although he does not consider the Endobranchiæ, has arrived at conclusions essentially similar to the above. He points out, however, that the absence of complete interlamellar junctions in the gills of *Margaritana* would indicate that the new family which he has created for this genus, Margaritanidæ, is the most primitive group of the Naiades, and this inference, as was indicated above, is further strengthened by the fact that the simple gill structure of *Margaritana* is apparently similar to that of *Mytilus*, which belongs to a lower group of lamellibranchs than the fresh-water mussels.

His conclusions concerning the sequence of his three subfamilies of the Unionidæ may be quoted (p. 328):

Of the *Unionidæ*, the *Unioninæ* are certainly more primitive than the other two subfamilies, as is evidenced by the simple character of the structure of the marsupial gills. The *Anodontinæ* and *Lamp-*

silinæ are more advanced, but they have advanced in different directions, and each has developed special features of the sexual apparatus. Generally speaking, the *Lampsilinæ* contain the most highly advanced types, as is shown by the restriction of the marsupium to a part of the outer gill, and by the strong expression of the sexual differentiation in the outer shell. Yet there are forms among the *Anodontinæ* which show extremely complex structures (*Strophitus*) unparalleled in any other genus, and the peculiar glochidia of the *Anodontinæ* surely mark a high stage of development.

It is not necessary for our purpose to enter into a further discussion of the subject in this place.

CONGLUTINATION OF THE EMBRYOS.

After extrusion of the eggs from the genital apertures, they are received into the supra-branchial chambers, and thence pass, as has already been described, into the water tubes of the gills, eventually filling up those portions which function as the marsupium. In a short time after entering the latter the eggs usually become conglutinated into masses which are molded into the exact shape of the cavity of each marsupial water tube (Lefevre and Curtis, 1910b). The masses are of course separated from each other by the intervening interlamellar junctions of the gills.

Since it is a matter of convenience to have a word to apply to these compact masses in which the eggs or embryos are held together, whether they be plate-like, club-shaped, cylindrical, or of some other form, we shall employ the term conglutinate in referring to them. Ortmann (1911) has proposed the word placenta, which was introduced by Sterki (1898) for the peculiar cords of *Strophitus*, but this is obviously misleading, as there is no connection whatever between the masses and the maternal tissues. The conglutinates vary greatly in different species in size and shape, and, since each is a cast of the cavity of its water tube, they conform to the special conditions existing in the several types of marsupium. The commonest form is that of a flat plate, either elliptical or lanceolate, being usually slightly blunter and thicker above and more pointed and thinner below. Since we have already seen that the antero-posterior diameter of the marsupial water tubes varies very much in different species, the thickness of the conglutinates must vary to the same extent. In *Quadrula* and *Unio*, for example, in which the interlamellar junctions are set close together, the conglutinates are very thin, being not more than twice the diameter of an egg in thickness; whereas in *Lampsilis*, with its much more capacious tubes, they may be three or four times as thick. In other words, just as many eggs will lie abreast in a horizontal section of the marsupium as the antero-posterior diameter of the water tube will allow.

This commoner lanceolate form of the conglutinate, differing, however, in size and thickness, may be seen in the species of *Quadrula*, *Pleurobema*, *Unio*, and *Lampsilis*. In figure 41, plate XI, two conglutinates of *Lampsilis ligamentina* are represented, one from the flat side, the other on edge. An unusual form of conglutinate has been observed by us in *Quadrula metanevra;* it is bifurcated and consists of two flat lanceolate masses which are united for the upper third of their length, but free below. In those genera, however, in which the form of the water tubes of the marsupium departs more widely from the usual condition, the conglutinates are similarly modified. In *Obliquaria reflexa*, for example, in which the marsupium consists of several elongated and distended water tubes of tubular form, the conglutinates are large, slightly curved cylindrical masses of nearly uniform diameter and generally blunt at each end. Three of them are shown in figure 42, plate XI; the one on the right was taken from the most posterior water tube of the marsupium, which is not as long as the rest, and its conglutinate is correspondingly shorter. The relation will be understood by reference to the figure of the marsupium of this species (fig. 7, pl. VII).

