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III

# UPPER MIOCENE LACUSTRINE MOLLUSKS FROM SONOMA COUNTY, CALIFORNIA

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The collection of freshwater and brackish water fossils which are described in the following pages was obtained in 1916 by Mr. J. B. Kerr from deposits in the Petaluma and Santa Rosa Quadrangles of Sonoma County, California. The stratigraphy of the region has been studied in detail by Dr. Roy E. Dickerson[1] who concluded that "* * * the formation is a freshwater and brackish water phase of the marine San Pablo of upper Miocene age, as both are unconformably below the Sonoma group and its equivalent, the Pinole tuff."

The fossils do not furnish information which would necessitate a modification of that statement. The absence of such genera as Parapholyx, Carinifex, and Gonidea, all wide-spread in California Pliocene lakes, is very good evidence that these deposits antedate the Pliocene.

The localities at which the fossils were secured are more particularly described as follows, the numbers being of the Academy's series:

415. "In cañon about 2.1 miles north, 26° east of Elmore School, and 2.5 miles southeast of Mountain School Road, Petaluma Quadrangle, Sonoma County, California. Clay-shale and soft fossiliferous sandstones occur interbedded." The mollusks indicate that the deposit was formed in brackish water.

417. "In Haggin Creek, about 200 feet below bridge, one mile southeast of Penn Grove, Santa Rosa Quadrangle, Sonoma County,

[1]Proc. Calif. Acad. Sci., 4th ser., Vol. XI, No. 19, pp. 540-543, 1922.

California. Strictly freshwater fossils occur in green clay beds, immediately above which is conglomerate. The strata dip 12° southwest and have a strike of north 60° west."

418. "In ravine, .4 mile south, 20° west from Sartori's ranch house, Petaluma Quadrangle, Sonoma County, California. Fossiliferous clay-shale dipping 55° southwest, strike, north 32° west." Fossils are strictly freshwater forms.

### BRACKISH WATER SPECIES

The best preserved specimens of the brackish water fauna occur at locality 415. Here *Corbicula gabbiana* occurs in all of its many variations and in all ages. Associated with it are *Goniobasis rodeoensis* (Clark), a Mya and a Nematurella. All are either identical or closely related to forms found in various places in the uppermost portion of the San Pablo formation. This lends weight to the supposition that the two horizons are equivalent.

#### 1. **Mya dickersoni** Clark ?

The hinges of a pair of Mya shells were found at locality 415 associated with *Corbicula gabbiana*. It cannot be positively stated that they belong to the San Pablo species to which they have been questionably referred, because only the shape of that form is known.

#### 2. **Corbicula gabbiana** Henderson

Plate I, figures 1 and 2

*Cyrena californica* Gabb, Geol. Surv. Calif., Paleon., Vol. II, p. 26, pl. VII, fig. 45, 1869. (Not *Cyrena californica* Prime, Mon. Amer. Corbiculidæ, Smith. Misc. Coll., No. 145, p. 23, 1865.)

*C*[*orbicula*] *californica* Gabb, Dall, Trans. Wag. Free Inst. Sci., Vol. III, Pt. VI, p. 1451, October, 1903; placed in subgenus Cyanocyclas Ferussac, 1818.

*Cyrena* (*Corbicula*) *californica* Gabb, Clark Univ. Calif. Pub., Bull. Dept. Geol., Vol. VIII, No. 22, p. 459, pl. 56, fig. 2, 1915.

*Corbicula gabbiana* Henderson, Nautilus, Vol. XXXIII, p. 120, April, 1920.

*Corbicula californica* Gabb, Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. XI, No. 19, p. 542, 1922. Trask, Univ. Calif. Publ., Geol., Vol. XIII, p. 150, 1922.

At Locality 415, this species is exceedingly abundant in all stages of development. Fully mature individuals have thick, heavy shells, but young ones are thin and delicate. The hinge structure is figured herewith, apparently for the first time. The long lamellar, serrated laterals seem to distinguish Corbicula from Cyrena, but the genotypes have not been investigated thoroughly in this connection.

Unfortunately, Gabb's name, *C. californica*, was used by Prime for a very different species four years earlier. Prime's *californica* was a substitute name for *californiensis* Prime,[2] and this in turn was used to replace the name *Cyrena subquadrata* Deshayes.[3] Under the latter name was described a living shell from "California" which Cooper[4] stated came from the Gulf of California. Cooper also referred to the prior use of Gabb's name by Prime but substituted no other. Nor does it appear that any author prior to Henderson has re-named it.

Prime's ground for changing *C. subquadrata* Deshayes to *C. californiensis* Prime, was the fact that *Cylas subquadrata* Sowerby (1836)[5] was considered to belong to the genus Cyrena by him and by Morris.[6] Whether such action was justified or not cannot make Gabb's name tenable, as Henderson has shown.

This seems to be a characteristic species of the Upper Miocene brackish water deposits. Cooper[7] listed it from three localities; Kirker Pass (type locality) and Green Valley, Contra Costa County; and Soquel, Santa Cruz County. Clark[8] has listed it from six places in the Upper San Pablo Miocene. It has usually been found associated with such forms as Mya, Littorina, Goniobasis and Nematurella.

### 3. **Nematurella euzona** Hanna, new species

Plate II, figure 10

Spire elevated, conical, composed of 5½ whorls, sides slightly but evenly rounded. Surface marked only with fine, even growth striæ; body whorl obtusely but very decidedly angulated; imperforate; columellar and parietal walls thickened; peristome not

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[2]Proc. Acad. Nat. Sci. Phila. 1860, p. 276.
[3]Proc. Zool. Soc. XXII, p. 21, 1854.
[4]7th Ann. Rep. State Mineralogist p. 238, 1888.
[5]Geol. Trans. 2nd Ser. IV, p. 345, pl. XXI, fig. 8, 1836.
[6]Brit. Foss. p. 200, 1854.
[7]7th Ann. Rep. State Min. Calif. p. 238, 1888.
Univ. Calif. Pub. Bull. Dept. Geol. Vol. 8, No. 22, p. 459, 1915.

expanded or thickened. A small but very well-marked anal sulcus at the upper apertural angle. Operculum not found.

*Measurements*

| Altitude mm. | Diameter mm. |
|---|---|
| 5. | 3.1 (Type) |
| 5.5 | 3.7 |
| 4.5 | 2.9 |
| 5.8 | 3.6 |

*Type*: No. 511, Mus. Cal. Acad. Sci.

*Type-locality*: 415, Upper Miocene of Sonoma County, California.

The genus Nematurella Sandberger, or its allies, Stenothyra Benson, and Euchilus Sandberger, have apparently not been heretofore detected in America but are represented in European Tertiary by several species. There is little doubt, however, that the form with which we are dealing, as well as the much larger San Pablo species belongs therein. The latter was described as "*Littorina pittsburgensis*" by Dr. Clark,[9] but his figure shows the decided sulcus in the upper angle. That species is 12 mm. in altitude, has a proportionately lower spire and no angulation on the body whorl.

### 4. **Goniobasis rodeoensis** (Clark)

Plate I, figure 3

*Cerithium rodeoensis* Clark, Univ. Calif. Pub. Bull. Dept. Geol., Vol. VIII, No. 22, p. 491, Pl. 69, figs. 1-10., 1915.

*Bittium rodeoensis* (Clark), Dickerson, Proc. Calif. Acad. Sci., 4th ser., Vol. XI, p. 542, 1922.

This excessively variable species is common at localities 415 and 417. At the former it is associated with Corbicula and Mya, supposedly of brackish water habitat, while at the latter it is found with such strictly freshwater forms as Planorbis and Lymnæa. The only difference which could be made out in the shells from the two localities is the slightly greater attenuation of those from 415. This is visible in the figures given where *a*, *b*, *c*, and *d*, are from 415 while *e* and *f* are from 417. This difference, however, does not seem to be sufficient to warrant the separation of the forms specifically since, in a series of measurements, it is found to

[9]Univ. Calif. Pub., Bull Dept. Geol., Vol. 8, No. 22, p. 484, Pl. 65, fig. 22, 1915.

amount to only about half a millimeter. Certain forms of sculpture can be matched exactly at the two localities although more variations occur at locality 415.

