

photographed in Fig. 423 e to h, and Fig. 418 a, represents specimens collected in abundance near the Delaware River below Plum Point, near Riverton, New Jersey. Fig. 418 b is a similar but smaller shell from Audubon, New Jersey.

Living animals, collected May 19, are figured. Fig. 418 a. The animal in active condition is decidedly larger than the shell, and incapable of complete retraction within it. On a ground-color of very pale gray or faintly yellowish it is tessellated with squarish spots of black or of gray punctate with black. Sole gray. Tentacles marked with a black streak, which extends back to the shell more or less distinctly. Mantle, when the shell is removed, varies from black (except for a light streak over the kidney) to pale flesh tinted, with several gray spots near the edge, and the principal veins outlined with gray. Under the lens the gray tint is seen to be produced by minute black dots, and the black by the coalescence of innumerable dots. There is wide variation in the intensity of the markings, but not much in the pattern. The cool color-tones are a little relieved under the shell, which vicariously lends its yellow tint to the light part of the mantle.

The seminal vesicle and hermaphrodite duct, and the penes of three Plum Point specimens are drawn in Fig. 416 E, e-e₂. The hermaphrodite duct is intensely black, the gray talon a single simple follicle. The rather slender penis is somewhat wider in the posterior half, enclosed in the usual very thin sheath. It is cylindric, in some specimens it becomes broad and thin-walled, with numerous small ridges internally sometimes showing through the wall, and bearing a very short, rather wide appendix (Fig. 416 e, ap). From this point the epiphallus (Fig. e₁, ep) ascends, describes a coil of one whorl, and passes into the vas deferens. In other examples (Fig. 416 e, e₂) the epiphallus is folded or coiled somewhat differently. Other organs about as in specimens from Chestertown, Md. Jaw, Fig. 414:11.

It will be seen that this snail differs from that of Maryland by having a longer, coiled epiphallus, by the simple talon and the deeply pigmented hermaphrodite duct: but as the genitalia show variation among the Plum Point specimens, I do not regard the differences as specifically important. In a specimen from Audubon, N. J., the talon is simple, as in the typical form, and the hermaphrodite duct is black.

In a specimen from Chestertown, Maryland Fig. 416 d, d, the mantle has pale gray streaks near the edge, as in some Riverton, N. J., specimens, and the head is similarly marked. Anatomically there is a general resemblance to Floridan *O. effusa*, but the penis (Fig. 416 d) is recurved near the summit, and bears a short appendix (ap), beyond which the epiphallus descends, recedes and then ascends to the summit of the penial sheath where it passes into the vas deferens. The broad and rather short talon has a lateral process, and is sparsely flecked with black pigment. The hermaphrodite duct also is rather sparsely pigmented. This form differs from the New Jersey (Riverton and Audubon) chiefly by having a shorter, straight epiphallus, but only a single one was examined.

Oxyloma salleana (Pfeiffer)

Fig. 424.

Succinea salleana Pfeiffer, 1849, Proc. Zool. Soc. London, p. 133 (New Orleans); Mon. Hel. Viv., 3; 16; Conchyl. Cab., p. 49, pl. 5, figs. 7, 8.—W. G. Binney, 1878, Terr. Moll., 5:429, fig. 306, pl. x, fig. N (teeth); 1885, Man. Amer. L. Sh., p. 443, fig. 488.—Frierson, 1900, Nautilus, 14:68.—F. C. Baker, 1939, Fieldbook Illinois Land Snails, p. 127.

“The shell is depressed ovate, very thin, weakly striate and marked with irregular spiral lines; pellucid, corneous whitish. Spire very short, subpapillate. Whorls $2\frac{1}{2}$, the penult convex, the last exceeding three-fourths of the length. Columella somewhat calloused, straightly receding. Aperture subparallel with the axis, angulate, oval; peristome submarginate, the right margin slightly arcuate. Length 19 mm., diameter 10 mm., height 7 mm., aperture 16 mm., long, 9 mm. wide below the middle.” (Pfeiffer.)



FIG. 424. *Oxyloma salleana*. a, New Orleans; b, Crève Coeur Lake, Missouri; c, Frierson, Louisiana; d, Samburg, Tennessee.

Length 19.3 mm., diameter 10.7 mm., length aperture 16 mm.
New Orleans.

Length 16.7 mm., diameter 8 mm., length aperture 12.8 mm.
Frierson.

Length 14.4 mm., diameter 7.4 mm., length aperture 11.8 mm.
Frierson.

Length 19.8 mm., diameter 10 mm., length aperture 15.7 mm.
Samburg.

Length 17.7 mm., diameter 9.7 mm., length aperture 14.5 mm.
Samburg.

LOUISIANA: New Orleans (Salié, Hemphill, Pilsbry); Bayou Pierre and Frierson, De Soto Parish (L. S. Frierson). TENNESSEE: near Memphis, Shelby Co., and Samburg, Obion Co. (S. N. Rhoads). MISSOURI: margin of Crève Coeur Lake, St. Louis Co. (Leslie Hubricht). ILLINOIS: Pittsburg Lake, near East Saint Louis, St. Clair Co., and Hill Lake, 3 mi. northwest of Columbia, Monroe Co. (Leslie Hubricht).

The surface is often distinctly and rather coarsely wrinkled on the back of the last whorl. The spiral impressions mentioned by Pfeiffer are variable, often hardly to be seen.

The smaller number of whorls ($2\frac{1}{2}$), as well as the relatively shorter spire, separate this species from all forms of *S. retusa*. It is very much like *S.*

effusa, but the spire is slightly longer in *salleana*. It appears to be restricted to the lower Mississippi valley north to St. Louis. L. S. Frierson found it living deep in the tussocks of sedges growing on the Great Raft of the Red River, Louisiana. It is straw-yellow colored in life.

The specimens dissected were from New Orleans, No. 60931 ANSP. The genitalia of *O. salleana* (Fig. 422 d) are much like those of *O. effusa*, both having the penis and epiphallus nearly straight. Such differences as the figures show appear to be of little importance, though they should be tested by dissection of further material. In several *O. salleana* of the single lot opened, the spermatheca was extremely large as figured, and the seminal vesicle is larger than in the *effusa* compared. The hermaphrodite duct is very dark but not black. Seminal vesicle black, but both of these features may be related to sexual activity. Jaw, Fig. 414:13.

Oxyloma sanibelensis (Rehder)

Fig. 425.

Succinea sanibelensis Rehder, 1933, Nautilus, 47:20. pl. 3, fig. 4.

"Shell elongate, slender for the genus, with an acute spire; glossy, whitish yellow or straw-yellow in color, the shells with the former color being quite thin and fragile, while those of a straw-yellow color are somewhat less fragile. Whorls $3\frac{3}{4}$ to 4, generally 4, only slightly convex, so that the sides of the shell above the periphery of the last whorl seem almost flat; suture moderately deep. Sculpture consists of minute growth lines, and fine, low, irregular wrinkles. Aperture narrowly ovate, practically vertical, and almost symmetrical.

"Length 14.4 mm., breadth 7.3 mm., length of aperture 9.6 mm., holotype. 16.3 mm., 7.9 mm., 10.4 mm., paratype. 15.0 mm., 6.8 mm., 9.5 mm., paratype." (Rehder.)



Fig. 425. *Succinea sanibelensis*. a, southeastern Florida; b, Sanibel Island; c, Boynton; d, Long Pine Key; all actual size. e, reduced copy of type, about $\times 1\frac{1}{3}$.

FLORIDA: Sanibel Island, Lee County, Type: M.C.Z. No. 59645, collected by W. F. Clapp in 1911. Paratypes are in the U.S.N.M. No. 424706, and A.N.S.P. 163082. Also sawgrass swamps, southeastern Florida, large, straw-yellow specimens; in marl dredged from channel to Lake Worth, through Boynton, Palm Beach County (P. L. McGinty); near Coconut Grove (Morgan Hebard); Long Pine Key (Pilsbry).

"This form can not be mistaken, after a little study, for any other species. *S. retusa* has practically always a much shorter spire and longer aperture. *S. luteola* has a more broadly ovate aperture, due to the fact that typically the columella makes a more or less definite angle with the parietal

wall. *S. sanibelensis* has also some slight resemblance in color and texture to *S. concordialis*, but here again the more flattened whorls give *sanibelensis* a more slender appearance." (Rehder.)

Specimens from "southeastern Florida" (Fig. 425 a) measure up to 19.3 mm. long, and vary in size of aperture. Two measure:

Length 18.3 mm., diam. 9 mm., aperture 12.2 mm.; barely 4 whorls.

Length 17.6 mm., diam. 7.4 mm., aperture 11 mm.; barely 4 whorls.

Fossil specimens from the channel at Boynton (Fig. 425 c) are relatively slender with small aperture, three measuring:

Length 18.1 mm., diam. 8.3 mm., aperture 11 mm.; 4 whorls.

Length 17.6 mm., diam. 8 mm., aperture 11 mm.; 4½ whorls.

Length 13.7 mm., diam. 7.1 mm.; 4 whorls.

A specimen from Long Pine Key, in the Everglades, resembles these and measures: length 11.7 mm., diam. 5.4 mm., aperture 6 mm.; 4 whorls. It is translucent whitish, collected alive (Fig. 425 d).

The species is evidently quite variable, especially in color, the absolute size of adults and the relative length of the aperture. It has not been dissected.

***Oxyloma nuttalliana* (Lea)**

Fig. 426 a.

Succinea nuttalliana Lea, 1841, Proc. Amer. Philos. Soc., 2:32; Trans. Amer. Philos. Soc., 9:4 (Oregon, Nuttall); 1867, Jour. Acad. Nat. Sci. Phila. (2), 6:182.—Binney, 1851, Terr. Moll., 2:81, pl. 67a, fig. 4.—W. G. Binney, 1885, Man. Amer. L. Sh., p. 159, fig. 145.—Henderson, 1924, Univ. Colo. Studies, 13:158; 1929, 17:119 (full references).—Cockerell, Nautilus, 6:23.—Elrod, Nautilus, 15:129 (Flathead Lake, Montana).

"Shell long-ovate oblique, transparent, striate; pale yellow; spire rather elevated; sutures impressed; whorls three, somewhat convex; aperture long-ovate. Diameter 0.25, length 0.50 of an inch.

"A very oblique, slender and graceful species allied to *retusa nobis*, but smaller, less elongated, and not having the inferior part, or base quite so retuse. The aperture is about three-fourths the length of the shell." (Lea.)

"It certainly is very different from *ovalis* Gould, being much more slender, more oblique and different in color. In fact, I believe that Dr. Gould has described the same shell as *rusticana*." (Lea, 1867.)

The original locality of *O. nuttalliana* is not known. Thomas Nuttall apparently collected plants on the lower Columbia, as far up river as The Dalles, and also, it is thought, some distance up the Willamette River; but no itinerary of his Oregon visit is known to exist. We are taking Portland as type locality.

Specimens dissected were from Meadow Lake, 14 miles southwest of Spokane, Washington, 147747 A.N.S.P., Fig. 416 F, f. The lung is dark gray. The mantle edge, the foot and head are peppered with black, more or less in spots or stripes. The hermaphrodite duct is less bulky than in most species, and not much convoluted, of a rather dark gray shade. The very small

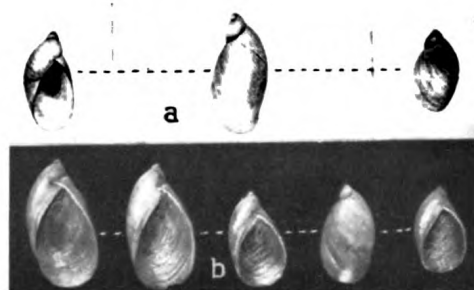


Fig. 426. a, *Oxyloma nuttalliana*, after Binney. b, *Oxyloma nuttalliana chasmodes*, Type and paratypes.

seminal vesicle has a lateral projection and is solid black. The prostate gland is rather large. The penis, enclosed in a thin sheath, is cylindrical, in the upper part coiled, forming one revolution, in the middle of which it gives off a moderately long appendix, which is recurved in the specimen figured (Fig. 416 f), and is longer than in related eastern species. The short, stout part above the appendix, the epiphallus, passes into the vas deferens where it emerges from the penial sheath. The vagina is long. In some individuals it is angular at the point of insertion of the spermathecal duct, but is not noticeably so in others, such as that figured. The large, globular spermatheca is on a tapering duct, which is a little dilated at base.

The line between *O. decampi gouldi* and *O. nuttalliana* Lea is far from distinct. The usual practice has been to call shells of this type east of the continental divide *Succinea ovalis* Gould, or *S. retusa* Lea, and those west of the divide *S. nuttalliana* Lea. From a rather superficial study of the shells, I was disposed to consider *nuttalliana* practically identical with the eastern species. However the single *nuttalliana* dissected, Fig. 416 f, f₁, shows small differences, the appendix being larger, the epiphallus is stouter, and merely curved rather than convoluted in *nuttalliana*. For the present, therefore, *nuttalliana* is left here as a different species. Dall (1905) included all succineas of this type from Manitoba to Alaska in *S. retusa* Lea, restricting *S. nuttalliana* to the region from Vancouver Island to California, but he did not indicate their distinctive features.

***Oxyloma nuttalliana chasmodes* new subspecies**

Fig. 426 b.

The shell is extremely similar to *O. effusa*, being elliptical-ovate with very large and broad aperture, occupying about 85 to 90 per cent of the length, and a short spire of 2½ whorls. It is thin and fragile, pale buff, the last whorl rather convex in the upper part on the left margin (in ventral view), but later becoming more flattened there. In basal view the columella is seen to form a rather broad spiral.

Length 16.5 mm., diameter 9.7 mm., length aperture 14.5 mm. Type.
Length 16.4 mm., diameter 9.1 mm., length aperture 13.4 mm.

CALIFORNIA: Stockton (Wheatley), Type 5609 A.N.S.P.

The aperture is more ample and the spire shorter than in *O. sillimani*, but this Californian race has often been known in collections by that name.

Oxyloma sillimani (Bland)

Fig. 427 a, b, c, d.

Succinea sillimani Bland, 1865. Ann. Lye. Nat. Hist. N. Y., 8:167, fig. 13 (Humboldt Lake, Nevada).

“Shell oblong-ovate, thin, coarsely striate, shining, whitish? spire short, acute; whorls 3, convex; suture impressed; aperture oblique, elongate-oval, angular above, effuse at the base; columella slightly arcuate, with a thread-like thickening above.

“Length 20, diam. $8\frac{1}{2}$, aperture 13 mm. long. 6 wide in the middle; last whorl $17\frac{1}{2}$ mm. long.” (Bland.)

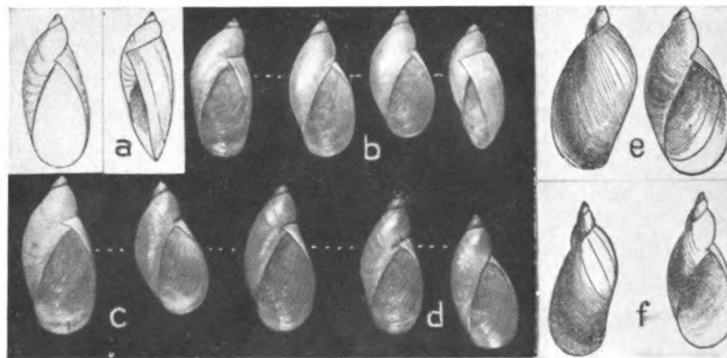


Fig. 427. *Oxyloma sillimani*. a, photographic copies of type figures; b, Humboldt River, Carlin, Nevada; c, d, Meadow Lake near Spokane, Washington. e, *Oxyloma haydeni*, after W. G. Binney. f, *Oxyloma hawkinsi*, after W.G.B.

NEVADA: Humboldt Lake (Type locality); Humboldt River, Carlin, Elko Co. (Rehn & Hebard).

“A single example without epidermis, but fresh in appearance, was found and sent with fluvatile species to C. M. Wheatley by Professor B. Silliman, of Yale College, New Haven, to whom I dedicate the species. This shell in general form may be compared with *S. haydeni* W. G. Binn., to which indeed it is closely allied, but it is more attenuated, the last whorl less tumid and the aperture more narrow. It is distinguishable from *S. hawkinsi* Baird of Brit. Columbia, having one whorl less and a differently formed aperture.” (Bland.)

Whether this form can be held specifically distinct from *O. haydeni* appears doubtful. Bland's original figures are reproduced in Fig. 427 a. Specimens from the western edge of Elko Co., Nevada, are partly very much like Bland's figure but in most of them the last whorl is decidedly more convex, Fig. 427 b.

Length 17 mm., diam. 9.3 mm., aperture 12.2 mm.; $3\frac{1}{2}$ whorls.
 Length 16.4 mm., diam. 8 mm., aperture 11.7 mm.; $3\frac{1}{2}$ whorls.
 Length 15.8 mm., diam. 8.1 mm., aperture 10.5 mm.; $3\frac{1}{2}$ whorls.

Some others are smaller, down to 14 mm. long, 3 whorls. The shells are translucent with very faint yellowish tint.

A small lot from near Meadow Lake, 14 miles from Spokane, Washington (Fig. 427 c, d) seems to contain this species and *O. hawkinsi*, and possibly a larger series would fully connect them. The largest specimen, Fig. 427 c, measures: length 19.8 mm., diam. 9.8, aperture 14 mm.; $3\frac{1}{2}$ whorls. It is very faintly yellowish. The more slender specimens (Fig. 427 d) are ochraceous buff, and appear referable to *O. hawkinsi*.

Oxyloma haydeni (W. G. Binney)

Fig. 427 c.

Succinea haydeni W. G. Binney, 1858, Proc. Acad. Nat. Sci. Phila., 10:114, with var. *minor*, p. 115; 1859, Terr. Moll., 4:40, pl. 79, fig. 1; 1878, Terr. Moll., 5:415, fig. 204; 1885, Man. Amer. L. Sh., p. 196, fig. 203.—Bland, 1865, Ann. Lye. Nat. Hist. of N. Y., 8:168, fig. 14.

"Shell elongate-oval, thin, shining, amber-colored; spire short, acute; whorls 3, convex, the last marked with wrinkles of growth and irregular, heavy, spiral furrows; suture moderate; columella covered lightly with callus, and allowing all the interior whorls to be seen from below to the apex; aperture oblique, oval, five-sevenths the length of the shell, the lower portion of its margin considerably expanded. Length, 21 mm.; diameter, 9 mm.

"Its aperture is nearer that of *S. ovalis* Gould, not Say, but the peristome is much more flexuose, and the upper third of the shell becomes gradually attenuated, so as to give a sharp-pointed appearance, though the spire itself is short. The revolving lines are sometimes continuous over the whole body-whorl, but generally interrupted, or confined to the interstices of the incremental striae or wrinkles. It shares this peculiarity with *S. concordialis* Gould, and *S. lineata*." (W. G. Binney.)

NEBRASKA: between the rivers Loup Fork and L'Eau qui Court (Dr. F. V. Hayden).

"Var. *minor*: length 15 mm. Red River of the North and at Fort Resolution, Great Slave Lake." (W. G. Binney.)

Oxyloma haydeni kanabensis new subspecies

Fig. 428.

The shell is pale ochraceous-buff with salmon color spire, or in smaller specimens these tints are diluted; glossy, with irregular wrinkles of growth. The spire is drawn out, of oblique, convex whorls, the last whorl flattened in the upper part, convex below. The aperture is ovate, shorter than in *O. haydeni* or *sillmani*, the basal margin slightly retracted, not deeply curved. Columella thin, curving into the parietal margin. Parietal callus very thin.

Length 19 mm., diameter 9.3 mm., length aperture 12.3 mm.; $3\frac{1}{2}$ whorls. Type.

Length 14.3 mm., diameter 6.9 mm.; $3\frac{1}{2}$ whorls.

Length 15 mm., diameter 7.3 mm.; $3\frac{1}{2}$ whorls.

UTAH: "The Greens," 6 miles above Kanab, on Kanab Wash, on a wet ledge among moss and cypripediums (J. H. Ferriss, 1909). Type and paratypes 103166 A.N.S.P.

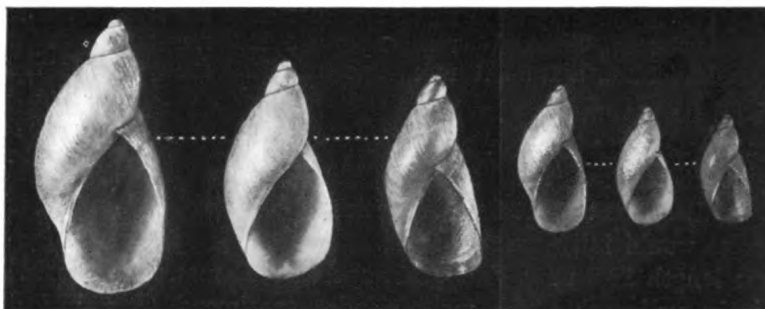


Fig. 428. *Oxytoma haydeni kanabensis*, enlarged and actual size.

The spire is more slender and drawn out than in *O. haydeni*. This form was referred to *S. hawkinsi*, with some doubt, at the time it was found, but according to the original account and figures, that species has 4 whorls, and a more slender body-whorl. This is one of those forms to be considered when the *haydeni*, *hawkinsi*, *sillimani* group can be revised.

The genitalia show some resemblance to *O. nuttalliana*, but this species differs by the short penis, more coiled epiphallus, the twinned seminal vesicles and (in the specimen dissected), the massive hermaphrodite duct.

Mantle over the lung not pigmented. Genitalia, Fig. 419 A. The hermaphrodite duct is very large and swollen in specimens examined, and with the talon, is covered with a thin light gray membrane. The prostate gland is long. Penis short, somewhat swollen above, where it is abruptly bent, gives off a small, tapering appendix and the epiphallus, which makes about one spiral turn (Fig. 419 a). The vagina is nearly as long as the penis.

***Oxytoma hawkinsi* (Baird)**

Fig. 427 f.

Succinea hawkinsi Baird, 1863. Proc. Zool. Soc. London, p. 68; in Lord, 1866. Naturalist in Vancouver Island and British Columbia, 2:362.—Bland, 1865. Ann. Lyc. Nat. Hist. of N. Y., 8:168, fig. 15.—Binney & Bland, 1869, Land and F.-W. Sh., 1:268, fig. 481 (E. of Colville, Wash.)—Hanham, 1899. Nautilus, 13:3 (Carbury, Man.)—Mozley, 1926, Nautilus, 40:59 (Ninette, near Round Lake, Birtle, Manitoba).—Henderson, 1929, Univ. Colo. Studies, 17:119, fig. 86.

Shell lengthened obovate, thin, pellucid, glossy, waved-striate; reddish, pearly within; spire acute; whorls 4, convex, the last about two-thirds the length of the shell; suture impressed; aperture oval, effuse below, length $\frac{3}{4}$ inch, width $\frac{1}{4}$ inch. (Baird.)

BRITISH COLUMBIA: Lake Osoyoos (British North-American Boundary Commission), type in B. M. MANITOBA (Hanham, Mozley). WASHINGTON: Colville (W. G. Binney).

The spire is longer and more slender than in *O. nuttalliana*, and of four whorls. The figures are from Binney & Bland, said to be traced from an unpublished plate prepared to illustrate Baird's paper.

(Named after Lt.-Col. Hawkins, R.E., Commissioner of the B. N.-A. Boundary Commission.)

SUCCINEA Draparnaud

Succinea Draparnaud, 1801, Tableau des Moll. Terr. et Fluv. de France, p. 55.—Herrmannsen, 1848, Ind. Gen. Malac., 2:522, Type *S. putris*. Cf. International Commission Scientific Nomenclature. Op. 94, in Smiths Misc. Coll., 73: no. 4, p. 13, where *Succinea* was placed in the official list, with *Helix putris* L. as type.—Quick, 1933, Proc. Malac. Soc. Lond., 20:295-318; 1934, same Proc., 21:96-103; 1936, Ann. Natal Mus., 8:19-45.—C. R. Boettger, 1939, Zool. Anzeiger, 127:49-64.

Lucena Oken, 1815, Lehrbuch der Naturgeschichte, Zool., 3:311-312, for *L. putris* only.

Tapada Studer, 1820, Naturwiss. Anzeiger der Allgem. Schweiz Ges. Naturwiss., 3ter Jahrg., p. 86. *S. putris* designated type by Lindholm, 1927, p. 329.

Cochlohydra Férussac, 1821, Tableau Syst. Limaçons, p. 30(26), in part.—Pilsbry, 1922, Nautilus, 36:31, Type *Helix putris* L.

Amphibina Hartmann, 1821, in Steinmüller's Neue Alpina, 1:208-247 (cf. also p. 199). *S. putris* designated type by Lindholm, 1927.

Amphibulina Hartmann, 1821, Syst. Erd- u. Süßw. Gasterop. Europas, in Sturm, Fauna Deutschlands, 6 Abth., pp. 42, 55 (error for *Amphibulima* Lamarck; see p. 27).

Neritostoma "Klein" Mörch, 1864, Synops. Moll. Daniae, p. 32, in Videnskab. Meddel. Naturhist. Forening i Kjobenhavn for 1863, p. 294. Not *Neritostoma* H. & A. Adams, 1855, = *Radix* Montf.

Austrosuccinea Iredale, 1937, Australian Zoologist, 8:307, Type *Succinea australis* Fér.⁶⁹

Hydrophyga Lindholm, 1927, Archiv. Molluskenk., 59:330, Type *Succinea oblonga* Drap.

Penis is without an appendix; it is provided with a sheath which may envelop the greater part of the penis, or all or part of the nearly straight, sinuous or looped epiphallus also. The vagina may be rather long or extremely short. The thin, ovate shell of about 2½ to 3 whorls, though variable in degree of elongation, usually has shorter whorls than *Oxyloma*. The jaw has the usual median projection and sometimes some accessory ribs. The marginal teeth of the radula have low, wide basal plates.

Type *S. putris* (L.).

The penial retractor in *Succinea* is attached at or near where the vas deferens passes into the epiphallus, with fibres running also to the distal extremity of the penial sheath. This seems to be substantially the condition also in the European species *S. putris* (L.) and *S. oblonga* Drap., as described and illustrated by Quick (Proc. Malac. Soc. London, 20, last paragraph on p. 306, and plate 24, figs. o and r.). But while in those European species the epiphallus is merely a little sigmoid, in the Americans the epiphallus (sometimes with part of the penis also) is sufficiently redundant to form a loop between the two points of attachment of the retractor muscle, as in Fig. 429.

⁶⁹ T. Iredale has named two genera of Australian *Succineidae*, without characters; such qualities as he mentions being misleading in the case of *Austrosuccinea*, as *S. australis* is not related to *S. arenaria*, as stated, but to *Succinea* s. str., cf. Quick, Annals Natal Mus., 8:30.

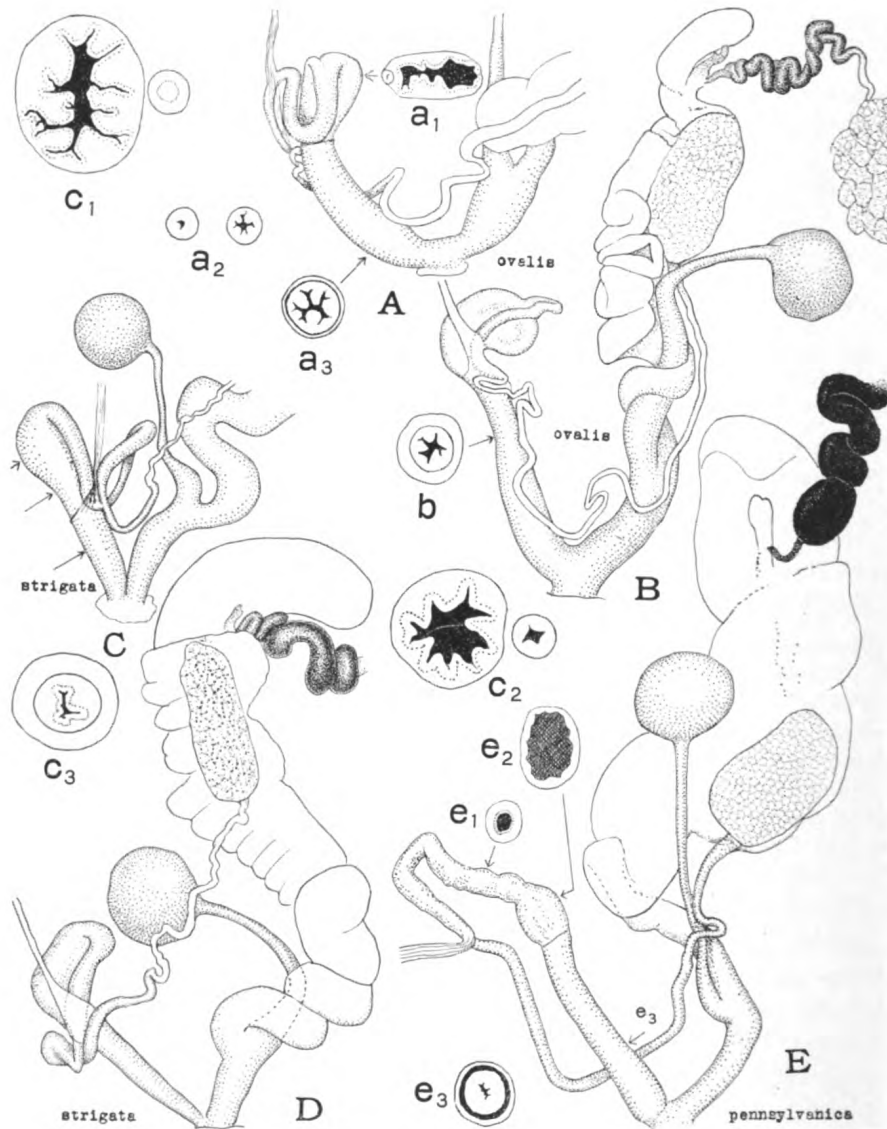


Fig. 429. A. *Succinea ovalis*, Riverton, N. J., anterior genitalia with sections a_1 , enlarged upper part of penis; a_2 , descending and ascending parts of epiphallus; a_3 , lower part of penis. B. *S. ovalis*, St. Johns Bay, Newfoundland, section of penis at b. C. *S. strigata*, Besboro I., Alaska, with three sections of penis and epiphallus at c_1 , c_2 , c_3 . D. *S. strigata*, Besboro I. E. *S. pennsylvanica*, with sections of penis, e_1 , e_2 , and epiphallus e_3 .

In a series of species comprising *S. concordialis* (and perhaps *S. bayardi*, *S. grosvenori* and *S. unicolor*), the attachment of the retractor appears to be at the point where epiphallus passes into penis, the proximal end of the epiphallus being enveloped in the retractor and the penial sheath as in Fig. 442 G, H, I and Fig. 449 E. This condition requires further study. I have not time now to review the dissections with reference to the exact point where the penis passes into the epiphallus.

The length of the vagina varies in *Succinea*, a very short one occurring in some species which otherwise do not appear to be closely related. The jaw has accessory ribs in *S. ovalis*, *pennsylvanica* and *strigata*, similar to *S. putris*; but in all of our other species examined there is a single median projection only.

SUCCINEA OVALIS GROUP (Section *Novisuccinea*, new section)

The end of the penis and adjoining part of the epiphallus project in a loop free from the penial sheath; the farther end of the epiphallus being usually bound into the junction of penial retractor and sheath. The vagina is of moderate length, the free oviduct typically very long.

This is the specially North American group of *Succinea*. The genitalia are illustrated in Figs. 429, 442 and 449. Typical species, such as *S. ovalis* and *S. strigata*, have accessory projections of the jaw, as in the European *S. putris*, but other species have only the usual median projection of the cutting edge.

The western species *rusticana* and *stretchiana* may belong elsewhere. They have not been dissected.

Succinea ovalis Say

Figs. 430-433.

Succinea ovalis Say, 1817, Jour. Acad. Nat. Sci. Phila., 1:15.—DeKay, in part, 1844, Nat. Hist. New York, Mollusca, p. 53, pl. 4, fig. 52.⁷⁰—Pilsbry, 1908, Proc. Acad. Nat. Sci. Phila., p. 45, with var. *optima*, p. 47, and var. *chiltangoensis*, p. 49.—Walker, 1928, Terr. Moll. Alabama, p. 167.—Walker, 1904, Sixth Rep. Mich. Acad. Sci., p. 187 (variation of jaw).—Ingram, 1943, Nautilus, 56:92 (*Leucochloridium*).

Helix (Cochlohydra) ovalis Say, Férussac, 1822, Tabl. Syst. Limaçons, p. 26; Hist. Nat. Moll., pl. 11 a, fig. 1.

Succinea ovalis Leidy, 1851, in Terr. Moll., 1:213, 231, pl. 13, figs. I-III (genitalia, jaw).

Succinea obliqua Say, 1824, in Appendix to Keating's Narrative Exped. source St. Peter's River, etc., Major Long's Second Expedition, 2:260, pl. 15, fig. 7 (vicinity of Philadelphia).—W. G. Binney, 1878, Terr. Moll., 5:423, and of most authors of the last century.

Succinea campestris Say, Gould, 1841, Invert. of Mass., p. 195, fig. 126.—DeKay, t.c., p. 53, pl. 4, fig. 54. Not *S. campestris* Say.

⁷⁰ DeKay's *S. ovalis* is ambiguous, as he was misled by Gould's treatment of that species. His fig. 52 and the last sentence of his remarks appear applicable to *S. ovalis* Say. His description of the shell was mainly taken from Say's description of *S. ovalis*, and that of the living animal from Gould's account of his different *S. ovalis*. The var. *lineata* was perhaps a specimen of Gould's species.

Succinea totteniana Lea, 1841, Trans. Amer. Philos. Soc., 2:32.—W. G. Binney, 1878, Terr. Moll., 5:425, pl. 67b, fig. 2.

Helix (Cochlohydra) putris var. δ , Férussac, Tableau Syst. fam. Limaçons, p. 26, no. 9; Hist. Nat. Moll., pl. 11 A, fig. 9 (Iles Miquelon et Saint-Pierre, près Terre-Neuve).

Succinea putris L., Cockerell, Nautilus, 6:30.

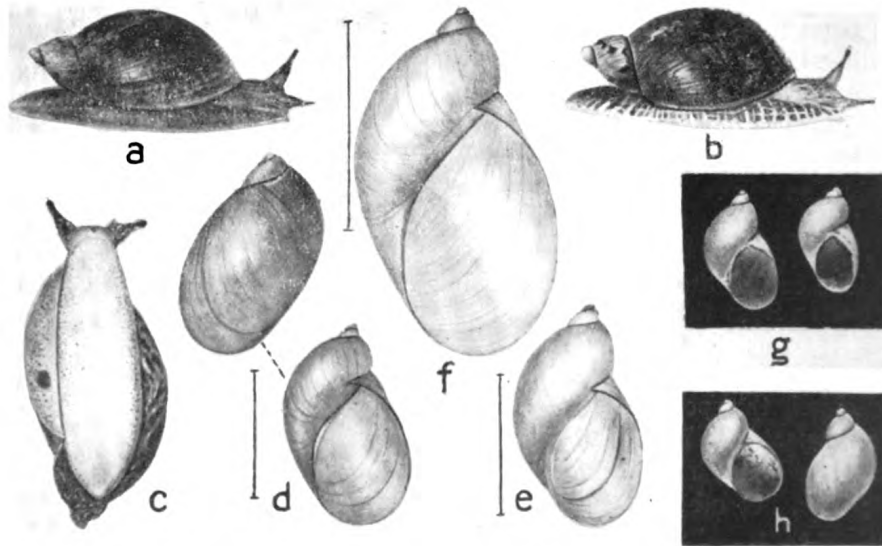


Fig. 430. a, b, c, *Succinea ovalis*, living, Plum Point, Delaware River above Riverton, N. J.; d, e, Cazenovia, New York. f, *Succinea ovalis optima*, Cruger's Valley, Dutchess Co., N. Y. g, *Succinea ovalis pleistocenica*, paratypes; h, same, Des Moines, Iowa. Scale lines = length of shells.

The shell is oval, inflated, thin, translucent, of a greenish yellow tint, the summit paler or reddish; glossy; lightly marked with wrinkles of growth. Whorls $2\frac{1}{2}$, strongly convex, the last inflated, convex throughout. The aperture is ovate, about three-fourths the length of shell.

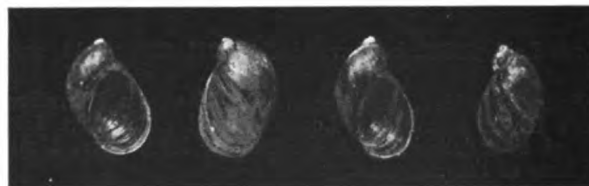


Fig. 431. *Succinea ovalis*. Fairmount Park, Philadelphia.

Length 16.5 mm., diameter 11 mm., aperture 11.2 mm. Wissahickon.
 Length 16 mm., diameter 10.8 mm., aperture 12.2 mm. Fairmount Park.
 Length 14.2 mm., diameter 9 mm., aperture 9.8 mm. Fairmount Park.

Distribution.—Newfoundland and James Bay to North Dakota and Nebraska, south to Alabama. Type locality, Philadelphia, Pa. Some peripheral localities follow. Southeastern states below North Carolina, and lower Mississippi valley records are wanting.

NORTH CAROLINA: Smith's Island, Cape Fear, Brunswick Co. TENNESSEE: Summit of Roan Mt.; Thunderhead, Great Smoky Mountains; Mt. Le Conte. ALABAMA: Baldwin, Mobile, Perry, Sumter, and Tuscaloosa counties. MISSOURI: Boone and Callaway counties. NORTH DAKOTA: Sully's Hill, Devil's Lake. MINNESOTA: Minneapolis.⁷¹

This *Succinea* is larger and more inflated than any other of the region it inhabits. The confusion as to its proper name had been noticed by several authors and fully explained by Dr. Binney long ago, but it persisted in manuals and papers until 1908, when the author published this note:

"(1) *Succinea ovalis* Say was based upon Philadelphian specimens of the form subsequently described as *S. totteniana* Lea. It was figured by Férussac from examples sent by Say, as early as 1822. The proportion of aperture to length given by Say applies to no other *Succinea* of the region about Philadelphia. (2) *Succinea ovalis* Gould, 1841, is a totally different species, . . . The true identity of *S. ovalis* Say was recognized by Dr. Binney in 1851. (3) *Succinea obliqua* Say, 1824, was based upon elongate specimens of *S. ovalis* Say, also from Philadelphia. (4) *S. totteniana* Lea and W. G. Binney is identical with the typical *S. ovalis* Say."



Fig. 432. Tablet bearing *Succinea ovalis*, labelled by Thomas Say. Actual size.



Fig. 433. Say's tablet (cotypes) of *Succinea obliqua*. Actual size.

The tablet of three specimens of *S. ovalis* labelled by Say is photographed, fig. 432. His type specimen was an immature shell, now lost, or probably discarded and large adult specimens substituted. These may be accepted as neotypes (No. 12390 A.N.S.P.). A series of modern specimens from Fairmount Park, Philadelphia, is represented in fig. 431. These show a considerable amount of variation in contour, some being as long as Say's

⁷¹ Many years ago I found a large and very globose bleached specimen of *S. ovalis* on the beach at Galveston, Texas. It probably floated down the Mississippi and drifted ashore, as there is no other austroriparian record from west of Mobile. It measures: length 20.4 mm., diameter 14.9 mm., and is no. 73693 A.N.S.P.

types of *S. obliqua*. Philadelphian examples do not attain a large size, rarely exceeding 16 or 18 mm. in length. It is a region of crystalline metamorphic rock, deficient in lime, where the land shells generally run under the size usual in New York or the West. The color is yellowish green, and the shell very thin.

This type of shell is widely distributed, from Ontario to the mountains of North Carolina (summit of Thunderhead), and west to Minnesota and Missouri, but in many places it is larger, a Newfoundland specimen 18.5 mm. long, and this is about the usual size in the middle west.

S. ovalis is usually found on low ground near streams, in summer often upon the weedy herbage of such places, a foot or two from the ground. Dr. James Lewis found it in August, 1866, on apple trees in an upland pasture near Mohawk, "adhering to the undersides of the horizontal limbs and on the trunks of the trees six or eight feet from the ground". In Essex County, New York, I have found it in rather dry woods, under stones and leaves, but these stations are exceptional.

It often attains the ordinary size in one season. Old shells which have hibernated become thicker, often yellowish-pink, showing one or two well-marked growth-rest lines.

In the examples of *S. ovalis* taken at Chittenango Falls, N. Y., the mantle of the upper part of the spire in living animals is whitish with a papery appearance; the last whorl is pale buff, becoming olivaceous and dusky over the lung. This is, in some examples, more or less obscured by a gray network, marked with some black blotches, but in others there is a pattern of black streaks much like that of *S. ovalis chittenangoensis*. See Fig. 435: 9-11.

In living specimens from Riverton, New Jersey, the sides of the living animal are more or less suffused with orange, deeper towards the edges of the foot (but sometimes diluted, or replaced by light yellow); the orange color under the lens appearing in minute flecks. The back is gray or blackish with pale venation. Usually short black or gray stripes adorn the sides, and a dark patch is on the top of the tail. Sole bluish-gray, shading to orange at the edges. In progression it shows five or six moderately distinct waves across the sole. Tentacles dark gray. Mantle edge closely flecked with orange. The mantle over the lung, when the shell is removed, is variable in color among individuals of one colony. It is rarely almost black, more often blackish marbled with a pale tint, or it may be pale yellow with scattered gray or black spots in a tracery of gray. Usually there are some black dashes bordering and at right angles to the mantle-edge. The two living animals figured (Fig. 430, a, b, c) are from the same place and taken the same day, May 19.

Specimens from the Delaware River bank above Philadelphia (Fig. 429 B) and from St. Johns Bay, Newfoundland (Fig. 429 A) were dissected. The genital orifice is in a short fossa. The hermaphrodite duct is dark gray; the seminal vesicles, much less pigmented, have one long lobe with a short lateral projection. The prostate gland is rather large and posterior. The

vas deferens is long and sinuous. The penis is long and enveloped in a thin sheath, its cavity with four principal longitudinal ridges (Fig a., b). The upper end above the sheath is dilated, with thin walls, which are irregularly ridged internally (Fig. 429 a), and passes into a narrow epiphallus, also free from the sheath. Farther down the penial retractor attaches to the epiphallus, and where it unites with the sheath, binds the epiphallus to the penis. The vagina is of medium length. The duct of the globose spermatheca is very thick in its lower part, slender near the bulb.

Jaw, Fig. 414:1, 2.

Dr. Bryant Walker examined the jaws of thirty specimens from eight localities in Michigan, Indiana and North Carolina, but only an abstract of his results was published. He says:

“The special feature of the jaw in this species, which has been mentioned by previous authors, is a variable number of prominent transverse ribs, which denticulate the cutting edge of the jaw.

“This was found to exist to a greater or less extent, in all the specimens examined. But the variation in number, size and position of these ribs, was very great. Not only were no two of the jaws alike, but not in a single jaw was the number or position of the ribs on both sides of the central projection, which was uniformly present, the same. There was, however, a great similarity in the jaws from each locality, in color and thickness. The result to be deduced from the limited amount of material examined, is that in this species, no reliable specific character can be found in the number and position of the ribs.”

***Succinea ovalis optima* Pilsbry**

Figs. 430 f. 434.

Succinea ovalis optima Pilsbry, 1908. Proc. Acad. Nat. Sci. Phila., p. 48. fig. 4.

The shell is much more robust than *S. ovalis*, with coarser wrinkle sculpture, and yellow predominates over green. The contour is about that of the larger examples of *ovalis* (such as Say called *S. obliqua*), but varies to nearly or quite as broad as typical *ovalis*.



Fig. 434. *Succinea ovalis optima*, type and paratypes, actual size.

The suture is deep, and at the last whorl, oblique.

Length 26 mm., diameter 16 mm., length aperture 18 mm.

Length 25 mm., diameter 13.5 mm., length aperture 17.5 mm.

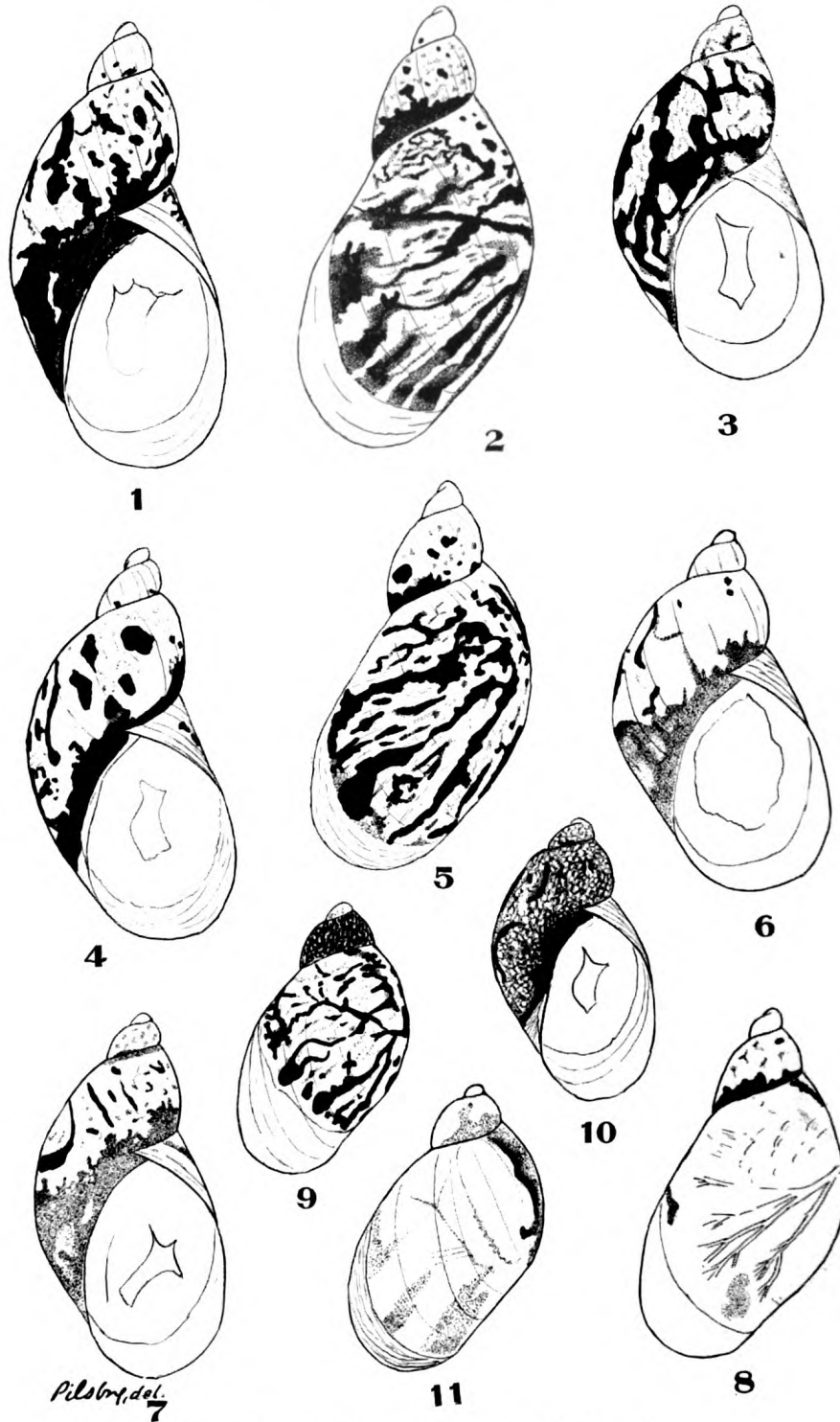


Fig. 435. See bottom of page 807 for legend.

New York to Minnesota, south to Kentucky, Type 79692 A.N.S.P. from Cruger's Valley, near Upper Red Hook, Dutchess Co., New York.

The size indicated by the figures and measurements above is not often reached. In the middle west it is usually from 20 to 22 mm. long, and the size of some individuals which seem to be adult does not exceed the largest *S. ovalis*. It is thus rather a dubious subspecies, more likely only a large form, reflecting optimum conditions. At the time *optima* was defined, I was not aware of the great variation in size often observed between different populations of the same species of *Succinea*.

Succinea ovalis chittenangoensis Pilsbry

Figs. 435: 1-8; 436.

Succinea ovalis chittenangoensis Pilsbry, 1908, Proc. Acad. Nat. Sci. Phila., p. 49, fig. 5; pl. 7, figs. 1-8.

The shell is yellow or pinkish-yellow, much lengthened, with a longer spire than any other race of *S. ovalis*; suture deep; whorls $3\frac{1}{2}$, the last rather flattened above, not so convex there as in *S. ovalis* or *S. o. optima*. Aperture very oblique, relatively small.

Length 22.4 mm., diam. 11.3 mm., length aperture 14 mm. Type.

Length 23.3 mm., diam. 11.3 mm., length aperture 14 mm.

Length 21 mm., diam. 11.3 mm., length aperture 13 mm.

Length 19 mm., diam. 10.5 mm., length aperture 12 mm.

Length 19 mm., diam. 10.5 mm., length aperture 12 mm.

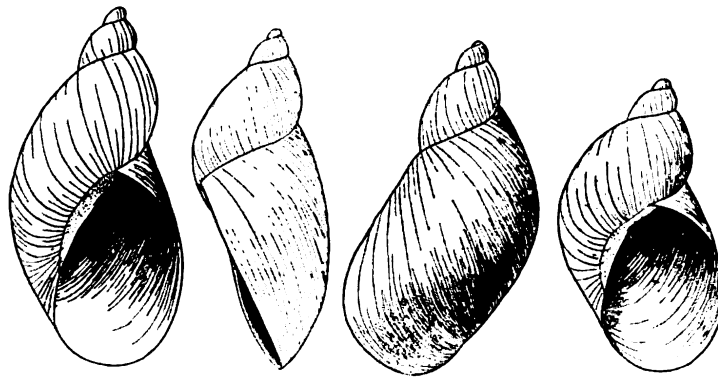


Fig. 436. *Succinea ovalis chittenangoensis*. Three views of type and face of a shorter specimen, $\times 2$.

NEW YORK: Chittenango Falls, Madison Co., on a sloping weedy talus near the foot of the falls (Henderson, Walker, Clapp and Pilsbry, Aug. 27, 1905). Type 90087 A.N.S.P.

It occurred in great abundance. A few typical *S. ovalis* were found with them, but no intergradation was seen.

Fig. 435. 1-8. *Succinea ovalis chittenangoensis*. 9-11. *Succinea ovalis*, Chittenango Falls, New York. Mantle markings seen through the shell, drawn from living specimens, $\times 2\frac{1}{2}$.

In the living animal the mantle as seen through the shell is pale yellow with a slight olive tint, olive over the lung; the apex is more or less ruddy. This ground is profusely striped and blotched with black on the last $1\frac{1}{2}$ whorls, as shown in Fig. 435:1 to 5. Over the kidney the black blotches are interrupted and the ground tint is lighter, making a light streak across the whorl, partially seen in figs. 2 and 5 at the right upper portion of the last whorl. Very exceptionally the black blotches are almost absent, as in figs. 6, 7, 8. Fig. 435:8 represents the least marked individual seen, and probably to be regarded as a case of partial albinism. The lower edge (collar) of the mantle is gray peppered with white dots. The foot is pale yellowish, back and flanks gray with slate tessellation, tentacles slate. The posterior end of the foot is somewhat blackish above.

All figures of page 806 were drawn with camera lucida from living animals. In alcohol the black and gray pigment remains, but the yellow tint is fugitive. The pattern of pigmentation of the lung has clearly been influenced by a tendency of the markings to follow veins; but in many specimens this tendency has been lost to a great extent.

***Succinea ovalis pleistocenica* F. C. Baker**

Fig. 430 g. h.

Succinea ovalis pleistocenica F. C. Baker, 1927, *Nautilus*, 40:117.

"Shells differing from typical *ovalis* in having a rounder aperture and comparatively longer spire; it averages somewhat smaller than the *ovalis* now living in Illinois.

Length 19.0 mm., diam. 11.5 mm., aperture 11.5×8.0 mm. Type.
 Length 17.2 mm., diam. 10.0 mm., aperture 10×5.5 mm. Paratype.
 Length 16.0 mm., diam. 9.0 mm., aperture 9.0×6.0 mm. Paratype.
 Length 15.0 mm., diam. 9.3 mm., aperture 9.4×6.5 mm. Paratype.
 Length 11.5 mm., diam. 7.0 mm., aperture 7.8×4.9 mm. Paratype.

ILLINOIS: Type locality: Clark Co., 3 miles southwest of Marshall, in loessal silt of Yarmouth age. Types: Museum of Natural History, Univ. Ill., P2088a; Acad. Nat. Sci. Phila., 142710. Also near Alton, Madison Co. (Sangamon); Mercer, Warren, Rock Island, Bureau, Peoria, Union counties (Peorian). (Baker.)

IOWA: Peorian loess at Freeport (Baker); Des Moines (Van Hynning); Legrand, Marshall Co. (H. S. Conard). MISSOURI: Music Ferry, St. Louis Co. (Leslie Hubricht). NEBRASKA: Oxford, Furnas Co., in alluvium (T. D. A. Cockerell).

"This variation of *Succinea ovalis* is abundant in the loess deposits of Illinois and Iowa and differs sufficiently and constantly enough for recognition as a variety of the recent form. It was apparently characteristic of the dry conditions under which the loesses were deposited. Immature specimens have been identified as *Succinea grosvenori*, from which they differ in the wider aperture and shorter spire. . . . *Pleistocenica* has not been observed from strata later than Peorian. The shorter, wider aperture is its chief characteristic, specimens of the fossil and of the recent form of the same size having the following comparative measurements:

Pleistocenica, L. 19; D. 11.5; Ap. L. 11.5; D. 8.0 mm.

Recent *ovalis*, L. 18.5; D. 11.1; Ap. L. 13.2; D. 8.0 mm." (F. C. Baker.)

Succinea pennsylvanica new species

Fig. 429 E.

The shell is thin, oval, ochraceous buff or somewhat paler, of three rather weakly convex whorls, the last noticeably flattened in the upper part as in the *Oxyloma retusa* group. The suture is only lightly impressed. The long-ovate aperture is angular above. Columella simple, thin, passing into the parietal wall in a continuous curve.

Length 16.4 mm., diameter 9 mm., dorso-ventral diameter or "convexity" 6.3 mm., length of aperture 11.5 mm. Type.

PENNSYLVANIA: Derrick City, McKean Co. (W. E. Burnett, 1926). Type and paratypes 142496 ANSP., other paratypes in U.S.N.M., MCZ., and Carnegie Mus.

This species is closely related to *S. ovalis* Say, but it differs by the flattening of the upper surface of the shell, the far less deeply impressed suture, and by the strongly angular upper end of the aperture, the outer lip posteriorly being nearly straight and sloping steeply, not strongly curved and approaching a horizontal direction at the end, as it is in *S. ovalis*. Anatomically it differs from *ovalis* by having the penial retractor and junction of epiphallus and vas deferens entirely free from the penial sheath, this difference being constant in numbers of each examined. The spermathecal duct is less swollen than in *ovalis*, and the seminal vesicles not quite the same. The jaw, while of the *ovalis* type, has very weak accessory ribs. Fig. 414:3.

It occurred in abundance in May and July, 1926-7, on rushes and grass stems near the water. The soft parts were reported to be cream white spotted with brown or black.

The genital orifice is in a short slit, with an overhanging lobe and below it a straight ridge. The hermaphrodite duct is entirely black in some specimens, nearly black in others. Seminal vesicle is nearly black and has a very indistinct division under the pigmented membrane, or sometimes a slight protuberance lower down. The prostate gland is placed rather far forward. The vas deferens is rather redundant, as in *S. ovalis*. The penis is long, cylindric, thick-walled, with a thin sheath. It terminates above in a thin-walled dilation (Fig. 429 E, e₂). The long epiphallus forms a loop before receiving the retractor muscle, fibres from which thinly envelop its latter end. The vas deferens and the penial retractor have no connection whatever with the penis proper or its sheath, which terminates at the dilation of the penis mentioned above. The vagina is of moderate length. Spermathecal duct is slender, enlarging somewhat near its origin. Jaw, Fig. 414:3, as in *S. ovalis*.

Succinea pronophobus new species

Fig. 437 a.

The elliptical-ovate shell is very thin, dilute olive-yellow, very glossy, nearly smooth, but with weak wrinkles of growth. The spire is very short. There are 2½ or 2¾ whorls, not very convex, the last half turn descending rather deeply. The aperture is broadly ovate, angular above, broadly expanded below, the peristome receding at the base. Columella thin; reflection of inner lip on the parietal wall very thin and inconspicuous. In basal view the false-umbilicus formed by the spiral columella is small.

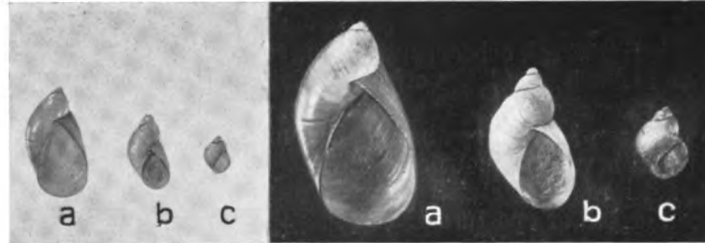


Fig. 437. a, *Succinea pronophobus*, type and paratypes. b, *S. gabbi*, paratype. c, *S. stretchiana*, specimen from Bland. Actual size and enlarged.

Length 14 mm., diameter 8 mm., length aperture 11 mm. Type.
Length 11.5 mm. Greenfield pond.

NORTH CAROLINA: near Wilmington (S. N. Rhoads, H. A. Pilsbry), Type 95021 A.N.S.P.; Greenfield Pond in the same vicinity. GEORGIA: St. Simon's Island (Wheatley Coll.).

This *Succinea* was collected in course of an excursion to the Cape Fear River region in 1908, in company with Dr. Paul Bartsch, George H. Clapp, Bryant Walker and John B. Henderson. Probably there are specimens in their several collections. It is like *S. pennsylvanica* in the inflated form, but that is darker colored and decidedly more roughened by wrinkles of growth, has a more produced spire of fully three whorls, and the basal lip does not recede as in this species.

A single specimen from St. Simon's Island measures: length 12.2 mm., diameter 7.5 mm., length aperture 9 mm., and is of a clearer buff tint than the type. It was found in a lot of *S. wilsoni*.

***Succinea strigata* Pfeiffer**

Figs. 438, 439.

Succinea strigata Pfeiffer, 1855, Proc. Zool. Soc., London for 1854, p. 297; 1859. Mon. Hel. Viv., 4:815 (Port Clarence).⁷²

Succinea rotundata Sowerby, 1872, Conchologia Iconica, 18, pl. 11, fig. 78 (Port Clarence). Not *S. rotundata* Gould, 1846.

Succinea chrysis Westerlund, 1883, Nachrbl. d. m. Ges. 15 Jahrg., p. 51 (Lake Imau-ruk, Port Clarence); 1885, Vega Exped. Vetensk. Iakttag., 4:198, pl. 3, fig. 10; also p. 167 (Greenland).—Dall, 1905, Harriman Alaska Exped., 13:59.—Hanna, 1925, Nautilus, 38:123.—Eyerdam, 1933, Nautilus, 46:128.—Von Martens, 1885, Conchologische Mittheil., 2:183, pl. 33, figs. 19, 20, 23, 24, with var. *aurelia*, p. 184, pl. 33, figs. 21, 22 (Alaska).—Hanna, 1940, Jour. of Morphology, 66:115-129, pl. A, B (anatomy).—Dall, Harriman Alaska Exped., 13:59.

Succinea annexa Westerlund, 1883, t.c. p. 52; Vega Exped., p. 199, pl. 3, fig. 11 (Port Clarence).

Succinea lineata W. G. Binney, 1885, Man. Amer. Land Sh., p. 473, fig. 515. Not *S. lineata* W.G.B., 1857.

"The shell is ovate-acuminate, thin, longitudinally striate, scarcely shining; reddish-corneous ornamented with narrow pale streaks. Spire conic,

⁷² Not "*Succinea strigata* Pfr." of Angas, 1864, Proc. Zool. Soc. Lond. for 1863, p. 522, and in some of the older collections such as A.N.S.P. These shells are *S. australis* Fér., as Hedley has noted, Rec. Australian Mus., 7:284.

rather acute. Whorls 3, convex, the last about three-fifths of the length, inflated. Columella callous, somewhat straight, a little receding. Aperture a little oblique, subregularly oval, slightly angular, and bent in, especially in the uppermost part; peristome simple, the margins subequally arcuate, joined by a callus. Length $9\frac{1}{2}$, diameter $6\frac{1}{2}$, height [convexity] 4 mm.; aperture 6 mm. long, 4 wide.

"Var. β , larger, more solid, whorls $3\frac{1}{2}$; length 12, diam. $7\frac{2}{3}$, height 5 mm." (Pfeiffer.)

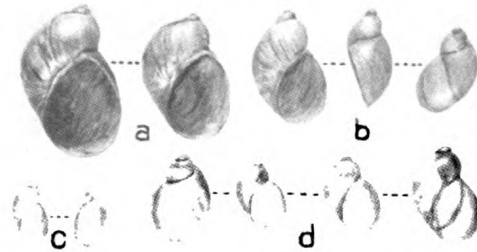


Fig. 438. *Succinea strigata*. a. Uganik Bay, Kadiak Island; b. Besboro Island, Norton Sound; c. Cape Denbigh; d. Yukon River 20 miles below Andreofski.

Length 11.5 mm., diam. 7.5 mm., aperture 7.5×5 mm.; *chrysis*⁷³
 Length 13 mm., diam. 7.5 mm., aperture 9×7.5 mm.; *chrysis*⁷³
 Length 14 mm., diam. 8 mm., aperture 8×6 mm.; *annexa*⁷³
 Length 10 mm., diam. 6.5 mm., aperture 6×4.5 mm.; *annexa*⁷³
 Length 19 mm., diam. 13 mm., aperture 13.3 mm. Uganik Bay.
 Length 15.5 mm., diam. 11.4 mm., aperture 11.2 mm. Uganik Bay.
 Length 14 mm., diam. 9.2 mm., aperture 9.7 mm. Besboro I.

"Fort Simpson, Mackenzie River; watershed of the Yukon, near Dawson, Yukon Territory, 30 miles below the Tanana River mouth on the Yukon, Alaska, the Koyukuk River, north of the Yukon, Nulato, Andreofski, and the Yukon delta, Point Romanoff, shores of Norton Sound at Egg Island, Besboro Island, Cape Denbigh, Norton Bay, Golofnin Bay, Port Clarence, Konyam Bay on the Asiatic shore of Bering Strait; St. Michael, St. Mathew, St. Paul, and St. George, Islands, Bering Sea; north end of Nunivak Island, the Aleutian chain, Unalaska, Kadiak Island, Sitka, At Chilkat Inlet, Alaska, Krause obtained the variety *aurelia* von Martens." (Dall.)

Norton Sound region at Golofnin Bay, Cape Denbigh, Besboro Island and Egg Island (R. C. McGregor). Yukon River 10 miles below Andreofski, and Cape Romanof (P. B. Randolph, 1898).—"Makushin Bay, Glacier River and Unalaska town, Unalaska Island; Amoknok Island near Dutch Harbor; Nazan Bay, Atka Island; at these localities the species has not attained the large size and beautiful golden color of the shells from St. Paul Island, 200 miles to the northward; St. Paul Island among mosses and grass" (G. D. Hanna). Unalaska, Atka, and False Pass, Umiak Island; Raspberry Island; Uganik Bay Kadiak Island (Eyerdam).

GREENLAND: Igaliko Fjord, 60° 45' N. (Nordenskiöld, Stockholm Museum).

This Arctic species has very convex whorls and a deeply cut suture. It varies from somewhat translucent to opaque, and nearly always has some

⁷³ These measurements from Westerlund.

or many light and dark streaks when adult. Pfeiffer's type was a small example.

Neglect of the first description, together with the extreme variability of this snail, has led to its appearance in literature under no less than six names. In size, adult specimens vary from about 7.5 mm. long, of $2\frac{3}{4}$ whorls (Cape Denbigh) to 19 mm. long. The shell may be thin, straw yellow to mustard yellow with darker streaks, and of the same color inside, or the external color may be brown-streaked, the inside ochraceous-orange. On the Aleutian Islands, and also around Norton Bay, Point Romanoff, Port Clarence and sporadically elsewhere, the smaller, paler colored forms occur. Shells from Kadiak Island are the largest seen, but some from the lower Yukon and Port Clarence on Bering Strait are the most deeply colored, of medium size and rather opaque texture.

The various forms appear to be ecologic varieties, probably connected directly with local pH, food supply, length of growing season and possibly other non-genetic factors. It may be doubted whether any of the forms are subspecifically established. All appear to be connected by intermediate specimens.

The specimens from Uganik Bay, Kadiak Island (Fig. 424 a) found under alder leaves, are large and very globose, the aperture wide. In a less variable species they might be thought racially distinct.

The living animal and anatomy have been described by G. D. Hanna from specimens taken by him on St. Paul Island. Extracts from his account follow:

"Animal light gray in ground color with a series of radiating darker incised lines extending downward to a similar longitudinal line above the margin of the sole. About 5 mm. back of the base of the right eyestalk and midway between the mantle margin and the sole of the foot is the gonopore. It is narrow, extends obliquely downward and forward, is surrounded by a large round white disk with distinct boundary. This disk may be folded in by retraction of the genital organs so that it is scarcely visible in imperfectly expanded material.

"The common anus and nephridial pore opens through the collar on the opposite side of the angle from the breathing pore, so that the discharges are directed backward over the right side of the tail.

"The integument is membranous back of the nephridium and is coarsely mottled with large blotches of black or rarely brown pigment. Between the markings the covering is transparent, with the coils of the intestine imbedded in the liver distinctly visible.

"The animal creeps by making a series of undulations pass the length of the foot. These are barely perceptible with hand lens magnification as the animal crawls up a piece of glass.

"The pedal cavity is almost as long as the foot.