There seem to be two methods by which the embryos are bound together to form conglutinates—they may either be attached more or less firmly to each other by their egg membranes, which are in this case of an adhesive nature, or they may be embedded in a mucilaginous matrix of varying consistency. The former is by far the commoner condition and is seen in figure 17, plate VIII, which is a detail drawn from one of the conglutinates of *Obliquaria reflexa* shown in figure 42, plate XI; the immature glochidia with their valves open are still contained within the membranes, which are closely adhering and by mutual pressure are squeezed into a polyhedral form. In cases like this it is difficult to determine whether there is a glutinous matrix between the embryos or not, but if any is present, it must be in very small amount, since the embryos seem to be held together solely by the adhesive surfaces of their membranes. In those cases, however, in which a matrix is evident (*Lampsilis*), the embryos are not so closely appressed and are embedded, more or less loosely, in a glutinous binding substance. This condition is illustrated in figure 16, plate VIII, which is a portion of a conglutinate of *Lampsilis ligamentina* seen under higher magnification; as the matrix is transparent, it can not be shown in the figure.

The conglutinates differ markedly in tenacity, for, whereas in some cases the mutual adhesion is not strong and the masses consequently break up readily (*Quadrula*, *Pleurobema*, *Unio*, *Lampsilis*), in others (notably in *Obliquaria*) the embryos adhere so firmly that they may be separated only with difficulty by teasing.

In still other species the embryos can not be said to form conglutinates at all, as they are merely suspended in a slimy mucus which is not of such a consistency as to enable the mass to maintain a definite form when removed from the gill. We have observed this condition in *Alasmidonta*, *Anodonta*, and *Symphynota*, and Ortmann (1911) states that it also occurs in *Anodontoides*.

In most species (*Quadrula*, *Unio*, *Lampsilis*, *Dromus*) in which the conglutinates are found, the adhesion exists only during the embryonic development and by the time the glochidia are fully formed they are found to be free but for the mucus which holds them more or less loosely together. In *Obliquaria reflexa*, however, the conglutination persists, and the fully developed glochidia, still tenaciously adhering, are discharged from the marsupium in the cylindrical masses already described (fig. 42, pl. XI); even after lying in the water for some time they do not separate, and it has perplexed us to understand how the glochidia of this species ultimately become attached to fish, if they pass through a subsequent parasitic stage. Can it be that parasitism has been lost in *Obliquaria* as it has been in *Strophitus*, and that the metamorphosis takes place while the glochidia are in the conglutinates? We have not yet had the material by which to answer this question.

The relation of the embryos and glochidia of *Strophitus* to each other is so unusual that its description is reserved for a special section (see below).

STRATIFICATION OF UNFERTILIZED EGGS.

It has already been pointed out that not infrequently eggs pass into the marsupium without being fertilized and remain there throughout the period of embryonic development, as one may find them in the same gill with fully formed glochidia. In some individuals we have found every egg in the marsupium in this condition. Such eggs have been encountered chiefly in summer-breeding species, and they seem to be especially common in *Pleurobema* and *Quadrula*, nearly every gravid female of which has been found to contain at least some unfertilized eggs. After remaining in the marsupium for a time such eggs generally become swollen and stratified into three distinct layers, a heavier, often pigmented, mass at one pole, a clear or hyaline intermediate zone, and a small granular cap at the lighter pole. As the eggs lie in a constant position in the gills, which are placed vertically in the normal position of the animal, it can not be doubted that the stratification is produced by gravity. It has not yet been determined whether the substances which occur in these layers are the same as would be separated out by centrifuging or not, but this is not at all unlikely. As many of the species of mussels in which we have seen this condition, for example, *Quadrula ebena*, *Q. trigona*, and *Pleurobema æsopus*, have brightly colored red or pink eggs, the stratification is quite striking, the pigment being always at the heavier pole, as it is invariably directed toward the lower border of the gill.

ABORTION OF EMBRYOS AND GLOCHIDIA.

There has been a certain amount of discussion among the conchologists as to whether or not the functioning of all four gills as a marsupium is a constant character in *Quadrula*, and observations have been to a certain extent conflicting. Since Simpson has made use of this feature in characterizing the group Tetragenæ, some importance has been attached to the apparent discrepancy in observations.