*Measurements*

| Locality 415 | | Locality 417 | |
|---|---|---|---|
| Altitude mm. | Diameter mm. | Altitude mm. | Diameter mm. |
| 13. | 4.8 | 12.5 | 4.8 |
| 13.5 | 4. | 13.5 | 5. |
| 11. | 4.4 | 16.4 | 6.2 |
| 12.5 | 4.1 | 11. | 5. |
| .... | 5. | 12. | 5.2 |
| 9.5 | 4. | 13.2 | 4.5 |
| 11.5 | 4.3 | | |

While variation in sculpture is great, in no specimen is there an approach to the Pliocene, *G. kettlemanensis* Arnold.[10] It appears however to be a dwarfed counterpart of *Goniobasis tenera* (Hall)[11] as defined by White.[12] His Wyoming, Colorado and Utah specimens figured, however, show some variations in sculpture which have not been found in the western form and the Rocky Mountain specimens are consistently larger; also, the diameter is greater as compared with the altitude.

### STRICTLY FRESHWATER FORMS

### 5. **Sphærium cynodon** Hanna, new species

Plate I, figures 4, 5, 6

Shell ovate, large and robust, almost equilateral, beaks full and elevated; anterior dorsal margin slightly concave, posterior convex. Right valve with two laterals anterior and two posterior, all about of equal height, dorsal ones placed opposite centers of ventral ones and channels between very deep to accommodate the high blade-like laterals of the left valve; right cardinal single, convex side uppermost, thickened posteriorly; left laterals, one posterior and one anterior, the latter being higher and less elongated than the former; left cardinals two, situated directly beneath the beak, the lower being the larger and having a triangular base.

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[10]Bull. U. S. G. S. 396, p. 99, Pl. XXX, fig. 7, 1909.
[11]Fremont's Rep. Ore. and N. Calif. p. 308, Pl. III, fig. 6, 1845.
[12]3rd Ann. Rep. U. S. Geol. Surv. p. 464, Pl. 31, figs. 1 to 30.

*Measurements*

| Length mm. | Height mm. | Half diameter mm. | |
|---|---|---|---|
| 11. | 9. | 3.5 | (Type l. v.) |
| 11. | 9. | 3.5 | (Type r. v.) |
| 12. | 9.5 | 3.5 | (Freak shell.) |
| 13.5 | 10.5 | 4. | (r. v.) |
| 13.4 | 10.5 | 4. | (l. v.) |

*Type*: No. 514, Mus. Cal. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

The combination of characters found in this species cannot be matched with specimens and descriptions which are available. *S. cooperi* Arnold[13] while having a somewhat similar shape has much lower beaks and the hinge and teeth are very different. It seems closer to that species, however, than to any other which has been adequately figured. The three species described by Hannibal,[14] *S. rodgersi*, *S. catherinæ* and *S. andersonianum*, from California Tertiary deposits were too poorly figured and too briefly described for the specific characters to be made out. Unfortunately, the same is true of some recent species.

### 6. **Pisidium curvatum** Hanna, new species

Plate I, figure 7; Plate II, figures 1, 2, 4

Shell trigonal in shape, beaks high and capped with the embryonic shell in some cases; hinge strongly arched, with the apex much to posterior of center of shell; anterior margin almost straight, posterior gently curved; right valve with two anterior and two posterior laterals, the former the larger, the space between each pair deep, to accept the high pointed laterals of the other valve; dorsal laterals long and narrow, ventrals high and pointed; the single right cardinal is anterior to the beak, high, bow-shaped, and placed symmetrically on the hinge; from its posterior dorsal border a well-marked ridge extends posteriorly in a straight line toward the hinge margin but does not meet it; this marks the lower border of the ligament attachment.

Left valve with single, high pointed laterals, anterior and posterior; cardinal teeth two, the anterior the larger and with tri-

[13]Bull. 396, U. S. Geol. Surv., p. 94, Pl. XXX, figs. 2, 2a, 1909.
[14]Proc. Mal. Soc. Lon. Vol. X, p. 131-132, Pl. VI, fig. 11, Pl. VII, figs. 20, 21, 1912.

angular base; posterior cardinal a low lamella extending backward parallel to a counterpart of the ridge mentioned as bounding the lower ligament attachment in the other valve.

*Measurements*

| Length mm. | Height mm. |
|---|---|
| 4.2 | 3.7 (Type r. v.) |
| 4.4 | 3.9 (Type l. v.) |

*Type*: No. 515, Mus. Cal. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

Ten specimens were found at the type locality. In shape the species is very much like the west American recent *P. compressum* Prime. The teeth in this, however, are much lower in specimens which are available for comparison; and the lower boundary of the ligament attachment area is marked by a bow-shaped ridge which meets the shell margin and has the convex side downward. A few other differences can be seen in the shells but it is believed these will be sufficient for segregation.

*P. curvatum* appears to be much like *P. supinum* Schmidt of Europe. The latter, however, has higher beaks if we may judge by Woodward's figures,[15] and the hinge is heavier. The dorsal laterals are located above the centers of the ventrals in *supinum*, whereas they are almost directly opposite in *curvatum*.

Another name is added with reluctance to the long list in this genus, since synonyms must already be abundant. But a great many of the American forms have been described without illustrations, so that it is practically impossible to make identifications therefrom, while many of those described years ago and illustrated by wood cuts are but little better.

### 7. **Lymnæa petaluma** Hanna, new species

Plate II, figures 3, 7

Shell imperforate; spire elevated, conical, consisting of about four whorls which are but little rounded; surface malleated and marked with coarse growth lines on the body whorl; upper whorls irregularly marked with growth ridges. Columellar wall thickened and the callous deposit over the parietal wall broadened out; aperture not expanded. Interior of shell iridescent.

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[16]Cat. Brit. Sp. Pis. Pl. XXVI, fig. 7, 1913.

Length of type, 22.5 mm; diameter, 14.5 mm. Original full dimensions of same specimen about 25 mm. by 16 mm.

*Type*: No. 516, Mus. Cal. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

This species belongs to the subgenus Bulimnæa, and is closely related to the living American species, *L. megasoma*, but has fewer whorls; whorls flatter on the spire, the columella more thickened and the callus over the parietal wall broader. The type has the spire broken away but a young individual is figured to show the characters.

The collection contains about 30 specimens from locality 417. All are more or less crushed and broken. Some were considerably larger than the type, but it is the most perfect.

### 8. **Lymnæa filocosta** Hanna, new species

Plate II, figure 5

Shell small, ovate, whorls 3½, very convex; sutures deep; surface marked with fine even, close-set longitudinal riblets; spiral sculpture absent; aperture ovate; peristome thickened within; columella straight and reflected over the narrow umbilicus. Altitude, 3.5 mm.; diameter, 2.1 mm.

*Type*: No. 518, Mus. Cal. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

The species is similar in size to the recent *L. dalli* Baker,[16] but that species has more whorls and they are shouldered; also the growth lines are uneven and inclined to be coarse. Four other specimens of *filocosta* from the type-locality show but little variation. *Lymnæa alamosensis* Arnold[17] from the Pliocene of Los Alamos Valley, Santa Barbara County, California, is of undoubted close relationship, but it is larger, (six mm.) is more slender, and the whorls are less rounded.

### 9. **Lymnæa kerri** Hanna, new species

Plate II, figure 6

Shell long and slender, conical, apex slightly obtuse; composed of a little over four whorls which are only slightly rounded. Surface

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[16]Naut. XX, p. 125, 1907. Monog. Lym., p. 251, Pl. XXX, figs. 13-18, 1911.

[17]Bull. 322, U. S. Geol. Surv., p. 59, pl. XXI, figs. 6, 7, 1907. (No description.) Arnold Smith. Misc. Coll., Vol. L Quarterly Issue Vol. IV, pt. 4, p. 430, pl. LIV, figs. 6, 7, 1908. Baker, Mon. Lym. North Am., Chicago Acad. Sci., Spec. Pub. No. 3, p. 104, pl. XVII, figs. 9, 10, 1911.

glossy, marked by delicate lines of growth crossed by minute spiral striæ, only visible under considerable magnification; aperture ovate; peristome thin; columella swollen inside, broadly reflected, partially concealing the umbilicus when viewed from directly in front. Altitude, 4.2 mm.; diameter, 2.3 mm.

*Type*: No. 519, Mus. Calif. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

Only one specimen was found in the material collected. It is a perfect shell, although broken and slightly displaced in being mended. Its glossy surface with spiral sculpture seems to indicate that we are here dealing with a relative of *Lymnæa(?) limatula*, but sufficient material is not available to definitely decide the point. The species apparently does not approach closely any living American Lymnæa.