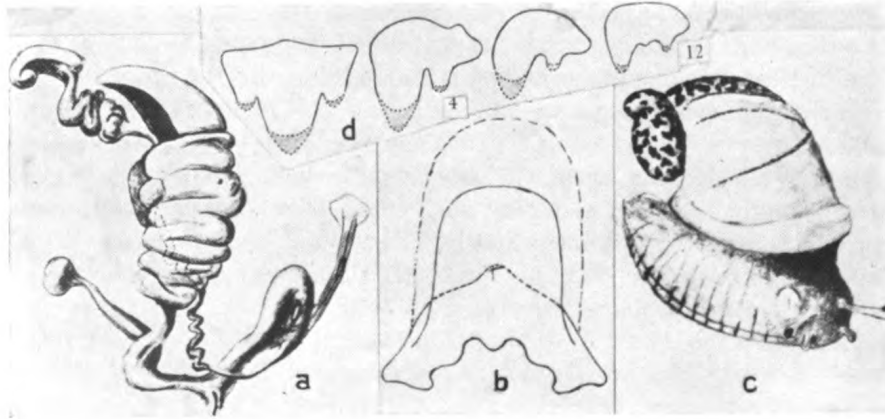


Fig. 439. *Succinea strigata*, genitalia, jaw, teeth, and alcoholic animal. After Hanna (*S. chrysis*.)

"The jaw (Fig. 439 b). The cutting edge of the blade is concave with five blunt projections. There are 55 longitudinal rows of teeth, and a variable number, up to 30 teeth, in each row. Teeth of central row are tricuspid, 10 rows on each side are bicuspid. In several rows out from this the teeth are usually tricuspid, and the eight or nine marginal rows have four or more cusps (Fig. 439 d).

"Reproductive system, Fig. 439 a. There is no cloaca; penis and vagina open to the exterior by adjacent pores on the white disk back of the right eyestalk. The vas deferens leads from the apex of the penis, doubles back and is firmly attached to this organ about 1.5 mm. from the end. At this point there is an interior connection between the two cavities [an error; no connection in my preparations—H.A.P.] as well as fibrous connection and the retractor muscle is attached at the same place. Distally this band-like muscle is attached to the membranous posterior extremity of the pericardial cavity in the extracted animal; in life it seems to be attached to the shell at the same point. In passing backward the muscle lies beneath the pulmonary cavity, the kidney, and one fold of the intestine. Penis, vas deferens, vagina and spermatheca have very thick muscular walls the fibers of which run concentrically. The prostate gland at the distal end of the vas deferens is roughly cubical in shape and closely appressed to the ventral side of the oviduct. The testicle forms the extreme end of the organ usually termed the hermaphroditic gland. Since, in this species, it is structurally distinct from the ovary it is not convenient to treat the two as a single unit. In common with the ovary, discharges are carried to the upper end of the oviduct by the hermaphroditic duct. The spermatheca is globular and membranous but the duct from it to the vagina is a highly muscular organ. The oviduct is a translucent, greatly pouched organ forming the floor of the pulmonary cavity. Its walls are membranous and contain a great deal of albuminous material. The albumen gland is attached directly to the posterior end." (Hanna.)

My dissections of specimens from Besboro Island are drawn in Fig. 429 c, d. The hermaphrodite duct is nearly black. The prostate gland is somewhat pigmented. The jaw is drawn in Fig. 414:14. By the genitalia, which are of the American type, as well as by the jaw, this Arctic species resembles *S. ovalis*.

The occurrence of *S. chrysis* (= *strigata*) in southern Greenland may be thought improbable, that place being so remote from its known range; however, the specimens were identified by Westerlund in 1887 (Vega-Expeditionen's Vetenskapliga Iakttagelser, 4:167). They were collected by Nordenskiöld's Greenland Expedition of 1883, and are in the Stockholm Museum. Posselt (1899, Meddelelser om Grönland, pt. 23, p. 263), merely copied the name from Westerlund, or from the museum label.

Westerlund's Port Clarence record of the Siberian *Succinea turgida* Westerlund (1887, in Vega-Exped. Vetensk. Iakttag. 4:163) probably was based upon greenish specimens of *S. strigata*. The name appeared without comment in his Alaskan list.

***Succinea bayardi* Vanatta**

Fig. 440.

Succinea bayardi Vanatta, 1914, Proc. Acad. Nat. Sci. Phila., 66:222, figs. 1-3.

"Shell rather small, oval, globose, thin, polished, apex red, obtuse, body whorl translucent amber colored, with a few growth striae, whorls about $2\frac{1}{2}$, convex, rapidly increasing, suture impressed. Aperture more than half the altitude, very broadly oval, parietal callus thin; outer and basal lips thin and evenly arched, columella very narrow below, expanded above into a translucent white fold." (Vanatta.)

Length 5.5 mm., diameter 4 mm., length aperture 4 mm.



Fig. 440. *Succinea bayardi* (after Vanatta). Scale line = 1 mm.

MARITIME PROV. OF CANADA: Indian River, Kensington, Prince Edward Island (Bayard Long, Aug. 29, 1912). Type and paratypes 106651 A.N.S.P.

"This shell is very closely related to *Succinea oregonensis* Lea, but has a lower and more obtuse spire and is a smaller species. It differs from *Succinea chrysis* West. by lacking the opaque streaks, is not green or reddish, and is smaller. I take pleasure in naming this shell after Mr. Bayard Long, the botanist, who collected it." (Vanatta.)

This species is about the size of the western *S. stretchiana* Bld., but it has a shorter spire and larger aperture. *Oxyloma verrilli* (Bld.) from the lower St. Lawrence Valley is a longer shell.

The type specimen was dissected (Figs. 442 G, g and 414:7, jaw). The very voluminous hermaphrodite duct is only lightly pigmented, the talon still paler. Prostate gland situated anteriorly. Vas deferens short. The penis is rather slender with a four-ribbed cavity, and enveloped in a very thick sheath which has a thick circular muscular layer outside (Fig. 442 g₁). The upper part is dilated, recurved with terminal epiphallus (Fig. 442 g, origin of epiphallus at *ep*) and retractor, which envelops the epiphallus for a short distance and attaches below to the penial sheath. The vagina is of medium length. Duct of the spermatheca is rather slender throughout.

Succinea aurea Lea

Fig. 441.

Succinea aurea Lea, 1846, Trans. Amer. Philos. Soc., 9:4; Obs. Genus Unio, 4:4.—Gould, 1851, in Binney, Terr. Moll., 2:76, pl. 67c, fig. 2.—W. G. Binney, 1878, Terr. Moll., 5:422, pl. 67c, fig. 2; 1885, Man. Amer. Land Sh., p. 340, fig. 370.—Sterki, 1907, Proc. Ohio State Acad. Sci., 4:380.—F. C. Baker, 1938, Field book Illinois Land Sh., p. 148.

Succinea indiana Pilsbry, 1905, Nautilus, 19:28.—Goodrich & Van der Schalie, 1944, Amer. Midl. Nat., 32:382.

"Shell obliquely ovate, shining, transparent, smooth, golden; spire rather elevated; suture impressed; whorls 3, convex; aperture ovate. Diam. .30, length .32 of an inch.

"This is a beautiful little species, remarkable for its fine surface and bright golden color. In form it is related to *vermeta* Say. . . . The aperture is about three-fifths of the length of the shell." (Lea.)

The shell is small, ovate, inflated; yellow, the spire or the apex typically red-gold or salmon tinted (but often the whole shell is pale yellow). Surface glossy, under the microscope showing wrinkles of growth. Whorls 3, very convex, parted by a deep suture. The aperture is oblique, about two-thirds the total length of the shell.

Length 9 mm., diam. 6 mm., length of aperture 6 mm.

Length 7 mm., diam. 4.5 mm.

Length 11.8 mm., diam. 7.4 mm., aperture 8.5 mm.; 3 whorls.

Cape May.

Length 6 mm., diam. 4.5 mm., aperture 4.5 mm.; 2½ whorls.

S. Dennis, Mass.

ONTARIO: Ottawa (Litchford). MAINE: salt marsh at Wells, York Co. (Bayard Long). MASSACHUSETTS: Barnstable Co., on a dryish wooded slope bordering maple swamp, near East Sandwich, and on plants in a cat-tail marsh near South Dennis (Bayard Long). NEW YORK: Niagara, Monroe, Herkimer, Otsego, Westchester, and New York counties, Staten Island, Long Island. NEW JERSEY: Little Beach north of Brigantine Inlet, and Stratham Neck, Cumberland Co. (B. Long); brackish tidal marshes of Cohansy Creek near Greenwich, Cumberland Co. (S. N. Rhoads). Lavallette (H. L. Viereck); Cape May (W. B. Marshall, R. C. Alexander); Ocean View, Cape May Co. (B. Long); MARYLAND: Cambridge (A. F. Archer, R. W. Jackson); opposite Chestertown, Queen Anne Co. (Vanatta). VIRGINIA: Chincoteague Island (H. W. Fowler). SOUTH CAROLINA: Yemassee, Beaufort Co. (J. B. Henderson). OHIO: Springfield (Lea, Type locality); Oldtown, Greene Co. (Archer); Cincinnati (Wetherby). INDIANA: Clark Co. (according to F. C. Baker); Posey Co. (L. E. Daniels, for *S. indiana*).

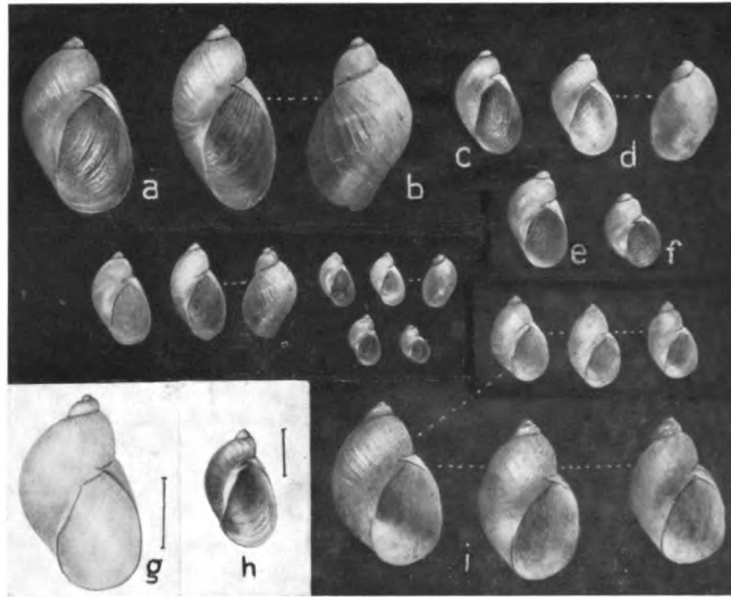


Fig. 441. *Succinea aurea*. a, b, Cape May, N. J.; c, Ottawa; d, Niagara Falls; e, S. Dennis, Barnstable Co., Mass.; f, Wells, York Co., Maine. g, Niagara Falls; h, reproduced from Binney. i, New Harmony, Indiana (*S. indiana*, type and paratypes). Unlettered middle figures actual size, the same enlarged in upper and lower rows. Scale lines for figs. g and h = actual length of shell.

The rather short, ventricose shape is somewhat like the much larger *S. ovalis*, and the color is warmer than that. *S. campestris* is duller and more opaque. The whorls are more convex than in the *retusa* group but less convex than in *S. avara*, which has a longer spire and deeper suture.

This amber snail, if we have correctly identified it, has a somewhat anomalous distribution. It seems rather generally spread in New England and New York, thence running down the coast. Inland localities in Ohio and Indiana are widely separated from the eastern. In Ohio it appears to occur in the southwest only, as Dr. Sterki, working mainly in the north-eastern part of the state, did not know it. In Indiana, Goodrich and Van der Schalie do not mention *S. aurea* in their list, but F. C. Baker recorded it from Clark Co., on the Ohio River. *S. indiana*, which I think is specifically the same as *aurea*, is from southwestern Indiana. F. C. Baker stated (1939) that *S. aurea* does not occur in Illinois. *S. aurea* has been reported by Walker (Terr., Shell-bearing Mollusks of Alabama, p. 170) from Mobile and from Point Clear, Baldwin Co., Alabama. I have not seen these southern specimens.

The genitalia are figured (Fig. 442 E) from a Cape May specimen, 67795 ANSP. The hermaphrodite duct is but very slightly pigmented, the seminal

vesicles white. The prostate gland is small, anterior. The long, cylindrical penis has a thin sheath, from which the epiphallus partially emerges. The vagina is of moderate length, the free oviduct very long. In other specimens from Lavellette, N. J. (Fig. 442 F), the mantle over lung is gray, being peppered with minute dark flecks. Foot is spotted with gray above. The genital orifice is a rather deep slit, open in front. The penis is cylindrical, with a large cavity. The sheath is thin. Jaw, Fig. 414:8.

The long, cylindrical penis is characteristic of *S. aurea*. Unfortunately specimens from Ohio, the type area of *aurea*, have not been dissected. Comparison with the Eastern form is desirable.

Succinea indiana Pilsbry, fig. 441 i, appears to be a rather dull form of *aurea*, more coarsely and irregularly striate, and somewhat more globose in form; possibly a subspecies. It was described thus:

Shell obesely ovate, thin, brownish-amber or raw sienna colored, the apex reddish. Sculpture of fine growth-lines and wrinkles, becoming rather coarse wrinkles on the last half whorl. Whorls $3\frac{1}{2}$, very convex, the last large and inflated. Aperture large, oblique, the outer lip either regularly arcuate or somewhat flattened in the middle. Columella thin and strongly arcuate throughout.

Length 11 , diam. 7 , length of aperture 7.7 mm.

Length 10.7, diam. 6.9, length of aperture 7.7 mm.

Length 10 , diam. 6 , length of aperture 7 mm.

INDIANA: just south of New Harmony, Posey Co., on the hillside facing the west between the marl cliffs and the highway. Type and paratypes 12378 A.N.S.P.; other paratypes in collections of the State Museum at Indianapolis and of L. E. Daniels. Collected by L. E. Daniels.

***Succinea unicolor* Tryon**

Fig. 443 a-c.

Succinea unicolor Tryon, 1866, Amer. Jour. Conch., 2; 230, pl. 2 (17), fig. 3.

Succinea campestris unicolor, Tryon, Walker, 1928, Terr. Moll. Alabama, p. 168, fig. 264.

“Oval, inflated, very thin, translucent, finely striate; spire very short, apex acute, suture moderately impressed; whorls 3, the last very large; aperture short, ovate, outer lip somewhat expanded, light corneous. Length 8 mm., diam. 6 mm.” (Tryon.)

TEXAS: Galveston (Pilsbry). LOUISIANA: New Orleans (Hemphill, Pilsbry, and others), Type 12426 A.N.S.P. MISSISSIPPI: Biloxi (Joshua L. Baily, Jr.). ALABAMA: Kelly's Pond, Choctaw Point and Toulminville, Mobile Co. (all according to Walker, 1928). FLORIDA: Arredonda and around Gainesville, Alachua Co. (Van Hyning); Lake Griffin, Lake Co.; Kissimmee Lake, Osceola Co. (Van Hyning). SOUTH CAROLINA: Yemassee, Beaufort Co. (J. B. Henderson).

S. unicolor is much like *S. campestris* in contour, but it is somewhat translucent, not earthy, pale yellow, without whitish streaks, often with pinkish apex, and a smoother, decidedly more glossy, surface. The striation is sometimes rather coarse. The small northern *campestris* is more opaque than *S. unicolor*.

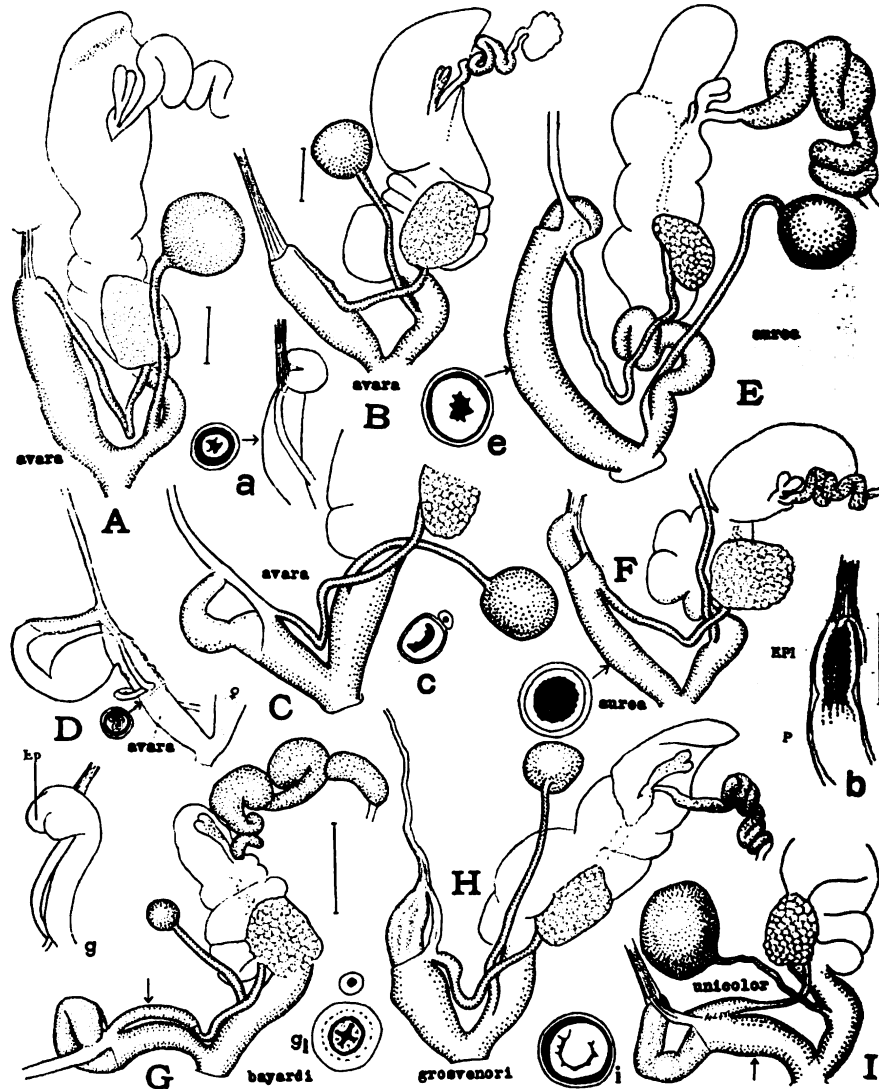


Fig. 442. A. *Succinea avara*. Sea Isle City, N. J.; at a the penis of another specimen. B, Warm Spring Canyon, Arizona, the upper part of penis and epiphallus opened at b. C. Hurricane Fault, Arizona, with section of penis at c. D, penis from a drawing by C. M. Cooke. E. *Succinea aurea*, Cape May, N. J. with section of penis at e. F. *S. aurea*, Lavallette, N. J., with section of penis at f. G. *S. bayardi*, type, with sketch of penis at g, and section at g₁. H. *S. grosvenori*, Frierson, La. I. *S. unicolor*, New Orleans, with section of penis at i. Scale lines = 1 mm.

Tryon's type, the left upper figure, was a rather small New Orleans specimen, the usual size being about 9 mm. long, sometimes larger. The largest seen are a lot from Yemassee, S. C., one measuring length 12.2 mm., width 7.6 mm., length of aperture 9.6 mm., Fig. 443 c.

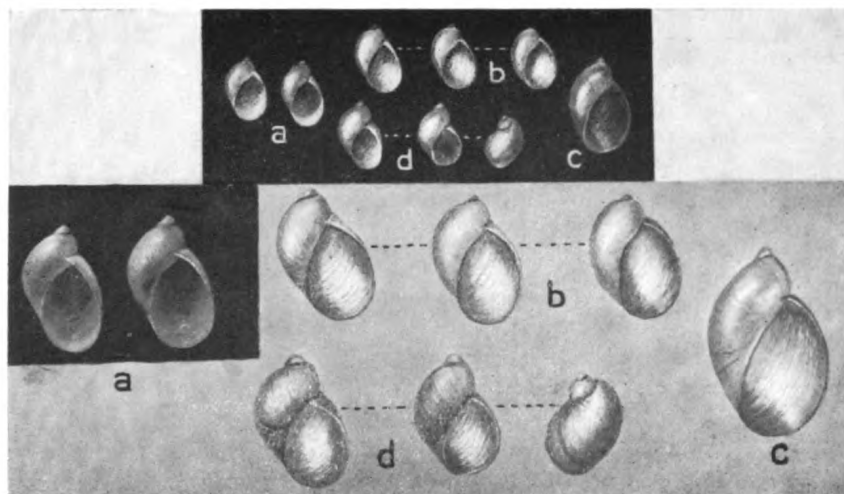


Fig. 443. *Succinea unicolor*. a, Type and paratype, New Orleans; b, New Orleans; c, Yemassee, S. C. d. *Quicquella vagans*. Type and paratypes, Cape May Point, N. J. Actual size and $\times 2$.

It often occurs in abundance, as around Gainesville, Florida, and at New Orleans. There are several large gaps in the distribution as now known, but being a small snail, it has probably been overlooked or thought to be young.

Specimens from New Orleans (68982 A.N.S.P.) were dissected, Fig. 442 I. The prostate gland is short and anterior. The penis is rather thick, its cavity contains a large pilaster (Fig. 442 i), the outer sheath thin. The upper loop has a thin wall and internally there are many nodulose ribs. The penial retractor inserts at the end, and envelops the epiphallus as far as the sheath. The vagina is short. The large, globular spermatheca has a very slender duct.

The jaw is dark, with a central projection.

This snail was formerly thought to be related to *S. campestris*, but it differs by the thin penial sheath, the longer vagina and the texture of the shell. Just where it belongs in the series is uncertain.

Succinea grosvenori Lea

Figs. 444. 452 i, j.

Succinea lineata W. G. Binney, 1857, Proc. Acad. Nat. Sci. Phila., p. 19; Man. Amer. Land Sh., p. 174, fig. 167. Not *S. ovalis* var. *a*, *lineata* DeKay, 1814.

Succinea grosvenori Lea, 1864, Proc. Acad. Nat. Sci. Phila., p. 109; Obs. Genus Unio, 11:135, pl. 24, fig. 108.—Cockerell, 1892, Nautilus, 6:30, with var. *rufescens*.—Pilsbry, 1906, Proc. Acad. Nat. Sci. Phila., p. 161; 1898, Nautilus, 11:143.—Clench, 1929, Nautilus, 43:35 (Happy Jack, La.)—Henderson, 1924, Univ. Colo. Studies, 13:159 (dist. in Colorado, Montana, Utah, Idaho); 1936, 23:114 (Utah, N. M.)—Dall, 1905, Harriman Alaska Exped., 13:57.

Succinea mooresiana Lea, 1864, Proc. Acad. Nat. Sci. Phila., p. 109 (Court House Rock, Platte River, on the Colorado route); Obs. Genus Unio., 11:136. pl. 24, fig. 109.—Cockerell, 1893, Nautilus, 7:44.

Succinea greeri Tryon, 1866, Amer. Jour. Conch., 2:232, pl. 2 (17), fig. 8 (Vicksburg, Miss.).

Succinea lineata forma *elongata* Cockerell, 1892, Jour. of Conch., 7:39.

“Shell obliquely ovate, striate, somewhat transparent, straw-yellow and thin; spire exerted; suture very much impressed; whorls four, convex; aperture nearly round and rather large; outer lip expanded; columella bent in and twisted.

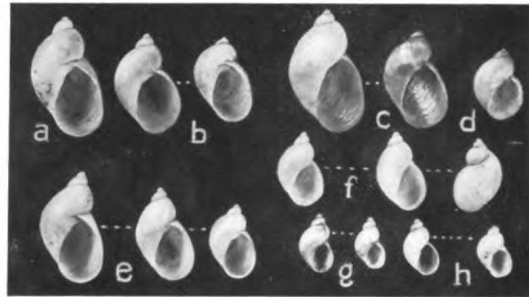


Fig. 444. *Succinea grosvenori*. a, Vicksburg, Miss. (*S. greeri*). b, Alexandria, La., from Lea; c, Ogalalla, Neb.; d, Frierson, La.; e, Mt. Trumbull, Arizona; f, Antelope Valley, Ariz. g, *Succinea grosvenori gelida* near Irene, Boone Co., Ill.; h, near Wyenet, Bureau Co., Ill.

“From the two habitats I have some twenty specimens. Those from Santa Rita are all dead shells and opaque white from partial decomposition. Those from Alexandria are in a perfect state, and present an interesting symmetrical species. While the shell is a fine bright straw color, the surface is not shining, being covered with well marked lines of growth. It is nearly allied to *lineata*, W. G. Binny, from Nebraska Territory, but it is higher in the spire, not so round, and has not the parallel revolving lines described by him. The aperture is about six-tenths the length of the shell. I have great pleasure in naming the species after Mr. Grosvenor, to whom I am indebted for many interesting Mollusca.

“Length 0.51 inch, diam. 0.32 inch.” (Lea.)

FLORIDA: Chipola R., 1 m. E. of Marianna (C. W. Johnson). ALABAMA: Woodville, Jackson Co. (H. B. Baker); Dallas Co. (H. H. Smith). LOUISIANA: Alexandria (Type locality of *S. greeri*, Tryon). TEXAS: in the following counties: Bexar, Comal, Dallas, Galveston, Lee, Taylor. ARKANSAS: Paragould, Green Co. (A. F. Satterthwait), Jefferson Co. (C. B. Moore). MISSOURI: near Pattonville, St. Louis Co. (Hubricht). ILLINOIS: Edgemont, St. Clair Co. (Hubricht). MINNESOTA: Traverse Co. (W. H. Over). KANSAS: Shawnee Co. (J. B. Quintard). NEBRASKA: Court House Rock, Platte R. (Lea, for *S. mooresiana*); Ogalalla (Simpson); Alliance (J. Henderson). SOUTH DAKOTA: many places in Jackson, Pennington, Perkins, Stanley, Vermillion, Washabaugh and Washington counties (W. H. Over). NORTH DAKOTA: Benson, Ramsey and Sioux counties. MONTANA: Wolf Point, Roosevelt Co. (Woodring). COLORADO: Denver and Kremmling, Grand Co. (Henderson); Greely (L. C. Wooster); Colorado Springs (H. B. Baker). See also Henderson, 1924). UTAH: near Garfield, Salt Lake Co. (Henderson); Payson, Utah Co. (Wheeler Exped.); Cache Valley (Hemphill); near Clinton's Cave, Lake Point, Tooele Co. (H. B. Baker.) NEW MEXICO: around

Las Vegas, Pleistocene and living; San Andres Mts. (Cockerell); Grant (J. Baily, Jr.); Tularosa (Ashmun). ARIZONA: Willow Spring, Navajo Reservation, 80 mi. N. E. of Flagstaff; Walnut Creek, Winona, Coconino Co. (H. S. Colton); Big Springs, Snake Creek, Kaibab Plateau, 6750 feet elev., and Mt. Trumbull (Ferriss).

ONTARIO: Lac des Mille Lacs, Thunder Bay District (Oughton). ALBERTA: Egg Lake and Red Deer (Dall); White Mud River, 56° 5' N., 118° W., Peace River District (J. B. Clark). MACKENZIE: Great Slave Lake (Geo. H. Horn).

Type locality: "Santa Rita Valley, Kansas ? Mr. H. C. Grosvenor: and Alexandria, Louisiana, J. Hale, M.D."

This is a rather short, inflated shell with strongly convex whorls, very deep suture and usually somewhat coarse sculpture in places, rarely showing some irregular and interrupted spiral impressions in the peripheral region. It varies from thin and pale yellow to rather opaque, and is never transparent. Like some other species, the size varies a good deal locally, and probably has some direct relation to the length of growing season or the food supply. The smallest evidently adult specimens seen were taken on old, charred pines to 20 feet up, at Frierson, La. Measurements follow:

Length 15.5 mm., diam. 9.0 mm., aperture 9.6 mm.; 3½ whorls (Ogallala).

Length 12.2 mm., diam. 7.4 mm., aperture 7.7 mm.; 3½ whorls (Ogallala).

Length 15 mm., diam. 8.7 mm., aperture 9.7 mm.; 3½ whorls. Vicksburg.

Length 12.5 mm., diam. 8.0 mm., aperture 8.2 mm.; 3½ whorls. (*mooresiana*, see Fig. 435 j.)

Length 8.8 mm., diam. 6.0 mm., aperture 6.1 mm.; 3 whorls. Frierson.

Length 11.4 mm., diam. 6.9 mm., aperture 7.8 mm. Great Slave Lake.

Length 14.2 mm., diam. 8.7 mm., aperture 8.6 mm.; 3½ whorls. Mt. Trumbull.

S. grosvenori, as now understood, tolerates an astonishingly wide range in practically all external conditions. It occurs from the warm humid Gulf coast to semi-arid areas in the great plains and mountain states, and in British America it extends north within the border of Northwest Territory.

Two or three miles below Las Vegas, N. M., Professor Cockerell informed me that living shells of *S. grosvenori* were found by Mrs. E. L. Hewett among ferns in cool, rocky limestone ledges along the Gallinas River, an isolated environment in an arid region, where it elsewhere has been found only fossil.

Two of the many aspects of individual variation have been named. Specimens from Lee County, Texas (Singley) "comprised two forms, one greenish and the other, which may be called var. *rufescens*, reddish and more globose" (Cockerell). "*Succinea lineata* forma *elongata*, length 13, aperture length 7, spire length 6 mill., Kremmling, Colorado. The ordinary form, also from Kremmling, measures 11 mill. long, aperture 7, spire 4 mill. long." (Cockerell.)

Professor B. Shimek (1935, *Nautilus*, 49:7-10) has given an account of the habitats of this species, from which we extract the following paragraphs.

"In most of the published reports of this species no habitat is given,—a very common fault of local reports on molluscs,—and in several others the habitat, as given, is widely variant from that which the writer has observed along its eastern limit. Thus, Simpson (*Conchologists' Exchange*, vol. I, 1887, p. 65) reports it from the vicinity of Ogallala in western Nebraska, as abundant 'in pools of alkali water near the South Platte River, in early spring.' Walker (*NAUTILUS*, vol. 20, 1906, p. 81) states that it occurs in the Salt Basin at Lincoln, Nebraska, and at Hackberry Lake in Cherry County, of the same state. Hanna (*l.c.*, vol. 23, 1909, p. 96) says that in Douglas County, Nebraska, it was 'found in colonies in wet places,' while Over (*l.c.*, p. 92) notes it as common 'on plains and prairies.' More recently, Cheatum and Burt (*Field and Laboratory*, vol. II, no. 2, 1934, p. 50) report that in Dallas County, Texas, 'it has been collected in swampy regions, as well as under thin blankets of humus in relatively dry areas.'

"With the exception of a small set collected in the Salt Basin at Lincoln, Nebraska, in 1889, the writer has never found the species living excepting on loess banks or bluffs along the Missouri River in Iowa (as far north as Sioux City), Nebraska and Missouri; on the west side of the Mississippi in Arkansas, and on the east side of the same stream in Kentucky, Tennessee, Mississippi and Louisiana. . . . Throughout this loess bluffs range, the habits and habitat of this species were quite uniform. In drier weather the scattered individuals were found clinging to the bare faces of the loess bluffs, or on the equally bare upper parts of the talus at their base, and always on the more sheltered sides, either facing north, or protected by turns and crevices in the bluffs.

"It is evident that this species selects two quite different major habitats, namely, that noted above, and another on the plains which may be quite moist or wet, but more or less alkaline or saline. To the latter group belong those reported in the references quoted above (with the exception of the last), and also the sets which the writer has received from South Dakota, Kansas and Texas. Both types, however, are distinctly xeric. . . . This species is far removed in habit from the co-generic 'amphibious' and mesophilous forms, and is a distinct xerophile." (B. Shimek.)

The specimens dissected are from Frierson, Louisiana, 76673 ANSP. Fig. 442 H. The mantle over the lung is faintly clouded with light gray, with more distinct short gray streaks behind the edge. The thick mantle edge and the entire head and foot are cream-white.

The genital orifice is in a rather large longitudinal pit or slit. The hermaphrodite duct is rather sparsely peppered with black. The rather stout and long talon is two-lobed at the end, sparsely dotted in the specimen drawn (but in another the talon is without dots and the hermaphrodite duct has very few). The prostate gland is of moderate size and rather far forward. Vas deferens is large and short. Where it enters the epiphallus it is partially enveloped in the penial retractor, being thereby lightly attached to the summit of the penis where the retractor joins the penial sheath. The penis is stout in figure, somewhat swollen near the apex, where its cavity

contains a small fleshy nodule on the outer wall. Passage into the epiphallus is marked by a circle of small projections into the cavity. The epiphallus has thinner walls and some low longitudinal internal ridges. (In another specimen opened the penis is somewhat more slender, and the epiphallus longer.) The globose spermatheca is on a very slender, long duct, which enters low, leaving a quite short vagina. Jaw, Fig. 414:5.

***Succinea grosvenori gelida* (F. C. Baker)**

Fig. 444 g. h.

Succinea grosvenori gelida, Baker, 1927, Nautilus, 40.118.

"Shell small, elongated, rather narrow; whorls $3\frac{1}{2}$, convex, separated by deep sutures, last whorl comparatively small, flat-sided, or but slightly convex; spire long, acute; aperture rounded, about half as long as shell; columella straight curving into the parietal wall in a gentle curve, not forming a distinct angle; there is a slight callus which is spread over the parietal wall; sculpture of rather fine, vertical striae.

L. 8.0; D. 4.2; Ap. L. 4.0; D. 2.4 mm. Type.

L. 7.3; D. 4.0; Ap. L. 3.5; D. 2.3 mm. Paratype.

L. 6.8; D. 4.5; Ap. L. 3.7; D. 2.2 mm. Paratype.

L. 6.6; D. 3.3; Ap. L. 3.1; D. 2.0 mm. Paratype.

L. 7.4; D. 4.1; Ap. L. 3.7 mm. Paratype." (F. C. Baker.)

ILLINOIS: "Boone Co., one-half mile northwest of depot at Irene, in Peorian loess. Types: Museum Nat. Hist. Univ. Ill., P875a; Acad. Nat. Sci. Phila., 142712. Distribution: Bureau Co. (Yarmouth); Boone Co. (Sangamon); Mercer, Warren, Whiteside, Bureau, Boone, Rock Island, Adams, Carroll, Ogle, Stephenson, Madison (Peorian); Bureau, Tazewell, Gallatin Co. (Early Wisconsin); Henry Co. (Late Wisconsin). It is most abundant in the Peorian interval, common in early Wisconsin time, and rare in late Wisconsin. It is not abundant, apparently, in Yarmouth or Sangamon time.

"This small *Succinea* has been identified as *grosvenori*, *avara*, and *vermeta*, and certain specimens resemble each of these species. In the paper in Journ. Geol., XXX, pp. 44-56, the writer referred the form to *vermeta* Say, a variety of *avara*. It is not this form, however, being smaller, with a rounder aperture and a relatively longer spire. It appears to be most nearly related to *grosvenori* Lea, the fossil resembling certain small or young specimens of that species. The aperture is, however, smaller, rounder and less elongated, and the shell is much narrower, besides being only about half the size of adult *grosvenori*. True *grosvenori* is reported from the Iowa loess by Shimek, but none have been seen from Illinois. *Gelida* occurs in the Iowan loess and some of the Iowa records of *grosvenori* may have been based on this form." (F. C. Baker.)

Fischer & Crosse have described a *Succinea lineata* W.G.B., var. *sonorensis*, from Yacque River, Sonora, Mexico (Dr. E. Palmer), in Mission Scientifique Mexique, Mollusques, 1:662, pl. 27, figs. 8-8b.

***Succinea wilsoni* Lea**

Fig. 445.

Succinea wilsoni Lea, 1864, Proc. Acad. Nat. Sci. Phila., p. 109; Jour. Acad. Nat. Sci. Phila. (2), 6:177, pl. 24, fig. 105.

“Shell obliquely elongate, very much striate, transparent, deep golden color and somewhat shining and thin; spire very much extended. Suture much impressed; whorls four, slightly convex; aperture somewhat large, ovate; outer lip somewhat expanded; columella thin, incurved and twisted. Diam. 0.3, length 0.66 inch.

“A single specimen only was sent to me some years since by Dr. Wilson, after whom I name it. It is a slender, symmetrical, graceful species, and is one of a group which may embrace *Wardiana* (nobis,) *Concordialis* Gould, *Haydeni* N. G. Binny, *vermeta* Say, and *retusa* (nobis). It has one more whorl than either of these species, and is quite as oblique as *retusa*. The color is richer than in any of them. The aperture is about seven-twelfths the length of the shell.” (Lea.)

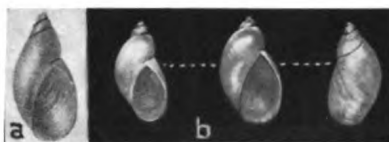


Fig. 445. *Succinea wilsoni*. a, Lea's type figure; b, St. Simon's Island, Georgia.

GEORGIA: near Darien, (type locality, S. W. Wilson, M.D.); St. Simon's Island (Wheatley and A. D. Brown collections).

Lea's type was somewhat larger and more slender than those seen from St. Simon's Island, two of which measure:

Length 13.4 mm., diam. 7 mm., length aperture 8.5 mm., $3\frac{1}{2}$ whorls.
Length 14 mm., diam. 7.8 mm., length aperture 9.25 mm., $3\frac{1}{2}$ whorls.

The length of the spire varies in these lots, as shown in the figures. The suture is deeply impressed. Surface is glossy, distinctly wrinkle-striate in some specimens, but only weakly so in others. The color is a translucent or dilute colonial buff throughout. The aperture is rather strongly oblique. The outer lip is a little sinuous, being slightly advanced in the lower-outer part.

It has not been dissected, and the position is uncertain.

***Succinea rusticana* Gould**

Fig. 446.

Succinea rusticana Gould, 1846. Proc. Boston Soc. Nat. Hist., 2:187; 1852, U. S. Expl. Exped., Mollusca and Shells, p. 28, pl. 2, fig. 29 (Oregon).—W. G. Binney, 1885, Man. Amer. Land. Sh., p. 159, fig. 144.—Dall, Harriman Alaska Exped., 13:58, with var. *alaskana*.—? Cockerell, Nautilus, 7:44.

“Shell elongate, ovate-conical, rather large, thin, and fragile; pale greenish horn-color, surface rude and without lustre, coarsely and irregularly marked by the lines of growth. Spire acute, of three or more moderately convex whorls, separated by a well-impressed suture, the last whorl large and long, narrowing towards the base; body portion of the face of the shell moderately large. Aperture ovate, three-fourths the length of the shell; fold of the columella distinct. Length of axis half an inch; breadth one-fourth of an inch.” (Gould.)

Length 11.8 mm. (Blue Lake, Grand Coulee.)

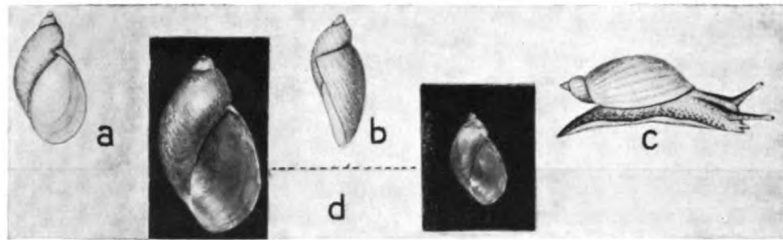


Fig. 446. *Succinea rusticana*. a, b, c, after Gould; d, Blue Lake, Grand Coulee, Washington. $\times 2$ and actual size.

CALIFORNIA: Tulare Valley (Dall). OREGON: (U. S. Exploring Exped., type locality). WASHINGTON: Blue Lake, Grand Coulee (Henderson). BRITISH COLUMBIA: Comox, Vancouver Island; Sumas Prairie Fraser River valley (Dall).

The last whorl is more oval, and the suture less deeply impressed than in *S. oregonensis* or *S. grosvenori*.

“Var. *alaskana* Dall, polished, of an olive greenish tinge, with rather inconspicuous lines of growth; with 3 tumid whorls, the general form of *rusticana* as figured by Binney, but shorter and more tumid; length 10, max. diam. 8, length of aperture 6.5 mm. This may prove, with more material, to be a distinct species. Flats near St. Michael, Alaska; Point Romanof; Unalaska; St. Paul; Kodiak Island.” (Dall.) Not figured and not seen by the author.

***Succinea stretchiana* Bland**

Figs. 437c, 447.

Succinea stretchiana Bland, 1865, Ann. Lyc. Nat. Hist. N. Y., 8:168, fig. 16.—W. G. Binney, 1878, Terr. Moll., 5:422, pl. x, fig. J, teeth; 1885, Man. Amer. Land. Sh., p. 158, fig. 142.—Cockerell, 1892, Nautilus, 6:31, with form *major*; cf. p. 72, and Nautilus, 7:46.

“Shell globose conic, thin, pellucid, shining, striatulate, greenish horn colored; spire short, rather obtuse; suture deep; whorls 3, convex, the last roundly inflated; columella arcuate, slightly thickened, receding; aperture oblique, roundly oval; peristome simple, with the margins joined by a thin callus. Length 6.25 mm., diam. 5 mm., aperture 5 mm. long, 4 wide in the middle.” (Bland.)

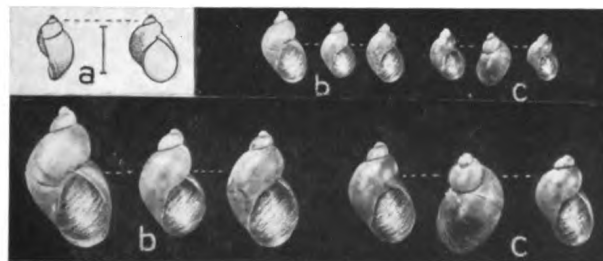


Fig. 447. *Succinea stretchiana*. a, Bland's original figures, scale line = actual length; b, Red Meadow; c, Palisade Creek. Actual size above and $\times 2$, lower line.

WYOMING: Green River City (Hemphill); Fort Bridger (Joseph Leidy). IDAHO: near Big Payette Lake (E. H. Ashmun); Cache Valley (Hemphill). UTAH: near Brigham City, 4500 feet, on low marshy land (H. Hemphill). NEVADA: Little Valley, Washoe Co., 6500 feet, on the eastern slope of the Sierra Nevada (Richard H. Stretch, Type loc.). CALIFORNIA: Bartles, McCloud River, Siskiyou Co., Duck Lake, 20 mi. w. of Susanville, Lassen Co. and Goose Lake, Modoc Co. (R. C. McGregor); Wacubah Spring, Inyo Co. (Ferriss); Yosemite Valley (C. B. Wurtz), and near Wawona, Sequoia Park, Mariposa Co. (H. N. Lowe); Pumice Flats, Red Meadow, and Jackass Dyke, Madera Co. (Ferriss); Grouse Meadow, Tehipite Valley and Pavilion Dome, Palisade Creek and Fish Creek, Fresno Co. (Ferriss); Giant Forest and Summit Meadow, near S. Fork King River, Tulare Co. (Ferriss); Funston Meadow, Kern Co. (Ferriss); Bluff Lake, San Bernardino Mts. (S. S. Berry).

This is a rather widely spread snail of the Sierra Nevada, but also occurring elsewhere, nearly uniform in the length of about 6 mm.; the largest seen, from a lot of smaller shells, measures 8.5 mm. (Fig. 437 c). They vary in degree of obesity and also in color. In middle California it is transparent, light yellowish olive or a more greenish cool tint, but in a lot from Bluff Lake in the San Bernardinos the color is warmer, subtransparent and somewhat dilute ochraceous orange.

It is shorter than is usual in *S. avara*, and the whorls are usually not quite so convex; but a few outlying lots, such as that recorded from Payette Lake, Idaho, are much like the larger species *avara* and *gabbi*. A paratype is the only specimen as short as the type which I have seen. All others are somewhat longer, as the figures (Fig. 447) show. Further comparison of Nevada and California material is desirable. *S. stretchiana* may be a *Quickella*.

"There is a form *major* Ancey, *ms.* (sine descr.), nearly twice the size of the type, recorded by Yarrow, from Pagosa, Colo." (Cockerell.) Dubious! and the name is preoccupied.

SUCCINEA CAMPESTRIS GROUP (Section *Calcisuccinea*, new sect.)

Succineae having a slender penis in a very ample sheath, from which the epiphallus emerges; the end of the vas deferens is enveloped in the penial retractor and the sheath; vagina extremely short or almost absent. Jaw with a median projection only. Type *S. campestris* Say.

The shells in this group (which is a subdivision of *Novisuccinea*) have a tendency to be earthy and opaque, and there is very little pigment in either shell or soft parts, except in *S. concordialis*, which is placed here with doubt.

Succinea campestris Say

Fig. 448.

Succinea campestris Say, 1817, Jour. Acad. Nat. Sci. Phila., 1: 281 (Sea Islands of Georgia and Cumberland Island; Amelia Island, N. E. Florida).—Binney, 1851, Terr. Moll., 2: 67, pl. 67b, fig. 1.—W. G. Binney, 1878, Terr. Moll., 5: 426; 1885, Man. Amer. Land Sh., p. 443, fig. 489.

Succinea inflata Lea, 1844, Trans. Amer. Philos. Soc., 9: 5; Obs. Genus Unio, 4: 5 (South Carolina).

The shell is short and wide, oval, with very short spire and ample aperture; opaque whitish or pale buff streaked with translucent gray (or in some shells, translucent gray with a faint yellow tint and usually some buff

streaks); not glossy, as there is a weak, irregular, microscopic granulation; the sculpture otherwise of low wide axial wrinkles and often some coarse weak malleation. The $3\frac{1}{3}$ to $3\frac{1}{2}$ whorls are very strongly convex, the suture deeply impressed. Aperture wide, ovate, about 73 to 75 percent of the total length of the shell, the outer margin regularly arched, columella margin deeply concave in the middle; base broadly arcuate. Interior cream colored or white.

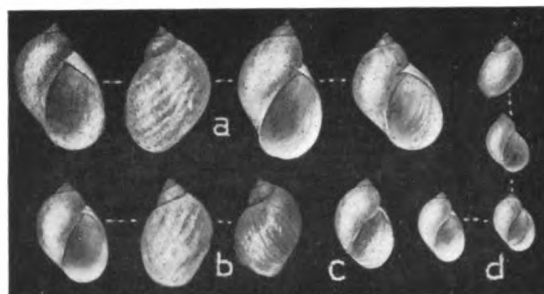


Fig. 448. *Succinea campestris*. a, Clearwater Island; b, Sullivan's Island; c, Piver's Island, Beaufort; d, Atlantic Beach, N. C.

“Length not quite three-fifths, breadth seven-twentieths of an inch,”
(Say).

Length 15.0 mm., width 10.5 mm., aperture 11.2 mm.

Length 14.2 mm., width 9.8 mm., aperture 10.5 mm. Sullivan's I.

Length 13.0 mm., width 9.0 mm., aperture 9.6 mm. St. Simon's I.

Length 17.0 mm., width 11.5 mm., aperture 12.6 mm. Clearwater I.

Length 9.4 mm., width 6.8 mm.; $3\frac{1}{4}$ whorls. Volusia Co.

Length 11.0 mm., width 7.3 mm., aperture 8.2 mm. Beaufort.

FLORIDA: Amelia Island, Nassau County (Say); Mayport, Duval Co. (M. A. Mitchell); St. Augustine (C. W. Johnson *et al.*); New Smyrna, Volusia Co. (S. A. West); Sanford, Orange Co. (Pilsbry); Clearwater Island, south end (J. B. Clark). GEORGIA: Sea Island (Say); St. Simon's Island (Wheatley); near Savannah (I. R. Tompkins). SOUTH CAROLINA: Edisto Beach (Ruth Patrick); Fort Sumter, Sullivan's Island and Isle of Palms (Mazzyk). NORTH CAROLINA: Southport, Brunswick Co. (Pilsbry); Beaufort (McLean); Piver's Island at the base of coarse grass, and Atlantic Beach on grass in dunes (Mrs. A. G. Hackney).

The globose shell of not over $3\frac{1}{2}$ whorls, the short spire and the opaque white or whitish-streaked coloring, characterize this mainly coastwise species.

The northern specimens are small, 10 to 11 mm. long around Beaufort, N. C., typically colored or often with pinkish apex. *Succinea inflata* Lea was based upon such small specimens, the length given as 0.45 inch. Some inland Florida lots also contain only small shells. The large series from Clearwater Island contains some of the largest specimens seen. This place is remote from the well-known range, being the only locality known to me on the west coast. However, Bryant Walker has reported *S. campestris*

from Nanna Hubbard Bluff, Mobile, Alabama (1928, Terr. Moll. Alabama, p. 167). The specimens reported from Long Key, Florida (Nautilus, 7:45) are *S. l. floridana* Pils.

Say gave this description of the living snail: "Animal whitish; eyes, inferior tentacula and a line passing from the eyes, disappearing under the shell, black; a gamboge colored vitta is visible through that part of the shell which is opposed to the mouth." In St. Augustine W. G. Binney found them mating in December.

The soft parts of rather small specimens (length of shell 10.8 mm.) from Beaufort, N. C., are light colored, the mantle not pigmented over the lung and visceral mass. The broad kidney is light buff. The hermaphrodite duct is voluminous and yellowish, scarcely at all pigmented. The seminal vesicles are short, oval. The penis appears stout but most of the thickness is in the very thick sheath, the penis proper being slender, with a large cavity (Fig. 449 a). The epiphallus is recurved, with terminal retractor, which continues to the sheath. The vas deferens is bound to the penis sheath for some distance. Vagina practically not existing, as the long, slender spermathecal duct arises close to the atrium (Fig. 449 A).

The great thickness of the penial sheath is an unique feature separating this snail from all species otherwise resembling it. I regret that I have not been able to dissect topotypes.

Succinea luteola Gould

Fig. 450.

Succinea luteola Gould, 1848, Proc. Boston Soc. Nat. Hist., 3:37 (Texas).—Von Martens, 1898, Biol. Centr. Amer., Moll., p. 331.—Cockerell, Nautilus, 7:43.—Frierson, 1900, Nautilus, 14:68.—Pilsbry, 1906, Proc. Acad. Nat. Sci. Phila., p. 158.

Succinea luteola, in part, Gould, 1851, in Binney, Terr. Moll., 2:75, pl. 67c, fig. 1.—W. G. Binney, Terr. Moll., 5:419.

Succinea texasiana Pfeiffer, August, 1848, Mon. Hel. Viv., 2:526; 1849, Roemer's Texas, p. 456; Conchyl. Cabinet, Succinea, p. 42, pl. 4, figs. 21-23 (Galveston).

"*Succinea citrina* Shuttl.", Pfeiffer, 1859, Mon. Hel. Viv., 4:815 (undescribed, in synonymy of *S. luteola*).

Succinea lutescens Sowerby, 1872, Conchologia Iconica, 18, pl. 10, figs. 67a, b (Texas).

"The shell is variable, ovate-turritid, rather solid, striate, externally white or corneous but usually buff, inside yellowish (*lutea*); whorls 4, the upper rounded, the last conic-ovate; aperture moderate, ovate, slightly exceeding half of the length; columella normally arched, scarcely folded; narrowly reflected in the umbilical region. Length one-half, width one-fourth of an inch." (Gould.)

a. Length 14.3 mm., diam. 7.4 mm., aperture 9.2 mm.; 3½ whorls.

b. Length 12.8 mm., diam. 6.8 mm., aperture 7.3 mm.

c. Length 11.3 mm., diam. 6.3 mm., aperture 7.6 mm.; 3¾ whorls.

d. Length 14.7 mm., diam. 7.6 mm., aperture 8.4 mm.; 4 whorls.

d. Length 12.5 mm., diam. 7.2 mm., aperture 8.4 mm.; 3¾ whorls.

d. Length 9 mm.; 3½ whorls.

(a, Derby, Frio Co.; b, Texas specimen from Gould; c, Galveston; d, High land west of Devil's River.)

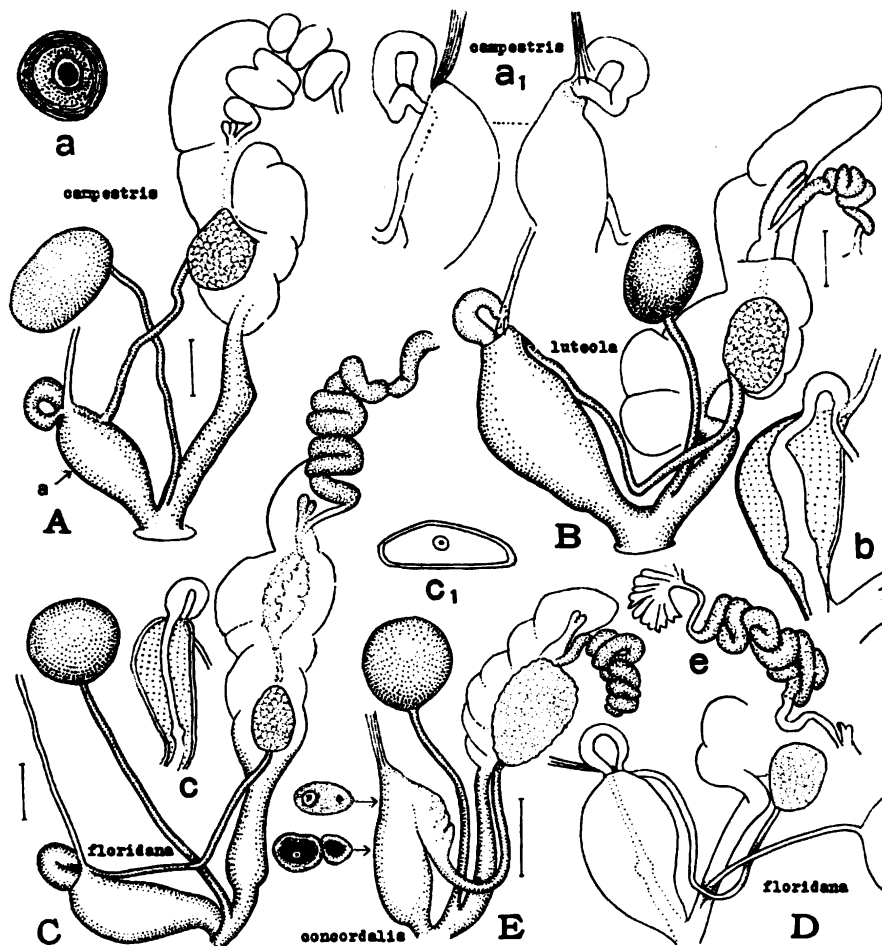


Fig. 449. A, *Succinea campestris*, Beaufort; a, section of penis. a₁, penis of another individual, from above and below. B, *S. luteola*, Freeport, Texas, with diagram of opened penis sheath at b. c, *S. luteola floridana*, Long Key, with diagram of opened penial sheath at c, and section midway of penis at c₁. D, Anterior genitalia, Grassy Key. E, *S. concordialis*, Del Rio, with two sections of penis and epiphallus; e, hermaphrodite duct of another specimen. Scale lines = 1 mm.

LOUISIANA: Cheniere aux Tigre, Vermillion Parish (Wharton Huber). TEXAS: Dallas Co. (A. A. Hinkley); Waco (Hemphill); Galveston (Gould, Römer, Pilsbry); near Freeport, Brazoria Co. (C. D. Orchard); Houston (A. C. Chandler); Austin (Pilsbry); San Antonio (Pilsbry); Macdona, Bexar Co. (Wenzel); New Braunfels, Comal Co. (Singley); Hondo, Medina Co. (Pilsbry); Maverick Co. (Julia Gardner); Colorado City, Mitchell Co. (Ferriss); Rio Grande City, Starr Co. (Ferriss); Lyford and Brownsville, Cameron Co. (Ferriss); Alice, Jim Wells Co. (C. B. Orchard); Sabinal, Uvalde Co. (G. H. Clapp); Val Verde Co. at Del Rio, high land west of Devil's River, High Bridge of the Pecos, Langtry (Ferriss and Pilsbry); Dryden (Ferriss) and Sanderson, Terrell Co. (Hebard and Rehn); Alpine (Ferriss); NEW MEXICO: near Las Vegas (Mary Cooper). ARIZONA: Laguna Canyon, Navajo Co. (Ferriss). MEXICO: widely spread.

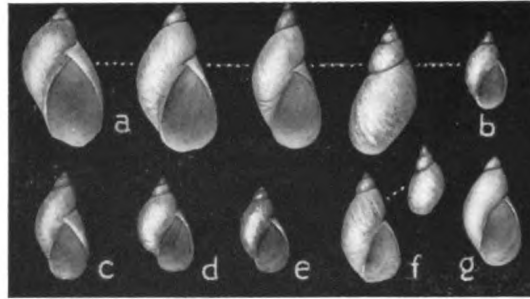


Fig. 450. *Succinea luteola*. a, b, Brownsville; c, Derby, Frio Co.; d, Texan specimen from Gould; e, Galveston; f, Devil's River, Val Verde Co., Texas; g, Laguna Canyon, Navajo Co., Arizona.

In Gould's original description the only locality given was Texas. In the *Terrestrial Mollusks* he states "found in Florida, and more abundantly in Texas, especially in the region of Galveston." Specimens collected at Galveston by the author in 1885 agree perfectly with Gould's figures, and that place may be accepted as the type locality.

In this species the shell tapers toward the spire more than in *S. floridana*, the sides being more flattened above the periphery. It has the opaque texture of that snail, and is usually slightly buff, sometimes distinctly pale yellow, though not as deeply colored as some of the Florida species. The relative length of the aperture may vary rather widely in the same lot. In one of the specimens received from Gould the aperture is 57 percent of the length, but it varies up to about 64 percent.

In the southern counties of Texas *S. luteola* reaches larger size than in other parts of the state. At Rio Grande City, Starr Co., the extremes are 11 and 15 mm. long, with $3\frac{3}{4}$ and $3\frac{3}{8}$ whorls respectively. At Lyford, Cameron Co., 12.3 to 14.5 mm. long. The largest are from Brownsville. They are opaque white, faintly yellow inside, and as in most other lots the ratio of the apertural to total length is variable. It is somewhat disconcerting to find some small, but apparently adult shells in lots of large ones, but other species of this genus show the same anomaly. Those measured are figured.

Length 19.4 mm., diam. 10.4 mm., aperture 12.4 mm.; $3\frac{3}{8}$ whorls.

Length 18.3 mm., diam. 10.7 mm., aperture 13.3 mm.; $3\frac{1}{2}$ whorls.

Length 19.3 mm., diam. 9 mm., aperture 11.3 mm.; 4 whorls.

In this lot there are also a few small ones, length 10 mm., $3\frac{1}{2}$ whorls.

Genitalia (Fig. 449 B, b) from Freeport, Texas, characterized by the very ample penis, as in *S. campestris*; but the breadth is mainly in the thin sheath, which encloses a true penis of moderate size. Epiphallus looped, with terminal retractor. Vas deferens enveloped for a short distance by the retractor and penial sheath.

Succinea luteola floridana Pilsbry

Fig. 451.

Succinea luteola in part, Gould, 1851, Terr. Moll., 2:75.—W. G. Binney, in part, 1885, Man. Amer. Land Sh., p. 441.

Succinea floridana Pilsbry, 1905, Nautilus, 19:40.—Walker, 1928, Terr. Moll. Alabama, p. 168, fig. 265.

Shell obesely ovate, thin but strong for the genus, opaque flesh-tinted or pinkish-white, marked with corneous-fleshy streaks, and usually a few scattered clear dots, readily seen by holding the shell up towards the light; apical whorl usually reddish-brown. Interior more or less deeply *tinted*

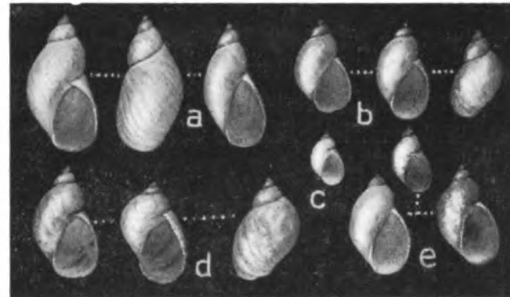


Fig. 451. *Succinea luteola floridana*. a, Boca Chica Key; b, Big Pine Key; c, Boca Chica Key; d, Long Key; e, Key West.

with ochre-yellow. Whorls $3\frac{1}{2}$ to $3\frac{3}{4}$, very convex, the last whorl evenly convex. Sculpture of fine, unequal growth-lines and coarse but low wrinkles, with some indistinct malleation on the last whorl. Aperture ovate, short; outer lip well arched; columella oblique and nearly straight.

a. Length 11.7 mm., diam. 6.6 mm., aperture 6.8 mm.

a. Length 12.2 mm., diam. 7 mm., aperture 7.5 mm.; $3\frac{3}{4}$ whorls.

Type.

a. Length 12.6 mm., diam. 7 mm., aperture 8 mm.

b. Length 14.1 mm., diam. 9.3 mm., aperture 10 mm., $3\frac{1}{2}$ whorls.

c. Length 15 mm., diam. 8.5 mm., aperture 8.8 mm., 4 whorls.

c. Length 13.7 mm., diam. 8.8 mm., aperture 8.9 mm., $3\frac{1}{2}$ whorls.

d. Length 14.8 mm., diam. 9 mm., aperture 9.1 mm., 4 whorls.

(a, Big Pine Key; b, Key West; c, Long Key; d, Grassy Key.)

FLORIDA: probably all of the keys; seen from Key West, Boca Chica, Sugarloaf, Cudjoes, Summerland, Big Pine (Type 87358 A.N.S.P.), Little Pine, Vaca, Grassy, Long Key, Lignum Vitae and Biscayne Key. On the west coast seen from Marco and neighboring localities; Cayo Tuna, San Carlos Bay; Mound Island, Estero Bay; Sanibel Island; Ft. Myers; Boca Grande Pass, Charlotte Harbor; Little Gasparilla Island, and Pass-a-Grille; southern end of Clearwater Island. ALABAMA: reported by Walker from the following counties: Baldwin, Dallas, Montgomery, Perry, Sumter and Wilcox.

S. l. floridana is usually more solid than *S. luteola*, with the upper part of the last whorl more convex. The last whorl is usually shorter, and the ochreous color of the aperture is often decidedly more pronounced. It is less inflated than *S. campestris*, with longer spire. But it varies rather

widely in shape, as the measurements and figures show, and the relationship with *S. luteola* is so intimate that Gould and W. G. Binney thought that the Floridan and Texan shells were specifically the same. Gould's later description of *luteola*, copied by W. G. Binney, applies better to *floridana* than to Texan *luteola*, and was probably composite. The clear dots mentioned in the original description are very often absent.

Many years ago I collected a large lot of noticeably different shells on Boca Chica Key (100071 A.N.S.P.). These shells approach the large form of *S. luteola* very closely, and indeed may be referable to that species, the spire being more slender and drawn out than in any other lot of *floridana* from the Keys, but not so much flattened as in *S. sanibelensis*. A specimen measures: length 18.1 mm., diameter 9.3 mm., length of aperture 10.5 mm., $4\frac{1}{2}$ whorls; another, 17.8 mm. long, has 4 whorls. These are photographed in Fig. 451 a.

In another lot from Boca Chica Key, collected for Clarence B. Moore (96982 A.N.S.P.), the largest are 7 mm. long with 3 whorls, Fig. 448 c. In texture and color these pigmy specimens resemble typical *S. l. floridana*, and with some doubt I refer them to that subspecies.

The localities for *floridana* are all near or on the coast but this may be an accident of collecting. It is a common species on coasts of the lower half of the peninsula, but Bryant Walker has reported it from many places in the southern half of Alabama. I have not seen the Alabama specimens.

Succinea citrina Shuttl[e]worth], from Florida (Pfeiffer, 1859, Mon. Hel. Viv., 4:815), was doubtless this species; but since it was never described, being defined only by being placed as a synonym of *S. luteola*, the name could not be used properly in any other connection.

Specimens were dissected from Long Key No. 87443, ANSP. and from Grassy Key.

The penis appears short and very capacious, but when opened the penis proper is seen to be very slender, occupying only a small part of the cavity of the sheath, as in the sections, Figs. 449 c and d. The epiphallus extending beyond the sheath is somewhat dilated and recurved (Figs. 149 c and d), with terminal vas deferens enveloped by the penial retractor, which arises from the sheath. The retractor is extremely long and slender. The vas deferens descends to near the peni-oviducal crotch, then ascends to the small prostate gland, which is not pigmented. A vagina can hardly be said to exist as the long, slender spermathecal duct arises nearly at the atrium. The free oviduct is stout and muscular, with an annular enlargement near the atrium, in one drawn from Long Key, wanting in Grassy Key specimens. The seminal vesicles and hermaphrodite duct are pale gray, being very lightly pigmented.

Whether *floridana* is a peninsular subspecies of *luteola*, or a distinct species, remains for further investigation. The differences in the shells are

certainly not very prominent. In a number opened from two localities, *floridana* shows the penis to be far more slender than *luteola*, but I have dissected the latter from only one place.

***Succinea concordialis* Gould**

Figs. 452 a-h, 453, 454.

Succinea concordialis Gould, 1848, Proc. Boston Soc. N. H., 3:38 (Lake Concordia); 1851, in Binney's Terr. Moll., 2:82, pl. 67a, fig. 2.—W. G. Binney, 1878, Terr. Moll., 5:418; 1885, Man. Am. Land Sh., p. 441.—Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 159, figs. 11, 12 (distribution, living animal).—F. C. Baker, 1939, Fieldbook Ill. Land Sh., p. 123, figs.

Succinea munita Binney, 1851, Terr. Moll., 1:128 (nude name), teste W. G. Binney. *Succinea forsheyi* Lea, 1864, Proc. Acad. Nat. Sci. Phila., p. 109; Jour. A.N.S.P. (2), 6:178, pl. 24, fig. 107 (Rutersville, Texas).

Succinea haleana Lea, 1864, Proc. Acad. Nat. Sci. Phila., p. 109 (Alexandria, La.).

Succinea halei Lea, Jour. A.N.S.P. (2), 6:180, pl. 24, fig. 110. (Variant spelling of *S. haleana*.)

Succinea witteri Shimek, 1913, Nat. Hist. Bull. State Univ. Iowa, 6:31, pl. 1, figs. 1-1v (Coralville and Iowa City).

