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CONTENTS PAGE

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ANNOUNCEMENT

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.

STERKIANA will appear twice a year or oftener, as material is available. All correspondence should be addressed to the Editor.

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STERKIANA est une collection de travaux sur les Mollusques extra-marins des deux Amériques, distribuée par un groupe de malacologues du centre des Etats-Unis. STERKIANA publie des travaux en anglais, en français et en espagnol acceptés par le conseil de rédaction. Prière d'adresser toute correspondance au Rédacteur.

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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.

PLEISTOCENE LAND AND FRESH-WATER MOLLUSKS FROM NORTH TEXAS*

E. P. CHEATUM AND DON ALLEN

Prior to the use of Carbon 14 dates, many local Pleistocene molluscan faunas associated with sparse vertebrate remains were incorrectly dated. Since the date determinations were postulated upon the basis of the vertical range records of fossil mollusks in the Mid-Continental United States, the misconceptions are easily understood. Southern species appearing in the faunules are unknown from the Mid-Continent region. Collections of fossils from many localities were considered as isolated local faunas and few attempts were made to correlate them.

Detailed studies in recent years of formations such as the T-2 terrace (Slaughter, *et al.*, 1962), Good Creek (Dalquest, 1962), and Groesbeck (Dalquest, 1965) brought forth inconsistencies in earlier conceptions of the Pleistocene in Texas. Some investigators had predetermined an early extended period of desiccation to have occurred during the Illinoian epoch, surmising that post-Illinoian faunas would reveal a noticeable climatic change.

The Carbon 14 dated faunas in this study reveal that if such a period of desiccation existed, its occurrence was some time after 9,000 B.P. (before present), near the close of the Wisconsin epoch. Records of the Kansan age faunas from formations in Texas such as the Cudahy (Hibbard, 1944, 1949; Frye and Leonard, 1952, and others), and the Seymour (Hibbard and Dalquest, 1960) were better determined because of the presence of the overlying Pearlette volcanic ash, and the presence of abundant vertebrate remains.

*We are indebted to the Graduate Research Center of SMU for financial assistance in the employment of help for separating and assorting shells from the matrix.

Fossil Molluscan Faunas

The fossil molluscan assemblages in this study have been re-examined since early publications and as a result, there will be additions to and deletions from the faunas. The additions are often the result of continued collections made from the localities after publication.

All of the fossil shells were collected from Pleistocene sediments in large pieces of matrix which were then stored in burlap bags until dry; they were then washed through screens in the manner described by Hibbard (1949). Many of the smaller shells were dipped from the water as they floated free from the submerged matrix. Others were sorted from the remaining solids that failed to pass through the screen. The collected shells were soaked in detergent overnight then boiled briskly for thirty minutes to remove the sediment clays from the shell apertures. Tiny specimens were boiled separately to prevent their being sucked into the larger shells during the cleaning process. The shells were then dried, examined, sorted, catalogued, and then placed in the shell depository in the Department of Biology at Southern Methodist University. Catalogue numbers accompany the listed species.

In tables presented in this report the ap-

proximate abundance of species in one gallon of concentrate is indicated as follows: A = over 50, C = 21-50, S = 20, and R = 1-5 shells.

FOSSIL MOLLUSCAN ASSEMBLAGES

The Good Creek Local Fauna, Good Creek Formation, Foard County, Texas

Cummins (1893) was the first to observe and publish on vertebrate fossils in Pleistocene beds in north central Texas. One of these sites was near Good Creek in Foard County. For many years, these Pleistocene beds were considered to be a part of the Seymour Formation which was probably of a Kansan glacial age (Hibbard and Dalquest, 1960). Subsequently Dalquest (1962) re-examined these classic deposits and postulated them to be of Sangamonian age by vertebrate faunal inference.

Land and fresh-water fossil shells were abundant in the sediments of these deposits. Most of the shells came from breccia layers throughout the gray clay sediments. The concentrations of shells as noted could be indicative of repeated rapid deposition from the intermittent streams of ancient Good Creek. The unusual number of land species present would furnish supplementary evidence of this postulation.

Fossil shells were collected from the following three localities, and after comparison all were found to contain the same species, and hence considered contemporaneous.

Localities:

1. The Easley Ranch local fauna (Dalquest, 1962) was collected from the Easley Ranch where State Farm Market Road 654 crosses Monument Creek. This locality is considered the type locality of the Good Creek formation. This locality furnished the most abundant fossil shells.

2. Collections were also made from the Leslie McAdams ranch downstream from the Easley ranch.

3. Additional collections came from the J. D. Smith ranch which is located upstream from the type locality. Caliche encrusted fossil shells of *Quadrula forsheyi* were abundant from concentrated terrace gravels at this site. Although the clam shells were not found in the other localities, the fossil land and fresh-water fauna also taken from the Smith Ranch was composed of substantially the same species as from the Easley and McAdams ranches.

Specimens from all locations were in excellent preservation and in some instances the small sphaeriids, such as *Sphaerium striatinum* were found articulated.

The Good Creek formation has been assigned a late Sangamonian age on the basis of a substantial collection of vertebrate remains and upon geological evidence.

List of Molluscan Species

	Relative Abundance
Pelecypoda	
Quadrula forsheyi Lea - SMU P 737	R
Elliptio dilatatus (Raf.) - SMU P 738	R
Sphaerium striatinum (Lamarck)	C
Pisidium nitidum Jenyns - SMU P 723	S
Gastropoda	
Amnicola limosa (Say) - SMU P 713	R
Helisoma trivolvis (Say) - SMU P 722	R
H. anceps (Menke) - SMU P 704	S
Gyraulus circumstriatus (Taylor) - SMU P726	S
G. parvus (Say) - SMU P 719	A
G. crista (Linnaeus) - SMU P 731	R
Physa anatina Lea - SMU P 702	A
P. gyrina Lea - SMU P 703	S
Stagnicola palustris (Müller) - SMU P 707	R
S. caperata (Say) - SMU P 708	C
Fossaria dalli (Baker) - SMU P 706	S
F. obrussa (Say) - SMU P 705	S
Gastrocopta armifera (Say) - SMU P 714	R
G. procera (Gould) - SMU P 715	R
G. pentodon (Say) - SMU P 716	C
G. corticaria (Say) - SMU P 728	R
G. cristata (Pils. & Van.) - SMU P 730	S
G. pellucida hordeacella (Pils.) - SMU P 727	R
Pupilla blandi (Morse) - SMU P 711	R
Vertigo ovata (Say) - SMU P 717	C
V. milium (Gould) - SMU P 718	C
Pupoides albilabris (C.B. Adams) - SMU P 712	C
Discus cronkhitei (Newcomb) - SMU P 709	C
Vallonia gracilicosta Reinhardt - SMU P 725	R
Hawaiia minuscula (Binney) - SMU P 701	C
Euconulus fulvus (Müller) - SMU P 733	R
Succinea sp. - SMU P 720	S
Stenotrema leai (Binney) - SMU P 724	S
Mesodon indianorum (Pilsbry) - SMU P 734	R

Ecology

The most unusual species in this assemblage is *Gyraulus crista* (pl. 1, fig. 5), since its present range is from Michigan to Maine. Only two species of shells are listed as abundant, *Physa anatina* and *Gyraulus parvus*, and these are species which prefer quiet waters and abundant algae. The presence of the pelecypods and *Amnicola* indicates perennial waters. Moist woodlands with abundant humus are indicated by *Vertigo milium, V. ovata, Vallonia gracilicosta, Stenotrema leai* and *Carychium exiguum*.

Among the seventeen species of land snails listed, *Vallonia gracilicosta, Vertigo milium, Pupilla blandi*, and *Discus cronkhitei* range north of Texas today. *Gyraulus circumstriatus, Gyraulus crista, Stagnicola palustris*, and *Stagnicola caperata* are all aquatic species which today range north of Texas.

Assuming that the present day environmental needs of the species present in the Good Creek deposit are essentially the same as they were in the Sangamon, then these shells would partially support Dalquest's (1962) conclusions. Dalquest postulated for the area a marshy stream flowing through a 'rather arid grassland' 'More humid woodlands must have occurred along the immediate banks of the stream, to permit the existence of such forms as the short-tailed shrew, rice rat, fulvus harvest mouse, etc.' However, as far as temperatures are concerned, there would be no reason to conclude that the winters were any milder than they are today, but by inference based upon the shells of current northern distribution, the summer temperatures apparently did not show the sustained high extremes as they do at present.

Moore Pit Local Fauna of the T-2 Trinity River Terrace

Shuler (1918) first described vertebrate fossils from the Pleistocene Trinity River terrace deposits near Dallas, Texas. Slaughter and others studied and collected from the terrace deposits for several years prior to publication (Slaughter, *et al.*, 1962). The shells were taken from an exposure in the Wood Pit located at the south end of Deepwood Street, south of the southern arc of Loop 12 in Dallas. Subsequently (Slaughter, 1965) has incorporated the Wood Pit as a locality of the Moore Pit local fauna.

The fossil shells were homogeneous in gray clay beneath the familiar laminated sands of the Lower Shuler formation. Probably the gray clay represented an extinct pond on the old flood plain.

Carbon 14 dates from matrix within the Upper Shuler unit, which overlies the Lower Shuler in the Wood Pit, gave the age at slightly more than 37,000 years B.P. (Brannon *et al.*, 1957).

List of Molluscan Species	Relative Abundance
Gyraulus parvus (Say) - SMU P 469	C
G. circumstriatus (Tryon) - SMU P 474	A
Planorbula armigera (Say) - SMU P 470	C
Helisoma anceps (Menke) - SMU P 460	S
H. trivolvis (Say) - SMU P 472	S
Stagnicola caperata (Say) - SMU P 480	S
Fossaria humilis modicella (Say)-SMU P 465	S
F. dalli (Baker) - SMU P 481	R
F. obrussa (Say) - SMU P 479	S
Aplexa hypnorum (Linn.) - SMU P 482	S
Physa gyrina Say - SMU P 459	A
Bulimulus dealbatus (Say) - SMU P 451	R
Carychium exiguum (Say) - SMU P 468	S
Hawaiia minuscula (Binney) - SMU P 461	S
Retinella indentata (Say) - SMU P 477	R
Zonitoides arboreus (Say) - SMU P 475	S
Strobilops texasiana (Pils. &Ferr.)-SMU P 456	S
Helicodiscus parallelus (Say) - SMU P 464	S
Gastrocopta armifera (Say) - SMU P 466	R
G contracta (Say) - SMU P 473	R
G. pentodon (Say) - SMU P 457	A
G. albilabris (C.B. Adams)-SMU P 453	S
Pupisoma dioscoricola (C.B. Adams) - SMU	R
Succinea sp. - SMU P 458	S
Helicina orbiculata tropica Pfr.-SMU P 452	R
Mesodon thyroidus (Say) - SMU P 455	S
Polygyra texasiana (Moricand) - SMU P 463	R
Stenotrema leai (Binney) - SMU P 454	A

Ecology

Among the 29 species listed for the Moore Pit Local Fauna of the T-2 Terrace are only five species which do not inhabit this area today. *Gyraulus circumstriatus, Planorbula armigera, Stagnicola caperata*, and *Aplexa hypnorum* are all aquatic pulmonates of a more northerly distributional range, whereas *Pu-*

pisoma dioscoricola ranges from extreme southern Texas to Brazil. The five species of aquatic pulmonates listed above are forms which thrive in shallow, sluggish temporary or perennial waters. They all can be considered species which can tolerate temporary desiccation assuming that moisture is still retained in the dried up slough or pond.

Indicative of moist woodland is the species *S. leai* which is listed as abundant. Associated along with this species in a humid environment are *M. thyroidus, Z. arboreus, C. exiguum, S texasiana,* and *H. parallelus*. Species which can apparently thrive in humid environments as well as the more open, exposed, well-drained areas are the *Gastrocopta* species, *Helicina, Hawaiia* and *Bulimulus*. However, characteristic of open, well-drained woodlands is *Helicina* and *Bulimulus*, the latter genus a typical prairie species with the ability to withstand several months of desiccation by producing epiphragms over the shell aperture thus conserving body moisture.

The presence of *Pupisoma* might indicate a climatic condition which would involve greater humidity than that which exists in the area today. One might also infer that low temperature extremes for periods of several weeks did not occur because under such circumstances such genera as *Bulimulus, Helicina,* and *Pupisoma* probably could not have survived. We might also infer that since the species previously mentioned with a more recent northerly distribution lived in the Moore Pit area that extreme high temperatures of several weeks duration did not exist as they do today.

Quitaque Local Fauna, Motley County, Texas

In 1958, Mr. Gene Wilson of Ringgold, Texas, brought some teeth of an extinct camel (*Camelops* sp.) to W. W. Dalquest of Midwestern University. He found these in the bed of a small arroyo tributary to Quitaque Creek in the northeast corner of Motley County, south of Turkey, Texas, approximately one-half mile east and downstream from the crossing of the creek with State Farm Market Road 599. Subsequent trips by Dalquest (1965 B) yielded additional vertebrate remains and a substantial molluscan fauna.

The Quitaque deposits are assumed to be terrace sediments. The fossil remains were taken from clay beds that were probably ponds or oxbow lakes in the old flood plain. Shells of the sand clam, *Lampsilis anodontoides* Lea were abundant in one of the clay beds containing fossil bones. These shells were submitted to E. E. Bray of Socony Mobil, Dwllas, Texas, for C 14 determination. The test revealed an age of 31,400 years B. P. ±5600 years. A second test gave a marginal error of only ±3200 years.

List of Molluscan Species	Relative Abundance
Pelecypoda	
**Lampsilis anodontoides* Lea - SMU P 167	C
Sphaerium striatinum (Lamarck) - SMU P 121	A
Pisidium compressum Prime - SMU P 126	C
Gastropoda	
Valvata tricarinata (Say) - SMU P 118	S
Amnicola integra (Say) - SMU P 131	R
Fossaria parva (Lea) - SMU P 119	S
F. dalli (Baker) - SMU P 134	S
F. obrussa (Say) - SMU P 135	C
Stagnicola caperata (Say) - SMU P 136	C
S. palustris (Müller) - SMU P 122	A
Gyraulus parvus (Say) - SMU P 102	A
***Gyraulus labiatus* (Leonard - SMU P 101	R
G. circumstriatus Tryon - SMU P 103	R
Promenetus umbilicatellus (Ckll.)-SMU P 125	C
Helisoma anceps (Menke) - SMU P 116	S
H. trivolvis (Say) - SMU P 129	R
Ferrissia rivularis (Say) - SMU P 137	R
Aplexa hypnorum Linn. - SMU P 138	S
Physa anatina Lea - SMU P 120	A
P. gyrina Lea - SMU P 107	A
Strobilops sparsicostata (Baker) - SMU P 105	R
Discus cronkhitei (Newcomb) - SMU P 108	A
Helicodiscus parallelus (Say) - SMU P 115	R
H. singleyanus (Pilsbry) - SMU P 117	C
H. eigenmanni (Pilsbry) - SMU P 133	R
Gastrocopta armifera (Say) - SMU P 110	S
G. procera (Gould) - SMU P 111	S
G. tappaniana (C.B. Adams) - SMU P 113	S
G. cristata (Pils. & Van.) - SMU P 112	C
G. pentodon (Say) - SMU P 114	S
Vertigo ovata (Say) - SMU P 104	A

*The shells of *Lampsilis anodontoides* are listed as common but were not collected by the technique used for the other shells. They were quite fragile and only a few perfect specimens were collected although the shells were close together in a three-inch layer at the base of the clay sediment. They were not compressed or distorted.

Pupilla muscorum (Linn.) - SMU P 124	S
Pupoides albilabris (C.B. Adams) - SMU P 109	C
Zonitoides arboreus (Say) - SMU P 127	S
Euconulus fulvus (Müller) - SMU P 130	S
Vallonia gracilicosta (Reinh.) - SMU P 122	S
Succinea ovalis Say - SMU P 133	R
Succinea sp. - SMU P 132	R
Stenotrema leai (Binney) - SMU P 123	R

Ecology

The presence of *Lampsilis anodontoides*, the sand clam, is indicative of a stream or lake habitat with sand or gravel bottoms and the water well oxygenated. Such a stream or lake would have to be of sufficient size to support the garfish which serves as intermediate host for *L. anodontoides*. W. W. Dalquest (1964) described the sand and gravel beds of the Quitaque Site and assumed the terraces resulted from the filling of an older, broader valley. The clays, according to his postulation, were 'deposited in ponds or oxbow lakes on the old floodplains.'

In this habitat the fossil shells seem to bear out the ecological assumption of Dalquest. Well aerated perennial wwters along with abundant standing waters were necessary to provide adequate habitat for the 19 species of aquatic mollusks reported for the Quitaque site. As previously mentioned, the common occurrence of *L. anodontoides* indicates clear perennial water with a flow adequate for good aeration, and a sand or gravel substrate. Lending support to such an environment is the presence of *Sphaerium striatinum*, *Pisidium compressum*, and *Valvata tricarinata*, all of which seldom occur in ponds, bogs, or swamps. However, an abundance of sluggish waters supporting abundant vegetation undoubtedly existed because such habitats were optimum for the genera *Fossaria*, *Stagnicola*, *Gyraulus*, *Helisoma*, *Ferrissia*, *Aplexa*, and *Physa*. Among the land shells, *Discus cronkhitei* and *Vertigo ovata* were the only species classified as abundant at the Quitaque site. Both of these species require humid surroundings. Both usually occur along stream beds or in well-shaded areas where moisture is retained.

Species of a more northerly distribution in the Quitaque site that to our knowledge have not been reported as Recent for Texas are *Stagnicola caperata*, *Stagnicola palustris*, *Gyraulus labiatus*, *Gyraulus circumstriatus*, *Aplexa hypnorum*, *Strobilops sparsicostata* (now extinct) and *Pupilla muscorum*.

The Clear Creek Local Fauna, Denton County, Texas

In 1960, Ritchie Slaughter and Ritchie (1963) found a concentration of fossil shells in sediment revealed in an abandoned gravel pit in Denton, Texas. The fossil location lies along Clear Creek, north of Denton, Texas. This portion of Clear Creek which empties into the Elm Fork of the Trinity River is on the farm of Mr. Phillip Frietsch. Fossil freshwater and land shells were found in a sandy clay zone overlying basal gravels. Radiocarbon tests which were run on the shells by the Socony Mobil Field Research Laborstory in Dallas, Texas (Test No. SM 534) gave a date of 28 840 4 740 B.P. for the deposit.

Pelecypoda	Relative Abundance
Sphaerium striatinum (Lamarck) - SMU P 269	S
Pisidium nitidum Jenyns - SMU P 374	S
Gastropoda	
Valvata tricarinata (Say) - SMU P 356	R
Amnicola integra (Say) - SMU P 367	C
Physa anatina Lea - SMU P 373	S
Gyraulus parvus (Say) - SMU P 357	A
Helisoma anceps (Menke) - SMU P 351	C
Fossaria dalli (Baker) - SMU P 370	R
F. bulimoides (Lea) - SMU P 379	R
Gastrocopta armifera (Say) - SMU P 354	A
G. procera sterkiana Pilsbry - SMU P 360	A
G. pellucida hordeacella Pils. - SMU P 358	A
G. contracta (Say) - SMU P 361	A
Pupoides albilabris (C.B. Adams) - SMU P 353	C
Helicodiscus parallelus (Say) - SMU P 364	C
H. singleyanus (Pilsbry) - SMU P 362	C
Anguispira alternata (Say) - SMU P 376	R
Strobilops texasiana (P. & V.)-SMU P 365	A
Vallonia gracilicosta Reinhardt - SMU P 368	R
Carychium exiguum (Say) - SMU P 359	R
Hawaiia minuscula (Binney) - SMU P 363	S

** There is some question as to the validity of *Gyraulus labiatus* (pl. I, fig. 3). It is considered by many to be of large size but well within the size range of *G. parvus* (pl. I, fig. 4). In this report *G. labiatus* was separated from *G. parvus*, the separation based upon the unusually large shell diameters of *G. labiatus*.

Euconulus fulvus (Müller) SMU P 380 R
Zonitoides arboreus (Say) - SMU P 375 R
Retinella indentata (Say) - SMU P 366 S
Conella lubrica (Müller) - SMU P 377 R
Succinea sp. - SMU P 381 R
Stenotrema leai (Binney) - SMU P 352 R
Polygyra texasiana (Moricand) - SMU P 355 R
Praticolella berlandieriana (Mor.)-SMUP 378 R
Helicina orbiculata tropica Pfr. - SMU P 372 S
Bulimulus dealbatus (Say) - SMU P 371 C

Ecology

With the exception of the fresh wwter branchiate, *Valvata tricarinata*, and the land snail *Vallonia gracilicosta* (both species of a more northerly distribution) the shells of the Clear Creek deposit are found in this area today. The land snails, *Bulimulus dealbatus* and *Helicina orbiculata tropica* are able to withstand prolonged drouth and are typical prairie and sparse woodland species. Perennial cool water was present to support the sphaeriid species and the branchiate gastropods *Valvata* and *Amnicola* Assuming that adequate spring fed water was available to support the branchiate species of mollusks then one could postulate a prairie environment with sparse woodland, perhaps with more dense tree clusters.