Named for Mr. J. B. Kerr who collected the material.

### 10. **Lymnæa** (?) **limatula Hanna,** new species

Plate II, figures 8, 9

Shell acutely conical, smooth and glossy, highly polished. Whorls, 5½, very slightly rounded; sutures weak; surface marked with fine growth lines and fine spiral striæ which, under high magnification, appear as a satiny sheen; aperture long and narrow, acutely angular above; columella straight, reflected over the very narrow umbilical perforation; peristome thin. Altitude, 9.9 mm.; diameter, 4.5 mm.; length of aperture, 5 mm.

*Type*: No. 520, Mus. Cal. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

This shell may not be a Lymnæa. Its characters suggest strongly such genera as Ferrusacia and Obeliscus of the Achatinidæ, but the type is a little too poorly preserved to warrant its separation as a distinct genus, or the placing of it in a group hitherto unknown in North America. Therefore, until better specimens are found, it seems best that it be retained under Lymnæa with a question.

One other adult shell besides the type was found but it also has been badly crushed. There are also eight small shells from the same locality which have the same form of sculpture and are

believed to be young of this species. One of them is figured in order to show the character of shell at that age. It will be seen that the aperture of this differs materially from that of the type. The broken columella of the type, however, gives a false impression of the shape as it actually existed. The young shell shows a heavy callus over the parietal wall; this has apparently been lost in the type specimen.

The species bears a suspicious resemblance to the fossil described as *Bulimus limnæiformis* Meek & Hayden,[18] and which was later placed in the genus of land mollusks, Thaumastus Albers, by Meek.[19] It came from the Laramie Group of the upper Missouri River.

### 11. **Lymnæa contracosta** (?) Cooper

At locality 418 several specimens of a large Lymnæa were collected. They appear very much like the figures of *L. contracosta*,[20] a very imperfectly known form. All of the specimens are too badly crushed for a positive identification to be made.

### 12. **Physa** sp.?

At locality 418 there was collected a single young shell of a Physa which cannot be identified specifically. The absence of this well known genus in the other deposits of Sonoma County is very noteworthy.

### 13. **Planorbis pleiopleurus** Hanna, new species

Plate III, figures 1, 2, 3

Shell widely umbilicate, discoidal, spire about equally depressed above and below; surface ribbed both above and below, the ribs varying slightly in height and distance apart; periphery obtusely angulated; whorls slightly more than three; last half of last whorl depressed slightly below the one preceding but the aperture is not abruptly deflected. Altitude, 1.2 mm.; diameter, 3.2 mm.

*Type*: No. 521, Mus. Cal. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

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[18]Proc. Acad. Nat. Sci. Phila. Vol. VIII, p. 118, 1856.
[19]U. S. G. S. Terr. Vol. IX, p. 553, Pl. 44, fig. 8, a, b, c, d, 1876.
[20]Cooper, Proc. Calif. Acad. Sci., ii, Vol. IV, Pl. XIV, fig. 12, 1894. Baker, Mon. Lym. Pl. XVII, fig. 12, 1911.

This minute form belongs to the *P. parvus* group of living species. The coarse sculpture and obtusely angulated periphery distinguish it. Eight specimens were collected at the type locality. Almost all are perfect and show very little variation in size, shape and sculpture.

14. **Planorbis plenus** Hanna, new species

Plate III, figures 4, 5, 6

Shell widely umbilicate, discoidal, last whorl depressed, making the width of the spire less below than above; surface evenly sculptured with delicate striæ above and below; whorls 3½, almost circular in cross section.

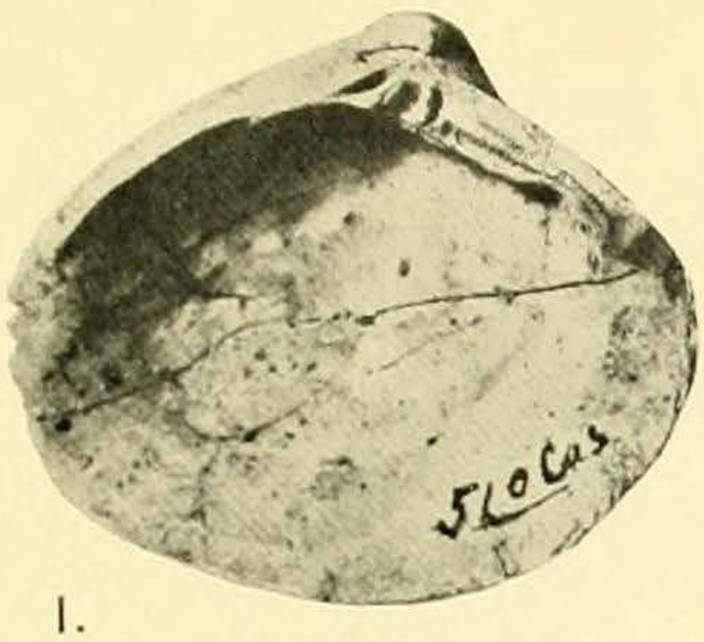
*Measurements*

| Altitude mm. | Diameter mm. |
|---|---|
| 3.5 | 7.5 (Type) |
| 3.7 | 8.5 |
| 3. | 7. |

*Type*: No. 522, Mus. Cal. Acad. Sci.

*Type-locality*: 417, Upper Miocene of Sonoma County, California.

The 25 specimens in the collection from the type-locality show little variation. In the type there is an enlargement near the last of the last whorl, probably indicative of a period of rest during development; it is absent in some senile individuals which contain over four whorls. The species appears unique among United States planorbs, although there is a superficial resemblance to the toothed genus, Segmentina. Its closest relative seems to be *Planorbis cornu* Bourg., of European Upper Miocene.



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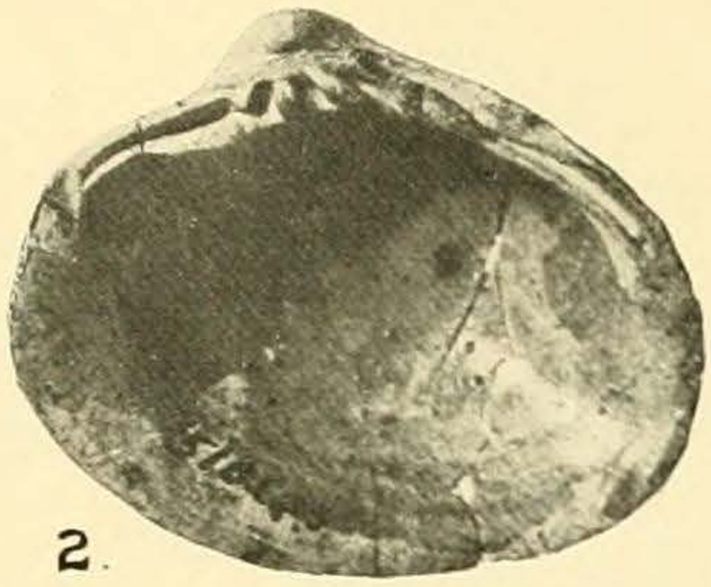

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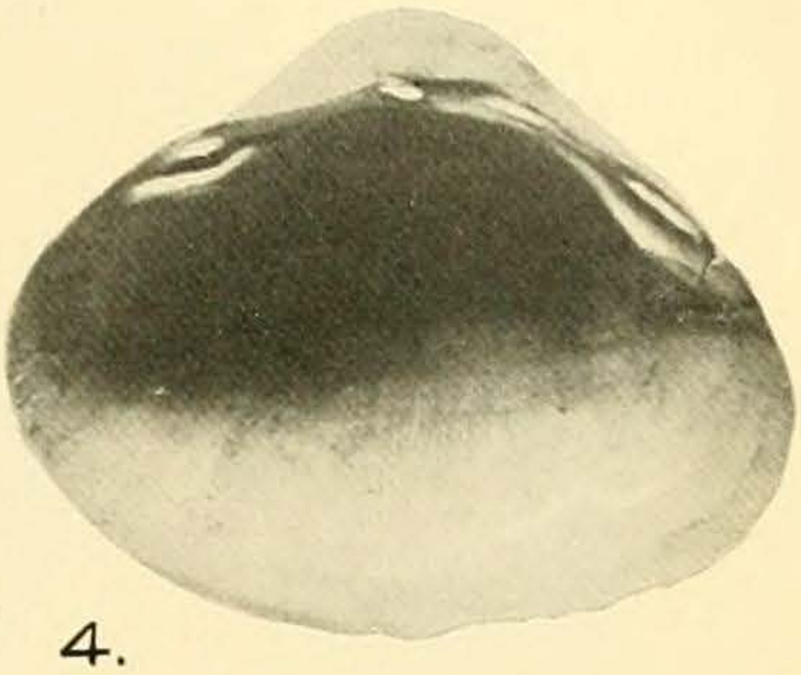