“Shell obliquely ovate, elongate, reflexed, apex acute, thin but firm, transparent, shining, feebly striated lengthwise and spirally, color pale honey-yellow, with the tip ruddy; whorls three and somewhat more, very oblique, the two uppermost very small, outer whorl somewhat compressed above the middle; suture well marked; aperture ample, not less than two-thirds the length of the shell, well rounded at base; columella regularly arcuated, more so than the outer lip, simple, but its upper portion is reflexed

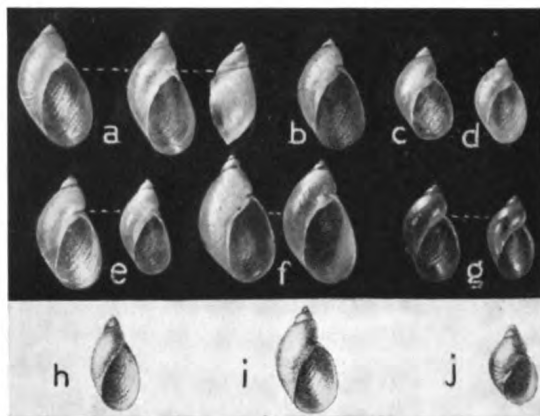


Fig. 452. *Succinea concordialis*. a, San Marcos, Texas; b, Bayou Pierre, Louisiana; c, Del Rio, Val Verde Co., Texas; d, Rutersville, Texas (*S. forsheyi*, specimen from Lea); e, Del Rio, Texas; f, Mayport, Florida; g, Micco, Florida. h, *S. forsheyi* (after Lea). i, *S. grosvenori* (after Lea). j, *S. moorsiana* (after Lea).

and raised so as to form a marginal wall to the aperture, as it enters the shell, and produces a slight fold where it disappears within the spire; a broad, thin callus covers the left margin, which is slightly detached anteriorly, so as to form the rudiment of an umbilicus. Length, half an inch; breadth, one-third of an inch.” (Gould.)

TEXAS: San Marcos, Hays Co. (Pilsbry); Lee Co. (Singley); Rutersville, Fayette Co. (Lea, for *S. forsheyi*). Spring Creek, Victoria Co. (J. D. Mitchell); New Braunfels, Comal Co. (Pilsbry); San Antonio, Bexar Co. (Pilsbry); Val Verde Co. at Del Rio, Devil's River, etc. (Ferriss & Pilsbry). LOUISIANA: Lake Concordia (Bartlett, type loc.); Bayou Pierre, De Soto Parish (Geo. Williamson); Frierson, De Soto Parish (L. S. Frierson). ARKANSAS: Sulphur City, Washington Co. (A. D. Brown). MISSOURI: Galena (Hinkley); near Eureka, St. Louis Co. (Hubricht). ILLINOIS: Canton (J. Wolf); Athens (E. Hall); bank of Little Muddy River near Dubois (Hinkley). IOWA: near Des Moines and Valley Junction, Polk Co. (Van Hynning); Iowa City and Coralville (B. Shimek, for *S. witteri*). TENNESSEE: Davidson Co. (S. N. Rhoads); Tennessee R. near Knoxville (Mrs. Geo. Andrews). ALABAMA: Florence and Cypress Creek, Lauderdale Co. (Hinkley). FLORIDA: Mayport, Duval Co. (M. A. Mitchell); Panosoffkee, Sumter Co. (C. C. Allen); Micco, Brevard Co. (F. C. Baker).

It lives on the moist earth immediately adjacent to the water's edge, and where found is usually abundant. The type locality, Lake Concordia, is not in Texas, as Gould and Binney supposed, but in Louisiana. The lake is an abandoned oxbow of the Mississippi river, opposite Natches, Mississippi. Some of Lea's original lot of *S. halei* (*haleana*) before me show that to be merely the young of *concordialis*. *S. forsheyi* Lea, of which two paratypes are in the Philadelphia collection, is surely identical with *concordialis*.

It is a thin shell, rather deeply amber-colored, with the apical whorls darker, reddish-orange. Whorls $3\frac{1}{2}$, the last deeply descending, somewhat flattened above, *very convex basally*, having thus a more sack-like contour than *S. retusa*; this being its chief peculiarity. The sculpture consists of rather coarse wrinkles and often some indistinct spiral impressions on the last whorl. The aperture is symmetrically ovate, the columella concave throughout, with a delicate fold above. Large specimens from San Marcos, Texas, measure:

Length 16.8, diam. 9, length of aperture 11.5, width 6.7 mm.

Length 16, diam. 8, length of aperture 10.5, width 6 mm.

The mantle is intensely black, dappled throughout in the last whorl with rounded yellowish spots. Those above the kidney are brighter, more conspicuous and usually larger, often more or less confluent. Towards the edge

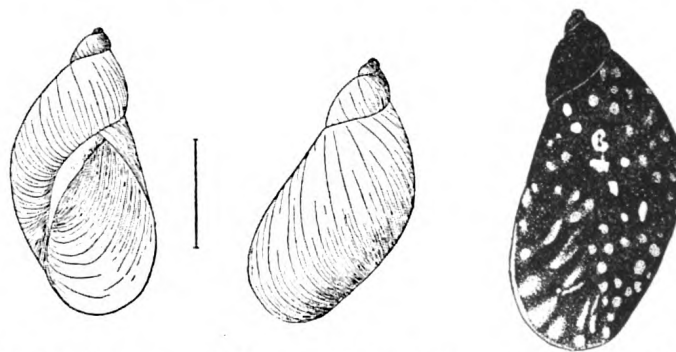


Fig. 453. *Succinea concordialis*, San Marcos, Texas. Shells, the scale line actual length, and mantle markings of living animal seen through the shell, $\times 3$.

of the mantle the spots are large and lengthened. The foot, including head and eye-stalks, is pale grayish-white, speckled with irregular grayish-black spots. The sole is pale yellow. The color and markings of the mantle are substantially the same in all colonies we found in Texas, though there is individual variation in the size of the light spots, the figure representing one of the darker individuals. The black color of the mantle remains in specimens in alcohol more than forty years. The mantle edge and the foot are sparsely spotted with black.

Mr. Van Hyning noted on the label of specimens from Des Moines, Iowa, that "the animal is black with small yellow dots".

In western Texas the shell is smaller, down to about 11.5 mm. long. Those from Iowa measure about 13 or 14 mm. (Des Moines) or longer, up to 17.5 mm. long at Iowa City, where it has been described as *S. witteri* Shimek.

Specimens from Mayport, northeastern Florida, Fig. 435 f, are very pale colored with rusty summit, and do not appear to differ materially from some western *concordialis*. Two measure:

Length 15.8 mm., diameter 9 mm., aperture 11.2 mm.; $3\frac{1}{2}$ whorls.

Length 16 mm., diameter 8.8 mm., aperture 11 mm.

Those from Brevard County, Florida, are smaller and thinner, pale yellow, about 12 to 13 mm. long. Mantle color is unknown in the Floridan lots.

The genitalia were examined in rather small specimens from Del Rio, Texas, length 12 mm. The genital orifice is a short slit. The twinned seminal vesicles are not pigmented and the very complexly knotted hermaphrodite duct is only very lightly pigmented. The carrefour is rather capacious. Prostate gland is large. The penis is quite slender, in a moderately capacious, rather thick sheath. The penial retractor is attached at the penial end of the epiphallus, not at the vas deferens end, as in *S. campestris*. The epiphallus is very capacious in some examples, of more moderate size in others, and part of its length is bound into the penial sheath. The vagina is extremely short. Fig. 449 e.

While this species resembles the *campestris* group by the proportions of the penis and its sheath, and the very short vagina, it diverges widely from that group by the black pigmentation of the mantle and the relations of penial retractor and epiphallus. Other less important differences are the large prostate gland and the texture of the shell. An isolated species.

Succinea witteri Shimek was based upon a northern form of *S. concordialis*, a species which Shimek apparently did not compare. The original description follows:

"*Shell*: Ovate-conic, rather heavy for a species of this genus; whorls $3\frac{1}{2}$, somewhat rounded, but more or less flattened below the suture, forming a slight shoulder, or even constricted by a shallow spiral groove which leaves the shoulder a low ridge following the suture, this being most prominent on

the body-whorl; the spire is elevated, and on account of the flattening of the whorls, quite regularly conical, forming a third or more of the length of the shell; body-whorl relatively large, but not greatly expanded, its upper contour being distinctly flattened; aperture ovate, broadly rounded below, acute above, its columellar margin somewhat incurved by an indistinct columellar fold; the peristome sharp, very oblique to the axis of the shell in side view, and in this view usually slightly sigmoid; the surface is covered with distinct lines of growth which are more or less unequal, and crossed by irregular, unequal and interrupted spiral grooves which are especially prominent on the body-whorl; the color is a distinct yellow, deeper at the apex, sometimes approaching orange.

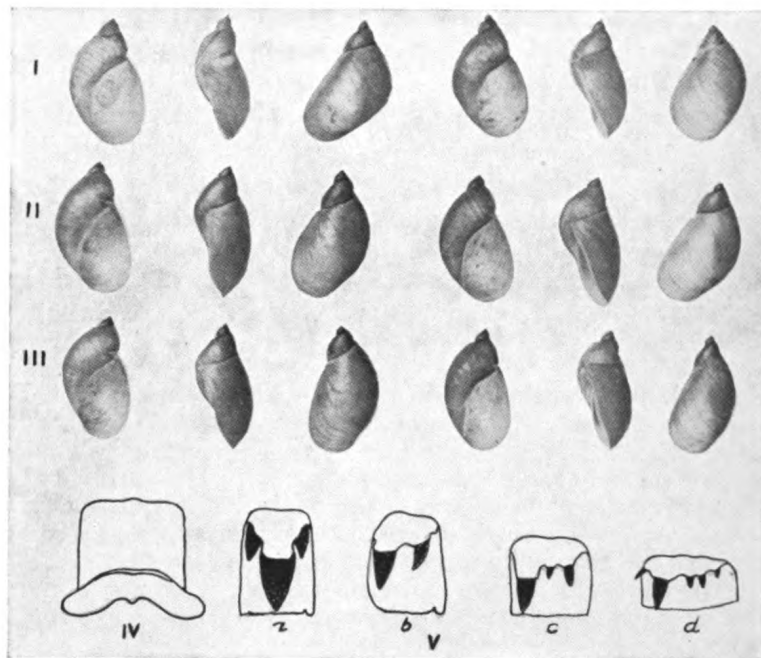


Fig. 454. *Succinea witteri* (= *concordialis*). After Shimek.

Length 17 mm., width 10 mm., aperture 11.5×6.5 mm.

Length 15 mm., width 8 mm., aperture 10×5 mm.

“*Jaw*: Strongly arcuate, the ends rounded and enlarged, the convex margin somewhat wavy, the concave margin with a single blunt central projection. (See fig. 454:IV.) *Radula*: The radula shows 1 row of central teeth, and 9 rows of lateral and 19 rows of marginal teeth on each side. The outer one of the two side cusps of the laterals is quite uniformly larger. (See fig. 454:V.)” (Shimek.)

SUCCINEA AVARA GROUP

Shell slender with produced spire and short, strongly convex whorls.

The shell resembles the European *S. oblonga* Drap., type of the section *Hydrophyga* Lindholm. The genitalia show remarkable differences in the

few specimens dissected, some being like *Succinea s. str.*, others resembling *Novisuccinea*. As I do not have specimens from the type region of *S. avara*, this species is superficially treated here, being left for further study by someone who can dissect long series from all over the range of *avara*-like forms.

***Succinea avara* (Say)**

Fig. 455 a to k.

Succinea avara Say, 1824, in Appendix to Keating's Narrative Exped. source St. Peter's River, etc., Major Long's Second Expedition, 2:260, pl. 15, fig. 6 (Northwest Territory).—Binney, 1851, Terr. Moll., 2:73, pl. 67c., fig. 4.—Lewis, 1868, Amer. Jour. Conch., 4:244 (variations etc.).—W. G. Binney, 1878, Terr. Moll., 5:420, pl. 67c, fig. 4; pl. x, fig. κ.—Hemphill, 1901, Nautilus, 14:125, pl. 1, fig. 4 (California).—Dall, 1905, Harriman Alaska Exped., 13:57.—G. D. Hanna, Nautilus, 36:106 (Rancho la Brea).—Henderson, 1924, Univ. Colo. Studies, 13:159; 1936, 23:114 (references and localities in Colorado, Wyoming, Utah and Idaho).—Chamberlin and Jones, 1929, Bull. Univ. Utah, 19, no. 4, p. 117, fig. 55, left.

Succinea vermeta Say, 1829, New Harmony Disseminator, 2:230.—W. G. Binney, 1885, Man. Amer. Land Sh., p. 343.

Succinea wardiana Lea, 1841, Proc. Amer. Philos. Soc., 2:31.

Succinea venusta W. G. Binney, cited as a typographical error, Man. Amer. Land Sh., p. 343.

Succinea avara var. *major* W. G. Binney, Proc. Acad. Nat. Sci. Phila., 1858, p. 199 (nude name).—Cockerell, 1893, Nautilus, 7:44 (Utica, N. Y.).

Succinea avara var. *compacta* Cockerell, 1892, Jour. of Conch., 7:39.

Succinea avara Say forma *alba* Cockerell, 1893, Nautilus, 7:43 (Custer Co., Colo.).

[*Succinea*] *poeyensis* Wolf, W. G. Binney, 1885, Man. Amer. Land Sh., p. 497 (without description; name cited as a form or synonym of *S. avara* Say; but name is apparently an error for *peoriensis* Wolf).

[*Succinea*] *illinoisensis* Wolf, W. G. Binney, 1885, Man. Amer. Land Sh., p. 447 (as a form or synonym of *S. avara* Say, from Illinois, No. 39768 U.S.N.M. No further description).

The shell is slender, the diameter contained about one and three-fourths times in the length, fragile; pale yellowish (varying from a greenish to an ochraceous or a pinkish tint). Surface irregularly wrinkled, coarsely so on the latter part of the last whorl; usually daubed or coated with earth. Slightly more than 3 whorls, which are very strongly convex, the suture deep. The aperture is ovate, two-thirds the length of the shell or less.

Length 9 mm., diameter 5.5 mm. Dutchess Co., N. Y.

Length 11 mm., diameter 6.8 mm. Herkimer Co., N. Y.

Length 7 mm., diameter 4 mm. Herkimer Co., N. Y.

There is a distinct "locomotive disc," half to two-thirds the width of the sole. In rapid movement it shows forwardly moving waves with oscillatory backward movement between them. The mantle under the shell is beautifully spotted with opaque white and black on a pale gray ground; tentacles black. The sole is either of uniform pale tint or peppered with black.

Distribution.—Newfoundland; Ontario north to James and Hudson Bays; north to Lat. 62° on the Mackenzie River; British Columbia; south to Florida in the east and to northern Mexico in the west. Some marginal localities follow.

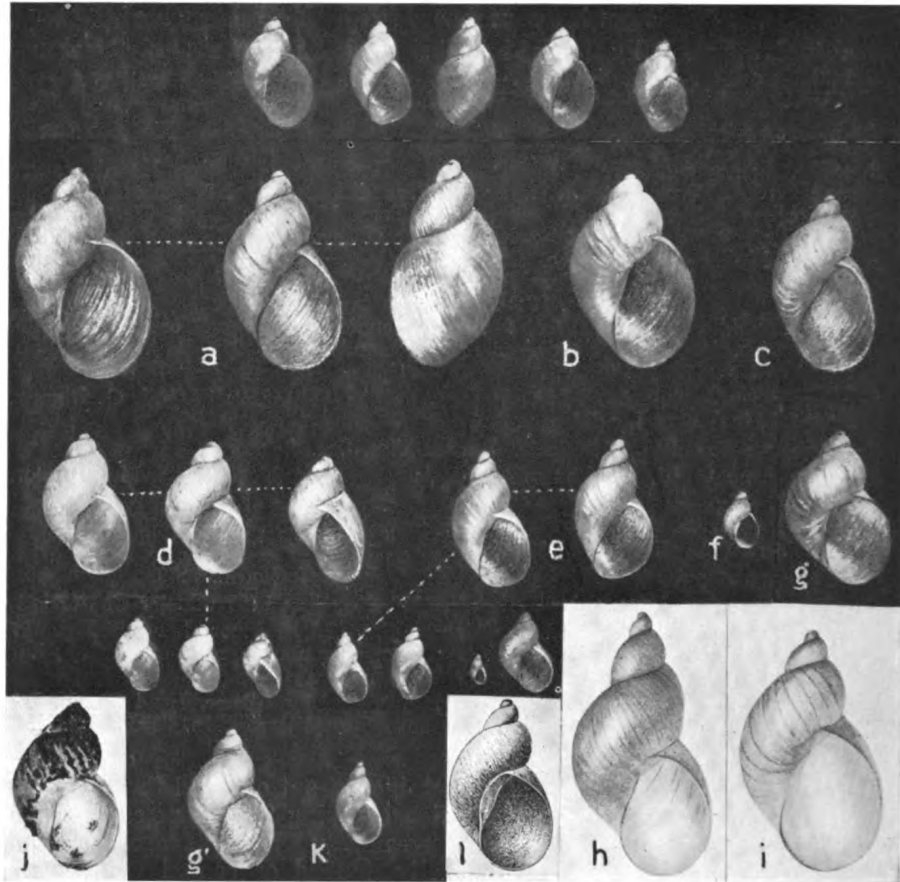


Fig. 455. *Succinea avara*, actual size and $\times 2$. a, Edgeworth, Pa.; b, Caslar Point, Sandusky Bay, Ohio; c, Des Moines, Iowa; d, meadows, Sea Isle City, N. J.; e, Porterville, Tulare Co., Cal.; f, Miami, Fla.; g, g', New Affton, St. Louis Co., Mo.; h, j, Cambridge, Mass.; i, Winfield, Herkimer Co., N. Y.; k, Julian, San Diego Co., Cal. l, *Succinea rusticana guadelupensis* photographic copy of original figure, Guadalupe Island, Baja California.

NEWFOUNDLAND: Straits of Belle Isle and many other localities (Bayard Long). NOVA SCOTIA: Cape Breton I. (B. Long). ONTARIO: Butler I. in Moose River near Moose Factory (H. G. Richards); White Mud River at Clear Hills, Peace river district (J. B. Clark). ALBERTA: Banff (R. C. Crosby); Near Laggan above Lake Louise about 8,000 feet elevation (Mrs. Chas. Schaeffer). BRITISH COLUMBIA: Field (S. Brown); Victoria (Mrs. Chas. Schaeffer). MINNESOTA: "Northwest Territory" (Thomas Say, Type 59542 A.N.S.P.). FLORIDA: Miami. TEXAS: throughout the state. NEW MEXICO: and ARIZONA: mountains throughout the states. CALIFORNIA: San Nicolas Island, fossil.

More than 250 lots in the collection of the Academy as well as many published records, show the occurrence of this snail in all of the states, but in the Pacific states there is some confusion with *S. gabbi* and other species.

Succineas which do not seem distinguishable from *S. avara* and usually associated in lots with shorter shells formerly referred to *S. oregonensis*, turn up in many places in Washington, Oregon, Idaho and also in Nevada, such as the following lots: Blue Lake, Grand Coulee (R. E. Snodgrass), and near Yakima (Eyerdam), Washington; Fort Creek, north of Klamath Indian Agency building, Oregon (J. Henderson); Symand's Canyon, near Pyramid Lake, Nevada (J. H. Paine). The same condition is found in some Californian lots referred to *S. oregonensis*. The relations of some lots of these species probably cannot be understood without a comparative study of the anatomy.

On some of the Californian islands, fossil, presumably Pleistocene, succineas similar to *avara* occur, such as those figured by Hemphill.⁷⁴

S. avara is usually found on vegetable debris thrown up on muddy shores, or crawling on the muddy banks of ditches, often exposed to the sun; also in swampy places in pastures, as I have found it in Essex County, N. Y. But it is an upland species as well, to be seen under stones with Pupillidae, or occasionally after rains crawling up the trunks of trees. In such relatively dry places it does not reach the size of individuals living in humid situations. Fig. 455 j represents a typical *S. avara* in its natural dirty coat.

Though conspicuous differences in texture, size and shape, at least partly correlated with station, are seen in specimens from most parts of the wide range of *S. avara*, I have not been able to satisfy myself that there are any subspecific forms. I am disposed to view the variations as direct reactions to environment, the small upland form (typical *avara*) being to some extent a "hunger form", while that called *S. avara vermeta* is the full development of the species in humid places. However, the variations observed in the genitalia may indicate the existence of several species or races.

The form known as *Succinea vermeta* Say, described "from the margins of ponds near New Harmony, Indiana," is remarkable for the very deep indentation of the suture, giving the whorls of the spire the appearance of being almost separated. The color varies from corneous to bright golden yellow. *S. avara* var. *major*, defined by Professor Cockerell from a specimen in the Binney and Bland collection, American Museum of Natural History, is "about 13½ mm. long, from Utica, N. Y." Lewis reported specimens from Mohawk as 11/20 inches long (nearly 14 mm.). Mutation *alba* Cockerell has the "shell greenish-white". According to Bryant Walker: "The varieties *major* and *vermeta* occur quite frequently associated with the type and intergrade completely with it and with each other. The var. *alba* is more rare. Two or even all of the varietal characteristics may be not uncommonly found exemplified in a single individual."

⁷⁴ Hemphill (1901, *Nautilus*, 14:125), considered *vermeta*, *guadalupensis*, *oregonensis* and *rusticana* to be subspecies of *avara* represented as fossils on the Californian islands. His figures are stated to be about four-fifths actual size.

Var. *compacta* Cockerell. "A form with a whitish shell, much incrustated with dirt, a large body-whorl, and a very short spire, resembling in outline *S. stretchiana* with which it was formerly doubtfully identified. Chalk Cliff, Chaffee County, Colorado." (Cockerell.)

Specimens from Warm Spring Canyon, Arizona, no. 103165, coll. by Ferriss, 1909 (Fig. 442 B, b) were dissected. There is hardly any external pigmentation, and very little on the hermaphrodite duct and seminal vesicles. The cylindric penis passes by a slight constriction (not visible externally) into the epiphallus (Fig. b). This is wholly included in the sheath in some specimens (Fig. A, B.) but in others the epiphallus emerges, forming a loop as in Fig. a, c. Fig. 442 D, drawn by Dr. C. Montague Cooke, also shows the *Novisuccinea* type of penis. I do not know the locality of this specimen. In some cases both of these conditions were present in the same lot of specimens, as in Fig. 442A, a, Sea Isle City, N. J.

The genitalia of *S. avara* require further study, as there seems to be rather wide variation among the few I have opened. The shell of this species has much resemblance to the European *S. oblonga* Drap., type of the subgenus *Hydrophyga* Lindholm, but the penial structure shows some differences.

Jaw, Fig. 414:6.

Western *avara*-like forms. In lots such as Fig. 457A, d,j,l, representing fossils collected on San Clemente and San Nicolas Islands there are transitions from rather stout *rusticana* forms to the slender *avara* shape. These island shells are what Hemphill distributed as a variety of *S. avara* named for San Clemente, but not published. Fig. 430 d may be taken as typical of his variety. Until a thorough anatomical comparison can be made, it seems wise to leave the limits of *rehderi* and *avara* somewhat indefinite and to suspend judgment on some of the western *avara*-like snails. *S. gabbi* and *S. avara* differ noticeably in the range of variation.

Compare also *Succinea (rusticana* Gld. var.?) *guadelupensis* Dall,⁷⁵ Fig. 455 l.

"*Succinea (rusticana* Gld. var.?) *guadelupensis* Dall. Shell small, acutely pointed, strongly marked with incremental lines; whorls very convex, with deep sutures; last whorl the largest; aperture small for the genus, oblique, with a well-marked callus over the body. Lon. of shell 8.5, of aperture 5, of last whorl 7, diam. of shell 5, of aperture 3.2 mm." (Dall.)

BAJA CALIFORNIA: Guadalupe Island (Anthony, 1896).

"This variety differs from *S. rusticana* in its much smaller size with the same number of whorls, also by the incurving outer lip where it joins the body. The surface is rather coarsely striated with incremental lines. The specimen obtained was dead, and the color when fresh was doubtful, but the appearances indicate that it was pale yellow."

⁷⁵ Proc. Acad. Nat. Sci. Phila., 1900, p. 102, pl. 8, fig. 12.

Succinea gabbi Tryon

Fig. 457c.

Succinea gabbi Tryon, 1866, Amer. Jour. Conch., 2:234, pl. 2(17), fig. 14.

"Elongate ovate, thin, sub-pellucid, coarsely undulately striate; spire long, acute, suture deeply impressed; whorls nearly 4, but slightly oblique, very convex, the last three-fourths of the total length; aperture small, roundly oval, columella well incurved. Light yellowish. Length 9, diam. 5 mill." (Tryon.)

"Larger and more convex than *groenlandica*, and differently colored. The spire is proportionally longer in this than in the other species of the group."

The type lot consists of three shells collected dead. They are quite thin, whitish-gray,⁷⁶ and have a great resemblance to *S. avara*. However, the whorls are even more convex and the suture deeper than in *avara*. The suture is less oblique, the spire being a little less drawn out. Sculpture is of many narrow, sometimes almost riblet-like, oblique wrinkles, unevenly spaced, subobsolete in places. The aperture is quite oblique, broadly ovate occupying half of the total length; its width about 71 percent of its length.

Length 9.1 mm., diam. 5.5 mm.; 3 $\frac{3}{4}$ whorls. Type.

Length 9.8 mm., diam. 6.3 mm.; 3 $\frac{1}{2}$ whorls. Paratype.

WASHINGTON: Blue Lake, Grand Coulee (R. E. Snodgrass). OREGON: Crooked Creek of Owyhee, sixty miles west of boundary S.-E. Oregon (W. M. Gabb, type and two paratypes 12487 A.N.S.P.). CALIFORNIA: Crane Lake Valley N.-E. Cal. (Gabb). Mazuka Canyon, Tank Spring, Inyo Co. (J. H. Ferriss).

Though it is so similar to *S. avara*, it looks different, and may be closer to *Q. rehderi*. W. G. Binney thought it synonymous with *S. oregonensis* Lea. The Inyo County shells have a dirty coating, as in many *S. avara*.

(Named for W. M. Gabb, author of *Paleontology of California*, 1864.)

Succinea californica Fischer & Crosse

Fig. 457d.

Succinea californica Fischer & Crosse 1878, Jour. de Conchyl., 26:68; Mission Scientifique au Mexique, Mollusques, p. 663, pl. 27, figs. 9-9b.

"Shell oblong-ovate, marked with five wrinkle-striae, transparent, quite glossy, and of a rather deep amber yellow color. Spire quite acute, suture well marked, whorls 3, very weakly convex, the last whorl larger than the spire. Aperture subovate, very glossy within and of the same color as the outside. Peristome simple; columellar margin thin and thread-like; parietal margin very feeble calloused; basal margin receding and rounded; outer margin slightly inflexed and sharp. Length 7 mm., diam. 4 mm., aperture 5 mm. long, 3 mm. wide" (Fischer & Crosse).

LOWER CALIFORNIA: San Tomas (H. Hemphill).

The only locality recorded for this snail is about seventy miles below our border. It is included here as one of the forms which must be considered in

⁷⁶The light yellowish color mentioned by Tryon was perhaps dirt, as the specimens had not been washed; or it may have been taken from the Crane Lake Valley specimens, which are smaller than any of the type lot, though apparently the same species.

the study of succineas of southwestern California. Doubtless topotypes are in the Hemphill collection, California Academy of Sciences, though probably under another specific name. Not seen by the author.

Succinea oregonensis Lea

Fig. 457a.

Succinea oregonensis Lea, 1841, Proc. Amer. Philos. Soc., 2:32; Trans. Amer. Philos. Soc., 9:5.

"Shell oblique, thin, rugosely striate, reddish, subdiaphanous; spire exerted; sutures much impressed; whorls 3, inflated; aperture large, wide-ovate. Diam. 0.15, length 0.30 of an inch.

"A single specimen only of this small species was given to me by Mr. Nuttall. It nearly answers to Mr. Say's description of *S. avara*, but differs in size and colour and form from that usually received as his species. The spire is elevated for a *Succinea*, and curls somewhat like a worm. The aperture is a good deal rounded, and is about two-thirds the length of the shell." (Lea.)

Dr. Rehder has kindly lent Lea's type for illustration. It has 2½ whorls, the first nearly smooth, the second finely and *sharply striate*, the sculpture becoming coarser and more spaced on the last half whorl, which is irregularly wrinkled. The whorls are strongly convex, and the suture is very deeply impressed. The matt surface is near antimony yellow (of Ridgway), rather opaque, though the shell is thin. The ovate aperture occupies about 65 per cent of the shell's length. It is rather wide, its width about 62 per cent of its length. The upper part of the outer lip curves so as to make about a right angle where attached to the preceding whorl.

Length 6.5 mm., diameter 4.0 mm.

"OREGON: Prof. Nuttall" (Lea). Type 117935 U.S.N.M.

Described from a single shell, but subsequently Lea sent a specimen evidently thought to be the same species, to Gould (Terr. Moll., 2:67, footnote). This specimen was described and figured in Binney's *Terrestrial Mollusks* as *S. oregonensis*, p. 77, pl. 67c, fig. 3; the description repeated in W. G. Binney's later volumes. This supposed *S. oregonensis* differs from Lea's type by having the whorls less convex, the suture not so deep, and the sculpture is described as "rather coarsely, though obtusely and distantly striated," terms which could not be applied to Lea's type.

The *S. oregonensis* of American land shell collectors and conchologists hitherto, is not the *S. oregonensis* of Lea, their identifications having been based upon the erroneous information in *Terrestrial Mollusks* and other Binney publications. The species of Lea has not been collected again so far as is known.

QUICKELLA C. Boettger

Succinea, section 1, Quick, 1933, Proc. Malac. Soc. London, 20:310.

Quickella C. R. Boettger, 1939, Zool. Anzeiger, 127:50.

The penis is without a sheath, and has an appendix in form of a very short, blunt protuberance, lateral at the apex (or, in the subgenus *Mediap-*

pendix, a sac arising at and below the middle). There is no distinctly differentiated epiphallus. The vagina is very short. Jaw of the usual arcuate form with rather strong median projection. "Marginal teeth of radula few, about equal in number to the laterals, and with very short, broad basal plates." The shell is succineiform, with strongly rounded whorls and produced spire.

TYPE: *Succinea arenaria* Bouchard-Chantereux.

Distribution.—Europe, Atlantic and Channel coast zone of France, Holland and southern England. America (subgenus *Mediappendix*), coastwise New Jersey and south to North Carolina; Pacific states.

This group was established by Dr. H. E. Quick and was named in his honor by C. R. Boettger, who gave it generic rank. It is regarded as more primitive than the other genera, in which the penis is provided with a sheath, but it is otherwise specialized by the development of a penial appendix. Survival of the few widely scattered *Quickellae* may have been favored by their occupation of an ecologic niche immune from invasion by more evolved succineids—our eastern species living in small thickets in the sandy shore zone, the European *Q. arenaria* in similar dune conditions, as C. R. Boettger has related.

There is a single European species, and so far as is known two in the United States. The West African *S. concisa* Morelet is similar to *Quickella* by lacking a penial sheath, but it differs by characters of the free muscles, the hermaphrodite duct, the long vagina and atrium, and there is no appendix on the penis.⁷⁷

Key to subgenera

Penis having "a short, blunt subapical protuberance on the inner side, apparently representing the penial appendix." Subgenus *Quickella* s. str. European.

Penis having a large and prominent appendix about midway of its length. Subgenus *Mediappendix*.

Subgenus MEDIAPPENDIX new subgenus

Like *Quickella* in having no penial sheath or distinctly differentiated epiphallus, and by the very short vagina, but differing by having a large, blunt appendix which arises about midway of the penis. Type *Q. vagans* (Pilsbry).

***Quickella vagans* (Pilsbry)**

Fig. 443 d.

Succinea campestris vagans Pilsbry, 1900, Nautilus, 14:74.

The shell is similar to *S. campestris* in the globosely oval shape, very convex whorls and rather dull or weakly glossy surface, which is irregularly and often in places somewhat coarsely wrinkled. It is small, fragile, with only $2\frac{1}{2}$ to $2\frac{3}{4}$ whorls in the type lot, in southern specimens as many as three whorls; subtranslucent ecru-olive, without the opaque whitish streaks or the whitish inner layer of *campestris*. It differs from *S. unicolor* by the duller luster and more strongly convex whorls.

⁷⁷ See H. E. Quick, 1936, Annals Natal Museum, 8:39. Cf. also, Proc. Malac. Soc. London, 23:298 (Indopacific), 333 (*S. andicola*).

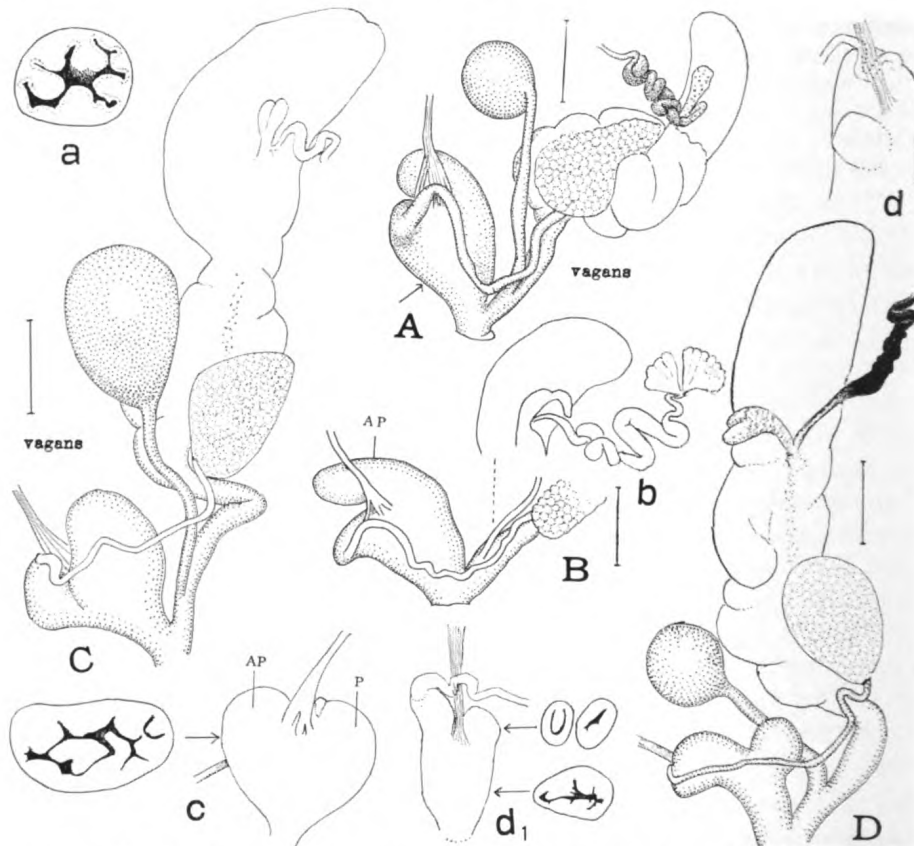


Fig. 456. Genitalia of *Quickella*, subgenus *Mediappendix*. A. *Quickella vagans*. Cape May, New Jersey, with transverse section of lower part of the penis at a. B, b, another specimen, anterior and posterior parts only. c, Lake Waccamaw, N. C.; at c the penis from above, and a transverse section. D. *Quickella rehderi*, five miles west of Davenport, Washington; at d₁ the penis from above, with two sections. AP, appendix; P, penis. Scale lines = 1 mm.

Length 8.8 mm., diam. 6.8 mm., length aperture 6 mm.

Length 8.2 mm., diam. 6.4 mm., length aperture 5.5 mm.

Length 7 mm.

NEW JERSEY: Cape May Point, on the sandy terrain near the beach, in a dense growth of cedar, oak, plum, bay, prickly pear, etc. (Pilsbry, 1898). Type and paratypes 78882 and 78882a A.N.S.P. Gloucester (W. M. Gabb). NORTH CAROLINA: Lake Waccamaw, Columbus Co. (Pilsbry).

Probably this species will be found along much of the coast where suitable conditions occur. Only a very short and simple dissection is required to disclose the remarkable penis.

The specimen from Lake Waccamaw is more glossy than the type lot, with slightly more produced spire of three whorls. Length 7.5 mm., diameter 5 mm., length aperture 4.5 mm.

The mantle over the lung is translucent whitish with some faint gray spots (seen under magnification to be composed of minute flecks of pigment); several next to the thickened edge being larger and longer. The cream-white body and head are sparsely peppered with minute dots. The thick mantle edge, the sole and pedal margin are not dotted.

Genitalia, Fig. 456 A, B, C. The external orifice is in the posterior end of a shallow slit extending forward. The hermaphrodite duct is moderately pigmented. The talon (vesicula seminalis) is large, club-shaped and undivided. It is sparsely marked with small brown dots; but in another specimen, Fig. b, the talon has a narrower extension, showing some faint dots, but the larger part, as well as the hermaphrodite duct, is wholly without pigment. The prostate gland is large, irregularly oval (partly concealed in the figure), and not pigmented. Vas deferens descends in a moderate loop but is not very long. The ascending limb of the penis seems to be a trifle enlarged, and might be epiphallic, but this is not very obvious. It enters the penis at the apex, farther out than the insertion of the penial retractor. The penis is broad and obtuse. There is no trace of a sheath. It has no black spot below the point of entry of the vas deferens such as characterizes *S. arenaria*. Inside it has several strong unequal longitudinal ridges, the surface finely granose, especially between the ridges. When the penis is opened lengthwise and pinned out, the ridges appear smaller and more separated than in the transverse section (Fig. a), which, however, was traced with camera lucida. In the middle the penis gives off a broad branch which rises above the penis proper, and is free from the retractor muscle. This branch appears to be homologous with the "short, blunt sub-apical protuberance on the inner side, apparently representing the penial appendix of *elegans*," described by Quick for *S. arenaria*. The cavity of this appendage is ribbed continuous with the penis proper, and has some irregular thickenings at the end. The penial retractor widens near its insertion, and there is a narrow slip to the vas deferens. The vagina is very short, but relatively longer than in *S. campestris*. The globular spermatheca is on a rather long duct, which in one example drawn, is slightly dilated below the middle, but not noticeably expanded at its insertion. In another specimen (Fig. c) the spermathecal duct is of equal diameter throughout.

Genitalia of a Lake Waccamaw specimen are drawn in Fig. 456 c. The penis is more massive than in Cape May specimens, the appendix about equal to the free part of the penis. The spermatheca is very large and the seminal vesicles of the usual twinned type.

The jaw is rather highly arched with a median projection and rather wide lateral wings. Fig. 414:9.

Quickella rehderi new species

Figs. 457b, 457A, a.

Succinea oregonensis Lea, of many collections. not of Lea.

The oblong-ovate shell is glossy, near deep chrome color of Ridgway, of 3½ strongly convex whorls united by a rather deep suture. Sculpture of unequal low wrinkles irregularly spaced, with occasional smoothish intervals. The moderate oblique aperture occupies about 0.6 of the total length; it is

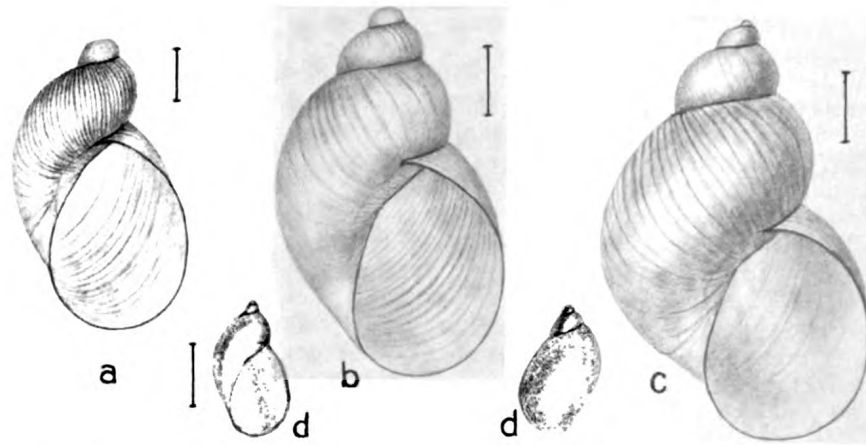


Fig. 457 a, *Succinea oregonensis*, type b, *Quickella rehderi*, type. c, *Succinea gabbi*, type. d, *Succinea californica*, after Fischer & Crosse. Scale lines = lengths of shells.

rather broadly oval, the right and left margins about equally curved. Length 8.4 mm., width 5.5 mm., length of aperture 5.4 mm. Type.

Length 9.7 mm., width 6 mm. Dalles.

WASHINGTON: five miles west of Davenport, Lincoln Co. (Junius Henderson), Type and paratypes 147757 A.N.S.P. OREGON: Dalles (Wheatley).

The shell is less drawn out and is more convex in the upper part of the whorls than *Succinea avara*. *S. gabbi* has a deeper suture and more strongly convex whorls. *S. oregonensis* Lea has closer, sharper sculpture.

Specimens dissected from 5 miles west of Davenport, Washington, No. 147757 A.N.S.P., collected by Junius Henderson. The mantle over the lung is copiously streaked with brown partly following veins. Foot and head closely sprinkled with dark brown flecks, with some pale veins running toward head above and obliquely downward on the sides. The genital orifice is in an irregular fossa with a small overhanging lobe, and open in front. The hermaphrodite duct is black and not much twisted in the specimen drawn, but in another is very dark gray and normally knotted. Talon is rather large and two parted, with scattered pigment dots. The large prostate gland is rather far forward; vas deferens is not very long, and near the end it is very slightly thickened, perhaps epiphallic. The stout penis has no sheath, and bears a large rounded appendix in the middle. The penial retractor attaches rather far down on the penis, but beyond the appendix. The spermatheca is rather small on a moderately long duct.

This species differs from *Q. vagans* by the much shorter appendix.

The snails segregated here as *Q. rehderi* were part of the mélange in collections under the name *Succinea oregonensis* Lea. Dr. Rehder, who compared the type of *rehderi* with that of *oregonensis*, found them different, and

this decision is supported by my comparison and the figures of each, given above.

In the Pacific states there is, however, a long series of succineas which resemble *rehderi* more or less, or are of stouter figure, and have generally gone under the name of "*S. oregonensis*". Shells of that kind occur from Montana and Washington to southern California.

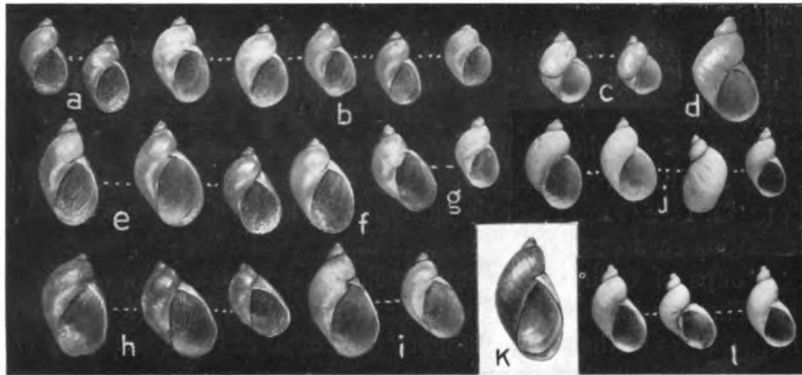


Fig. 457A. a, *Quickella rehderi*, The Dalles b, undetermined succineas from Walla Walla, Oregon; c, Oxford, Meagher Co., Montana; d, San Clemente I., Cal.; e, San Francisco; f, Stockton, g, San Diego; h, Mojave Desert; i, Lower California near San Diego, Cal.; j, l, San Nicolas Island; k, copy of Binney's figure of *S. "oregonensis,"* "length one-fourth of an inch."

In some places remarkably short shells occur, the aperture 65 to 67 percent of the length, as at Walla Walla, Washington (Hemphill), Crooked Creek, tributary of Owyhee R., Malheur Co., S.E. Oregon (Gabb), near Franklin, Idaho (Henderson and Daniels), and near Oxford station, Meagher Co., Montana where Dr. S. S. Berry collected the small, short examples photographed in fig. 457A at c.

Length 11 mm., length aperture 7.2 mm. Walla Walla, Washington.

Length 10 mm., length aperture 6.8 mm. S.E. of Franklin, Idaho.

In southern California similarly wide short forms are found. Those figured being from the Mohave Desert, Fig. 457A h and Lower California near San Diego Fig. 457A i, collected by C. R. Orcutt.

Length 12.7 mm., diam. 8.7 mm., aperture 9.7 mm. Mohave Desert.

Length 11.2 mm., length aperture 8 mm. Near San Diego.

Some of these lots are illustrated in Fig. 457A, b, c, e, f, g, h, i, but many other localities for similar shells are known. Until many of these are dissected, it seems impossible to identify them specifically, or even to ascertain the genus. It is one of the tasks left for the West Coast malacologists.

Suborder ORTHURETHRA

Orthurethra Pilsbry, 1900. Proc. Acad. Nat. Sci. Phila., p. 562.

Holopod snails in which the kidney tapers anteriorly into the ureter, which runs directly forward, remote from the hindgut, and opening within the forward border of the lung (Fig. 460:3).

This Suborder, of world-wide distribution, is represented in America by very small or minute snails only, but they are generally spread and species are numerous.

The division of the Orthurethra into families appears to be largely a matter of expediency. Hugh Watson, 1920, after showing that the several anatomical characters occur in a great number of combinations, suggested that the entire series be merged into three families, Achatinellidae, Partulidae, and Pupillidae. C. M. Steenberg, 1925, proposed to recognize sixteen families. H. B. Baker, 1935, thought that "the total range of anatomical differentiation seems much less than in most families of pulmonates." The family groups of Orthurethra have been considered by the author, 1910-1935.⁷⁸ The division into families used herein has its basis in (1) the recognition of features of the shell as important enough to serve as family characters and (2) the idea that penial complications are fundamental, apparently present in the group as it was before breaking up into most of the existing families, and retained with little change in some members of all of them. In nearly all there are also genera in which the penis has been secondarily simplified. It seems inexpedient to make families so comprehensive that the name conveys no definite image.

Our families can be recognized by the following artificial key.

Shell depressed-conic or discoidal, perforate or umbilicate, wider than high.

Aperture having entering lamellae and folds in all post-embryonic stages of growth *Strobilopsidae*

Aperture rounded, toothless; whorls few, 3 to 4..... *Vallonidae*
Shell higher than wide.

Ovate, with rounded, toothless, thin-lipped aperture and ribbed surface.

Vallonidae, genus *Zoogenetes*

Without that combination of characters.

Perforate or rimate, cylindrical to ovate or conic, with short whorls, the aperture about as wide as long, with or without teeth..... *Pupillidae*

Imperforate, long, very smooth and glossy, the aperture decidedly longer than wide, toothless in our species... .. *Cionellidae*

Family XIX. STROBILOPSIDAE

Strobilidae Jooss, 1911, Jahrb. Nassau. Ver. Naturk., 64:61.

Strobilopsinae Pilsbry, 1918, Man. Conch., 24:x.

Strobilopsidae Hanna, 1922, Nautilus, 35:91.—Pilsbry, 1927, Man. Conch., 28:1 (monograph).—H. B. Baker, 1935, Man. Conch., 28:193 (anatomy).

Characters those of the genus *Strobilops*.

⁷⁸ Manual of Conchology (2), vols. 20-28.

While near to the Valloniidae in genitalia, the complicated internal lamellae of the shell, which appear to be partly homologous with the teeth of Pupillidae, and which were already developed in the Eocene, seem to me sufficient motive for segregating *Strobilops* as a family.

By the accelerated lamellæ and folds of the shell, which appear early in the neanic stage, *Strobilops* resembles various Tornatellinidæ. In that family both parietal and palatal folds or laminae are sometimes present in the neanic stage. Various Pupillid genera also, such as *Orcula* and *Lauria*, have apertural armature during the neanic stage, but it differs from that developed in the mature stage. In *Strobilops* the armature appears very early, and the lamellae from their inception appear to develop continuously into those of the adult shell. The family may be regarded as relatively conservative in genitalia ⁷⁹ but highly specialized in shell structure.

Terminology of lamellae and folds

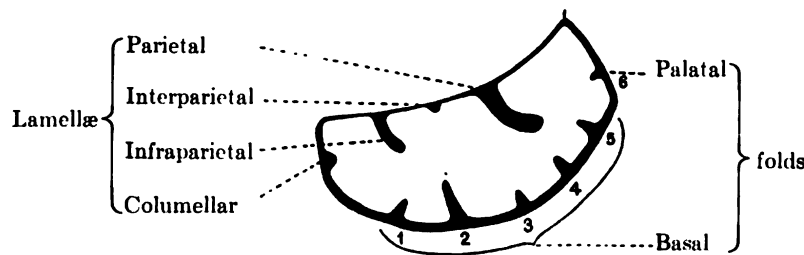


Fig. 458. Section of last whorl of *Strobilops* at the internal barrier. Diagrammatic.

Probably the parietal and columellar lamellae of *Strobilops* are homologous with those of Pupillidae, and the folds numbered 2 and 5 in the diagram may represent the pupillid lower and upper palatals. In Pupillidae the palatal folds of the adult stage are never continuous with, or correspond to, such as may sometimes be present in immaturity.

STROBILOPS Pilsbry

Strobila Morse, 1864, Jour. Portland Soc. N. H., 1:26, for *Helix labyrinthica* Say.

Not *Strobila* Sars, 1835, nor of Sodoffsky, 1837.

Strobilus Sandberger, 1872. Not *Strobilus* Anton, 1839.

Strobilops Pilsbry, 1893, Proc. Acad. Nat. Sci. Phila. for 1892, p. 403, substitute for *Strobila* Morse; 1927, Man. Conch., 28:12, monograph.

The shell is small, perforate or umbilicate, trochiform to subdiscoidal, with rounded, angular, or carinate periphery, of $4\frac{1}{2}$ to 6 closely-coiled whorls.

⁷⁹ In other words, its genitalic complications had already been evolved in the ancestral stock from which Strobilopsidae and most other orthurethrous families of the present time arose.

Cavity of the last whorl is obstructed by two or three long parietal lamellæ, the upper one emerging to the edge of the parietal callus, the lower one weaker, emerging or immersed, the intermediate one when present, smallest and remote from the aperture; a series of two or more short folds on the basal wall of the cavity deep within the last whorl. These lamellæ and folds appear very early in life, grow at the forward end and are absorbed behind. Peristome expanded, usually thickened, the insertions of the lip remote.

The sole is short and broad, in movement showing two or three advancing muscular waves at one time; no pedal grooves. The integument has a network of impressed lines. Eyes are well-pigmented, on eye stalks a little swollen distally. Tentacles short but moderately well-developed (Fig. 459, *S. labyrinthica*).

(Στρόβιλος, δψ, having the appearance of a pine cone.)

The anatomy of two species has been studied by H. Burrington Baker, 1935, whose account follows.

"*Strobilops aenea* Pilsbry. Fig. 460:5 to 8. The animals studied were collected during May, 1928, in Springfield Township, near Philadelphia, Pa.; in most of the individuals of this lot and in all those from Necaxa, Mexico, the vas deferens ends near the base of the spermatheca and the other male organs are lacking. Embryos have not been observed.

"Mantle edge (Fig. 8) broad; lappets weak; glands encroaching on lung. Lung more than 3 times its base or 4 times length of kidney. Principal vein very close to kidney; weak venation present along columellar side and anteriorly. Kidney (broader, longitudinally trabeculate region) about as long as its base or length of pericardium; orthoureter about 3 times as long, similarly thick-walled but with weak transverse trabeculae; recurved groove short.

"Ovotestis (Fig. 7) imbedded in basal end of apical liver lobe; consisting of two lobes, each divided into few, short-clavate lobules; duct thickened below middle in animals with male organs; carrefour clavate with ovoid base; talon not developed. Spermatheca clavate, short-stalked and imbedded in side of oviduct. Vagina very long. Prostate short with clavate alveoli. Epiphallus (Fig. 5) developed in vas deferens some distance above entrance into penial side through a low papilla. Penis bifurcate; appendicular arm clavate and shorter than epiphallar, which extends beyond entrance of vas deferens; appendix elongate fusiform and thin-walled, entering apex of appendicular penial arm through a thickened ring. Penial retractor arising from diaphragm, bifurcating below its middle and inserting

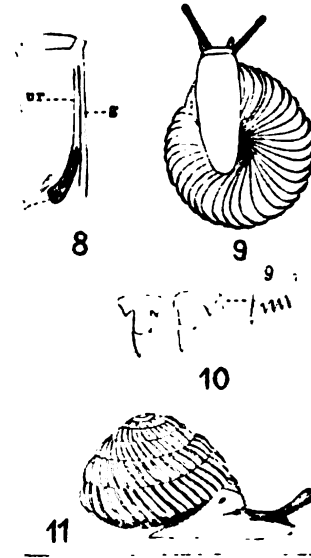


Fig. 459. *Strobilops labyrinthica*. 8, kidney; 9, 11, living animal; 10, teeth. *ur*, ureter; *g*, hindgut.

near apex of appendicular arm and alongside entrance of vas deferens on epiphallar branch. Atrium short, opening near right inferior tentacle.

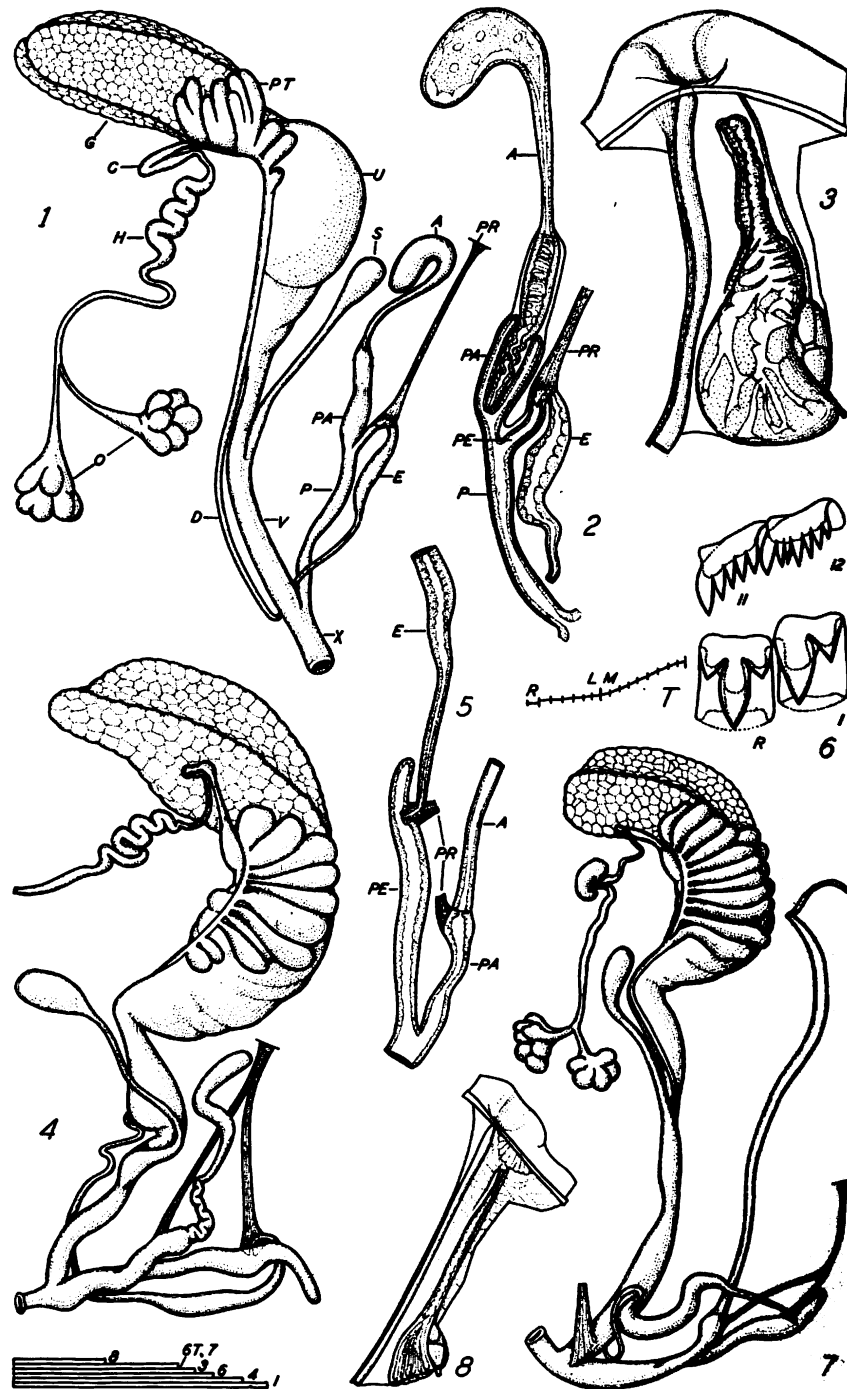
"Columellar retractor (left) gives off almost immediately the shortly united left free and buccal muscles, soon after the right free retractor and then continues to form the strong tail fan. Right free gives off right ocular, which passes through penioviducal angle, at about level of salivary glands, and divides terminally into fan of short muscles, of which first is inferior tentacular, second goes to vagina and penioviducal angle and remainder to sides of foot.

"Cerebral commissure about $\frac{1}{3}$ as long as width of each cerebral ganglion; pleural connective medium in length; pedal much longer. Salivary glands long lanceolate, about length of buccal mass but more slender; right one $\frac{1}{3}$ to $\frac{1}{2}$ longer than left and completely separate from it; ducts short. Oesophagus long and slender (probably knotted when contracted). Stomach without special gland, but alongside inferior lobe of liver which is narrow and terminally bilobed like in *Vallonia* (Steenberg, 1917) although intestinal S-loops are mainly imbedded in albumen gland. Radular formula (Fig. 6): 14-1-(6 + 8), with 83 rows (T).

"*Strobilops texasiana* Pils. & Ferr. Fig. 460:4. Cf. *S. labyrinthica* Hanna (1922, *Nautilus*, 25:91) and Man. Conch., 28:13. The animal described was collected June 18, 1929, along the Guadalupe River, north of New Braunfels; the other 23 individuals in the lot lacked terminal male genitalia. All individuals in several lots of the related *S. labyrinthica*, from several localities, are similarly emasculate. Only salient differences from the structure of *S. aenea* will be noted. Carrefour (Fig. 4) enlarged transversely at apex. Vagina relatively shorter. Epiphallus nearer penis. Penial appendix long clavate (base much contracted). Penial retractor bifurcating near origin from diaphragm; insertion on appendicular penial arm farther from apex." (H. B. Baker.)

Distribution.—Humid eastern half of North America from Quebec, Ontario and Manitoba, N. Lat. 52°, to Guatemala; Cuba and Jamaica; South America from Venezuela to Para in eastern Brazil, and the Galápagos Islands; Japan, Korea, China and the Philippines. Eocene to Pliocene of central and western Europe. One species, *Strobilops densecostata* F. C. Baker (1938, *Nautilus* 51:127), is known from the Pliocene of Meade Co., Kansas. It is closely related to *S. texasiana*.

Strobilops comprises small snails living on decaying logs and dead leaves in moderately humid forest. The genus is not known in North America west of the 100th meridian, but eastward its distribution is probably almost continuous, from Ontario in the north to Guatemala. In Europe about twenty fossil species are known running from the Eocene (Bartonian) to the Upper Pliocene, when it became extinct in that area. The remarkable discontinuity in the distribution of *Strobilops*, and even of its subgenera, will be seen by the accompanying map where the occurrence of the genus is roughly indicated.



Drawn by H. Burrington Baker.

Fig. 460. See bottom of page 853 for legend.

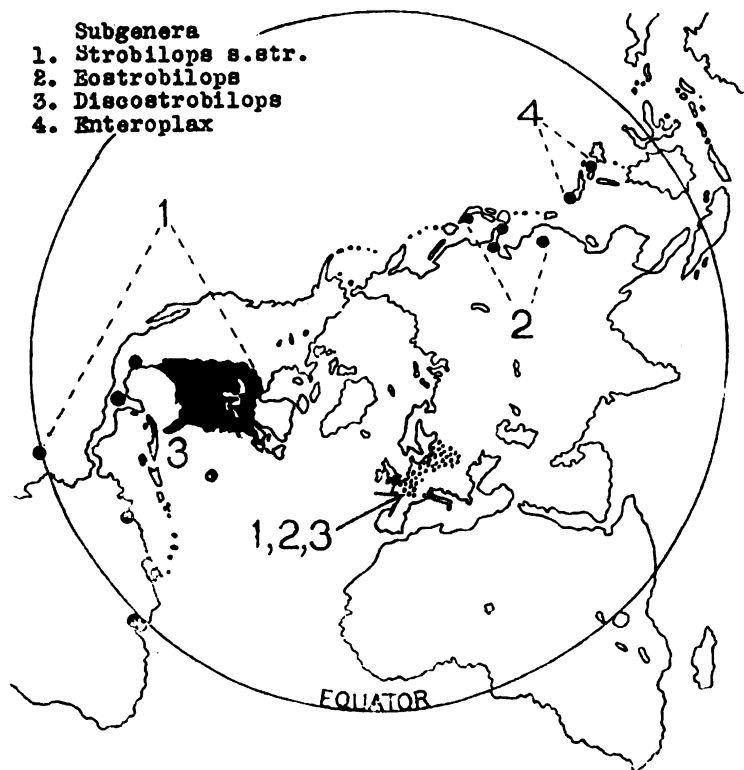


Fig. 461. World in North Polar projection. Tertiary distribution of *Strobilops* represented by stipple; Recent by black spots.

Old World species show greater diversity than the American; our two subgenera being represented there, and two others in addition. We infer that the center of evolution was probably in Asia, with early Tertiary radiation west into Europe and east by way of a Bering Sea bridge into America. The date of this migration is uncertain.

Fig. 460. 1-3, *Planogyra asteriscus*, Douglas Lake, Michigan. 1, genitalia. 2, penis and accessories from glycerin jelly mount. 3, internal view of pallial complex. 4, *Strobilops texasiana*, New Braunfels, Texas. Genitalia (ovotestis omitted). 5-8, *Strobilops aenea*, Philadelphia, Pa. 5, penial apex from glycerin jelly mount. 6, radula. 7, genitalia. 8, internal view of pallial complex.

A, penial appendix. C, carrefour. D, vas deferens. E, epiphallus. G, albumen gland. H, hermaphroditic duct. L, radular laterals. M, radular marginals. O, ovotestis. P, penial trunk. PA, appendicular arm. PE, epiphallar arm. PR, penial retractor. PT, prostate. R, radular central. S, spermatheca. T, outline of radular transverse row (right half). U, oviduct (uterus + free oviduct). UC, oviducal cul-de-sac. V, vagina. X, atrium.

Scales are collected at bottom of page and represent .02mm. for figs. of radular teeth, .1 mm. for radular transverse rows (T) and jaws, and 1 mm. for all others.

Key to subgenera and species

1. Trochiform or dome-shaped species, in which the height much exceeds half the diameter; umbilicus narrow or moderate, contained 6 to 12 times in the diameter; Subgenus *Strobilops* proper 2
 Subdiscoidal species, the height about half of the diameter; umbilicus contained between 3 and 4 times in diameter; subgenus *Discostrobilops*.....*S. hubbardi*
2. Spire convexly conic or dome-shaped; elevated; usually 5 or more internal basal and palatal folds..... 3
 Spire rather low conic, its outlines but slightly convex; less elevated; periphery angular; 3 or 4 internal basal folds, none above the periphery.....*S. acnea*
3. Diam. 2.3—2.5 mm.; basal folds strongly unequal..... 4
 Diam. 2.75—2.9 mm.; basal folds short, subequal, disposed in a regular curve.
S. affinis
4. Finely ribbed.....*S. labyrinthica*
 Coarsely ribbed; southern.....*S. texasiana*

Subgenus STROBILOPS s. str.

***Strobilops labyrinthica* (Say)**

Fig. 463.

Helix labyrinthica Say, 1817, Jour. Acad. Nat. Sci. Phila., 1:124.*Strobila labyrinthica* Say, Morse, 1864, Terr. Pulm. Maine, in Jour. Portland Soc. N. H., 1:26, figs. 64-67, pl. 8, fig. 68.—Binney, 1878, Terr. Moll., 5:259, pl. 5, fig. o, teeth.*Strobilops labyrinthica* (Say), Pilsbry, 1927, Man. Conch., 28:20, pl. 1, figs. 1-11.*Strobila labyrinthica* var. *virgo* Pilsbry, 1892, Nautilus, 6:94.

The shell is narrowly umbilicate, the width of umbilicus contained about 11 (9 to 12) times in the diameter of the shell; very convexly conic or dome-shaped, the periphery obtusely subangular. Whorls $5\frac{1}{2}$, convex, very slowly widening, the first $1\frac{1}{2}$ smooth, pale, the rest chestnut-brown, sculptured with narrow, obliquely radial ribs, narrower than their intervals, passing over the periphery but weakening at the base, the first half of which is typically nearly smooth. The aperture is semilunar. Peristome brown, expanded, thick. The parietal lamella emerges to the edge of the parietal callus and penetrates inward a little more than half a whorl. The infraparietal lamella is much smaller, only shortly emerging, the end visible in a basal view; inside it penetrates as far as the parietal lamella. There is a low and slender interparietal lamella between these lamellæ deep within; all three are strongly nodose at the edge, the nodes armed with minute prickles directed towards the aperture (Fig. 463:11). Within the basal and outer walls, at the last third of the base, there is a low, rather blunt columellar lamella and a forwardly curving series of five (or six) unequal basopalatal folds; first and second folds are large and high, the second longer; two or three following folds are low and thin, the one immediately above the periphery usually longer, and there is sometimes another fold above it (Fig. 463:6, a topotype; also figs. 463:7, 9). Height 1.7 to 1.8, diam. 2.3 mm. (Philadelphia).

Distribution.—Maine and Quebec west to Manitoba, Minnesota, Kansas and Arkansas, south to Georgia and Alabama. Type 9285 A.N.S.P., coll. by Hyde and Mason, Philadelphia, Pa.

Its usual stations are "under loose bark of logs, in half-decayed wood, among dead leaves and in sod at bases of trees."

The back, eye-stalks and tentacles are blackish gray, darker streaks running from the collar to the eye-stalks; sides of the foot and the tail are clear whitish gray (Fig. 459:9, 11).

S. labyrinthica differs from *S. affinis* by the longer, more conspicuously unequal basal folds, the inner two much larger than the others, and the series does not form an even curve as in *affinis*; the infraparietal lamella generally emerges more; the shell is smaller and generally less elevated, the spire with more strongly convex outlines. In *S. ænea* the whole shell, and especially the last whorl, is lower, the outlines of the spire are less convex; the basal folds are less numerous, and there are none above the periphery; the color is brighter and more transparent than in *S. labyrinthica*.