Interestingly enough the above environmental assumption based upon mollusks coincides with the postulation of Slaughter and Ritchie (1963) who stated as follows concerning the fossil vertebrates of Clear Creek: 'If one does not consider the preferences of the fossil lemming species as necessarily identical with those of the living species, there is not a single mammal in the Clear Creek local fauna that would be considered a northern type. It would appear that during the time of the Clear Creek local fauna, winters were at least as warm as today, or perhaps warmer. Annual rainfall was five to ten inches less unless warmer winter temperatures made the moisture less effective.' These writers go on to say that based upon 'current rwnges of the extant species are more suggestive of an interglacial-interstadial climate than of a glacial age.' Considering the general ecology of the Clear Creek molluscan assemblage the species present could easily support the environmental postulations of Slaughter and Ritchie.

The Howard Ranch local fauna (Groesbeck formation), Hardeman County, Texas

Since 1891, when W. F. Cummins discovered mammalian remains at the forks of the Groesbeck Creek in Hardeman County, local outcroppings were considered a part of the Seymour formation. The Seymour formation has been assigned to the Kansan Glacial Age (Hibbard and Dalquest, 1960).

W. W. Dalquest, Midwestern University, Wichita Falls, Texas, in 1958 began a study of the area described by Cummins. Through collected vertebrate remains, *Bison antiquus* and *Bison occidentalis*, it became evident that the deposits were post-Kansan in age (Dalquest, 1965). Land and fresh water shells were abundant and were preserved in fossiliferous lenses of sandy gravel stratum beneath grayclay layers throughout the Groesbeck formation. On the Howard Ranch, approximately one-half mile upstream from the junction of the South and North Fork of Groesbeck Creek abundant fossil shells of the pea clam, *Sphaerium striatinum*, were taken from the shell lenses and submitted to Mr. E. E. Bray of the Socony Mobil Oil Company of Dallas, Texas, for Carbon 14 dates. Fourteen determinations were made of the shells. The mean of five determinations, all of which were within the statistical limit given, was 16,775 ±565 years B. P. Mr. Bray stated in personal correspondence that he had also made a carbon determination of the surface of the shell and that 'carbon from the surface of the shells was the same age (within experimental error) as carbon from the interior portions, indicating that partial replacement was improbable.' The Groesbeck formation was thus laid down during the Brady interstadial event of the Wisconsin Glacial age.

A second collection of shells from a locality described by Frye and Leonard (1963) on the Howard Ranch was also submitted to Mr. Bray for carbon dating. The species from this locality were used in the test and are indicated on the faunal list under Laboratory No. SM 620. A date of 19,908 ± 1,074 B.P. was obtained. The variation in the dates and some faunal differences in localities indicates a slight nonconformity. The faunas, however, are quite comparable and the carbon dates are close enough to indicate a nearly contemporaneous deposition for the two localities.

All collections of the Howard Ranch local fauna were collected entirely on the Howard Ranch near Quahnah, Texas.

Locality 1. Collections from many typical shell lenses throughout the Groesbeck formation were made between 1959 and 1963. These were kept separated until it became obvious that the fossils were all from the basin of a single lake. These lake basin faunas are listed as Locality 1.

It is interesting to note that the presence of perfect specimens of *Lymnaea stagnalis jugularis* (Pl. I, fig. 1 & 2) is recorded for the first time in Texas Pleistocene studies. The presence of this species indicates permanent water and a substantial lake described by Dalquest (1965). The first *Lymnaea stagnalis* shells collected were found in a gray clay deposit about thirty feet above the channel which was eroded into the Permian bed rock. The shells were whole but badly fractured. A few were preserved for the collections by removing them partially encased in their native clay and saturating the entire mass with shellac for preservation. Many spires and fragments of *L. stagnalis jugularis* were evident in the screenings. Thus one could see that the spires of the broken shells of this species might be misconstrued as *Acella haldemani*.

Locality 2. Collections also from the Howard Ranch known as the Windmill Site are separated from the basin faunas because of the slight faunal differences within a restricted area. This locality is located 5½ miles north and 4 miles west of Highwwys 287-283 intersection at Quanah, Hardeman County, Texas.

Locality 3. The molluscan fauna from a third locality described by Frye and Leonard (1963) and Dalquest (1965) is considered separately because of the C14 date 19,098 10,074 B.P., which shows some nonconformity. This site is described by Dalquest (1965) as follows: '... beside a small bridge on a country road on the south side of the North Fork of Groesbeck Creek, 6.4 miles north and 4.2 miles west of the intersection of Texas State Highway 283 and U.S. Highway 287, beside the courthouse in Quanah.' Spires of *Lymnaea stagnalis* were also collected from this area.

Pelecypoda	Localities 1	2	3
Sphaerium striatinum (Lamarck) *673	A	A	S
Pisidium compressum Prime *687	A	A	S
Gastropoda			
Carychium exiguum (Say) *690	R	R	A
Fossaria dalli (Baker) *655	S	S	C
F. obrussa (Say) *683	R	S	C
Stagnicola palustris(Müller) *675	A	A	A
S. caperata (Say) *681	S	R	S
Lymnaea stagnalis jugularis (Say) *680	S	S	S
Gyraulus parvus (Say) *659	A	A	A
G. crista (Linn.) *671	-	C	-
Helisoma anceps (Menke) *653	C	A	R
H. trivolvis (Say) *672	S	S	S
Ferrissia meekiana (Stimpson) *689	R	R	-
Physa anatina Lea - *651	A	A	C
Amnicola limosa (Say) *690	A	A	-
Valvata tricarinata (Say) - *691	-	-	S
Strobilops sparsicostata Baker - *660	S	-	S
Gastrocopta armifera (Say) *662	R	C	C
G. cristata (Pils. & Van.) *664	C	C	S
G. pentodon (Say) *665	C	C	S
G. procera (Gould) *663	S	S	-
Pupoides albilabris (C.B. Adams)*667	C	C	C
Pupilla blandi Morse *692	R	S	S
P. muscorum sinistra Franzen *687	S	S	S
Vertigo ovata (Say) - *668	R	C	S
Vallonia parvula Sterki *688	S	S	S
Cionella lubrica (Müller) *679	R	-	S
Succinea cf. *S. grosvenori* Lea *674	R	-	R
S. cf. *S. luteola* Gould - *678	S	R	R
Discus cronkhitei Newcomb - *669	S	-	S
Helicodiscus parallelus (Say) *657	S	C	C
Deroceras sp. *693	R	R	-
Euconulus fulvus (Müller) *670	R	S	C
Hawaiia minuscula (Binney) *670	C	C	S
Zonitoides arboreus (Say) *684	S	R	C
Polygyra texasiana (Moricand) *682	S	-	-
Stenotrema leai (Binney) - *695	R	R	C

Ecology

Dalquest (1965) in discussing ecological conditions which may have existed during Groesbeck time postulated that these conditions differed, but not sharply, from those that exist today. His assumption is based largely upon the premise that nine species of the eighteen species of indicator vertebrates still exist in the area today. Because of the existence of northern species he concludes that ex-

*The asterisk here represents the abbreviation 'SMU P' preceding the catalogue number in other tables.

treme summer temperatures were lower than those of today, and that, because of the existence of the rice rat and opossum, the winter temperatures were not lower than they are today and without the presence of cold fronts the winter temperatures would be much more uniform.

Certainly conditions of prolonged desiccation did not exist in Groesbeck time. Supporting such a conclusion is the abundance of such forms as *Sphaerium striatinum*, *Pisidium compressum*, and *Amnicola limosa*, all of which require permanent water. *S. striatinum* and *P. compressum*, particularly, are species which are seldom found even in ponds, swamps, or bogs but occur in lakes, rivers and creeks where there is usually some current action. However, marsh, bogs, and swwmp areas must have also existed in the Groesbeck as attested to by the presence of genera such as *Stagnicola*, *Ferrissia*, *Lymnaea*, *Gyraulus*, *Helisoma*, and *Physa*, all of which contain species associated with quiet waters, temporary waters, and abundant vegetation.

Among the 37 species of mollusks identified from the Groesbeck assemblage are *Stagnicola palustris*, *Lymnaea stagnalis jugularis*, *Stagnicola caperata*, *Gyraulus crista*, and *Valvata tricarinata*, all aquatic species which are largely northern in distribution. However, Wallen and Dunlap (1953) reported living *Stagnicola palustris* and *Valvata tricarinata* from Oklahoma.

The following six species of land snails are listed ws common in two of the three Groesbeck localities: *Gastrocopta armifera*, *G. cristata*, *G. pentodon*, *Pupoides albilabris*, *Helicodiscus parallelus*, and *Hawaiia minuscula*. Most of these species may be found in deep woodlands, flood plains, sparse woodlands or well-drained uplands.

Byers Local Fauna, Byers, Clay County, Texas

In 1960 some school children playing on the farm of Mrs. Paul Dowdy, three miles west of the town of Byers in Clay County, Texas, found some large elephant bones in an eroded gully. Their discovery was reported to W. W. Dalquest of Midwestern University, who began collecting matrix from the clay sediments around the bones for other possible vertebrate remains. These remains were meager, but fossil land and fresh-water shells were abundant and dispersed homogeneously throughout the deposit.

In the first report (Allen & Cheatum 1961) the age of the deposit was postulated to be glacial, possibly Illinoian based upon faunal Pleistocene studies in Texas at that time. More recent studies and Carbon 14 dating (by Socony Mobil of Dallas) reveal a Wisconsin age. The Carbon-14 tests were made on *Physa gyrina* shells and gave a date of 16,920 ± 665 B. P.

List of Molluscan Species	Relative Abundance
Pomatiopsis lapidaria (Say) SMU P 9	C
Helisoma trivolvis (Say) - SMU P 4	C
Planorbula armigera (Say) - SMU P 12	A
Gyraulus circumstriatus (Tryon) - SMU P 15	S
Promenetus umbilicatellus (Ckll.) SMU P 16	R
Physa gyrina (Say) - SMU P 17	A
Stagnicola exilis (Lea) - SMU P	S
S. caperata (Say) - SMU P 2	C
Gastrocopta armifera (Say) - SMU P 6	C
G. tappaniana (C. B. Adams) - SMU P 18	C
Pupoides albilabris (C.B. Adams) - SMU P 8	C
Vertigo ovata (Say) - SMU P 9	
Strobilops sparsicostata (Baker) - SMU P 11	R
Euconulus fulvus (Müller) - SMU P 13	R
Succinea sp. - SMU P 5	S
S. ovalis (Say) - SMU P 20	R
Oxyloma retusa (Lew) - SMU P 1	C
Helicodiscus parallelus (Say) - SMU P 7	R
Retinella electrina (Gould) - SMU P 14	S
Hawaiia minuscula (Binney) - SMU P 19	A
Stenotrema leai (Binney) - SMU P 3	C

Ecology

Allen and Cheatum (1961) postulated the Byers deposit as lacustrine, this assumption based upon the homogeneous distribution of the fossil shells and the species collected which were typical dwellers of swales, lakes and ponds. Among the species collected the following are more northerly in distribution: *Gyraulus circumstriatus*, *Planorbula armigera*, *Promenetus umbilicatellus*, *Physa gyrina*, *Succinea ovalis*, *Oxyloma retusa*, *Retinella electrina*, *Pomatiopsis lapidaria*, and *Stagnicola exilis*.

Ben Franklin Local Fauna (Sulphur River Formation), Ben Franklin, Delta County, Texas)

In 1929 a series of channels were cut through the meanders of the North Sulphur River in Delta County to reclaim flooded bottom lands. These channels shortened the distance and steepened the gradient of the stream thus resulting in a down-cutting that exposed Pleistocene alluviums for a distance of 40 or more miles (Slaughter and Hoover 1963). Snail faunas were collected over much of this distance and by comparison they proved to be essentially the same.

One charcoal and one shell sample were taken from the exposure for Carbon 14 dates. Sample No. SM-532 charcoal was dated 9,550 ± 375 B.P. The second sample, No. SM-533, composed of shells of the fresh-water clam, *Amblema perplicata*, was dated 11,135 ± 450 B.P. The Carbon 14 dates were made by Socony Mobil Oil Company at Dallas. The clam shells were taken in sites from a location in the fossil zone 813 feet west of the center of a highway bridge that crosses the Sulphur River on Highway 38, north of the small town of Ben Franklin, in Delta County. Land and fresh-water fossil shells are abundant in the sediments.

Planorbula armigera (Say) - SMU P 617	C
Helisoma anceps (Menke) - SMU P 603	A
H. trivolvis (Say) - SMU P 604	S
Gastrocopta contracta (Say) - SMU P 608	C
G. armifera (Say) - SMU P 609	S
G. procera mcclungi (Hanna & Johnston) - SMU P 612	R
G. pentodon (Say) - SMU P 610	C
Pupoides albilabris (C.B. Adams) - SMU P 615	S
Helicodiscus parallelus (Say) - SMU P 633	R
H. singleyanus (Pilsbry) - SMU P 632	C
Discus cronkhitei (Newcomb) - SMU P 626	R
Strobilops texasiana (Pils. &Ferr.) - SMU P614	A
Valionia gracilicosta Reinhardt - SMU P 639	R
Carychium exiguum (Say) - SMU P 635	R
Hawaiia minuscula (Binney) - SMU P 634	R
Euconulus fulvus (Müller) - SMU P 638	R
Retinella indentata (Say) - SMU P 636	R
Zonitoides arboreus (Say) - SMU P 637	R
Helicina orbiculata tropica Pfr. SMU P 606	S
Mesodon thyroidus (Say) - SMU P 605	R
Stenotrema leai (Binney) - SMU P 607	S
Succinea ovalis Say - SMU P 602	S
Succinea sp. - SMU P 625	S

Ecology

The present ranges of *Ferrissia meekiana, Planorbula armigera, Valvata tricarinata, Somatogyrus depressus, Stagnicola reflexa,* and *S. caperata* are more northerly today. Their distributional patterns follow cooler climates, greater moisture, or combinations of both. All of these preceding species are either listed as common or abundant in the Ben Franklin fauna.

The most abundant shells in the Ben Franklin site were those of *Valvata tricarinata*. This branchiate species requires perennial, cold or cool water. The requirements for *Amnicola integra* are similar to those of *Valvata*. Perennial waters were also necessary for species under the genera *Pisidium* and *Sphaerium*. *Today, Sphaerium partumeium* and *Pisidium nitidum* thrive best in the soft muddy bottoms of lakes and rivers, whereas *Sphaerium striatinum, Pisidium wwlkeri,* and *P. compressum* occur in larger bodies of water or rivers where the substrate is more compact than flocculent.

Cheatum and Allen (1963) in discussing the ecology of the Ben Franklin state the following: 'The mollusks of the Ben Franklin local fauna, together with those of other Wisconsin deposits suggests that the final glaciation of the Pleistocene brought with it much moisture, and provided many lakes and streams of cool or cold running water in Texas. The fauna contains several species indicative of such an environment. Increasing aridity, the high summer temperatures of the sub-Recent, and continued seasonably severe winters must have eliminated from the local scene those species which now exist in more northern localities.

Recent and sub-Recent shells are also abundant in cross-channel fills but are easily recognizable not only by the visible differences in the make-up of the deposits, but also in the color of the shells. Carbon 14 determinations of sub-Recent clam shells from the base of the channel fills revealed a date of 1835 ± 144 B.P. (Socony Mobil, Dallas). Other channel fills in the exposure were dated 1123 ± 366 B.P. and 1170 ± 157 B.P. which would indicate a near contemporaneous deposition. The channel fill species are listed as follows:

Physa anatina Lea	R
Helisoma trivolvis (Say)	S
Fossaria dalli (Baker)	R

Stagnicola bulimoides techella (Hald.)	R
Gastrocopta armifera (Say)	C
G. contracta (Say)	A
G. procera (Gould)	A
G. pentodon (Say)	S
Pupoides albilabris (C.B. Adams)	C
Carychium exiguum (Say)	C
Vallonia sp. ?	R
Helicodiscus eigenmanni (Pilsbry)	C
Anguispira alternata (Say)	R
Hawaiia minuscula (Binney)	A
Retinella indentata paucilirata (Morelet)	C
Zonitoides arboreus (Say)	R
Euconulus chersinus (Say)	R
Strobilops texasiana (Pilsbry & Ferriss)	C
S. labyrinthica (Say)	C
Mesodon thyroidus (Say)	R
Polygyra texasiana (Moricand)	A
Bulimulus dealbatus (Say)	C

The superimposition of the sub-Recent and channel fill molluscan assemblage over the older Ben Franklin assemblage provided an excellent opportunity for comparative studies of the two faunas.

The channel fill fauna could not have been changed much by man's intervention as the species lived, died and became deposited some 1500 years ago. At the same time of the channel fill deposition the common, hardy Texas Recent species such as *Bulimulus dealbatus*, *Polygyra texasiana*, and *Anguispira alternata* had become wbundant, thus attesting to climatic conditions as variant as those which exist today. None of the northern species found were present in the channel fill. A period of desiccation could have been responsible for their disappearance, but a remarkable climatic change that ended the more equable temperatures of the late Pleistocene probably brought about their extinction in the area. The seasonable highs and lows of the winter and summer temperatures of today must have reached their inclemency during the interim of the two depositions.

Domeba Local Fauna, Stecker, Caddo County, Oklahoma

In April, 1962, fossil land and fresh-water shells were collected from an excavation site of an apparent mammoth kill near Stecker, in Caddo County, Oklahoma. Mr. Adrian Anderson, of the Museum of the Great Plains, Lawton Oklahoma, who was directing the excavation, assisted in collecting the shells from the sediments containing the mammoth remains. Mr. Bob Slaughter of the Shuler Museum, SMU, also made several trips to the site to recover matrix from the fossil zone and the shells separated from the resulting concentrate are included in this report. Carbon 14 tests (made by Mr. E.E. Bray of Socony Mobil Oil Company in Dallas) on lignitic wood which was removed from black silt about two feet from above the actual mammoth remains placed the date of the wood at 10,123 ± 280 years B.P.

List of Molluscan Species

	SMU P Number
Pelecypoda	
Sphaerium occidentale Prime	832
Pisidium variabile Prime	827
Uniomerus tetralasmus (Say)	824
Gastropoda	
Valvata tricarinata (Say)	825
Pomatiopsis lapidaria (Say)	803
Stagnicola caperata (Say)	804
S. palustris (Müller)	806
Fossaria dalli (Baker)	805
Physa anatina Lea	807
P. gyrina (Say)	807
Gyraulus parvus (Say)	821
Promenetus umbilicatellus (Cockerell)	822
Carychium exiguum (Say)	810
Gastrocopta contracta (Say)	811
G. pellucida hordeacella (Pilsbry)	814
G. armifera (Say)	812
G. pentodon (Say)	813
Vertigo ovata (Say)	815
Cionella lubrica (Müller)	831
Helicodiscus parallelus (Say)	826
H. singleyanus (Pilsbry)	830
Discus cronkhitei (Newcomb)	817
Strobilops labyrinthica (Say)	816
Vallonia gracilicosta Reinhardt	820
Euconulus fulvus (Müller)	823
Retinella electrina (Gould)	828
R. indentata (Say)	829
Hawaiia minuscula (Binney)	818
Succinea ovalis Say	808
Succinea sp.	809
Stenotrema leai (Binney)	802
Mesodon thyroidus (Say)	800

Ecology

The largest number of shells collected in the sediments of this site fell under those

species which prefer shallow, quiet water. The drouth-tolerant species constituted the smallest number of shells present and the other species indicate permanent water surrounded by woodlands and abundant moist humus. Cheatum and Allen* (1965) described the ecology of the site as follows: 'Judging from our data at hand the area in which the mammoth was found was probably a spring-fed marsh or bog with a luxuriant growth of vegetation. Surrounding the marsh or bog was woodland ranging from sparse to dense. Considering the shell size of *L. caperata* (many reaching a length of 20 mm), *P. gyrina* (prevalent with many shells 18 mm long), and *L. dalli* (some 6.5 mm long) growth conditions were apparently at the optimum for these species. *S. leai* and *P. lapidaria* also indicate greater moisture in this area than that which exists today since these species thrive best in broadleaf deciduous tree zones where the annual rainfall varies from 30 to 60 inches. The southern geographical range of *H. singleyanus* and *G. pellucida hordeacella*, which are seldom found living north of the 42° parallel, can be used to indicate a relatively mild winter climate. Sub-freezing temperatures (if encountered) would have been of short duration. On the other hand the presence of *V. tricarinata*, *P. umbilicatellus*, *D. cronkhitei*, and *L. caperata* which seldom range to the south of the 35° would indicate the absence of the seasonable high temperatures of Oklahoma today.

Summary

Seventy-five species of gastropods have been recorded for the eight Pleistocene deposits reviewed. According to our known records the following eleven species among the seventy-five species recorded for Pleistocene are not extant today in Texas and Oklahoma: *Stagnicola caperata*, *S. reflexa*, *S. exilis*, *Lymnaea stagnalis jugularis*, *Aplexa hypnorum*, *Gyraulus labiatus*, *Somatogyrus depressus*, *Pupisoma dioscoricola*, *Discus cronkhitei*, *Strobilops sparsicostata*, and *Retinella electrina*. Among these eleven species eight are aquatic species which may indicate that the land species are much more tolerant to changing climatic conditions than the aquatic forms.