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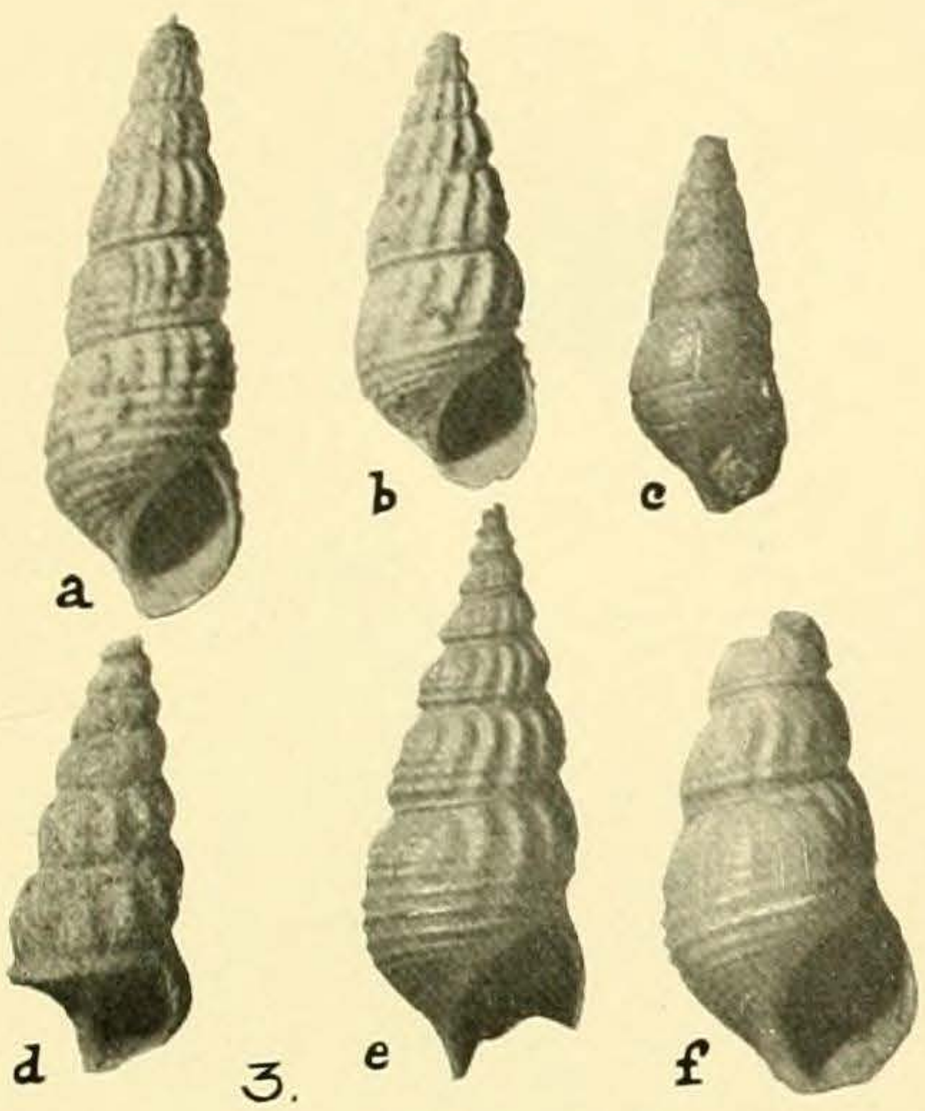

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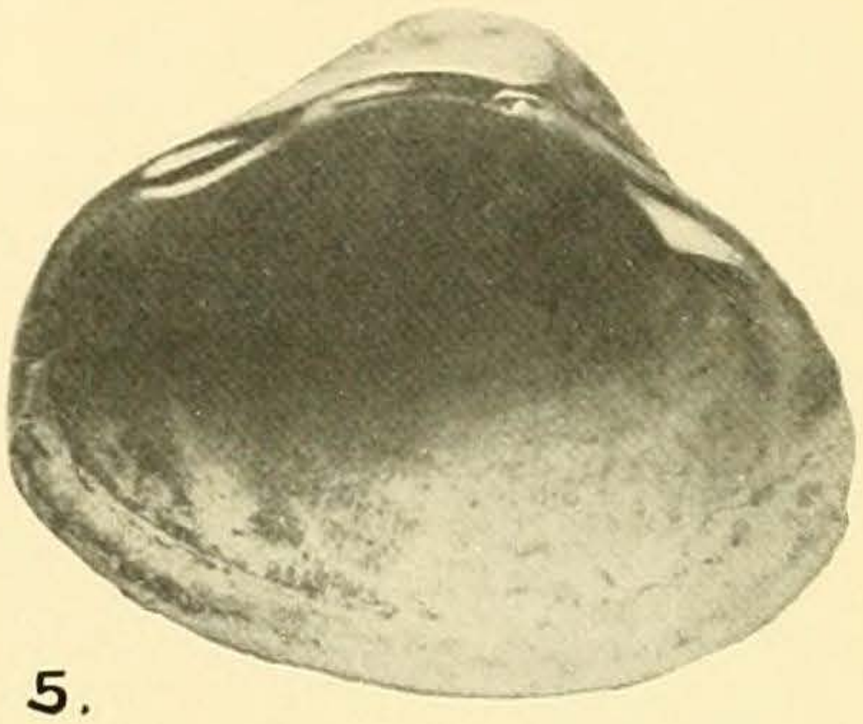

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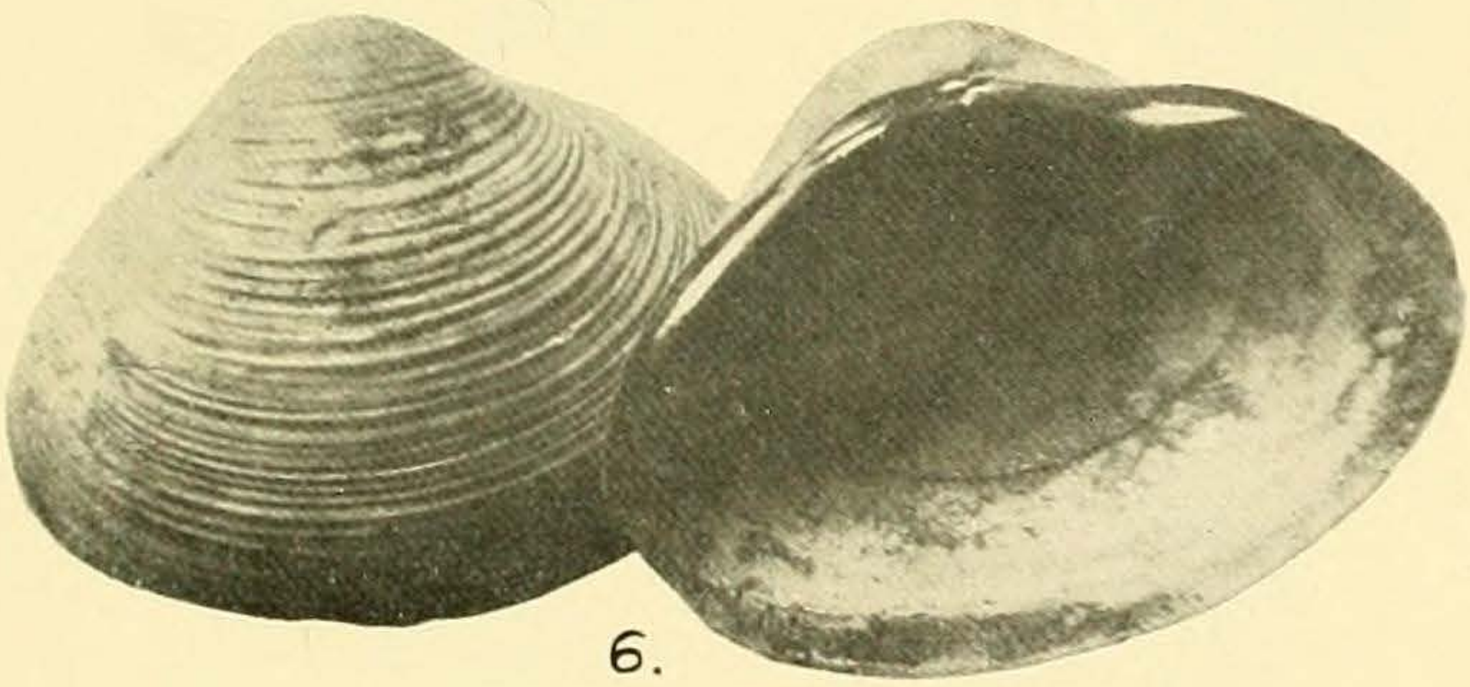