The umbilicus may be narrow, enlarging but little in the last whorl, or it may enlarge to double the former width in the last half-whorl. The infraparietal lamella emerges more or less conspicuously. The degree of angulation at the periphery varies somewhat, and the sculpture of the base is also variable, often nearly smooth in front of the aperture as in the type, but sometimes distinctly ribbed throughout (the ribs are represented somewhat too strong in Fig. 463:8). The parietal lamella in rare instances penetrates as much as three-fourths of a whorl (var. *parietalis*). The number of basopalatal folds outside of the second one (the third from the columellar), varies from three to four in adult shells, and there may be either one or two of them above the periphery.

The color of the shell varies from dark to light brown, and albino shells occur (Neosho Co., Kansas) which are similar to *S. l. virgo* in color, but have a wider umbilicus and a less emerging infraparietal lamella than typical northern *virgo*.

In a young shell of 1.7 mm. diameter the internal barrier consists of a rudimentary columellar lamella, four long basal folds and one above the periphery. In some individuals the number of basal folds is increased in the late neanic stage. In one young Kansas specimen, nearly ready to form the lip, there are ten, including the columellar lamella (Fig. 463:10); but so large a number is very exceptional, and I have never seen a fully adult shell with more than a columellar, four basal and a palatal fold—six in all. The supernumerary folds are evidently absorbed at the inception of the adult stage.

Concerning its distribution in Canada John Oughton writes: "From Lakes Erie and Ontario north to Lake Temagami and to Lake Superior at Heron Bay. Binney (1861), Dall (1905) and Latchford (1896) record this species from Moose Factory. I suspect this record to be erroneous. It is apparently based on the same collection that contained the much more doubtful northern record of *Stenotrema monodon*, mentioned by Dall."

Var. *virgo* Pilsbry Fig. 462. Shell whitish with a faint green or yellow tint (or pale brown), the lip and lamellæ white. Umbilicus small, contained 10 times in the diameter. The infraparietal lamella emerges somewhat more strongly than usual in *labyrinthica*; otherwise the lamellæ and folds are the same. Height 2, diam. 2.5 mm.

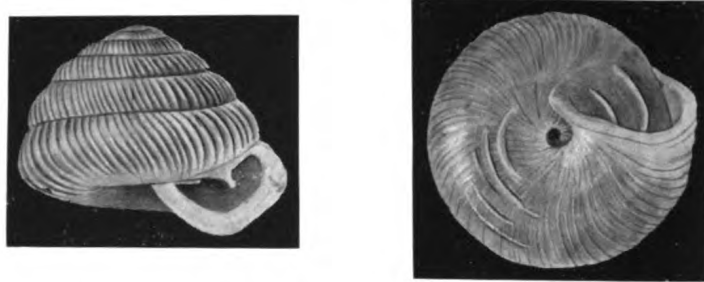


Fig. 462. *Strobilops labyrinthica* var. *virgo*. Type $\times 14$.

Maine to Minnesota and Iowa; reported also from Arkansas; described from Sebec Lake, Piscataquis Co., Maine, type 63348 A.N.S.P., coll. by H. W. Winkley.

The albino shells are found associated with pale brown specimens in the type locality, all agreeing in lamellæ and other characters except color. As a color variety it is noticeable, but I believe of little or no significance racially. It appears to be chiefly a Canadian Zone form.

Strobilops labyrinthica form *parietalis* Pilsbry. Page 864, fig. 467:10, 11. Similar to *S. labyrinthica* in the convexly conic, ribbed shell and weakly emerging infraparietal lamella, but the lamellæ penetrate more deeply, being *between two-thirds and three-fourths of a whorl long* (fig. 10). There is a blunt columellar lamella and four basal folds, four within the side wall (fig. 11, oblique view of baso-palatal folds). The whole base is ribbed in some examples, or smoothish, merely finely striate in others. Height 1.75, diam. 2.35 mm.

The type locality of this form is Ardsley, Montgomery Co., Pennsylvania (Bayard Long); but very similar examples are before me from Gray Bluff, Marion Co., Tennessee; Lookout Mountain, near Valley Head, and Blount Spring, Alabama (H. H. Smith); Talahassee, Florida (C. W. Johnson); and Catahoula Parish, Louisiana, 1.55 x 2.15 mm. (C. B. Moore).

Most of the southern specimens are rather small, but in a lot from Woodville, Ala. (H. E. Sargent), the largest measures 2×2.7 mm. While it approaches *S. texasiana* and *floridana* by the long parietal lamella, it differs by the decidedly less coarse ribbing. The status of this form is doubtful; the sporadic distribution, as now known, seems to indicate that it is not a subspecies, properly speaking.

***Strobilops texasiana* (Pilsbry & Ferriss)**

Fig. 464:5-11.

Strobilops labyrinthica texasiana Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., pp. 147, 557.—Strecker, Nautilus, 22:65 (McLennan Co., Tex.).—Wheeler, Nautilus, 31:114 (Arkadelphia, Ark.).

Strobilops texasiana P. & F., Pilsbry, 1927, Man. Conch., 28:24.

Shell moderately elevated with dome-shaped spire; light brown; umbilicus contained about 8 times in the diameter. Whorls $5\frac{1}{2}$, the first $1\frac{1}{2}$

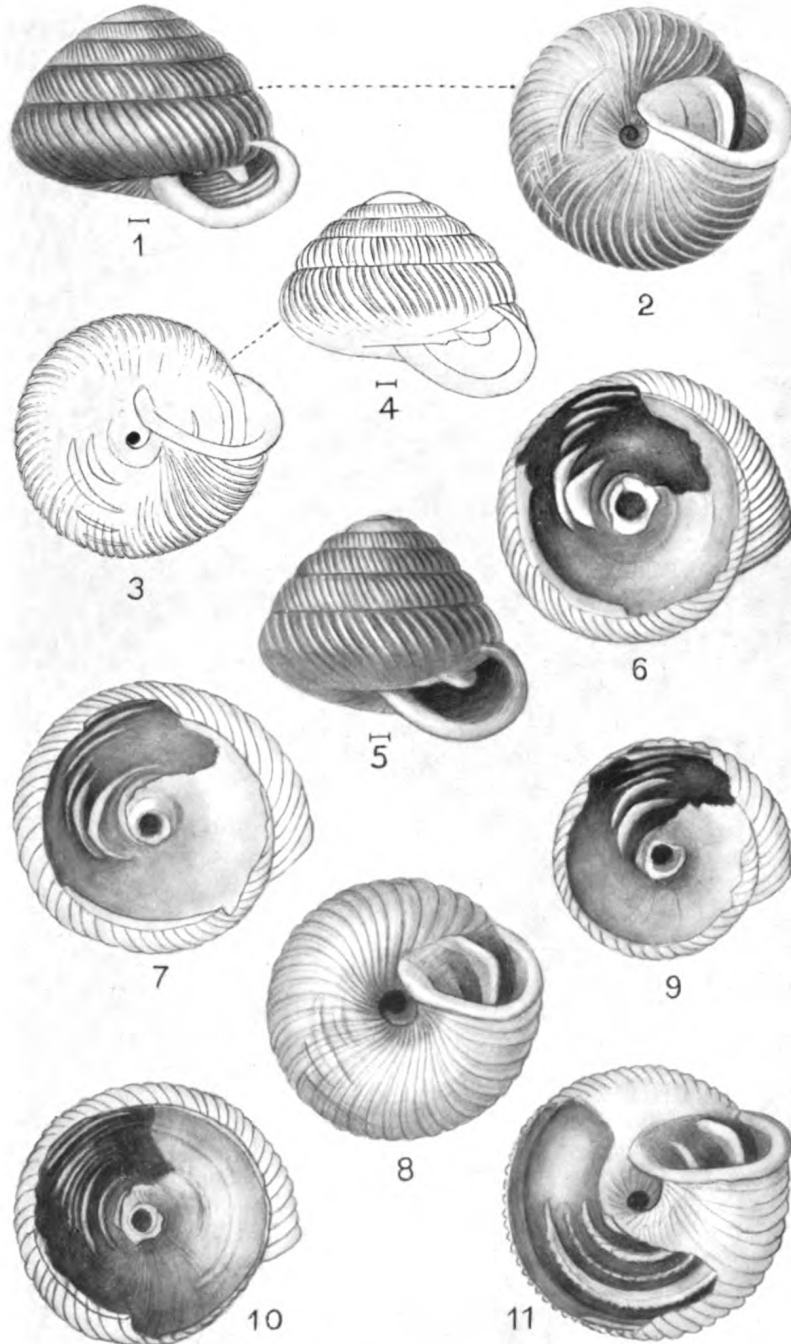


Fig. 463. 1-4. 6, *Strobilops labyrinthica* (3, 4, the Type), Philadelphia; 5, Kittery, York Co., Maine; 7, Ann Arbor, Michigan; 8, 9, 10, Silver Lake, Kansas; 11, Dallas Lake, Wright Co., Minnesota. Enlarged; actual diameter shown by lines below figures 1, 4, 5.

smooth, pale-corneous, the rest brown, regularly ribbed obliquely, the last whorl rounded peripherally or a trifle and obtusely subangular in front, *the ribs passing over undiminished upon the base*, which is *as strongly sculptured as the upper surface* (or sometimes smoothish just in front of the aperture). Aperture with slightly expanded, well thickened, whitish peristome and a strong parietal callus. Parietal lamella emerging to the edge of the callus, penetrating fully three-fourths of a whorl. Infraparietal lamella less emerging, being very shortly and weakly visible in a basal view, penetrating about as deeply as the parietal. There is a quite short and very low interparietal lamella, situated near the inner ends of the others. A third of a whorl within there is a very short, low lamella on the axis and five basopalatal folds: near the axis two large basal folds, the inner tongue-shaped, the outer one longer; outside of these there is a minute and low third fold, often wanting, leaving a space; the fourth and fifth folds long and low (fig. 8). Just above the periphery on the outer wall a very weak, low, long sixth fold may often be traced, but in fully adult shells the smaller folds are usually reduced in number (fig. 10), or even wanting (fig. 9); the full number described above being rare except in the late neanic stage.

Height 2, diam. 2.4 mm. Type.

Height 2, diam. 2.3 mm. Alexandria, La.

TEXAS: drift of the Guadalupe River about four miles above New Braunfels, (Type 91330 A.N.S.P., Pilsbry and Ferriss); Austin (Pilsbry); San Marcos (Pilsbry and Ferriss); New Braunfels (Ferriss, Pilsbry, and Singley); Guadalupe river bottom, Victoria County, and Lavaca River, Jackson County (J. D. Mitchell); Lee Co. (Singley); Calhoun Co. (E. W. Hubbard); Gainesville (J. B. Quintard); Colorado River near Travis, Bastrop Co. (Julia Gardner). A smaller form, diam. 2 mm., was taken in drift debris of the Hondo River about two miles north of Hondo, Medina Co. (Ferriss and Pilsbry). OKLAHOMA: Limestone Gap and Wyandotte (Ferriss and Pilsbry); Fort Gibson (E. W. Hubbard); Pottawatomie Co. (J. B. Quintard). ARKANSAS: Ashley and Calhoun counties (C. B. Moore). LOUISIANA: Sycamore and Wilson landings, Morehouse Parish; Alexandria, Rapides Parish (C. B. Moore).

This form differs from the closely related *S. labyrinthica* by the stronger, more spaced ribs, continued over the base, and by the more deeply penetrating parietal lamella.

***Strobilops texasiana floridana* Pilsbry**

Fig. 464:1-4.

Strobilops floridanus Pilsbry, 1909, Nautilus, 23:90.—Vanatta, Nautilus, 26:21, 33.—Walker, Nautilus, 31:56, Palm Beach.

Strobilops texasiana floridana Pilsbry, 1927, Man. Conch., 28:26.

The shell is sculptured with narrow, *rather widely separated* ribs (about 30 on the last whorl). These *ribs continue on the base*, which is radially ribbed. Parietal lamella emerges to the edge of the callus, *penetrating inward fully a whorl* (Fig. 464:3). Infraparietal lamella scarcely emerging, penetrating as far inward as the parietal lamella. There is one small, short axial lamella and four basal folds, the outer one peripheral in position; a single palatal fold is generally developed. These folds form a curved, very obliquely radial series, the middle of which is about a half-whorl back of the aperture. The two inner basal folds are much stouter and higher than the others, the second from the axis (or third, counting the axial) being the longest and highest of the folds, and somewhat sinuous (Fig. 464:4).

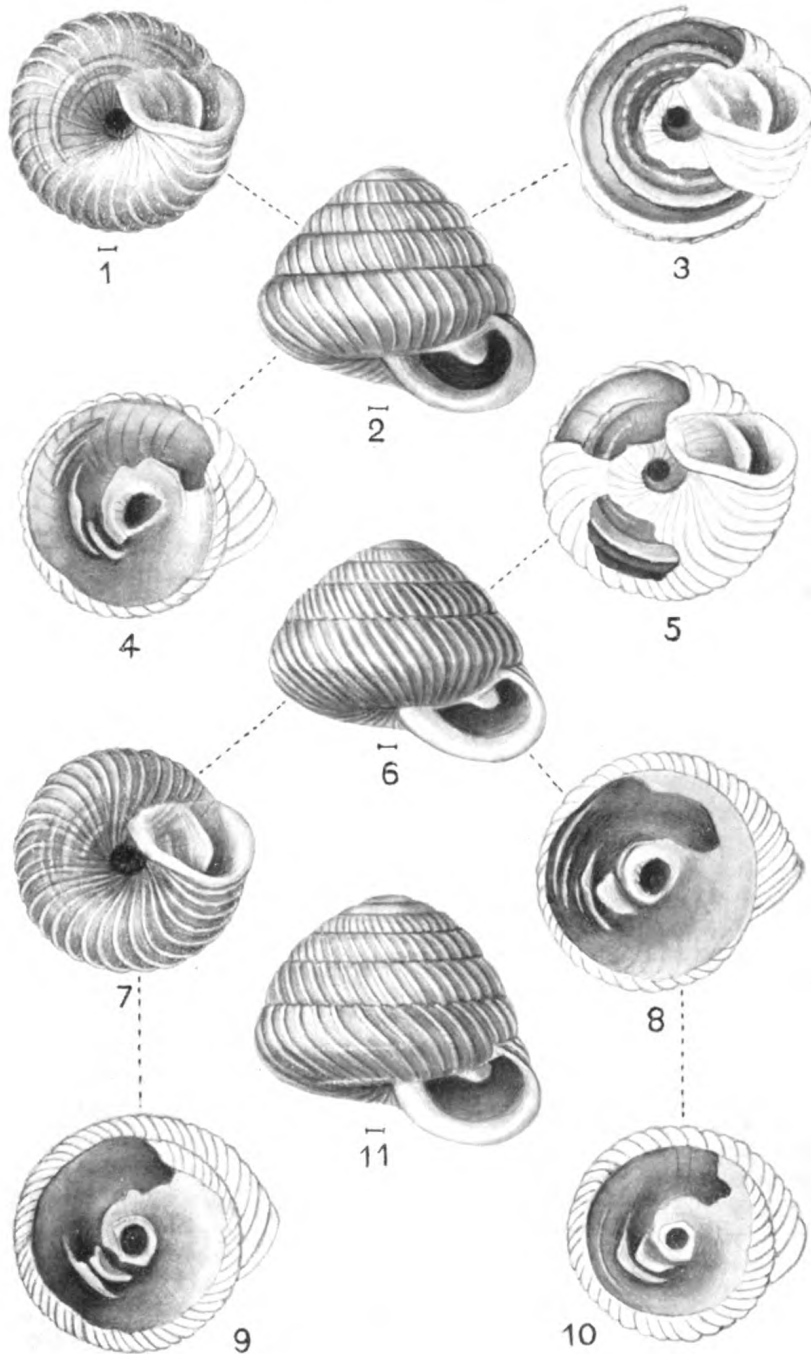


Fig. 464. 1-4, *Strobilops texasiana floridana*, type and paratypes, Miami, Florida. 5-11, *S. texasiana*, type, fig. 7, and paratypes, near New Braunfels, Texas. Enlarged; actual diameter shown by lines below figures 1, 2, 6, 11.

Height 2 mm., diameter 2.4 mm. (Miami).

Height 1.9 mm., diameter 2.2 mm. (Orlando).

FLORIDA: Miami, Dade Co., type 77044 A.N.S.P., coll. by S. N. Rhoads; also M. Hebard and Pilsbry. Throughout the State, from Sugarloaf, Boca Chica and No-name Keys to Clay Co. on the St. Johns River and Jackson Co. on the Chipola. VIRGINIA: Near Willoughby Bay, Ocean View, Norfolk (Leslie Hubricht).

This race differs from *S. labyrinthica* by its widely spaced ribs and long parietal lamella. This is typically a full whorl long, or somewhat more, thus differing from *S. texasiana* in which the lamella is a little short of one whorl long, as will be seen on comparing Fig. 464:3 (*floridana*) and 5 (*texasiana*). However, on examining long series I find some examples of *floridana* in which the parietal lamella is not over three-fourths of a whorl long, so that the distinction between *floridana* and *texasiana* is not a complete one, though obvious in most examples. There are also shells which approach the long-lamellate *parietalis* form of *labyrinthica* rather closely, though the coarser ribbing of the base in *floridana* is generally a differential character.

It is sometimes quite elevated, as in the second measurement above, but the high examples occur in lots with lower specimens.

***Strobilops affinis* Pilsbry**

Fig. 465:1-5.

Strobilops affinis Pilsbry. 1893, *Nautilus*, 7:57; 1927, *Man. Conch.*, 28:27.—Baker. 1939, *Fieldbook Ill. Land Snails*, p. 113.

The shell is convexly conic with obtusely angular periphery; the base moderately convex, becoming rather strongly so in its last third; glossy, brown, with pale apex; narrowly umbilicate, the umbilicus contained about $7\frac{1}{2}$ to 8 times in the diameter. There are 6 moderately convex whorls, increasing very slowly, the first two smooth, the rest sculptured with narrow, somewhat retractive ribs. The first half of the base is smooth, the ribs barely passing over the peripheral angle and reappearing within the umbilicus, but they continue weakly over the last half. The aperture is semi-lunar, oblique. Peristome is well expanded, thickened within, its face convex and fleshy-brown in color. Parietal callus moderately strong. The parietal lamella emerges to the edge of the callus and penetrates inward about two-thirds of a whorl. The infra-parietal lamella is low and weak, deeply immersed, not visible in a front or basal view. Interparietal lamella short and very weak. A third of a whorl within there is an obliquely radial series of about 8 folds: a short low lamella on the columellar axis, followed by two folds larger and higher than the rest, and an oblique series running to the suture, composed of 4 to 7 short subequal folds (Fig. 465:4).

Height 2.5 mm., diameter 2.75 mm.

Distribution.—Ontario and Massachusetts to Minnesota and Kansas, south to northern New Jersey and west of the Alleghanies to northern Alabama and Oklahoma.

MASSACHUSETTS: New Bedford (J. H. Thomson). NEW YORK: Syracuse, Pleistocene (Burnett Smith); Poughkeepsie (G. Van Ingen); Upper Red Hook, Dutchess Co (W. S. Teator), Type 74414 A.N.S.P.; Staten Island (E. W. Hubbard, T. Bland).

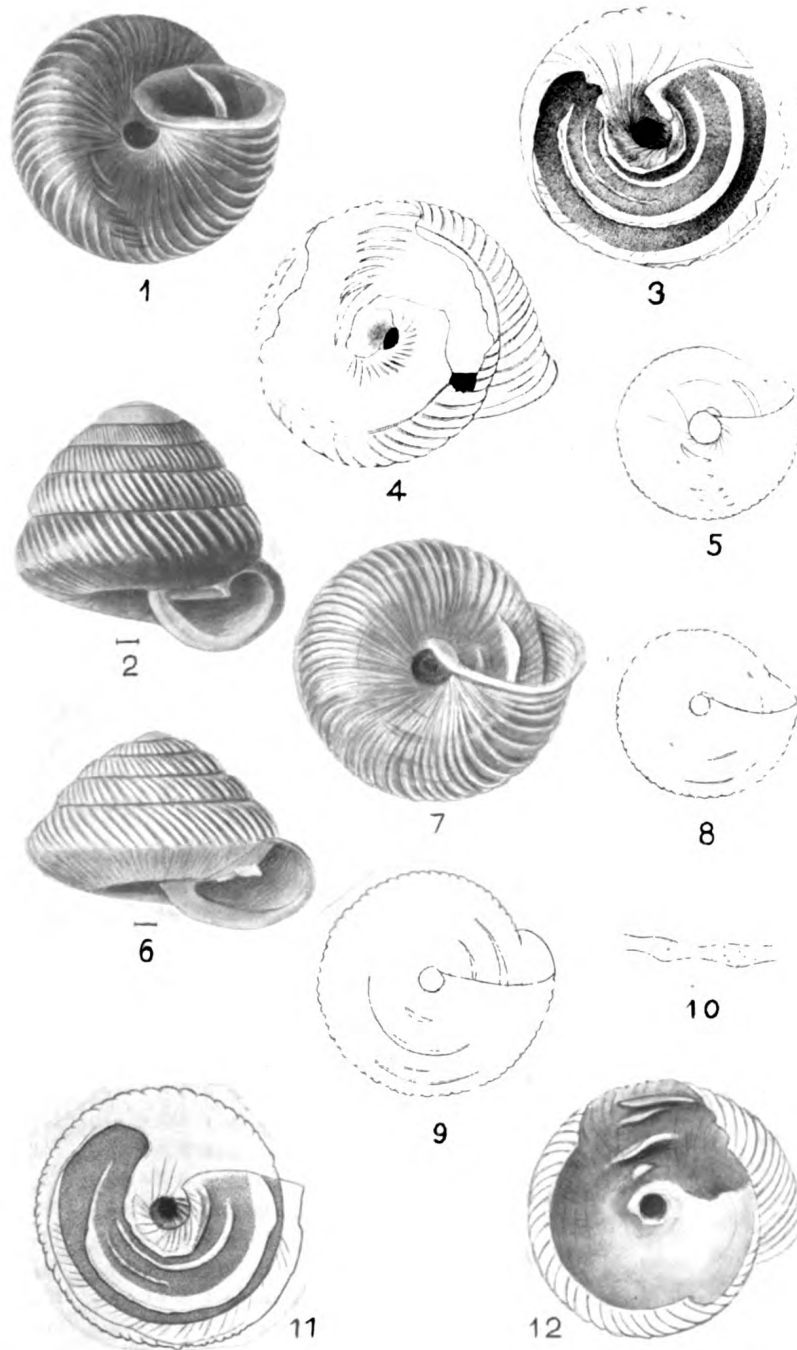


Fig. 465. 1-5, *Strobilops affinis*. 1, 2, the type, Upper Red Hook, N. Y. 6-11, *Strobilops aenea*. 6, 7, the type. 8, 9, young. 10, edge of parietal lamella, Cazenovia, N. Y.: 12, Brandywine valley, Delaware. Enlarged; actual size shown by lines below figures 2 and 6.

NEW JERSEY: White Pond, Warren Co. (Pilsbry). OHIO: Kent (G. W. Dean). MICHIGAN: Pine Lake, Oakland Co. (B. Walker). MINNESOTA: Dallas Lake, Wright Co. (H. E. Sargent). ILLINOIS: Athens (E. Hall); Lake, McHenry, Kane and Cook counties (Baker).

This shell is somewhat larger than *S. labyrinthica*, thinner, with the infraparietal lamella more deeply immersed and the baso-palatal folds less unequal, all being rather short and forming a regular curve across the base and up the outer wall as in Fig. 465:1 and 4. The outlines of the spire are somewhat less convex than in *S. labyrinthica* but more convex than in *S. aenea*.

According to John Oughton, in southern Ontario it does not occur north of counties bordering Lake Ontario; scarce; recorded by Mozley (1930) from Fort Frances, Rainy River District.

***Strobilops aenea* Pilsbry**

Fig. 465:6-12.

Strobilops labyrinthica strebeli Pfr., Pilsbry, 1893, Nautilus, 7:57; Proc. Acad. Nat. Sci. Phila., 1900, p. 133; 1902, p. 429.—Ferriss, Nautilus, 14:56. Not *Helix strebeli* Pfeiffer.

Strobilops labyrinthica (Say), Walker, 1906, Ill. Cat. Moll. Mich., p. 506, fig. 119 (excl. syn.).

Strobila labyrinthica Say, Dall, 1885, Proc. U. S. Nat. Mus., 8:262 (excl. syn.).

Strobilops aenea Pilsbry, 1926, Nautilus, 40:69; 1927, Man. Conch., 28:29, with form *micromphala*, p. 30, and *S. a. spiralis*, p. 31.—Walker, 1928, Terr. Moll. Alabama, p. 155, fig. 247, with *S. a. micromphala*, p. 158, and *S. a. spiralis*, p. 159. Many Alabama localities.—F. Haas, 1945, Fieldiana, Zoology, 31, no. 2, p. 14 (Oahu, T. H., apparently introduced).—F. C. Baker, 1939, Fieldbook Illinois Land Snails, p. 114.

The shell is narrowly umbilicate, the width of umbilicus contained about $6\frac{1}{2}$ times in the diameter of the shell, low conic, with obtuse, rounded summit, the periphery distinctly but bluntly angular. The base is somewhat flattened below the periphery, elsewhere moderately convex. Whorls $5\frac{1}{2}$, convex, slowly increasing, the first $1\frac{1}{2}$ smooth, corneous, the rest dark brown with a red-golden gleam; sculptured with narrow riblets which are somewhat

oblique, retractive, rather fine and close. The base is smoothish, marked with growth-striae only, except on its last third, where the riblets of the upper surface continue over the base. The aperture is semilunar, low but wide. Outer and basal lips brown, well expanded, somewhat thickened, the columellar margin dilated. The parietal lamella emerges to the edge of the parietal callus, penetrating inward a half whorl. Infraparietal lamella weakly emerging. Midway between the lamellæ there is a very weak, low, deeply-placed interparietal lamella. These lamellæ are nodose far within, the nodes roughened, shortly prickly (Figs. 465:10, 466). The internal barrier, situated one-third of a whorl from the aperture, is radial, but slightly oblique (Fig.

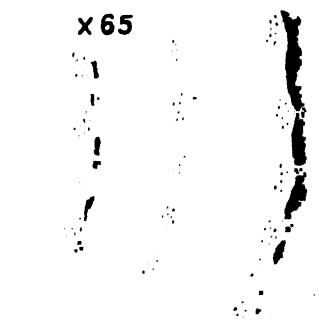


Fig. 466. *S. aenea*, parietal lamellæ near their inner ends.

465:12); it consists of a short, weak columellar fold and four basal folds, visible through the shell; the second and fourth folds from the axis are long, the first short, the third fold weak or sometimes wanting; there is no fold above the periphery.

Height 2 mm., diameter 2.7 mm. Paratype.

Height 1.9 mm., diameter 2.75 mm. Type, fig. 465:6.

Height 1.5 mm., diameter 2.4 mm. Randolph Co., Ala.

Distribution.—Southern Ontario and Massachusetts to Michigan, Illinois and Arkansas, south to southern Florida and Louisiana. Type 90785 A.N.S.P., from Cazenovia, N. Y. Localities of specimens examined follow:

MASSACHUSETTS: Mt. Holyoke (A. D. Brown). NEW YORK: Cazenovia (Henderson, Walker, Clapp and Pilsbry, 1905); Lanesville and Marbletown (Van Ingen). NEW JERSEY: Burlington Co. (Bayard Long). PENNSYLVANIA: Philadelphia; Chester Co. (B. Long); Media, Delaware Co., and Berks Co. (Pilsbry); York Furnace (W. Stone). DELAWARE: Delaware City and Dover (S. N. Rhoads). MARYLAND: Great Falls (also on the Virginia side) (Pilsbry). OHIO: Kent (G. W. Dean); Garrettsville (R. Walton). ILLINOIS: Edwards Co. (C. S. Hodgson); Steelville, Randolph Co. and LaSalle Co. (F. C. Baker); Sheridan (Ferriss). TENNESSEE: Cades Cove, Blount Co., 2000 ft. (Ferriss); Cumberland Plateau, South Pittsburgh and Dove (H. H. Smith). FOUNTAIN CITY and Dove, Knox Co., near Pikeville, Bledsoe Co., Jasper, Marion Co., Knoxville, Knox Co. and Kelley Cove, Marion Co. (H. B. Baker). NORTH CAROLINA: Wilmington, New Hanover Co. (S. N. Rhoads); Murphy and Bates Creek, Cherokee Co. (A. F. Archer); Tuskegee Mts., Graham Co. (Ferriss). SOUTH CAROLINA: Manning (W. Stone); Columbia (J. B. Clark). FLORIDA: Istachatta, Hernando Co., and 6 mi. north of Gainesville (Van Hynning); Manhattan, Lake Co. (Pilsbry and Johnson); Imri, Hamilton Co. (E. B. Chope); Fort Lauderdale (C. T. Simpson); Gainesville (J. B. Clark). ALABAMA: many places throughout the northern half of the state (H. H. Smith, H. E. Sargent). MISSOURI: near Valley Park, St. Louis Co. (Leslie Hubricht).

This species is well characterized by being more depressed than others of its region, with a decidedly angular periphery, the base flattened just below the angle; by the fine, thin ribs, the dark color and the wider umbilicus; moreover, there is no internal fold above the periphery. It was recognized as distinct over forty years ago, but at that time it was confused with the Mexican species *S. strebeli* Pfr., which differs by its far narrower umbilicus.

S. ænea is often found associated with *S. labyrinthica*, these two being the most abundant and widely distributed species of *Strobilops* in the states east of the Mississippi River. West of the Mississippi *S. ænea* has been found only in Missouri, Arkansas and Louisiana. It is the common *Strobilops* of the Gulf coastal plain.

John Oughton writes: "southern Ontario north to Leeds County. All our records lie in the counties bordering the lower Great Lakes; scarce."

Form *micromphala* Pilsbry. Fig. 467:8, 9. Lighter colored than *S. ænea*, between cinnamon and cinnamon-brown; outlines of spire more convex; umbilicus narrower, contained about 8 times in the diameter; last third of base ribbed. The infraparietal lamella does not emerge. Three folds visible through the base. Height 1.7 mm., diameter 2.5 mm.; $5\frac{1}{2}$ whorls.

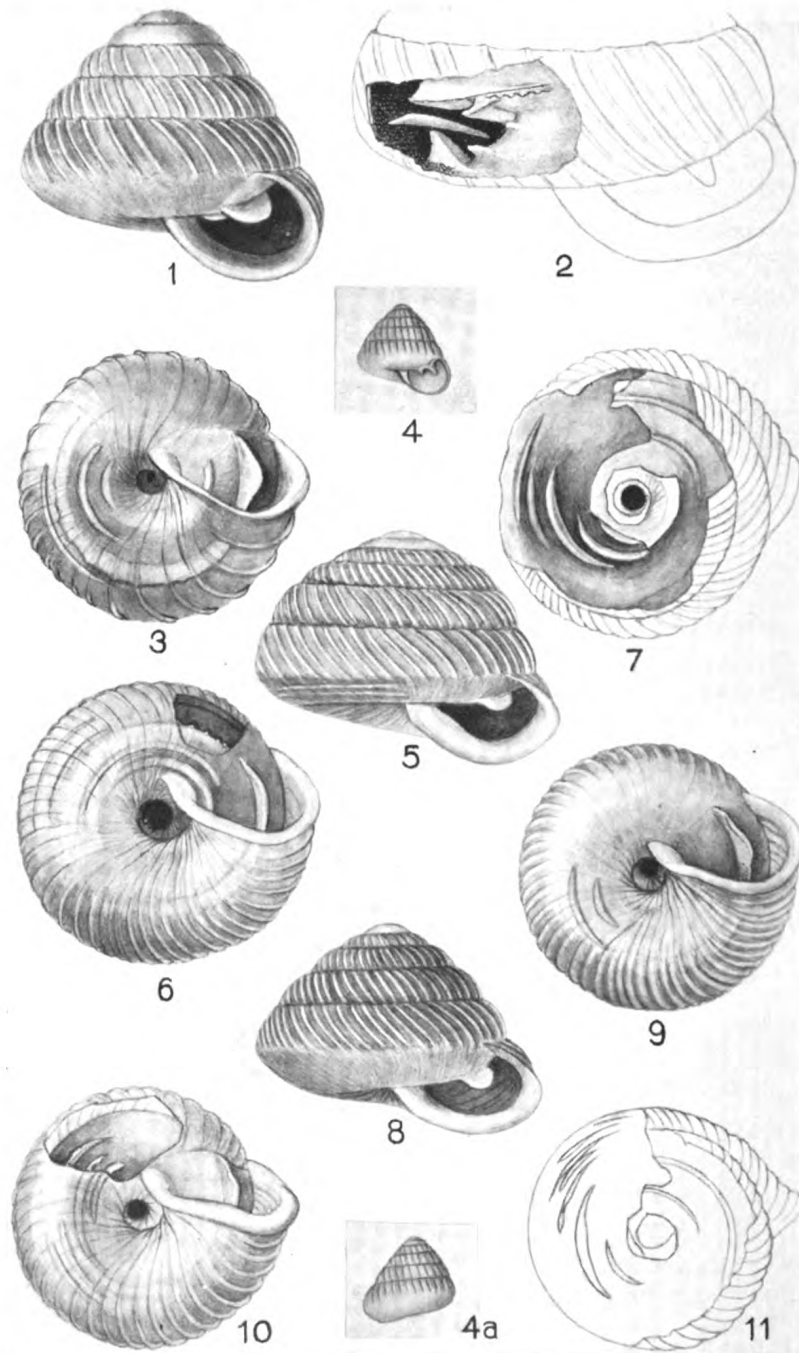


Fig. 467. (1-3, *Strobilops veracruzensis* Pils.; 4 and 4a, var. *crosssei*, Mexico). 5, 6, 7, *Strobilops aenea spiralis*, type. 8, 9, *S. aenea* form *micromphala*, Charleville, Louisiana. 10, 11, *S. labyrinthica* form *parietalis*, Ardsley, Pennsylvania. Figures, except 4 and 4a, $\times 15$.

ARKANSAS: Menard Landing, Arkansas Co.; Ouachita Co. (C. B. Moore). LOUISIANA: localities in Morehouse, Richland, Franklin, Catahoula and Rapides parishes (C. B. Moore); Grand Cane (Williamson) and Frierson (L. S. Frierson), De Soto Parish; type loc. Boeuf River above Charleville, Richland Parish. MISSISSIPPI: Yazoo and Jackson counties (C. B. Moore). ALABAMA: Wetumpka (H. H. Smith); Simpson Island, Mobile River, Baldwin Co. (C. B. Moore). WASHINGTON, D. C. (E. Lehnert). NEW JERSEY: Barton Run, Burlington Co. (Bayard Long). PENNSYLVANIA: Tulpehocken Valley, near Germantown (B. Long). ILLINOIS: White, Washington and Hardin counties (F. C. Baker).

This form occurs in the lower Mississippi Valley farther southwest than the typical form of the species has been found. By its small umbilicus it approaches the Mexican *S. strebeli*, in which the ribs are more slender. I considered it a southwestern race of *S. aenea* until lots from Washington, D. C., Pennsylvania and New Jersey turned up, in which the umbilicus is almost as small as in Louisiana specimens—being contained $7\frac{1}{2}$ times in the diameter. Further collections are required to fix the status of this form, which appears quite distinguishable in the series now available.

***Strobilops aenea spiralis* Pilsbry**

Fig. 467:5, 6, 7.

"The shell is somewhat less depressed than *S. aenea*, light brown; ribs rather distinct on the base. *The parietal lamella is much longer*, forming a full whorl in the type (but slightly shorter, over three-fourths of a whorl, in specimens from Wyandotte, Indiana). *The basal barrier is situated more deeply than in aenea*, and consists, as in that species, of four basal folds and a small, short one on the columella." (Pilsbry.)

Height 1.9 mm., diameter 2.6 mm. Type.

Height 2.0 mm., diameter 2.6 mm. Paratype.

ARKANSAS: North side of the summit of Magazine Mountain, Logan Co., Type A.N.S.P. 91331 (Ferriss and Pilsbry, 1903). ILLINOIS: Union Co. (F. C. Baker). INDIANA: Wyandotte (L. E. Daniels, 1905). ALABAMA: Roanoke, Randolph Co., and Lookout Mountain near Valley Head (H. H. Smith).

Subgenus DISCOSTROBILOPS Pilsbry

Discostrobilops Pilsbry, 1927, *Man. Conch.*, 28:18, 46. Type *S. hubbardi*.

The subgenus *Discostrobilops* comprises a single variable living species in America and one species, *S. uniplicata* (Sandberger), with two subspecies, in central European Tertiary. In all of its characters the Tertiary species agrees so completely with the living *S. hubbardi* that the relationship appears to be well established. See Fig. 468:10-13, *S. uniplicata* (Sandberger), *Hydrobienschichten, Budenheim bei Mainz*; Lower Miocene.

***Strobilops hubbardi* A. D. Brown**

Fig. 468:1-9.

Helix hubbardi A. D. Brown, 1861, *Proc. Acad. Nat. Sci. Phila.*, p. 333, text-fig.—Bland, 1875, *Ann. Lyc. Nat. Hist. of N. Y.*, 11:86.

Strobila hubbardi A. D. Brown, W. G. Binney, 1878, *Terr. Moll.*, 5:260, fig. 153, pl. 5, fig. n, teeth.

Strobilus hubbardi Clessin, *Malak. Blätter*, n. F., 7:79.

Helix vendryesiana Gloyne, 1871, *Jour. de Conch.*, 19:333 (Jamaica).

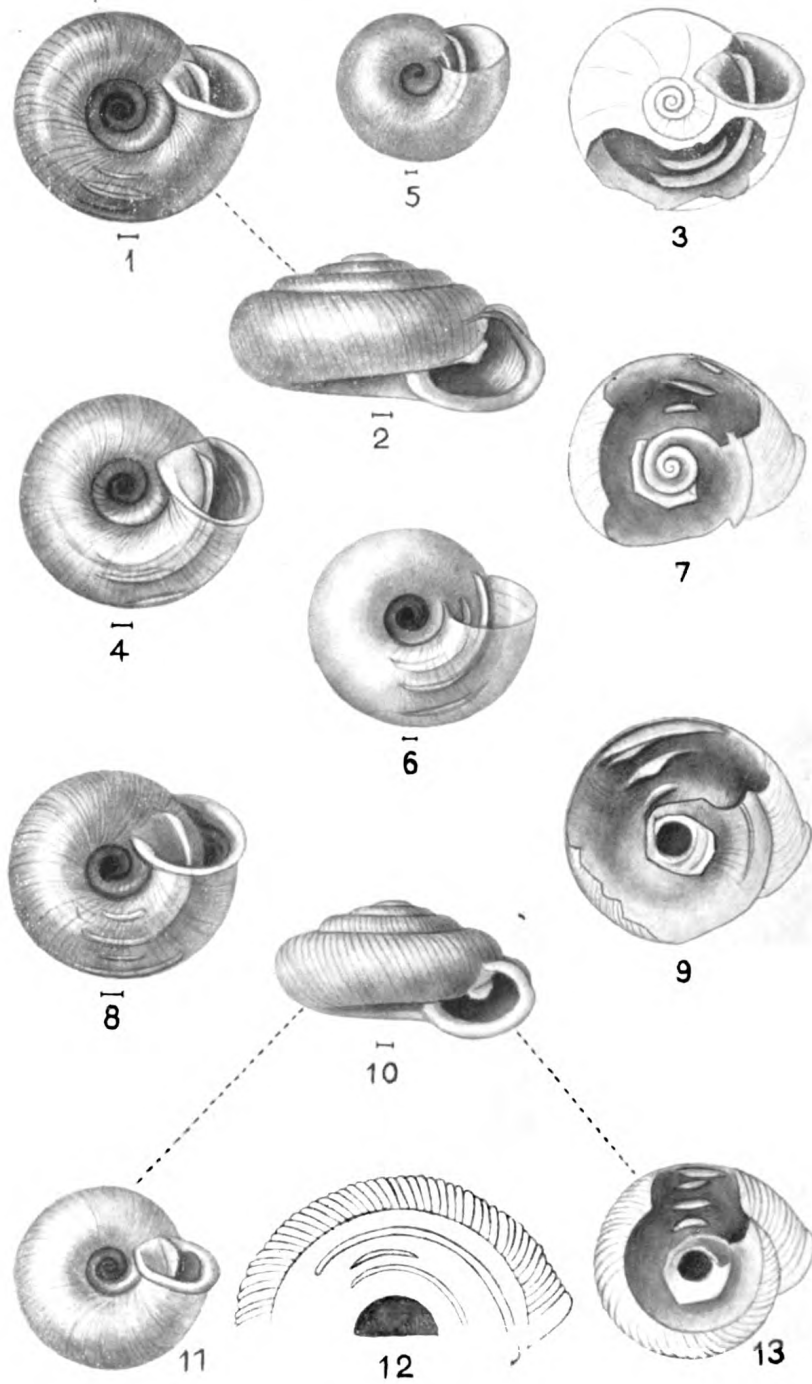


Fig. 468. See bottom of page 867 for legend.

Strobilops hubbardi stevensoni Pilsbry, 1899, Proc. Acad. Nat. Sci. Phila., p. 404.

Strobilops hubbardi A. D. Brown, Pilsbry, 1927, Man. Conch., 28:47, and *S. h. vendryesiana*, p. 48.

The shell is subdiscoidal with very low spire, rounded periphery and convex, broadly umbilicate base; width of umbilicus contained $3\frac{2}{3}$ times in that of the base. The whorls are strongly convex, increase slowly, and the last descends a little to the aperture. Surface light brown (opaque in the "dead" type, but when living glossy and somewhat translucent). Initial $1\frac{1}{2}$ whorls pale, minutely granulose, the rest with slightly irregular sculpture of close, retractive riblets, about as wide as their intervals, weaker and partly obsolete on the base, where close, weak, microscopic spiral lines are seen. The aperture is rounded-lunate, the lip well expanded and thickened within. The parietal lamella is somewhat elevated and triangular, reaching the edge of the parietal callus. Infraparietal lamella very low, inconspicuous, weakly emerging, but not to the edge. Both enter slightly further than one-third of a whorl; between them near their inner ends there is a thread-like interlamellar lamella in the type specimen. At about a third of a whorl within there is a series of four basal folds: the first one situated where the basal curves into the columellar floor; the second, stout and erect, in the middle of the basal wall; the third one small; the fourth near the periphery and longer than the others.

Height 1.2 mm., diam. 2.6 mm.; $4\frac{1}{2}$ whorls. Type.

Distribution.—Coastal plain of northeastern Mexico, Texas, Mississippi, Florida and Georgia; Jamaica; Cuba; Bimini Islands on the western edge of the Bahamas; Bermuda.

GEORGIA: Bonaventure Cemetery near Savannah (W. Newcomb). FLORIDA: Sugarloaf Key, Big Pine Key (Pilsbry); Lossman's Key (C. B. Moore); Miami (S. N. Rhoads); LaCosta Island, Demorey Key, Fikahatchee Key, Josselyn Key, Dismal Key, all in Lee Co. (C. B. Moore); Volusia Co. at Tick Island (Pilsbry and Johnson); and Lake Helen (G. W. Webster); near Gainesville (T. Van Hyning); St. Augustine (C. W. Johnson); Imri, Hamilton Co. (E. B. Chope). MISSISSIPPI: mouth of West Pascagoula River, Jackson Co. (C. B. Moore). TEXAS: Indianola, Calhoun Co., Type 124 A.N.S.P.

Brown's type is a "dead" shell which I illustrated in Man. Conch., 28, pl. 7, figs. 1-3. After those figures were drawn, it was opened and found to have basal folds as described above, and like those of Fig. 468:9. The anterior part of the infraparietal lamella is very low. The interparietal lamella is delicate and thread-like but perfectly distinct, and by possessing this lamella, the type from the Texas coastal plain differs from all other *hubbardi* from Mexico, the West Indies and Florida which I have opened. The significance of this lamella is uncertain, in the absence of series from the coast of Texas. It may turn out to be merely occasional, and to be regarded as an atavistic mutation. This lamella is present in the Miocene species of

Fig. 468. 1-7, *Strobilops hubbardi*, Miami, Florida; 8, 9, Lake Helen, Fla. 10-13, *Strobilops uniplicata* Sandberger, Miocene of Budenheim, Germany; 12, parietal lamellae seen through the partition; 13, palatal and basal folds. Enlarged; actual size shown by lines below figures.

Discostrobilops. If it is a constant character in this region, a separate sub-species is indicated for the Florida form.

The usual form of the species is light brown, glossy, finely costulate above, striate beneath. Infraparietal lamella either wholly immersed (as in Fig. 468: 3, 4) or having a very low extension forward. *No interparietal lamella*. Basal folds typically *three* (Fig. 468:7), but frequently four, and in rare cases five in immature shells (Fig. 468:1, 8, 9). Lip narrow, but slightly thickened, more or less brown-tinted.

In a young shell from Miami 1.2 mm. diameter (Fig. 468:5) there are no basal folds, but the two parietal lamellæ are well developed. Folds are present but small in a shell 1.5 mm. diameter, and at 2.2 mm. (Fig. 468:6) they are longer than in an adult of the same lot (Fig. 468:7).

The parietal lamellæ of *S. hubbardi* generally appear to be smooth, but under a high power the rounded edge is seen in the most perfect specimens to bear irregularly and sparsely-placed little points directed towards the aperture, and some minute granulation, but without a trace of nodes.

Family XX. PUPILLIDAE

Pupillidae Turton, 1831, *Man. Land and Fresh-water Shells Brit. Is.*, pp. 8, 97, for *Pupa* (= *Pupilla*) and *Vertigo*.

Pupillidae Pilsbry, 1916-1935, *Man. Conch.*, vols. 24-28, monograph.—Steenberg, 1925, *Études sur l'anatomie et la systématique des maillots*, in *Videnskabelige Meddelelser fra Dansk naturhistorisk Forening*, vol. 80, anatomy.—H. B. Baker, 1935, *Man. Conch.*, 28:191-209, anatomy.

Vertiginidae Stimpson, 1851, *Shells of New England*, p. 53, for *Vertigo*, including *Columella*.

Pupidae, in part, of many older authors.

Small Orthurethra with elongate (ovate to cylindric or rarely depressed) shell, rimate or umbilicate, typically with five laminae or teeth in the truncate-oval or rounded aperture: angular, parietal, columellar, upper and lower palatal; but part or all of them are often wanting. When teeth are present in youth they are not continuous with, or corresponding to, those of the adult stage. Penis with an epiphallus and a lateral fork bearing an appendix, or simple, without appendix. Prostate gland short, posterior. Spermathecal duct of medium length.

A large family of small or minute snails, comprising over forty genera and nearly 700 recent species, distributed over all the continents and most islands.

The shape of the shell is changed from the usual ovate or cylindric form in some genera, but not especially in the direction of other families of Orthurethra. From the strict homologies of the five primary teeth throughout the family it seems likely that the original pupillid stock possessed them, but in all of the derivative lines of descent (subfamilies) there are forms with the full tooth formula, together with others in which there has been reduction or total loss of teeth. In the collateral family Valloniidae there is no trace of a five-plicate aperture in any of the living or fossil forms, though

two of the leading genera are known by many species from Paleocene to the present time.

It is believed that the Pupillidae had originally an appendix on the penis and a forked penial retractor, such as occurs in some of the related families; but in several phyletic lines these penial appendages have been lost through secondary simplification.

Terminology of the teeth of Pupillidae

As the specific characters and classification depend largely upon the apertural teeth, and the principal ones are homologous throughout the family, a terminology is essential for their recognition and description. This is sufficiently shown in the diagram, fig. 469.⁸⁰

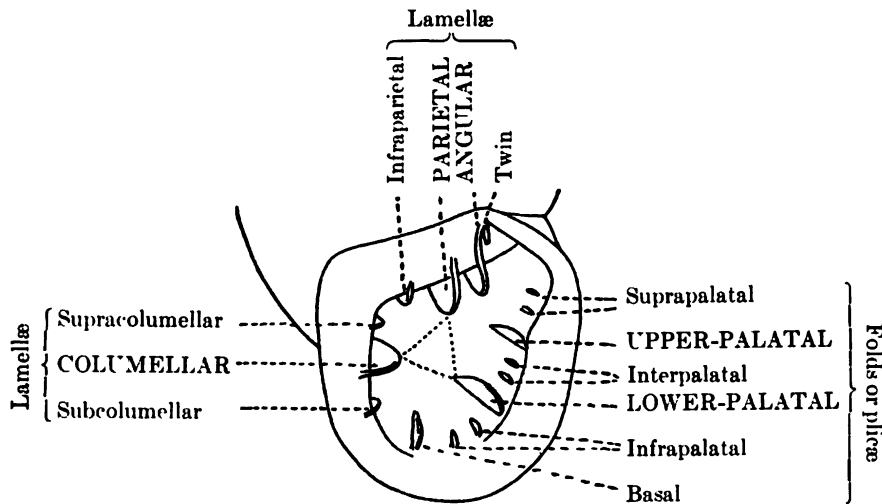


Fig. 469. Terminology of pupillid teeth, the five primary lamellæ and folds indicated by capitals. Diagrammatic.

All teeth, tubercles or laminae situated upon the parietal wall and the columellar margin are called *lamellæ*, whatever their shape. Those within the outer and basal margins are called *folds* (or *plicæ*).

The number and general arrangement of teeth can be indicated briefly by use of a formula, thus: 2-2-3 denotes 2 teeth on the parietal margin, 2 on the columella and 3 within the outer and basal margins; 1-0-0 indicates only a parietal tooth present.

The embayment of the peristome often present above the upper-palatal fold is termed the *sinulus*.

⁸⁰ The terminology now used is an amplification of that of L. Pfeiffer, 1848.

History.—The first American Pupillidae were described by Thomas Say in 1816 to 1822. After the early work of A. A. Gould and Amos Binney, 1840-51, describing numerous species, the pupillids were critically studied by E. S. Morse, 1864-68; the results of work up to 1878 being incorporated by W. G. Binney in *Terrestrial Mollusks*, vol. 5. In 1889 and the following twenty years Dr. Victor Sterki published a series of papers which made him the first American authority on Pupillidae. By his personal influence and writings, conchologists throughout the country were led to observe and collect these and other minute snails. The species of the mountain states were little known until those of Arizona and New Mexico were collected by E. H. Ashmun, and in Colorado were studied by T. D. A. Cockerell. This field was extended by Pilsbry & Vanatta, 1900, and Pilsbry & Ferriss, 1906-1910. Brooks & Kutchka published an illustrated account of West Virginian pupillids in 1938. The family was reviewed by the author in *Manual of Conchology*, vols. 24-28, the present account being abbreviated from that work, with additions and alterations. The anatomy of American species is known chiefly by an essay by H. B. Baker, 1935, published in *Manual of Conchology*, vol. 28.

Classification

Four subfamilies represented in America may be briefly characterized thus, the North American genera given for each:

Tentacles present; radula with bicuspid lateral teeth, marginals with several or many cusps, the inner one largest.

Penis without appendix; retractor simple, GASTROCOPTINAE (*Gastrocopta*, *Chaenaxis*).

Penis branched, bearing an appendix; retractor forked, PUPILLINAE (*Pupilla*, *Pupoides*).

Tentacles subobsolete or wanting; teeth of radula with accessory cusplets, the laterals tricuspid, marginals with three larger cusps; or all the side teeth may have two subequal cusps and some interstitial cusplets.

Penis provided with an appendix; retractor forked, NESOPUPINAE (*Pupisoma*, *Bothriopupa*, *Sterkia*).

Penis without appendix; retractor simple, VERTIGININAE (*Vertigo*, *Columella*).

Key to genera ⁸¹

- | | |
|--|--------------------|
| 1. Angular and parietal lamellae converging inward and more or less concrescent, or wholly united into one sinuous lamella | 2 |
| Angular and parietal lamellae distinct and separate, or one or both may be lacking | 3 |
| 2. Shell perforate or rimate, the internal axis slender | <i>Gastrocopta</i> |
| Shell widely umbilicate, internal axis large | <i>Chaenaxis</i> |
| 3. Peristome more or less expanded, thickened, or with a smooth finish | 4 |
| Peristome thin and sharp, unexpanded except at columellar margin, without a smoothly finished edge; no teeth | 7 |
| 4. Cylindric or tapering shells, 3.3 to 6 mm. long | 5 |
| Ovat to cylindric shells, 1.5 to 3 mm. long | 6 |

⁸¹ A key using only characters of the shells is necessarily artificial.

5. Whorls narrow, of slow increase; shell cylindrical with blunt ends*Pupilla*
Whorls increasing in width more rapidly; shell tapering or subcylindrical with tapering summit*Pupoides*
6. Angular and parietal lamellæ long, the former emerging to the lip-insertion; cylindrical, 1.5 to 2 mm. long*Sterkia*
Angular lamella wanting (or minute, in the lip-angle); parietal, columellar and 1 or 2 palatals present; surface pitted or granulose; ovate-conic*Bothriopupa*
Angular lamella not near the insertion of lip, if present; teeth 0 to 9; shell smooth or striate, ovate to cylindrical*Vertigo*
7. Shell cylindrical, of 5½ to 9 whorls, aperture small*Columella*
Shell obesely ovate-conic, of 3 to 5 whorls, aperture large*Pupisoma*

Subfamily GASTROCOPTINAE

Gastrocoptinae Pilsbry, 1918, Man. Conch., 24:x; 1935, 28:ix.

GASTROCOPTA Wollaston

Gastrocopta Wollaston, 1878, Testacea Atlantica, p. 515.—Pilsbry, 1916, Man. Conch., 24:6, type *G. acarus* (Bens.).

Leucochilus Boettger, 1881, Conchologische Mittheilungen, 1:64, Type *Pupa armifera*. Not *Leucochila* von Martens, 1860.

Bifidaria Sterki, in Pilsbry, 1891, Proc. Acad. Nat. Sci. Phila., p. 315.—Sterki, Nautilus, 6:4, 99.—Dall, Nautilus, 17:116, type *B. servilis* (Gld.)

Eubifidaria Sterki, 1893, Nautilus, 6:101, type "*P. hordeacea* Gabb" of Sterki, = *G. cristata* (P. & V.).

Includes also the subgenera *Albinula*, *Vertigopsis* and *Privatula* Sterki, *Staurotrema* Pilsbry, and *Immersidens* P. & V.

The shell is rimate or perforate, cylindrical or ovate-conic, having the angular and parietal lamellæ more or less completely united into one biramous, bifid, lobed or sinuous lamella (or rarely the angular lamella is wanting). Columellar lamella present; palatal folds present (except in *G. corticaria*); lip well expanded.

Genitalia characterized by the absence of appendages of the penis, which has the retractor inserted near the end; epiphallus well developed, vagina very short; spermathecal duct rather long. Central teeth of radula tricuspid, much narrower than the laterals which are bicuspid; marginals with prominent mesocone and several ectocones.

Locomotion rhythmic; in *G. armifera* about 4 waves visible at one time.

Distribution.—Nearly world-wide in tropical and temperate regions, but wanting on many oceanic islands and in the recent European fauna, though represented there as Oligocene to Pliocene fossils. Species and individuals are most numerous on limestone terrains or where the country rock contains considerable lime, living under stones or wood or among leaves. The absence of this genus on the West Coast is remarkable.

Gastrocopta is the most widely distributed genus of the family. The subgenera fall into two main groups: (1) a northern series, comprising subgenera *Albinula*, *Vertigopsis*, *Staurotrema* and *Privatula* in America, with various other forms in Eastern Asia and the European Tertiaries; and (2) a tropical and southern continent series, with *Gastrocopta* s.s. and *Immersidens*, also the related genus *Chaenaxis*, together with some other extra-

limital forms. A few species of this austral series extend northward into temperate North America, where they meet the group of northern genesis.

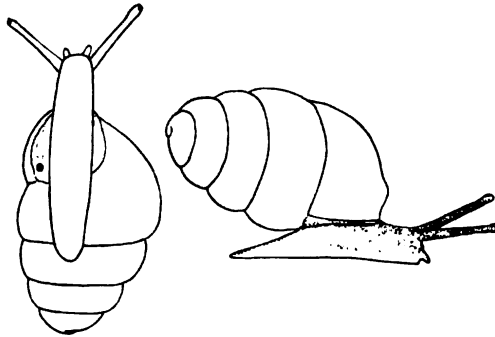


Fig. 470. *Gastrocopta pentodon* in movement. Cape May, N. J.

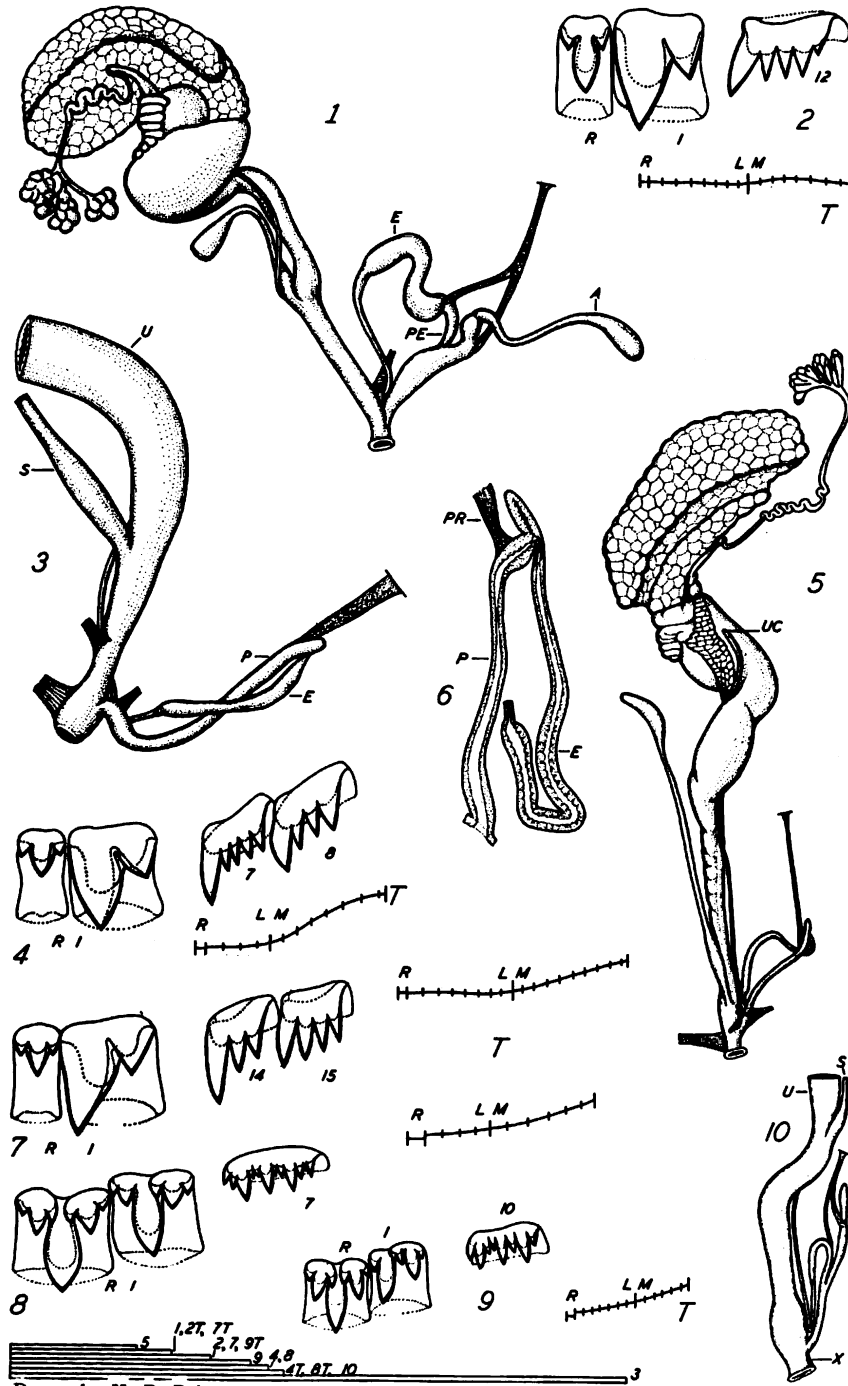
G. armifera of the subgenus *Albinula*, and *G. octonaria* of the typical group have been dissected by H. B. Baker, whose account follows.

GASTROCOPTA (ALBINULA) ARMIFERA (Say) Fig. 471:5 to 7. The description is founded on animals from Williams Canyon, near Manitou, Colorado, collected Sept. 19, 1931, but specimens from near Spearfish, South Dakota, collected a week earlier, and from near Philadelphia, collected in the spring, have the same structure. Male organs, although small, seem to be always developed. No embryos have been observed.

Ovotestis (Fig. 5) with three lobes of clavate alveoli; carrefour elongate and enlarged at both ends. Oviduct with apical half (uterus) swollen and apically convoluted; basal half slender; cul-de-sac slender and almost as long as uterus. Spermathecal sac imbedded near middle of uterus. Epiphallus (Fig. 6) swollen and internally papillate in first half; slender and simpler towards entrance into penis which is without definite papilla. Penis small and slender; swollen apically, where it has thick walls and is prolonged some distance beyond epiphallar entrance. Penial retractor arising from diaphragm and inserting slightly below epiphallus. Atrium short. Right inferior as well as ommatophoral retractors passing through penioviducal and attached to both sides and to vas deferens by slips of muscle; right free retractor with large branch to atrium. Radular formula (Fig. 7): 18-1-(8 + 10), with 82 rows (T); central about half width of 1st lateral, with short reflection and 3 small cusps; marginals with prominent mesocone and with few ectocones.

GASTROCOPTA (s.s.) OCTONARIA Pilsbry. Fig. 471:3 and 4. The animals are from Bonaire, Dutch West Indies, collected August, 1922; they may be

Fig. 471. 1, 2, *Pupoides nitidulus* Pfr., Aruba, Dutch West Indies. 1, genitalia; 2, radula. 3, 4, *Gastrocopta octonaria* Pils., Bonaire, Dutch West Indies. 3, terminal genitalia; 4, radula. 5-7, *Gastrocopta armifera* Say, Williams Canyon, Colorado. 5, genitalia; 6, penis and accessories from glycerin jelly mount; 7, radula. 8, *Nesopupa wesleyana* Anc., Kalihi, Oahu. Radula. 9, 10, *Bothriopupa tenuidens* C. B. A., Jamaica, British West Indies. 9, radula; 10, terminal genitalia.



Drawn by H. B. Baker

Fig. 471. See bottom of page 872 for legend.

stout examples of *G. curacoana* Pilsbry (teeth of shell destroyed to see animals and vice versa). Only salient differences from *G. armifera* are noted.

Free oviduct (Fig. 3) stouter; vagina relatively longer. Epiphallar entrance nearer apex of penis. Radular formula (Fig. 4): 12-1-(4 + 8); marginals usually broader and often with more ectocones.

Key to subgenera

1. Parietal wall and columella with one or two very small teeth 2
Teeth of parietal wall moderately to strongly developed 3
2. Palatal folds also present *Vertigopsis*
No basal or palatal folds and no palatal callus *Privatula*
3. Palatal folds standing on a white callous ridge; aperture nearly filled by the large teeth *Albinula*
Palatal folds not connected by a callus 4
4. Angular and parietal lamellae diverging forward, the tooth like a mirrored letter y *Immersidens*
Angular and parietal lamellae con crescent into one sinuous or bilobed lamella. *Gastrocopta*
Angulo-parietal lamella simple, bent; shell whitish-translucent with 4 teeth in cross arrangement *Staurotrema*

Subgenus ALBINULA Sterki

Albinula Sterki, 1892, *Nautilus*, 6:101, type *Pupa contracta* Say.

Whitish-translucent gastrocopts having the *inner end of the parietal lamella curved towards the periphery*; angular lamella well developed, con crescent in varying degree with the parietal; the palatal folds stand upon a white palatal callus, and a suprapalatal fold is usually developed. Except in *G. armifera*, the columellar lamella is horizontal in front and curves towards the base within. The lip is thin and expanded.

Distribution: North America except the Pacific slope; Oligocene to Pliocene of Europe.

Key to species

- Shell oblong, 3.3 to 4.5 mm. long; angulo-parietal lamella lobed and sinuous but not much bent and not forked in front *armifera*, *proarmifera*
Shell ovate-conic, 2.3 to 2.5 mm. long; angulo-parietal lamella bent L-shaped within. *contracta*
Shell cylindric, about 1.75 mm. long; angulo-parietal lamella forked in front. *holzingeri*, *falcis*

Gastrocopta armifera (Say)

Fig. 472:1-4.

Pupa armifera Say, 1821 *Jour. Acad. Nat. Sci. Phila.*, 2:162.—Binney, *Man. Amer. Land Sh.*, p. 325.

Bifidaria armifera Say, Sterki, 1909, *Nautilus*, 23:52, with var. *interpres* (p. 52), *similis*, *affinis*, *abbreviata* (p. 53).

Bifidaria armifera var. *ruidosensis* Cockerell, 1899, *Nautilus*, 13:36.

Bifidaria clappi Sterki, 1909, *Nautilus*, 22:108, pl. 8, fig. 4.

Gastrocopta armifera Say, Pilsbry, 1916, *Man. Conch.*, 24:15-21.—Brooks & Kutchka 1938, *Ann. Carnegie Mus.*, 27:66.—F. C. Baker, 1939, *Fieldbook Ill. Land Snails*, p. 99, figs. A-D, varieties.—Franzen, 1947, *Trans. Kansas Acad. Sci.*, 49:417, pl. 1, figs. 8, 9, pl. 2, figs. 10, 11 (N. W. Kansas).

Pupa armigera "Say," Potiez & Michaud, 1848. and of W. G. Binney, in Warren's Prelim. Rep. Expl. in Neb. and Dakota in 1855-57, reprint 1875, p. 107.

[?] *Pupa moreletiana* Grasset, 1856. Jour. de Conchyl., 5:348, pl. 13. fig. 7 (Canary Is.).

The shell is perforate and rimate, oblong, the summit obtusely conic; thin, paraffine-white, glossy, weakly marked with very oblique, irregular growth-striæ. Whorls about $6\frac{1}{2}$, moderately convex, the last compressed around the axis. Aperture irregularly rounded. Peristome thin, well expanded, the margins approaching, often (and typically) connected by a short callus with raised edge across the parietal wall. Angular lamella joined to the outer lip near its insertion, united with the parietal lamella, its summit projecting as a short spur on the right side. The columellar lamella, as seen in a shell broken to show the interior (Fig. 472:3, 4), is subvertical, advancing slightly downward, then retracted towards the base; giving off a short, horizontal branch in front, and visible in the aperture. Basal lamella is low and often inconspicuous. Palatal folds stand upon a white callus; lower-palatal fold short, entering, the upper one shorter; a small supra-palatal tubercle stands above it. Length 4.4, diam. above aperture 2.2 mm.