It is also significant that such species as *Pomatiopsis lapidaria*, *Valvata tricarinata*, *Stagnicola palustris*, *Planorbula armigera*, *Armiger crista*, and *Promenetus umbilicatellus* are recorded as Recent for Oklahoma but not for Texas. It should be further noted that *Valvata tricarinata* and *Stagnicola palustris* are, according to Branson (1961) considered rare in Oklahoma and Taylor (1960) regards the record of *Promenetus umbilicatellus* in the Ozark Mountains of northeastern Oklahoma as 'an isolated occurrence.'

Seven of the eight Pleistocene sites reviewed are located in Texas. The total number of extant species listed for Oklahoma is greaterthan the total number of species extant for Texas, and, as previously stated, some of these species are definitely of a more northerly distributional range with Oklahoma apparently serving as a southerly distributional limit.

Based on the molluscan faunas studied in this report, there was no apparent major faunal change in post-Kansan times until after 9,000 B.P. Each fauna contains some species that are allopatric today. Using the premise that the ecological requirements of the species in our study are essentially the same as they are today, there apparently is no area in the continental United States today where all species represented in our study are sympatric. This assumption implies that the species listed have, from the standpoint of environmental preference, been genetically stable over the span of Pleistocene times.

Broecker *et al.* (1960) postulated an 'abrupt world-wide change in climate close to 11,000 years ago marking the end of the Wisconsin glacial period.' Their evidence was drawn from studies on deep-sea sediments from the Atlantic Ocean and adjacent seas, deposits from the pluvial lake area of the western U.S.A., sediments from the Great Lakes and their associated drainage networks and the pollen sequences of northwestern Europe. This abrupt world-wide change in climate was first recognized by Ewing (1956) as a result of studies on deep sea cores. Later, Ericson *et al.* (1956) presented

*This paper titled 'Ecological Significance of the Fossil Fresh-water and Land Shells from the Domeba Mammoth Kill Site in Caddo County, Oklahoma' will be published by the Great Plains Museum, Lawton, Oklahoma.

radiocarbon measurements on these cores. All of the correlated evidence supported the conclusion concerning the abrupt change in climate near the end of the Wisconsin period.

Hester (1960), on the basis of C 14 dates in an archeological study indicated that many of the larger mammals becsme extinct at this time. He stated that 'most herding animals such as the Columbian mammoth, horse, camel, and extinct bison (*Bison antiquus*) as well as the dire wolf, rapidly becsme extinct 8 000 years ago.'

Coinciding with Broecker's postulation and Hester's conclusion there is also a noticeable change between the Recent molluscan fauna of the study area today and the Ben Franklin and Domeba local faunas of some 9,000—12.000 B.P. The Pleistocene species in our collection which today are northern in distribution have to a certain extent been replaced by species of a more southerly distribution. To our knowledge, these southern species have not, heretofore, been recorded in fossil collections for this area. Much is to be desired in information concerning the vertical range of the Recent species in Texas and the broad distributional picture cannot be clarified until extensive field studies are conducted in Mexico, Central and South America whence these southern species may have originated.

In comparing the molluscan study faunas with those of post-Kansan age in the mid-continental region of the United States, there seems to be little evidence to support any radical difference between the post-Kansan mean annual temperatures of the two areas. The now predominant Texas land snails, *Bulimulus dealbatus*, and *Helicina orbiculata tropica* which do appear in the Clear Creek local fauna (28,840)B.P.) and the Sulphur River local fauna (9,550 B.P.) are not recorded in post-Kansan faunas from the mid-continental United States. Both species are hardy land snails that survive periods of drought and summer temperatures in excess of 100° F. They are not, of course, active during the excessive hot, dry, day time temperatures but, nocturnally are active in 90° F. temperatures even in dry seasons. They are comparatively few in Pleistocene collections and at most would indicate only the possibility of a somewhat warmer temperature in Texas. However, they do help to reinforce the premise that the winter temperatures during the Wisconsin were no more severe than they are in Texas today. The dominant Pleistocene species would, however, require much more moisture and permanent water than is indicated by the presence of *Bulimulus*, which is known locally as the prairie snail.

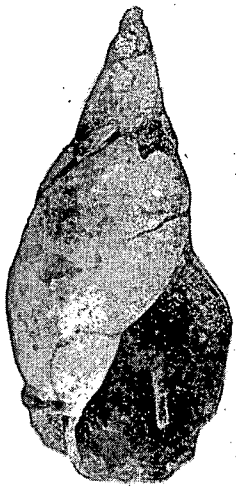
In order to support the larger species of Lymnaeids which at present do not live in Texas and southern Oklahoma, the periods prior to each deposition were probably of a much more equable humid climate. Major climatic changes were, of course, possible between the recorded depositions for they generally represent time periods of several thousand year intervals. If such periods of desiccation did occur, there apparently is to date no evidence based upon known fossil molluscan collections which would support such conclusions.

We are aware of weaknesses involved in the interpretation of fossil environments by using taxonomic paleoecolkgy. Undoubtedly many of our species have not reached a habitat equilibrium, therefore, their presence would not imply that the environment is ideal for their existence. However, we do feel that the pre-

EXPLANATION OF PLATE I OPPOSITE

1. *Lymnaea stagnalis jugularis* (Say), X1½, (Groesbeck) Hardeman Co., Texas.
2. *Lymnaea stagnalis jugularis (Say), X1½,* (Groesbeck) Hardeman Co., Texas, spire only.
3. *Gyraulus labiatus* (Leonard), X 5½ (8 mm.), (Quitaque) Motley Co., Texas.
4. *Gyraulus parvus* (Say), X 10 (4 mm.), (Quitaque) Motley Co , Texas.
5. *Gyraulus crista* (Linnaeus), X 17 (2 mm.), (Good Creek) Foard Co., Texas.
6 & 7. *Ferrissia rivularis* (Say), X 9½ (Quitaque) Motley Co., Texas.
8. *Strobilops labyrinthica* (Say), X 15, (Domeba), Caddo Co., Oklahoma.
9. *Strobilops texasiana* (Pils. & Ferr.), X 15 (Sulphur River) Delta Co., Texas.

PLATE 1



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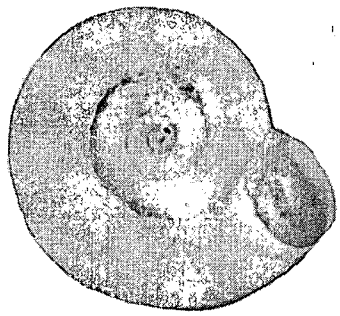

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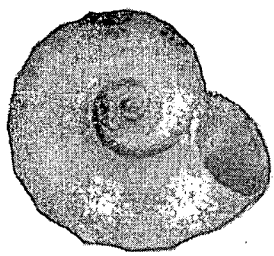

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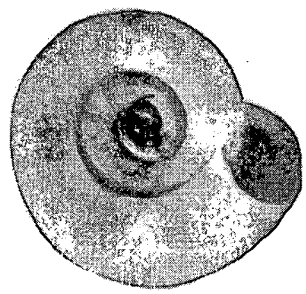

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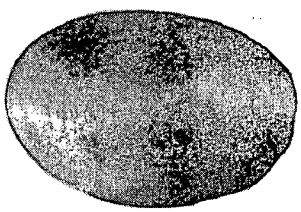

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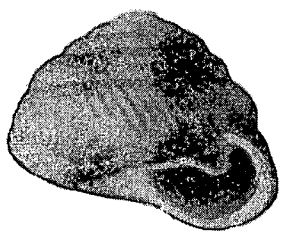

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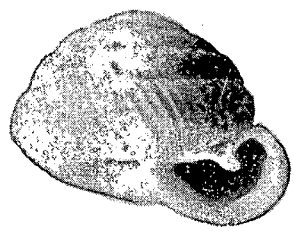

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sence or absence of several species in a given area, rather than the selection of one indicator species lessens the chance of error in paleoecological interpretation. Genetic changes may also have occurred in species which would lead to physiological differences. Thus, the habitat demand of the species living thousands of years ago may not be the same as it is for the same species today. Yet with these weaknesses that could exist we feel that by the use of large taxonomic fossil assemblages, a fairly accurate environmental picture can be obtained of past environments.

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RELATIVE ABUNDANCE OF MOLLUSK SPECIES COLLECTED IN EIGHT PLEISTOCENE DEPOSITS IN TEXAS AND OKLAHOMA

For explanation of abbreviations, see page 16.

	1	2	3	4	5	6	7	8	9
Class Pelecypoda									
Amblema plicata perplicata (Conrad)	-	-	-	-	-	-	X	-	X
Elliptio dilatatus (Raf.)	X	-	-	-	-	-	-	-	-
Lampsilis anodontoides(Lea)	-	-	X	-	-	-	-	-	X
Unicmerus tetralasmus (Say)	-	-	-	-	-	-	-	X	X
Quadrula forsheyi (Lea)	X	-	-	-	-	-	-	-	X
Sphaerium striatinum (Lamarck)	R	-	A	S	A	-	S	-	X
S. partumeium (Say)	-	-	-	-	-	-	S	-	-
S. occidentale (Prime)	-	-	-	-	-	-	-	S	-
Pisidium compressum (Prime)	-	-	C	-	A	-	S	-	X
P. nitidum (Jenyns)	S	-	-	S	-	-	S	-	X
P. walkeri (Sterki)	-	-	-	-	-	-	S	-	-
P. variabile (Prime)	-	-	-	-	-	-	-	X	-
Class Gastropoda									
Amnicola integra (Say)	-	-	R	-	-	-	A	-	X
Amnicola limosa (Say)	R	-	-	-	A	-	-	-	X
Somatogyrus depressus (Tryon)	-	-	-	-	-	-	A	-	-
Valvata tricarinata (Say)	-	-	S	R	-	-	A	X	X
Goniobasis sp	-	-	-	-	-	-	R	-	X
Carychium exiguum (Say)	-	S	-	R	A	-	R	X	X
Fossaria dalli (Baker)*	S	R	S	R	C	-	S	X	X
F. obrussa (Say)	S	S	C	-	C	-	-	-	X
F humilis modicella (Say)	-	S	S	-	-	-	-	-	X
Stagnicola bulimoides techella (Haldeman)	-	-	-	R	-	-	-	-	X
S. caperata (Say)	C	S	C	-	S	C	R	X	-
S. reflexa (Say)	-	-	-	-	-	-	S	-	-
S. palustris (Müller)	R	-	A	-	A	-	-	X	X
S. exilis (Lea)	-	-	-	-	-	S	-	-	-
Lymnaea stagnalis jugularis (Say)	-	-	-	-	S	-	-	-	-
Physa anatina (Lea)	A	-	A	-	A	-	-	X	X
P. gyrina (Lea)	S	A	A	S	-	A	S	X	X
Aplexa hypnorum (Linn.)	-	S	S	-	-	-	-	-	-

EXPLANATION OF PLATE 2

1 & 2. *Zonitoides arboreus* (Say), X 9, (Domeba) Caddo Co , Oklahoma.

3 & 4. *Retinella electrina* (Gould), X 9, (Domeba) Caddo Co , Oklahoma.

5 & 6. *Retinella indentata* (Say), X 8, (Domeba) Caddo Co., Okla.

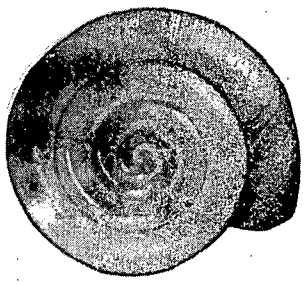
7. *Gastrocopta pentodon* (Say), X 18, (2 mm.), (Sulphur River) Delta Co , Texas.

8. *Gastrocopta tappaniana* (C. B. Adams), X 18 (1.7 mm), (Sulphur River) Delta Co., Texas.

9. *Succinea ovalis* (Say), X 2, (Sulphur River) Delta Co , Texas.

10, 11, & 12. *Stenotrema leai* (Binney), X 4, (Groesbeck) Hardeman Co , Texas.

PLATE 2



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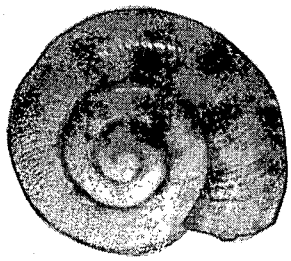

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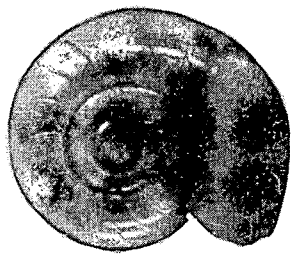

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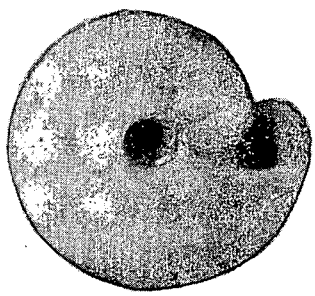

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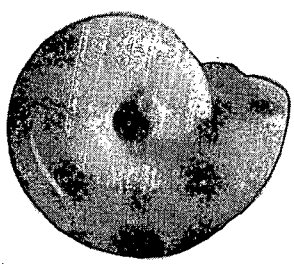

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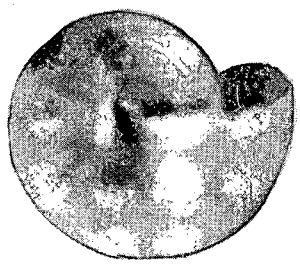

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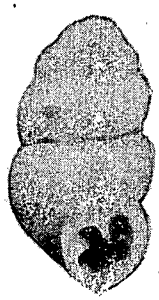

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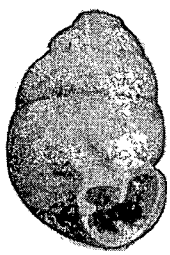

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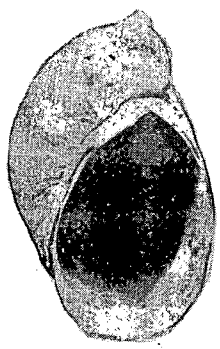

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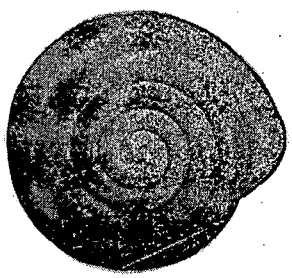

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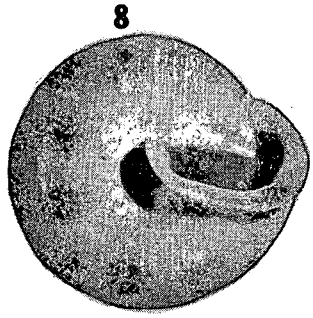

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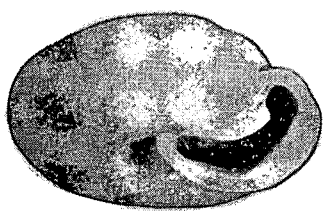

12

RELATIVE ABUNDANCE OF MOLLUSK SPECIES COLLECTED IN EIGHT PLEISTOCENE DEPOSITS IN TEXAS AND OKLAHOMA (Cont.)*

	1	2	3	4	5	6	7	8	9
Gyraulus circumstriatus (Tryon)	S	A	R	-	-	S	-	-	X
G. parvus (Say)	A	C	A	A	A	-	A	X	X
G. crista (Linn.)	R	-	-	-	C	-	-	-	X
G. labiatus (Leonard)	-	-	R	-	-	-	-	-	-
Helisoma anceps (Menke)	S	S	S	C	A	-	A	-	X
H. trivolvis (Say)	R	S	R	-	S	C	S	-	X
Planorbula armigera (Say)	-	C	-	-	-	A	C	-	X
Promenetus umbilicatellus (Cockerell)	-	-	C	-	-	R	-	X	X
Ferrissia rivularis (Say)	-	-	R	-	-	-	-	-	X
F. meekiana (Stimpson)	-	-	-	-	R	-	-	-	X
Pomatiopsis lapidaria (Say)	-	-	-	-	-	C	-	X	X
Cionella lubrica (Müller)	-	-	-	-	S	-	-	X	X
Gastrocopta armifera (Say)	R	R	S	A	C	C	S	X	X
G. corticaria (Say)	R	-	-	-	-	-	-	-	X
G. procera sterkiana (Pilsbry)	-	-	S	A	-	-	-	-	X
G. procera mcclungi (Hanna and Johnston)	R	-	-	-	-	-	R	-	X
G. procera (Gould)	-	-	-	-	S	-	S	-	X
G. pellucida hordeacella (Pilsbry)	R	-	-	A	-	-	-	X	X
G. cristata (Pilsbry and Vanatta)	S	-	C	-	C	-	-	-	X
G. pentodon (Say)	C	A	S	-	A	-	-	X	X
G. tappaniana (C. B. Adams)	-	-	S	-	-	C	-	-	X
G. contracta (Say)	-	R	-	-	-	-	-	X	X
Vertigo ovata (Gould)	C	-	A	-	C	A	-	X	X
V. milium (Gould)	C	-	-	-	-	-	-	-	X
Pupoides albilabris (C. B. Adams)	C	S	C	C	C	C	S	-	X
Pupilla muscorum (Linn.)	-	-	S	-	-	-	-	-	X
P. blandi (Morse)	R	-	-	-	S	-	-	-	X
P. sinistra (Franzen)	-	-	-	-	S	-	-	-	X
Pupisoma dioscoricola (C. B. Adams)	-	R	-	-	S	-	-	-	-
Vallonia parvula (Sterki)	-	-	-	-	S	-	-	-	X
V. gracilicosta (Reinhardt)	R	-	S	-	-	-	-	X	X
Helicodiscus parallelus (Say)	-	S	R	C	C	R	R	X	X
H. singleyanus (Pilsbry)	-	-	S	-	-	-	-	X	X
Anguispira alternata (Say)	-	-	-	R	-	-	-	-	X
Discus cronkhitei (Newcomb)	C	-	A	-	S	-	R	X	-
Helicodiscus eigenmanni (Pilsbry)	-	-	S	-	-	-	-	-	X
Strobilops labyrinthica (Say)	-	-	-	-	-	-	-	X	X
S. texasiana (Pilsbry and Ferriss)	-	S	-	A	-	-	A	-	X
S. sparsicostata (Baker)	-	-	R	-	S	R	-	-	-
Deroceras sp.	-	-	-	-	R	-	-	-	X
Bulimulus dealbatus (Say)	-	R	-	C	-	-	-	-	X
Helicina orbiculata tropica (Pfeiffer)	-	R	-	S	-	-	S	-	X
Hawaiia minuscula (Binney)	C	S	-	S	C	A	R	X	X
Euconulus fulvus (Müller)	R	-	S	R	C	R	R	X	X

* For explanation of abbreviations, see page 16

RELATIVE ABUNDANCE OF MOLLUSK SPECIES COLLECTED IN EIGHT PLEISTOCENE DEPOSITS (CONCLUDED)

	1	2	3	4	5	6	7	8	9
Zonitoides arboreus (Say)	-	S	S	R	C	-	R	-	X
Retinella indentata (Say)	-	R	-	S	-	-	R	X	X
R. electrina (Gould)	R	-	-	-	-	S	-	X	-
Stenotrema leai (Binney)	S	A	R	R	R	C	S	X	X
Polygyra texasiana (Moricand)	-	R	-	R	S	-	-	-	X
Mesodon thyroidus (Say)	-	S	-	-	-	-	R	X	X
M. indianorum (Pilsbry)	R	-	-	-	-	-	-	-	X
Praticolella berlandieriana (Moricand)	-	-	-	R	-	-	-	-	X
Succinea sp.	S	S	X	X	-	X	X	X	X
S. ovalis (Say)	-	-	R	-	-	R	A	X	X
S. cf. S. grosvenori (Lea)	-	-	-	-	R	-	-	-	X
S. cf. S. luteola (Gould)	-	-	-	-	R	-	-	-	X
Oxyloma retusa (Lea)	-	-	-	-	-	C	-	-	X

F. dalli (Baker), *F. obrussa* (Say), and *F. humilis modicella* (Say) are considered to be synonymized under the specific epithet of *Lymnaea humilis* (Say) by Hubendick (1951).

Explanation of Abbreviations

Relative abundance of species in one gallon of matrix:

X : occurrence
A : over 50
C : 21-50
S : 6-20
R : 1-5

1. Good Creek Local Fauna, Foard County, Texas.
2. Moore Pit (Hill-Shuler) Local Fauna, Dallas County, Texas.
3. Quitaque Creek Local Fauna Motley County, Texas. 31,400 ± 5600 B.P.
4. Clear Creek Local Fauna, Denton County, Texas. 28,840 ± 4740 B. P.
5. Howard Ranch (Groesbeck Creek) Local Fauna, Hardeman County, Texas. 19,098 ± 1074 B.P.; 16,775 ± 565 B.P.
6. Beyers Locsl Fauna, Clay County, Texas. 16920 ± 665 B.P.
7. Ben Franklin (Sulphur River) Local Fauna, Delta County, Texas. 9,550 ± 375 B.P.; 11,135 ± 450 B.P.
8. Domebo Local Fauna, Caddo County, Oklahoma. 11,045 ± 647 B.P.
9. Recent for Texas and Oklahoma.