While examining mussels on the upper Mississippi River in the summer of 1908, we observed a peculiarity of behavior in all of the species of *Quadrula* collected which may account for the conflicting descriptions of the marsupium in this genus, and also for the fact that in some species gravid females have never been observed at all. Every species of *Quadrula* that came into our hands exhibited to a greater or less degree the habit of aborting embryos and glochidia when taken out of the river, and if they were not opened and examined at once upon capture they were generally found shortly afterwards to be either partially or entirely empty. Some individuals discharged the contents of their gills more readily and completely than others, the abortion involving either all four gills or only the inner or outer ones, or, again, only a portion merely of one or more gills. In the pre-glochidial stages, when the embryos are conglutinated, the entire masses were discharged, while individuals were frequently seen in the act of aborting their embryos or glochidia which were often expelled with considerable force through the exhalent siphon.

This behavior was so characteristic of the genus that, in order to make a correct determination of the condition of the marsupium, it was necessary to open quadrulas immediately after taking them from the water. When this was done, all four gills were invariably found to be charged on opening females which contained embryos in pre-glochidial stages—that is, at any time before normal spawning had occurred. The habit of readily aborting embryos when disturbed has also been observed by us in *Unio complanatus*, which has been repeatedly seen in the act of discharging the contents of the marsupium shortly after being placed in aquaria. In all likelihood it occurs in other species of *Unio*, and it may possibly be characteristic of all forms in which there is but little structural differentiation of the marsupium. We have, however, also observed the discharge of embryos in *Lampsilis ligamentina*, but only after the gravid females have been kept in the laboratory for some time. This species is apparently very much less sensitive with respect to abortion than the quadrulas and *Unio complanatus* and only frees its gills of the conglutinates after long exposure to artificial conditions. The premature extrusion is probably due to imperfect aeration of the water and results from an effort on the part of the female to secure more oxygen; if this be true, one would not expect to find it occurring so readily in those forms which have a differentiated marsupium, like the Heterogenæ, since here the respiratory and marsupial functions of the gills are not so intimately associated.

Both Schierholz (1888) and Latter (1891) have referred to the occurrence of abortion in *Anodonta*, but according to our experience it has never been encountered in a single instance in either *Anodonta* or *Symphynota*, although gravid females have been kept in tanks in the laboratory for weeks or even months. The presence of the respiratory canals, which have been described as occurring in these genera during gravidity, as well as the temporary membrane which roofs over the marsupial division of the water tubes, might well account for the absence of abortion, or at least its rare occurrence, in the forms in which these special conditions exist. The respiratory canals doubtless lessen the evil effects of poor aeration, while the roofing membrane of the water tubes would certainly offer some obstruction, as long as it was present, to a liberation of the embryos.

BREEDING SEASONS.

In connection with our study of artificial propagation of fresh-water mussels, we have found it necessary to collect data bearing upon the breeding seasons of a fairly wide range of species, since the records of previous observers, for North American Unionidæ at least, have been insufficient to enable us to determine the full extent of the seasons, especially in the case of some of the more important commercial species.

Although our observations have been largely confined to species occurring in the upper Mississippi Valley and have been concerned primarily with species of commercial value, we have continuous records throughout the entire year for a number of important genera, and in every case the exact stage of development of the embryos has been determined by microscopic examination. Many thousands of such observations have been made, so that we are now in possession of detailed information dealing with the duration and progress of the periods of gravidity obtaining in over a dozen genera of the Unionidæ.

We have fully confirmed the conclusion reached by Sterki (1895) that the North American Unionidæ, with respect to their breeding seasons, fall into two classes, the so-called "summer breeders" and "winter breeders" — a distinction, however, which had previously been pointed out by Schierholz (1888) for European forms and frequently recorded by later observers. The designation "winter breeders," however, is not strictly appropriate, for in the species which belong to this group the eggs are fertilized during the latter half of the summer and the glochidia, which are carried in a fully developed condition in the marsupium throughout the winter, are not discharged until the following spring and summer. In the case of the summer breeders, the eggs are fertilized during late spring and summer and spawning as a rule is over by the end of August.

In view of these facts, it would seem to accord better with the actual conditions to separate the species with respect to the length of time that the glochidia remain in the marsupium, designating them as those that have a "short period" and those with a "long period" of gravidity, rather than to distinguish them as "summer breeders" and "winter breeders," respectively, for with respect to the latter neither ovulation nor discharge of the glochidia takes place in winter. This suggestion was made by us in an earlier paper (1910b), and subsequently Ortmann (1911) proposed the somewhat awkward terms *tachytictic* and *bradytictic* (meaning quick-breeding and slow-breeding) for Sterki's "summer breeders" and "winter breeders," respectively.