Distribution.—Eastern United States and Canada: Quebec to northern Florida, west to Red Deer, Alberta, Dakota, near Boulder, Colorado, Lincoln Co., New Mexico, and the mouth of the Pecos River, Texas. Type 11624 A.N.S.P., Pennsylvania.

This species is easily recognized by its large size, oblong shape, the spermaceti or paraffin tint and large teeth. In life the shell is daubed with dirt.

It inhabits almost the whole country east of the continental divide, but is lacking in southwestern New Mexico, southern Texas, southern Florida, and the higher parts of the Alleghany Mountain system. It prefers limestone districts. I have selected Germantown, Philadelphia, as the type locality, the specimens from there agreeing exactly with Say's.

The columellar lamella, as seen in a view in the back (Fig. 472:3), is most prominent at the lower third. From this prominence a short horizontal branch runs forward (Fig. 4), below which the lamella recedes. The peristome is either continued as a thread across the parietal wall, or the interruption is short. The usual variation in size, in the type locality, is from 4 to 4.6 mm. long, 2 mm. wide above aperture. The short individuals, having about the same diameter as the long ones, are quite different in contour, being oval, while the long shells are cylindrical. The basal fold is sometimes distinct, though low, as in Fig. 472:3, 4, but usually it is less conspicuous, as in fig. 1.

Shells agreeing well with the types are to be found over nearly or quite the whole range of the species, but there are also several incipient races which have been defined by Dr. Sterki. The most tangible differential features of these races are found in the shape of the columellar lamella, but all details vary by easy stages. The areas of the several named forms are not

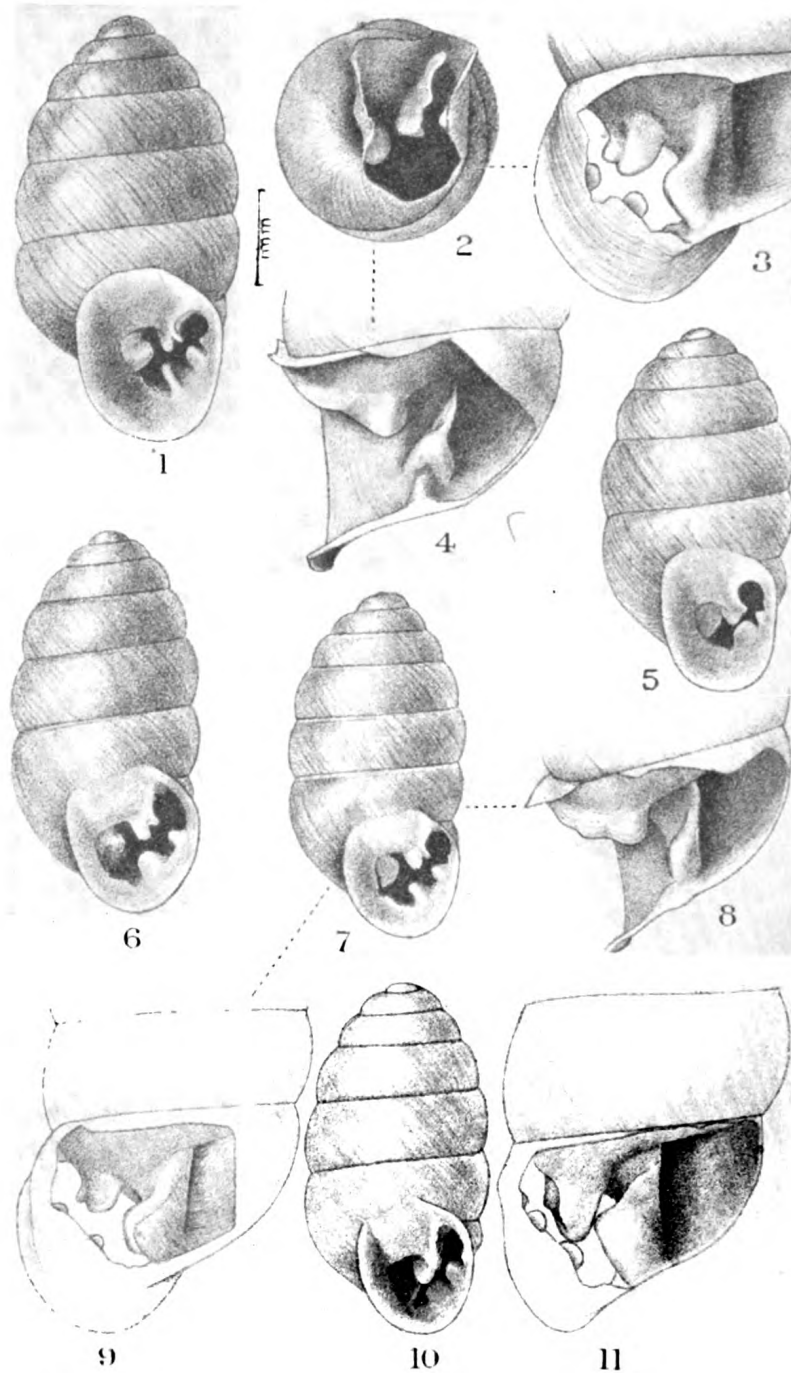


Fig. 472. 1, *Gastrocopta armifera*, type specimen; 2-4, Germantown, Philadelphia. 5, *G. a. affinis*, Evansville, Ill. 6, *G. a. similis*, Rose Hill, Ont. 7-9, *G. a. clappi*, Knoxville, Tenn. 10, *G. a. ruidosensis*, Ruidoso, N. M.; 11, Gallinas canyon, N. M.

well defined. Most of the named forms do not appear sufficiently detached to be named as races; but the data are given here for what they may be worth.

Form *interpretes* Sterki. "Near the typical form, generally somewhat slender; inferior columellar lamella rather high up; the base is narrow inside and more keel-like outside; the aperture is narrowly rounded at the base, and from this feature specimens are easily recognized. More than any other form this shows clearly that the so-called 'basal' is really an inferior columellar.

"Distribution: Southern, especially southwestern; it appears to be the prevalent form in Kansas, Arkansas, Oklahoma, and thus represents a geographical variety." (Sterki.)

This form is so intimately related to the typical *armifera* that I am unable to segregate it. I never identified it. Only two sets in the Sterki collection, Carnegie Museum, Fort Gibson, Okla., and Wichita, Kans., but the type cannot be found.

Form *similis* Sterki. Fig. 472:6. "Averaging somewhat smaller, more cylindrical; striae slighter; more milky-whitish; peristome never continuous". This is very close to *armifera*, the columellar lamella being practically the same, but the margins of the peristome are separated rather widely above. "Northern New York to Iowa, Minnesota."

Type 62.22516 C.M. from Rose Hill, Ontario.

Form *affinis* Sterki. Fig. 472:5. Rather small, 3.4 to 4 mm., near *similis* but less cylindrical; peristome never continuous. The lobe of the columellar lamella is rather thin, abrupt above, and the forward branch is almost obsolete. Difficult to distinguish from the typical *armifera* and from *similis*.

From Fairport, Ohio, in sand dunes on Lake Erie, 62.22500 Carnegie Mus., probably type lot, but not so designated. Also Michigan, Indiana to Minnesota and Kansas, where it is common; Evansville, Wisconsin.

Gastrocopta armifera abbreviata (Sterki)

Page 832, fig. 474:1-3.

Vertical lobe of the columellar lamella quite short, placed low on the pillar, its short forward branch as in *armifera*; basal fold well developed. Length 3.3 to 4.2 mm.

Bismarck, North Dakota, Type 62.22700 Carnegie Mus., to the Rio Grande, Val Verde Co., Texas, and from the Missouri River and Caddo Parish, La., west to Trinidad, Colo. and Las Vegas, N. M. A form of the prairie states and semiarid country westward.

In a garden near Lincoln, Neb., J. B. Clark found several gigantic specimens, length 5.4 mm., diam. 2.3 mm., $7\frac{1}{2}$ whorls; aperture normally developed. The usual form, 3.5 to 4 mm. long, was present in abundance.

Gastrocopta armifera ruidosensis (Cockerell)

Fig. 472:10, 11.

The teeth are more massive than in the typical or any of the preceding forms, making the orifice much narrower. Columellar lamella large and

thick, having a triangular outline as seen from the back (Fig. 11), the highest part being the receding lower lobe. Length 4, diam. above aperture 2 mm.

NEW MEXICO: Blackwell's ranch, Ruidoso, type 73944 ANSP. Also Gallinas canyon (T. D. A. Cockerell).

Gastrocopta armifera clappi (Sterki)

Figs. 472:7, 8, 9; 472 a.

The shell averages somewhat smaller than *G. armifera*; apex more acute; striae finer; peristome not continuous; length 3.5 to 4 mm., $6\frac{1}{2}$ to $7\frac{1}{2}$ whorls. In a profile view, Fig. 472:8, the plane of the columellar lamella is straight very nearly to the base, while in *armifera* the greatest projection forward is well above the base. The forward branch, more or less apparent in *armifera*, is wanting. East Tennessee, northern Alabama. Type 5772 Carnegie Mus., from "The Thickets" Knoxville.

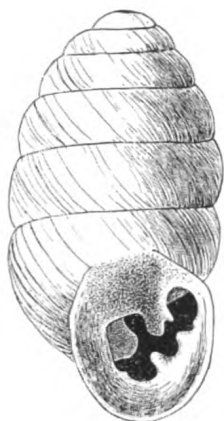


Fig. 472a, *G. a. clappi*, original figure.

Gastrocopta proarmifera Leonard

Fig. 473:3-5.

Gastrocopta proarmifera Leonard, 1946, Nautilus, 60:21, pl. 3, figs. 3, 4, 5.

"*Diagnosis*: Shell with the characters of the subgenus *Albinula* Sterki, except that the parietal lamella is actually bifurcate, having a short heavy limb turned toward the periphery. The shell is ovate-oblong, with 7 lamellae, all exceptionally large and massive save the basal, always small and sometimes nearly obsolete, and the suprapalatal, which is small, but invariably present in a large series. The large, disc-shaped columellar lamella is a distinctive character.

"*Description of holotype*: Shell perforate, rimate, ovate-oblong, summit obtusely conic. Whorls a little more than 6 in number, first $1\frac{1}{2}$ finely granular, remaining whorls finely and diagonally striate; whorls only slightly inflated, last whorl compressed around axis, subangulate below; suture moderately impressed. Aperture irregularly oval; peristome flared; lip thin and simple, reflected, adnate and continuous upon body whorl. A depressed, seamlike scar, behind peristome, indicates position of lower palatal plica. Lamellae 7 in number; a fused anguloparietal, a columellar, a basal, lower palatal, upper palatal, and suprapalatal. The massiveness of the lamellae restricts the size of the orifice. The angular lamella arises from peristome above sinus, curves, and is deflected toward periphery, fused with parietal at its lower termination; parietal heavy with rounded edges, bifurcate below, an elongate limb turns towards the periphery, a shorter, heavier limb curves toward the columella; columellar lamella, when viewed from in front, appears as of a slightly concave disc; it extends obliquely downward, the lower part most deeply immersed. Basal lamella almost obsolete, subcolumellar in position; palatal plicae on a low rounded callus; the lower palatal very deeply placed in cavity (above the termination of the parietal) heavy, bluntly chisel-shaped, transverse in cavity; upper palatal lamella less deeply immersed, less than $\frac{1}{2}$ as large as lower palatal.

termination rounded, and directed slightly toward the periphery; supra-palatal lamella small, nodular, located on lower border of sinulus. Lamellae and walls of aperture finely punctate." (Leonard.)

	Height	Diameter	Aperture Height	Aperture Diameter	Whorls
Type	4.08 mm.	2.16 mm.	1.60 mm.	1.4 mm.	6½
Paratype	3.37 mm.	2.0 mm.	1.44 mm.	1.24 mm.	6¼
Paratype	3.93 mm.	2.16 mm.	1.50 mm.	1.44 mm.	6½
Paratype	3.96 mm.	2.16 mm.	1.60 mm.	1.44 mm.	6½

KANSAS: Lower Pleistocene; sec. 35, twp. 14 S, R 11 W; 3 mi. SW Wilson, in Russell County, Type: Cat. No. 3741, University of Kansas Mus. Nat. Hist.

"*G. proarmifera* occurs in deposits 6 miles north of Meade, Meade County, Kansas, in addition to the type locality. This species resembles *G. a. ruidosensis* Cockerell, but differs from it in the following details: Lamellae

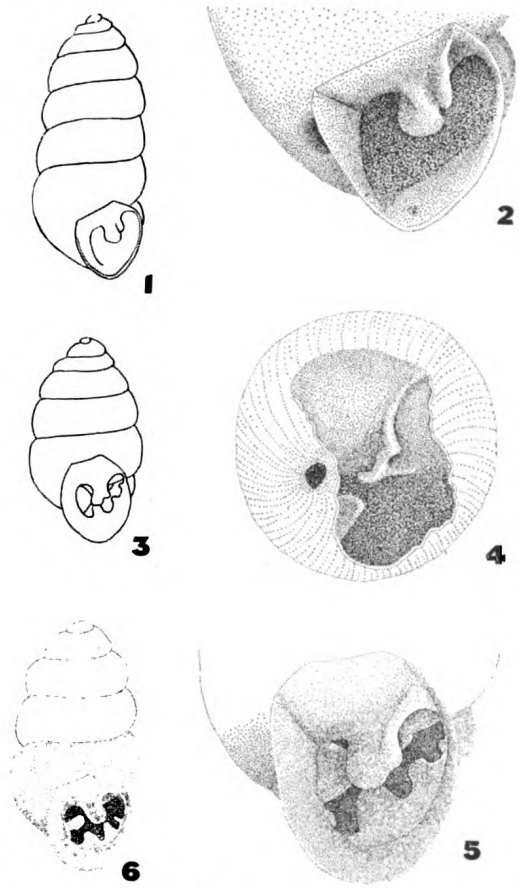


Fig. 473. 1, 2, *Gastrocopta tridentata*. 3-5 *G. proarmifera*. 6, *G. falcis*. After Leonard.

generally more massive; the parietal distinctly bifurcate below; the columellar rounded, rather than triangular in profile, and the lower palatal much more deeply situated within the aperture." (Leonard.) Probably to be ranked as a subspecies of *armifera*, but I have not seen it.

Gastrocopta tridentata (Leonard)

Fig. 473: 1, 2.

Columella tridentata Leonard, 1946, *Nautilus*, 60:20, pl. 3, figs. 1, 2.

"*Diagnosis*: Shell large, elongate, cylindrical with three well-developed lamellae; a strong angulo-parietal and a deeply immersed, rounded columellar lamella; whorls $7\frac{1}{2}$.

"*Description of holotype*: Shell large for the genus, subcylindrical, with $7\frac{1}{2}$ compressed whorls; suture well impressed; umbilicus round, small, diameter only $\frac{1}{3}$ diameter of body whorl; first 3 whorls enlarging rapidly, producing bluntly conic apex; remaining whorls increasing in size slowly but regularly; first $1\frac{1}{2}$ whorls with finely granular sculpture, remaining whorls embellished with fine, diagonal, closely spaced growth lines; last half of body whorl compressed around axis, subangulate below; aperture small, subtriangular; peristome simple, continuous by thin callus across body whorl; lip relatively heavy (broken?); lamellae 3; the angular bluntly triangular, arising near angular lip of peristome and extending downward, curving slightly toward periphery; fused with parietal lamella except near termination, which is situated midway along peripheral border of parietal; parietal lamella (not visible in front view) deeply immersed, thick, heavy, broadly spatulate, rounded; columellar lamella compressed; peristome, including lamella, finely punctate. Measurements (in mm.): height, 5.2; diameter, 2.52; height of aperture, 1.5; diameter of aperture, 1.44." (Leonard.)

KANSAS: Lower Pleistocene; sec. 35, twp. 14 S. R 11 W; 3 mi. SW Wilson, in Russell County, Type: Cat. no. 3737, University of Kansas Mus. Nat. Hist.

"Known only from the type. *C. tridentata* resembles *Columella hasta* in size and shape, but the latter lacks the lamellae, and has 9 whorls." (Leonard.)

This enigmatic species may turn out to be a case of gigantism; further collecting is needed to demonstrate its status. The much smaller *G. proarmifera* occurred in the same formation. By the absence of palatal folds, it agrees with the subgenus *Privatula*, but the shell is otherwise different. Not seen by the author.

Gastrocopta contracta (Say)

Fig. 474: 9-12.

Pupa contracta Say, 1822, *Jour. Acad. Nat. Sci.*, 2:374.—W. G. Binney, 1878, *Terr. Moll.*, 5:207.—Arango, *Fauna Mal. Cubana*, p. 130.

Pupa dellostoma "Chap." Küster, 1852, *Syst. Conchyl. Cab.*, p. 181.

Pupa nebraskana W. G. Binney, in Warren's *Prelim. Rep. on Expl. in Nebr. and Dakota in 1855-57*, reprint of 1875, p. 107, (Ft. Berthold), name only; quoted as *Pupa nebrascana* by W. G. B., *Terr. Moll.*, 5:213.

Gastrocopta contracta (Say), Pilsbry, *Man. Conch.*, 24:22, with form *peninsularis*, p. 24; *Proc. Acad. Nat. Sci. Phila.*, 1906, p. 144.—Aguayo, 1935, *Mem. Soc. Cubana Hist. Nat.*, 9:123 (occurrence in Cuba).—Brooks and Kutchka, *Ann. Carnegie Mus.*, 27:67.—Franzen, 1947, *Trans. Kansas Acad. Sci.*, 49:416, pl. 1, fig. 5, pl. 2, fig. 1 (N.-W. Kansas).

The shell is rimate, ovate-conic, tapering from the last whorl to the obtuse apex, bluish-milky or spermaceti-colored, imperfectly transparent, glossy, marked with fine growth-striæ. Whorls 5½, very convex, the last half of the last whorl straightened, pinched at the base, impressed over the lower-palatal fold, and on both sides of a low rounded ridge which stands a short distance behind the peristome (Fig. 474:11). Aperture rounded-triangular, almost closed by large teeth. Angulo-parietal lamella joining the lip, angularly bent to the right near the middle, then abruptly becoming much lower and bent inward (Fig. 9). Columellar lamella large, thin, very deeply placed, subvertical, the upper end curving forward (fig. 12). A subvertical callus stands in front of it, near the margin (Fig. 12). Palatal folds two, connected by a low callus, the lower one obtuse, transverse, more deeply placed and larger than the tuberculiform upper fold. Peristome thin, well-expanded, continuous.

Length 2.5, diam. 1.4 mm.

Length 2.3, diam. 1.3 mm.

Distribution.—Eastern United States and Canada: Maine, Ontario and Manitoba, south to Miami, Florida, and Vera Cruz, Mexico; Cuba and Jamaica (probably introduced). Type locality, Occoquan, Virginia.

This species is readily known by the conic shape, and peculiar aperture, nearly closed by the large teeth. There is some variation in the shape, some individuals being more shortly conic than that figured. Also in the prominence of the low ridge or crest behind the outer and basal lips, which varies from strong to very weak.

Its western limit, as represented in the collection of the Academy, is Clay Co., South Dakota, Payne Co., Oklahoma, and mouth of the Pecos River, Val Verde Co., Texas. Southward it extends over peninsular Florida in a slightly different race, but has not occurred on the keys. In the higher parts of the Alleghany Mountains, *G. contracta* seems to be rare, if not absent.

Form *peninsularis* Pilsbry. Fig. 474:8. The shells of peninsular Florida are slightly more fragile than the typical form, and differ by having the inward continuation of the parietal lamella, beyond the second angular bend, much lower and often detached from the rest of the lamella. Figured Type, 91246 A.N.S.P., is from Crystal River, Citrus Co., Florida.

***Gastrocopta contracta climeana* (Vanatta)**

Page 887, fig. 477:1, 4.

Bifidaria contracta climeana Vanatta, 1911, Proc. Acad. Nat. Sci. Phila., p. 525, figs. 1-3.

"Shell similar to typical *contracta* (Say), but the parietal tooth lacks the inner continuation, being L-shaped (fig. 4). Alt. 2.29, diam. 1.43 mm." (Vanatta.)

Distribution.—Gulf coastal plain from Alabama to Texas, and lowlands of the Mississippi north to Arkansas.

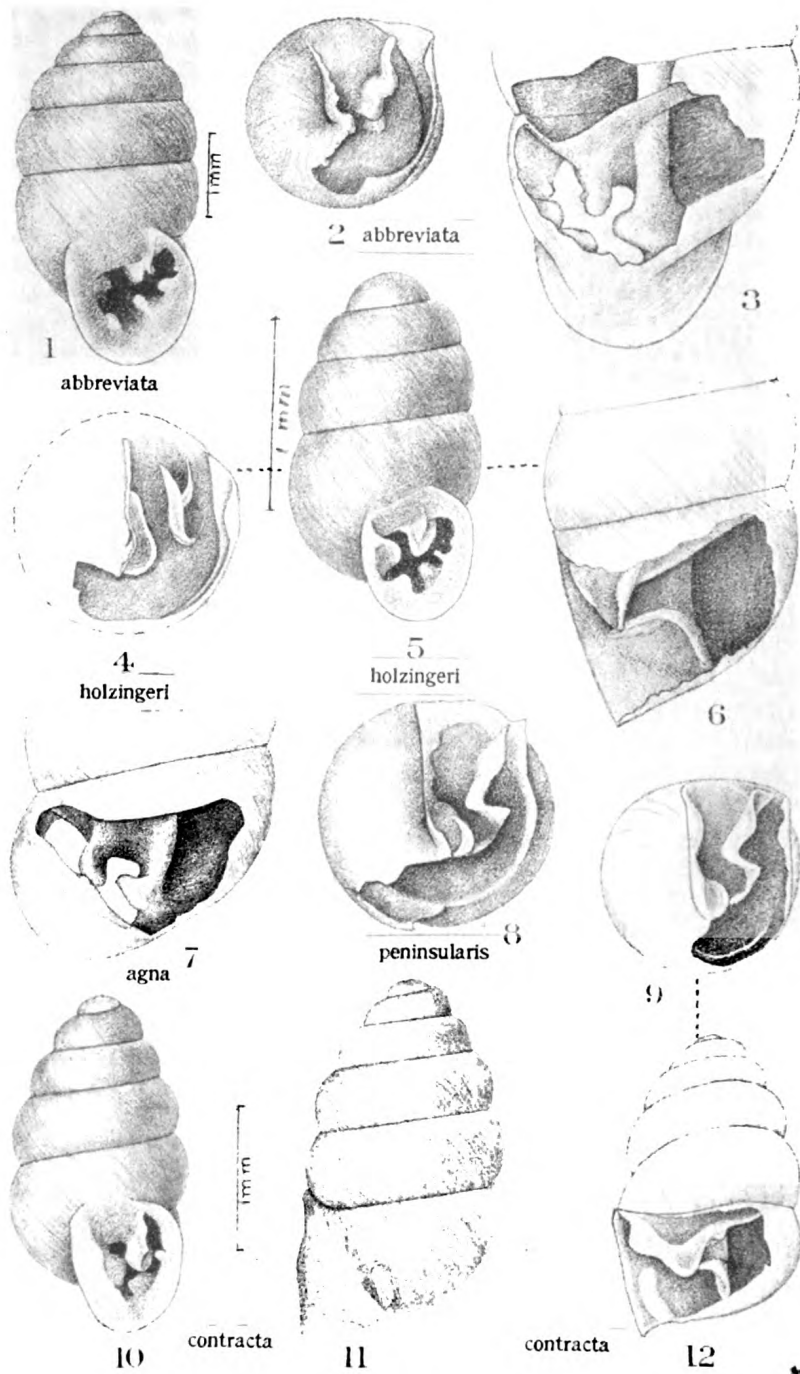


Fig. 474. See bottom of page 883 for legend.

ALABAMA: near Blakeley, Baldwin Co.; Simpson Island, Baldwin Co., (Clarence B. Moore); Calera and Wetumpka (H. H. Smith). MISSISSIPPI: near Anderson Landing, on the Sunflower River near the confluence with the Yazoo River, Sharkey Co., Type 97,605 A.N.S.P., O'Neil Landing, Yazoo Co., (C. B. Moore). LOUISIANA: City Park, New Orleans (S. N. Rhoads); above Eagle Island Landing, Franklin Parish and Sycamore Landing, Morehouse Parish (Clarence B. Moore). ARKANSAS: Carlock Place and Tebbs Place, Ashley Co., and near Menard Landing, Arkansas Co. (C. B. Moore). TEXAS: Navidad River bottom, Jackson Co. (J. D. Mitchell).

In its area this subspecies replaces *G. contracta*. The Floridan form (*peninsularis*), in which the inner continuation of the parietal lamella is weak or interrupted, forms a partial transition between *contracta* and *climeana*.

(Named for Mr. Arthur W. Clime, one of Mr. Moore's assistants, who collected this race.)

Gastrocopta holzingeri (Sterki)

Figs. 474:4-6; 475.

Pupa holzingeri Sterki, 1889, Nautilus, 3:37, 96, 119; Proc. Acad. Nat. Sci. Phila., 1889, p. 414, pl. 12, figs. 4-7.—B. Walker, Nautilus, 5:93; 11:82.—Pilsbry, Nautilus, 14:82. (Mesilla, N. M.)

Gastrocopta holzingeri (Sterki) Pilsbry, 1916, Man. Conch., 24:25, pl. 2, figs. 4-6.—F. C. Baker, 1939, Fieldbook Ill. L. Snails, p. 99, figs. A, B (Will, LaSalle, Hancock & Jackson counties, Illinois).—Franzen, 1947, Trans. Kansas Acad. Sci., 49:416, pl. 1, fig. 4, pl. 2, fig. 4 (Mitchell to Cheyenne counties, n-w. Kansas).

Gastrocopta holzingeri and *G. h. agna*, Brooks and Kutchka, 1938, Ann. Carnegie Mus., 27 pp. 68, 69, text fig.

The shell is cylindric, transparent or whitish; whorls 5, convex, the last with an oblique crest some distance behind the outer lip. Aperture broadly oval. The peristome thin, expanded, not continuous. The inner end of the parietal lamella curves strongly towards the periphery, and its anterior end is produced forward of the junction with the angular lamella, the two lamellæ diverging forward, the whole, when viewed from the base, shaped somewhat like a mirror image of the letter y. Columellar lamella thin, high, and curving down at the inner end. Palatals on a callous ridge. Length 1.7 mm., diameter 0.8 mm.

Distribution.—Ontario and western New York to Helena, Montana, south to Illinois, Kansas, and Albuquerque and Mesilla, New Mexico. Type 62.20385 Carnegie Mus., from Will Co., Illinois.

G. holzingeri differs from *G. contracta* by its nearly cylindric shape, the presence of a strong basal fold, the small size, and discontinuous peristome. The columellar lamella (fig. 6) ascends the axis and towards the upper end curves forward almost exactly as in *G. contracta*. It differs from both *contracta* and *armifera* by the shape of the angulo-parietal lamella, which is forked in front, and in a basal view has the shape of the Greek letter λ, as

Fig. 474. 1, 3, *Gastrocopta armifera abbreviata*, Eastport, Iowa; 2, Shawnee Co., Kan. 4-6, *G. holzingeri*, Joliet, Ill. 7, *G. h. form agna*, Trinidad, Colo. 8, *G. contracta peninsularis*, Crystal R., Citrus Co., Fla. 9, 12, *G. contracta*, Troy, N. Y.; 10, Fairfax Co., Va.; 11, Washington, D. C.

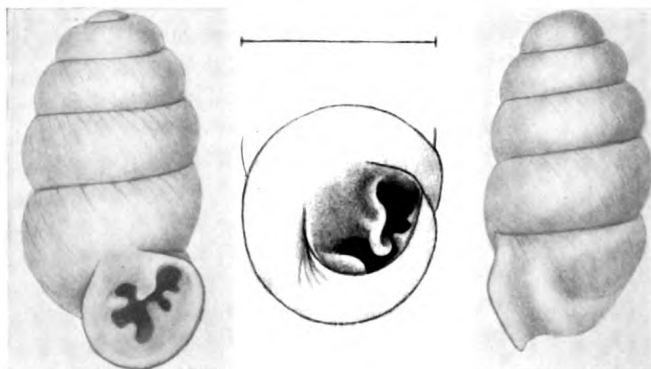


Fig. 475. *Gastrocopta holzingeri*. Elm Creek 8 mi. southwest of Buffalo Gap, Taylor Co, Texas.

in the subgenus *Immersidens* (Fig. 474:4). The palatal callus and armature, however, are typical for *Albinula*.

Gastrocopta holzingeri agna (Pilsbry & Vanatta)

Figs. 474:7: 476.

Bifidaria holzingeri var. *fordiana* Sterki. 1892, Nautilus, 6:4. Name only.—Pilsbry and Johnson, 1898, Nautilus, 11:117, Wichita, Kansas. Nude name.

Bifidaria agna Pilsbry & Vanatta, 1907, Nautilus, 20:144, figs. 1-3.

Gastrocopta holzingeri agna (P. & V.) Pilsbry, 1916, Man. Conch., 24:26, text-figs. 9-11, pl. 2, fig. 7.



Fig. 476. *Gastrocopta holzingeri agna*, left and center (the type), Trinidad, Colorado; right, Silver Lake, Kansas.

The columellar lamella in this form descends only a little inwardly, differing thereby from *holzingeri* in which the inner end turns nearly in a right angle toward the base as in fig. 474:6.

I have not reviewed the long series of specimens to determine the geographic relations of this supposed subspecies and typical *G. holzingeri*. I have seen *G. h. agna* from as far west as Trinidad (Type 93052 A.N.S.P.), in southeastern Colorado, and east to Fern Glen, St. Louis Co., Missouri, Pleistocene (Hubricht).

Gastrocopta falcis Leonard

Page 879, fig. 473:6.

Gastrocopta falcis Leonard, 1946, *Nautilus*, 60:22, pl. 3, fig. 6.

"*Diagnosis*: A small species, the shell about 1.7 mm. in height. The shell is cylindrical, with 5 whorls. Seven lamellae, the angular and parietal widely divergent, the latter curving strongly toward the periphery. The columellar lamella rises low in the orifice, extends toward the parietal, and is then reflexed toward the periphery, extending nearly to the free edge of the lip. The basal plica is transverse in the cavity; the lower palatal is large, deeply entering, elongate, and curved toward the periphery; upper and suprapalatal not unusual.

"*Description of holotype*: Shell small, cylindrical, narrowly perforate; whorls 5 in number, moderately convex; summit obtuse; suture deeply impressed; first whorl microscopically granular, remaining whorls minutely punctate and striate; body whorl compressed around axis, broadly angulate below; aperture rounded below, squarish above; peristome thin, simple, and reflected, lips approaching, scarcely connected by a thin callus on body whorl; a constriction behind reflected lip of peristome, followed by a heavy crest on right side only; behind the crest an axially elongate, depressed scar indicates position of lower palatal plica. Lamellae 7 in number; angular, thin, high, confluent with angular lip of peristome above, and with parietal lamella below; it curves slightly forward, and is deflected toward the periphery; parietal lamella heavy, widely divergent from angular above; below the lower end of the angular, where it is strong, high, and rounded, the parietal lamella curves toward the periphery; columellar lamella highly specialized; it arises low in orifice as a high plate extending toward the parietal, turns slightly upward, and extends straight forward on the columellar wall of the peristome to the point where the lip flares, where it ends in a thickened callus; the whole resembling a pruning knife with the thin edge turned toward the columella. No subcolumellar denticle; basal plicae heavy, triangular, deeply placed in the cavity; lower palatal plica arising broadly from the callus on which are set also the basal and upper palatal plicae, deeply entering, to a point above the termination of the angular, free surface plane; upper palatal plica less deeply placed, high, toothlike; two minute, conical suprapalatal plicae. Denticles and walls of orifice smooth and glistening." (Leonard.)

	Height	Diameter	Aperture Height	Aperture Diameter	Whorls
Type	1.7 mm.	.87 mm.	.62 mm.	.55 mm.	5
Paratype	1.5 mm.	.87 mm.	.62 mm.	.59 mm.	5
Paratype	1.75 mm.	.87 mm.	.62 mm.	.55 mm.	5

KANSAS: Lower Pleistocene; SW $\frac{1}{4}$ sec. 2, twp. 31 S, R 28 W; 6 mi. N. Meade, Meade County, Type: cat. no. 3729, University of Kansas Mus. Nat. Hist.

"Only four examples known; one from the type locality, and three (one broken) from Pyle Ranch deposits, NE $\frac{1}{4}$ sec. 11, typ. 30 S, R 23 W, Clarke County, Kansas. There is no significant variation from the type among these individuals. Even more nearly cylindrical than *G. h. agna* Pilsbry & Vanatta, it is obviously related to this form, but it differs from *agna* in the

following details: angular and parietal lamella more divergent anteriorly; parietal curving more strongly toward the periphery; columellar lamella generally similar in form, but projecting further from the axis near its origin, extending further upward, and extending further forward on the peristome; basal plica transverse in the cavity; lower palatal larger, entering more deeply, elongate, and slightly curved toward the periphery, its free edge plane, upper palatal and suprapalatal not unlike the corresponding lamellæ in *agna*." (Leonard.)

Not seen by the author.

Subgenus VERTIGOPSIS Sterki

Vertigopsis Cockerell ms., Sterki, 1893 Nautilus, 6: 101, type *P. curvidens* Gld.

Vertigopsis differs from *Sinalbinula* chiefly by the weakness of the parietal lamellæ, the angular being very small or wanting, and the parietal short and simple.

It is not directly related to other American groups of the genus, having evidently been derived from the Asiatic section *Sinalbinula*.

Key to Species

1. A distinct palatal callus within the outer lip 2
No distinct palatal callus 4
2. Shell ovate-conic, usually with 7 teeth; length 1.7 to 2 mm *tappaniana*
Shell oblong-conic or cylindric 3
3. Oblong-conic, with 5 to 8 teeth; 1.5 to 1.8 mm. long *pentodon*
Cylindric, with 5 teeth *pentodon gracilis*
4. Ovate-conic, with 4-5 teeth; 1.2 × 1 mm *carnegiei*
Cylindric, with 3 to 5 teeth; 1.6-1.9 mm. long *pilsbryana*

Gastrocopta pentodon (Say)

Fig. 477:2, 3, 5-8.

Vertigo pentodon Say, 1821, Jour. Acad. Nat. Sci. Phila., 2:376. Pennsylvania.

Pupa pentodon Say, W. G. Binney, 1878, Terr. Moll., 5:200.—Stearns, 1893, N. A. Fauna No. 7, p. 273, Charleston Mts., Nevada.

Bifidaria pentodon Say, Pilsbry & Vanatta, 1906, Nautilus, 19:121, pl. 6, 7, figs. 1-41 (variation).

Gastrocopta pentodon Say, Pilsbry, 1916, Man. Conch., 24:28, pl. 3, figs. 2, 3, 5-8.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:70.

Pupa curvidens Gould, 1841, Invert. Mass., p. 109. Lynn, Mass.

Pupa cincinnatiensis Judge, 1878, Quart. Jour. Conch., 1:343.

Pupa montanella Cockerell, 1889, Jour. Conch., 6:63. Colorado.

Pupilla floridana Dall, 1885, Proc. U. S. Nat. Mus., 8:261, (Archer, Alachua Co., Florida).

Pupa curvidens var *gracilis* Sterki, 1890, Nautilus, 3:119.

The shell is rimate, oblong-conic with obtuse summit, clear corneous or whitish, smooth. Whorls 5, convex, the last with a rounded ridge or crest

Fig. 477. 1, 4, *Gastrocopta contracta climeana*, type. 2, 3, *G. pentodon*, Lebanon Springs, N. Y.; 5, Ventnor, N. J.; 6, Ocean City, N. J.; 7, 8, Troy, N. Y. 9, *G. tappaniana*, Philadelphia, Pa. 10, 12, *G. pilsbryana*, Oak Creek, Arizona; 11, Santa Catalina Mts., Arizona.

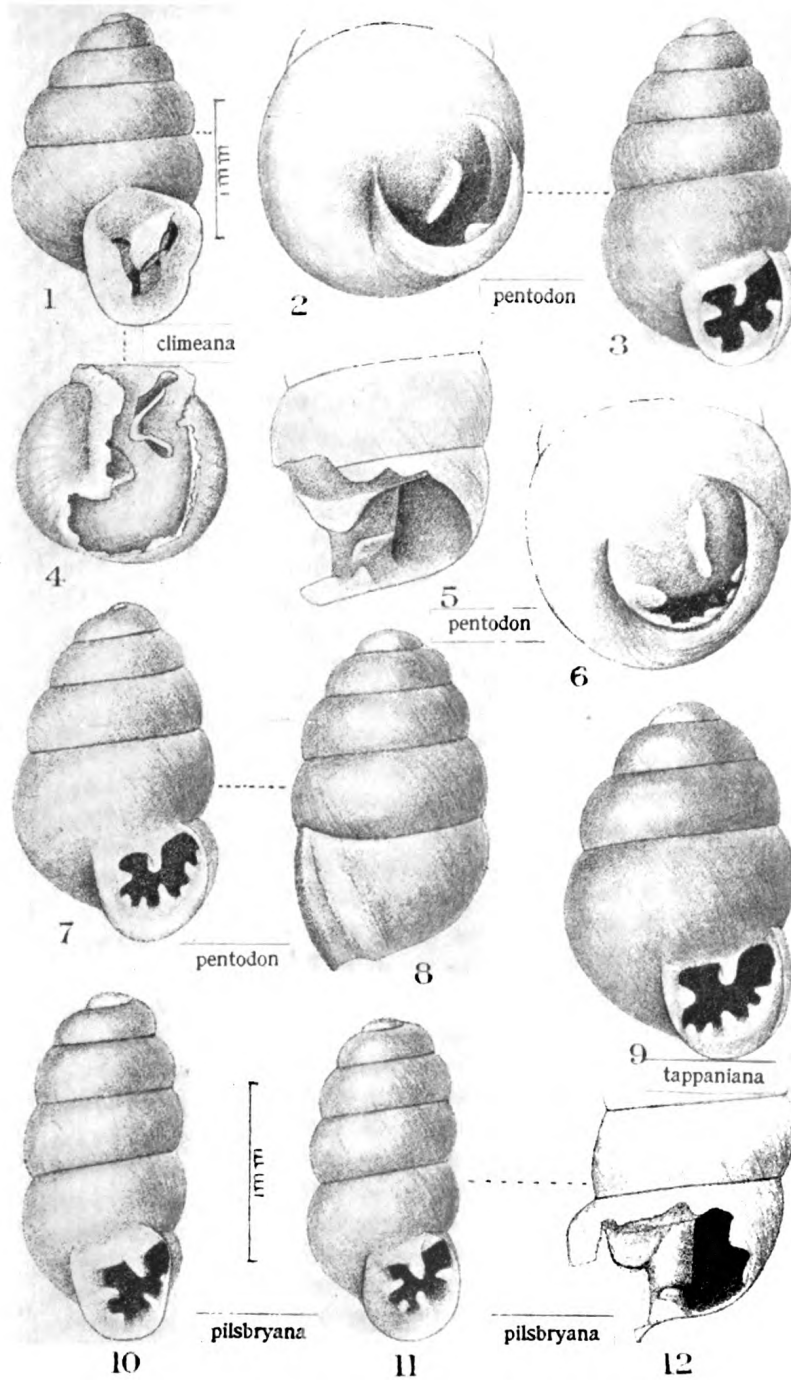


Fig. 477. See bottom of page 886 for legend.

(low or well developed) close behind the lip, and flattened near the base behind the ridge. Teeth typically five, the angulo-parietal lamella almost simple and straight, columellar lamella thin, horizontal; the palatal folds stand upon a low callus ridge, the lower fold compressed and entering a little more deeply than the smaller, tuberculiform upper one. Accessory denticles are usually developed in the subcolumellar, basal and interpalatal positions. The peristome is thin, narrowly expanded, with a thin, straight, parietal callus between the widely separated ends.

Length 1.8, diam. 1.1 mm.

Length 1.5, diam. 0.8 mm.

Distribution.—Eastern United States and Canada: Prince Edward and Magdalen Islands to Alberta, south to central Florida and Texas; New Mexico; west in Arizona to the Santa Cruz River. Eastern Mexico and Guatemala. Type loc. Pennsylvania.

This species has an extraordinary zonal range. It is found over a greater area than any other North American *Gastrocopta*. It may be recognized by the small size, spermaceti or bluish-white color and simple parietal tooth, with lip-teeth arranged on a white callous rim. It is most easily obtained by dirt or leaf sifting. It lives on wooded hillsides or in well-drained groves, among leaves in the underbrush; also "is common among moss and grass in forest and on open slopes."

The variations in shape and teeth have been illustrated in *Nautilus*, 19, pl. 6, 7, figs. 1-41. Fig. 477:2, 3 are typical *pentodon*, which has 5 teeth. The parietal lamella "is really composite, that is, composed of the parietal and the angular, although the latter is generally quite small, a mere appendage of the former. In many specimens of *pentodon* it is quite distinct, as in Fig. 477:6; and "in some the whole lamella is even bifid, somewhat like that of *B. holzingeri*" (Sterki). More commonly, and typically, the angular lamella is wanting, or so small that it is not distinguishable from the parietal (Fig. 477:2). The columellar lamella descends spirally (Fig. 477:5).

The development of a crest behind the lip varies a good deal, from weak to very strong, with all intergrades.

The increase in number of accessory denticles or teeth culminates in the form named *curvidens*, represented in Fig. 477:7, 8. There is absolutely no line to be drawn between *pentodon* and *curvidens*. The number of teeth varies from 5 to 9 in perfectly adult shells of the same gathering from one spot. Gould's type of *curvidens* had 9 teeth. It was from Phillips Point, Lynn, Massachusetts.

It may be stated as proven that some colonies consist of "*pentodon*" and intermediate forms; some of "*pentodon*," intermediate and "*curvidens*" forms; and some of the intermediate and "*curvidens*" forms. We have found no large gathering of wholly typical *pentodon* or entirely *curvidens*.

Either form may be found with a low or high crest—this being usually more constant in any one colony than the number of teeth or the size and shape of the shell. The only theory upon which *curvidens* could be retained as a species or subspecies would be to assume that two species are living in a state of hybridism.

The development of an infraparietal denticle is extremely variable in many lots. This infraparietal tubercle is exactly comparable to that of some Asiatic species, such as *G. armigerella* of Japan and China. It is not found in other American *Vertigopsis*, though occasionally developed in the typical section of *Gastrocopta*.

P. floridana Dall, figured in *Nautilus*, 19, pl. 6, fig. 9, a cotype from the author, is absolutely identical with *curvidens*. The var *gracilis* Sterki is "long slender, nearly cylindrical, with only 5 typical lamellae." From New Philadelphia, Ohio; also Rhode Island, Tennessee and Alabama. The name is preoccupied, but it is not considered a valid race, merely an extreme of variation.

***Gastrocopta tappaniana* (C. B. Adams)**

Fig. 477:9.

Pupa tappaniana "Ward" C. B. Adams, 1842, in Thompson's History of Vermont, p. 158.

Pupa tappiana Ward, Pfeiffer, 1842, Symb. Hist. Hel., 2:55.

Gastrocopta tappaniana C. B. Adams, Pilsbry, 1916, Man. Conch., 24:33.—Brooks and Kutchka, Ann. Carnegie Mus., 27:71.—Franzen, 1947, Trans. Kansas Acad. Sci., 49:418, pl. 1, fig. 6, pl. 2, fig. 3.

Pupa pentodon f. *curta* Sterki, 1894, Land and Freshwater Moll. New Philadelphia, p. 5; *Nautilus*, 19:134.

The shell is larger than *pentodon*, markedly conic though obtuse; only one tooth on the parietal wall, usually 6 on the columellar, basal and outer margins, those on the latter standing on a strong rib. Lower-palatal fold usually not so long and entering as in *G. pentodon*.

Length 2, diam. 1.2 mm.

Length 1.7, diam. 1.1 mm.

Distribution.—Ontario and Maine to Virginia and Alabama, west to South Dakota and Kansas, southwest to Arizona, but not known from the southeastern Atlantic States, Virginia to Florida. Type locality, Vermont, coll. Amherst College.

It is rather a common species in central Arizona, the westernmost locality being Jerome, Yavapai Co., a little west of the 112th meridian. Southward it has been found near the Mexican boundary in the Huachuca Mountains (Tanner canyon, 6000 ft.).

While it must be admitted that occasional individuals are intermediate between *tappaniana* and *pentodon*, yet the two forms are quite readily separable in the great majority of lots. They differ in station, *tappaniana* being found in low, moist places, under wood, often with *Vertigo ovata*, while

pentodon lives in dryer situations, as Dr. Sterki has noted. *G. tappaniana* is not known from the southern Atlantic states, Virginia to Florida, but its range extends to the Gulf of Mexico in Alabama.

G. pentodon was long known as *Pupa curvidens*, and *G. tappaniana* as *P. pentodon*. In W. G. Binney's several publications the two are united under *P. pentodon*, the wood-cut representing *tappaniana*.

Form *curta* Sterki. "Examples from wet places are small and short ovoid." New Philadelphia, Ohio.

Gastrocopta carnegiei (Sterki)

Fig. 480: 5.

Bifidaria minuta Sterki, 1916, *Nautilus*, 29:105. Not *Pupa minuta* "Say." Pfeiffer, 1842, = *Gastrocopta procera*.

Bifidaria carnegiei Sterki, 1916, *Nautilus*, 30:84.

Gastrocopta carnegiei (Sterki), Pilsbry, 1916, *Man. Conch.*, 24:35.

Shell ovate-conic with the apex nearly pointed, narrowly umbilicate and shortly rimate; whitish. Whorls 4 to 4½, well rounded with deep suture. Surface with very slight, irregular striae. Aperture rather large, well rounded; peristome sharp, not expanded, a very slight crest close to the margin; inside with a very slight callus or none. Parietal lamella rather large, nearly simple; columellar moderate, a basal fold near the base or wanting; two palatal folds. Length 1.2 mm., diam. 1 mm. Others 1 × 0.9 mm.

ОНЮ: woods north of Geneva, Ashtabula Co. Type no. 1990, Sterki collection of N. A. Pupillidæ, Carnegie Mus.

"This *Bifidaria* is near *tappaniana* Adams, but differs from that species as follows: it is much smaller, more conical, the whorls are less in number, more rapidly increasing, more convex, the last is comparatively larger; there is no callus in the palate or a very slight one, the palatal folds are longer and there are no secondary ones." (Sterki.)

The type and only perfect specimen of the three found is figured. It appears to be distinct from *pentodon* and *tappaniana*, but in so variable a group further specimens are required for a full understanding of its relation to these species.

Gastrocopta pilsbryana (Sterki)

Page 887, figs. 477:10-12; 478.

Pupa pilsbryana Sterki, 1890, *Nautilus*, 3:123. Colorado River.

Gastrocopta pilsbryana Sterki, Pilsbry, 1916, *Man. Conch.* 24:36; 28:64.

Pupilla stoneri Chamberlin & Jones, 1929, *Bull. Univ. Utah*, 19:83, fig. 32.

The shell is cylindrical, colorless, with a faint bluish tint, smooth; whorls moderately convex with a rather impressed suture, the upper ones tapering to the obtuse apex, the last whorl with extremely weak crest behind the lip, and an impression over the lower-palatal fold. Aperture subovate, with approaching margins, the peristome somewhat expanded, thin, without a callus in the palatal wall. Parietal lamella rather high, simple; columellar lamella horizontal. Upper-palatal fold small, the lower more deeply placed and larger; basal fold very small or wanting. Length 1.6 to 1.9 mm., diam. 0.8 to 0.9 mm.; about 5 whorls.

Distribution.—Arizona and New Mexico, southward only in mountains; Utah, near Cedar City. Type 62.20382 Carnegie Mus., from Colorado River, Arizona.

G. pilsbryana is similar to slender examples of *G. pentodon* in shape and color, but it differs by having the lip thin, without any internal callus whatever, and there are never more than five teeth, but always five in adult shells. It has some resemblance to *G. pellucida*, but is retained in the section *Vertigopsis* because the parietal lamella is simple, an angular lamella being entirely wanting; but more because the basal fold is placed rather far to the left, a special character of *Vertigopsis*. The columellar lamella is a directly horizontal and rather short tubercle, not descending as in *pentodon*. There is considerable variation in the size of the teeth, and also in the size of the shell, even in the same lots.

This is one of the commonest species in the mountains or plateaus of over about 4000 ft. elevation in both New Mexico and Arizona. Excepting the practically unexplored northern tier of counties in New Mexico, and the equally unknown two western counties of Arizona, it is known to occur in suitable places all over both states; but in the south these places are well up in the mountains, where hundreds of specimens can often be obtained by sifting.

Pupilla stoneri, of which I have examined the type (Fig. 478) is wholly typical *G. pilsbryana*. It is from near Cedar City, Utah.

***Gastrocopta pilsbryana amissidens* Pilsbry**

Fig. 479.

Gastrocopta pilsbryana amissidens Pilsbry, 1934, Man. Conch., 28:118, pl. 24, figs. 5, 6.

Like the typical form except that there is no basal fold; sometimes the upper-palatal fold also is wanting.

ARIZONA: In the San Francisco Mts.: Mahan Mt., Type 161437 A.N.S.P., coll. by J. H. Ferriss; 20 miles south of Flagstaff; Betatakin Ruins. NEW MEXICO: at Golden, Santa Fe Co.

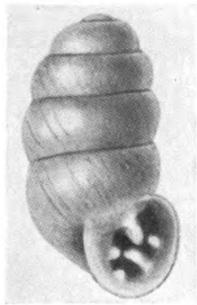


Fig. 478. *Gastrocopta pilsbryana* (Type specimen of *P. stoneri*).

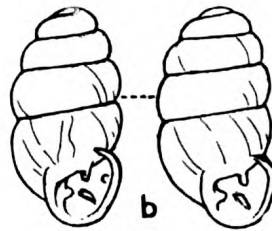


Fig. 479. *Gastrocopta pilsbryana amissidens*.

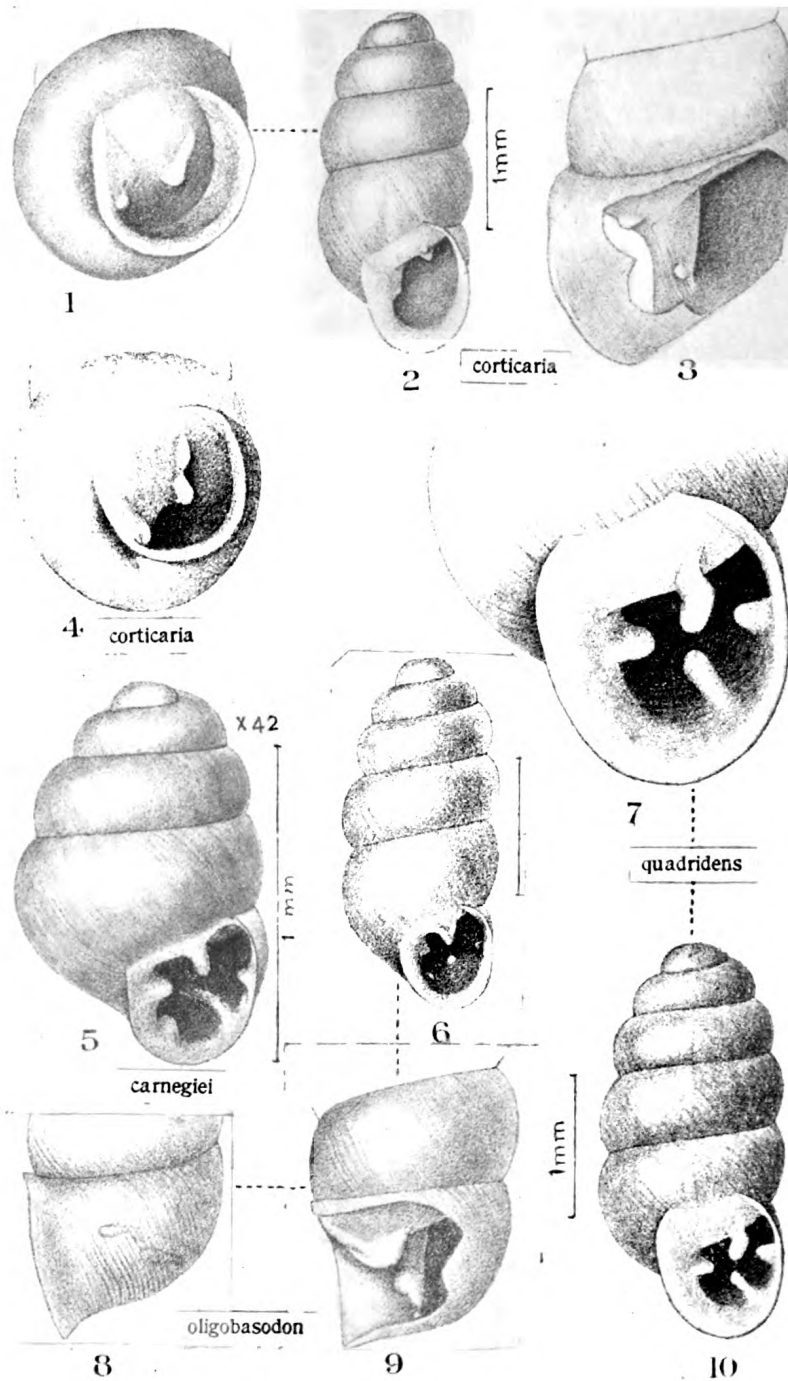


Fig. 480. 1, 2, *Gastrocopta corticaria*, Upper Red Hook, N. Y.; 3, 4, Philadelphia, Pa. 5, *G. carnegiei*, Geneva, O., type. 6, 8, 9, *G. oligobasodon*, Huachuca Mts. 7, 10, *G. quadridens*, Capitan Mts., N. M.

Subgenus STAUROTREMA new subgenus

The shell is translucent white, cylindrical, without prelabral crest; aperture with four teeth in form of a cross: a strong, nearly simple angulo-parietal, smaller columellar lamella and upper and lower palatal folds. Type *G. quadridens*.

Gastrocopta quadridens Pilsbry

Fig. 480: 7, 10.

Bifidaria quadridens Sterki, 1899, *Nautilus*, 12:125. Not *Pupa quadridens* Klein, 1853, also a *Gastrocopta*.

Bifidaria quadridens Sterki, Pilsbry & Vanatta, 1900, *Proc. Acad. Nat. Sci. Phila.*, p. 607, undefined (*lapsus calami*).

Gastrocopta quadridens Pilsbry, 1916, *Man. Conch.*, 24:57, pl. 10, figs. 7, 10.

The shell is subcylindric, slowly tapering upward, the apex obtuse; translucent whitish; of 6 convex whorls, the last with a slight impression over the lower-palatal fold but no crest behind the lip. Peristome thin, moderately expanded, with four teeth in form of a cross; angulo-parietal lamella strong, nearly simple; columellar lamella and lower-palatal fold smaller but well developed; upper-palatal fold smaller than the lower.

Length 2.7 mm., diameter 1.3 mm.

Length 3.1 mm., diameter 1.3 mm.

NEW MEXICO: Capitan Mts., Lincoln Co., Type 62.21981 Carnegie Mus. (E. H. Ashmun); Mogollon Mts., Socorro Co.; Black Range, Sierra and Grant counties (Ferriss and Pilsbry). ARIZONA: Bill Williams Mt., Coconino Co. (Pilsbry and Ferriss); Mt. Mingus, near Jerome, Yavapai Co. (Ashmun); Santa Catalina and Chiricahua Mts. (Ferriss). UTAH: Fish Lake, Sevier Co. (Chamberlin).

This is a strikingly distinct species. By the very thin, translucent, paraffin-white shell, without a crest behind the thin lip, it recalls *G. corticaria*, which is perhaps the species most nearly related. The angulo-parietal lamella is simple, as in *pentodon* or *pilsbryana*, or sometimes an extremely minute trace of the forward end of the parietal lamella, appearing as a branch on the columellar side, may be seen near the outer end. The lower or free edge of the parietal lamella is bent towards the columella as in *G. cristata*. The lower-palatal fold is usually rather long. The columellar lamella is transverse, as in the *procera* group, and there is no callus below it. In a great number seen, none has a basal fold.

It is a common shell in the heavily forested and humid upper zone of the Santa Catalina Mountains, north of Tucson, Arizona, and in the Black Range, New Mexico, but very rare in the Chiricahua Range, at the southern limit of the species, where it occurred in Barfoot Park, 10,000 ft. elevation. Its stations are chiefly between 7,000 and 11,000 ft.

Subgenus PRIVATULA Sterki

Privatula Sterki, 1893, *Nautilus*, 6: 101, monotype *P. corticaria* Say.

The shell is whitish, without palatal callus or folds, the columellar lamella minute, tubercular; angulo-parietal lamella small and straight, its crest bilobed.

The teeth are reduced more than in any other *Gastrocopta*. Only one species is known. It is probably related to *Staurotrema*, also to *Albinula* and *Sinalbinula*, from which it differs by the absence of palatal callus and folds.

***Gastrocopta corticaria* (Say)**

Fig. 480: 1-4.

Odostomia corticaria Say, 1816, Nicholson's American edition British Encyclopedia, ii, pl. 4, fig. 5.

Pupa corticaria Say, W. G. Binney, 1878, Terr. Moll., 5:209.

Gastrocopta corticaria Say, Pilsbry, 1916, Man. Conch., 24: 52.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:72.

The shell is minutely rimate, nearly cylindric, tapering slightly to the very obtuse summit; thin, translucent-white, almost smooth, very faintly marked with growth-lines. Whorls $5\frac{1}{2}$, quite convex, the last rounded basally, without a crest behind the lip. Aperture irregularly oval; peristome thin, well expanded, the lip-ends widely separated. Angular and parietal lamellæ united into one small bilobed lamella, or almost separate. Columellar lamella very low, subvertical, a minute tubercle in front of its lower end. Length 2.5, diam. 1 mm.

Distribution.—Maine and Ontario to Minnesota, south to St. Simon's Island, Georgia, and Gainesville, Florida, northern Alabama and Alexandria, Louisiana. Type locality, Philadelphia, Pa.; Neotype 64524a A.N.S.P.

G. corticaria has the teeth more reduced than in any other *Gastrocopta*. The angular lamella is variable, sometimes rather well developed, as in figures 1, 4, sometimes minute, and scarcely united with the parietal lamella, and in some apparently mature shells it is entirely wanting. The very low columellar lamella runs vertically on the back of the rather large axis, and at the lower end either turns outward in a short horizontal limb, or a very low tubercle, visible from in front, stands in front of its lower end (Fig. 480:3).

As the name implies, *G. corticaria* is often found crawling upon trees a foot or two from the ground. While generally distributed, it rarely occurs in abundance, and is not known from the higher Catskills, southern Alleghanies, or other elevated regions. So far as I have seen specimens, its western limit is in Minnesota, Iowa and Arkansas. No local or geographic races have been noticed.

Subgenus IMMERSIDENS Pilsbry & Vanatta

Immersidens Pils. & Van., 1900; Proc. Acad. Nat. Sci. Phila., Dec. 11, p. 606 (for *B. ashmuni* and *B. perversa*).—Pilsbry & Ferriss, 1910, Proc. A. N. S. Phila., p. 136.

Gastrocoptas in which the angular lamella is united with the parietal at the inner end of the former, the two diverging forward, and together shaped like the Greek letter λ , or like a reversed y . The basal fold, when present, is radial, or transverse to the cavity. There are two palatal folds, *not standing on a callous ridge*, the lower one often deeply immersed. Peristome thin, expanded. Shell cylindric, thin, pale brown to whitish.

Type *G. ashmuni* (Sterki).

Distribution.—Central plateau and mountains from the Grand Canyon of the Colorado, northern Arizona, southward to southern Brazil and western Argentina.

Most species of *Immersidens* daub the shell with dirt, like the species of *Albinula*.

Key to Species of Immersidens

1. Inner end of the parietal lamella strongly curving towards the periphery; teeth large. 2
 Inner end of the parietal lamella curving outward very little; teeth not large; ends of peristome well separated; angular lamella low; columellar lamella very short; lower palatal fold rather deeply placed; basal fold minute, rarely wanting; Arizona. *G. oligobasodon*
- Inner end of the parietal lamella not distinctly curving towards the periphery; palatal and basal folds well developed, visible in a front view. 5
2. Sinistral; last whorl straightened and produced forward. *G. perversa*
 Shell dextral. 3
3. Columellar lamella running forward upon the parietal wall in the position of an infra-parietal lamella; lower-palatal and basal folds very deeply immersed; neck gibbous; peristome continuous. *G. ashmuni*
 Columellar lamella normal in position, not running forward on the parietal wall, turned down at the inner end; peristome scarcely or not continuous; palatal folds visible in a front view; basal fold well developed. 4
4. A very strong, white crest behind the lip; columellar lamella having a long, vertical inner portion; length about 1.75 mm. *G. holzingeri*
 No distinct crest on the neck; length, 2 mm. or more; Arizona. *G. cochisensis*
5. Entire columellar lamella horizontal; margins of peristome rather remote. 6
 Columellar lamella horizontal in front, the inner end bent down at a right angle; peristome continuous; lower-palatal and basal folds deeply placed. *G. bilamellata*
6. Columellar lamella simple; parietal lamella projecting very little forward of its junction with the angular. *G. dalliana*
 Columellar lamella having a small callus below its inner end; parietal lamella projecting distinctly forward of its junction with the angular lamella *G. d. media*

***Gastrocopta perversa* (Sterki)**

Fig. 481; 483:9-11.

Bifidaria perversa Sterki, 1898, *Nautilus*, 12:90 (Nogales, Ariz.). Pilsbry & Ferriss. *Proc. Acad. Nat. Sci. Phila.*, 1906; 144. Ashmun, *Nautilus*, 13:14.

Gastrocopta perversa St., Pilsbry, 1916, *M. C.* 24:40, and form *sana*, p. 357, pl. 46, f. 13.

The shell is sinistral, perforate and rimate, cylindric, tapering above to an obtuse apex; very thin; light brown, minutely striate. Whorls 5½, strongly convex, the last one distorted, then straightened and projecting forward. The aperture is squarish, the peristome well expanded, thin, continuous. The angular lamella emerges to the edge; parietal lamella higher and farther in, both uniting to form a *y*-shaped tooth; no other teeth visible, but there is a wide, deeply placed columellar lamella and two palatal folds, deeply immersed, the lower one farther in.

Length 2.4 mm., diameter above aperture 1.1 mm.

ARIZONA: in mountains of Maricopa, Pinal, Pima, Cochise and Santa Cruz counties. Type from Nogales, 62.22567 Carnegie Mus., coll. by E. H. Ashmun.



Fig. 481. *Gastrocopta perversa*, basal view, most of the last whorl removed to show the angular, parietal and columellar lamellæ.

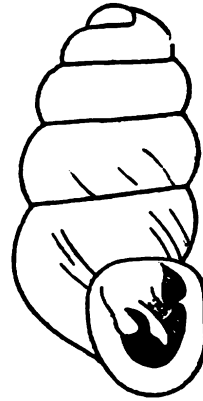


Fig. 482. *Gastrocopta perversa* form *sana*, Tempe, Arizona.

Except that it is sinistral, this species resembles *G. ashmuni* rather closely. The straightened part of the last whorl is somewhat longer, though the length of the free portion varies. There are also slight differences in the details of the teeth. It does not occur at high elevations. I have never found it so abundant as *G. ashmuni*. The localities are all in the southeastern part of Arizona.

Gastrocopta perversa form *sana* Pilsbry Fig. 482. Shell dextral. It occurred with the typical form in the drift of Salt River at Tempe, Arizona, Type 45146 A.N.S.P.; also in the Huachuca and the Mustang mountains.

***Gastrocopta ashmuni* (Sterki)**

Figs. 483: 5, 6, 7; 484.

Bifidaria ashmuni Sterki, 1898, Nautilus, 12:49 (Santa Rita Mts., Arizona).—Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 144; 1910, p. 137.

Bifidaria ashmuni form *minor*, Sterki, Nautilus, 12:92 (Nogales, Arizona).

Gastrocopta ashmuni (Sterki) Pilsbry, 1916, Man. Conch., 24:41.

Gastrocopta ashmuni imperfecta Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75:63.

The shell is nearly cylindrical, tapering but slightly, composed of five strongly convex whorls. The last whorl becomes straightened and slightly sinuous in basal view, and has a more or less conspicuous oblique swelling or crest some distance behind the aperture. This crest is not always so strong, as shown in fig. 484c and sometimes it varies from strong to wanting in the same lot. The peristome is well expanded, continuous, and usually stands shortly free from the whorl in front. The parietal lamella is sigmoid, bending far to the right at its inner end. The angular lamella, also sigmoid, runs from the peristome to the parietal lamella, the two lamellæ together forming a figure like the Greek letter λ. The columellar lamella is broad and horizontal far within, arising a half-whorl back (Fig. 483:7), then sinuated where the basal fold approaches it, as shown in Fig. 483:6, but near the

Fig. 483. 1, 2, 8, *Gastrocopta cochisensis*, Tanner canyon, Huachuca Mts., Ariz.; 3, Santa Catalina Mts.; 4, Santa Rita Mts. 5, 6, 7, *G. ashmuni*, Dragoon Mts., Ariz. 8, *G. cochisensis*. 9, 10, *G. perversa*, Benson, Ariz.; 11, Dragoon Mts., Ariz.