MANUSCRIPT RECEIVED FEBRUARY 26, 1965.

THE ROLE OF AQUATIC PLANTS AND SUBMERGED STRUCTURES IN THE ECOLOGY OF A FRESHWATER PULMONATE SNAIL, *PHYSA INTEGRA* HALD.

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ABSTRACT

Physa integra Hald. was abundant on aquatic plants in the Ohio River and apparently preferred species with dense foliage. The termination of annual plant growth in fall was followed by a die-off of snails. Strong currents in spring carried off segments of the mollusk population that were living on submerged driftwood and the bottom. The *Physa* population was largely maintained from fall to summer by individuals inhabiting stable and somewhat protected dock pilings.

INTRODUCTION

The importance of aquatic higher plants as habitats for freshwater organisms is well known, but few reports have dealt in detail with the mollusk inhabitants. This paper is primarily concerned with the role of plants and other submerged surfaces in the ecology of *Physa integra*. These observations were made during a study of the mollusks in a small area of the Ohio River (River Mile 600.5—600.6) at Louisville, Kentucky. Other findings will be considered in future papers.

At this location the river bottom varied from loose silt and sand mixtures on a broad shoal with depths up to 1 m, to coarse sand and pebbles in the main channel. Scattered beds of the aquatic plants, *Potamogeton pectinatus*, *P. crispus*, and *Najas minor*, formed a zone of submerged vegetation throughout the littoral area, but were more concentrated among a line of boat slips that extended over much of the area studied. Three types of submerged surfaces (permanent, seasonal, and temporary) were present in this area. The permanent substrata were dock pilings and the wooden or stone retaining walls that bordered the shoreline. Aquatic plants and larger pieces of submerged driftwood were considered seasonal because they were present only during certain times of the year. Their removal and subsequent return was an annual phenomenon. Larger driftwood, consisting mostly of tree branches, was washed awwy and replaced with similar material by heavy currents that accompanied spring floods. Thus, there was a yearly overturn of materials that were light enough to be transported by the increased current during late winter and spring. Temporary substrates were miscellaneous smaller objects, such as trash or small pieces of wood, that were readily displaced by minor water movements.

Four other gastropods, *Somatogyrus subglobosus*, *Amnicola integra*, *Promenetus exacuous*, and *Ferrissia fragilis*, were associated with *Physa* on these surfaces.

MATERIALS AND METHODS

Plants were collected with a fine wire mesh hand net or with a plant hook, and all snails were removed, sorted, and counted in the laboratory. The wet plants were weighed after being blotted free of excess wwter. Gastropod densities were expressed as the number of snails per 100 g of wet plant material. Five such quantitative collections were made between August and November, 1963 and samples were taken again in June and July, 1964. An Ekman dredge was used to take quantitative bottom samples twice monthly from 11 to 16 sites in the 90 m square study area. Samples from such irregular surfaces as submerged driftwood and dock pilings were evaluated somewhat subjectively using the terms abundant, common, and infrequent. A species was regarded as abundant when it constituted a major part of all samples, common if present in over 50 percent of the samples, and infrequent if found in considerably less than 50 percent of the samples. Dock pilings and retaining walls were sampled with a plant hook or by hand. In most cases it was unnecessary to remove the animals from driftwood to evaluate their densities, and they were returned to the water on the object.

RESULTS

Aquatic plant growth commenced in June but snail communities were not established on the plants until mid July. At this time plant beds covered about 44 percent of the bottom at depths of 3 m or less. *Physa integra* was most abundant on *Potamogeton pectinatus* and *Somatogyrus subglobosus* preferred *Najas minor*. These species were also present, although less abundant, on *Potamogeton crispus*. Small numbers of *Amnicola integra* and *Promenetus exacuous* were found only on *Potamogeton pectinatus* (Table 1). The plants died off in late October and early November but snail populations stayed on the degenerating plant bodies as long as the material survived. Shoots of *Potamogeton pectinatus* were the first to appear in June, 1964, and eggs and juveniles of *Physa integra* were present on these plants by early July. Later in the month the other plant species had developed scattered growths and *Amnicola, Promenetus,* and *Somatogyrus* began to appear on plants. Throughout the study *Potamogeton pectinatus* supported the highest densities and largest variety of mollusks.

TABLE 1

Average snail populations of higher plants August through October, 1963. Values are the number of snails per 100 g of plant material. P. p. - *P. pectinatus*, P. c. - *P. crispus*, N. m. - *Najas minor*.

Snail	P.p.	P.c.	N.m.
Physa	101	1	13
Somatogyrus	7	2	24
Amnicola	1	-	-
Promenetus	2	-	-

Most submerged driftwood was situated near the docks and amid plant beds, since the pilings tended to immobilize and accumulate material carried by floodwaters. *Physa integra* was present on the driftwood and boatslips throughout most of the year (Table 2). *Somatogyrus subglobosus* was abundant on these substrata, while *Promenetus exacuous* and *Amnicola integra* occurred only rarely. A freshwater limpet, *Ferrissia fragilis*, was collected infrequently and seemed to be restricted to driftwood. The wood and stone retaining walls along shore were void of snails.

Gastropods were usually found on the free undersides of submerged branches, while upper surfaces of the same branches were covered with gelatinous clumps of filamentous algae and silt. The gelatinous nature of this material was not due to diatom growths. These accumulations of algal filaments and silt particles were swwyed about by weak water currents. In three separate experiments, neither *Physa* nor *Somatogyrus* showed any tendency to retreat from natural or artificial light in laboratory aquaria that were provided with plants or wood pieces for cover. Apparently the instability of the algal growths atop submerged surfaces limited snail habitation of these areas.

Dredge samples showed that *Physa integra* occurred infrequently on the bottom and at densities below those encountered on submerged objects. Specimens were present on the bottom from early fall through spring, but were ab-

sent from bottom samples between spring and early summer (Table 2). The annual decline of aquatic plants was apparently responsible for the increase in snail numbers on the bottom in fall. During October and November a substantial number of empty shells, both juvenile and adult, taken in dredge hauls indicated that a greater part of the *Physa* population perished instead of becoming part of the bottom community after plants disintegrated. The spring decrease in density was seemingly brought about by increased current that removed driftwood and carried off a few centimeters of silt from some spots. Through December, discharges were normally less than 50 000 cfs. However discharges during March and April averaged over 150 000 cfs and over 600,000 cfs between March 8 and 21. During this time the densities of most members of the mollusk assemblage were reduced.

TABLE 2

The distribution of *Physa integra* from August, 1963 through July, 1964. A : abundant, C : common, I : infrequent (see text).

SURFACE	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.
Potamogeton pectinatus	A	A	A	-	-	-	-	-	-	-	C	C
Potamogeton crispus	I	I	I	-	-	-	-	-	-	-	-	-
Najas minor	C	C	C	-	-	-	-	-	-	-	-	-
Submerged driftwood	I	C	C	C	C	C	C	C	-	-	I	-
Dock pilings	-	-	C	C	C	C	C	C	C	C	C	C
Bottom (number per m^2)	0	2	9	8	5	11	4	6	0	0	0	4

DISCUSSION

Physa integra inhabited submerged portions of the dock structure throughout the year. The snails spread to maturing hydrophytes in mid summer most likely by means of a few pioneer individuals ovipositing on the plants. The species reached its highest density for the year on these surfaces due to intense oviposition in mid summer. Several workers have demonstrated that egg laying is induced in aquatic pulmonates by rises in temperature (De Witt, 1954). Although it was not observed as closely, newly accumulated driftwood was probably tenanted in the same manner. When the plants disintegrated at the end of their growing season, many of the inhabiting gastropods died; however, some continued to live on the bottom over winter. Both the driftwood and bottom populations were decreased by the impellent action of springtime floods. Thus, individuals established on the more permanent substrata were apparently the nucleus for annual replenishment of the local population. The absence of snails from retaining walls alongshore was probably due to the exposure of these areas to wave action generated by wind and boats.

The three plant species have characteristically different growth forms. That is, *Potamogeton pectinatus* has filiform leaves that develop dense tangles, while *Najas minor* has closely spaced rigid leaves. The broad leaves of *Potamogeton crispus* are more widely spaced. These morphological differences seemingly influenced snail preferences. Boycott (1936) stated that associations between any species of snail and aquatic plant were due to coincident occurrence of the two species. However, vegetation in the area I studied was mixed in such a way that preferences between different plants could be exercised by aquatic organisms. The dense foliage probably offered the advantages of protection from fish predators and a greater food supply in the form of epiphytic algal growths.

Physa integra possibly required high dissolved oxygen concentrations that were provided in this instance by close association with plants and algae during the summer months. Those individuals that ended up on the bottom

later in the year survived due to higher dissolved oxygen concentrations that normally develop in the Ohio River from fall to late spring (Table 3). Dawson (1911) proposed that aquatic plants offer an advantage to snails by oxygenating surrounding waters. Also, high rates of oxygen consumption have been reported for some freshwater pulmonates (Von Brand and Mehlman 1953).

TABLE 3

Typical fall through spring variations in dissolved oxygen in the Ohio River. From weekly values reported by Nall (1963).

MONTH	Dissolved Oxygen (ppm)
October	7.2
November	8.6
December	12.9
January	14.5
February	16.0
March	13.1
April	11.2
May	9.2

Physa was never seen migrating to the surface to breathe atmospheric oxygen, and it is doubtful that the snails inhabited any object merely because it gave them access to the water surface. Hunter (1955) found that populations of *Lymnaea peregra* and *Physa fontinalis* in shallow areas of Loch Lomond surfaced for air, while those in deep water utilized dissolved oxygen.

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MANUSCRIPT RECEIVED APRIL 5, 1965.

REPRINTS OF RARE PAPERS ON MOLLUSCA

SMITHSONIAN MISCELLANEOUS COLLECTIONS
143

LAND AND FRESH WATER SHELLS

OF

NORTH AMERICA

PART II.

PULMONATA LIMNOPHILA AND THALASSOPHILA.

BY

W. G. BINNEY

REPRINTED WITH THE
PERMISSION OF THE
SMITHSONIAN INSTITUTION

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PREFATORY NOTE

Almost a hundred years ago, the Smithsonian Institution issued Binney's Pulmonata Limnophila and Thalassophila. Although the original edition was ample and most libraries have a copy, yet the individual malacologist often wishes to have a copy of his own. To fulfill this wish STERKIANA will reprint this work in several instalments, identified as to original pagination, and indicating the position of each figure in the text. The figures will be gathered into plates because of the higher cost of reproduction. The Editorial Board of STERKIANA and the Editor take this opportunity of thanking the officials of the Smithsonian Institution for permission to reprint this important work.

A. L.

(PAGE iii)

PREFACE.

The *Pulmonata* are usually divided into *Geophila, Limnophila,* and *Thalassophila,* according as their habits are terrestrial, fluviatile, or marine. The first division is included in the Land and Fresh-Water Shells, Part I, now ready for the press. The second and third divisions form the subject of the present volume.

The descriptions of the family *Auriculidae* have already been published in the fourth volume of the Terrestrial Mollusks of the United States. In the other families I have adopted the plan of giving the original description, or an English translation of it, and a fac-simile of the original figure not only of each species but also of all those I have considered synonyms. I have thus placed within the reach of every American student all the materials for a complete monograph of the *Lymnaeidae,* &c., of North America which can be obtained from books. The other, more important, source of knowledge of the subject can be gained only by gathering together from every part of the country large suites of specimens, fairly representing each species. Not until this is done can their characters be described, and information given of their variation, their geographical distribution, and their relations to each other.

Though not competent to prepare a monograph all whose decisions may be considered as final, it has been easy in numerous cases to refer supposed new species to those previously described. These instances arise from ignorance on the part of one author of the labors of those preceding him, or in his exaggeration of variations which to me have appeared too slight to denote specific difference. The repetition of the original description and figure of each of these synonyms will enable the student to judge for himself of the correctness of my decisions.

The Museum Register printed after the description of each species will show how large a collection of specimens I have had

(PAGE iv)

before me belonging to the Smithsonian Institution. In addition to these I have had the opportunity of studying all the original specimens of Mr. Say, Prof. Haldeman, Dr. Gould, Mr. Lea, the Academy of Sciences of Philadelphia, the Museum of Comparative Zoology at Cambridge. I have received also typical specimens from almost all those who have described species, and corresponded so generally on the subject, that were I to specify those to whom I am indebted for information, the list would contain the name of nearly every living American concholoogist.

The description of orders, families, genera, and subgenera are principally copied from 'The Genera of Recent Mollusca.'

All the original figures of shells and lingual dentition were drawn by Mr. E. S Morse, of Gorham, Maine.

W. G. BINNEY.

Burlington, N.J., August, 1865.

(PAGE v)

CONTENTS.

(PAGE vii)

LAND AND FRESH WATER SHELLS OF NORTH AMERICA

II.

SYSTEMATIC INDEX.

* It has been impossible to follow here the elaborate type-setting scheme of the original.

LAND AND FRESH-WATER SHELLS

OF

NORTH AMERICA.

II.

PULMONATA.

SUBORDER LIMNOPHILA

Eyes sessile; tentacles subcylindrical or flattened, simply contractile. Operculum wanting. Animal usually lacustrine or fluviatile, sometimes marine or littoral, rarely terrestrial.

All the known families of *Limnophila* are represented in this country. Their habits are described under each.

FAMILY AURICULIDAE

Lingual membrane broad and elongated; teeth numerous, in slightly bent, cross series; central tooth equilateral; lateral

Fig. 1
Lingual dentition of *Alexia myosotis*.

teeth rather inequilateral, diminishing in size towards the outer edge. Head ending in a snout; mouth with a horny lunate upper jaw,[1] and with two dilated buccal lobes, united

[1]See *Alexia myosotis*, p. 4 (1)

(PAGE 2)

above, separated below; tentacles subcylindrical, contractile; eyes sessile at the inner sides of the bases. Mantle closed, with a thickened margin; foot long, posteriorly blunt; respiratory orifice posterior, on the right side, excretory orifice near it. Sexes united, orifices of generative organs distant, on the right side.

Shell spiral, covered with a horny epidermis; aperture elongate, with strong folds on the inner lip; outer lip often dentate.

Animal usually frequenting salt marshes.

The *Auriculidae* are easily distinguished from the other inoperculated air-breathing Mollusks. They are furnished with but one pair of non-retractile tentacles, on the inner base of which are situated the sessile eyes. The head is extended beyond the tentacles into an obtuse, rounded, bilobed snout. The mantle is thin, thickened on its margin. The foot is elongated and pointed, The sexes are united in each individual.

The shell is spiral, extremely variable, and in the American species conic, generally with a flattened spire, and furnished with numerous tooth-like laminae, which contract the narrow aperture. The internal septa are usually removed.

The *Auriculidae* are amphibious Mollusks, breathing free air, but apparently dependent for existence on a great deal of moisture, if not on the actual vicinity of the sea. Some species pass their whole life under circumstances which seem to preclude the possibility of their respiring air. Thus *Alexia myosotis* is often found on isolated stones in salt marshes, which are entirely covered by the tide four hours out of twelve. This species, when immersed in fresh water, becomes benumbed and soon dies.

Carychium exiguum, on the other hand, though found under similar circumstances, does not depend on the proximity to salt water, being widely distributed far beyond its influence over the interior of the country. *Blauneria pellucida*, also, has been detected living far from any water in a garden in the District of Columbia, whither it was introduced on plants from Charleston, S. C. With the exception of the two last mentioned, the American species are found on salt marshes and in brackish water near the sea.

Of the geographical distribution of our species but little is yet known. *Melampus bidentatus* is found from Maine to Texas.

(PAGE 3)

Melampus obliquus is referred by Say to South Carolina. *Alexia myosotis* was probably introduced from Europe; I have never known of its being found south of New York harbor. *Carychium exiguum* will probably be found in all the States. The other species are confined to

the coast of Florida and the Gulf of Mexico, some of them being common to Cuba and other West Indian Islands.

There are several genera of *Auriculidae* not represented in this country, some attaining a large size, and with more brilliant coloring than our plain species, such as *Pythia, Cassidula, Auricula,* &c. They are widely distributed over the globe, reaching the greatest perfection in the Pacific Islands.

The family has been subdivided into *Auriculinae* and *Melampinae,* characterized by the comparative thickening or expansion of the outer lip.

SUBFAMILY AURICULINAE.

Animal terrestrial, living chiefly on the land. Tentacles developed. Shell with the inner lip plicate; outer lip thickened or expanded.

AURICULA, Lamarck.

No species of this genus, as now restricted, is found in the United States. The following list contains all the species described as Auriculae, and the position in which they are now classed.

SPURIOUS SPECIES

Auricula bidentata, Gld &c. is the same as *Melampus.*

Auricula biplicata, Desh., is the same as *Melampus bidentatus.*

Auricula cingulata, Pf. &c., is the same as *Tralia.*

Auricula cornea, Desh., is the same as *Melampus bidentatus.*

Auricula denticulata, Gld., DeK., is the same as *Alexia myosotis.*

Auricula floridana, Shuttl., is the same as *Tralia.*

Auricula jaumei, Mittre, is the same as *Melampus bidentatus.*

Auricula obliqua, DeK., is the same as *Melampus obliquus.*

Auricula sayii Küster, is the same as *Leuconia sayii.*

Auricula stenostoma, Küster, is the same as *Tralia cingulata.*

Auricula bidens, Say of Pot. et Mich. Mr. Say never described any such species.

(PAGE 4)

ALEXIA, (LEACH), GRAY.

Foot simple beneath, without a transverse groove. Fig. 2

Jaw narrow, slightly arcuate, extremities but little attenuated, striae obsolete, scarcely any median projection. Lingual dentition, see p. 1, Fig. 1. Fig. 3

Shell oblong-ovate, thin, spire pointed; last whirl large, rounded at base; aperture rather broad, oval, acuminating; parietal wall furnished with from one to five tuberculous laminae; columellar fold oblique; peristome expanded, armed with teeth, or thickened within.

But one species is known to inhabit North America. Most of the few foreign species inhabit the coasts of the Mediterranean, though the genus is represented in South America and the West Indies.

Alexia myosotis, Draparnaud.—Shell elongate-oval, thin, semi-transparent, smooth and shining; dark horn-color, with a narrow reddish sutural line; spire produced with an acute apex; suture distinctly impressed; whirls from seven to eight, the upper ones rather convex, the last one elliptically ovate, equalling five-sevenths of the shell's length; aperture subvertical, about four-sevenths of the shell's length; peristome somewhat expanded and thickened, sometimes furnished with tooth-like folds on its inner side; its basal termination appressed to the shell, slightly reflected over a minute perforation, and turning upwards till it blends with the columellar fold, which winds into the aperture; the parietal wwll is furnished with a white, transverse, thin, and sharp denticle, and a second smaller, much less prominent one, placed above it. Greatest diameter 4, length 8 millimetres. Fig. 4

Auricula myosotis, Draparnaud, &c.

Auricula denticulata, Gould, Invert. of Mass. 199, f. 129 (excl. *Voluta denticulata,* Mont. et syn. suis.) (1841), not of Montfort.

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1 From Moquin-Tandon.

(PAGE 5)

Auricula denticulata, DeKay, N.Y. Moll. 58, pl. v, f. 91, 93 (excl. *Voluta denticulata*, Mont. et syn.), nec Montfort.

Melampus borealis, Conrad, Am. Journ Sc., [2], XXIII, 345 (1833).

Alexia myosotis, Pfeiffer, Mon. Auric. Viv. 148; Brit. Mus. Auric. 114.--W. G. Binney, T. M. IV, 172, pl. lxxv, f. 33; pl. lxxix, f 16.

Carychium (Phytia) myosotis, Moquin-Tandon, Moll. Fr. II, 417, pl. xxix, f. 33-39; pl. xxx, f. 1-4.

Conovulus myosotis, Reeve, Br. L. & Fr. W. Sh. 130 (1864).

Animal short, about one-half the length of the shell, dirty white, darker on the head and tentacles; eyes black, placed at the inner base of the feelers; feelers quite short, wrinkled, bulbous at tip, sufficiently dark to be visible through the thin shell when the animal withdraws itself; head continued beyond the tentaculae into an obtuse, short, bilobed snout; the shell is carried horizontally on the animal's back; the obtusely pointed posterior termination of the foot is just visible beyond the shell; the animal is sluggish in its movements. (See p. 4, fig. 2).

Jaw. (See p. 4, Fig. 2).

Lingual dentition. (See p. 1, Fig. 1).

I have received specimens of this species from Nova Scotia to Rhode Island. It is also a well-known inhabitant of parts of the coasts of England, France, Spain, &c.