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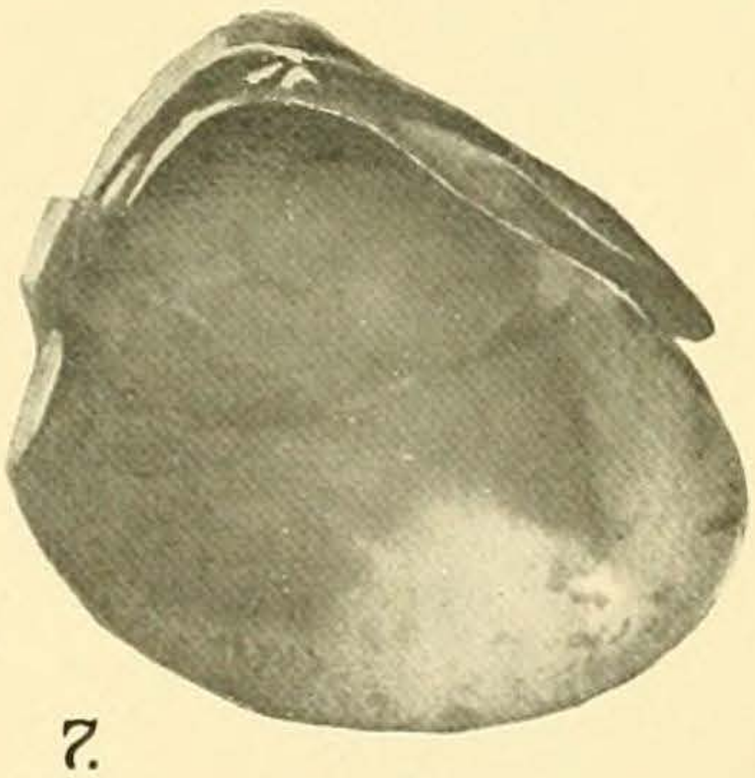

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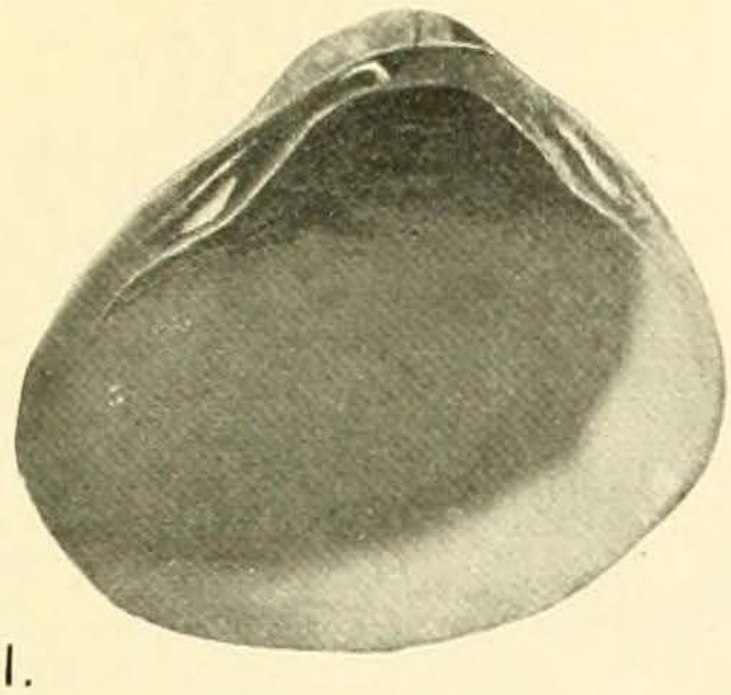
Fig. 1. *Corbicula gabbiana* Henderson, inside of right valve, X 1; Fig. 2. *Corbicula gabbiana* Henderson, inside of left valve, X 1; Fig. 3. *Goniobasis rodeoensis* (Clark), *a*, *b*, *c*, *d*, various forms of sculpture from locality 415, *e*, *f*, shells from locality 417, X 3; Fig. 4. *Sphærium cynodon*, new species, type, interior of right valve, X 4; Fig. 5. *Sphærium cynodon*, new species, interior of left valve of freak shell, X 4; Fig. 6. *Sphærium cynodon*, new species, type, interior of left valve and exterior of right valve, X 4; Fig. 7. *Pisidium curvatum*, new species, type, interior of left valve, X 10.



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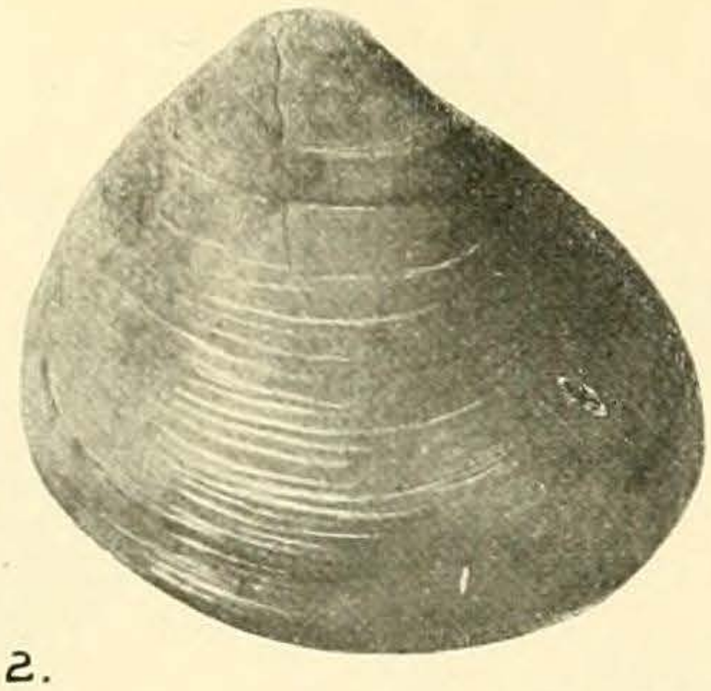

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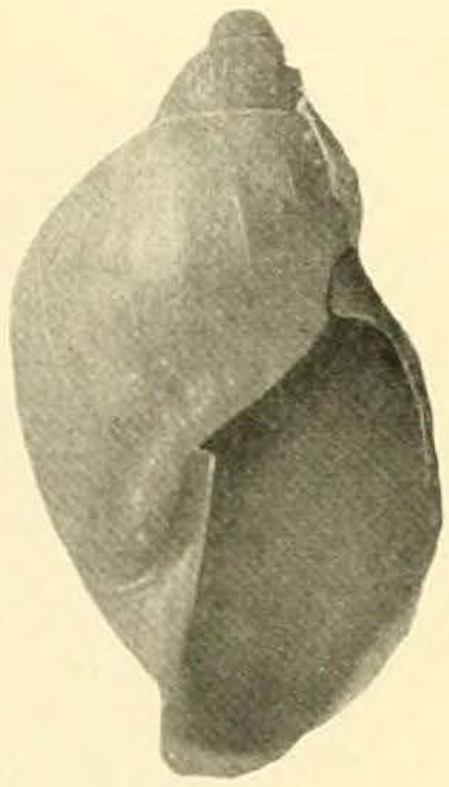