The breeding seasons as here defined are based upon data collected in the middle and northern sections of the United States, and in the absence of adequate records from higher and lower latitudes, it is impossible to say to what extent a colder or warmer climate might affect the period of gravidity. That it would have some influence can hardly be doubted, although a distinction between a long and a short season will probably be found to hold true in general.

The breeding season is a generic character, for so far as our observations have gone all of the species belonging to a given genus have essentially the same period of gravidity. The prolonged period, furthermore, is correlated with the more pronounced structural modifications of the marsupium which have been described above.

LONG PERIOD OF GRAVIDITY.

In the forms which fall into this category the eggs are fertilized, as has been stated, during the latter half of the summer, from the middle of July to the middle of August, and the glochidia, instead of being discharged when fully formed, are carried in the marsupium until the following spring or early summer. In fact, in some cases the close of one breeding period may overlap on the beginning of the next, as one may still find in late July a few straggling females gravid with glochidia formed in the previous autumn, while in other individuals of the species at the same time and in the same locality the eggs are passing into the gills for the next season. This seems to be true of several species of *Lampsilis*. We have encountered it in *ligamentina*, Conner (1909) records it for *radiata* and *nasuta*, while Ortmann (1909) states that his observations make it probable for *ventricosa* and *luteola*. Yet, as Ortmann observes, it is generally true that an interval exists between the close of one period and the beginning of the next. This interval, however, varies in length in different species, in some extending from late spring until August, whereas in others it is of much shorter duration. It is also to be noted that the discharge of glochidia does not take place in all of the individuals of a species at the same time, but on the contrary, spawning may extend over a considerable period throughout the spring and early summer (cf. Ortmann, op. cit.).

All of the genera included in Simpson's Heterogenæ, Ptychogenæ, Eschatigenæ, and Diagenæ have the long period of gravidity, as do also a number of genera of the Homogenæ (*Alasmidonta*, *Anodonta*, *Anodontoides*, *Arcidens*, *Symphynota*), while the Mesogenæ are represented in this group by *Cyprogenia*. These genera are embraced in Ortmann's subfamilies *Anodontinæ* and *Lampsilinæ*, and it should be noticed that in all the gills show a high degree of specialization in adaptation to the marsupial function, a specialization which is undoubtedly correlated with the habit of retaining the glochidia over a period of several months.

In the following list are given the species in which we have determined the long period of gravidity:

Alasmidonta truncata.
Anodonta cataracta.
Anodonta grandis.
Anodonta implicata.
Arcidens confragosus.
Cyprogenia irrorata.
Dromus dromus.
Lampsilis (Proptera) alata.
Lampsilis (Proptera) lævissima.
Lampsilis anodontoides.
Lampsilis gracilis.
Lampsilis higginsii.
Lampsilis ligamentina.
Lampsilis luteola.
Lampsilis recta.
Lampsilis subrostrata.
Lampsilis ventricosa.
Obovaria ellipsis.
Plagiola elegans.
Plagiola securis.
Strophitus edentulus.
Symphynota complanata.
Symphynota costata.

Ortmann (1909) has published some observations on the breeding seasons of the Unionidæ of Pennsylvania, supplemented by data from Lea and Sterki; his results in all essential points agree closely with ours. He includes among "winter breeders" several genera which we have not had under observation, namely, *Truncilla*, *Micromya*, *Ptychobranchus*, and *Anodontoides*, while *Arcidens*, which we have recorded, does not appear in his list.

There is given below a brief summary of our breeding records for the genera here concerned. Although in many species we have examined hundreds of individuals and have had them under observation continuously throughout the year, in others the material has been more or less meager and observations scattered, but in most of the forms the records have been adequate for a determination of the general limits of the breeding season.

Alasmidonta.—Embryos from latter part of July to middle of August. No fully formed glochidia have been seen, as gravid females have not been secured after August.

Anodonta.—Embryos from the middle of August to September; ripe glochidia from early October to first of July. A distinct interim exists between close of one period and beginning of next. According to Harms (1909), in European species of *Anodonta* the eggs are fertilized about the middle of August, all of the individuals entering upon the breeding season at nearly the same time, and by the middle of October almost all of the females are gravid with glochidia.