I have placed this shell in this genus on the authority of Pfeiffer and of Adams' genera. It has been placed in many different genera by European authors. In America it has been considered an *Auricula* by Gould and others, until Stimpson classed it among the Melampi. From the exterior of the animal there appears no difference between it and *Melampus bidentatus*. It does not even agree with the animal of *Alexia*, given by Adams in the Genera of Recent Mollusca, which I have copied on pl. 75, fig. 22, of the Terrestrial Mollusks. This figure represents the true *Alexia denticulata*, Montfort, with which Gould confounds this species. The shell is also quite distinct. It is, however, united to *Alexia myosotis*, by Forbes and Hanley, in their work on British Mollusca, and by Moquin-Tandon. Pfeiffer considers them distinct, as does also Reeve.

It is probably an imported species, as Stimpson remarks (Sh. of New Eng.), being found only in the Atlantic seaports. At Boston it is common on old wooden wharves in the harbor. It is also found on isolated stones which are immersed by the rising tide at least four hours out of the twelve. When placed in

(PAGE 6)

fresh water it becomes benumbed and dies; it will live without water in captivity several days.

There can be no doubt of *M. borealis*, Conrad, being identical with this species. Conrad's description is given below.

Melampus borealis.—Shell ovate-acute, elongated; pale horn-color, with darker longitudinal bands; whirls six or seven, with a revolving impressed line below the suture; spire elevated, conical; columella with three distant and distinct plaits, the middle one most prominent; aperture obovate-acute. Length about one-fourth of an inch.

This small species of *Melampus* has been found sparingly on the coast of Rhode Island, by Lieut. Brown, of Newport. It is similar in form to a *Bulimus*, and is very unlike the common species with which it associates. (Conrad.)

Cat. No.[1] No. of Sp. Locality. From whom received. Remarks.

8743 - 4 - Massachusetts. - W.G. Binney. - Cabinet series.

8799 - 12 - Massachusetts. - W. Stimpson. - ...

CARYCHIUM, Müller.

Fig. 5 Foot not transversely divided beneath.

Shell pupa-shaped, very thin, transparent, with but few whirls; aperture suboval; with one dentiform columellar fold, sometimes

[1] In the original, materials under these headings are arranged in tabular form. To save space here, the arrangement is changed somewhat but all the text is reproduced. AL

obsolete; parietal wall with 1 or 2 teeth; peristome expanded, terminations not approximating, the right hand one with one internal tooth.

Jaw slightly arched, without ribs or marginal denticulations, hardly striated towards the margin.

Fig. 6

Teeth in slightly bent cross series, central equilateral, narrow, laterals broad, short, denticulated.

But very few species of this genus have been described, most of which are from Europe. Animal terrestrial.

Carychium exiguum, Say.—Shell elongated, tapering at both ends, white, translucent, shining; apex rather obtuse; whirls five to six,

(PAGE 7)

convex, very oblique, with transverse striae, suture distinct, impressed;

Fig. 7

aperture obliquely oval, white, with a prominent

Fig. 8

plait on the columellar margin, about midway between the extremities of the lip, and a slightly prominent fold near the junction of the lip with the umbilical extremity of the shell; lip thick, reflected, flattened; umbilicus perforated. Length 1 3/5, diam. ¾ mill. Aperture ½ mill. long.

Pupa exigua, Say, Journ. Acad. II, 375 (1822); ed. Binney, 26. — Gould, Bost. Journ. III, 398, pl. iii, f. 20 (1841); IV, 358 (1843); Invertebrata, 191, f. 122 (1841). —DeKay, New York Fauna, 49, pl. iv, f. 46 (1843).—Adams, Vermont Mollusca, 158, fig. (1842).

Bulimus exiguus, Binney, Terr. Moll. II, pl. liii, f. 1.

Carychium exiguum, Gould, in Terr. Moll. II, 286.—Chemnitz, ed. 2, 61, pl. i, f. 13, 14.—Pfeiffer, Mon Auric. 165; Brit. Mus. Auric, 127; Wiegm. Arch. 1841, I, 224.—W. G. Binney T. M. IV, 178.—Frauenfeld (1847), Akad. der Wiss. XIX, 79; Zool. Bot. Wien. IV, 10, pl. 1, f. 1 (1854). — Bourguignat, Mag. Zool. 1857, 209.

Carychium exile, H. C. Lea, Am. Journ. Sc. [I], XLII, 109, pl. i, f. 5 (1841).—Troschel, Ar. f. Nat. II, 128 (1843).

Carychium existelium, Bourguignat, *l.c.* 220.

Carychium euphoeum, Bourguignat, *l.c.* 221.

Has been found in the New England, Northern and Middle States, in South Carolina, Arkansas, and Texas.

Animal colorless; tentacles stout, hyaline, one-third the length of the foot. The foot is short, thick, distinctly divided into two segments,[1] the anterior of which is bi-

Fig. 9.

lobed, and projects, when the animal is in motion, considerably in advance of the head. Eyes oval, situated on the back, near the base of the tentacles. Its motions are very sluggish. It carries the shell directed horizontally; the shell is so transparent that the viscera of the animal may be seen through it.

It has been said to resemble *Carychium minimum*, of Müller, but neither the figure nor description, as given by Draparnaud, correspond with our shell.

It is found under stones and fragments of wood, and especially among moss, in damp places. It is the only species of this

[1] This does not agree with the generic description of *Carychium*.

(PAGE 8)

family inhabiting the interior, but though found over a wide extent of country, it still possesses a fondness for the sea in common with the other species of the family. Around Boston it is found at or below the surface in swamps, growing among mosses.

This minute shell is well known in American cabinets as a *Pupa*. Say described it as such in 1822, though he mentions the probability of its being a *Carychium*. It has been described since that time as a *Pupa* by Gould, DeKay, and Adams, and catalogued among the species of the same genus by all the American writers who have mentioned it, until 1851, when its correct position was pointed out by Stimpson (Shells of New England) and Gould (Terr. Moll II). The former places it in his family of *Melampidae*.

Dr. Binney, in 1843 (Boston Journal, p. 106), considers it a *Pupa*. In the Terrestrial Mollusks he places it under *Bulimus*.

In 1852, Jay removed it from *Pupa* to *Carychium* (Cat. p. 263).

Notwithstanding its distinct generic peculiarities having been pointed out in 1851, we find the shell considered as a *Pupa* in several American catalogues as late even as 1857 *(vide* Boston Proc. VI, 128).

In Europe we find its true position pointed out by Pfeiffer ws early as 1841, and by all subsequent writers.

In the fourth volume of the Terrestrial Mollusks I have given copies of the original descriptions of this species, and a figure of *C. exile*.

Lingual dentition (see p. 6).

Cat. No. 8440; No. of sp. 7; Locality .... From whom received: .....; Remarks: .....

SPURIOUS SPECIES

Carychium armigera, contracta, and rupicola, of Say, and *C. corticaria,* of Ferussac (Tabl. Syst.), are species of *Pupa*.

(PAGE 9)

SUBFAMILY MELAMPINAE

Animal amphibious, or living in brackish water. Shell with the inner lip plicate; outer lip straight and acute.

MELAMPUS, Montf.

Foot bifid posteriorly. Shell ovate-conical; spire short, obtuse; aperture narrow, linear; inner lip with several transverse folds; outer lip acute, internally plicate.

Jaw ----- ?

Lingual membrane ----- ?

Numerous species of this genus have been met with, widely distributed over the world.

Melampus olivaceus, Cpr.--Shell small, rather smooth, conical; spire depressed, obtusely angulated below the suture, which does not distinctly separate the whirls; color dirty white, with irregular patches or revolving lines of dark red or purplish; epidermis olive-colored; on young or very fresh specimens there are sometimes microscopid revolving lines near the base of the shell, and on the spire, which cross the delicate lines of growth so as to present under the microscope a granulated surface; whirls seven to nine, the upper ones distinguished only by means of the lens, and flattened; aperture long, equalling 11/13 of the shell, edge variegated in color by the termination of the reddish bands on the white ground of the shell, within white; the outer lip is furnished with numerous sharp, white laminae, in the specimens before me varying from 1 to 9; the parietal wwll of the aperture is covered with an almost imperceptible shining, callus; there is one constant, prominent, elevated white tooth-like lamina revolving within the shell, which is usually placed within two smaller shorter ones; on the columella there is also a stouter lamina entering into the aperture, and passing outwards and curving downwards so as to join the termination of the labium. Length 13, diam. 18 mill. Fig. 10

Melampus olivaceus, Carpenter, in Reigen Cat. of British Museum, 178 (1856).--W.G. Binney, T.M. U.S. IV, 27, pl. lxxix, f. 8.

San Diego to Mazatlan (Reigen Cat.).

This is the first species of the family *Auriculacea* found on the Pacific Coast of North America. There were numerous specimens found by M. Reigen, which Mr. Carpenter describes as dis-

(PAGE 10)

tinguished generally by the olive-green epidermis, variegated with purplish brown patches. I find the number of laminae in the aperture very variable, but the two prominent ones on the labium are constant, in all the individuals I have had the opportunity of examining.

The figure is taken from a specimen received from Mr. Carpenter.

Cat. No.	No. of Sp.	Locality	From whom received	Remarks
8366	1	W. Coast	.....	.....
3414	9	"	.....	.....
8550	3	"	.....	Cabinet series

Melampus bidentatus, Say. — Shell imperforate, elliptically- ovate, rather thin, shining when perfect, but usually found much eroded; the surface is marked with longitudinal wrinkles, and very minute revolving striae; horn-color, or grayish-red, often with revolving, narrow rufous bands, four or five in number; suture well marked; spire short, and usually obtuse, often somewhat eroded; whirls usually six, the upper ones flattened, the body whirl equalling about 5/6 of the entire length of the shell, and obtusely angulated at its greatest width; aperture hardly oblique, very long and narrow, enlarging gradually towards the base, about 5/7 the length of the shell; peristome very thin and sharp, not reflected, on the interior furnished with no laminae, or with from one to seven; these laminae are elongated, white, and do not reach the margin; they are usually separate, placed at irregular intervals, but sometimes are found on a longitudinal elevated, white callus; they enter but a short distance into the aperture; the parietal wall of the aperture is covered with a thin, shining, enamel-like callus, and bears on its lower half a single, white, prominent and transverse tooth, entering into the aperture; the columellar is also furnished with a white, tooth-like fold, commencing at the termination of the sharp peristome, and revolving upwards into the interior of the shell; this fold does not extend far into the aperture, as all the internal whirls and axis of the shell are early absorbed by the animal.

Fig. 11. Fig. 12.

Length of an unusually large individual 13, breadth 7 millimetres.

Melampus bidentatus, Say, Journ. Acad. Nat. Sc. Phila. II, 245 (1822); Binney's ed. 84.—Russell, Journ. Essex Co. Nat. Hist. Soc. I, part 2, 67 (1839).—Pfeiffer, Mon. Auric. Viv. 45 (excl. *Mel. borealis*).—W. G. Binney, T. M. IV, 156, pl. lxxv, f. 23.

*Melampus bipli*catus,* Pfeiffer, Mon. Auric. Viv. 21; Br. Mus. 14.

Melampus? jaumei, Pfeiffer, Mon. Auric. Viv. 25; Brit. Mus. Cat. 18.

Auricula cornea, Deshayes, Encycl. Méth. II, 90 (1830); Ib. in Lam. ed. 2, VIII, 339; ed. 3, III 390 (1839).

(PAGE 11)

Auricula bidentata, Gould, Inv. Mass. 197, f. 131 (1841).—DeKay, N.Y. Moll. 57, t. v, f. 92, 1, 2, 3 (1843).—Küster, Chemn. ed. 2, Auric. 41, pl. vi, f. 7-11.

Not *Auricula bidens,* Potiez et Michaud, Gal. 201, pl. xx, f. 9, 10.

Auricula jaumei, Mittre, Rev. Zool. (Mars, 1841), 66,

Auricula biplicata, Deshayes, Encycl. Méth. II, 91.

Melampus bidentatus, var. *lineatus,* Say, p 46 of ed. Binney.

Melampus bidentatus, β, Pfeiffer, Mon. Auric. 46.—Var. a. DeKay, *l.c.*

Along the whole coast from New England to Texas. A very common shell among the grass of salt marshes near high water mark.

Animal about as long as the shell, and the foot is transversely bifid; tentacula somewhat wrinkled, cylindrical, rather smaller towards the tips, which are obtuse or rounded; eyes placed at the inner base of the tentacula; rostrum somewhat wrinkled, nearly as long as the tentacula, bilobate before; foot, anterior segment bifid at the extremity; all above, with the exception of the tentacula and rostrum, glabrous, reddish-brown, beneath paler. (Say.)

The shell when young is quite pretty, being shining and often variegated by the revolving bands. But few mature shells are met with in a perfect condition. They are usually much eroded. From the toothless outer lip to that bearing a heavy callus ridged with transverse laminae, every intermediate variety is found. The absence of the laminae is equally common in mature and young shells.

Authentic specimens of this species are still preserved in the collection of the Academy of Natural Sciences of Philadelphia.

The original descriptions of Mittre and Deshayes are given in Terr. Moll. IV. I have seen authentic specimens of neither of their shells. The descriptions are merely copied by Pfeiffer, in the works referred to in the synonymy.

Say designates by the name of *lineatus*, a form peculiar for its revolving lines or bands and more narrow base of the aperture (*vide* Binn. ed. p. 85). I have met with none sufficiently marked to form a variety, much less a distinct species. The revolving

[1]Gould mentions its being said to have been found living with a *Planorbis* at Windsor, Vt. If so, it must be adapted to a remarkable difference of station, being usually found near the sea. Pfeiffer also gives Vermont as the habitat, probably on the above authority.

(PAGE 12)

lines are commonly found on young specimens DeKay mentions this as var. α, Pfeiffer as β. The latter author also describes a var. γ :—

Fig. 13. Last whirl sub-excavated below the suture, minutely spirally striated; lip with a white ridge of callus within the dark-colored margin, with from 6-10 regular folds.

Georgia. *(Pfeiffer.)*

He quotes in the synonymy of this variety *Mel. borealis*, Conrad, of Cuming's collection, Conrad's species is much more likely to be *Alexia mycsotis* than any variety of *Mel. bidentatus*.

Potiez & Michaud describe and figure quite a distinct shell under the name of *Auricula bidens*, Say.

Stimpson gives precedence to Deshayes's name *corneus*. Say's name has eight years' priority, and is not pre-occupied in the genus *Melampus*. It was while treated as an *Auricula* that any question existed in regard to its specific name.

Pl. 75, Fig. 23, of the Terrestrial Mollusks, IV., represents a specimen not furnished with laminae within the peristome.

The date of publication of this species is erroneously quoted by Pfeiffer as 1821. The title-page of the first part of Vol. II of the Academy Proceedings bears this date. The description wws actually published at the date given by me.

Cat. No. - No. of Sp. - Locality. - From whom received. - Remarks. [None in this list. AL]

8436 - 8 - Georgia. - Dr. J. Lewis. .....
8437 - 8 - Indianola, Tex. - G. Wurdemann. ..
8438 -12 - Charleston, S.C. - Lieut. Kurtz.
8439 -10 - Indianola, Tex. - .....
8441 - 3 - Charleston, S.C. - Lieut. Kurtz.
8800 -20+ St. Simon's Island, Ga. .....
8801 -100? Massachusetts. - W. Stimpson. ...
8804 - 5 - Key West. .....
8832 -11 - Indian Key, Fla. - G. Wurdemann.
8823 - 3 - Texas. - Capt. Pope. .....

Melampus flavus, Gmel.—Shell imperforate, obconic, smooth, chestnut-colored,
Fig. 14. with three light, narrow bands; spire short, convex conic; suture slightly impressed; whirls from nine to ten, the upper ones flattened, the last about equalling three-fourths of the length of the shell, arcuately ridged below; aperture subvertical, narrow, angulated below; one deep parietal fold, one subvertical, stout, columellar fold, extended towards the base; peristome straight, acute, its outer margin reddish, thickened with white within and fur-

(PAGE 13)

nished with ten short, transverse ribs, its columellar portion expanding and callous. Length 12, breadth 8 2/3; length of aperture 9½, breadth at the middle 3 millimetres.

Lister, Hist. t. dcccxxxiv, f. 60. — Favanne, Conch. t. lx7, f. H, i.
Auricula midae parva, &c., Mart. & Chemn. II, 119, 126, t. xliii, f. 445.
Voluta, n. 106, Schröter, Einl. I, 272.
Voluta flava, Gmelin, Syst. 3436, No. 5.—Dillwyn, Cat. I, 506, n. 17.
Voluta flammea, γ, *Gmelin*, l.c. 3435, n. i.
Bulimus monile, Bruguiere, Encycl. Méth. I, 338, n. 70.
Melampa monile, Schweigger, Handb. 739.
Conovulus monile, Goldfus, Hand. 657.
Conovulus flavus, Anton, Verz. 1776.
Auricula monila, Ferussac, Podr. 105.—Lamarck, An. sans Vert. VI, 2, 141; ed. Desh. VIII, 333.—Küster in Chemn. ed. 2, Auric. 30, pl. iv, f. 7-9.
Auricula flava, Deshayes in Lam. VIII, 33.—Petit Journ. Conch. II 427 (1851).
Auricula coniformis, Orbigny, Moll. Cuba.
Melampus monile, Lowe, Zool. Journ. V, 292.

Melampus flavus, Adams, Congr. 42, 186.—Poey, Mem. I, 394.—Pfeiffer, Mon. Auric. Viv. 21; Brit. Mus. Auric. 14.—W. G. Binney, T. M. IV, 186, wood-cut.
Melampus teroca, Mörch, Cat. Yoldi, 38.
Melampus monilis, Shuttleworth, Diag. 7, 162.

A West Indian species, found in Florida by Mr. Bartlett.

Cat. No. 8542; No. of Sp. 1; Locality: Florida. From whom received: W.G. Binney. Remarks: Cabinet series.

Melampus coffea, Lin.—Shell imperforate, cone-shaped, very solid and heavy, smooth and shining in fresh specimens, with delicate wrinkles of growth, and very numerous microscopic revolving lines; Fig. 15. light fawn-color when deprived of its russet epidermis, with three or four revolving bands of white on the body whirl, of which the uppermost is broadest; suture moderate; spire short, conic, apex black, shining, pointed; whirls from nine to ten, the upper ones flattened, the last obtusely angulated below the suture, 17/19 the length of the entire shell; aperture subvertical, long and narrow, gradually widening towards the base of the shell, about 16/19 the entire length of the shell; peristome acute, not reflected, but thickened within by a heavy white callus, extending as high up as the carina of the body whirl; on this callus are from fifteen to twenty-two white, transverse laminae or ridges, not reaching the edge of the peristome, and not

(PAGE 14)

entering far into the aperture; sometimes there is a second and even third series of these laminae visible within the aperture; on the parietal wall are two elevated, white, entering folds, the upper one much more prominent; the columella is covered with a shining, brown callosity, and furnished with one rather prominent fold, which commences at the termination of the peristome, and winds upwards into the interior of the shell; the interior whirls and axis are entirely absorbed. Diameter of a large specimen, 10, length 19 diameters.

Bulla coffea, Linnaeus, Syst. Nat. X, 729.
Voluta coffea, Linnaeus, Syst. Nat. XII, 1187,—Schröter, Einleit. II, 200.—Gmelin, Syst. Nat. XIII, 3438.—Dillwyn, Descr. Cat. I, 506.
Voluta minuta, Gmelin, Syst. 3436, ex parte—Dillwyn, *l. c.* 506.
Auricula midae parva, fusca, albo-fasciata, Martini et Chemnitz, II, 119, pl. xliii f. 445? (or *Mel. flavus?*).
Ellobium barbadense, Bolten, Mus. 106, ed. nov. p. 74?
Bulimus coniformis, Bruguiere, Encycl. Méth. I, 339,
Melampus coniformis, Montfort, Conch. Syst. II, 318.—Lowe, Zool. Journ. V, 292.
Melampus coffeus, Adams, Gen. Rec. Moll. t. lxxxii, f. 7, 7a (no desc.).—Pfeiffer, Mon. Aur. 28; Br. Mus. Cat. 19.—W.G. Binney, T. M. IV, 162, pl. lxxv, f. 21, 25.
Melampa minuta, Schweigger, Handb. 739.
Tornatelle coniforme, Blainville, Dict. Sc. Nat. pl. Malac. liv, f. 4.
Auricula coniformis, Lamarck, Hist. an. s. Vert. VI.—Deshayes in Lam. VIII, 332; ed. 3, III, 387.—Potiez et Michaud, Gal. I, 202.—Reeve, Conch. Syst. II, t. clxxxvii, f. 7 (teste Pfr.).—Sowerby, Conch. Man. 77, f. 298?—Chemnitz, ed. 2; Auric. 31, t. iv, f. 14-17.
Auricula ovula, Orbigny, Moll. Cub. I, 187, t. xiii, f. 4-7 (1853).
Convulus coniformis, Lamarck, Encycl. Méth., t. cccclix, f. 2 (no desc.).—Woodward, Man. Moll. 173, t. xii, f. 37 (1854).

The only specimens I have seen were collected in Florida, by Mr. Bartlett, more than ten years ago. It is a well known and very common shell in the West Indies. Referred also to Mexico by Pfeiffer.

Mr. Thomson sent me specimens from New Bedford, where they were probably introduced by the schooners of the live-oak trade running to Florida.