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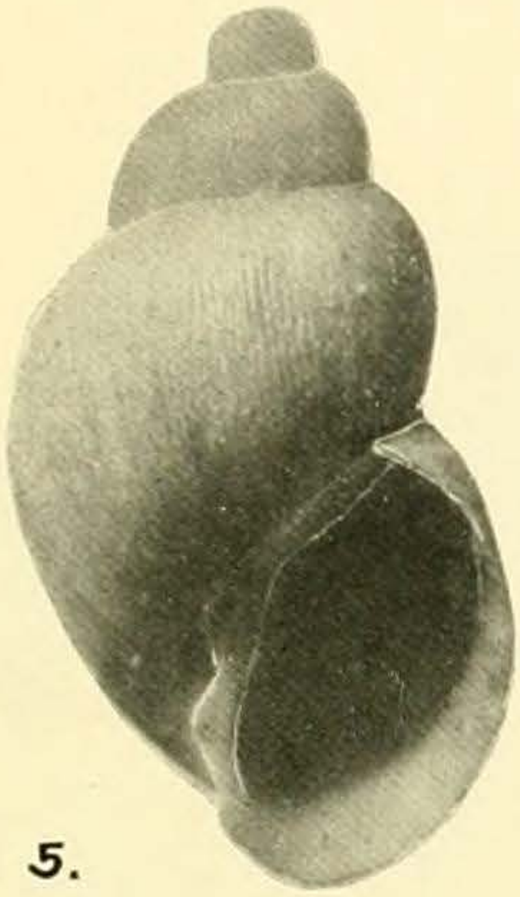

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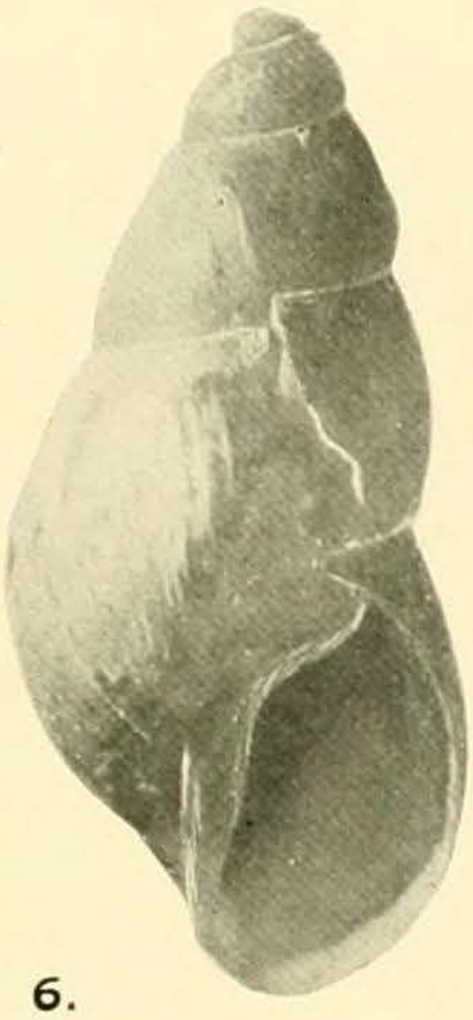

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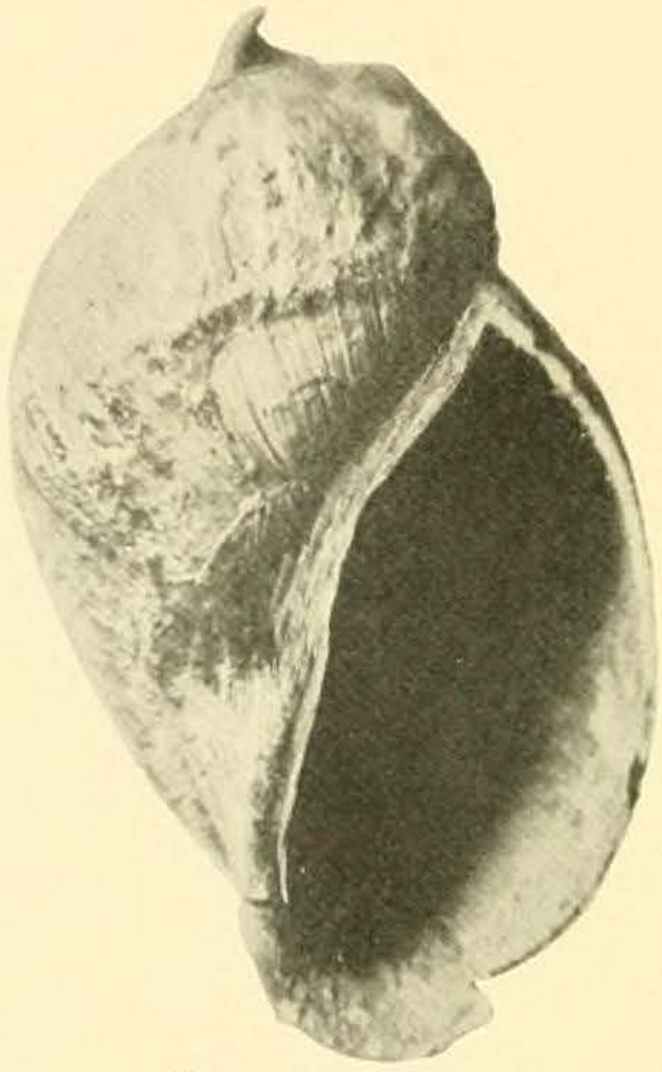

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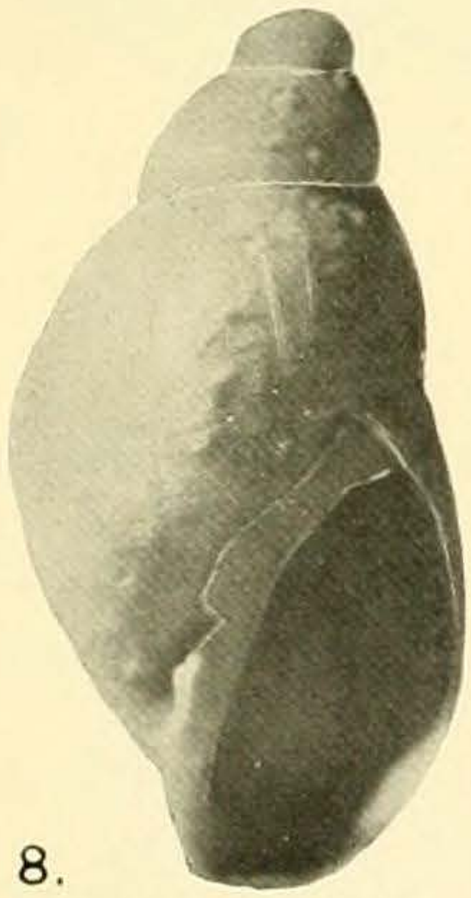

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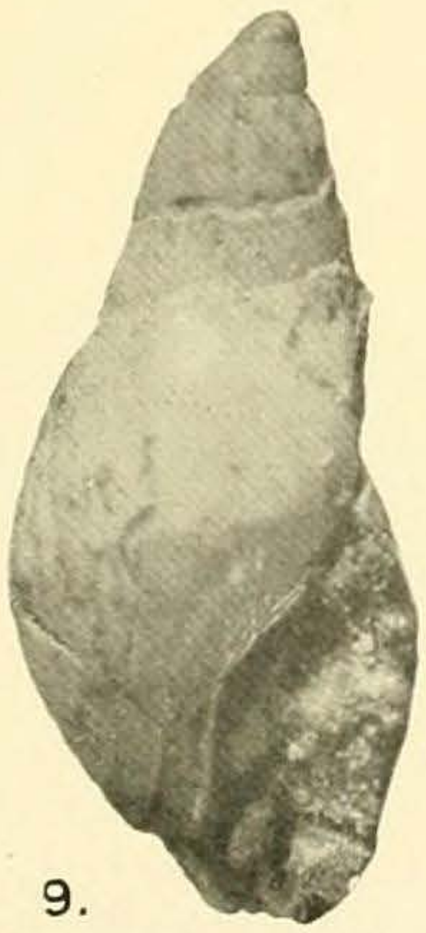