Arcidens.—Glochidia in winter months. Only a few individuals secured.

Cyprogenia.—Glochidia in November.

Dromus.—Glochidia in November.

Lampsilis.—Embryos from first of August to late September; glochidia from late September to first of August. Our most complete record concerns this genus, several species of which (*anodontoides*, *ligamentina*, *recta*, *subrostrata*, *ventricosa*) we have repeatedly had under observation continuously throughout the year. The gravid period seems to be more extended in *Lampsilis* than in any other genus, for, although June is apparently the month when the liberation of glochidia is at its height, some females bearing glochidia may still be found, but in diminishing numbers of course, until the beginning of August, a time when the next season is just setting in. Since ripe glochidia may be obtained in abundance from October to July, inclusive, and since *Lampsilis* furnishes several species of commercial value, the extended period of gravidity in this genus becomes of the greatest importance in artificial propagation, as material is available for the infection of fish throughout the greater part of the year.

Obovaria.—Glochidia during the fall, winter, and spring months. Spawning must occur before June, as no glochidia have been encountered in June, July, and August, although a number of females have been obtained during these months.

Plagiola.—Ripe glochidia during the winter and as late as the end of July; no embryos have been obtained.

Strophitus.—Embryos from late July to middle of August; glochidia from November to middle of July. The interval between the seasons is very short, much shorter than that observed by Ortmann (1909), who records an interim from May 22 to July 11.

Symphynota.—Embryos during August; ripe glochidia from late September to late June. *S. complanata* is a species which we have had on hand constantly for several years, and we have followed it continuously through the year. Spawning is most active in June.

SHORT PERIOD OF GRAVIDITY.

In the species having the short period of gravidity the entire breeding season is confined to about four months, as it extends only from about the end of April to the middle of August, and the glochidia are discharged as soon as they are fully developed. It is highly probable, however, that the beginning of the breeding season is influenced to a certain extent by temperature, for it would seem that ovulation may be postponed for some weeks by cold weather at this time of the year. It was first pointed out by Sterki (1895) that these summer-breeding forms are confined to a limited group of genera, and Ortmann (1911) has emphasized the fact that it is only the genera having the least specialized marsupia that possess this apparently more primitive breeding season; these are the genera which constitute his subfamily Unioninæ. *Margaritana*, unquestionably a primitive form, likewise breeds only in the summer. In all of these genera the structure of the marsupium approaches most closely that of the respiratory gills; none of the special modifications, so prominent a feature of the marsupium of other genera, is present. There is apparently, however, one exception, for, as will be shown below, our records indicate clearly that *Obliquaria*, which has a highly specialized marsupium, is a summer breeder.

The following are the species which we have observed to have the restricted breeding season:

Obliquaria reflexa.
Pleurobema æsopus.
Quadrula ebena.
Quadrula heros.
Quadrula lachrymosa.
Quadrula metanevra.
Quadrula obliqua.
Quadrula plicata.
Quadrula pustulosa.
Quadrula trigona.
Quadrula (Tritogonia) tuberculata.
Quadrula undulata.
Unio complanatus.
Unio gibbosus.

The following species, which do not appear above, have been determined by Ortmann (1909) to be summer breeders: *Unio crassidens; Pleurobema clava* and *coccinea; Quadrula kirtlandiana*, *rubiginosa*, and *subrotunda*. Our list, on the other hand, supplements his by the addition of several species of *Quadrula*, for which data have previously been either entirely wanting or quite meager.

Obliquaria.—Since all of the forms which carry the glochidia over the winter have a highly specialized marsupium, we should expect that *Obliquaria*, whose marsupium is of such a nature, would also have the long gravid period. This expectation would be further strengthened by the fact that the very closely related genus *Cyprogenia* belongs in the former group, as has been seen. It was therefore with some surprise that we found *O. reflexa* breeding during the summer. Our record is as follows: Embryos from the latter part of May to July 9; glochidia from June 20 to August 8. This is a typical record for a summer breeder, and there can be little doubt that the species must be placed in this group. On the other hand, Sterki (1898, 1903) states that all forms which have a differentiated marsupium carry their glochidia over the winter, and Ortmann (1911) includes *Obliquaria* in his *Lampsilinæ*, all of which he says are "bradytictic," although specific reference to the breeding season of this genus is not made. Since, however, we have not had an opportunity of observing the species during the fall and winter, it is possible that it has the long period, although, if such is the case, its season begins two months earlier than that of any other species in this class—a quite improbable supposition. For the present, at all events, we must consider it a summer breeder.