Animal (see T. M. U.S. IV, pl. 75, fig. 21) about the length of the shell; tentacles short, pointed, eyes at their interior base; proboscis extending beyond the head, bilobate, bluntly terminating; posterior termination of the foot short, bifid, color dark-brown.

Figure 25 of plate 75, of Terr. Moll. IV, is a fac-simile of

(PAGE 15)

(PAGE 15)

Orbigny's figure of *Auricula ovula*. It is a good representation of our Florida shells.

West Indian specimens are well known in cabinets. I know of no American specimens with the exception of the few collected by Mr. Bartlett.

Plate 79, fig. 6, of T.M. IV, may represent a variety of this species. It is from Texas.

Cat No.; No. of Sp.; Locality; From whom received; Remarks.

8821 - 5 - Indian Key, Fla. - G. Wurdemann. - Cab. ser. Var. and sp. dist.? *Vide* T.M. IV.

8824 - 1 - Texas. - Capt. Pope. - Cab. ser. Var. and sp. dist.? *Vide* T.M. IV.

SPURIOUS SPECIES OF MELAMPUS.

Melampus borealis, Conrad, I have referred to *Alexia myosotis*.

Melampus denticulatus, Stimpson, is also identical with *Alexia myosotis*.

Melampus redfieldi, Pfr. (See T.M. IV, 170.)

Melampus pusillus, floridanus, and cingulatus (see *Tralia*.)

Melampus obliquus, Say. —Obconic, reddish brown, rather thick; spire very little elevated; whirls eight or nine, wrinkled across; labium with two very distinct teeth, and an intermediate and equidistant, slight obtuse prominence; inferior tooth very oblique, terminating at the base; labrum with about eight teeth or striae, which terminate on the margin; base of the aperture a little contracted by the basal tooth. Length more than seven-twentieths of an inch.

I am indebted to Mr. Stephen Elliott for this species, who obtained it on the coast of South Carolina. It is closely allied to *Bulimus monile*, Brug., but it has no appearance of bands, which distinguish that shell. In the collection of the Academy are specimens from the West Indies. *(Say.)*

Melampus obliquus, Say, Journal Acad. Nat. Sc. Phila. II, 377 (Dec. 1822); Binn. ed. 27.—W. G. Binney, T. M. IV, 167.—Pfeiffer, Mon. Auric. Viv. 30.

Auricula obliqua DeKay, N. Y. Moll. 58 (1843).

It is not now known what shell Say had in view when the above description was written. No authentic specimen is preserved, and no author has seen any shell from that locality answering to the characters laid down. DeKay mentions it among the extra-limital species in his report, his words being nearly a repetition of Say's. Pfeiffer repeats Say's words and suggests the identity of the species with *Melampus coffea*. Say being familiar with that shell (*M. coniformis, vide ed.* Binn. p. 85), it seems hardly probable he would have described a variety of it.

The question must remain undecided until we are better acquainted with the species of the South Carolina coast.

(PAGE 16)

FOSSIL SPECIES.

Melampus priscus, Meek, Phila. Acad. Nat. Sc. 1860, 315.

Melampus (Ensiphorus) longidens, Conrad, Pr. A. N. Sc. Phila. 1862, 584.

TRALIA, Gray.

Foot posteriorly acute, entire.

Fig. 16. Shell ovate, smooth; spire elevated; aperture narrow, linear, dilated anteriorly; inner lip usually with three oblique plaits; outer lip acute, sinuated posteriorly, internally with one or more transverse, elevated ridges.

This genus differs from *Melampus* in having the foot entire posteriorly, not bifid. It is not admitted by Pfeiffer.

Tralia floridana, Shuttl.—Shell imperforate, ventricose, fusiform, thin, smooth, grayish, with varying chestnut bands;

Fig. 17. spire regularly conic, acute; suture linear; whirls ten, flattened, the upper ones radiately striate, the last comprising three-fifths of the length of the shell, obsoletely angulated above, and very much smaller at its base; aperture subvertical, narrow, angular; two parietal plicae, one strong, one on the columella, obliquely continued towards the base; peristome acute, its right side in adult specimens armed with transverse, white, subequal folds, its columellar

portions both short and callous. Length 7½, diameter 4 1/3; aperture in length almost 5, in breadth 1 1/3 millimetres.

Auricula floridana, Shuttleworth, MSS.
Melampus floridanus (Tralia), Adams, Pr. Zool. Soc. II, 1854 (no desc.).—Pfeiffer, Malak. Blatt. (1854); Mon. Auric. Viv. 36; Brit. Mus. Cat. 25.—W. G. Binney, T. M. IV. 165, pl. lxxv, f. 30.

Found at Florida Keys.

Cat. No. 8541; No. of Sp. 2; Locality. Florida. From whom received. W. G. Binney. Remarks. Cabinet series.

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[1]I do not know what species this represents. It was drawn from nature by Dr. Stimpson, in Charleston harbor. [Footnote refers to Fig. 16, on this page. A.L.]

(PAGE 17)

Tralia pusilla, Gmel.—Shell imperforate, lengthened-ovate, solid, shining, smooth, marked with microscopic revolving lines, most easily detected on the spire; reddish-brown, with lighter, hardly perceptible revolving bands; suture moderate, less ragged than in the other species; spire elongate-conic; apex acute, shining, black; whirls six to seven, the upper ones flattened, the body whirl obtusely carinated, regularly decreasing in diameter towards the base, and equalling about 18/23 the length of the shell; aperture subvertical, narrow, rapidly widening towards its base, and equalling in length about 15/23 of the entire shell; peristome simple, acute, within thickened by callus, and furnished with a rather blunt, short, transverse, not very prominent lamina; the basal termination of the peristome is appressed to the shell, and imperceptibly terminates in a columellar lamina which ascends and winds into the aperture; the columella and parietal wall are covered with a shining callus; there are two parietal teeth, which are white, and enter into the aperture of the shell, the lower one being much the smaller. Internal septae absorbed. Greatest diameter 5, length 11 millimetres.

Fig. 18.

Auricula midae parva fusca unicolor, Martini & Chemnitz, II, 119 t. xliii, f. 446.—Favanne, t. lxv, f. H, 4 (teste Pfr.).
Voluta, n. 108, Schröter, Einl. I, 273.
Voluta pusilla, Gmelin, Syst. 3436 (teste Pfr.).—Dillwyn, Cat. I, 507.—Wood, Ind. pl. xix, f. 20.
Voluta triplicata, Donovan, Brit. Shells, V, pl. cxxxviii (1808).—Montagu, Test. Brit. Suppl. 99.—Dillwyn, Cat. 507.—Wood, Ind. pl. xix, f. 19.
Bulimus ovulus, Bruguiere, Encycl. Méth. I, 339.
Melampa ovulum, Schweigger, Handb. 739 (teste Pfr.).
Auricula ovula (Conovula), Ferussac, Tabl. Syst. 108 (absq. desc.).
Auricula nitens, Lamarck, An. s. Vert. VI, 2, p. 141.—Deshayes in Lam. VIII, 332; ed. 3, III, 387.—Chemnitz, ed. 2, Auric. 18. pl. ii, f. 11-13.
Auricula pusilla, Deshayes in Lam. VIII, 332.
Conovulus nitens, Voight in Cuv. Thierr. III, 112 (teste Pfr.).
Conovulus pusillus, Anton, Verz. 48.
Melampus pusillus, Pfeiffer, Monog. Auric. Viv. 48; Brit. Mus. Auric. 34.—W.G. Binney, T.M. 168, pl. lxxv, f. 29.
Tralia pusilla, H. et A. Adams, Gen. Rec. Moll. II (Sept. 1855), 244, pl. lxxxii, f. 8.

The only American specimens I have seen are in my collection. I detected them among marine shells and sand, collected in Florida by Mr. Bartlett.

This species is well known in cabinets by specimens from the

(PAGE 18)

West Indian Islands, in several of which it exists. Pfeiffer also refers it to the Sandwich Islands.

It is readily distinguished by its shining mahogany-colored shell. It varies less than most of the *Melampi*.

Tralia cingulata, Pfr.—Shell imperforate, fusiform, heavy and thick, shining polished, with numerous microscopic revolving lines, most prominent on the last whirl; brownish with numerous irregularly wide, white revolving bands; spire convex-conic, terminating in an acute transparent

Fig. 19.

point; suture simple; whirls ten, the upper ones flattened and narrow, the last one tapering towards the base, and equalling about two-thirds the length of the shell; aperture hardly oblique, very narrow, divided at its base by a stout, sharp columellar fold, which ascends and winds obliquely into the aperture; peristome simple, acute, armed within with from six to eight elongated laminae, not quite reaching the edge of the lip, the lower one being most fully developed. Length of the specimen before me 11, breadth 5; length of aperture 6 millimetres.

Auricula cingulata, Pfeiffer in Wiegm. Arch. f. Nat. 1840, I, 251.—Chemnitz, ed. 2, Auric. 40, t. xl, f. 4-6.
Auricula oliva, Orbigny, Moll. Cub I, 189, t. xii, f. 8-10.
Auricula stenostoma, Küster, olim, in Inc.ds2a ifeP)E.F. Ft tes RE f4
Melampus cingulatus, Pfeiffer, Mon. Auric. Viv. 18; Brit. Mus Cat.—W. G. Binney, T.M. IV, 161, pl. lxxv, f. 12-13.
Tralia, H. & A Ad.

The only American specimens of this species I have seen, were collected in Florida by Mr. Bartlett. The species is also found in Cuba, Jamaica, and Porto Rico.

Cat. No. 8803; No of Sp. 5; Locality. Florida. From whom received. W. Stimpson. Remarks. Cabinet series.

LEUCONIA, Gray.

Foot divided inferiorly by a transverse groove.

Shell ovate-oblong, imperforate, smooth; spire conical; aperture elongate, oval; inner lip with two plaits anteriorly; outer lip smooth internally, the margin simple, acute.

Of the six species of this genus described, two are found in

(PAGE 19)

the West Indies, three in Europe, and one of doubtful identity is referred to the United States.

Leuconia sayii, Küster.—Shell small, conic-ovate, shining, horn-colored, striate; spire acute, broadly conic, whirls five, rather convex; aperture oblong, columella biplicate. Length 2½ lines, diam. 1½.

United States. *(Küster.)*

Auricula sayii, Küster in Chemn. Fig. 20. ed. 2, 12, pl. vi, f. 14, 15.
Leuconia sayii, Pfeiffer, Mon. Auric. 157; Brit. Mus. Auric. 170.—W. G. Binney, Terr. Moll. IV, 177, pl. lxxv, f. 34.

The above is Küster's description. The figure I give is a fac-simile of one of his. This is the only information I have been able to obtain with regard to the species. It has not been described by any other author but Pfeiffer, who merely quotes the above description, not having ever seen the shell.

Küster's figure represents no known American shell; there exists, however, a strong resemblance between it and his figure of *Alexia myosotis*. His original specimen may have been a variety of that species.

Pfeiffer compares the species with *Melampus infrequens*, Ad.

PEDIPES, Adanson.

Foot divided inferiorly by a transverse groove.

Shell subglobose, imperforate, transversely striated; spire short, obtuse; aperture narrow; inner lip flattened, excavated, with three plaits, the posterior the largest; outer lip posteriorly sinuated, with two teeth internally; margin acute.

Species of *Pedipes* have been found at Panama, in Africa, the West Indies, Madeira, and Isle of France. They are said to inhabit crevices of rocks, especially those exposed to the full force of the tide. The generic name was suggested by the peculiar mode of progression. When the animal walks, the hind part of the foot is fixed, and the fore part, which is separated from the hind part by an extensible groove, is advanced, and the hind half is then drawn forwards so as to touch the anterior half, and so progression is effected by a series of little steps. This movement

(PAGE 20)

is executed with such quickness that the *Pedipes* is one of the most agile of mollusks.

Pedipes lirata, W. G. Binney—Shell imperforate, globose-conic, solid, shining, straw-colored, regularly marked with revolving ridges; spire short, depressed, apex obtuse; whirls three, the upper ones short, the lower one about equalling five-sixths the length of the shell; aperture semicircular, its parietal wall covered with shining callus, and furnished with a thick, elevated, hooked and entering fold; columella furnished with two thick, acute, tooth-like processes, placed side by side; peristome acute, furnished on its interior with a shining callus, which is protracted into a high tubercle at its middle. Greater diameter 2½, length 3 1/3; length of the aperture 2½ mill.

Fig. 21.

Pedipes lirata, W. G. Binney, Phila. Acad. Nat. Sc. Proc. 1860, 154.

Cape San Lucas, Lower California.

The specimen figured is the only one found. It may, perhaps, be somewhat related to *P. angulata*, Adams, of Panama, which I have not seen.

Cat. No. 8567; No. of Sp. 1; Locality. Cape St. Lucas; From whom received. John Xantus; Remarks. Cabinet series. Type.

BLAUNERIA, SHUTTL.

Shell imperforate, oblong-turreted, thin; aperture narrow; elongated; inner lip with a single plait, columella subtruncate; outer lip simple, straight.

Foot somewhat truncated in front, pointed behind, long as the shell's aperture; head large, projecting beyond the foot, forming a snout with dilated lips; tentacles short, cylindrical, eyes at their superior base.

But one species of this genus is known, the *B. pellucida*. It is one of those shells whose generic position cannot be ascertained without a knowledge of the characters of the animal. It was placed among the *Helicidae* as *Achatina* and *Tornatellina*, as a *Glandina* among the *Oleacinidae*, and among the Pectinibranchiates as *Odostomia*, until it was ascertained by Dr. Gundlach to belong to the *Auriculidae*.

(PAGE 21)

Blauneria pellucida, Pfr.—Shell sinistral, ovate-lanceolate, acuminate, pellucid, highly polished and glistening. Whirls seven, very oblique, scarcely convex, the last one somewhat ventricose, towards the base, about two-thirds the length of the shell; aperture narrow ovate, acutely prolonged posteriorly; lip simple; turning up the columella it becomes thickened, and winds into the aperture in the form of a tooth-like lamella. Length 5 mill.; breadth 1 2/3; aperture 2 mill. long.

Fig. 22.

Achatina (?) pellucida, Pfeiffer in Wiegm. Archiv. 1840, I, 252.—Gould in Binn. Terr. Moll. II, 294, pl. liii, f. 2.

Tornatellina cubensis, Pfeiffer, Symb. II, 130; Monog. Helic. Viv. II, 391.—Chemnitz, ed. Pupa, 151, pl. xviii, f. 16, 17.

Blauneria pellucida, Pfeiffer, Malak, Bl. 1854; Mon. Auric. Viv. 153; Brit. Mus. Cat. 110.—W.G. Binney, T.M. IV, 175.

Odostomia? cubensis, Poey, Mem. I, 394.

Found in Florida, among small shells drifted in the sand.

It has been detected in Cuba, Jamaica, and Porto Rico, and has been introduced into England.

Binney is the only American author who mentions its existence in this country. He places it under *Achatina*. Gould, in Terr. Moll., leaves it in that genus provisionally, mentioning the doubt existing concerning it.

SPURIOUS SPECIES OF AURICULIDAE.

Otina zonata, Pfeiffer. *Vide Velutina zonata*, p. 22.

Family OTINIDAE.

Lingual membrane, as in *Auriculidae*, broad, teeth in numerous cross series. Head large, broad, obtuse, mouth vertically cloven, furnished with distinct jaws. Tentacles flattened, eyes at the upper part of their base.

Shell ear-shaped, colored; columellar margin simple; outer lip simple and acute.

Animal amphibious, living near the sea.

The species of this small family differ from the *Auriculidae* in having flattened tentacles, and from the *Limnaeidae* in having the eyes on the upper part of the base of the tentacles, instead of at the inner edge of the base, and in having colored shells.

(PAGE 22)

SPURIOUS SPECIES OF OTINIDAE.

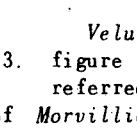

Fig. 23.

Velutina zonata, Gould, whose figure I copy (Invert. p. 242), is referred to this family under the name of *Morvillia zonata,* Gray (see Gen. Rec. Moll. II, 645). It is a deep-water shell, without doubt belonging to *Velutina*. Pfeiffer describes it also among the *Otinea*, as *Otina zonata* (Mon. Auric. p. 12).

FAMILY LIMNAEIDAE.

Lingual membrane armed with numerous, quadrate teeth, arranged in transverse rows, the central minute, the laterals

(Fig. 24.)

uncinated or simply denticulated. Head with a broad, short muzzle, dilated at the end; mouth with one or more jaws; tentacles contractile, flattened or subulate, with the eyes sessile at their inner bases. Mantle margin variously modified; respiratory orifice at the right side. Foot flattened, lanceolate or ovate. Excretory orifices on the left side of the neck. Sexes united; male and female organs with separate orifices, on the right or left side.

Shell of a varied form, thin, horn-colored, usually with an oblique fold on the columella, and with the outer lip simple and acute.

Animal fresh-water, living in the water, usually coming to the surface to respire the free air.

The *Limnaeidae* are found in every quarter of the globe; but in North America most of the genera are represented, excepting *Chilina, Camptoceras, Amphipeplea, Latia,* &c. They are more plenty in species and individuals in the more temperate portions of the continent. Especially among the innumerable lakes of the British possessions do the large species flourish.

(PAGE 23)

They are strictly aquatic in their habits, abounding in the small quiet streams and stagnant ponds, feeding exclusively on vegetable substances. They usually come to the surface to breathe the free air, but their organs of respiration must be adapted, in some species at least, to breathing through the medium of water, as they are occasionally found in circumstances precluding any possibility of an approach to the surface.

Their eggs are laid in clusters, surrounded by a gelatinous matter.

Many of the species possess the power of gliding along the surface of the water, shell downwards, and letting themselves down by means of a gelatinous thread.

From the fact of my finding young individuals only in the spring, and numerous dead full-grown shells during the late autumn and winter, I presume they arrive at maturity in one season. They are active during the spring, summer, and autumn, but bury themselves in the mud during winter, at least in the Northern States.

The *Limnaeidae* have been grouped by some authors according to the number of their horny jaws, but in the present stage of knowledge of them it seems to me preferable to adopt that division into subfamilies based upon the form of the shell, which is found to be spiral and elongate, spiral and flattened, or non-spiral and simply patelliform.

The shells of some of the various genera present considerable difference in form, but their characters are not as well marked or reliable as in the *Helicidae*. I have therefore given, under the genus, a description of the typical form, leaving to the subgenera the descriptions of the various diverging forms.

So variable are the species in each of the American genera, and so imperfect is our knowledge of them, I have not attempted a full description of each species at this time. It seems best to me to give all the original descriptions both of true species and synonyms (translated when not in English), and a facsimile of the original figure of each. My work must therefore be considered rather a report on the present state of our knowledge of the family than an exhaustive monograph. I am in hopes of obtaining material for a more perfect work at some future day.

(PAGE 24)

SUBFAMILY LIMNAEINAE

Shell spiral, more or less elongated, the last whirl large; aperture oblong.

LIMNAEA, Lamarck.

Tentacles flattened and triangular. Mantle with the front edge thickened. Foot short, rounded. Shell dextral, spiral, oblong, translucent, horn-colored; spire acute, more or less produced, last whirl ventricose; aperture large, wide, rounded in front; inner lip with an oblique fold; outer lip simple.

Fig. 25. Jaws three, smooth; one upper, large, transversely oblong or ovate; two lateral, rudimentary, narrow, convex.

Fig. 26. Lingual membrane (of *L. columella*) broad, teeth crowded, numerous; central narrow, long, apex attenuated, recurved; laterals broad, blunt, apex recurved, denticulated. Fig. 27.

This genus is found over almost the whole world, but prefers the more temperate portions of it. In North America, likewise, it is found in greater abundance and perfection in the lake region of the United States, and still more so in the British possessions. In the States bordering on the Gulf, and in Mexico, it is hardly represented.

The geographical distribution of the species is but little known. It seems certain that the boreal regions are inhabited by several species common to similar latitudes in Asia and Europe, such as *L. stagnalis* and *L. palustris*.

The name *Limnaea* is now universally adopted for this genus.

(PAGE 25)

It is useless, therefore, to refer here to the thirty synonyms quoted by Hermannsen.[1]

As a subgeneric name for the typical *Limnaea, Lymnus*, Montf. has priority--*Stagnicola*, Leach, being a synonym.

Limnaea stagnalis, Lin.-- Shell elongated-ventricose; volutions six; spire regularly attenuated to an acute tip, rather shorter than the aperture; body whirl dilated, proportionally large; aperture ample; columella with the sinus of the fold profound, callus perfectly appressed upon the shell to the base.

Inhabits Lake Superior.

Fig. 28.

This shell exhibits very much the appearance of *L. stagnalis*, but its body whirl is less proportionally dilated. The callus of the labrum is perfectly appressed to the surface of the whirl even to the base, exactly as in *stagnalis*. I have seen but a single weathered and broken specimen, which was sent me for examination by my friends Messrs. Collins and Barnes, of New York. It was found in Lake Superior, by Mr. Schoolcraft. Since writing the above, Mr. Jessup presented me with several specimens, which he collected in Canandaigua and Cayuga Lakes. *(Say. L. appressa.)*

Limnaea jugularis, Say, Nich. Encycl. 1817, 1818, 1819; ed. Binney, p. 46.--Haldeman, Mon. 16, pl. iv (1841).--DeKay, N. Y. Moll. 74, pl. v, f. 81 (1843).--Küster, Ch. ed. 2, p. 3, pl. i, f. 7.