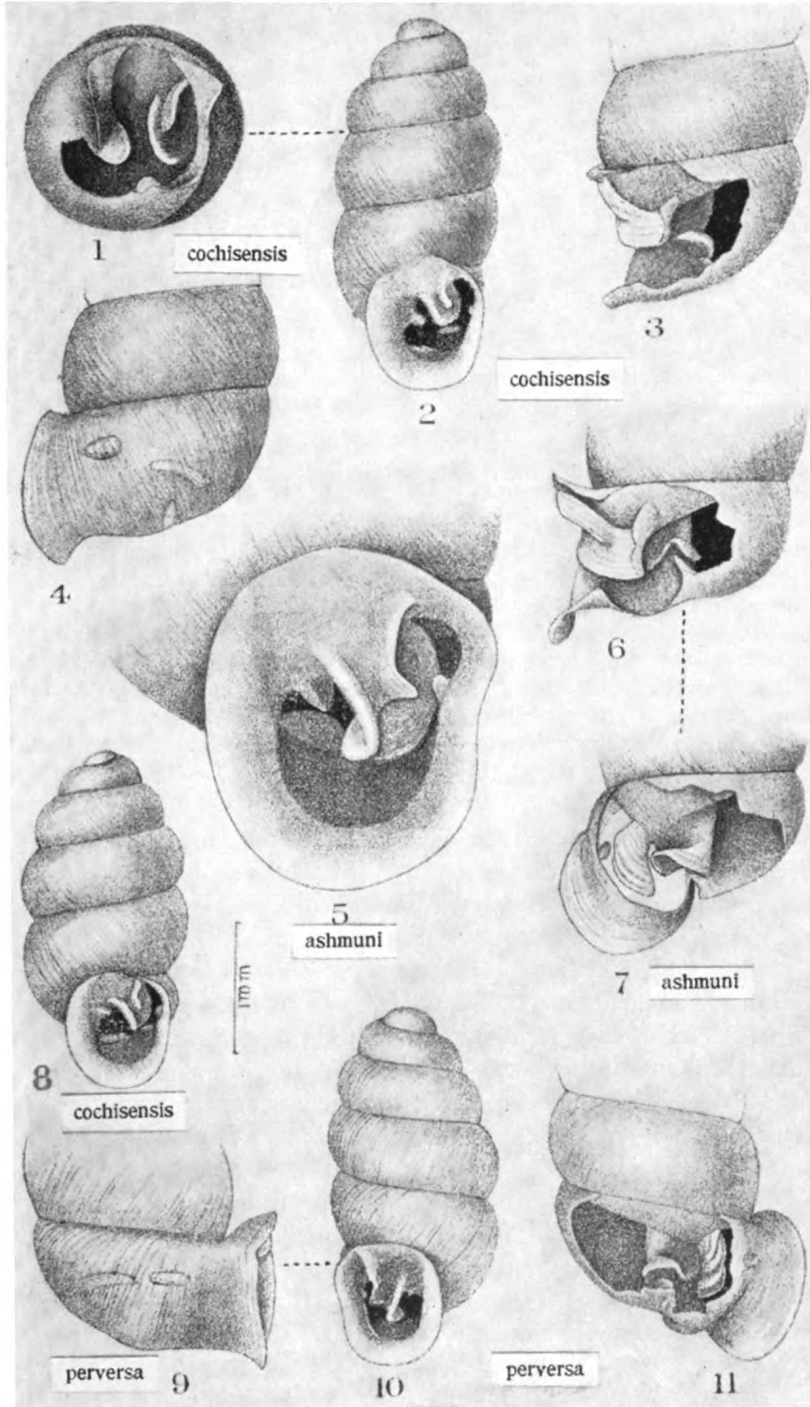


Fig. 483. See bottom of page 896 for legend.

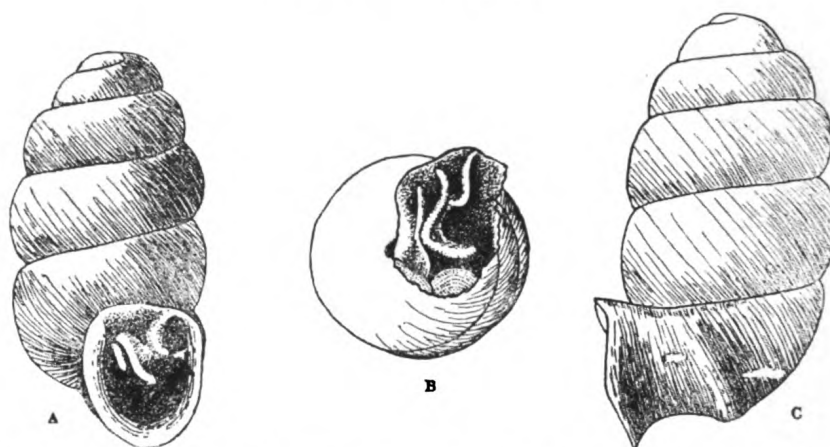


Fig. 484. *Gastrocopta ashmuni*. A, B, Florida Mts., N. M.; C, Oak Creek, Yavapai Co., Arizona.

aperture it runs out upon the parietal wall, where it appears as a more or less elevated cord between the parietal lamella and the columella, occupying, therefore, the place of an infraparietal lamella. These lamellæ are shown in fig. 484B, a basal view in which the base of the shell has been removed. The upper-palatal fold is short, situated some distance within the mouth, but visible from in front. The lower-palatal is long, entering, and so deeply immersed that it is not visible in a front view, being concealed behind the massive parietal barrier. There is a radially-placed basal fold, scarcely or not visible in a front view; the edge is seen in fig. 483:6. Length about 2 mm., diameter 1 mm.

Distribution.—From Valencia Co., New Mexico, and the southern rim of the Grand Canyon, Arizona, south to the Mexican boundary from Nogales, Arizona, to the Big Hatchet Mountains, New Mexico; and from the Organ Mountains and Whiteoaks, Lincoln Co., N. M., on the east, to the vicinity of Jerome, Yavapai Co., Arizona, on the west. Chiefly in broken country and foothills, but up to about 8000 ft. in some places.

This species is readily known by the strong development of the angulo-parietal lamella, the very deep immersion of the lower-palatal and basal folds, the anterior continuation of the columellar lamella upon the parietal wall, alongside the parietal lamella, and the long, gibbous neck of the last whorl.

It is a common species within the limits given above, the territory being well covered by over fifty lots in the museum of the Academy, collected chiefly by Ashmun, Ferriss and the writer.

Form *minor* Sterki. Fig. 485. "Smaller than the types, 1.5 to 1.9 mm. high; the shell is also thinner, the color paler, the everted part of the lip

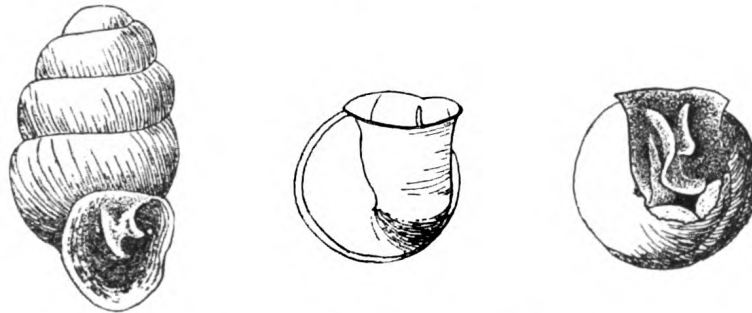


Fig. 485. *Gastrocopta ashmuni* form *minor*. Nogales.

less broad, the number of whorls one-half to one less" (Sterki). Length about 1.6 mm., with 4 to 4½ whorls. The structure is otherwise as in *ashmuni*.

ARIZONA: Nogales; also on the Mexican side of the international boundary, and Ephraim canyon, Santa Rita Mts. (E. H. Ashmum). Dragoon Mountains, in populations with the typical form (Pilsbry, Ferriss and Daniels).

***Gastrocopta ashmuni imperfecta* Pilsbry & Ferriss**

The columellar lamella is simply curved within, and outwardly remains horizontal, as in *G. cochisensis*, not passing into the position of an infra-parietal lamella. The more or less free or continuous peristome, the very large angulo-parietal lamella and the very deeply immersed lower-palatal fold remain as in *G. ashmuni*.

Huachuca and Mustang Mountains, Arizona. Type 162445 A.N.S.P., from the Mustangs.

***Gastrocopta cochisensis* (Pilsbry & Ferriss)**

Figs. 483:1-4, 8; 486.

Bifidaria cochisensis Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 139, figs. 32, 33.

Gastrocopta cochisensis P. & F., Pilsbry, 1916, Man. Conch., 24:44.

The shell is rimate, slightly tapering-cylindric, thin, pale brown, composed of 5½ strongly convex whorls, the last third of a whorl straightened. Striation faint. The aperture is squarish with rounded angles. Peristome rather broadly expanded, thin, brownish, interrupted on the parietal margin, or continuous by a fine thread. Parietal lamella high, its inner end distinctly curving towards the periphery. Angular lamella about half as high as the parietal, slightly sigmoid. Columellar lamella strong, short, its inner half descending somewhat. Palatal folds all visible in a front view. The upper one is rather high and short, not far within; lower one deeply immersed, partly concealed behind the parietal in a front view; basal fold radial (transverse to the cavity), deeply immersed.

Length 2.2, diameter 1.1 mm. } Cotypes.
 Length 2.5, diameter 1.1 mm. }
 Length 2.15, diameter 1.1 mm. Santa Rita Mts.

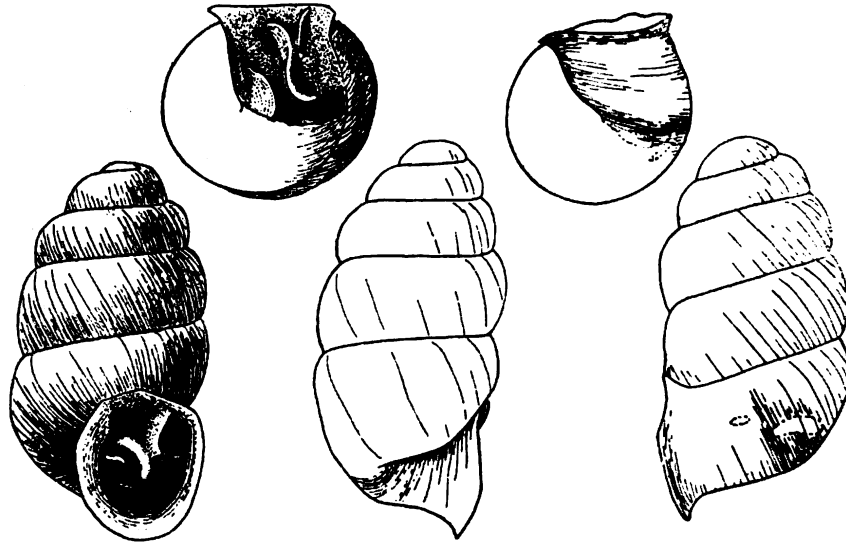


Fig. 486. *Gastrocopta cochisensis*. Santa Rita Mts., Arizona.

ARIZONA: Chiricahua Mountains, on the summit of Cross J Mt., Big Emigrant canyon, about 8000 ft.; White Tail canyon; Limestone Mountain (Pilsbry and Ferriss). Huachuca Mts., in Tanner canyon, type and paratypes 97442 A.N.S.P., coll. by Ferriss. Santa Rita Mountains (E. H. Ashmun). Drift of the Santa Cruz Rver. Pima Co. (Pilsbry). Santa Catalina Mts. at Alder Springs and Marble Peak (Ferriss).

This species differs from *G. ashmuni* in the following features: All teeth are smaller. The columellar lamella is very much shorter, and does not continue forward upon the parietal wall. The palatal folds are less deeply immersed, all being visible in a front view in the aperture. The parietal and angular lamellæ are much less curved. The last whorl is less protracted, never free in front, with a lower crest or wave on the neck, or none.

It is far less widely distributed than *G. ashmuni*, and even in its area is of less general occurrence, all of the known localities being given above.

***Gastrocopta oligobasodon* (Pilsbry & Ferriss)**

Figs. 480: 6, 8, 9; 487.

Bifidaria cochisensis oligobasodon, Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 141, figs. 34 a-c.

Gastrocopta oligobasodon (P. & F.), Pilsbry, Man. Conch., 24:46, figs. 16 a-c, pl. 7, fig. 8-11.

The shell resembles *G. cochisensis*, from which it differs in the following details: All of the teeth are smaller. The parietal and angular lamellæ are far less curved, and the angular joins the parietal near the outer end of the latter. The columellar lamella is much shorter. The basal fold is reduced to a minute tubercle, or in some individuals it seems to be wanting. The parietal margin of the peristome is adnate for a greater distance.

Length 2.6 mm., diameter 1.1 mm.

Length 2.1 mm., diameter 1 mm.

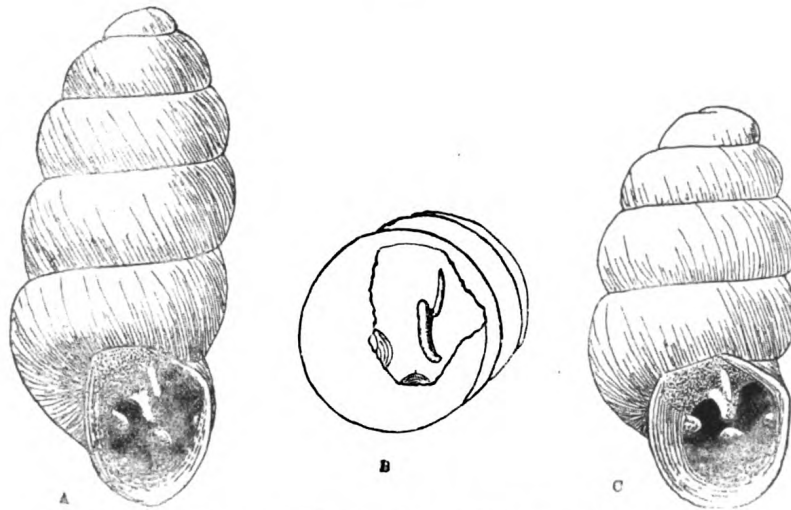


Fig. 487. *Gastrocopta obligasodon*. Ash canyon, Huachuca Mts.

ARIZONA: Ash canyon, Huachuca Mts., Type 97444 A.N.S.P. (Ferriss); Lower Rucker canyon, Chiricahua Mts. (Ferriss). NEW MEXICO: drift debris of the Mimbres River at Swartz P. O. and near Deming (Pilsbry & Ferriss); debris of Rio Grande at Mesilla (Cockerell).

This shell was formerly considered a subspecies of *G. cochisensis*, but having carefully gone over larger series of both than I had seen in 1910, I fail to find any connecting examples. It stands nearer *G. prototypus* Pils., of Mexico, but differs in the shape of the columellar lamella, which is placed somewhat obliquely, and descends inward as a whole, while in *prototypus* the whole lamella is horizontal but with a thickening below its inner end, and another running upwards. The lower-palatal fold is far more deeply placed in *obligasodon* than in *prototypus*. In a large series of *prototypus* examined, none has a basal fold. In *obligasodon* this fold though small is rarely absent.

***Gastrocopta dalliana* (Sterki)**

Figs. 488, 490: 5-9.

Bifidaria dalliana Sterki, 1898, Nautilus, 12:91. Nogales, Arizona.—Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 593, pl. 22, fig. 8.—Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 143, fig. 36a.—Ashmun, Nautilus, 13:14.

Gastrocopta dalliana (Sterki), Pilsbry, 1916, Man. Conch., 24:49, pl. 8, figs. 5-9.

Gastrocopta dalliana media Pilsbry, 1916, Man. Conch., 24:50, pl. 8, figs. 10, 11.

The shell is minute, oblong with blunt ends, corneous, translucent, microscopically striate; of about 5 moderately convex whorls, the last without distinct crest behind the lip, impressed over the lower-palatal fold. Aperture almost as wide as high; peristome thin, well expanded, the ends somewhat approaching, connected by a thin callus. Angulo-parietal lamella large; columellar lamella horizontal; basal fold transverse; palatal folds

rather near together, the upper one short, the lower longer, more deeply placed. Length 1.8 mm., diameter 0.8 mm.

ARIZONA: Nogales (type locality) and Santa Rita Mts., Santa Cruz Co. (Ashmun); mouth of Sabino canyon, Santa Catalina Mts., Pima Co. (Ferriss); Eagle Creek, Graham Co. (Ferriss); Dragoon and Chiricahua Mts., Cochise Co. (Pilsbry and Ferriss).

The shell is generally smaller than *G. p. hordeacella*, the angulo-parietal lamella is conspicuously complex, and the basal fold is transverse instead of entering. It is related to *G. bilamellata*, from which it differs by the more cylindric shape, the less diverging outer ends of the parietal and angular lamellæ, and the simple columellar lamella. The ends of the lip are rather widely separated in *dalliana*, connected in *bilamellata*.

The shell is very fragile and usually dirty, like all the species of the same section. The inner end of the angular lamella lies adjacent to the outer end of the parietal, with a lower connecting callus between them. The parietal may project slightly forward of the junction, or it may stop there. Its inner end usually bends a trifle outward. The columellar lamella is stout and transverse (Fig. 490:8). Fig. 9 is from a paratype.

In the Chiricahua and Dragoon mountains it is often larger than the types, up to 2 mm. long, 0.85 wide. The basal fold is usually longer than in the typical form.

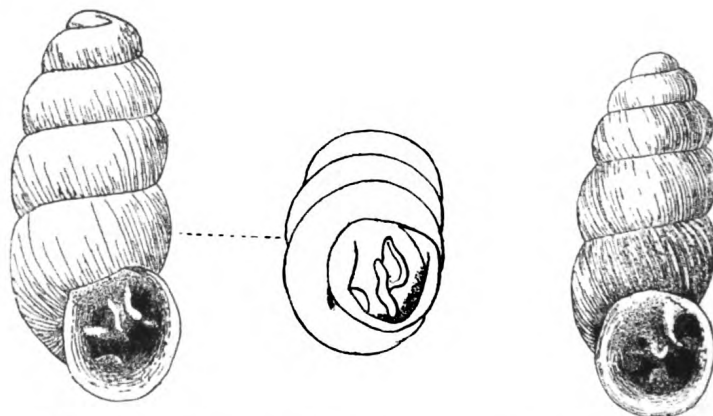


Fig. 488. *Gastrocopta dalliana*.

Fig. 489. *G. bilamellata*.

***Gastrocopta dalliana media* Pilsbry**

Figs. 490: 10, 11.

The shell is like *dalliana* in size, shape and fragility. It differs by having a callous buttress below the inner end of the columellar lamella (Fig. 11). This is much less developed than that of *G. bilamellata*. The parietal and angular lamellæ are less intimately united, and the former reaches farther forward (Fig. 10). The terminations of the lip are rather widely separated, as in *dalliana*.

ARIZONA: Montezuma's Well, several miles north of the S. P. Railroad close to where it enters Maricopa Co. from the east, Type 82918 A.N.S.P. Also 5 miles south of Jerome, Yavapai Co. (Ashmun).

The localities of *media* are west of all those known for *G. dalliana*, but its range seems to be overlapped by the eastern extension of *bilamellata*. Its structural characters are between the two.

Gastrocopta bilamellata (Sterki & Clapp)

Figs. 489; 490: 1-4.

Bifidaria bilamellata Sterki & Clapp, 1909, Nautilus, 22:126, pl. 8, fig. 7.—Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 143.

Gastrocopta bilamellata (S. & C.) Pilsbry, 1916, Man. Conch., 24:51.

The shell is long, slowly tapering to the obtuse apex, corneous or faintly brownish, translucent, microscopically striate. Whorls $5\frac{1}{2}$, convex, the last flattened or impressed on the back, the crest behind the lip varying from moderately strong to scarcely perceptible. Peristome thin, well expanded, continuous, but the parietal callus often adnate. Angulo-parietal lamella strongly developed; columellar lamella turning downward within; basal fold transverse; lower-palatal fold deeply immersed.

Length 2.35 mm., diameter 0.83 mm.

Length 1.95 mm., diameter 0.8 mm.

ARIZONA: foothills of Plumosa Range, about 8 miles east of Quartzsite, Yuma Co., in drift (type 5942 Clapp coll., Carnegie Mus., coll. by G. S. Hutson); Salt River drift, Tempe, Maricopa Co. (Pilsbry and Ferriss). Wall's Wells, in the Ajo Mts., and Tucson Range, Pima Co.; Galiuro Mts., Graham Co. (Ferriss).

This species, which replaces *G. dalliana* in western Arizona, differs from that by the longer, more tapering shell, the nearly or quite continuous peristome and the shape of the columellar lamella, which has a vertical portion running down from its inner end, longer than in *G. d. media*. The parietal lamella runs forward farther than in *G. dalliana*. In the type locality it was found in company with *G. hordeacella* and *Chaenaxis intuscostata*, in the ratio of about 1 *bilamellata* to 16 *hordeacella*.

Subgenus GASTROCOPTA Wollaston

The shell is rimate, cylindric or oblong-conic, having the angular and parietal lamellæ conerescent into a sinuous or bifid lamella; columellar lamella horizontal, short. Palatal folds not standing upon a callous ridge, the upper and basal sometimes wanting, the basal, when present, in the base of the aperture, not subcolumellar in position.

Distribution.—Tropical and warm temperate portions of America and Africa; Mascarene Is.; Ceylon; the Philippines; introduced in the Hawaiian Islands.

This group is developed in warm temperate and tropical America, chiefly from the southern tier of states in the United States to the Argentine Republic. They are the common and abundant pupillids of these regions.

The differential characters of species are not conspicuous, and close attention to small details is essential in their discrimination.

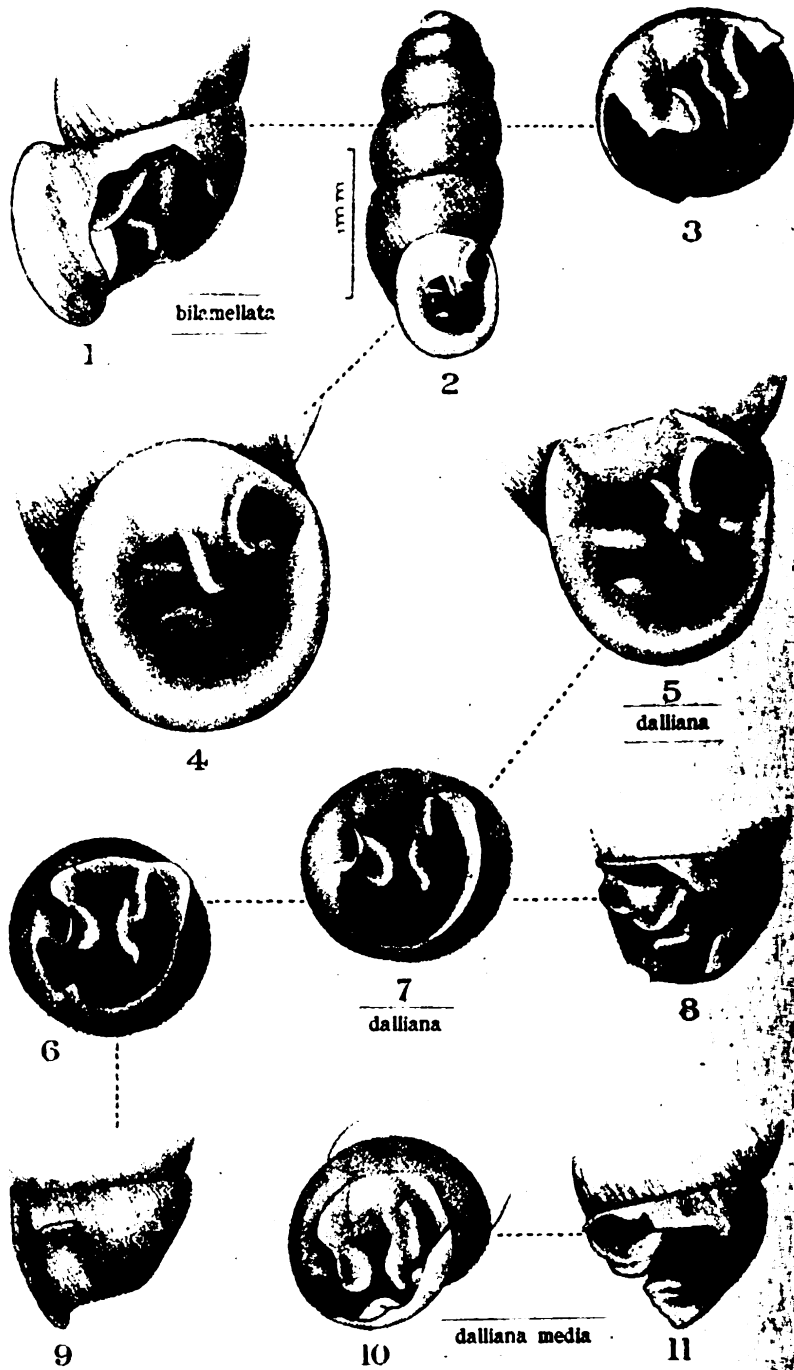


Fig. 490. 1-4, *Gastrocopta bilamellata*, near Quartzsite, Ariz. 5-7, 9, *G. dalliana*, Nogales, Ariz.; 8, Dragoon Mts., Ariz. 10, 11, *G. dalliana media*, Montezuma's Well, Arizona.

Key to species

1. Lip distinctly or heavily calloused. 2
Lip thin, not calloused within. 7
2. Shell distinctly tapering upward. *rupicola*
Shell cylindric or subcylindric. 3
3. Angulo-parietal lamella strongly bifid at the tip. 4
Angulo-parietal simpler, merely sinuous; a strong crest. *cristata*
4. Lip callus not very heavy; an infraparietal tubercle often present *riograndensis*
Lip callus heavy; no infraparietal tooth. 5
5. Angulo-parietal lamella forked in front; subcolumellar tubercle strongly developed. 6
Angulo-parietal lamella not forked in front; subcolumellar tubercle or callus rather weak or wanting *procera*
6. Lip callus thickest at margin. *procera mcclungi*
Lip callus thickest a little within. *procera sterkiana*
7. At least 5 well-developed teeth; basal fold present. 8
Four teeth, no basal; angulo-parietal lamella not bifid; whitish; 2 to 3 mm. long. *quadridens*
3-5 small teeth; basal and upper-palatal small or wanting; 1.5-2 mm. long. *pellucida parvidens*
8. A distinct crest behind the lip; an infraparietal tooth often present; brown; diam. more than 1 mm. *riograndensis*
Crest weak or wanting; no infraparietal tooth; diam. less than 1 mm. *pellucida hordeacella*

Gastrocopta rupicola (Say)

Fig. 491 a, b, c.

Pupa rupicola Say, 1821, Jour. Acad. Nat. Sci. Phila., 2:163.*Gastrocopta rupicola* (Say), Pilsbry, 1916, Man. Conch., 24:58.*Gastrocopta rupicola matacumbensis* Pilsbry, 1916, Man. Conch., 24:60 (pen error for *matecumbensis*).

"The shell is oblong-conic, tapering upwards much more than *G. procera*, which is subcylindric. The color varies from very pale brown to corneous, the surface being very finely, rather irregularly striate. The outer and basal margins of the peristome are spreading, broad, and *conspicuously thickened by a heavy white callus* within the sharp edge. This callus is narrowed near the posterior angle as usual. The angulo-parietal lamella shows a small lateral spur in the front view. Seen from below it is very slightly sinuous, nearly straight except in front, where it curves outward to unite with the outer lip. The columellar lamella consists of a very low vertical portion which bends forward below, forming a strong horizontal portion. The lower-palatal fold is not much lengthened, but is larger and more deeply placed than the upper. There is a narrow and low but distinct crest close behind the lip, and a flattening over the position of the lower-palatal fold. Length 2.5, diam. 1.1 mm.; 5 $\frac{3}{4}$ whorls." (Pilsbry.)

Distribution.—South Carolina to the keys of south Florida, west along the Gulf coastal plain to Galveston, Texas. Bermuda; Bimini group, Bahamas; varieties in the West Indies. Type locality, ruins of Fort Picolato, St. John's River, Florida.

In some places the average size is smaller than given above, as at Miami, Florida. In other colonies, as at Lossman's Key, in the Ten Thousand

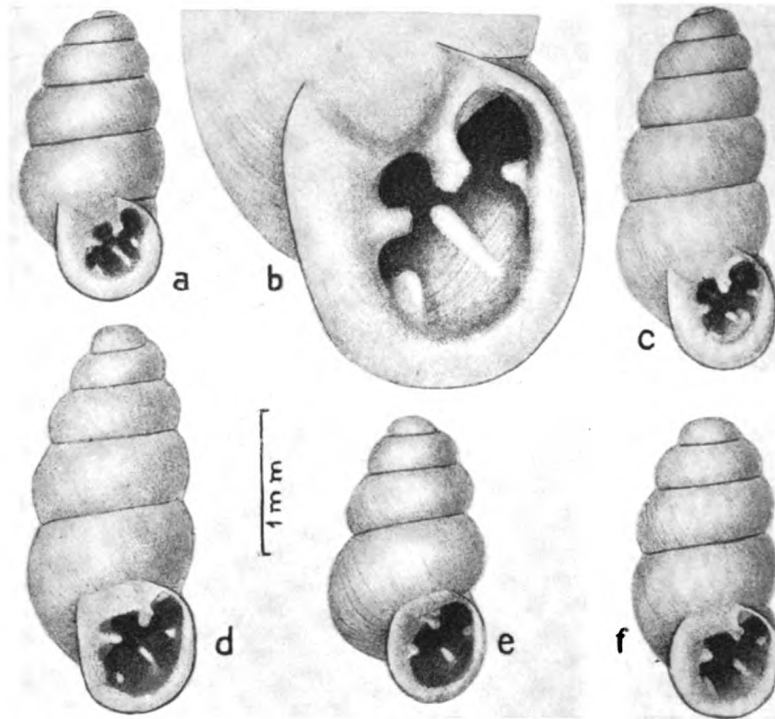


Fig. 491. *Gastrocopta rupicola*. a, Lossman's Key, Florida; b, South Carolina; c, Seville I., Lake George, Florida. d, e, f, *Gastrocopta rupicola matecumbensis*, type and topotypes.

Islands (Fig. 491 a; length 2.2 mm., 5 whorls) both the maximum and the minimum sizes were found living together, the smallest 2.1 mm. long. There is a more or less developed callus buttress under the inner end of the columellar lamella in this and some other lots, while in typical *rupicola* it is absent or only weakly developed.

Before 1890, this species was thought to include *G. procera* Gld., and the name was so used in the writings of W. G. Binney and others. Gould, and afterwards Sterki, pointed out the differential characters.

***Gastrocopta rupicola matecumbensis* Pilsbry**

Fig. 491 d, e, f.

The shell is fragile, milk-white, without a crest behind the reflected lip; the latter being only slightly or moderately thickened, very much less than in typical *rupicola*. There is a callus below the inner end of the columellar lamella. All of the teeth are somewhat smaller than in *rupicola*.

Length 2.5, diameter 1.1 mm. (type).

Length 2.35, diameter 1.1 mm.

Length 1.85, diameter 0.93 mm.

Lower Matecumbe Key, Florida, near the water-tank, abundant (Geo. H. Clapp). Type 105511 A.N.S.P.

Gastrocopta procera (Gld.)

Fig. 492: 1-5.

Pupa procera Gould, 1840, Bost. Jour. N. H., 3:401; 4:359.

Gastrocopta procera Gld., Pilsbry, Man. Conch., 24:62; with form *riparia*, p. 65.—F. C. Baker, 1939, Fieldbook Illinois Land Snails, p. 102, figs. A. B.—Franzen, 1947, Trans. Kansas Acad. Sci., 49:416, pl. 1, figs. 2, 3, pl. 2, figs. 5, 8, 9. (Not common in northwestern Kansas).

Pupa carinata Gould, 1842, Bost. Jour. Nat. Hist., 4: on cover; also p. 359.

Pupa gibbosa "Say", Küster, Syst. Conch. Cab., p. 123.

Pupa minuta "Say", Pfeiffer, 1842, Symbolae ad Hist. Hel., 2:54.

The shell is shortly rimate, cylindric, with convexly conic, obtuse summit; cinnamon to sayal-brown, paler at the summit, somewhat glossy, lightly, irregularly striate. Whorls 5½, rather strongly convex, the last one flattened in the region of the lower-palatal fold, and slightly impressed over the basal fold; having a low crest (Fig. 492:4) close behind the outer lip (variable in prominence). The aperture has five teeth. The angulo-parietal lamella is sinuous, showing a distinct spur on the right side, in a front view; in basal view (Fig. 492:5) this spur is seen to be the inner end of the angular lamella, while the parietal lamella forms a very inconspicuous projection of the outline on the left side, and its inner end curves slightly to the right. The columellar lamella is stout, transverse, nearly a half whorl long; below it there is a low tubercle (Fig. 492:2; variable in prominence, and often not visible in a face view). The upper-palatal fold is short, situated exactly opposite the spur of the parietal, and is rather deep within. Lower-palatal fold is much longer, more deeply placed, its inner end reaching a dorsal position. The basal fold is short, about as deep within as the upper palatal. The peristome is thickened within by a strong, cinnamon callus ridge, in front of the lip-teeth, and excavated near the upper insertion.

Length 2.5, diameter 1.1 mm.

Length 2.3, diameter 1 mm.

Distribution.—Eastern United States, Maryland to South Carolina, west to Shawnee Co., Kansas, and Payne Co., Oklahoma; south to Alabama and eastern Texas. Type locality, Baltimore, Maryland.

G. procera differs from *G. rupicola* by its dark color, tinted or dark-colored lip, and more cylindric shape. Both have the lip heavily calloused within, but in continental *G. rupicola* the callus is always white, and the shell very pale. *G. rupicola* is an austroriparian species, nowhere extending as far north as *G. procera*, but the latter extends south into part of the *rupicola* territory. In some places, as at Galveston, *G. rupicola*, *procera* and *hordeacella* occur together in the same spot.

I have seen *G. procera* from Cecil Co., Maryland, near the Pennsylvania line, and it may be expected to occur in Pennsylvania, in the lower Susquehanna valley. There are records of "*rupicola*" from New England (Binney) and New York, which if not due to mixture of specimens or labels, as

one may suspect, should pertain rather to *procera*. *G. procera* is found in the southern parts of all the states on the north bank of the Ohio River, in Missouri (St. Louis, St. Charles, Jefferson and Franklin counties, according to Hubricht) and Kansas (Shawnee Co.), and west as far as Perkins, Payne Co., Oklahoma (D. K. Greger); also Texas, in Lee Co., where the form seems to me intermediate between *procera* and *sterkiana*. In the west it may narrowly overlap parts of the areas of the subspecies *sterkiana* and *mcclungi*; and in some New Mexican lots, from the debris of the Rio Grande and Mimbres rivers, it is rather difficult to decide whether one has *procera* or *mcclungi*.

Dr. Sterki has reported *G. procera* from Iowa and from Winona, Minnesota (Nautilus, 4:140), places farther north than any from which I have seen specimens; also Cincinnati, Columbus and Hamilton, Ohio (Proc. Ohio Acad. Sci., 4:378). Baker recorded it from Joliet, Illinois (Moll. Chicago Area, pp. 20, 232). *G. procera* has been reported from Trinidad, Colorado (Univ. of Colo. Studies, 4:171), but the specimens are *G. p. mcclungi*.

Form *riparia* Pilsbry, Fig. 492:6. Columellar lamella shorter. *no callus or nodule below it*. Teeth whitish, the palatals usually smaller than typical. Calera and Big Will's Valley near Valley Head, Alabama (H. H. Smith), and Galveston, Texas (Pilsbry). Type 78684, from Galveston.

Gastrocopta procera sterkiana Pilsbry

Figs. 492: 7, 8; 493: 7.

Bifidaria duplicata Sterki, 1912, Nautilus, 25:116. Not *G. duplicata* (Preston). 1911.

Gastrocopta procera sterkiana Pilsbry, 1917, Man. Conch., 24: 65, 357. pl. 12, fig. 7. 8: pl. 13, fig. 7.

The shell differs from *procera* by having the angulo-parietal lamella more complex, due to the less complete concrescence of the two component lamellæ; the anterior end of the parietal is visible as a low, callous branch directed towards the columellar insertion (493:7). The parietal callus between ends of the lip is usually thick. The tubercle below the columellar lamella is typically strongly developed. Peristome and crest as in *procera*, of a very pale brown tint, and the callous thickening is heaviest a little inward from the edge.

Length 2.9, diameter 1.2 mm.; nearly 6 whorls (typical).

Length 2.25, diameter 1 mm. (smallest paratype).

Distribution.—Washington Co., South Dakota, to the Rio Grande, Val Verde Co., Texas. Type locality, Glenrose, Somerwell Co., Texas.

Additional localities are: OKLAHOMA: Fort Gibson (A. D. Brown coll.). ARKANSAS: Rogers, Benton Co. (Pilsbry and Ferriss). TEXAS: Austin: San Marcos, Hays Co.; New Braunfels, Comal Co.; near Hondo, Medina Co.; Devil's River, Val Verde Co. (Pilsbry and Ferriss).

Fig. 492. 1-5, *Gastrocopta procera*, Washington, D. C. 6, *G. procera* form *riparia*, Galveston, Texas. 7, 8, *G. procera sterkiana*, Glenrose, Texas. 9, 10, *G. riograndensis*, type, Hidalgo, Texas.

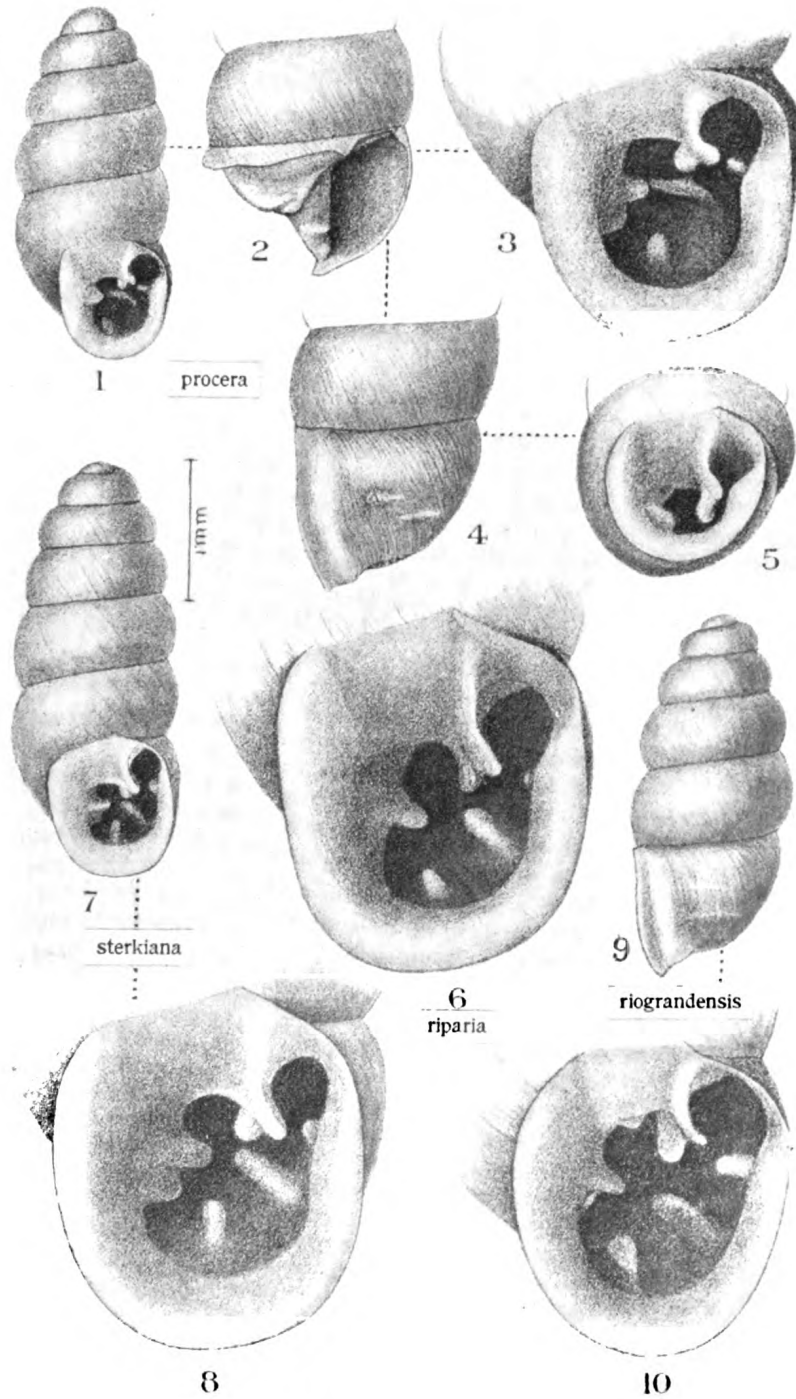


Fig. 492. See bottom of page 908 for legend.

It may be that this form of the subarid region deserves specific rank, but the difficulty of distinguishing many specimens from *procera*, owing to intermediate degrees of development of the angulo-parietal lamella, influenced me to consider it a subspecies. It varies in size in each colony, as usual in the group. Around New Braunfels, Texas, where it is common, the maximum length is 3.3 mm., with barely $6\frac{1}{2}$ whorls.

Nearly all of the specimens seen are from stream debris, though many are so fresh that it is not likely they had floated far.

Gastrocopta procera mcclungi (Hanna & Johnston)

Fig. 493: 1-5.

Bifidaria mcclungi Hanna & Johnston, 1913, Kansas University Science Bulletin. 7: 119, pl. 18, fig. 1, 2.

Gastrocopta procera mcclungi H. & J., Pilsbry, Man. Conch., 24:66.

The average size is smaller than *procera* or *sterkiana*; whorls typically shorter. The face of the thick lip is convex, and the greatest thickness of the lip-callus is at (not within) the edge of the aperture. Teeth as in *sterkiana*, the angulo-parietal lamella being bifid and forked in front (fig. 5), and there is a tubercular tooth below and partially united with the columellar lamella, which appears duplicated when the subcolumellar portion is strongly developed, as in fig. 4. There is a rather low crest behind the lip, and an external impression (sometimes wanting) over the lower-palatal fold.

"Length 2.03, diam. 0.96 mm.; length 2.07 and 2.44, diam. 1 mm." (Hanna and Johnston).

Length 2.26, diam. 1.08 mm.; fully 5 whorls (fig. 1, Clay Co., S.D.).

Distribution.—Clay county, South Dakota to the Rio Grande, at Laredo, Texas; west to eastern Colorado, the Rio Grande and Mimbres valleys, New Mexico, and Holbrook, Arizona. Type 226395 U.S.N.M., from Pleistocene of Prairie Dog Creek, Phillips Co., Kansas.

A subspecies of the semi-arid country, now probably extinct over much of its former territory, the limits of which are indicated above. Nearly all of the specimens known are from stream debris, in part at least washed from Pleistocene beds. The type specimen is identical in form with figs. 1 and 2. Some specimens are longer (fig. 3). *G. p. mcclungi* is separated from *G. p. sterkiana* chiefly by the character of the lip, as the shape and size of the shell are variable.

Many of the shells from New Mexico and Arizona could about as well be referred to typical *procera* as to *mcclungi*. The structure of the angulo-parietal lamella is intermediate, rarely so distinctly forked in front as in typical *mcclungi*, yet showing some trace of that structure, and sometimes distinctly. The nodule below the columellar lamella is lower than in typical *mcclungi*, yet equal to that of many individuals from Dakota and Kansas. In size the New Mexican shells run from the ordinary length of *mcclungi* to that of the largest *procera*; two shells, the largest and smallest noticed in a large lot from near Deming, N. M., measure:

Length 3, diameter above aperture 1.1 mm.

Length 2.3, diameter above aperture 1 mm.

Although in some localities *G. p. mcclungi* appears quite distinct, the many populations of shells intermediate with *procera* appear to indicate somewhat precarious rank even as a subspecies.

Gastrocopta riograndensis (Pilsbry & Vanatta)

Fig. 492: 9, 10.

Pupa riograndensis Sterki, 1892, Nautilus, 6:4 (no description).

Bifidaria riograndensis Sterki, Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 596.

Gastrocopta riograndensis Sterki, Pilsbry, 1917, Man. Conch., 24:69.

The shell has a slowly tapering shape, less cylindric than *G. procera*, cinnamon or sayal-brown, paler towards the summit, weakly, irregularly striate, composed of 5½ strongly convex whorls, the last one impressed over the lower-palatal fold and having a narrow, rather strong crest parallel to the lip a short distance behind it (fig. 9). The aperture has 6 teeth. The angulo-parietal is distinctly bifid in a front view, slightly sinuous, but not forked in front; the infraparietal is a small tubercle (often very small, and wanting in many individuals). Columellar lamella is strong, transverse, a low callus (or a low tooth) close below it. Upper-palatal fold short, the lower-palatal long and entering deeply, but not quite so deeply immersed as a whole, as in *G. procera*. Basal fold shorter, entering. The peristome is expanded, thin at the edge, but having a thin callous rim within. Length 2.55, diam. 1.15 mm.

TEXAS: lower Rio Grande valley, in river debris at Hidalgo, Type 60137 A.N.S.P. (J. A. Singley). Brownsville. Also Mexico: in the Pánuco River valley.

This species tapers a little more than *G. procera*, the whorls are more convex, and the lip-callus is thin, not nearly so heavy as in *procera* and its subspecies. The infraparietal tubercle is lacking in so great a proportion of the specimens which are otherwise adult that it cannot be depended upon for identifying the species, though significant when present.

Gastrocopta cristata (Pilsbry & Vanatta)

Fig. 493: 6, 8-12.

Pupa hordeacea Gabb, W. G. Binney, 1878, Terr. Moll., 5:205, fig. 109 (bad).—Sterki, 1891, Nautilus, 4:141; 1892, Nautilus, 6:4, 101. Not *Pupa hordacea* Gabb, 1866.

Bifidaria procera cristata Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 595, pl. 22, figs. 4, 5.

Gastrocopta cristata (P. & V.), Pilsbry, 1917, Man. Conch., 24:68, pl. 13, figs. 6, 8-12.—Franzen, 1947, Trans. Kansas Acad. Sci., 49:416, pl. 1, fig. 1, pl. 2, fig. 7.

The shell is cylindric, with convexly conic summit, the apex obtuse; surface glossy, brown, very finely, irregularly striate. 5½ rather convex whorls, the last having a strong whitish crest parallel to and behind the lip, and separated from it by a marked contraction. Behind the crest it is somewhat flattened over the lower palatal plica. The aperture has 5 teeth. The angulo-parietal lamella is not in the least bifid in front view, but has an obtuse prominence on the right side. The columellar lamella is rather short,

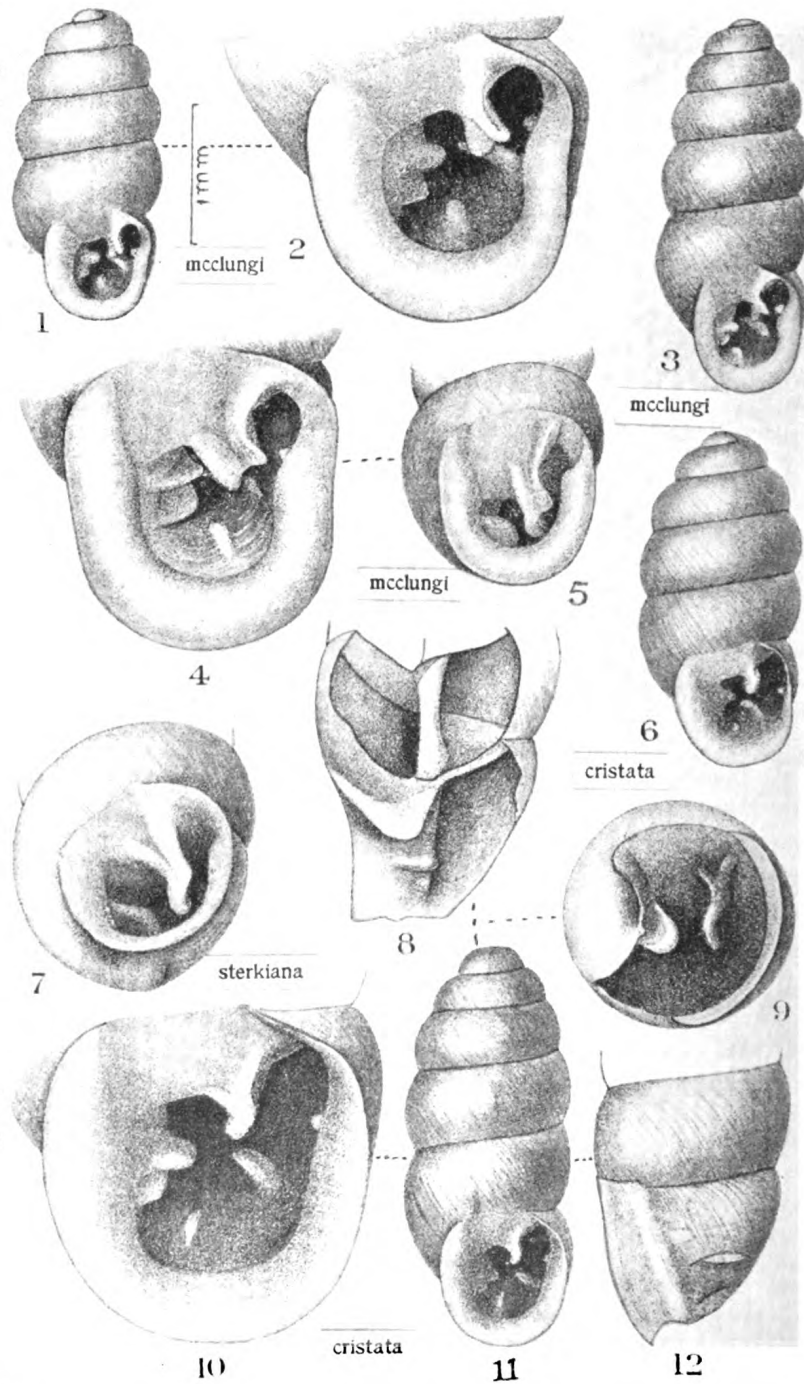


Fig. 493. 1, 2, *Gastrocopta procera mclungi*, Clay Co., S. D.; 3, Chamberlain, Brule Co., S. D.; 4, 5, Rogers, Ark. 6, *G. cristata*, Tempe, Ariz. 7, *G. procera sterkiana*, Glenrose, Texas. 8-12, *G. cristata*, Camp Verde, Arizona.

horizontal, and below it there is a low callus (sometimes strengthened into a small but distinct tubercular tooth. Upper-palatal and basal folds are short, directly entering; lower-palatal fold deeply placed, shorter than in *B. procera*. The peristome is well expanded and thin at the edge, but there is a rather thick, pale brown callous rim a short distance within.

Length 2.8, diam. 1.2 mm.

Distribution.—Eastern Oklahoma to Laredo, Texas, and west to Camp Verde, Yavapai Co., Arizona, type 78694 A.N.S.P., Camp Verde, Arizona.

While related to *G. procera* by its shape, color and size, this species differs by the *simpler angulo-parietal lamella*, which is *not bifid* at the summit, in a front view, and by the stronger crest behind the lip, farther back than that of *procera*. Having collected some thousands of specimens in many places, and carefully examined a great number, I find none in any way transitional to *procera*.

The variation in size is great; the largest and the smallest noticed in a lot from Tempe, Arizona, measure, length 3.2, diam. 1.3 mm., and length 2.3, diam. 1.1 mm. (Fig. 493:6).

***Gastrocopta pellucida hordeacella* (Pilsbry)**

Figs. 494:a-d; 495.

Pupa hordeacella Pilsbry 1890, Proc. Acad. Nat. Sci. Phila., p. 44, pl. 1, figs. g-k.

Bifidaria pellucida hordeacella Pilsbry, Vanatta, 1912, Nautilus, 26:17, pl. 2.

Gastrocopta pellucida hordeacella Pilsbry, 1916, Man. Conch., 24:78; 1934, 28:117.—Macmillan, 1946, Nautilus, 59:123.

Bifidaria hordeacella var. *parvidens* Sterki, 1899, Nautilus, 12:128.—Hanna, 1923, Proc. Cal. Acad. Sci. (4) 12:515 (Tortuga I., Gulf of California).

Shell cylindric-oblong, the upper part tapering convexly to the obtuse apex; of a pale brown tint (varying to whitish); minutely striate. Whorls convex, the last strongly flattened over the lower-palatal fold and having a

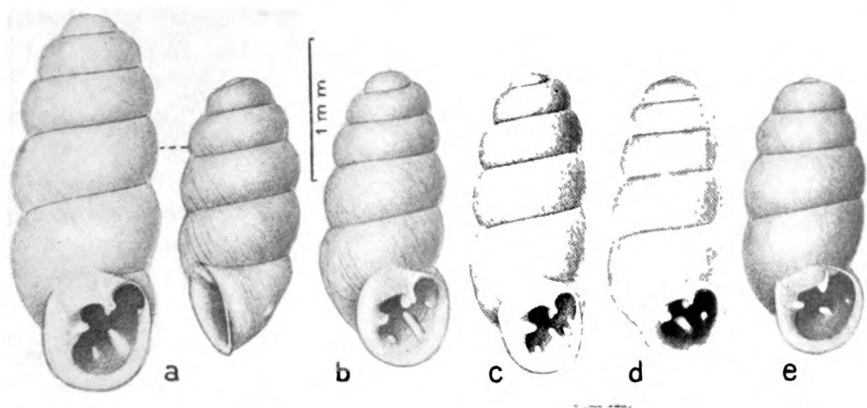


Fig. 494. a, *Gastrocopta pellucida hordeacella*, Pecos River, Texas; b, New Braunfels, Texas; c, Guajadami, Lower California; d, Mojave Mt., California; e, *G. pellucida parvidens*, Jerome, Arizona.

weak crest behind the lip (sometimes subobsolete). The peristome is thin, expanded, angulo-parietal lamella bilobed; columellar lamella rather stout, horizontal; three small folds within the palato-basal margin, about equally spaced, the middle one (lower-palatal) a little more deeply placed and somewhat larger than the upper and basal folds.

Length 1.8 mm., diam. 0.75 mm.; 5 whorls.

Length 2.3 mm., diam. 0.9 mm.; 5½ whorls.

Distribution.—Florida and north along the coast to Cape May, N. J.; Gulf States; eastern Oklahoma, southeast Colorado, New Mexico and Arizona south to Tampico, Mexico; local in southern and Lower California; Mojave Mt. (Ferriss); Palm Canyon in the San Gabriel Mts. (Berry); Type and paratypes 60460 A.N.S.P., from New Braunfels, Texas.

Smaller than any other of our species of this subgenus. *G. pellucida* (Pfr.) is a common West Indian species. The continental form *hordeacella* differs, in the average, by larger size, browner color and the possession of a crest behind the lip; but the smallest light-colored Florida specimens are scarcely if at all distinguishable from West Indian *pellucida*. There are shells with the crest obsolete. It often occurs in abundance.

G. p. hordeacella varies far more than Antillean *pellucida*, the length from 1.5 to 2.6 mm., whorls 4 to 5½, among shells of one lot. Mr. Vanatta remarked that in picking them over, one has a tendency to assort each lot into long, medium, short and obese shells, but these intergrade through a smaller number of individuals.

“To give an idea of the relative abundance of the forms; in a lot of *hordeacella* from Bahia Honda Key I counted 25 long, 31 medium, 15 small, and 7 obese shells. In another series from Key West there are 111 long, 358 medium, 22 small, and 140 obese specimens. Each of these lots was from dirt gathered in the area of a square yard or less. The size in mm. of the several forms may be measured by the scale supplied on the plate.” (Vanatta, *Nautilus*, 26:17.)

He found that “the long shells from Florida have weak teeth and the short shells strong teeth, while in Texas the converse is often the case.” Vanatta's camera lucida figures are reproduced in Fig. 495.

The northward extension along the Atlantic coast is very narrow, discontinuous so far as known, and perhaps mainly confined to the coastal islands.

Specimens from Mojave Mt., California (Fig. 494d) are long and cylindrical, with the lower-palatal fold of unusual length, and the basal fold either small or wanting; crest obsolete.

Length 2.6 mm., diam. 0.95 mm.

Length 2.25 mm., diam. 0.9 mm.

S. S. Berry has figured similar specimens from Palm Canyon, San Gabriel Mts., California (Proc. A.N.S. Phila., 1922, p. 97, figs. 1-4).

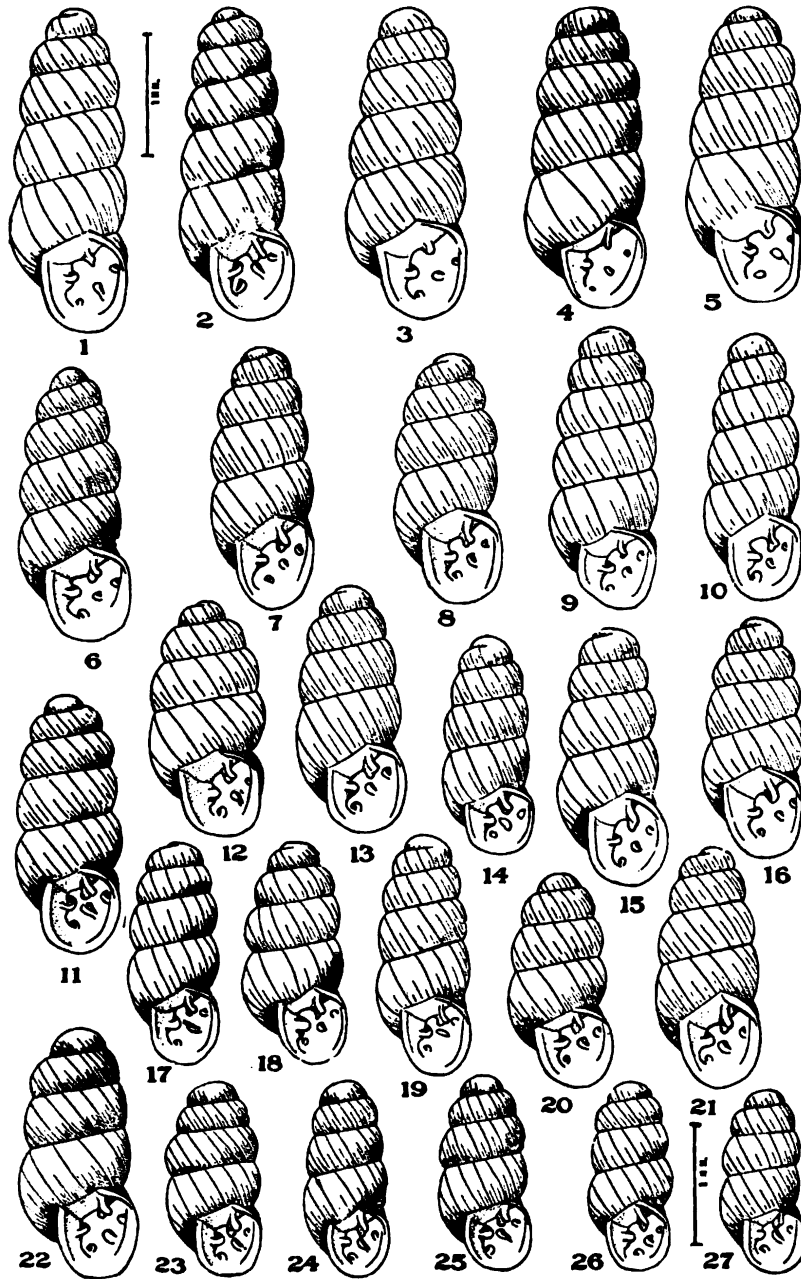


Fig. 495. *Gastrocopta pellucida hordeacella*. Key West, figs. 1, 3, 5, 6, 7, 8, 12, 13, 15, 16, 20, 21, 22. Bahia Honda Key, figs. 9, 10, 14, 17, 18, 19, 25. Summerland Key, figs. 4, 24, 26, 27. New Braunfels, Texas, figs. 2, 11, 23 (after E. G. Vanatta).

Gastrocopta pellucida parvidens (Sterki)

Fig. 494 e.

Bif.[idaria] hordeacella Pils. var. *parvidens* Sterki, 1899, *Nautilus*, 12:128.*Bifidaria hordeacella parvidens* Sterki, Pilsbry & Vanatta, 1900, *Proc. Acad. Nat. Sci. Phila.*, p. 594, pl. 22, fig. 2.*Gastrocopta pellucida parvidens* Sterki, Pilsbry, 1917, *Man. Conch.*, 24:80, pl. 17, fig. 8.—Hanna, *Proc. Cal. Acad. Sci.* (4), 12:515 (Tortuga I., Gulf of California).
—MacMillan, 1946, *Nautilus* 59:123.

Lamellae and folds reduced, the upper-palatal and especially the basal fold small or wanting; angular lamella not reaching the lip insertion.

ARIZONA: Navajo Springs, Apache Co. (Ashmun); Mahan Mt. near Mormon Lake, and at Yampai, Coconino Co. (Ferriss); around Jerome, Yavapai Co., type in Carnegie Mus. (Ashmun). UTAH: Willow Springs. Arches National Monument, Grande Co. (MacMillan). NEW MEXICO: Pecos River drift, Pecos, San Miguel Co. (Pilsbry & Ferriss); Jemez Mts., near Valle Grande, Santa Fe Co. (J. Henderson).

This race with degenerate teeth has occurred in a belt nearly across Arizona at the upper third of the State, and it has been reported also from Tortuga Island, Baja California.

CHAENAXIS Pilsbry & Ferriss*Chaenaxis* Pilsbry and Ferriss, 1906, *Proc. Acad. Nat. Sci. Phila.*, p. 145, for *Bifidaria tuba*.

The shell is cylindric or slightly tapering, having a *large, hollow axis, open below*, and about one-third the total diameter of the shell; lamellæ and plicæ substantially as in the typical group of *Gastrocopta*, the angular and parietal lamellæ being wholly conerescent into one lobed lamella; columellar lamella well developed, horizontal; a deeply entering supracolumellar lamella is sometimes developed. Upper and lower palatal folds and basal fold present.

Type *C. tuba* (P. & F.). The known species live in Arizona and the state of Sonora, Mexico.

A broadly open umbilicus at all stages of growth is unusual in Pupillidæ. Its development in *Chaenaxis* seems sufficient ground for generic rank, even though the rest of the organization is essentially that of *Gastrocopta*, at least so far as the shell is concerned—it has not been dissected. The position of the basal fold, as well as the structure of the wholly conerescent angulo-parietal lamella, indicate that *Chaenaxis* was derived from the southern typical *Gastrocopta* stock, not from the northern *Albinula* and *Sinalbinula* group of the genus.

Key to species and varieties

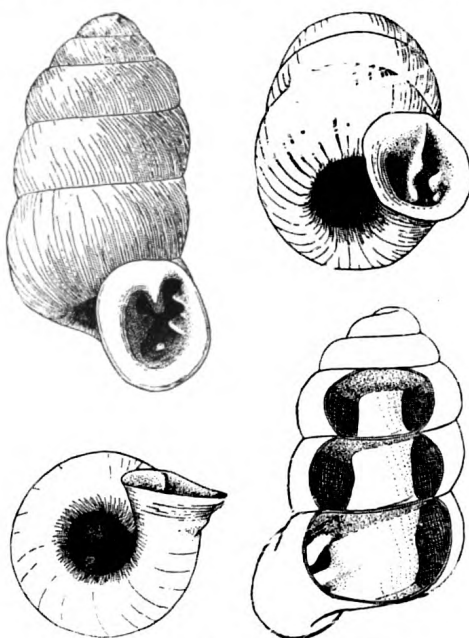
1. Interior of last whorl having a long cord-like lamella spirally ascending on the axis. 2
No long spiral lamella within the last whorl. *tuba*
2. Internal lamella $1\frac{1}{2}$ to 2 whorls long. *intuscostata*
Internal lamella about 1 whorl long form *brevicostata*

Chaenaxis tuba (Pilsbry & Ferriss)

Figs. 496, 497: 1-3.

Bifidaria tuba Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 145, fig. 6; 1910, p. 144; 1915, p. 390.*Chaenaxis tuba* (P. & F.) Pilsbry, Man. Conch., 24:2, pl. 9, figs. 1-3.

The shell is cylindric with a short terminal cone, *openly umbilicate*, the umbilicus nearly one-third the diameter of the shell, its large cavity penetrating to the first whorl. Pale brown, smooth, marked with light growth-lines. The apex is obtuse. Whorls $5\frac{1}{2}$ to $6\frac{1}{2}$, convex, the last three forming the cylindrical part of the shell; last whorl is compressed laterally and is obtusely angular around the umbilicus, scarcely straightened in front; in basal view it expands broadly at the aperture. The aperture is shortly oval.

Fig. 496. *Chaenaxis tuba*, type.

the peristome thin, continuous and broadly expanding. The angular and parietal lamellæ are concrescent into one long bilobed lamella. The columellar lamella is rather massive, having a sloping callus or a lower rounded tooth on its lower side; becoming a low cord, it continues inward to the back of the last whorl (Fig. 497:3). The upper and lower palatal and basal folds are situated as usual, the lower-palatal a little more deeply placed and longer than the others, and there is often a small interpalatal denticle. There is no supracolumellar lamella in the type lot.

Length 3.3, diam. 1.6 mm. (Fig. 496 and 497:1).

Length 3, diam. 1.5 mm. (smallest in type lot).