Pleurobema.—Embryos from early June to early August; glochidia during July.

Quadrula.—Embryos from late May to middle of August; glochidia from early June to middle of August. Hundreds of females belonging to different species of this genus have been examined throughout the rest of the year, but gravid individuals have never been encountered except during the months indicated.

It should be mentioned that in the case of *Q. heros* Frierson (1904) has not found this species gravid in Louisiana until October, when embryos were found. Young embryos were again encountered in November and immature glochidia in January. He concludes that *heros* is an exception in the genus and is not a summer breeder. Our observations on this species are very meager, but since we have found it bearing young embryos in the latter part of May, they would seem not to be in accord with those of Frierson.

According to Harms (1909), *Margaritana*, which breeds in Europe in July and August, produces two successive broods during that time, from sixteen days to four weeks, according to temperature, being required for the development of each. Although we have not determined it beyond all doubt, our records strongly indicate that the species of *Quadrula* also spawn twice during the season, first in June and July and again in July and August. This, however, could not be definitely proven without a most extended series of observations, and possibly not unless individual females were kept in aquaria under close observation throughout the breeding season.

Unio.—Embryos from early June to early August; glochidia from middle of June to middle of August. Conner (1907) records *U. complanatus* as beginning its breeding season in April, and Lea (1863) found it gravid in May; but we have not had an opportunity of examining any species of the genus during these months. According to Harms (1909) the breeding season of *Unio* in Europe begins early in March, or, if the weather is cold, not until the end of May.

III. THE LARVA.

STRUCTURE OF THE GLOCHIDIUM.

As has long been known, two well-marked types of glochidia are found in the Unionidæ; one provided with a strong shell bearing a single stout hook at the ventral margin of each triangular valve; the other with no such hooks and a more delicate shell, the valves of which are shaped like the bowl of a very blunt spoon.

A possible third type, which appears to be a derivative of the second, is seen in the "axe-head" glochidium, originally described and figured by Lea (1858, 1863, and 1874) in *Lampsilis* (*Proptera*) *alata*, *lævissima*, and *purpurata*.

The first type is characteristically parasitic upon the fins and other external parts of fishes from which scales are absent, the second upon the gill filaments. The occurrence of these types in the genera which we have examined is shown by the following list:

Hooked glochidia:
- Anodonta.
- Strophitus.
- Symphynota.

Hookless glochidia:
- Cyprogenia.
- Dromus.
- Lampsilis (majority of species).
- Obliquaria.
- Obovaria.
- Plagiola.
- Pleurobema.
- Quadrula.
- Tritogonia.
- Unio.

Axe-head glochidium:
- Lampsilis (Proptera) alata.
- Lampsilis (Proptera) lævissima.
- Lampsilis (Proptera) purpurata.
- Lampsilis capax.

The axe-head glochidium occurs, so far as known, in only a few closely related species which were generally included in the genus *Lampsilis*, but which, after being first placed in the subgenus *Proptera* by Simpson (1900), have been elevated to the genus *Proptera* by Sterki (1895 and 1903), a change which has recently been approved by Ortmann (1911). The species long known to possess this axe-head glochidium are *Lampsilis* (*Proptera*) *alata*, *lævissima*, and *purpurata*, and recently Coker and Surber (1911) have described it for *Lampsilis capax*.

There is considerable diversity in size among glochidia even from the same genus, as represented by the outlines in text figure 1 (A–O), all of which are drawn to the same scale, the most striking cases being the difference between the two species of *Plagiola* (G and H), and that between *Lampsilis recta* and *gracilis* (K and L). Harms (1909), who has studied the exceedingly minute glochidia of *Margaritana margaritifera*, finds that they are exclusively gill parasites, because their small size makes attachment elsewhere impossible.

The type of glochidium is constant for the genus, so far as our observations go, save in the case of *Lampsilis*, as has just been mentioned. In some cases the shape is also characteristic, as shown by *Symphynota* and *Anodonta* (A, B, and C), in which the shell outline is a distinguishing feature.