Limnaea appressa, Say, Journ. Acad. Nat. Sc. II, 168 (1818); Binney's ed. 66.--Haldeman, Mon. 18, pl. v (1842).--Adams, Shells of Vermont, 153 (pamphlet. 3), (1842).--DeKay, N. Y. Moll. 74 (1843). -- Küster, Ch. ed. 2, 4, pl. i, f. 8-9.

Limnaea stagnalis, Linnaeus, &c. -- Sheppard (1829), Tr. Lit. Hist. Soc. Quebec, I, 196. --Kirtland, Am. Journ. Sc. [I], XXXI, 35, f. 10; Ohio Report, 200.--Anon. Can. Nat. II, 196, f. 1, 2, 1857.

Limnaea speciosa, Ziegler of Rossmassler, Icon. pt. 2, p. 96; pl. ii, f. 50 (1835).

This species ranges from Vermont, through the northern tier

[1]H. & A. Adams suggest the use of Klein's name *Auricula,* he being the first to notice and describe the genus. I protest against the use of his names in preference to the well-established names of authors who truly understood and followed the Linnaean system of generic nomenclature. (See Sill. Am. Journ. [illegible], XXXV, 429.)

(PAGE 26)

of States, to the Pacific Ocean. It is also found in Oregon and southern Utah, though it occurs most plentifully in the lake region of British America. Specimens of it have been collected for the Smithsonian Institution by Mr. Kennicott, at Fort Resolution and Fort Simpson, and at Moose Factory, by Mr. Drexler.

From the means of comparison at my disposal I have no doubt of the identity of the European *Limnaea stagnalis* with this shell. Their proving to be the same will add another to the list of circumpolar species common to the two continents.

Authentic specimens of Mr. Say's *L. appressa* are still preserved in the collection of the Philadelphia Academy. They correspond well, though smaller, with the figure of *appressa* (Fig. 28), which I have copied from Haldeman. I have seen no authentic specimen of Say's *L. jugularis,* but have no doubt of its identity with the shell he afterwards called *appressa,* not only from his comparison of *jugularis* to *stagnalis,* but from the tradition of the earlier collectors, who always have considered them nearly related, if not the same. Mr. Say's description of *jugularis,* in the third edition of Nicholson's Encyclopedia (which is reprinted in my edition of his works), is extremely unsatisfactory, and would hardly be referred to the shell before me, without the words used by him in the first edition. Both are now given.

There is a species of this genus which resembles the *stagnalis* of Europe: we have named it *Limnaea jugularis.* Whirls about six, tapering; mouth within often brownish, lip white, column a little contracted in the middle; we have not a good specimen to describe or figure. *(Say, Nich. Encycl. first ed.)*

There is a species of this genus that we have named *Limnaea jugularis,* and which in consequence of its having been found but once, must be considered as a doubtful inhabitant of the United States. It may thus be described: Shell tapering; whirls about six; suture not deeply impressed; aperture hardly equal to half the length of the shell, but little dilated; within brownish, particularly on the column, which is contracted in the middle; outer lip white, and almost imperceptibly repand within; umbilicus very distinct. Length one inch. A specimen was also brought from the West Indies, by Mr. L'Herminier, of Charleston. *Say, 3d ed. Nich Encycl.)*

Haldeman admits *L. appressa* as a distinct species with doubt, but describes it as more attenuated, lighter in color, and having the spiral striae better developed than the typical *jugularis.* One of his figures of the latter is copied in my figure (Fig. 29).

(PAGE 27)

Fig. 29. Adams and DeKay describe *appressa* as a distinct species.

Fig. 30.

The shell has been figured roughly and described by Dr. Kirtland under the name of L. *stagnalis.* I here give a fac-simile of his figure, and a copy of his remarks, omitting Dillwyn's words.

After leaving Trumbull, we enter Portage County (Ohio). In this county we found a number of beautiful ponds, from each one of which flows a perennial stream. One which lies a few miles south of our route, in Stark County, called Congress Lake, was, until recently, the only known locality of the fine univalve shell, *Limnaea stagnalis.* It was discovered by Dr. K. in the course of the last season. I have one in my possession which is two inches in length, with the body whirl three-fourths of an inch in diameter. As this rare and elegant shell has not been figured or described by any American Conchologist, a drawing is given at fig-

ure 10. The description is copied from Dillwyn and appears to be so similar to that of our own shell, that there can be no doubt of its identity with the European species, although it is a rare fact, and which scarcely again occurs in all our long list of land and freshwater shells. Geoffroy calls it 'Le Grand Buccin.' *(Kirtland.)*

An anonymous writer in the Canadian Naturalist also refers the shell to *stagnalis*, giving a copy of a figure of that species in a foreign journal.

The species has also been described and figured, as the following copies show, by Rossmassler, under the name of *Limnaeus speciosus*, Ziegl. Haldeman quotes this description in the synonymy of *jugularis*, but afterwards refers it to *L. appressa*.

Shell imperforate, ovate-conical, with a long turreted acutely terminating spire, yellowish-brown, deeply striated, with very delicate striae under the lens on the whole upper surface; seven whirls, the last not very ventricose, but only slightly arched; no trace of a margin above; the upper whirls form a very long and slenderly drawn-out spire; aperture ovate, acute above, on the left side cut out in a shallow heart shape; outer lip but slightly prominent, and very delicately imbricated; the columellar callus is quite thin and adheres so closely as to be distinguished almost

(PAGE 28)

wholly by its white color, and hard-
Fig. 31. ly by a perceptible elevation, leaving scarcely any trace of an umbilicus.

Animal ----- ?

Habitat.—In the fresh-water lakes of North America. I compared twenty specimens from Lake Erie which appeared perfectly adult and whose characters were constant. This species certainly much resembles *L. stagnalis;* but the invariable tawny color, the decided almost regular striation, the narrower aperture, the outer lip less curved and not prominent, and, finally, the delicate, closely adherent, white columellar callus sufficiently distinguish it. *(Rossmassler.)*

Moquin-Tandon (Moll. Fr. II, 471) places *L. appressa*, Say, in the synonymy of *L. stagnalis*, var. , *roseolabiata (L. bicolor*, Mke, *L. stagnalis*, var. *obscurus*, Mke.).

Reeve (Brit. L. and Fr. W. Sh.) does not quote Say's species in the synonymy of *L. stagnalis*, but on p. 155 notices the marked degree of parallelism between, if not identity of, *L. limosa* and *L. catascopium*, *L. auricularia* and *L. macrostoma*, *L. stagnalis* and *L. jugularis*, *L. palustris* and *L. elodes*, and *L. truncatula* and *L. desidiosa*.

Limnaea stagnalis is catalogued by Middendorf among the circumpolar species of Asia. It is found in Europe, Siberia, and Cashmere. Like many of our extreme northern species, it appears common to the three continents.

Fig. 32 represents the lingual dentition of an American specimen of *Limnaea jugularis*. The

(Fig. 32.)

central tooth is small, narrow, conical. There are 40.1.40 teeth, arranged in a transverse, curving row, of variable form. There are 103 rows in all.

[1] Rather *L. ampla*.

(PAGE 29)

Cat. No.; No. of Sp.; Locality; From whom received.; Remarks.

8301	5	Michigan.	
8306	5	Ruby Valley.	Capt. J H. Simpson.
8307	4	.....	W. Stimpson.
8479	3	Lake Champlain.	W.G. Binney. Cabinet series.
8954	3	Ft. Simpson; Br. Am.	R. Kennicott.
9063	30+	Hudson's Bay.	Drexler.
9067	50+	Grand Rapids, Mich.	Dr. J. Lewis.
8959	..	Ft. Resolution	R. Kennicott.
9135	5	Ft. Simpson.	"
9140	5	Moose Factory.	Drexler.
9175	50+	Vermont.	J. E. Chittenden.
9182	2	Black River. N. Y	Gen. Totten.
9165	4	Milwaukee.	I. A. Lapham.
9154	6	Cayuga Inlet.	Mrs. H.W. Parker.
8425	3	Milwaukee, Wis.	I. A. Lapham.

8246 3 Michigan .....
8462 3 Southern Utah. Capt. J. H. Simpson. In al. with animals.
8473 2 Milwaukee, Wis. I. A. Lapham.
9285 5 Isle la Crosse. R. Kennicott.
9287 1 Otter Tail Creek, Minn. "
9290 20+ Great Slave Lake. R. Kennicott.
9248 3 Lake Superior. Dr. J.S. Newberry.
9250 2 " "
9252 5 Rhett L., Cal. "
9244 5 ....
9322 4 E. of Ft. Colville, W.T. N.W. Bound. Surv.
9325 12 Near Ft. Anderson, lat. 68° R.R. McFarland.

Limnaea lepida, Gould.--Shell very fragile, elongated, very acutely conical, subumbilicate, pale horn-color; whirls five, oblique, moderately convex, forming an acuminated spire; suture moderately impressed; surface smooth and shining, lines of growth faint, and when examined by a magnifier they are found to be rendered somewhat zigzag by distant, revolving furrows, which cross them. Aperture large and expanded, nearly semicircular, half the length of the shell; outer lip expanded; columella having a very strongly marked sharp fold, and broadly covered with a thin callus, which not being closely appressed at the umbilical region, leaves a small chink. Length 3/5, breadth ¼ inch.

Fig. 33.

Lake Vancouver, Oregon.

Most closely allied to *L. pallida,* Adams, but is much more delicate, the spire more acuminate, the aperture larger and expanded, the fold of the pillar more developed, and the surface well characterized, when closely examined, by the flexuose lines. The whirls are much more oblique and less convex than in *L. desidiosa. (Gould.)*

Limnaea lepida, Gould, Proc. Boston S.N.H. II, 211 (1847); U.S. Ex. Ex. Moll. 121, f. 141, 141*a* (1852); Otia, 41.

The description and figure given above are both copied from Dr. Gould. The original specimens are preserved in the Smithsonian collection.

(PAGE 30)

Cat. No. 8571 - No. of Sp. .. - Locality. Lake Vancouver, Or. - From whom received. Com. Wilkes. - Remarks. Cabinet series.

Subgenus RADIX, Montf.

Shell subovate, last whirl ventricose; aperture more than half the length of the shell, greatly expanded.

Gulnaria of Leach corresponds to this subgenus, but does not have priority. Klein describes a 'Radix Bryoniae' as a genus (?) at an earlier date than Montfort published, but I do not acknowledge him as authority. He did not use the Linnaean system of nomenclature. H. & A. Adams use Klein's name *Neritostoma,* but his description and figure refer rather to *Succinea,* which would prevent the use of the name, even if Klein were authority.

Limnaea ampla, Mighels.--Shell large, much inflated, suboval, rather thin, composed of five convex whirls, prominently shouldered at the upper part; epidermis of an obscure olivaceous green color; lines of accretion very fine and compact; transverse lines obscure, appearing serriform under a magnifier, giving the surface the appearance of very delicate lace work; suture deep, and in one specimen subcanaliculate; spire short and pointed when present; aperture oblong, very wide at the posterior part, but narrowing rapidly anteriorly and occupying rather more than two-thirds the length of the shell; labrum thin and somewhat reflected; labium broadly reflected, forming and partially covering an open and very deep umbilicus; columella fold very prominent; within it is of a light yellowish fawn color, with an obscure purplish zone, one line in breadth, and about two lines within the aperture. Length 1.3, breadth 1, height .8 inches. Divergence of the spire very variable.

Fig. 34.

Second Eagle Lake, Maine, N. lat. 47°.

This extraordinary and beautiful species was discovered by Mr. Alexander W. Longfellow, civil engineer, while engaged with other gentlemen of the scientific corps in the explora-

tion and survey of the northeastern boundary, in the summer of 1842. He informs me they were very abundant on the shore of the lake, but he had no means of preserving any more than four specimens, all of which are in my collection. No two of

(PAGE 31)

the specimens are exactly alike; but notwithstanding this and the remarkable difference between those represented in the plate, I doubt not they are specifically the same. It is allied to *L. decollata,* Nobis, but it is readily distinguished from that shell by its amplitude, by a proportionately larger penultimate whirl, by the reflected labrum, by a much broader labium, and by an open umbilicus, which is always entirely closed in *L. decollata*. I regard that represented by fig. *a* as the prevailing type of the species. Fig. *b* is a little shorter, and rather more tumid; fig. *c* represents a distorted specimen. *(Mighels.)*

Limnaea ampla, Mighels, Bost. Journ. N. H. IV, 347, pl. xvi, f. 1, *a, b, c* (Apr. 1843); Proc. I, 129 (Oct. 1843), not of Hartmann.[1]—Whiteaves, Can. Nat. (Apr. 1863), VIII, 112, f. 11.

This is a well-marked species, not easily confused with any other. The description and Fig. 34 are copied from Mighels. Since their publication, the species seems to have been entirely unnoticed till Mr. Kennicott found it at Fort Simpson.

Fig. 35.

The European species most nearly related to *L. ampla* is *L. auricularia*. So strong is the resemblance between some forms of the two that their identity is almost suggested. I have, therefore, copied Moquin-Tandon's figure of *L. auricularia*.

Cat. No.; No. of Sp.; Locality; From whom received; Remarks.

.... British America. Kennicott. .....
9283 50+ Isle La Crosse " .....

Limnaea decollata, Mighels.—Shell very ventricose, rather thick, subovate or subrotund, in outline an irregular rhomboid; epidermis of an olivaceous green color, rather thin, deciduous; whirls two to three; spire very short, generally decollated; whole surface generally rather rough; striae of growth coarse and fine alternately; transverse striae on the body whirl sparse, interrupted, sometimes obsolete; body whirl composes almost the whole shell; aperture very large, subcampanulwte; its length is very little greater than the breadth, and occupies more than two-thirds the length of the shell; labrum rather thin, simple; fold of the columella very prominent. Length 16, breadth .5, height .4 inch.

Fig. 36.

[1] *Gulnaria ampla,* Hartmann, 1842, is referred by Reeve to *L. auricularia*. Should it prove a distinct species, our shell might be called *L. mighelsi*.

(PAGE 32)

Animal dingy mouse-color, with a slight tinge of purple, covered with numerous microscopic, elongated white spots on every visible part of the surface, including the mouth and tentacula; foot of a chocolate color, rather broad, length rather greater than the aperture; habits sluggish. Cabinets of the Bost. Soc. N. H., Dr. Gould, S.S. Haldeman, J.G. Anthony, J.W. Mighels, and C.B. Adams.

Unity, Maine, discovered by Dr. Milliken of that town, to whom we are indebted for specimens.

This odd but interesting shell is readily recognized by its rhomboidal aspect, wide aperture, and rather rough and distorted appearance. It is allied to *L. catascopium,* Say, but is distinct from that shell by having less whirls by two, and a much shorter spire; by being wider, and its divergence greater by more than thirty degrees. By some it has been supposed to be identical with *L. emarginata,* Say. This is impossible. *L. emarginata is* much more cylindrical, the divergence of its spire is scarcely half as great as that of our shell; it is much thinner, and has at least two more volutions. Our shell is also destitute of the 'deep emargination' which distinguishes *L. emarginata. (Mighels & Adams.)*

Limnaea decollata, Mighels, Proc. Bost. Soc. I, 49 (1841); Bost. Journ. IV, 4-5, 336, pl. iv, f. 13 (and Adams) (1842).

Limnaea catascopium, Haldeman, part, Mon. 52, pl. xiv, f. 1-3 (1842).
Limnaeus decollatus, Küster in Ch. ed. 2, 45, pl. viii, f. 11-14.

Found around Lake of the Woods, in Maine and Connecticut.

Fig. 37.

Haldeman and DeKay refer this species to *L. catascopium*. I have given the original description and figure above. No. 9132, presented by Prof. Haldeman, were by him received directly from Mighels. One is figured in Fig. 37.

Cat. No.; No. of Sp.; Locality; From whom received; Remarks.
8300 9 Lake of the Woods. R. Kennicott. ...
8481 1 Maine. W.G. Binney. Cabinet series.
9132 6 " Haldeman. From Mighels.

Limnaea columella, Say.—Shell thin, fragile, horn-color; whirls four, longitudinally wrinkled. Spire prominent, acute. Suture not much impressed. Aperture dilated, ovate. Columella much narrowed near the base, so that the view may be extended from the base almost to the interior apex of the shell. Length 7/10 of an inch nearly, of the spire ¼ inch.

Inhabits stagnant waters and miry places. Collection of the Academy.

Animal aquatic, base not so long as the aperture; dusky, with small

(PAGE 33)

whitish spots; tentacula broad, pyramidal, compressed; eyes small, black, placed at the inner base of the tentacula.

This species is allied to *L. catascopium* of the American edition of Nicholson's Encyclopedia, but the revolution of the whirls is more oblique, the shell thinner, the aperture more dilated, and the columella differently formed. For several specimens of this shell I am indebted to Mr. Titian Peale.

Fig. 38.

Var. *a*. Small, black. From Cold Water Creek of the Missouri. This is most probably a distinct species; we obtained but a single specimen of it. *(Say.)*

Limnaea columella, Say, Journ. Acad. Nat. Sc. Phila. I, 14 (1817); II, 167 (1821).—Nich. Enc. 3d ed. (1819); Binney's ed. 60, 56.—Haldeman, Mon. 38, pl. xii (1842).—Gould, Inv. of Mass 215, f. 144, 216, f. 145 (1841).—DeKay, N. Y. Moll. 72 pl. iv, f. 75 (1843).—Potiez et Michaud, Gal. I, 216, pl. xxii, f. 5, 6.—Anon. Can. Naturali II, 197, fig. (1857).
Limneus columella, Küster in Ch. ed. 2, 44, pl. viii, f. 3-5.
Limnaea chalybea, Gould, Am. Journ. Sci. [1], XXXVIII, 196 (1840); Otia, 180.
Limnaea macrostoma, Say, Journ. Acad. Nat. Sc. II, 170 (1821); Binney's ed. 67.---Gould, Inv. 217, f. 148 (1841).—Anon. Can. Nat. II, 198, fig. (1857).
Limneus macrostomus, Küster in Ch. ed. 2, 43, pl. viii, f. 1, 2.
Limnaew acuminata, Adams, Am. Journ. Sc. [1], XXXIX, 374 (1840).
Limnaea navicula, Valenciennes, Rec. d'Obs. II, 251 (1833).
Limnaea strigosa, Lea, Proc. Am Phil. Soc. II, 33 (1841); Trans. IX 12 (1844); Obs. IV, 12.
Limnaea coarctata Lea, Proc. Am. Phil. Soc. II, 33 (1841); Trans. IX, 11 (1844); Obs. IV, 11.
Limnaea casta, Lea, Proc. Am Phil. Soc. II, 33 (1841); Trans IX, 11 (1844); Obs. IV, 11.
Limnaea columellaris, Adams, Sill. Journ. [1], XXXVI, 392, absq. descr.
Limnaea succiniformis, Adams MS. teste Haldeman.

This species has been found from New England and Lake Superior to Georgia. Its wide range and variable form has caused its being described under several names, which are mentioned in the synonymy and treated at length below. Mr. Say's specimens of *L. columella* are still preserved in the Philadelphia Academy. One is drawn in my figure (Fig. 38). Specimens of his *L. macrostoma* also are there preserved, one being drawn in my figure (Fig. 39). From an examination of it and of the following description, I am led to coincide with Haldeman and DeKay's opinion of its identity with *L. columella*.

(PAGE 34)

Limnaea macrostoma, Say.— Shell suboval; whirls five, body whirl somewhat reticulated; suture not profoundly indented; spire about two-thirds the length of the aperture, acute; aperture much dilated; labrum not thickened on the inner submargin.

Fig. 39.

Inhabits Cayuga Lake. Length ½ inch, and upwards.

Imperfect specimens of this shell were found on the shore of Cayuga Lake, by Mr. A. Jessup; but they are sufficiently entire to exhibit considerable similarity to some varieties of *L. auricularius,* of Europe. It may readily be distinguished from *L. catascopium* by its much more dilated aperture. *(Say.)*

Limnaea acuminata, Adams, seems a synonym of *L. columella.* Haldeman and DeKay so consider it, and Gould refers it to *L. macrostoma.* I have seen no authentic specimen, but give the original description below. It must not be confounded with Brongniart's species of the same name.

Limnaea acuminata, Adams.—Shell fragile, semi-transparent, ovate, with very numerous, revolving, irregular, transverse, parallel striae; whirls four; spire very short, subacute; last whirl very large; aperture very large, exhibiting the interior of the spire; columella thin sub-reflected; labium not appressed.

New Bedford.