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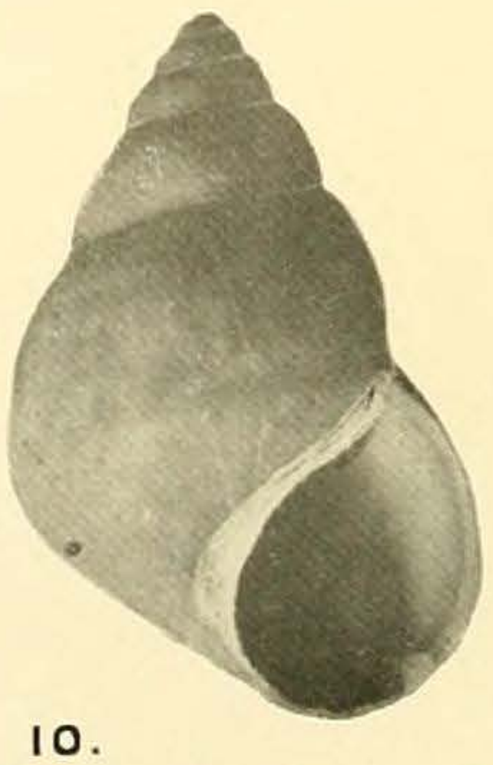
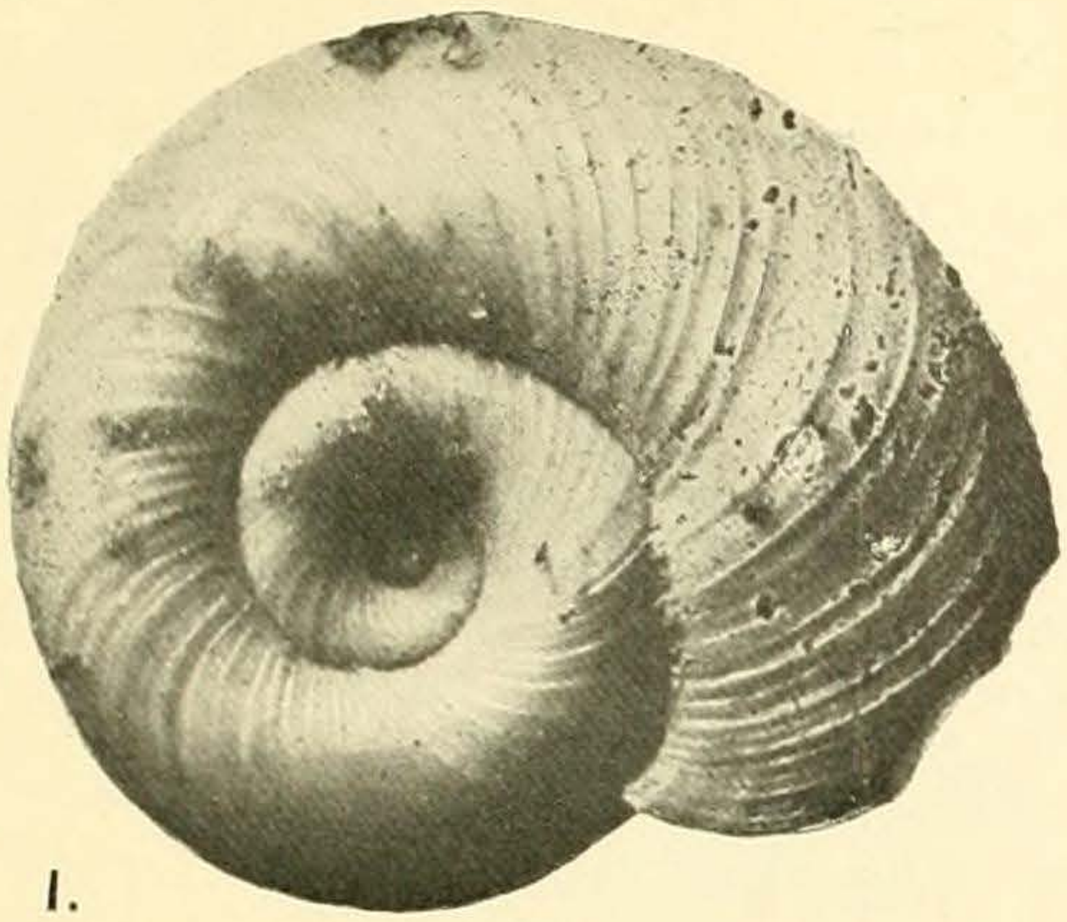


10.

Fig. 1. *Pisidium curvatum*, new species, type, interior of right valve, X 10; Fig. 2. *Pisidium curvatum*, new species, type, exterior of right valve, X 10; Fig. 3. *Lymnæa petaluma*, new species, young shell, X 5; Fig. 4. *Pisidium curvatum*, new species, type, vertical view, X 10; Fig. 5. *Lymnæa filocosta*, new species, type, X 15; Fig. 6. *Lymnæa kerri*, new species, type, X 15; Fig. 7. *Lymnæa petaluma*, new species, type, X 3; Fig. 8. *Lymnæa* (?) *limatula*, new species, young shell, X 15; Fig. 9. *Lymnæa* (?) *limatula*, new species, type, X 5; Fig. 10. *Nematurella euzona*, new species, type, X 8.5.



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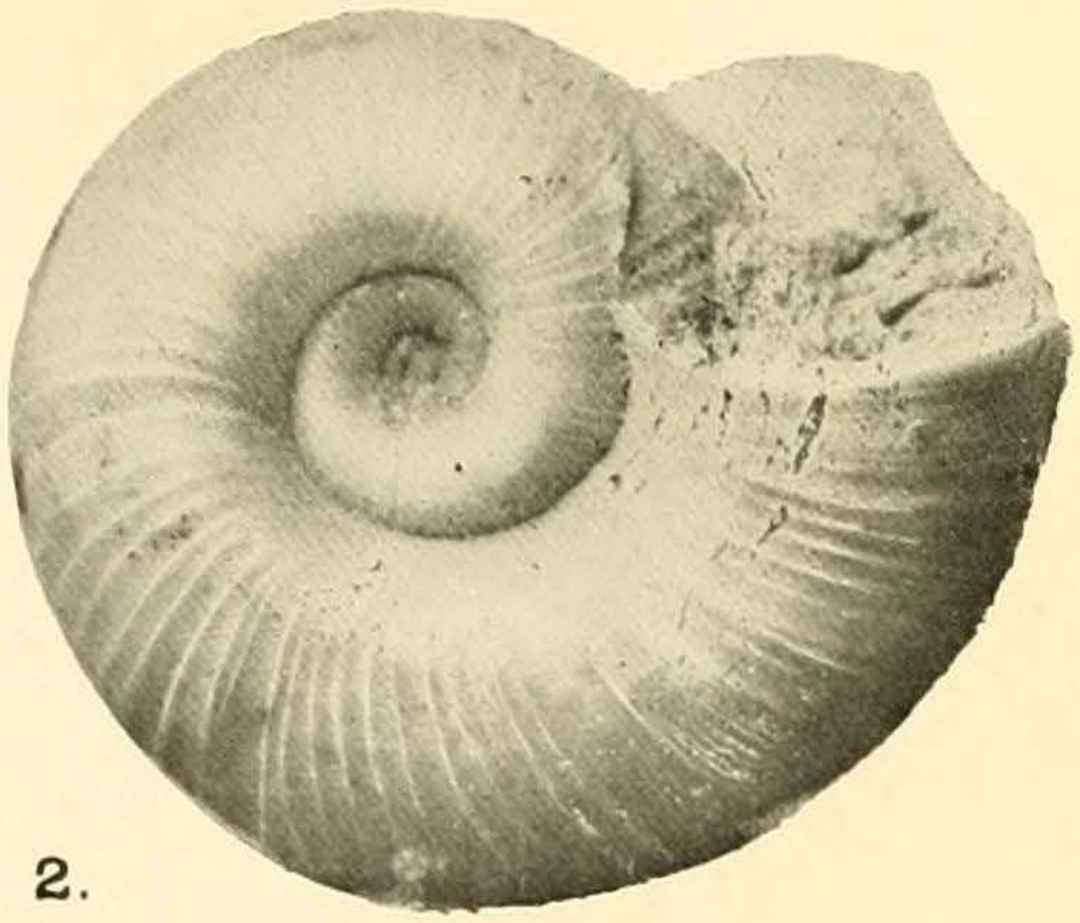