In *Dromus dromus* the glochidium, which is of the hookless type (text fig. 1, M), is greatly elongated antero-posteriorly thus presenting an interesting modification.

THE HOOKLESS TYPE.

Since the greater part of our experimental infections with glochidia of the hookless type have been made with our common species of *Lampsilis*, we have examined the glochidia in this genus more extensively than any others and shall describe, as representative of what has been observed, the hookless glochidium of *Lampsilis subrostrata* which is shown in figures 13, 14, and 15, plate VIII; and, since it is often necessary in the practical work of infection to examine the glochidia alive in water and to determine the exact stage of their development, we shall first speak of their appearance when in this condition.

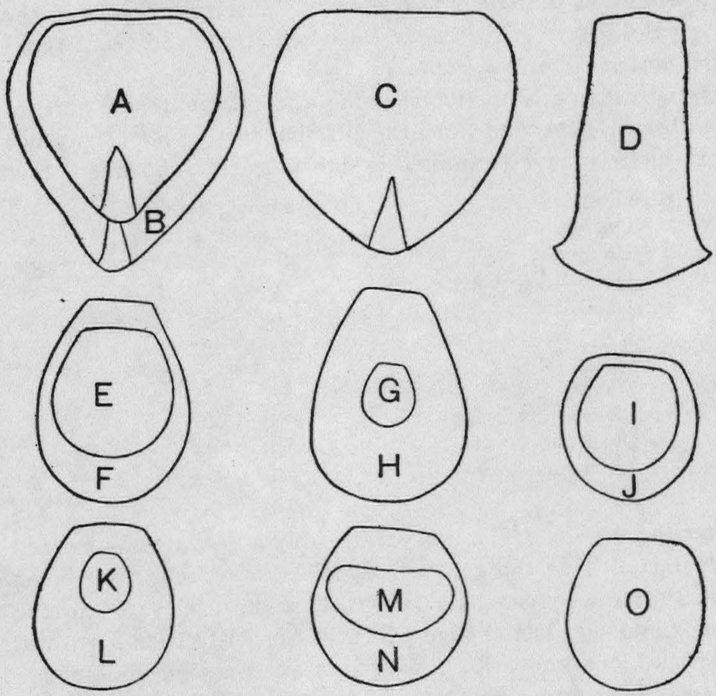

FIG. 1.—Figures showing relative sizes and shapes of the shells of a series of glochidia, belonging to the following species: A, *Symphynota complanata*, 0.30 × 0.29 mm.; B, *S. costata*, 0.39 × 0.35 mm.; C, *Anodonta cataracta*, 0.36 × 0.37 mm.; D, *Lampsilis (Proptera) alata*, 0.41 × 0.23 mm.; E, *Quadrula metanevra*, 0.19 × 0.18 mm.; F, *Q. pustulosa*, 0.30 × 0.23 mm.; G, *Plagiola elegans*, 0.09 × 0.075 mm.; H, *P. securis*, 0.31 × 0.23 mm.; I, *Quadrula ebena*, 0.15 × 0.14 mm.; J, *Q. plicata*, 0.21 × 0.20 mm.; K, *Lampsilis gracilis*, 0.085 × 0.075 mm.; L, *L. recta*, 0.24 × 0.20 mm.; M, *Dromus dromus*, 0.19 × 0.10 mm.; N, *Obliquaria reflexa*, 0.23 × 0.225 mm.; O, *Unio gibbosus*, 0.22 × 0.19 mm.

When examined alive (fig. 13, pl. VIII), this glochidium exhibits a shell which is comparatively firm in structure and which may remain unchanged by the water even many days after its living contents have been destroyed. Evidence of the shell's strength is shown by the fact that its shape remains unchanged after the glochidial muscle has caused the lips of the shell to bite deeply into a host's tissue, and by the fact that it is not easily broken by rough handling, as when the glochidia are tumbled in and out of a pipette during the process of breaking up the conglutinated masses. This strength is due to the carbonate of lime already laid down in the shell and not to the cuticle, which is often referred to by investigators as though it were the sole constituent of the shell of the glochidium; for when the carbonate of lime is dissolved by acid the cuticle becomes wrinkled and the shell partially collapsed. Viewed from the outside and closed (fig. 13, pl. VIII), this shell of the living glochidium exhibits a fine granulation over its entire surface and a distinct border