ARIZONA: drift debris of the San Pedro River, one mile east of Benson, Type 87062 A.N.S.P. (Ferriss and Pilsbry), and at Mammoth, Pinal Co. (Ferriss); near Dos Cabezas Cave, west of the Dos Cabezas Range, Cochise Co. (Mort Wien); Tumamoc Hill, under

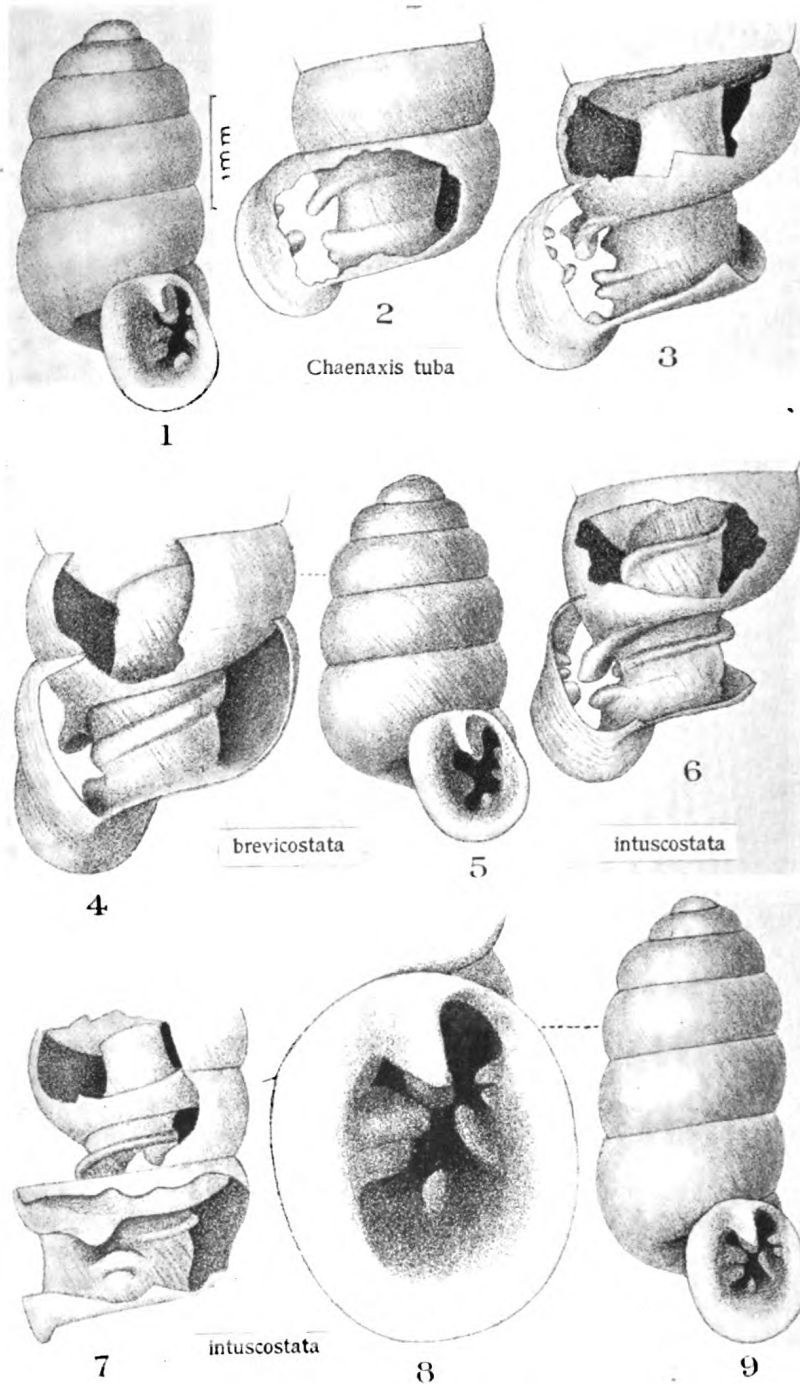


Fig. 497. 1, 2, *Chaenaxis tuba*, Benson, Ariz.; 3, Tucson, Ariz. 4, 5, *C. intuscostata brevicostata*, Tempe, Ariz. 6, *C. intuscostata*, Tucson; 7-9, east of Quartzsite, Yuma Co., Ariz.; cotypes.

stones, and in flood debris at the west end of Congress St., Tucson (Pilsbry and Ferriss); Empire and Mustang Ranges (Ferriss).

This species lives in the arid foothills and low mountains of the Lower Sonoran zone, not in the higher mountains. It is rare in the debris of the San Pedro River, probably washed in from the foothills. A few specimens were found under stones on Tumamoc Hill, and more, together with *C. intuscostata*, in flood debris of the Santa Cruz River at the foot of the hills at the west end of Congress Street, Tucson. These specimens have a small supracolumellar nodule, sometimes two (Fig. 497:3), but no spiral lamella running inward from it, though there is a shallow spiral depression, scarcely to be called a furrow, on the internal axis.

***Chaenaxis intuscostata* (Clapp)**

Figs. 497:6-9; 498.

Bifidaria tuba subsp. *intuscostata* G. H. Clapp, 1908, *Nautilus*, 22:76, 96, pl. 7, fig. 1-11.

Chaenaxis intuscostata (Clapp) Pilsbry, 1916, *Man. Conch.*, 24:3, pl. 9, figs. 6-9, with form *brevicostata*, p. 4, pl. 9, figs. 4, 5.

The shell is openly umbilicate, cylindric, usually longer than *C. tuba*, and composed of about $6\frac{1}{2}$ whorls; light brown. Last whorl, aperture and teeth as in *C. tuba*, but the supra-columellar lamella is almost invariably present and visible from in front, and the subcolumellar nodule is conspicuous. Inside there is a strong, cord-like lamella about $1\frac{1}{2}$ to 2 whorls long, terminating near and behind the supracolumellar nodule.

Length 3.85, diam. 1.65 mm.; $6\frac{1}{2}$ whorls (fig. 9).

"Length 4.2, diam. 2 mm.; $6\frac{3}{4}$ whorls (largest)."

"Length 3.25, diam. 1.8 mm.; $5\frac{1}{2}$ whorls (smallest normal shell)."

ARIZONA: foothills of the Plumosa range, about 8 miles east of Quartzsite, Yuma Co. type 5769 C.M., coll. by Geo. S. Hutson; also Short Horn range, 25 miles s. of Quartzsite; debris of Salt River, Tempe, Maricopa Co.; flood debris at west end of Congress St., Tucson (Pilsbry and Ferriss); Rincon, Tucson, Empire and Quijotoa ranges (Ferriss).

The main distinctive character of this species is the long, spirally ascending supracolumellar lamella, which is wanting in *C. tuba*. It is also, in the main, longer and more cylindrical than *tuba*. Dr. Clapp has figured several curious abnormal shells found in the original lot.

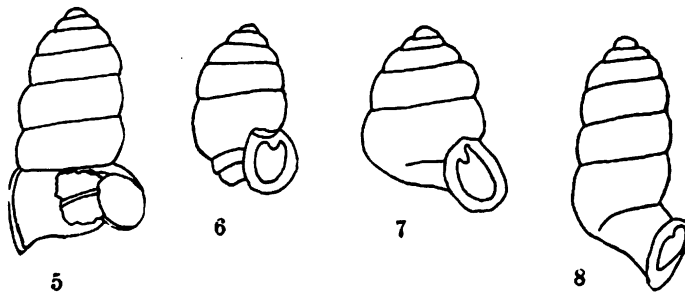


Fig. 498. Abnormal shells of *C. intuscostata* (after G. H. Clapp).

The specimens from Tucson are typical in structure.

Form *brevicostata* Pilsbry. Fig. 497:4, 5. The shell is smaller and tapers more upwards than *B. intuscostata*, and the spiral supracolumellar lamella is only about one whorl long. Length 3.25, diam. above aperture 1.6 mm.

Tempe, Arizona, in drift of Salt River, type 48527 A.N.S.P. (Pilsbry and Ferriss); Empire range; Carr Canyon, Huachuca Mts. (Ferriss).

A fragmentary example of this was figured in Proc. Acad. Nat. Sci. Phila., 1906, p. 146, fig. 7.

Subfamily PUPILLINAE

PUPOIDES Pfeiffer

Pupoides Pfeiffer, 1854, Malak. Blätter, 1:192.—Kobelt, 1880, Illustr. Conchylienbuch, p. 267, type *P. nitidulus* Pfr.—Pilsbry, 1921, Man. Conch., 26:108. 137. monograph; 1934, Man. Conch., 28:137.—H. B. Baker, 1935, Man. Conch., 28:200 (anatomy).

Leucochila von Martens, 1860, Die Heliceen, p. 296, type "*Pupa fallax*" (= *albilabris* C.B.Ad.).

Leucochiloides Pfeiffer, 1878, Nomencl. Hel. Viv., p. 292, type *Bulimus lardeus* Pfr., designated by Connolly, 1912.

Themapupa Iredale, 1930, Victorian Naturalist, 47:120, type *Pupa beltiana* Tate. Cf. Man. Conch., 28:80.

The shell is about 3 to 6 mm. long, rimate; long-ovate, turritid or rarely cylindrical, with obtuse apex and few (generally 5-6) rather long whorls. Aperture ovate, toothless except for a small, tuberculiform, angular lamella close to the insertion of the outer lip, or united with it, sometimes wanting; peristome expanded, reflected and usually thickened within. Internal axis slender, perforate.

The anatomy of the genotype, *P. nitidulus* (Pfr.), has been investigated by H. Burrington Baker, whose account follows.

"Among many specimens from the Dutch Leeward Islands, collected during the summer of 1922, one individual from Aruba was found to have mature male organs.

Ovotestis (page 873, fig. 1) with three lobes of short-clavate alveoli; duct enlarged and convoluted in lower half; carrefour elongate without distinct talon. Oviduct swollen in apical half; no embryos observed. Spermatheca short, without diverticulum (although a muscle attaches across its stalk below sac). Epiphallus sessile, considerably swollen, internally with longitudinal folds. Penis bifid but epiphallar arm demarcated from epiphallus only by narrower caliber and lack of folds; appendix short, thin walled, entering penial apex through a thickened ring (like in *Strobilops*). Penial retractor arising from diaphragm, bifurcating a little below its middle to insert around apex of epiphallar arm and near middle of appendicular arm of penis. Right ocular retractor in penioviducal angle. Radular formula 16.1.(8 + 8). with 82 rows (τ); central much narrower than inner laterals", tricuspid; laterals bicuspid; marginals with several ectoconal denticles and a longer mesocone (page 873, fig. 2).

Distribution.—All of the continents except Europe.

Pupoides differs from *Pupilla* by the tapering spire, the longer, more loosely coiled whorls, longer aperture and the obliquity of the parietal margin of the aperture. There is never a crest or a furrow behind the lip. So far as known, it is oviparous. Anatomically it "differs from *Pupilla* in the insertion of its penial retractor at the base (instead of on the side) of the epiphallus, in the simpler epiphallar arm of its penis (without apical caecum), by the lack of a spermathecal diverticulum and in the narrower radular central. Its genitalia appear the simplest in the group." (H. B. Baker.)

Key to subgenera and species

1. Shell distinctly tapering; diameter about half the length (Subgenus *Pupoides*). 2
 Shell cylindrical or subcylindrical; diameter decidedly less than half the length (Subgenus *Ischnopupoides*). 3
2. An angular lamella is represented by a small callus pad joined to the outer lip; shell about 5 mm. long, of 5½ to 6 whorls; U. S., Mexico, West Indies.
P. albilabris
 No angular pad or tubercle; 3.4 to 4.2 mm. long, 4½ to 5 whorls; Florida.
P. modicus
3. Cylindrical; no angular tubercle or pad. 4
 Slowly tapering, slender, with a small angular tubercle; Mazatlan, Mexico.
P. chordatus
4. With slender, spaced riblets; Arizona, New Mexico, Utah. *P. hordaceus*
 Nearly smooth; South Dakota, Colorado and New Mexico. *P. inornatus*

***Pupoides albilabris* (C. B. Adams)**

Fig. 499: 1-7.

Cyclostoma marginata Say, 1821, Jour. Acad. Nat. Sci. Phila., 2:172 (Upper Missouri). Not *Cyclostoma marginatum*, G. Fischer, 1807, Mus. Demidoff., 3:219.

Pupoides marginatus (Say), Pilsbry & Vanatta, Proc. Acad. Nat. Sci. Phila., 1900, p. 586.—Pilsbry, Man. Conch., 26:111, pl. 12, figs. 1-7.—Hanna, Proc. Cal. Acad. Sci. (4 ser.), 12:514.—Henderson, 1924, Univ. of Colo. Studies, 13:132; 1926, 23:102 (Colorado).—Woodbury, 1929, Nautilus, 43:57 (Zion Nat. Park, Utah).—Franzen, 1947, Trans. Kansas Acad. Sci., 49:418 (N.W. Kansas).

Pupa fallax "Say", Gould, Bost. Jour. Nat. Hist., 4:357.—W. G. Binney, Terr. Moll., 5:203, pl. 52, fig. 1, pl. v, fig. τ (teeth), and of most authors prior to 1900. Not *Pupa fallax* Say.

P[upa] albilabris "Ward's letter". C. B. Adams, 1841, Amer. Jour. Sci., 40:271. (New name for *Cyclostoma marginata* Say; no other description.)

Pupa (Modicella) arizonensis Gabb, 1866, Amer. Jour. Conch., 2:331, pl. 21, fig. 6.

The shell is minutely perforate, rimate, slowly tapering from the last whorl to the obtuse summit, cinnamon or slightly darker, somewhat glossy. Surface lightly marked with striae of growth. The whorls are rather strongly convex, the last half-whorl somewhat compressed laterally, tapering to the narrowly rounded base. The aperture is oval; peristome expanded and reflected, strongly thickened within, its face flattened; the outer lip is more strongly arched near the upper insertion. Parietal callus transparent, bearing a short low tubercle connected with the outer lip. Length 5, diam. 2.2 mm.; barely 6 whorls.

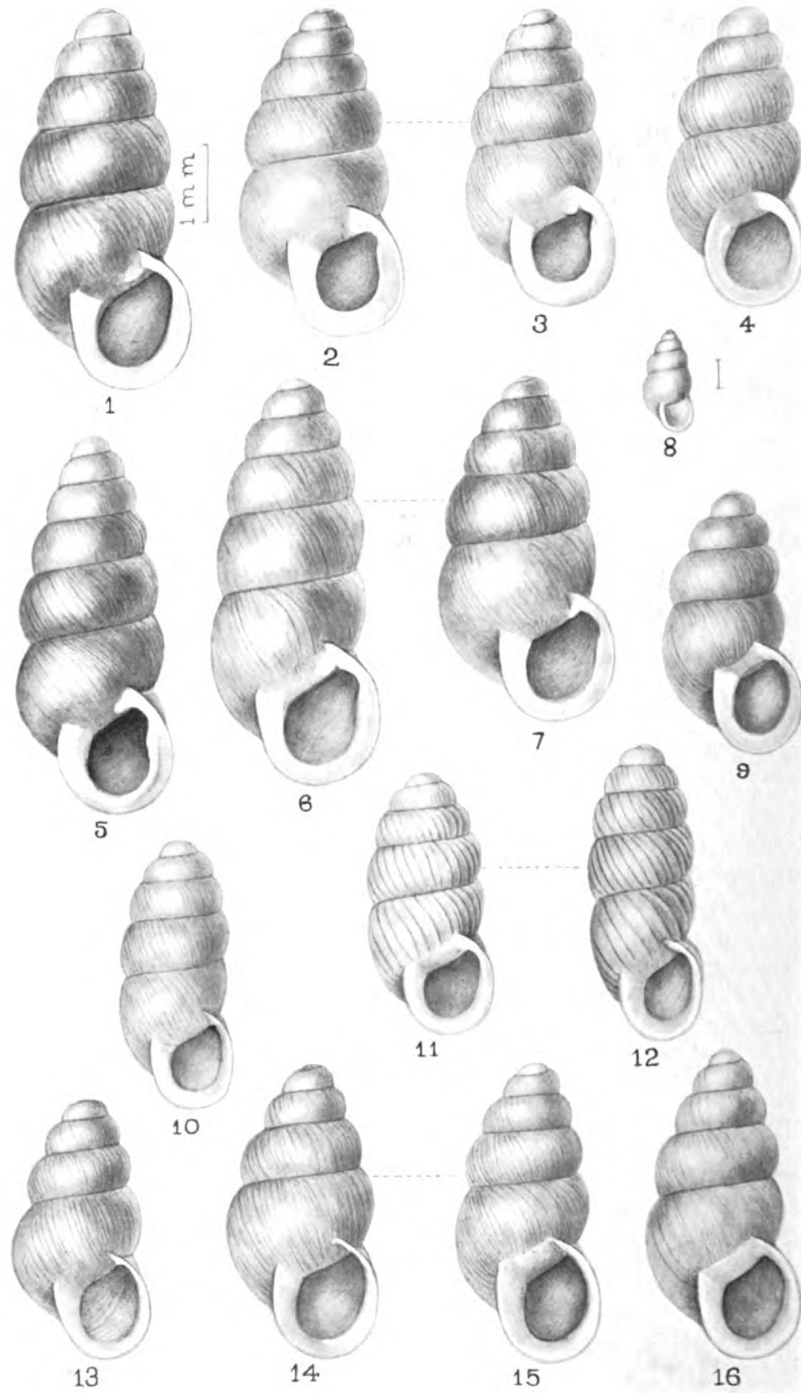


Fig. 499. See bottom of page 923 for legend.

Distribution.—Eastern North America from Ontario and Maine to the Gulf of Mexico, west to the Dakotas, Colorado, and western Arizona (Yuma Co.); in northern Mexico on islands in the Gulf of California, at Monterrey and Tampico. Cuba; Haiti; Porto Rico; Bermuda.

This common snail prefers limestone soils, though also found elsewhere. It lives under stones or at the roots of grass, in well-drained but often sunny places; following rains it is sometimes found on trees a few feet from the ground. It occurs in all the states from Arizona and Colorado eastward, but never at high elevations. The living shell is usually more or less coated with dirt.

The size varies in the same colony. Around Philadelphia they run from 4.2 to 5 mm. long (Fig. 499:1). Figs. 2, 3 represent shells from Washington Co., South Dakota. The size of the angular tubercle varies in most western lots. In Arizona the shell is often small and delicate, length 4 mm., hardly over 5 whorls, with scarcely any callous pad in the angle of the mouth (Fig. 499:4, Plumosa Range about 8 miles east of Quartzsite, western Arizona), thus resembling *P. modicus*; but in the same lots there are also larger shells. The most slender examples are from the Gulf States (Fig. 499:5, Big Wills Valley, Alabama), measuring, length 5, diam. 2 mm., 6½ whorls.

A sinistral specimen was found in Texas by Dr. Julia Gardner of the U. S. Geol. Survey, on the Colorado River 1½ miles below the Travis-Bastrop county line.

Nomenclature.—As Say's specific name *marginata* was preceded by *Pupa marginata* Draparnaud, Gould, Binney and later authors up to 1900, called this species *Pupa fallax* Say 1825, Jour. Acad. Nat. Sci. Phila., 5:121. That species, received by Say from a correspondent in Milton, Massachusetts, was actually based upon a stray example of *Ena obscura* (Müll.) of Europe. The same specimen, apparently, served for type of *Pupa placida* Say (1829, Disseminator of Useful Knowledge, 2:250). Say had forgotten his earlier description, as explained by the author in Proc. Acad. Nat. Sci. Phila., 1900, pp. 586-7. Say's earlier name, "*Cyclostoma*" *marginata*, was resuscitated for the species by Pilsbry & Vanatta in 1900; but Dr. Baker has called my attention to the prior use of this name by G. Fischer, in 1807. We now accept the substitute name *P. albilabris*, offered by C. B. Adams more than a century back.

***Pupoides modicus* (Gould)**

Fig. 499: 13-15.

Pupa modica Gould, 1848, Proc. Bost. Soc. Nat. Hist., 3:40 (Florida).—Binney, 1878, Terr. Moll., 5:204, pl. 52, fig. 2.

Fig. 499. 1. *Pupoides albilabris*, Philadelphia; 2, 3, Washington Co., S. D.; 4, near Quartzsite, Ariz.; 5, near Valley Head, Ala.; 6, 7, Cienfuegos, Cuba. 8. *Pupoides simoni* (Jousseaume), Venezuela (after Jousseaume). 9, 10, *Pupoides nitidulus* (Pfeiffer), west side Matanzas Bay, Cuba. 10. *Pupoides inornatus*, White River, S. D. 11. *Pupoides hordaceus*, near Las Vegas, N. M.; 12, near Adamana, Ariz. 13-15. *Pupoides modicus*. Key West.

Pupoides modicus Gld., Vanatta, Nautilus, 21:100 (Florida Keys).—Clapp, Nautilus, 27:64 (Bimini Is.).—Pilsbry, 1921, Man. Conch., 26:115, pl. 12, figs. 13-15.

The shell is perforate, rimate, tapering from the last whorl to the obtuse summit, thin, dull brown, somewhat glossy, irregularly striate. The whorls are strongly convex, the last ascending in front. The aperture is oval. Peristome thin, broadly expanded, very little or not thickened within, white, the outer margin regularly curved, columellar margin straightened, margins converging and joined by a transparent callus. No callous pad or tubercle in the angle.

Length 4.2, diam. 2.1 mm.; 5 whorls.

Length 3.9, diam. 2.15 mm.; 5 whorls.

Length 3.45, diam. 1.8 mm.; 4 $\frac{3}{4}$ whorls.

GEORGIA: St. Simon's Island. FLORIDA: Cedar Keys to Key West. Also Bimini Keys, Bahamas.

The shell is smaller and thinner than *P. albilabris*, somewhat more striate, the lip very little or not thickened. The last character is about all that separates *modicus* from the Antillean *P. nitidulus* (Pfr., 1839), which is about the same size, and when not quite mature cannot be distinguished. The angular tubercle is sometimes practically wanting in small forms of *P. albilabris*, which then resemble *P. modicus*. Key West examples are figured.

Subgenus ISCHNOPUPOIDES Pilsbry

Ischnopupoides Pilsbry, 1926, Man. Conch., 27:250, type *P. hordaceus* (Gabb).

A group of the dry country. Besides the following, there is one species, *P. chordatus* (Pfr.), at Mazatlan, and another, *P. paredesii* (Orb.), in Bolivia and Peru.

Pupoides hordaceus (Gabb)

Fig. 499: 11, 12.

Pupa hordacea Gabb, 1866, Amer. Jour. Conch., 2:331, pl. 21, fig. 7. Not *Pupa hordeacea* Binney; not *Bifidaria hordeacea* Sterki.

Pupoides hordaceus (Gabb) Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 240, pl. 22, fig. 11.—Walker, Occ. Pap. Mus. Zool. Univ. Mich., No. 15, 1915, p. 2-4.—Pilsbry, 1921, Man. Conch., 26:116, pl. 12, fig. 11, 12.—[?] Franzen, 1947, Trans. Kansas Acad. Sci., 49:416, pl. 1, fig. 10, pl. 2, fig. 5.

Pupa arizonensis Gabb, W. G. Binney, 1869, Land and Fresh-water Shells of N.A., pt. 1, p. 240, fig. 416, and in subsequent works. Not *P. arizonensis* Gabb.

Pupa arizonensis W. G. Binney, Sterki, Nautilus, 3:118, 119 (Seligman, Ariz., in ants' nests; Albuquerque, N. M.).

Pupa gabbi Dall, 1896, Proc. U. S. Nat. Mus., 19:367. New name for *P. arizonensis* Binney not Gabb.

Bifidaria hebes Ancey, Pilsbry, 1898, Nautilus, 11:117. Not *Pupa hebes* Ancey.

Pupa gabbi mexicanorum Cockerell, 1897, Nautilus, 10:143.

Pupoides eupleura Chamberlin & Berry, 1931, Proc. Biol. Soc. Wash., 44:7, fig. 1, cf. Pilsbry, 1934, Man. Conch., 28:138.

The shell is imperforate, shortly rimate; cylindrical, with a convexly conic summit and obtuse apex; cinnamon to avellaneous, without gloss, the apex and lip pale. The upper whorls are strongly convex, the last two weakly

convex or somewhat compressed laterally. Sculpture of slender retractive riblets, nearly straight, widely spaced, wanting on the first $1\frac{1}{2}$ whorls, which are weakly, densely, microscopically granulose. The aperture is slightly oblique, oval, angular above. The peristome is narrowly expanded, strongly thickened within. Parietal margin strongly oblique, covered with a very thin callus. There is no angular tubercle or callus.

Length 3.35, diam. 1.5 mm.; $5\frac{1}{2}$ whorls. Jerome, Arizona.

Length 3.9, diam. 1.65 mm.; $5\frac{1}{2}$ whorls. Jerome.

Length 3.65, diam. 1.65 mm.; $5\frac{1}{2}$ whorls. Adamana, Arizona.

Length 4.3, diam. 1.7 mm.; $5\frac{3}{4}$ whorls. Adamana.

COLORADO: Dolores canyon at mouth of Gypsum Creek, San Miguel Co. (Junius Henderson, 1914).

NEW MEXICO: near Las Vegas (Prof. Cockerell, Mary Cooper); Rio Grande drift at Albuquerque (Ferriss & Pilsbry); Grant (A. and J. Baily); Rio Grande drift at Mesilla (Cockerell). Canones Creek east of Mt. Pedernal, Coyote Creek near Rio Puerco and Arroyo Agua and Rio Puerco, all in Rio Arriba Co.; 14 miles north of Tucumcari (Walker).

ARIZONA: Navajo Springs (Ashmun), Chinle Creek and near Adamana, Apache Co. (Ferriss); Holbrook, Navajo Co. (Ashmun); Antelope Valley and Finley's reservoir, near Mt. Trumbull, Coconino Co. (Ferriss and Daniels); Verde River near Jerome, Yavapai Co. (Ashmun); Ft. Grant, Pinal Co. (G. H. Horn, type locality); San Pedro drift, near Benson, Cochise Co. (Pilsbry); Ft. Defiance, in drift (Walker).

UTAH: Henry Mountains and Cannonville (Chamberlin & Berry).

This toothless cylindrical snail resembles the following species, but is quite unlike all others of our fauna. It was one of our rarest and least known species before 1900, but since that time has often been taken in abundance. Its adventures under various aliases have been discussed in my papers of 1900 and 1934.

Gabb did not notice the ribs, which are often partially lost by wear, but they are present though worn in the only one of his specimens known to be preserved.

This is a species of the arid plateaus and foothills, not found in the humid upper zone of the mountains. It is known by specimens taken in the debris of streams or in Pleistocene or later deposits. The Mesilla, N. M. specimens may have floated from the upper river; those from the San Pedro River at Benson, Arizona, certainly came from farther south, and the type lot also may have been from the San Pedro drift. West of Benson, in Pima County, we saw nothing of it; but it penetrates west farther north. It appears to be most abundant in the northern counties of Arizona, extending north to San Miguel Co., Colorado, near the Utah line. Specimens from this place measure from length 4.15, diam. 1.6, aperture 1.4 mm., barely 6 whorls, to length 3.3, diam. 1.6, aperture 1.3 mm., $5\frac{1}{4}$ whorls.

In the deposits at Las Vegas, N. M., at its northeastern limit, it occurs with *P. inornatus*, which here reaches its southern limits as now known.

P. hordaceus has been reported by Dorothea S. Franzen from drift on the flood plain of the Arikaree River, Cheyenne Co., northwestern Kansas.

I do not know whether the single specimen was compared with *P. inornatus*, which might be expected to occur there.

Pupoides inornatus Vanatta

Page 922, fig. 499:10.

Pupoides inornatus Vanatta, 1915, Nautilus, 29:95.—Henderson, Univ. Colo. Studies, 13: 132.—Pilsbry, Man. Conch., 26:118, pl. 12, f. 10.

Pupa arizonensis var. *sazicola* Cockerell, 1891, Zoe, 2:18. Not *Pupa sazicola* Lowe.

Shell similar to *P. hordaceus* except that the upper part tapers slightly more, and the surface is nearly smooth, with some irregularly developed striae only, weaker near the suture.

Length 3.6, diam. 1.6 mm.; 5½ whorls. Type.

Length 3.4, diam. 1.57 mm.; 5½ whorls. Pike's Peak.

SOUTH DAKOTA: drift of White River, Washington Co., type 110977 A.N.S.P., coll. by W. H. Over; and Indian Creek, Pennington Co. (Over). COLORADO: Pike's Peak (E. Hall); Trinidad (Pilsbry); Round Mountain, Custer Co. (Cockerell); Bellevue, Larimer Co. (J. Henderson). NEW MEXICO: Arroyo Pecos, near Las Vegas, in ant hills, flood debris, and in the "charcoal zone" (T. D. A. Cockerell).

In a considerable number seen, this form differs constantly from *P. hordaceus*. It appears to be a species of the Rocky Mountains, spreading eastward, while *hordaceus* ranges southwestward, the areas overlapping at Las Vegas, N. M.

No "live" specimens have been seen; those from South Dakota and Las Vegas, though sometimes retaining the cinnamon color, may be Pleistocene or later fossils washed into the streams. Apparently it still lives in Colorado, as the Pike's Peak shells are quite fresh. By correspondence with Junius Henderson and the examination of specimens it appears that all published Colorado records for *hordaceus* were based on specimens of *inornatus*, with the possible exception of Sampson's Williams Canyon record (Nautilus, 6:102), which has not been re-examined. In Colorado the true *P. hordaceus* is known to occur only in the extreme southwestern part of the state, west of the Rocky Mountains.

PUPILLA Leach

Pupilla Leach, in Fleming, 1828, British Animals, p. 268.—Pilsbry, 1921, Man. Conch., 26:152, monograph.

The shell is cylindrical with rounded, obtuse ends, rimate and often perforate, of short, slowly increasing whorls, the sutures but slightly oblique. The small aperture has 0 to 5 teeth, the parietal, columellar and palatals deeply placed when present; no basal fold; no teeth present in immature stages. Peristome reflected narrowly. Shell axis small, perforate.

The foot is about half as long as the shell, skin nearly smooth. Inferior tentacles short but distinct. Shell carried with the spire slanting upward a little, Fig. 501. Some species (or probably all), are viviparous.

The anatomy has been studied by Steenberg, whose figures of the genitalia of *P. muscorum* have been copied in Fig. 500. The uterus (ut) is dis-

tended with embryos. The spermatheca has a variously shaped sac (rs) and develops a cylindrical diverticulum (di) which is longer in some of the other species. The penis is bifid; its epiphallar arm (ép₁) is considerably swollen and extends a short distance beyond the entrance of the epiphallus (ép); and its appendicular arm (ap) is swollen around the base of its appendix (ap₂). The bifid penial retractor (rp) inserts on the epiphallus and near the apex of the appendicular penial arm.

Type: *Pupa marginata* Drap. = *P. muscorum* (L.).

Distribution. — North America, Eurasia, Africa, Australia, almost wholly in temperate and cold regions. They are ground snails, living under wood and stones and among leaves in moderately humid situations.

Pupilla is a widely distributed group, nowhere numerous in species, but generally abundant in individuals. While the American species appear distinct enough from one

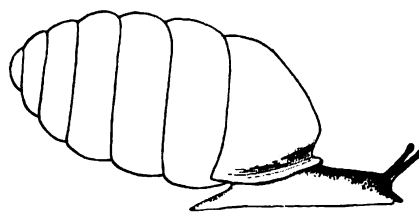
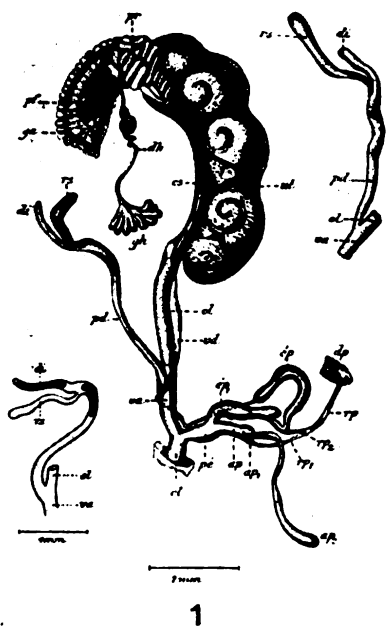
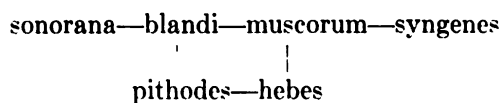


Fig. 500. *Pupilla muscorum*, genitalia (after Steenberg).

Fig. 501. *Pupilla muscorum*, Skaneateles, N. Y.

another typically, they vary remarkably in teeth, crest and size, so that the identity of a particular lot is sometimes in doubt. Thus, there are intermediate forms between *sonorana* and *blandi*, and the *pithodes* form of *blandi* has much in common with *P. hebes*. *P. muscorum* is sometimes thin-lipped, closely approaching *hebes*. They form an intricate complex of races, the affinities of which may be represented by a diagram:



P. sterkiiana (Pils.), from San Ramon, Lower California, Fig. 502:16, 17, stands apart from this complex of forms, being strongly characterized by

the sculpture of both embryonic and later whorls. It has allies on the Lower Californian island Guadalupe.

Populations containing albinos have been noted in *muscorum*, *syngenes*, *hebes* and *blandi*. *P. hebes*, *P. syngenes* and *P. muscorum* occur both dextral and sinistral.

The earliest reliable record of *Pupilla* in America is from the Mississippi valley Pleistocene (Yarmouth interglacial stage).⁸² The genus appeared in central European Upper Oligocene, probably from Asia, and became somewhat numerous in the Miocene. There was apparently an earlier migration from Asia to America which gave rise to the section *Striopupilla* of Lower California and Guadalupe Island. True *Pupilla* was a later immigrant, as the species are scarcely differentiated from Old World forms. *P. blandi* and especially *P. sonorana* are hardly separable from the Alpic *P. triplicata* (Studer), all having teeth like the European Miocene species. *P. hebes* resembles the European *P. cupa* (Jan) and *alpicola* (Charp.). Finally, *P. muscorum*, in Canada and New England, is indistinguishable from those of northern Europe, and is probably the latest immigrant.

Key to Species

1. Shell rib-striate, the embryonic whorls reticulate-granose; Lower California (Section *Striopupilla*). *P. sterkiana* Pils.
Shell minutely striate or smoothish (Section *Pupilla* proper) 2
2. Spire slightly wider above than below; parietal lamella long; 8-10 whorls.
P. syngenes
Spire not wider above; whorls less numerous 3
3. Aperture having three well-developed teeth, the palatal fold somewhat long. 4
Teeth wanting or, when present, small, the palatal fold tubercular 5
4. Length 3.2 to 3.75 mm. *P. blandi*
Length 2.5 to 3.25 mm.; palatal fold long; last whorl much flattened behind the crest.
P. sonorana
5. Lip typically thickened within, with a whitish crest externally; teeth small or wanting. *P. muscorum*
Lip thin; crest colored like the shell, often low, scarcely noticeable; typically toothless; Arizona to Idaho. *P. hebes*

Pupilla sonorana (Sterki)

Fig. 502: 10, 12, 13.

Pupa (*Pupilla*) *sonorana* Sterki, 1899, Nautilus, 12:128, with var. *tenella*, p. 129.

Pupilla sonorana Sterki, Pilsbry, 1915, Proc. Acad. Nat. Sci. Phila., p. 345; 1921, Man. Conch., 26:163, pl. 19, figs. 10, 12, 13, 15.—Walker, Occ. Pap. Mus. Zool. Univ. Mich., No. 15, pp. 4, 5.

“Shell perforate-rimate, cylindrical, apex obtuse, rounded; color brownish-horn; surface finely striated-rugulose, more coarsely so near the aperture; whorls $6\frac{1}{2}$, gradually increasing; suture rather deep; the last whorl comparatively small, compressed in its inferior part, the base narrow, almost

⁸² *Pupilla inermis* Russell, 1931, Trans. Roy. Soc. Canada (3), 25, sec. 4, p. 15, pl. 2, figs. 12, 13, from the Paleocene of Alberta, was referred to the genus provisionally and probably belongs elsewhere, but the very minute shell is imperfect.

keeled; near the aperture a high, sharp bulging [crest] filled with a strong whitish callus, shining through the shell; a narrow, deep constriction in front of it, and an impression over the palatal fold. Aperture rather small; margins abruptly but rather narrowly everted; lamellæ and folds 3, white; parietal rather deep-seated, long, spiral; columellar perpendicular (along the columella), lamellar; palatal (the inferior) rather strong, often with a thread-like prolongation inward. Alt. 2.6, diam. 1.3 mm." (Sterki).

Length 3.25, diam. above aperture 1.4 mm.; $7\frac{1}{2}$ whorls. Topotype.

Length 2.75, diam. above aperture 1.3 mm.; $6\frac{1}{2}$ whorls. Topotype.

Length 3.05, diam. above aperture 1.4 mm.; 7 whorls. Clouderoft.

Length 2.5, diam. above aperture 1.3 mm.; 6 whorls. Clouderoft.

NEW MEXICO: Whiteoaks (type loc.), Gilmores, Mescale (E. H. Ashmun); James canyon, Clouderoft, Sacramento Mts. (Rehn and Viereck); summit of Hacheta Grande, 8,500 ft., Big Hatchet Mts. (Pilsbry and Daniels); 14 miles northeast of Tucumcari. Cuervo River, San Miguel Co., and Turkey Creek, near Wagon Mound, Mora Co. (Dr. E. C. Case).

P. sonorana differs from *P. blandi* by its much longer parietal lamella (Fig. 10) and the far greater impression of the last whorl preceding the crest (fig. 13). The columellar lamella is longer. *P. syngenes dextroversa* is a longer species with more whorls and less impressed base.

In most lots seen there are longer, shorter and intermediate individuals.

In one lot from Clouderoft, in the Sacramento mountains, there are two examples with an upper-palatal tubercle also, making four teeth in all (Fig. 502:12).

This species would hardly be considered specifically distinct from *P. triplicata* of Europe were it not that the two inhabit antipodal parts of the globe.

P. sonorana form *tenella* (Sterki). Shell rather oblong or ovoid; the bulging in the palate less high, and only with a slight callus inside. Most specimens are less high than the types, 2.3 to 2.6 mm. (Sterki).

NEW MEXICO: Capitan Mts. (Ashmun).

The specimens before me, part of the original lot, differ very little from typical *P. sonorana*; the crest is often fully as high as in that. It seems scarcely separable as a race. One measures, length 2.7, diam. above aperture 1.45 mm.

***Pupilla blandi* Morse**

Fig. 502: 1-5.

Pupilla blandi Morse, 1865. Ann. Lyc. Nat. Hist. of N. Y., 8:5, fig. 8.—Henderson, Univ. Colo. Studies, 9:57; 13:134 (details of distribution in mountain states).—Pilsbry, Proc. Acad. Nat. Sci. Phila., 1906., p. 142, (Texas); Man. Conch., 26:159, pl. 19, fig. 1-5.—Walker, 1915, Occas. Pap. Mus. Zool. Univ. Mich., No. 15, pp. 2-4 (Rio Arriba Co., northern New Mexico).

Pupa blandi Mse., Binney, 1885, Man. Amer. Land Sh., p. 188.

Pupa blandi forma *obtusa* Cockerell, 1892, Jour. of Conch., 7:39.

Pupilla blandi mut. *alba* Cockerell, 1888, Science Gossip, 24:257; 1905, Nautilus 18:104.

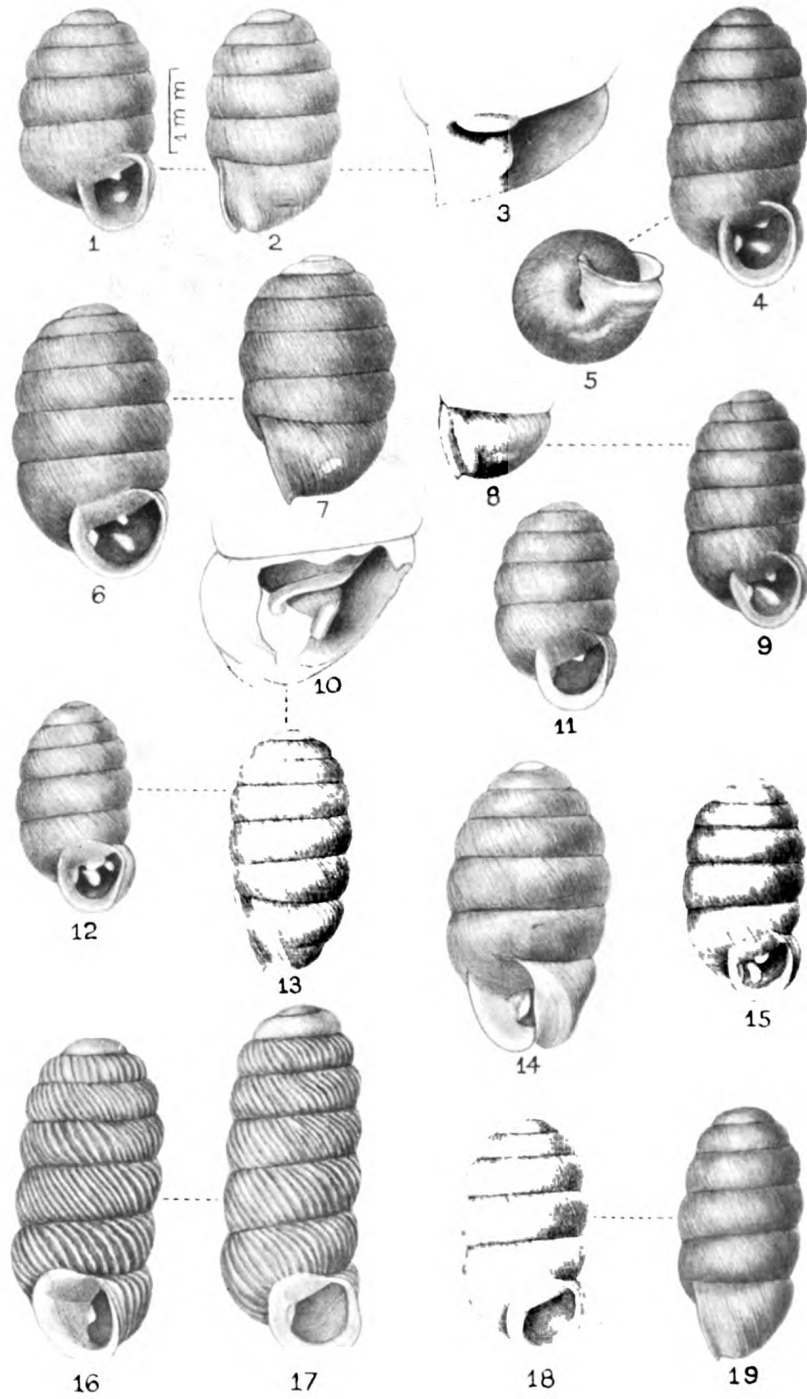


Fig. 502. See bottom of page 931 for legend.

Pupilla blandi pithodes Pilsbry & Ferriss, 1917, Proc. Acad. Nat. Sci. Phila., p. 103; 1918, p. 328.

Pupa sublubrica Ancey, 1881, Le Naturaliste, 1:389 (Nevada).

Pupilla blandi charlestonensis Pilsbry, 1921, Man. Conch., 26:163, pl. 19, figs. 8, 9.

?*Pupa blandi* var. *edentata* Squyer, 1894, Nautilus, 8:64, nude name; Mingsville (Wibaux). Mont.

Shell rimate, ovate-cylindrical, delicately striated, opaque, light brown. Apex obtuse, nucleus with microscopic granulations. Suture well defined. Whorls 6, subconvex, the last ascending at the aperture, rapidly expanding, with an external whitish callus, between which and the peristome there is a deep constriction. Aperture small, nearly circular, with three obtuse teeth of about equal size: one on the parietal margin, one on the columellar margin, and the third far within and at the base of aperture; peristome sub-reflected, the margins joined by a thin callus. Length .13 inch, breadth .06 inch [= 3.25 × 1.5 mm.]. (Morse.)

Distribution.—Rocky Mountain region, from Montana and Red Deer, Alberta, to New Mexico; west to Nevada; eastward in the semiarid region (mainly as a fossil, or in river drift) to McLean Co., North Dakota (at Ft. Berthold, type loc.); Brule Co., South Dakota; Phillips Co., Kansas; Comal Co., Texas.

P. blandi is a common shell in the Rocky Mountains, and southward in New Mexico west of the Rio Grande to Grant County; also in the adjacent part of Arizona. It occurs also in the northern counties of Arizona, in Utah, and (as *P. sublubrica*) in Nevada.

Variation.—1. The typical form, about 3.2 to 3.3 mm. long, 1.5 wide, of 6½ to 6¾ whorls (Figs. 4, 5, near Salt Lake City, Utah) is widely spread in Colorado, eastern Utah and New Mexico. The callus within the lip is moderate or sometimes heavy. The crest behind the lip is well developed.

In some localities there are wider shells: length 3.35, diam. 1.75 mm.; North Park, Colorado. The rather thick lip-rib is like typical *blandi*, the wide shell like form *pithodes*.

There are also similarly wide shells (length 3.4, diam. 1.7 mm., Sapello canyon, N. M.) without an internally calloused lip, being thus similar to form *pithodes*, though the parietal lamella is not so long.

2. The prevalent or almost exclusive form east of the mountains, from North Dakota to Texas, is small and compact, about 2.5 mm. long, 1.5 wide, of 5½ whorls, the lip often quite strongly thickened. Cockerell has described it as "Form *obtusa*. 2½ mm. long, broader in proportion to its length than

Fig. 502. 1-3, *Pupilla blandi*, Ft. Berthold, N. D.; 4, 5, near Salt Lake City. 6, 7, *Pupilla blandi pithodes*, type, Black Mts., N. M. 8, 9, *Pupilla blandi charlestonensis*, type, 10, 12, 13, *Pupilla sonorana*, Cloudercroft, N. M. 11, *Pupilla muscorum* form *zerobia*, type, Duran, N. M. 14, *Pupilla muscorum* var., White Oaks, N. M. 15, *P. sonorana*, White Oaks, N. M. 16, 17, *Pupilla sterkiana* Pils., San Ramon, L. Cal. 18, 19, *Pupilla hebes* (= paratypes of *P. m. idahoensis* H. & D.), St. Charles, Idaho.

the type. Near the Micawber mine, Custer Co., Colorado." It is probably a "hunger form" occupying arid situations. It occurs in many places in Colorado, in New Mexico, in the Rocky Mountains and along the Rio Grande, mostly known from Pleistocene and river-drift examples. Also in Arizona, from San Pedro river drift near Benson, and in the northeastern counties. Some examples of this form are hardly to be distinguished from *P. sonorana*; but the latter appears to inhabit higher, less arid places than the New Mexican *blandi*.

In some cases longer shells, which would fall into typical *blandi*, are in the same lots with form *obtusa*.

Cockerell has noted a mutation *alba*: "Shell white. Custer Co., Colorado."

3. Form *pithodes* Pils. & Ferr. (Fig. 502:6, 7) is common under and on dead wood in the forested zone, chiefly among aspens, in the Black Range, Grant and Sierra counties, New Mexico, 7,000-10,000 ft.; also westward in the Mogollon Mts., 9,500 to 10,000 ft., and in Greenlee and Graham counties, Arizona.

It is wider than typical *P. blandi*, with a weaker crest; the lip is but slightly thickened within. The shell is short, cylindric with rounded ends, walnut-brown, slightly shining. Whorls somewhat convex, the last slowly ascending a little in front, somewhat flattened and tapering to the narrow base, noticeably contracted behind the lip, having a quite low (or sometimes rather strong) crest of the same color as the rest of the shell. Parietal lamella deeply placed, about one-third of a whorl long. Lower-palatal fold rather long. Columellar lamella well developed, short. The type and paratypes, 115361 A.N.S.P., from the Black Range, measure:

Length 3.2, diam. 1.8 mm.; type.

Length 3.7, diam. 1.7 mm.; $7\frac{1}{2}$ whorls.

Length 3.25, diam. 1.75 mm.; $6\frac{1}{2}$ whorls.

Length 3.05, diam. 1.7 mm.; $6\frac{1}{2}$ whorls.

In the eastern counties of Arizona mentioned above, this form occurs with *P. hebes*, which it resembles very closely except by having teeth.

Pupa sublubrica Ancy was considered by W. G. Binney to be a synonym of *P. muscorum*, but Mr. Ancy in a letter to me stated that it is "a slender var. of *Pupa blandi* Morse." It was described thus:

"Length $3\frac{1}{2}$, width $1\frac{1}{2}$ mm. Shell elongate, cylindric, thin, pellucid, glossy, rimate, corneous; apex obtuse; closely, minutely, slightly striate. Whorls 8, convex, regular, the last slightly subturgid, then a little contracted at the aperture. Aperture truncate-oval, provided with two teeth within, one parietal, the other opposite this, basal; both white, quite deeply placed. Peristome thin, expanded. . . . It is separated from *P. muscorum* L. by the lack of a white calcareous deposit within the aperture. State of Nevada, Dr. Newcomb." (Ancy.)

Though not now found living east of the Rocky Mountains, *P. blandi*, in Pleistocene and perhaps later times, extended over a large area eastward. Dr. Sterki once wrote me that he "saw some specimens (poor, weathered) of *Pupilla blandi* from Carrollton, Missouri (Carroll Co., on Waconda Creek). Two of the specimens cleaned out had no palatal fold; a third had one". About forty years ago I found *P. blandi* in the flood debris of Guadalupe River, about four miles above New Braunfels, Comal County, Texas. The shortness of that river precludes the idea that it could have drifted any great distance. Mr. Singley also found one specimen at or near the same place. It was probably washed from a Pleistocene deposit containing shells, on the river banks.

***Pupilla blandi charlestonensis* Pilsbry**

Fig. 502: 8, 9.

A peculiar race, smaller and otherwise differing from the account of *sublubrica*, and similar to *sonorana*, was taken by Ferriss on Charleston mountain, Lincoln Co., in southern Nevada. Type 115215 A.N.S.P.

There is a well-developed crest behind the lip. The parietal lamella and lower-palatal fold are strong and long; columellar nodule distinct. Length 3, diam. 1.4 mm.; 6½ whorls.

This might be considered a form of *P. sonorana* were it not so remote from the known range of that species.

***Pupilla muscorum* (Linnaeus)**

Fig. 503: 12-16.

Turbo muscorum Linnaeus, 1758, Syst. Nat., 10:767.

Pupa muscorum L., Binney, 1885, Man. Amer. Land Shells, p. 78.

Pupilla muscorum L., Pilsbry, 1921, Man. Conch., 26:156, 173, pl. 18, fig. 12-15.—Henderson, 1929, Univ. Colo. Studies, 17:91 (Milton, Oregon).

Pupa badia C. B. Adams, 1840, Boston Jour. Nat. Hist., 3:331, pl. 3, fig. 18 (Crown Point, New York).

Pupilla muscorum zerobia Pilsbry, 1914, Nautilus, 28:38, pl. 2, figs. 1, 2.—Henderson, Univ. Colo. Studies, 13:133 (Colo., Wyo.).

The shell is shortly rimate, cylindric, auburn or some similar brown shade, white or light behind the lip, moderately solid. Summit rounded, obtuse. First 1½ whorls nearly smooth, the rest with fine, blunt, uneven striation, moderately convex; last half of the last whorl tapering downward, compressed, rising to the aperture, having a strong whitish crest near and parallel to the outer and basal lip. The aperture is somewhat oblique, truncate-rounded, typically without teeth (but in various varieties or mutations provided with one to three teeth). Peristome narrowly reflected outwardly, broadly on the columellar side, having a strong pale callus within.

Length 3.4 mm., diam. 1.6 mm. Thomaston, Maine.
 Length 3.15 mm., diam. 1.55 mm. Thomaston, Maine.
 Length 4 mm., diam. 1.7 mm. Mt. Desert, Maine.
 Length 3.25 mm., diam. 1.65 mm. Mt. Desert, Maine.
 Length 3.35 mm., diam. 1.73 mm. Rochester, N. Y.
 Length 3.5 mm., diam. 1.65 mm. Duxbury, Mass.
 Length 3 mm., diam. 1.7 mm. Duxbury, Mass.

Distribution.—Eastern North America from Anticosti Island south to Atlantic City, New Jersey, westward in Canada and the northern tier of states to Milton, Oregon; south in the Rocky Mountain region through Colorado to Socorro Co., New Mexico, and northern Arizona; north to Anuk, Alaska. Loess of Iowa and Kansas. Also Europe, north and central Asia, and south to Persia; north Africa. Type in coll. Linnean Soc. London, from Europe (Sweden).

American specimens rarely have the lip so much thickened or the white or yellowish area behind it so extensive as most European shells, though European shells similar to the American in these characters are readily found.

It differs from *P. blandi* by the much shorter and smaller teeth, the palatal fold small and tubercular when present. Some of the thinnest *muscorum* resemble *P. hebes* rather closely.

In limestone districts the white crest and the lip-callus are strongly developed, as in Fig. 503:13, 14 (limestone quarry at Thomaston, Me.), and over much of New York State. Where the rock is granitic or deficient in lime the crest is usually lower, of a reddish brown color but lighter than the rest of the shell, and the lip-callus is much thinner, Figs. 15, 16 (Mt. Desert, Maine). In either form the parietal tooth may occur, but the palatal tubercle is developed only in moderately thick-lipped shells.

P. muscorum has a far greater zonal or climatic range, as well as a wider geographic distribution in the Palæarctic Region than in America. Our form was doubtless derived from the northern herd of Siberia and northern Europe by way of Alaska, probably in interglacial Pleistocene time, and has not yet become adapted to warm climates such as the circum-Mediterranean zone which it inhabits in the Old World.

Four tooth-mutations occur as in Europe: (1) the typical form, in which there are no teeth (fig. 15, Mt. Desert, Maine). (2) Form *marginata* Drap. A small, short parietal lamella developed (figs. 13, 14). This includes *P. badia* C. B. Ad. (3) Form *masclaryana* Paladilhe. A tubercular or short parietal lamella and a small, tubercular lower-palatal fold present (fig. 12). (4) Form having a columellar tooth more or less well developed. fig. 14. White Oaks, New Mexico. This form has been noticed in America only in the mountain states of the West. Boettger has mentioned its occurrence in France.

The typical form, without teeth, is the most abundant and widely-spread in America. It usually occurs in lots containing forms *marginata* and *masclaryana*, such colonies being evidently hybrid.

A large series from High Pines, Duxbury, Mass., consists of very thin, toothless shells, with the crest low or very low, not paler, the lip scarcely calloused within. They run down to 3 mm. long, with $5\frac{1}{2}$ whorls, and re-

semble the western *P. hebes*. Similar shells occur as far south as Atlantic City, N. J., in island-like coves in the salt marshes.

Most of the Rocky Mountain specimens seen are of the typical toothless form, and none have a palatal tooth. They vary widely in size. Two from Holbrook, Arizona, measure:

Length 3.85, diam. 1.9 mm., 6½ whorls.

Length 2.75, diam. 1.5 mm., 5¾ whorls.

Pupilla muscorum form *xerobia* Pilsbry, Fig. 502:11, described from an arid sandstone butte near Duran, New Mexico, at 6700-6800 ft., is a small, compact form which I took at one time to be a subspecies. Length 2.25 to 2.75 mm. in the type lot, 104005 A.N.S.P. Similar shells occur in numerous Colorado localities, with intermediate sizes connecting with ordinary *muscorum*, so that it is apparently to be regarded as an arid station hunger form rather than a true race.

Junius Henderson's record of *P. muscorum* from Milton, Oregon, is the only record of the species from a Pacific coast state.

***Pupilla muscorum sinistra* Franzen**

Pupilla muscorum sinistra Franzen, 1946, *Nautilus*, 60:24.

“*Diagnosis*: Shell sinistral, subcylindric, whorls 7½, convex, increasing regularly and gradually in height; lip reflected, thickened within by a callus; parietal tooth low, elongate, curved around the axis; crest behind the lip high and round.

“*Type description*: Shell sinistral, subcylindrical, summit obtuse; whorls 7½, increasing regularly and gradually in height, convex; suture incised; greatest diameter at level of fifth whorl of spire from which the shell tapers to a constricted base; nuclear whorl finely granular; remaining whorls finely and irregularly striate; aperture ovate, oblique; lip reflected, thickened within by a low, rounded callus; peristome sharp, continuous across parietal wall by a thin callus; dentition consisting of a single, low, elongate parietal lamella; crest behind lip high and round.” (Franzen.)

	Height	Greatest Diameter	Aperture Height	Aperture Width	Whorls
Type (3728)	3.9 mm.	1.9 mm.	1.25 mm.	1.08 mm.	7½
Paratype (3827)	3.8	1.8	1.15	0.9	7½
Paratype (3827)	3.7	1.8	1.08	0.9	7
Paratype (3827)	3.4	1.8	1.08	0.9	7
Paratype (3827)	3.2	1.7	1.08	0.9	7
Paratype (3828)	4.0	1.7	1.25	..	7½

KANSAS: NE ¼ sec. 11, twp. 30 S, R 23 W, Clark County; Lower Pleistocene. Type: Cat. no. 3728, University of Kansas Mus. Nat. Hist.

“At the type locality, *Pupilla muscorum sinistra* occurs as a pure population. In a second locality, SW ¼ sec. 35, twp. 14 S, R 11 W, Russell County, Kansas, three-fourths of the *Pupilla* population consists of *Pupilla muscorum* (Linnaeus) and only one-fourth of *Pupilla muscorum sinistra*.

"Size is the only appreciable variable among the paratypes. The parietal lamella is wanting in only a few specimens. A small lower-palatal fold occurs rarely. The greatest diameter of the type specimen is at the level of the fifth whorl while in some of the paratypes the greatest diameter is at the level of the fourth whorl. *Pupilla muscorum sinistra* differs from *Pupilla muscorum* in being sinistral and in tapering to a more sharply constricted base." (Franzen.)

***Pupilla hebes* (Ancey)**

Fig. 503: 1-4.

- Pupa hebes* Ancey, 1881, Le Naturaliste, 3:389.—Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 589, pl. 22, figs. 9, 10.
Pupilla hebes Ancey, Pilsbry & Ferriss, 1911, Proc. Acad. Nat. Sci. Phila., p. 197, with *P. h. kaibabensis*.—Pilsbry, 1921, Man. Conch., 26:164, pl. 18, figs. 1-4.—J. Henderson, 1936, Univ. Colo. Studies, 23:103.
Pupilla hebes mut. *albescens* Ferriss, 1920, Nautilus, 34:14.
Pupa arizonensis Gabb, W. G. Binney, 1885, Man. Amer. Land Sh. p. 173; 1886, 2nd suppl., Bull. Mus. Comp. Zool., p. 40, pl. 3, fig. 12. Not of Gabb.
Pupilla muscorum idahoensis Henderson & Daniels, 1917, Proc. Acad. Nat. Sci. Phila., p. 57.
Pupilla hebes form *nefas* Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 135; 1918, p. 303.

"Shell subcylindric, rather thin, rimate, obtuse at the apex, corneous-tawny, very minutely scarcely striatulate. Whorls 6-7, strongly convex, joined by a deep suture, regularly increasing, the last swollen towards the aperture, then deeply contracted. Aperture truncate-suboval, toothless, or provided with a small parietal tubercle, not thickened within. Peristome thin, reflected. Length 3.25, width 1.5 mm.

"*P. hebes* has so much affinity [to *P. muscorum*] that I would have hesitated to separate them if it were not that all my specimens have the same peculiarity, the absence of a white calcareous deposit within the aperture; a character as everyone knows, of *P. muscorum*." (Ancey.)

WASHINGTON: Lime Point, Asotin Co. (H. St. John). IDAHO: banks of Salmon River (Hemphill); near mouth of St. Charles canyon, west of St. Charles (Henderson and Daniels). NEVADA: White Pine. type loc.; near Austin, Lander Co. (Hemphill). UTAH: Blue Mts. and on Monticello Creek, San Juan Co. (Ferriss). Rainbow Bridge and Black Mesa (Chamberlin). COLORADO: Tolland (Henderson). WYOMING: Chimney Rock, Albany Co. (Henderson).

ARIZONA: mountains and high country throughout the state from Coconino and Yavapai counties east, south to the Huachuca and Chiricahua Mts., Cochise Co. (Ashmun, Ferriss and Pilsbry); usually between 5000 and 9500 ft., in humid localities or stations, often abundant. NEW MEXICO: Magdalena Mt., Socorro Co. (Ferriss).

The absence of a white or tawny callus within the lip distinguishes *P. hebes* from typical *P. muscorum*. It never has teeth, such as *P. blandi* and many *muscorum* possess. There is a decided contraction behind the

Fig. 503. 1, *Pupilla hebes*, Lander Co., Nev.; 2, 3, Bill Williams Mt., Ariz.; 4, Rucker canyon, Chiricahua Mts., Ariz. 5, 6, 7, *Pupilla hebes nefas*, Bear Wallow, Sacramento Mts., Ariz.; 8, Spud Rock, Rincon Mts., Ariz. 9, *Pupilla syngenes*, type; 10, Kaibab Saddle, Ariz. 11, *P. syngenes* mut. *nivea*, Black Mesa, Ariz. 12, *Pupilla muscorum*, Rochester, N. Y.; 13, 14, Thomaston, Maine; 15, 16, Mt. Desert, Maine.

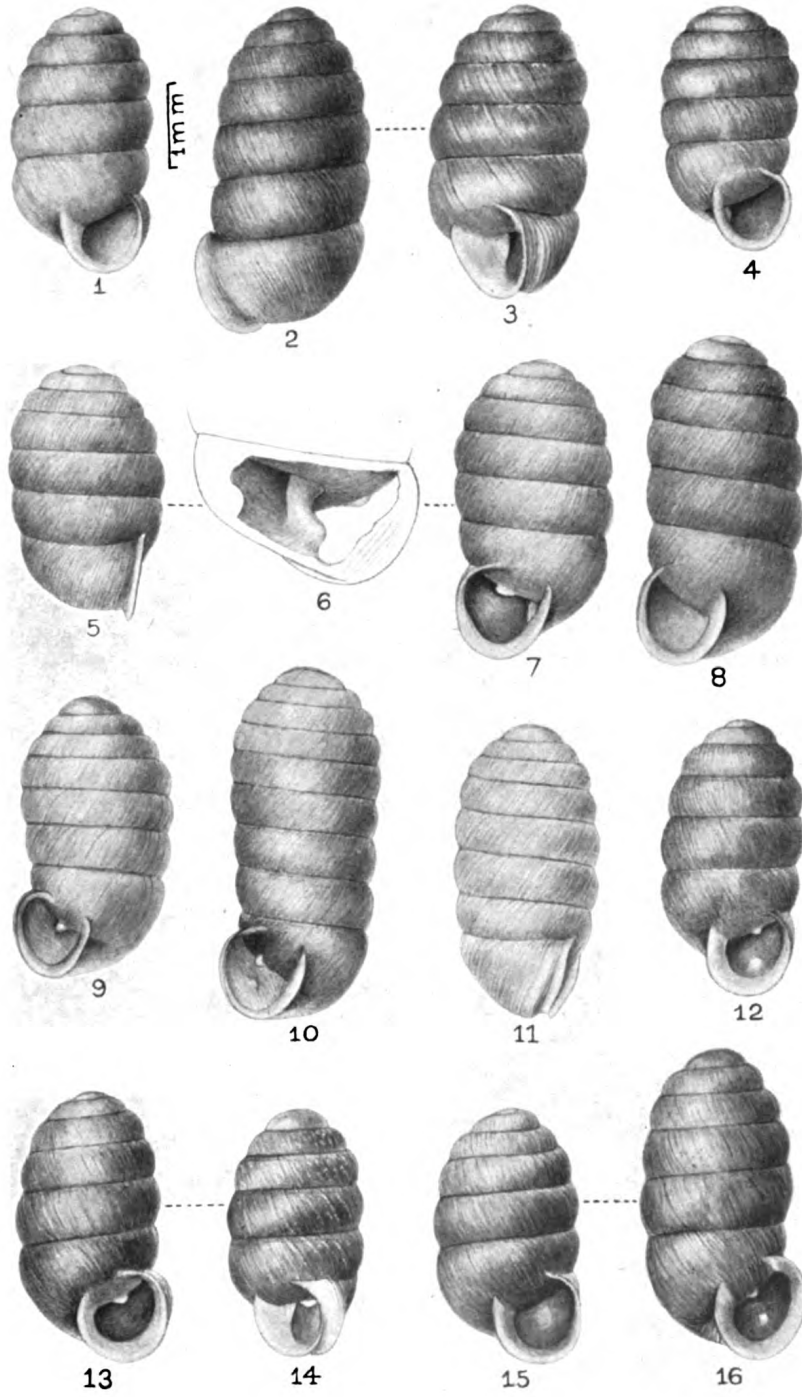


Fig. 503. See bottom of page 936 for legend.

outer lip; typically there is scarcely any crest and no yellowish streak, but sometimes the crest is well developed.

Length 4, diam. 1.85 mm., 7 whorls. Bill Williams Mt., Ariz.

Length 3.1, diam. 1.65 mm., 5½ whorls. Bill Williams Mt.

Length 3.5, diam. 1.6 mm., 7 whorls. Lander Co., Nev.

Length 3.25, diam. 1.55 to 1.6 mm. Lander Co., Nev.

Length 2.7, diam. 1.65 mm., 6½ whorls. Rucker canyon, Chiricahuas.

P. hebes has been reported from Tecumseh and Lawrence counties, Kansas, in river drift (Hanna, *Nautilus*, 23:94). I have not seen these specimens.

An albino form, mut. *albescens* Ferriss, was taken among aspens at the Betatakin ruins in northern Arizona, small numbers being associated with many specimens of the usual chestnut-brown color. Similar albinos were taken in one place on Mt. Lemon, in the Santa Catalina range, also with brown specimens, 6 albinos to 122 brown shells.

Form *kaibabensis* P. & F., from the Kaibab Saddle, north of the Grand Canyon, Arizona, was distinguished from *hebes* by its shorter form, length 2.7 to 2.8 mm., diam. 1.5 mm., 5½ whorls. While all of the specimens from the northern environs of the canyon were of this form, similar short ones also occur in other lots from south of the canyon in northern Arizona, sometimes associated with larger ones; also in Rucker Canyon, in the Chiricahua Mts., where all are small. I now regard *kaibabensis* as a stunted or hunger form, the diminished stature being probably traceable to locally unfavorable conditions which affect all individuals of a colony. It is probably not of racial significance.

"*Pupilla muscorum idahoensis*" H. & D. (Fig. 502:18, 19) closely resembles the *hebes* of Nevada, and does not seem to be racially distinguishable. It is not, in my opinion, a form of *muscorum*. The crest is often strongly developed, as in *muscorum*, but very weak in other specimens. The lip is thin, as usual. It is from west of St. Charles, southern Idaho. Two measure:

Length 3.3, diam. 1.47 mm.; 6½ whorls.

Length 3.1, diam. 1.5 mm.; 6 whorls.

P. hebes form *nefas* Pilsbry & Ferriss. Fig. 503:5 to 8. The shell is sinistral, usually with a small parietal lamella; in oblique view in the aperture a columellar tubercle may be seen. It differs from *P. syngenes* by the absence of a crest behind the lip, though there is a wide, shallow contraction there.

Length 4.2, diam. 1.75 mm., 7½ whorls. Spud Rock.

Length 3.65, diam. 1.9 mm., 7 whorls. S. Catalina Mts.

Length 3.2, diam. 1.85 mm., 6½ whorls. S. Catalina Mts.

ARIZONA: Santa Catalina Mountains, Pima Co., abundant, generally distributed from 8000 to 9500 ft.; Spud Rock, Rincon Mts.; Chiricahua Mts., Cochise Co., at the head of Cave Creek, 8000 ft., and Pine Canyon, 7500 ft., type 97503 A.N.S.P. (Ferriss).

In the Chiricahuas this race was not found associated with the dextral *hebes*, which was taken in Rucker canyon. In the Santa Catalina and Rincon mountains it was found at eleven stations, often in large numbers, but in only one place, near Marshall Pass, were *hebes* and *nefas* found together.

This sinistral race evidently appeared as a mutation somewhere in southeastern Arizona, and as yet has spread over only a few mountain ranges of that region. Nothing has been seen of it in the extensive regions north and northwest, inhabited by dextral *hebes*.

***Pupilla syngenes* (Pilsbry)**

Figs. 503:9, 10; 504.