This differs from *L. columella,* Say, in the much greater proportional size of the last whirl, the breadth of the shell, and the presence of very distinct revolving lines. It resembles *Succinea obliqua,* Say, but the spire is rather less, and no revolving lines are mentioned in the description of that species. The *L. acuminata* has also been found at Horn Pond, in Woburn, Mass., by T. J. Whittemore, Esq. *(Adams.)*

Limnaea chalybea, of Gould, whose description and figure are here copied, is no doubt a form of *L. columella.* It is so stated by him recently (Otia, p. 180), as well as by Haldeman in his Monograph.

Limnaea columella, var. *chalybea,* Gould.— The spire is more pointed, its divergence only about 50°; the aperture is more expanded, and the fold on the inner lip more obvious. It is thin, but not very brittle, ringing like hard-burnt crockery. The last whirl is partially detached from the preceding one, so as to form a thread-like channel at the suture. The enamel rests loosely against the shell, and is wrinkled The exterior is covered by a bluish-black pigment, not easily removed, and the interior has a steel-blue or black lead color.

Fig. 40.

This shell, which I found two years in succession in a muddy pool in Cambridge, I thought was sufficiently distinct to be regarded as a new species; and I accordingly gave its

(PAGE 35)

characters under the name of *Limnaea chalybea,* in Silliman's Journal, XXXIII, 196. But as it has not been found in any other place, I am now disposed to regard it as a strongly marked local variety of *L. columella.* It is very possibly such a shell to which Mr. Say alludes in the Journ. Ac. Nat. Sc. II, 167, as *L. columella,* var. *a.,* small, black, from Cold Water Creek, Missouri. *(Gould.)*

Limnaea navicula, of Valenciennes, whose description follows, is said to be a form of *L. columella,* by Haldeman and Gould, and also by Ferussac (Bull. Zool. p. 35, 1835) and Küster. I have seen no specimen or figure of it.

Limnaea navicula, Valenciennes.—Shell oval, pointed, subdiaphanous, whirls four, substriate. The last whirl is four times as long as the three others. The aperture is large and gaping, its length equalling two-thirds the shell's length. Shell very thin, slightly transparent. Color grayish-yellow. Length 10 lines.

Hab. Environs of Philadelphia. *(Valenciennes.)*

Finally, an examination of the specimens from which Mr. Lea drew his descriptions of *Limnaea strigosa, coarctata,* and *casta,* have convinced me of their identity with L. *columella.* In the case of the second species Haldeman agrees with me, he makes no mention of

the others. Mr. Lea's descriptions are copied below, and a figure given of each of the three forms, drawn from his types.

Limnaea strigosa, Lea.—Shell long-oval, somewhat oblique, diaphanous, striate, horn-colored, thin, imperforate; spire short; sutures impressed, whirls five, somewhat convex; aperture ovate. Fig. 41.

Hab. Near Cincinnati, Ohio. T.G. Lea. My cabinet and cabinet of T. G. Lea. Diam. .38, length .75 of an inch.

This is a very thin fragile species, somewhat resembling *L. columella,* Say, but may at once be distinguished from that species by its longer spire and less inflated body whirl. It is allied to *L. coarctata,* herein described; differing, however, in being more oblique, and in having the whirls more inflated. The aperture is about three fourths the length of the shell, and acutely angular above. *(Lea.)*

Limnaea coarctata, Lea is also referred to *L. macrostoma,* by Küster, *l.c.* Mr. Lea's description here follows, with a drawing of his original specimen.

Limnaea coarctata, Lea.—Shell fusiform, very thin, obsoletely striate, diaphanous, horn-color, imperforate; spire short, pointed; sutures slightly impressed; whirls four, rather flattened; aperture large, ovate.

(PAGE 36)

Hab. Newport, Rhode Island: Col. Totten, United States Army. My cabinet and
Fig. 42. cabinet of Col. Totten. Diam. .30, length .55 of an inch.

This is one of the most delicate and fragile of the genus *Limnaea* which I have seen. It is allied to Mr. Say's *L. columella;* but may at once be distinguished by the compression of the superior part of the body whirl, which causes an acute angle in the superior part of the aperture. Under a rather powerful lens, some of the specimens may be perceived to have very minute revolving striae. The aperture is two-thirds the length of the shell, and is inflated at the inferior part. The fold of the columella is delicate and incurved. *(Lea).*

Limnaea casta, Lea.—Shell subfusiform, rather thick, closely striate, yellow,
Fig. 43 perforate; spire rather elevated, acuminate; sutures impressed; whirls six, convex; aperture large, ovate.

Hab. Poland, Ohio: Dr. Kirtland. My cabinet and cabinets of Dr. Kirtland, and T. G. Lea. Diam. .30, length .58 of an inch.

The columella of this species is remarkably straight and being reflected, causes the lower part of the aperture to be slightly effuse. The last whirl is wrinkled. The aperture is more than half the length of the shell. It is allied to *L. desidiosa,* Say, but is a smaller species, has the spire more exserted, and a less curved fold. The perforation is very small. Dr. Kirtland kindly sent me many specimens several years since. *(Lea.)*

Fig. 44 represents at one view, the various forms which have been described as distinct species.

Fig. 44

Fig. 45 represents the lingual
Fig. 45. dentition of the species. There are eighty rows of about seventy teeth each.

Dr. T. R. Ingalls, of Greenwich, N. Y., to whom I am indebted for many specimens of shells and much valuable information, wrote me in 1860 the following curious note regarding *L. columella.* His words are —

(PAGE 37)

'The *L. macrostoma* which I send you requires a note. It comes as near a case of spontaneous generation as anything within my observation. It was found in a little pool about twenty feet in diameter, entirely cut off from streams and fed by a spring. I had for years frequented it for Desmidia, &c., in which it was very rich. One season, and one only, appeared these *Limnaeae,* which do not occur elsewhere, as far as I now know, within twenty miles. The pond dried up that season and destroyed the locality.'

Cat. No.; No. of Sp.; Locality.; From whom received; Remarks.
8295 3 Ohio. ....
8296 7 St. Simon's Island. Ga. ....

8297 1 Marietta, O. W. Holden .....
8298 9 South Carolina. W. Stimpson. .....
8299 5 ..... W.G. Binney. Var. *chalybea*, Gld.
8482 2 ..... W.G. Binney. Cabinet series.
9139 12 St. Simon's, Ga. Postell. .....
8979 San Felipe Spr. Capt. Beale. .....
8522 1 .... Ac. N. Sc. Phila. Marked *L. macrostoma* by Say.
9251 9 Massachusetts. ..... *strigosa*, teste Lea.

Subgenus BULIMNEA, Hald.

Shell thick in texture, ovate, inflated; spire short, outer lip not expanded.

Limnaea megasoma, Say.--Large, dilated subovate; spire short, rapidly diminishing, acute; whirls about five, rounded, obtusely wrinkled across; body whirl large, the wrinkles very obvious, suture deeply impressed; aperture subovate, much longer than the spire, within chestnut-brown; columella white. Length more than one and six-tenths of an inch; greatest diameter one inch. Fig. 46.

This remsrkably large and fine species was found in Bois Blanc Lake, Northwest Territory, by Dr. Bigsby, to whom I am indebted for specimens. The color is brownish, sometimes lineated across the body whirl with dull greenish and pale ochraceous; and the chestnut-brown color of the interior of the shell, combined with its large dimensions, distinguish this species from all others yet discovered in this country. *(Swy.)*

Limnaeus megasomus, Say, Long's Exp. II, 263, pl. xv, f. 10 (1824); Binney's ed. 129, pl. lxxiv, f. 10.--Küster in Ch. ed. 2, 36, pl. vi, f. 20, 21.

(PAGE 38)

Limnaea megasoma, Haldeman, Mon. 13, pl. iii, f. 1-3 (1841).--Adams, Shells of Vermont; Thoms. Vt. 153, excl. fig., pamphlet, p. 3 (1842).--DeKay, N. Y. Moll. 70 pl. iv, f. 70 (1843). Fig. 47.

Bulimnea megasoma, Chenu, Man. de Conch. III, 480, f. 3543.

This is a northern species, ranging from Lake Champlain to Michigan. The shell, by which it is commonly represented in collections, corresponds perfectly with Mr. Say's types in the Philadelphia Academy. His description and figure are copied above (Fig. 46).

Prof. Adams' figure does not represent this species.

Cat. No.; No. of Sp.; Locality.; From whom received; Remarks.
8253 1 Burlington, Vt. ....
8254 6 Lake Champlain. W. Stimpson. .....
8487 2 " " Cabinet series.
9249 4 Lake Superior. Dr. J. S. Newberry. .....

Subgenus LIMNOPHYSA, Fitz.

Shell ovate-oblong; spire conic, about as long as the aperture, whirls rounded; outer lip not spreading.

The date of publication of *Limnophysa* is 1833--*Limnaea palustris* being the type. I find this prior to all other names for the section. *Stagnicola*, Leach, was first described in 1840, in Gray's edition of Turton, Leach's work was not then printed, and the edition of Turton bearing date 1831 gives no description, merely referring in the synonymy of several species to Leach's manuscript. *Galba*, Schrank, antedates *Limnophysa*, but is placed in the synonymy by Herrmannsen, no doubt for valid reasons.

Limnaea reflexa, Say.--Shell fragile, very much elongated, narrow, honey-yellow, tinctured with brownish, translucent, slightly reflected from the middle; volutions six, oblique, wrinkled transversely; spire more than one and a half times the length of the aperture, acute, two or three terminal whirls vitreous, body whirl very much dilated; aperture rather narrow; labrum with a pale margin, and dusky red or blackish sub-margin.

(PAGE 39)

Inhabits Lakes Erie and Superior. Total length 13/10,[1] of the aperture 11/20 of an inch.

This shell is remarkable for its narrow and elongated form, and for Fig. 48.

the consequent very oblique revolution of the whirls. When viewed in profile it has a slightly reflected appearance. It was kindly sent to me for examination by my friends Messrs. S. B. Collins and D. H. Barnes, of New York, and was found in Lake Superior by Mr. Schoolcraft. I recollect to have seen a specimen two or three years since brought from Lake Erie by James Griffiths. It is proportionally longer than *elongatus*. *(Say)*.

Limneus reflexus, Say, Journ. Acad. Nat. Sc. Phil. II, 167 (1821); Am. Conch. IV, pl. xxxi, f. 2 (1832); Binney's ed. 65, 188, pl. xxxi, f. 2; ed. Chenu, 44, pl. vii, f. 4.—Küster in Ch. ed. 2, 41, pl. vii, f. 11, 12.

Limnaea reflexa, Haldeman Mon. 26, pl. viii (1842).—DeKay, N. Y. Moll. 71, pl. iv, f. 65, 72, (1843).

Limneus elongatus, Say, Journ. Ac. Nat. Sc. Phil. II, 167 (1821); Long's Exp. II, 263; Binney's ed. 65, 130; ed. Chenu, 43, pl. vii, f. 5.

Limneus umbrosus, Say, Am. Conch. IV, pl. xxxi, f. 2 (1832); Binney's ed. 187 pl. xxxi, f. 2.—Haldeman, Mon. 24, pl. vii (1842).—De Kay, N Y. Moll. 68, pl. iv, f. 76 (1843).—Küster in Ch. ed. 2, 41, pl. vii, f. 13-16.

Limnaea exilis, Lea, Tr. Am. Phil. Soc. V, 114 pl. xix, f. 82 (1837); Obs I, 226.—Küster *(Limnaeus)* in Ch. ed. w, 40, pl. vii, f. 9.

Limnaeus palustris, var. *distortus,* Rossmassler (1835), Icon. I, 97 pl. ii, f. 52.

Limnophysa reflexa, Chenu, Man. de Conch. II, 480, f. 3544.

This species has been observed through the northern tier of States, from New York to the Pacific, and in Canada. It extends more to the southward in the western portions of its area, having been found in Kansas and Utah, and in the Columbia and Sacramento Rivers.

I have given above a copy of Mr. Say's description of this species, and a fac-simile (Fig. 48) of the outline of one of his figures. It is a well-known shell, found in great numbers, and common in collections. It is subject to much variation, as shown by the large suite in the collection. Three forms have been described as distinct species, and are treated at length below. It is also readily confounded with *Limnaea fragilis,* so as indeed almost to warrant the conclusion of Forbes & Hanley that 'the

1 Probably 1 3/10 inch.

(PAGE 40)

reflexa, umbrosa, and *elodes* of Say, which form apparently but one species, are scarcely distinguishable from this variable shell *(palustris).'*

Mr. Say's type of *Limnaea umbrosa* is still preserved in the Philadelphia Academy. My Figure 49 is a fac-simile of the outline of one of his, and a copy of his description here follows. The name *umbrosa* was substituted by Mr. Say for the preoccupied *elongatus*. The shell is considered distinct by Haldeman and DeKay, doubtfully so in Adams' Shells of Vermont.

Limneus elongatus.—Shell horn-color, tinged with reddish-brown; spire elongated, tapering, acute; whirls six or seven, slightly convex, wrinkled across; body whirl, measured at the back, more than half the total length; suture moderately indented; aperture less than half the length of the shell; labium with cslcsreous deposit. Length one and three-tenths inch.

Fig. 49.

Inhabits, in considerable numbers, the ponds and tranquil waters of the upper Missouri. It is very distinct from *L. catascopium,* by the much greater proportional length of the spire. *(Say* in J.A.N.S.). Rainy Lake and Seine River f Upper Canada.

I am under the necessity of changing the name which I first applied to this shell, that of *elongatus* being pre-occupied by Draparnaud for a very different species. The fold of the columella is much less profound than that of *L. palustris,* Lin. which it much resembles. *(Say* in Am. Conch.)

Limnaea plebeia, Gould, is quoted doubtfully as a synonym of *L. umbrosus,* by Adams (Middlebury Shells, and Sill. Journ. [1], XL, 268). I refer it, however, to *L. palustris,* as that species is found in Massachusetts, while *umbrosa* is not. Gould mentions *plebeia* by name only in the Catalogue of Massachusetts Shells.

My opinion of the identity of *Limnaea exilis* with *L. reflexa* is based upon an examination of Mr. Lea's original specimen. His description and figure here follow. Haldeman and DeKay place *exilis* in the synonymy of *reflexa.*

Limnaea exilis.— Shell attenuated, very thin, longitudinally striate; whirls seven,

plano-convex, columella reflected; aperture ovate oblong.

Ohio. My cabinet. Diam. .4, length 1.5 inch.

This is, perhaps, the most attenuated *Limnaea* yet observed in this country. It approaches most to the *reflexus*, Say, but is more elongate than that species. The most remarkable character of the *exilis* is, per-

(PAGE 41)

haps, the reflection of its labium which is not laid on the body of the whirl. Where it joins above with the labrum, the angle is quite acute, and is separated from the body whirl. The specimen figured was not taken alive, and the epidermis being destroyed, the description and representation are partially defective. The aperture is about two-fifths the length of the shell. *(Lea.)*

Fig. 50.

I was at first inclined to place *Limnaea haydeni* in the synonymy of this species. It appears to be distinct after more careful study of the specimens in the collection.

Fig. 51 gives, at one view, the various forms which I have considered synonyms of *L. reflexa.*

Limnaeus palustris, var.

Fig. 51. var. *distortus*, of Ross- massler, is a form of this species, as shown by his figure, of which a fac-simile is here given. (Fig. 52).

Fig. 52.

Cat. No.; No. of Sp.; Locality; From whom received; Remarks.

8224 8 Milwaukee, Wis. I.A. Lapham. .....
8225 4 Big Sioux. ....
8226 16 Illinois. ....
8227 7 ....
8228 8 Goose Island, Mich. ....
8229 26 Big Sioux ....
8230 8 Milwaukee, Wis. I.A. Lapham. .....
8231 20 ....
8232 1 St. Clair River. ....
8233 3 ....
8234 7 Farwell's Mills, Madison, Wis. Prof. S. F. Baird .....
8235 1 Illinois ....
8236 1 Illinois ....
8236 7 Prairie Lke, n. Red Riv. R. Kennicott.
8237 2 Toledo, O. F. A. Bossard .....
8238 3 Ohio. Dr. J. Lewis. .....
8239 11 Goose Island, Mich ....
8240 8 Milwaukee, Wis. ....
8241 4 Illinois. Dr. J. Lewis. .....
8242 13 Grindstone Creek. ....
8243 15 Ft. Peirce. ....
8491 1 Aztalan, Wis. Prof S.F. Baird. Cabinet series.
8319 6 ....
8521 5 .... Cabinet series.
3523 3 Pacific Coast. ..... Cabinet series.
8734 2 San Francisco. Rowell. .....
9066 200+ Milwaukee. Lewis. .....
9139 20+ ..... " .....

(PAGE 42)

Limnaea attenuata, Say.-- Shell elongate turreted, somewhat translucent; spire slender, attenuated, acute; whirls six or seven, with but a very slight convexity; wrinkles more distinct towards the aperture; body whirl, measured at the back, obviously less than half the total length. Length one inch.

Fig. 53.

Inhabits Mexico.

This species abounds in ditches and ponds in the vicinity of the capital. It is more nearly related to *L. reflexus*, nob., than to any other known species of North America; but it is only necessary to compare the two in order to perceive a wide difference between them. The present is smaller and proportionally more slender, and the spire is more attenuated. *(Say.)*

Limnaea attenuata, Say, New Harm. Diss. II, 244 (1829); Binney's ed. 148; Descr. 23.--De Kay, N.Y. Moll. 75 (1843).--Haldeman, Mon. 28, pl. ix, f. 1-5 (1842). — Küster *(Limnaeus)*, Chemn ed. 2, 39, pl. vii, f. 8.

Limnaeus subulatus, Dunker in Küster, Ch. ed. 2, 24, pl. iv, f. 24.

Figure 53 is drawn from an authentic specimen of Mr. Say. His description is given above.

In describing the habitat of *Planorbis tenuis*, in Chemnitz, ed. 2, *Limnaeus subulatus*

is mentioned as common among graves near Mexico. There is also a *L subulata,* Kickx, mentioned in Dupuy's Mollusques de la France, p. 463. But the species referred to is, I suppose, the one described in Küster's ed. 2 of Chemnitz, Limnaea, p. 24, pl. iv, f. 24. As the last livraison devoted to Limnaea, which has reached this country, contains only a portion of the description of the species, I cannot say what locality is given by Küster for the shell. The figure corresponds with *Limnaea attenuata,* Say. It is copied in Figure 54. A translation of the description here follows:—

Shell imperforate, subulate-turreted, solid, striated, reddish horn-color; spire elongate, subulate, acuminate; whirls seven, flattened; aperture semioval, yellowish - red, sanguineous at the base; peristome straight, sharp, oblique, with a distinct columellar fold. *(Dunker.)*

Fig 54. Fig. 55.

Since writing the above the succeeding part of Chemnitz, ed. 2, having arrived, I find the locality to be Mexico, at Zimapan and Lake of Mexico.

(PAGE 43)

Fig. 55 gives, at one view, the two forms which I have considered synonymous.

Cat. No.; No. of Sp.; Locality; From whom received; Remarks.
8294 7 City of Mexico. ....
8283 5 " ....

Limnaea sumassi, Baird.—Shell elongate, attenuated, horn-colored, fragile; whirls six, the last twice the size of the remainder; aperture moderate; columella strongly plicate; external surface with microscopic, crowded, very minute decussations. Length of largest 1 1/6, breadth ½ inch.

Fig. 56, Fig. 57.

Hab. Sumass Prairie, Fraser River, British Columbia.

This species of *Limnaea* approaches *L. elodes, Say,* but is more elongated, more fragile, and has the columella very strongly plicated. The surface of the shell, when seen under a lens of moderate power, is finely decussately striated. It is of a horny color, and is of an elongated shape. *(Baird.)*

Limnaea sumassi, Baird, Proc. Zool. Soc. London, 1863, p. 68.

This species was collected by the British Boundary Commission. Members of the American Commission also collected the specimens in the Smithsonian collection, which show the species to be extremely variable. I have copied above the original description and two figures from the advance plates of the British Report, kindly furnished by Mr. Carpenter.

Fig. 58.

A curious specimen, from Ft. Colville, (Northwest Boundary Survey), is figured in Fig. 58. It may be referable to this species.

Cat. No. 932υ; No. of Sp. 30; Locality. E. of Ft. Colville, W.T.; From whom received. N. W. Boundary Surv.; Remarks. .....

(PAGE 44)

Limnaea haydeni.—Shell ovate conic, smooth, thin, light horn-colored, imperforate; spire rather short; whirls five, convex; sutures deeply impressed; aperture ovate; columella strongly plicate.

Fig. 59.

Yellowstone and Big Sioux: Dr. Hayden. *(Lea.)*

I was at firstinclined to place this species in the synonymy of *Limnaea reflexa.* Upon more careful examination of the specimens collected by Dr. Hayden (one of which is here figured), I am satisfied of its being distinct. Its rounded whirls and strongly plicate columella are its chief characteristics.

Cat. No.; No. of Sp.; Locality.; From whom received; Remarks.
8250 18 Yellowstone River ..... Original lot named by I. Lea.
8251 27 Ruby Valley. Capt. J. H. Simpson, Army of Utah. 'Swamps'
8252 8 Mo. of the Yellowstone. ..... 'In alluvial.'
8255 4 Big Sioux. ..... Named by I. Lea.
8253 9 30 m. w. of Ft. Kearney. ....

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