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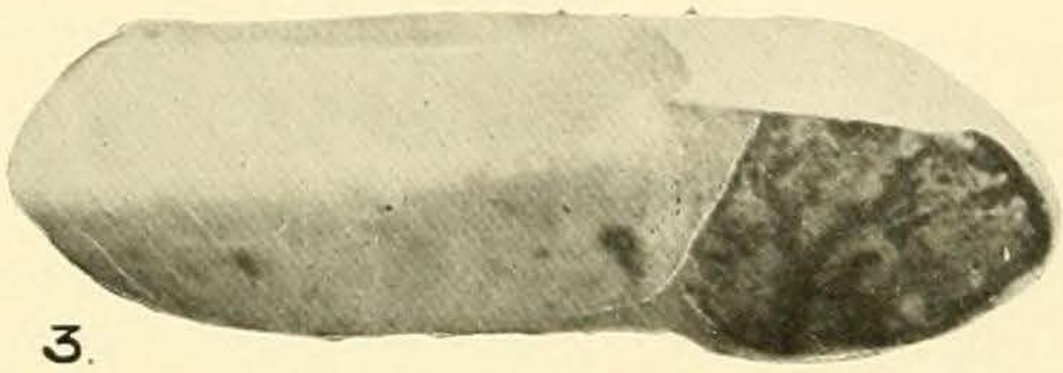

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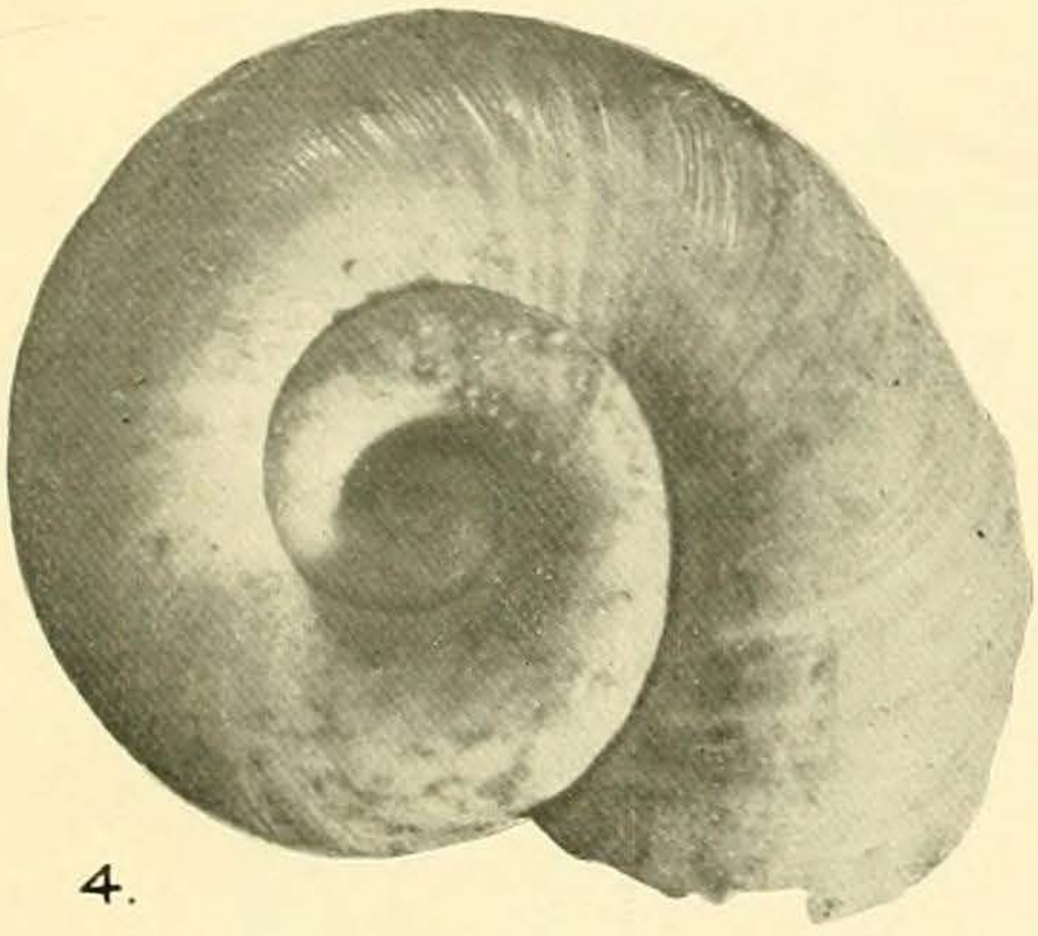

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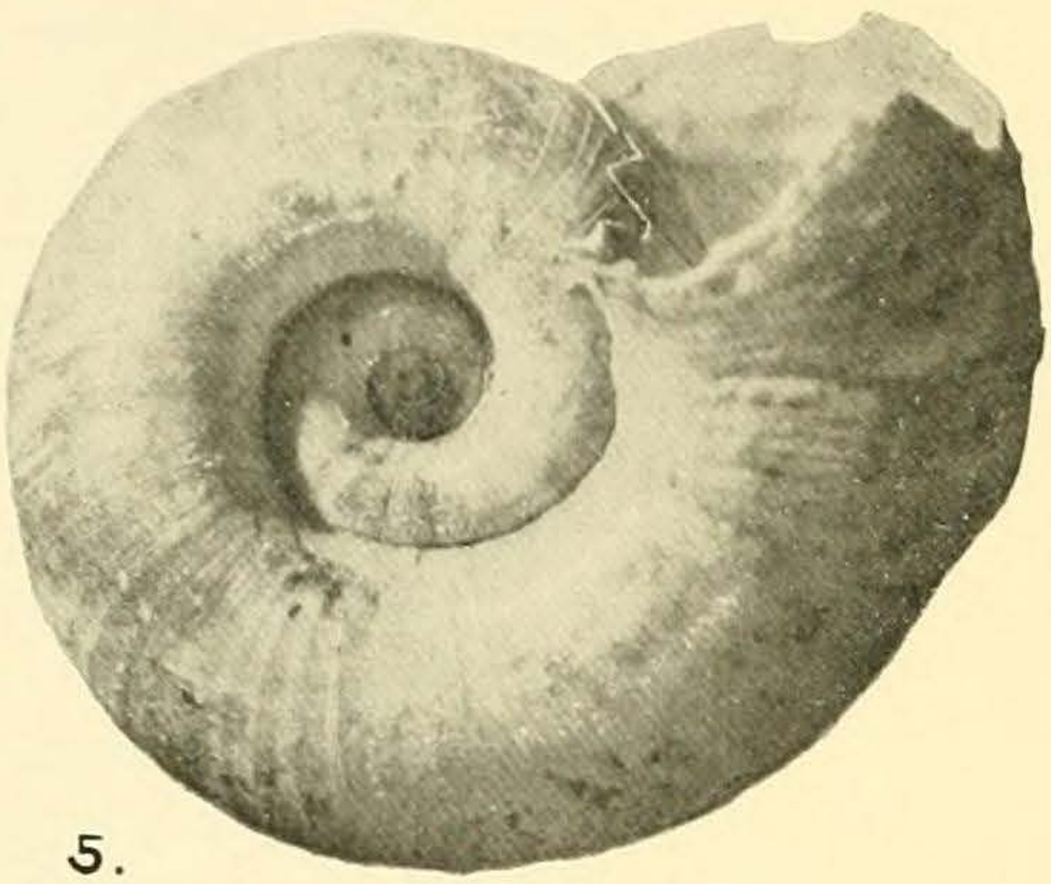

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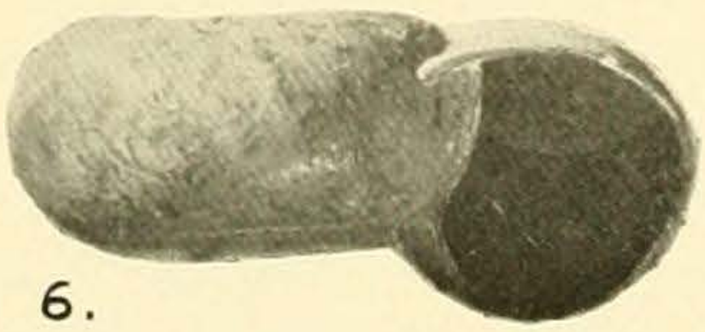

6.

Fig. 1. *Planorbis pleiopleurus*, new species, type, X 15; Fig. 2. *Planorbis pleiopleurus*, new species, type, X 15; Fig. 3. *Planorbis pleiopleurus*, new species, type, X 15; Fig. 4. *Planorbis plenus*, new species, type, X 8. 5; Fig. 5. *Planorbis plenus*, new species, type, X 8.5; Fig. 6. *Planorbis plenus*, new species, type, X 5.

# PROCEEDINGS

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