Pupa syngenes Pilsbry, 1890, Nautilus, 4:3, 39, pl. 1, fig. 7; 5:39, pl. 2, figs. 1, 2.—Dall, Nautilus, 8:35.—Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 606, with form *dextroversa*.—Squyer, Nautilus, 8:65.

Pupilla syngenes Pilsbry & Ferriss, 1911, Proc. Acad. Nat. Sci. Phila., pp. 193-195, fig. 7, with *P. s. dextroversa*, pp. 193-195, figs. 6, 8, and *P. s. avus*, p. 196, fig. 9.—Pilsbry, 1921, Man. Conch., 26:167, with mut. *nivea*, p. 169.—Henderson, 1924, Univ. Colo. Studies, 13:135.

The shell is sinistral, cylindrical but somewhat wider above, blunt at each end; cinnamon brown, or somewhat darker. Surface dull when fresh, delicately obliquely striate. Apex large, obtuse; suture impressed; whorls 8, the last one compressed and flattened around the lower-outer portion, its

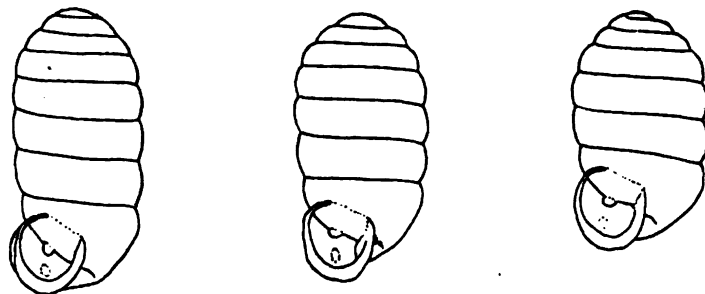


Fig. 504. *Pupilla syngenes*, "Spectacle Cove" near Bass Trail, Grand Canyon. Lengths 3.8, 3.5 and 3.2 mm.

last third ascending on the next earlier whorl, and elevated into a high rounded ridge or crest a short distance behind the outer lip. Aperture slightly oblique, truncate-oval in form; the outer lip narrowly expanded, basal and columellar margins broader; about the middle of the parietal wall, or nearer the upper end, there is a small parietal lamella about one-fourth of a whorl long. Far within there may be seen a blunt columellar lamella; and most specimens exhibit far within the outer lip a tubercular lower-palatal fold.

Length 3.3, diam. 1.75 mm.; 8 whorls. Type, fig. 9.

Length 4.15, diam. 1.7 mm.; 9 whorls. Yavapai Co.

Length 3, diam. 1.75 mm.; 7 whorls. Grand Canyon.

NEW MEXICO: San Rafael, Valencia Co. (Ashmun). ARIZONA: Holbrook (Ashmun), Black Mesa (Ferriss), Navajo Co.; branch of Chinle Creek, Apache Co. (Ferriss); Jerome and Purtyman's ranch, Oak Creek, Yavapai Co. (Ashmun); upper levels of the Grand Canyon at Bright Angel trail and Bass trail (Pilsbry & Ferriss), and north of the river at numerous places on Powell and Kaibab Plateaus (Ferriss & Daniels); San Francisco Mountains (Ferriss). UTAH: Zion National Park (Woodbury); Moab (Henderson). MONTANA: Wibaux, in drift of Beaver Creek, a tributary of Little Missouri River (Squyer).

P. syngenes differs from *P. muscorum* by the longer parietal lamella, the more numerous whorls, the last having a stronger crest and ascending farther, the lip less expanded, and the shape of the shell, wider above. It is more nearly related to the smaller *P. sonorana*, which occupies an area to the east and south of *syngenes*, the northern colonies of *sonorana* being separated from the nearest *syngenes* by the Rio Grande valley.

The type specimen has no palatal tubercle, but in most populations the lower-palatal is usually developed. There is great variation in length. A lot from "Spectacle Cove," Bass trail, in the Grand Canyon, contains shells from 3 mm. long, of 7 whorls, to those 3.7 mm. of 8 whorls. Some of those from the Kaibab Plateau are very long, over 4 mm., of fully 9 whorls.

Mut. *nivea* Pilsbry. At Marsh Pass, Black Mesa, Navajo Co., Arizona, Ferriss found beautiful albino specimens (Fig. 503:11) together with the brown ones. This mutation also occurs in some Grand Canyon lots.

"*Pupilla syngenes* Pils. and *P. syngenes dextroversa* seek the well-drained hillsides where grass roots and spawls of stone lying upon the soil furnish shelter. So far they have not been gathered in deep forest conditions where pupas mostly congregate" (Ferriss). Both are arid country forms of the plateau of northern Arizona, apparently distributed generally, but not found far north of the Colorado river. The records from the eastern border of Montana and northern Colorado, far from the main herd, appear to indicate extension north in western Colorado or eastern Utah, regions as yet but little explored for shells.

P. syngenes form *dextroversa* (Pilsbry & Vanatta). Figs. 505, 506. Similar to the typical form, but dextral. The shell is subcylindric, a little wider near the upper end. The last whorl is flattened laterally, with a strong, rounded crest followed by a deep constriction behind the lip, which is thin and very narrowly expanded. The parietal lamella is slightly over one-fourth of a whorl long; the columellar lamella small and deeply immersed, and the lower-palatal nodule well developed or weak, but invariably present in adult shells.

- Length 4, diam. 1.7 mm.; 9 whorls. San Rafael.
- Length 3, diam. 1.6 mm.; 7½ whorls. San Rafael.
- Length 4.5, diam. 1.8 mm.; 10 whorls. Grand Canyon.
- Length 3.7, diam. 1.8 mm.; 9 whorls. Grand Canyon.

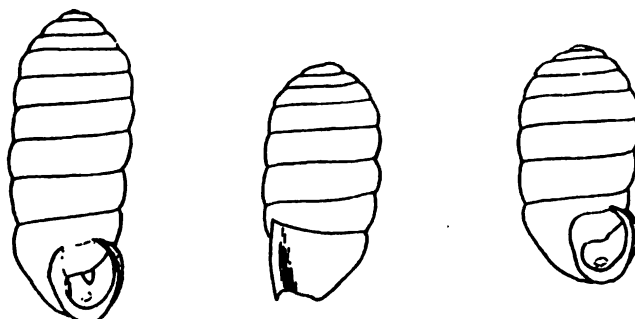


Fig. 505. *Pupilla syngenes dextroversa*, San Rafael, N. M.

NEW MEXICO: San Rafael* (type 79460 A.N.S.P., Ashmun), and Grant (Baily), Valencia Co. ARIZONA: Holbrook* (Ashmun); Grand Canyon, Bright Angel Trail,* and just below the south rim near Bass Camp (Ferriss & Pilsbry), and in Stone House Gulch, Kaibab Plateau* (Ferriss & Daniels). Mahan Mt.,* near Mormon Lake, Coconino Co. (Ferriss). COLORADO: Tolland, Gilpin Co. (Cockerell) and Eldora, Boulder Co. (Henderson). UTAH: Fish Lake, Horse Valley, near Pine Springs and Fruita (Chamberlin & Jones); Zion National Park (Woodbury); Lamb's canyon (E. G. Berry).

At localities marked with an * it occurred in association with sinistral *P. syngenes*. I have not seen the Utah examples.

This form differs from *P. muscorum* by the shape and number of whorls of the shell, and the longer parietal lamella (Fig. 506, at right).

P. s. dextroversa differs from *P. syngenes* only by the dextral coil. Since dextral forms are doubtless the more primitive in *Pupilla*, it is evidently *dextroversa* which perpetuates the original stock of the species. In half of the localities given above, only dextral shells were found; but at the two in Colorado only single shells were taken. In a few colonies, so far as our

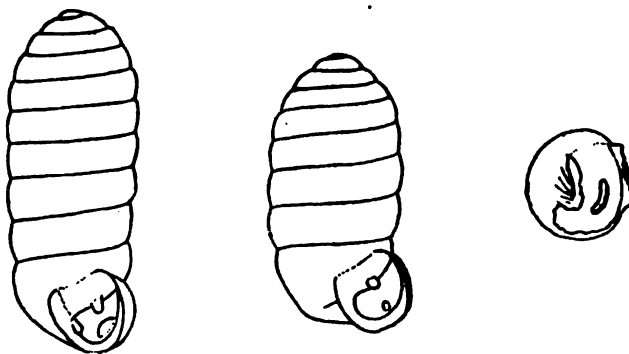


Fig. 506. *Pupilla syngenes dextroversa*, Bass Trail, Grand Canyon, about 200 ft. below the rim. Length 4.5 and 3.75 mm.

information goes, the dextral form occurs as a pure population and many more colonies are of purely sinistral shells.

The Colorado records quoted from Cockerell and Henderson are widely detached from those in New Mexico and Arizona. All of the material recorded from the latter states has been examined by the writer.

Pupilla syngenes avus Pilsbry & Ferriss

Fig. 507.

Shell sinistral, the last whorl deviating tangentially and ascending; teeth deeply immersed; *parietal lamella much longer* than in *P. syngenes* or *dextroversa*, about a half-whorl long.

Length 5.2, diam. 1.8 mm., whorls $10\frac{1}{2}$.

Length 4.3, diam. 1.7 mm., whorls $9\frac{1}{2}$.

Length 4.0, diam. 1.7 mm., whorls $9\frac{1}{2}$.

Type and paratypes no. 94,220 A.N.S.P., from upper slope of the Grand Canyon along the Mystic Spring or Bass Trail, about 200 feet below the rim; abundant with *P. s. dextroversa*.

The special characters of this race, being those of senility, are unequally developed in different individuals. The figures give a fair idea of the variations. Finding these shells associated with about an equal number of *P. s. dextroversa* of about the same size, we at first were disposed to think them all one race in which the shell was indifferently dextral or sinistral; but on

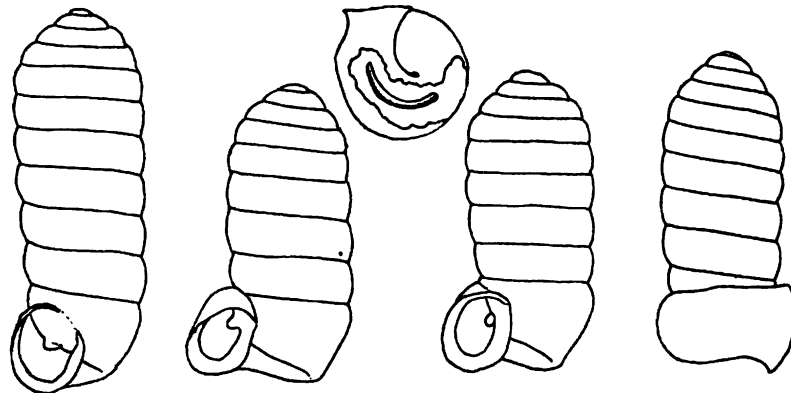


Fig. 507. *Pupilla syngenes avus*, cotypes. Lengths 5.2, 4, 4 and 4.2 mm. Middle figure broken to show length of the parietal lamella.

closer study it appears that the dextral forms never have the last whorl and aperture abnormal, nor are the teeth so deeply immersed, or the parietal lamella so long, while almost every sinistral shell collected in this colony is markedly distorted. It seems, therefore, that although the two forms are doubtless of common origin and live together, the different direction of the coil probably prevents interbreeding, thus segregating the sinistral stock, which in this colony is now in advanced senile degeneration.

Subfamily VERTIGININAE

Genus VERTIGO Müller

Vertigo O. F. Müller, 1774, Vermium terrestrium et fluviatilium Hist., 2:124, monotype *V. pusilla* Müll.

Isthmia Gray, 1821, London Medical Repository, 15:239, for "*Helix Isthmia cylindrica*" = *V. pygmaea* Drap.

Alaea Jeffreys, 1830, Tr. Linn. Soc. Lond., 16:357, type *V. antivertigo*, selected by Gray, 1847.

Nearctula Sterki, 1892, Nautilus, 6:5, type *V. californica*.

Haplopupa Pilsbry, 1908, Nautilus, 11:119, type *V. dalliana*.

Small, deeply rimate, oval, cylindrical-oblong or ovate, compact pupillids, with very blunt summit, usually glossy and some shade or tint of brown. Aperture having the typical six teeth of Pupillidae, none of them conrescent, part or all of them often wanting; the angular lamella not reaching the margin, when present. Outer lip straightened or looped inward in the middle.

Head without tentacles; Genitalia (Fig. 508:4) with well-developed penis, the epiphallus entering apically, small, the retractor muscle inserted on it. The prostate gland is very much shortened. Hermaphrodite gland of two groups of lobules. Uterus smooth; free oviduct long. Spermathecal duct long (Fig. 508:5).

Jaw weakly to strongly arched, of numerous (12 to 16) wide, flat ribs separated by narrow thin intervals. Teeth all fundamentally tricuspid, with numerous interstitial cusplets.

Locomotion is rhythmic, two or three waves visible at one time (in *V. ovata*).



Fig. 508. *Vertigo pusilla* Müll. (after Steenberg).

Distribution.—*Vertigo* inhabits practically the entire holarctic realm, from near sea level to at least 10,000 ft. About 80 recent species are known. They are generally to be found on and under dead wood and fallen leaves in humid places, but also some species live on grass stems and dead leaves at the borders of ponds or marshes. In the mountain states they are partial to aspen groves. *Vertigo* is known from the Eocene of Wyoming in two species, *V. arenula* White and *V. atavuncula* White. Cf. Yen, Jour. Paleontology 20:498-500, fig. 10, 11.

The teeth of the aperture, though among the best specific characters, are variable, especially the secondary denticles when present, but also the basal

and the upper-palatal folds and the angular lamella vary. If small, these teeth are either present or absent in the same species; if well developed they are usually constant features. The basal fold in *Vertigo* is generally situated upon the base of the columella, rather than within the basal margin. The inwardly-projecting point of the outer lip, possessed by many species, was termed the "auricle" by Dr. Sterki.

While considerable study has been given to the shells of our vertigines, there has been no adequate work done on the anatomy of American species. It is a virgin field which would certainly repay cultivation, as we have a highly diversified fauna, in part composed of species quite unlike any found in Europe.

Key to subgenera

1. Inner end of the columellar lamella turning strongly downward; lower-palatal fold entering deeply, its inner end turning downward; much longer than the upper-palatal fold.Subg. *Angustula*
Columellar lamella, when present, not turning downward within. 2
2. Columellar lamella short, tubercular or lamellar, subhorizontal or ascending slightly within, or often absent.Subg. *Vertigo*
Columellar lamella subvertical; upper-palatal fold short or wanting; no angular lamella or basal fold.Subg. *Vertillaria*

Subgenus ANGUSTULA Sterki

Augustula Sterki, 1888, Proc. U. S. Nat. Mus., 11:378 for *V. milium* and *V. venetzi*; Nachrbl. d. m. Ges., 1889, p. 117.—Pilsbry, Man. Conch., 25:145.

Angular, parietal and columellar lamellae are strongly developed, the parietal long, columellar crescentic, its inner end curving downward. Palatal folds strong, the lower entering to the dorsal side, its inner end curving downward. Type *V. milium*.

An American group of two recent species, *V. milium* Gld. and *V. bermudensis* Pils. A Pliocene species, *V. hibbardi* F. C. Baker, has been described from Meade County, Kansas (Nautilus, 51:126).

Vertigo milium (Gould)

Fig. 509-

Pupa milium Gould, 1840, Boston Jour. Nat. Hist., 3:402; 4:359.

Vertigo milium Gld., Binney, 1878, Terr. Moll., 5:215, pl. 71, fig. 1.—Sterki, 1888, Proc. U.S. Nat. Mus., 11:377, pl. 42, figs. 10, 13.—Pilsbry, Man. Conch., 25:147, 378.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:80 (Greenbrier and Hampshire counties, West Virginia)

The shortly oval shell is cinnamon or paler, glossy, weakly striate. The last whorl has an external impression over the lower-palatal fold and a swelling in front of it, below a deeper impression which runs to the lip, over the upper-palatal fold. The angular lamella is high, short, and situated inward from the insertion of the outer lip. The parietal lamella is high and long, entering deeply. The strong columellar lamella enters horizontally at first, then turns downward, being crescent shaped. The upper-palatal fold is long and high, slightly curved. The lower-palatal is a little

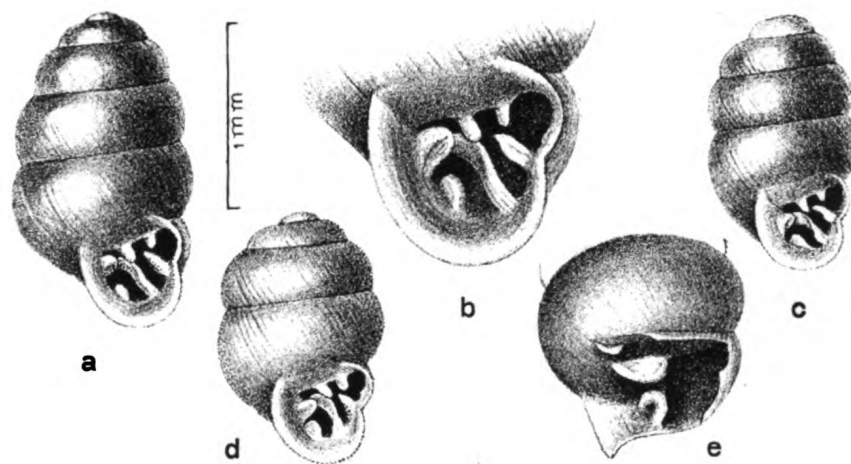


Fig. 509. *Vertigo milium*. a, b, c, e, Cleveland, Ohio; d, "Mt. Taylor", Volusia Co., Florida. Scale line applies to full-length figures.

immersed, high, thin, and enters to the dorsal side, where it *curves downward*. The basal fold is somewhat immersed, short and high. There is sometimes a small, tubercular suprapalatal fold. The outer lip is somewhat expanded and strongly biarcuate. The parietal callus is usually rather thick.

Length 1.74 mm., diameter 1 mm.; 5 whorls. Cleveland, Ohio.

fig. a.

Length 1.38 mm., diameter 0.8 mm.; 5 whorls. Cleveland, Ohio,

fig. c.

Length 1.65 mm., diameter 0.85 mm. Vermont.

Length 1.4 mm., diameter 0.9 mm.; $4\frac{1}{2}$ whorls. Volusia Co., Fla.

fig. d.

Distribution.—Maine and Quebec to the Florida Keys, west to South Dakota, Grand County, Colorado, and southeastern Arizona; Tampico, Mexico; Jamaica; Santo Domingo. Type locality: Oak Island, Chelsea, near Boston.

There is not much variation in the teeth, but the size and contour are quite variable in the same colonies. The shortest specimens seen were associated with others of ordinary proportions. In Canada J. Oughton reports it in "southern Ontario only: Lakes Erie and Ontario, north to Ottawa (Carleton County) and De Grassi Pt. (Simcoe Co.); all our records come from Palaeozoic (lime-rich) areas."

Subgenus VERTILLARIA Pilsbry

Vertillaria Pilsbry, 1919, Man. Conch., 25:144

Shell oblong, with the columellar lamella in form of a blunt *vertical* plate, other teeth short; outer lip biarcuate. In the type species there is no

angular lamella or basal fold, and the upper-palatal fold is minute or wanting. Type *V. oscariana*.

Distribution.—Australoriparian, from Florida to Texas.

The blunt, vertical columellar lamella, parallel to the axis, is unlike other American species of *Vertigo*. The deep external furrow of the last whorl suggests that an ancestral form had a long lower-palatal fold as in *V. nylanderi*, though the present species is rather degenerate in teeth. There is no external crest and little or no palatal callus.

***Vertigo oscariana* Sterki**

Figs. 509 a; 510: 8, 10, 11.

Vertigo oscariana Sterki, 1890, Proc. Acad. Nat. Sci. Phila., p. 33; Nautilus, 3:136; 4:39, pl. 1, fig. 5.—Clapp, Nautilus, 28:137, pl. 6, fig. 8.—Pilsbry, Man. Conch., 25:144, pl. 8, figs. 8, 10, 11.—Walker, 1928, Terr. Moll. Ala., p. 147.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:79, text figure.

“It is the size of *milium*, but oblong with either end nearly equally pointed, the last whorl being considerably narrowed and flattened towards the subtriangular small aperture. Shell thin, delicate, of pale horn color, as is the palatal wall and margin; the latter simple and straight, with a very slight, thin callus inside, lamellæ 3, whitish, rather small: one apertural [parietal], one columellar, longitudinal, and the inferior palatal: sometimes there is also a very small superior palatal. Length 1.5, diam. 0.8 mm.” (Sterki).



Fig. 509a.
V. oscariana.

Length 1.45 mm., diameter 0.8 mm.; nearly 5 whorls.
Length 1.53 mm., diameter 0.85 mm.

FLORIDA: Mosquito Island, Volusia Co., type 60463 A.N.S.P. (Oscar B. and G. W. Webster); Grassy Key (Raybon); Fort Lauderdale and Miami (Clapp). ALABAMA: Evergreen, Conecuh Co. (H. H. Smith); Baldwin, Chambers, Elmore, Jefferson and Jackson counties (Walker). TENNESSEE: Tellico Gorge, Monroe Co. (H. B. Baker). WEST VIRGINIA: Greenbrier, Monroe, Pendleton and Summers counties, according to Brooks & Kutchka. LOUISIANA: S.W. cor. Madison Parish, Bayou Macon (C. B. Moore). ARKANSAS: Keller Place Landing, Ouachita R., Calhoun Co. (C. B. Moore). TEXAS: Guadalupe River near New Braunfels (Ferriss and Pilsbry).

The surface is delicately but rather sharply and regularly striate, most conspicuously so on the penult whorl. The columellar lamella is rather blunt and thick, the lower end vertical, the upper slanting slightly inward. The parietal lamella is short and rather high. It varies in degree of inflation, as the figures show. Dr. Clapp has noted that the specimens from Evergreen, Alabama, are nearly smooth, showing only obsolete striation. One measures 1.45×0.8 mm. (Fig. 509a). The Texan form also is nearly smooth, 1.7×0.9 mm., and some have a thin palatal callus. It is an isolated species without near relatives in our fauna.

Subgenus VERTIGO s. str.

The type of *Vertigo*, *V. pusilla* Müll., is a sinistral species, but otherwise much like dextral forms of the group of *V. antivertigo* in Europe, *V. ovata* in America. The subgeneric name *Isthmia* Gray was based upon a dextral

form, *V. pygmaea*. It was used by Morse as a genus, by Binney as a subgenus; but in the absence of other distinctions, the difference in direction of coil is thought now to be merely a specific attribute.

Our species of this subgenus are seen to fall into a number of groups, but with limits so difficult to formulate that I have not been able to construct a key to them. The grouping follows:

<i>Vertigo hinkleyi</i> group	<i>Vertigo gouldi</i> group
<i>Vertigo ovata</i> group	<i>Vertigo modesta</i> group
<i>Vertigo pygmaea</i> group	<i>Vertigo californica</i> group
<i>Vertigo tridentata</i> group	

VERTIGO HINKLEYI GROUP

Vertigo hinkleyi Pilsbry

Page 1018, fig. 542: 12-16.

Vertigo hinkleyi Pilsbry, 1921, *Man. Conch.*, 26:234, pl. 6, figs. 12-16.—MacMillan, 1946, *Nautilus* 59:121.

The shell is minute, oblong-cylindric, of cinnamon-buff color, glossy, nearly smooth, very thin. The whorls are strongly convex, the last three forming the more or less cylindric portion; the last whorl tapers to the narrow base; there is a depression behind the auricle of the lip, and behind that a larger, deeper dorso-lateral impressed area extending nearly to the base. The aperture is shortly piriform, with strongly defined sinulus, limited below by a deeply bent in and thickened angle of the outer lip. The peristome is slightly expanded around the sinulus, elsewhere strongly so. The parietal lamella is low in front, high within, and enters deeply. The columellar lamella is deeply placed, not very long, ascending a little inwardly. Below it there is a subcolumellar tooth (probably a shifted basal fold). The upper-palatal fold is a high lamina, abrupt in front, where it arises some distance within the lip. Close to its *inner end* there is a short fold, apparently the lower-palatal; only its anterior end can be seen in the aperture.

Length 1.55 mm., diameter 0.75 mm.; 5½ whorls. Paratype.

Length 1.75 mm., diameter 0.77 mm.; 6 whorls. Type.

ARIZONA: Cave Canyon, near the reservoir, Huachuca Mountains (Hinkley and Ferriss, 1919). Type 46243 A.N.S.P. Ramsey Canyon (MacMillan).

This remarkable little *Vertigo* is so unlike other known species that comparisons need not be made. The peculiar shape of the aperture is characteristic, and the teeth differ strongly from all other species. In a few examples the parietal lamella emerges nearly to the edge of the parietal film. The aperture also varies individually in width.

It was associated with *Vertigo gouldi inserta*, *Gastrocopta ashmuni* and *G. pilsbryana*.

(Named for Anson A. Hinkley; *Nautilus*, 34:55.)

VERTIGO OVATA GROUP

Rather dark-colored, glossy shells usually having 7 to 9 teeth, never less than 5, the basal fold always present, but often subcolumellar in position; angular lamella present, often an infraparietal fold also. Crest and auricle generally distinctly developed.

Key to species

1. Shell distinctly striate, the palatal callus, crest and impressions behind the lip weak or wanting. Austroriparian. *V. rugosula*
Shell weakly or scarcely striate. 2
2. Last half whorl deeply impressed or constricted over the palatal folds (Fig. 510:14).
Lamellae and lower palatal fold long. Southern states. 3
Last whorl only moderately or slightly impressed over the lower palatal fold (Fig. 513:2). 4
3. 1.8 × 1 mm.; seven teeth. *V. alabamensis*
1.5 × 1 mm.; six teeth. *V. a. canecuhensis*
4. More than 2.6 mm. long, of 6 whorls; spire long, the aperture relatively small.
V. morsei 5
Shell smaller. 5
5. Ovate, the spire very convexly conic; length about 2.2, diam. 1.3 to 1.4 mm.; 5 whorls; usually with 7 to 9 teeth. 6
Oblong-conic, the spire more slender than in *V. ovata*; 2.5 × 1.35 mm., 5½ whorls; 6-7 teeth. California. *V. berryi*
Oblong-cylindric, 2 × 1.1 mm., 5 whorls. Rocky Mountains; 6 teeth. *V. binneyana*
Ovate, 1.7 to 2 mm. long, with 4½ whorls; 4 or 5 teeth; Canada to Ill. *V. ventricosa*
Oblong-conic, 2.15 mm. long, of 5 whorls; 5 to 7 teeth; a distinct palatal callus; Me. to Mont., south to Ohio R. *V. clatior*
6. Crest and auricle well developed. 7
Crest and auricle very weakly developed. California. *V. o. mariposa*
7. Teeth moderately large. *V. ovata*
Teeth longer and stronger. Texas. *V. o. diaboli*

Vertigo rugosula Sterki

Fig. 510: 1-3.

Vertigo rugosula Sterki, 1890, Proc. Acad. Nat. Sci. Phila., p. 34; Nautilus, 4:39, pl. 1, fig. 3.—Pilsbry, Man. Conch., 25:77.—Walker, 1928, Terr. Shell-bearing Moll. Ala., p. 142.

The shell is oval, chestnut-brown, distinctly, regularly striate, the striation stronger and more regular than in *V. ovata*, and the size smaller. Teeth much as in *V. ovata*, but the angular lamella differs, being rather long, low in front, rising inwardly, and emerging about as far as the parietal lamella, which is strong and quite long. The infraparietal lamella is a very small tubercle, as a rule, sometimes scarcely or not perceptible. The inner end of the upper-palatal turns downward. The crest and the impressions over the palatal folds are less marked or wanting. The basal fold is situated higher on the columellar margin, in the position of a subcolumellar lamella, while in *ovata* it is basal.

Length 2 mm., diameter 1.2 mm.; barely 5 whorls.

Distribution.—South Carolina, Sullivan's Island, type loc.; Tennessee, Alabama, Mississippi, Louisiana, eastern Oklahoma; south to Lee and Jackson counties, Texas.

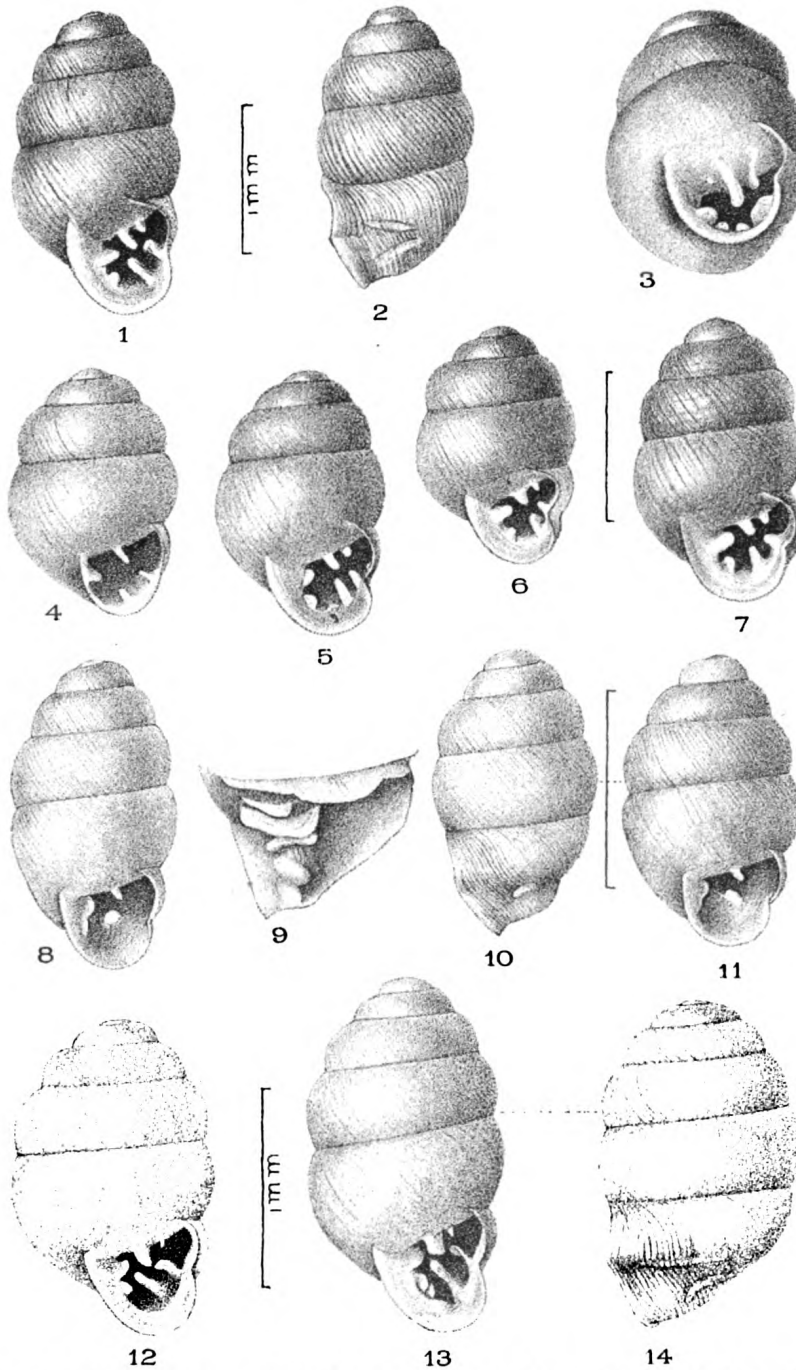


Fig. 510. 1, 2, *Vertigo rugosula*, De Soto Parish, La.; 3, Sullivan's I., S. C. 4, *Vertigo hebardii*, Long Key, Fla. 5, *Vertigo rugosula oralis*, Tallapoosa R., 7 miles above Wetumpka, Ala.; 6, 7, Volusia Co., Fla. 8, 10, 11, *Vertigo oscariana*, Volusia Co., Fla. 9, 13, 14, *Vertigo alabamensis*, Tuscaloosa Co., Ala. 12, *V. alabamensis conecuhensis*, Evergreen, Ala. Figs. 1-7 $\times 19$; figs. 4-8, 10-14 $\times 25$.

Vertigo rugosula oralis Sterki

Fig. 510:5.

[*Vertigo rugosula* var.] *ovulum* Sterki, 1890, Proc. Acad. Nat. Sci. Phila., p. 35.
Not *Pupa ovulum* Pfr., 1841, also a *Vertigo*.

Vertigo rugosula oralis Sterki, Pilsbry, 1898, Nautilus, 11:120; Man. Conch., 25:78,
pl. 8, figs. 6, 7.

Vertigo ovulum ovalis Sterki, Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila.,
p. 608, error for *oralis* Sterki.

Vertigo oralis Sterki, Walker, 1928, Terr. Shell-bearing Moll. Ala., p. 141.

Somewhat smaller than *V. rugosula*, often shorter; striation weaker; angular lamella shorter and not low in front. There is no infraparietal tubercle, but a small tooth usually appears between the basal and the lower-palatal folds. There is often a noticeable light colored crest behind the lip.

Length 1.7 mm., diameter 1.1 mm.; $4\frac{1}{2}$ whorls.

Length 2 mm., diameter 1.2 mm.; 5 whorls.

FLORIDA: Volusia Co., type 62.20394 Carnegie Mus.; Cape Sable; Marco; Seminole Pt., Monroe Co. ALABAMA: generally distributed.

This may be a distinct species, as Dr. Sterki ultimately concluded.

Vertigo alabamensis Clapp

Fig. 510:9, 13, 14; fig. 511.

Vertigo alabamensis G. H. Clapp, 1915, Nautilus, 28:137, pl. 6, fig. 6.—Pilsbry, Man. Conch., 25:79.—Walker, Terr. Shell-bearing Moll. Ala., 142.

The shell is cylindric-oval, light brown, of $5\frac{1}{2}$ convex whorls, the last tapering downward, deeply impressed over the palatal folds, bulging above them, with a distinct crest. Lip with the point impressed, and with a strong internal callus. The parietal lamella is very strongly developed, high and



Fig. 511. *Vertigo alabamensis*. After Clapp.

long. The angular lamella is far longer than usual in *Vertigo*, and converges inwardly towards the parietal. The columellar lamella descends near its outer end, and penetrates deeply. The basal fold, subcolumellar in position, descends obliquely inward, its crest either emarginate or level; the palatal callus extends to it. There is a basally situated infrapalatal tubercle, usually quite low. The palatal folds are very strongly developed, the upper in form of a high lamina, the lower rising to a peak deep within; both show outside as white lines.

Length 1.8 mm., diameter 1.1 mm.

ALABAMA: among rotting leaves in a ravine near junction of North River with the Black Warrior, Tuscaloosa Co. (H. H. Smith.) Type 7270 Clapp coll., Carnegie Mus.

This very distinct species has been found only in the original locality.

Vertigo alabamensis conecuhensis Clapp

Figs. 510:12; 511a.

Vertigo alabamensis conecuhensis Clapp, 1915, Nautilus, p. 137, pl. 6, fig. 7.

At Evergreen, Conecuh Co., Alabama (type 7371 Clapp coll., C.M.), Mr. Smith found a variety which differs in being shorter and more globose, with the teeth less strongly developed and the infrapalatal fold wanting. Length 1.53 mm., diam. 1 mm.

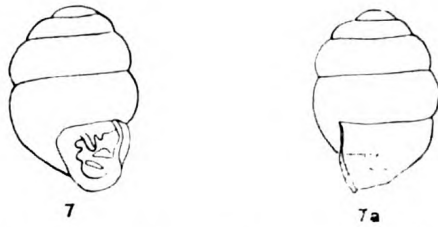
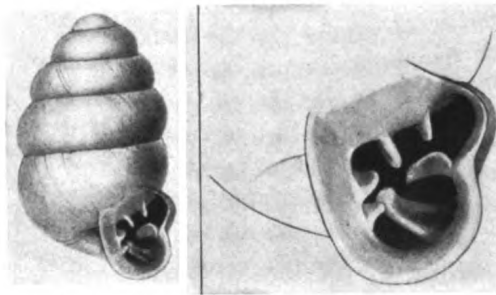
Fig. 511a. *Vertigo alabamensis conecuhensis*, after Clapp.**Vertigo clappi** Brooks & Hunt

Fig. 512.

Vertigo clappi S. T. Brooks and G. R. Hunt, 1936, Ann. Carnegie Mus., 25:121, fig. 1; 1838, same Annals, 27:74, text fig.

The shell is narrowly umbilicate, deeply rimate, convexly conic above, of about equal diameter in the last two whorls; pale brown, lightly striate; of $5\frac{1}{2}$ whorls, the last three strongly convex, the latter part of the last whorl having a spirally ascending concavity terminating at the point of the outer lip. Aperture 6-toothed, the angular lamella well separated from the

Fig. 512. *Vertigo clappi*, paratype, length 1.5 mm.

parietal, long, running nearly to the angle of the lip; it is nearly as high as the parietal, which is longer and does not emerge so far. Columellar strong, slightly ascending inward, a strong but smaller subcolumellar lamella close below it. The upper-palatal fold is a rather high lamina which descends inwardly. Lower-palatal wider, long, more immersed, and ascending inward. Peristome narrowly expanded, the outer lip biarcuate, being strongly looped inward in the middle. Length 1.5 mm., diameter 0.8 mm.

WEST VIRGINIA: Renick, Greenbrier Co. (G. R. Hunt.) Type 62.28186 Carnegie Mus., paratype 166707 A.N.S.P. Romney, Hampshire Co.; Judy Gap, Pendleton Co. (Brooks & Kutchka).

It is smaller, less strongly striate than *V. rugosula*, not so stout in figure; the lower-palatal fold is more deeply immersed, the angular lamella is stronger and longer, the outer lip is much more deeply looped in, and the external concavity leading to the lip-point is deeper. *V. alabamensis* is much more obese. *V. clappi* has the size and somewhat the appearance of *V. milium*, but otherwise they do not seem related.

(Named in honor of Dr. George H. Clapp.)

***Vertigo morsei* Sterki**

Fig. 513:8, 9.

Vertigo morsei Sterki, 1894, Nautilus, 8:89.—Pilsbry, 1919, Man. Conch., 25:81, pl. 6, figs. 8, 9.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:75 (Jefferson Co., West Virginia).—F. C. Baker, 1939, Fieldbook Ill. Land Snails, p. 104 (Joliet, Will Co., Ill.).

The shell is large (for a *Vertigo*), cylindrical-ovate, from auburn to chestnut-brown, glossy, with few, weak striae. Whorls slowly increasing, the last scarcely higher than the penult, having a moderate crest behind the lip, and a wide depression over the palatal folds; there is a distinct crease from the crest to the lip point. The aperture is relatively small, outer margin angularly inbent near the middle. Teeth typically nine: 3 on the parietal wall, as in *V. ovata*; a strong columellar lamella, a smaller basal fold, sub-columellar in position; upper and lower palatal folds high and rather long; small tubercular suprapalatal and infrapalatal folds. The infraparietal and infrapalatal tubercles are sometimes rudimentary or wanting. The peristome is a little expanded.

Length 3 mm., diameter 1.5 mm.; 6½ whorls.

Length 2.7 mm., diameter 1.3 mm.; 6 whorls (type).

Distribution.—New York and New Jersey west to Grand Rapids, Michigan, Indiana and Illinois. Type 62.20390 Carnegie Mus., from Joliet, Illinois. A single Ontario station known is near Thomasburg, Hastings County (J. Oughton).

Our largest *Vertigo*. It is closely related to *V. ovata* by the number and form of the teeth, but differs in the greater number and the relative size of the whorls. In *ovata* there are five whorls, rapidly increasing, while *morsei* has six or more, slowly increasing, the last whorl and aperture being relatively small, giving the shell quite a different appearance.

(Named to honor E. S. Morse.)

***Vertigo ovata* Say**

Fig. 513: 1-3, 4, 7.

Vertigo ovata Say, 1822, Jour. Acad. Nat. Sci. Phila., 2:375.—Binney, 1835, Man. Amer. L. Sh., p. 334.—Sterki, Proc. U.S. Nat. Mus., 11:375; Nautilus, 22:52 (locomotion).—Henderson, Univ. Colo. Studies, 13:136.—Dall, Moll. Harriman Alaska Exp., 32.—Pilsbry, Man. Conch., 25:82-88.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:76 (Hampshire, Pendleton and Summers counties, West Virginia).—Franzen, 1947, Trans. Kansas Acad. Sci. 49:416, pl. 1, fig. 7, pl. 2, fig. 2 (N.-W. Kansas).

Pupa ovata f. *antiquorum* Cockerell, 1891, *Zoe*, 2:18.

Zonites upsoni Calkins, 1880, *Valley Naturalist*, 2:53 (immature stage, Rockford, Ill.).

The ovate shell is auburn, the apex paler. Spire very convexly conic, the summit obtuse. Whorls increasing rapidly, the last much the largest, with, behind the lip a strong, opaque, light-colored crest; a depression with two furrows behind it, and a deep furrow running from crest to lip-point. The aperture has a distinct sinus defined by a strongly inbent point in the outer lip, which is thin and expanded. The parietal lamella is strong and rather long; angular lamella small; a minute infraparietal tubercle usually present. Columellar lamella strong. Basal fold well developed but small and thin, in a subcolumellar position; below it there is usually a minute infrapalatal fold in the basal margin. Upper and lower palatal folds are strong and stand on a tinted callous ridge, a minute suprapalatal tubercle usually above them.

Length 2.2 to 2.3 mm., diameter 1.4 mm.; 5 whorls.

Distribution.—Prince Edward I. and Ungava Bay, Labrador, south to Florida Keys and Texas, west to Puget Sound and northern Oregon, southwest to Fruita Utah, Tempe and Huachuca Mts., Arizona. Alaska on Kadiak and Tigalda Is. West Indies. Type locality, Philadelphia, Pa.

The most widely distributed *Vertigo*. It is common in the eastern and middle western states, rarer and local in the southern and western peripheral states of its range, and as yet not known from Wyoming, Nevada and California. John Oughton reports it from "almost all Ontario, from the lower Great Lakes northwest to Borthwick Lake, west to Rainy River District. We have no records of it from the country immediately south of James Bay. Some of our specimens are quite large, the maximum length at Borthwick Lake (Kenora District) 2.5 mm.; at Belleville (Hasting County) 2.6 mm.; Toronto 2.45 mm."

***Vertigo ovata diaboli* Pilsbry**

Fig. 513:11, 12.

Vertigo ovata diaboli Pilsbry, 1919, *Man. Conch.*, 25:88, pl. 6, figs. 11, 12.

All of the lamellae and palatal folds are larger than in *V. ovata*, entering farther; infraparietal lamella developed. Palatal folds very strong and long, especially the upper, which converges towards the lower. The entering point of the outer lip is well developed, and the crest behind the lip moderately strong, but lower than in typical *ovata*.

Length 2.2, diameter 1.25 mm.; 5 whorls (type).

Length 2.3, diameter 1.3 mm.

TEXAS: drift debris of Devil's River, about 4 miles from the Rio Grande, Val Verde Co. (Ferriss and Pilsbry.) Type 90437 A.N.S.P.

The specimens are all "dead" shells. The point of the outer lip is seen to project well forward, in a profile view. The impressions behind the lip are about as in *V. ovata*.

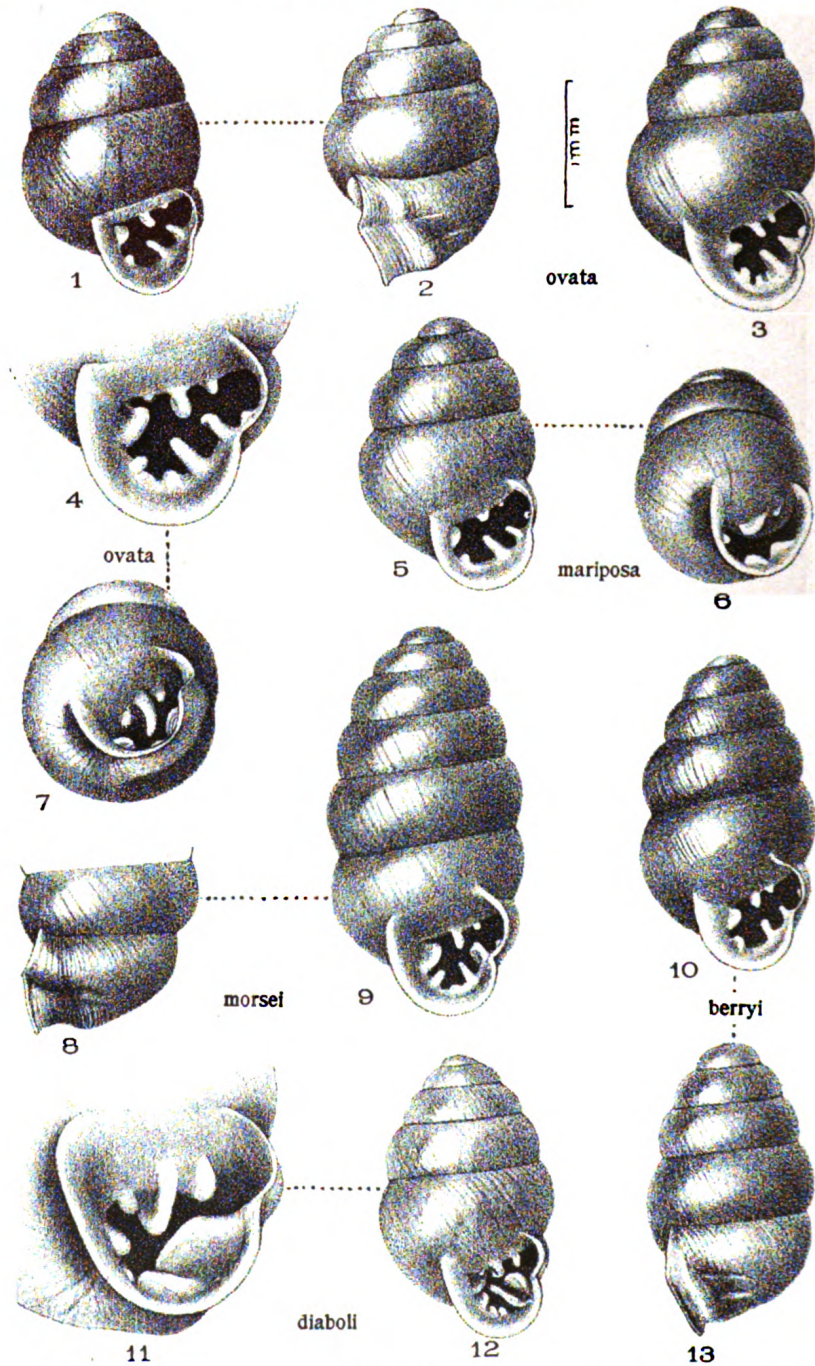


Fig. 513. 1, 2, *Vertigo ovata*, Upper Red Hook, N. Y.; 3, Oswego, Ore.; 4, 7, Hamilton, Ont. 5, 6, *V. ovata mariposa*, Mariposa Co., Cal. 8, 9, *Vertigo morsei*, Lake James, Ind. 10, 13, *Vertigo berryi* San Bernardino Mts., Cal. 11, 12, *Vertigo ovata diaboli*, De il's River, Texas.

Vertigo ovata mariposa Pilsbry

Fig. 513: 5, 6.

Vertigo ovata mariposa Pilsbry, 1919, Man. Conch., 25:88, pl. 6, figs. 5, 6.

The shell has the usual broadly ovate shape and auburn or darker color. The teeth are about as in typical *V. ovata*. Lower-palatal fold is longer and enters more deeply than the upper. The basal is subcolumellar in position. *The outer lip bends inward only very slightly*; the crest and the external impression over the palatal folds are but weakly developed. Length 2.2, diameter 1.35 mm.; length of aperture 0.85 mm.; 4½ whorls.

CALIFORNIA: Mariposa Co., type 11644 A.N.S.P.; meadow near Wawona, Sequoia Park, in the same county (H. N. Lowe).

Easily recognized by the shape of the outer lip. So far as known, typical *V. ovata* does not occur in California.

Vertigo berryi Pilsbry

Fig. 513: 10, 13.

Vertigo berryi Pilsbry, 1919, Man. Conch., 25:89, pl. 6, figs. 10, 13.

The shell is oblong-conic, auburn, glossy, slightly irregularly striate. The spire tapers from the last whorl, the lateral outlines being slightly convex; summit is very obtuse, of a paler tint. The whorls are rather strongly convex; the last having an inconspicuous narrow, low ridge close behind the lip expansion, preceded by a broad and deep impression over the palatal region, above which it remains strongly convex. Except for its smaller size, the aperture is about as in *V. ovata*. There is a small angular lamella near the large parietal; columellar lamella rather massive, ascending inward. Palatal folds subequal, rather long, the basal fold smaller; suprapalatal quite small. The teeth and palatal callus are much lighter than the lip. The peristome is expanded; outer border is slightly curved in, but far less than in *V. ovata*. Length 2.5, diameter to lip edge 1.35 mm.; length of aperture 0.9 mm.; 5½ whorls.

CALIFORNIA: Mill Creek Canyon, at 4600 feet, in the San Bernardino Mountains (S. S. Berry, 1910), Type 105166 A.N.S.P. LOWER CALIFORNIA: Valle Trinidad (C. R. Orcutt, 1901, 308964 U.S.N.M.).

This species differs from *V. ovata* by the relatively narrow, almost straightly tapering spire, the much weaker inbending of the outer lip, the minute crest outside the peristome, and the capacious external excavation over both palatal folds. *V. morsei* is similar to *V. berryi* in having the spire long relative to the aperture, but *morsei* is much larger, has more strongly convex lateral outlines, a more conspicuous point on the outer lip and a stronger crest.

(Named for S. Stillman Berry.)

Vertigo binneyana Sterki

Page 964, fig. 517:12.

Vertigo binneyana Sterki, 1890, Proc. Acad. Nat. Sci. Phila., p. 33; Nautilus, 3:125; 4:39, pl. 1, fig. 1.—Pilsbry, 1899, Man. Conch., 25:90; Proc. Acad. Nat. Sci. Phila., 1919, p. 315, fig. 2.

Cylindric-oblong, auburn, somewhat transparent, glossy, weakly, irregularly striate. Whorls moderately convex, the last having a low but distinct crest behind the lip, a small impression between the crest and the point

of the lip, and a rather large impression over the palatal folds. Parietal lamella strong but rather short; a short angular lamella stands even with its outer end. Columellar lamella strong but not long, ascending a little inwardly. Palatal folds both quite strong, the lower entering much farther; basal fold short. Outer lip a little bent inward above the middle. There is a moderate palatal callus.

Length 2.1 mm., diameter 1.1 mm., length aperture 0.75 mm.; 5 whorls.

MONTANA: Helena, Type 6221609 C.M., coll. by H. Hemphill; Glendive (Sterki): drift of Musselshell R., Winnecook, and Elk Cr., S.E. of Oxford, (Berry); Mingsville, (Squyer). MANITOBA: Winnipeg (Sterki). BRITISH COLUMBIA: Vancouver I. at Nanaimo (G. W. Taylor). NEW MEXICO: Albuquerque (Sterki). IOWA: drift of Missouri River (Sterki).

It is smaller and more cylindrical than any form of *V. ovata*, has a longer lower-palatal fold, and a less impressed point in the outer lip. *V. pygmaea* is wider, has a much stronger crest, and the angular lamella is small or wanting.

Mr. Oughton reports one lot from Ft. Severn, Kenora District, Ontario. "It differs from that figured by you in Man. Conch. in possessing stronger striae and stronger angular lamella."

Vertigo elatior Sterki

Figs. 514; 515:6.

Vertigo ventricosa var. *elatior* Sterki, 1894, The Land and Fresh Water Mollusca in the vicinity of New Philadelphia, a contribution to the Natural History of Tuscarawas Co., Ohio, p. 5; Eighth Ann. Report Ohio State Acad. Sci., 1900, p. 33; Nautilus, 8:107; 29:123.—Henderson, Univ. Colo. Studies, 4:172.—Pilsbry, 1919, Man. Conch., 25:95.

Vertigo gouldi lagganensis Pilsbry, Proc. Acad. Nat. Sci. Phila., 1899, p. 314, fig. 1. *Vertigo gouldii loessensis* F. C. Baker, 1928, Nautilus, 41:135; 1931, Jour. of Paleont., 5:287, pl. 32, fig. 9.

Vertigo elatior Sterki, Pilsbry, 1931, Man. Conch., 28:93, pl. 15, fig. 2.—Brooks & Kutchka, 1931, Ann. Carnegie Mus., 27:77 (Jefferson Co., West Virginia).—F. C. Baker, Fieldbook Ill. Land Snails, p. 106.

"Larger and more elevated than *ventricosa*, with a rather acute apex; a strong callus in the palate, into which the palatal plicae merge, a strong tooth-like lamella in the base" (Sterki).

The shape, more conic than *V. ventricosa*, the strong palatal callus and teeth, the well-developed basal fold and the larger size, give this species individuality. Compared with *V. pygmaea*, *V. elatior* is more conic, the outer lip has a more distinct point, the crest is less massive, usually weak, and there is a deeper external impression over the lower-palatal fold. Often a suprapalatal fold is developed, and occasionally an angular lamella.

Length 2.15 mm., diameter 1.2 mm.; 5 whorls.

Distribution.—All Ontario from lower Great Lakes north to James and Hudson Bays (Oughton). Aroostook and Hancock counties Maine, west to Darby and White's Springs, west of Ward, Montana; Field, B. C., and Laggan, Alberta (type of *lagganensis* Pils., 76427 A.N.S.P.). Oscuro Mts., Socorro Co., N. M.; Pleistocene at New Harmony, Indiana, Fulton Co., Illinois, and Erie Co., Ohio.

It has an extensive range west of that of *V. ventricosa*, but also occurs in territory of the latter as far northeast as Maine. According to F. C. Baker, who described loess specimens as *V. gouldii loessensis* (Fig. 514), it has a Pleistocene range from Aftonian to early Wisconsin time, the type locality being in Fulton Co., Illinois.



Fig. 514. *Vertigo elatior* (paratype of *V. gouldii loessensis* F. C. Baker). Scale line = 1 mm.

***Vertigo ventricosa* (Morse)**

Fig. 515: 1-3.

Isthmia ventricosa Morse, 1865, Ann. Lyc. Nat. Hist. of N. Y., 8:207.

Vertigo ventricosa Morse, Binney, 1878, Terr. Moll., 5:218.—Pilsbry, 1919, Man. Conch., 25:94.—Tomlin & Bowell, 1909, Jour. of Conch., 12:297, pl. 5, third fig. (dentition).

Vertigo approximans Sterki, 1890, Nautilus, 3:136.

Shell umbilicate, ovate, conic, smooth, polished; apex obtuse; suture deep; whorls 4, convex. Aperture semicircular, with 5 teeth, one prominent on the parietal margin, two smaller on the columellar margin, and two, prominent within, contracting the aperture at the base; peristome widely reflected, the right margin flexuose, within thickened and colored. Length .07, breadth .45 inch (1.75 × 1.1 mm.). (Morse.)

Length 1.7 mm., diameter 1 mm.; 4½ whorls. Hebron, Me.

Length 1.95 mm., diameter 1.2 mm.; 4½ whorls. Buckfield, Me.

Distribution.—Magdalen and Prince Edward Is.; Quebec; New England and New York, west to Ohio, Michigan and Illinois. Fern Glen, St. Louis, Missouri.

John Oughton writes: "In Ontario I have seen the typical form only at the Temagami Provincial Forest and Muskoka District, but reported elsewhere in Ontario by Goodrich (1933), La Rocque (1933) and E. M. Walker (1917). In my experience a few specimens, typical or near it, are to be found mixed in large lots of *V. ventricosa elatior* Sterki."

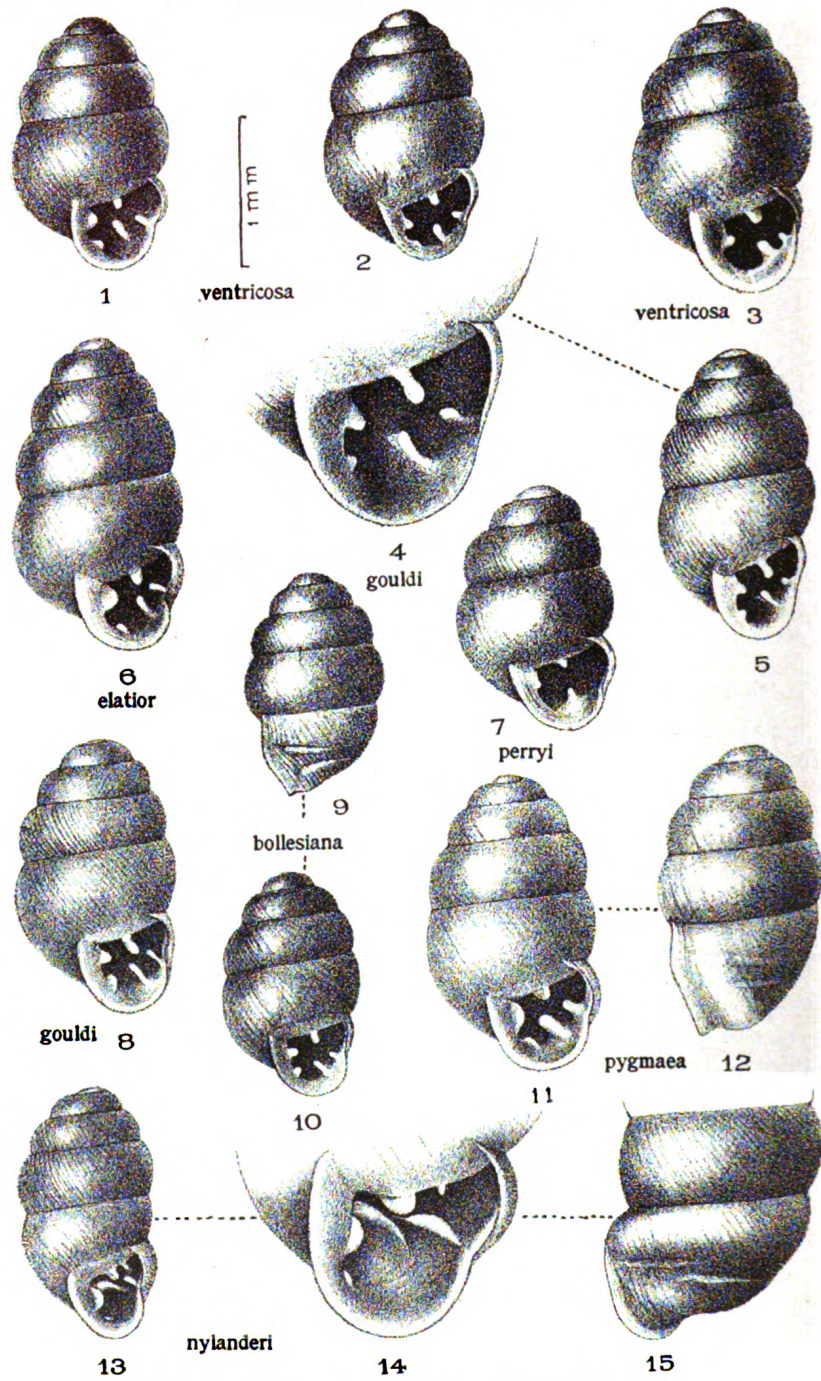


Fig. 515. See bottom of page 959 for legend.

V. ventricosa differs from *V. ovata* by the constantly smaller size, absence of an angular lamella and smaller number of teeth. It is of an auburn color, with only a faint trace of striation. Under a high power it shows microscopic punctation or granulation. The basal fold is usually quite small, though sometimes, as in the specimen from Prince Edward Island figured (fig. 1), it is well developed. In many Maine examples it is absent (fig. 3, Buckfield, Oxford Co., Me.). The degree of prominence of the inwardly bent point of the lip-edge varies a good deal. The crest is quite low.

The teeth of a specimen determined by Dr. Sterki have been figured by Tomlin & Bowell.

***Vertigo columbiana* Sterki**

Page 997, fig. 533: 12, 13.

Vertigo columbiana Sterki, 1892, *Nautilus*, 6:5, name only.—Pilsbry & Vanatta, Proc. Acad. Nat. Sci. Phila., 1900, p. 602, pl. 23 fig. 11.—Pilsbry, *Man. Conch.*, 25:108.—Henderson, 1929, *Univ. Colo. Studies*, 17:92.—Pilsbry & Cooke, 1922, *Nautilus*, 36:38 (Cameron Lake, Vancouver Island).—Chace, 1934, *Nautilus*, 47:112.

Shell minute, cylindric-oval, perforate, thin, pale corneous-brown (grayish cream-buff), somewhat transparent, glossy and weakly striatulate. Whorls nearly 5, convex, the last expanded in a very low crest very close to the lip, not noticeably constricted in front of the crest. Aperture truncate-oval, 4-toothed, the peristome thin, hardly expanded; parietal lamella short and high, columellar a little smaller, lower palatal a rather short fold, about twice as long as the upper palatal which is smaller, shorter, almost tuberculiform; all the teeth are white, and the palatals show through the outside wall.

Length 1.9, diameter 1.1 mm. (type).

Length 2.05, diameter 1.2 mm.

VANCOUVER ISLAND (George W. Taylor) Type 68881 A.N.S.P. WASHINGTON: Olympia and Tacoma (H. Hemphill); Seattle (Hemphill, P. B. Randolph); L. Quiniault, Chehalis Co. (S. S. Berry). OREGON: Douglas County (F. H. Andrus). ALASKA: St. Paul Island, Bering Sea (Dall).

The surface is decidedly less striate than in *V. coloradensis*, *V. concinnula* or *V. gouldi*. It is like that of *V. ventricosa*. There is no angular lamella and no basal fold in any of the specimens; but only a few have been seen from each locality. The single specimen from Olympia is very short, 1.4 × 1 mm. (Fig. 3). The species was mentioned in lists by Dr. Sterki as early as 1892, but it was described from 68881 A.N.S.P., in 1900 (page 997 fig. 12).

I have hesitated whether to rank *V. columbiana* as a western race of *V. ventricosa*, but leave it distinct temporarily. There is no "auricle" or incurved point of the outer lip, such as most specimens of *ventricosa* show,

Fig. 515. 1, *Vertigo ventricosa*, Tignish, P. E. I.; 2, Hebron, Me. 3, Buckfield, Me. 4, 5, 8, *Vertigo gouldi*, Brookline, Mass. 6, *Vertigo elatior*, Woodland, Aroostook Co., Me. 7, *Vertigo perryi*, Duxbury, Mass. 9, 10, *Vertigo bollesiana*, Buckfield, Me. 11, 12, *Vertigo pygmaea*, Upper Red Hook, N. Y. 13-15, *Vertigo nylanderi*, Woodland, Me. Scale line applies to full-length figures.

and none of the examples seen shows a basal tooth; yet in *ventricosa* this is sometimes lacking. If *columbiana* is not a race of *V. ventricosa*, it is certainly very near akin.

V. columbiana utahensis Sterki (Nautilus, 6:5, name only; Pils. & Van., P.A.N.S. 1900, 603, pl. 23, fig. 10; Pils. & Ferr. 1910, p. 144) is identical, I believe, with *V. gouldi coloradensis*, and has no direct relationship with *V. columbiana*. The type of *utahensis*, 109009 A.N.S.P., is figured, Fig. 518:13.

Vertigo idahoensis Pilsbry

Fig. 516.

Vertigo idahoensis Pilsbry, 1934, Man. Conch., 28:100, pl. 22, figs. 9-11.

The shell is ovate, rimate, with convexly conic spire and obtuse summit; cinnamon-brown, the spire paler; glossy, with extremely weak and rather sparse lines of growth and a faint microscopic granulation. The whorls are strongly convex, the last having an impression at the lip-point, a very low, hardly noticeable crest, and behind it a deep pit over the lower-palatal fold. The peristome is distinctly bent in above the middle of the outer margin,

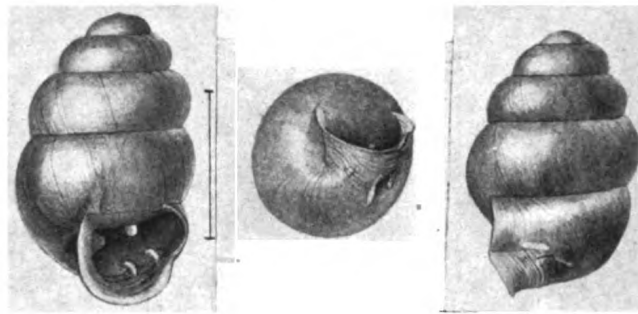


Fig. 516. *Vertigo idahoensis*, type. Scale line = 1 mm.

well expanded below the point. Columellar margin reflected. There are four teeth: a well developed parietal lamella, a somewhat oblique columellar lamella, and two palatal folds rather near together, as in *V. ventricosa* and its allies, the lower-palatal being decidedly larger and a little farther in. There is no palatal callus.

Length 2 mm., diameter 1.2 mm.; $4\frac{1}{2}$ whorls.

IDAHO: Meadows, Adams Co., along a creek east and northeast of the old town. Type and paratypes 158670 A.N.S.P., collected by H. Burrington Baker, Sept. 12-15, 1929.

The whorls are more convex and the suture deeper than in *V. ventricosa*, *V. columbiana* or *V. andrusiana*, and it differs from all of these by the much deeper external pit over the lower-palatal fold, the other species mentioned having the whorl only somewhat flattened there. The teeth are much the same in this whole *ventricosa* series, the palatal folds being nearer together than in the *V. modesta* series. The development of angular lamella and basal denticle is variable in some forms of the *ventricosa* group, but

neither is present in specimens of *V. idahoensis* seen. It does not have the strong crest behind the lip or the palatal callus within it which characterize *V. pygmaea*.

VERTIGO PYGMAEA GROUP

Key to species of the V. pygmaea and tridentata groups, etc.

1. Aperture with 3 teeth: parietal, columellar and lower-palatal; sometimes a small upper-palatal also 2
 Aperture having at least 4 well-developed teeth 4
2. Length 1.8 to 2.2 mm.; upper-palatal usually present but minute; Me. to Kan. and Tex. *tridentata*
 About 1.5 mm. long; upper-palatal rarely present 3
3. Subcylindric, yellowish; lower-palatal usually entering to dorsal side; Ohio, S. Appalachians *parvula*
 Ovate; dark olive-buff; lamellae and folds small and short; New England *perryi*
4. A strong crest behind the lip, which is not biarcuate; 4 or 5 strong teeth; 2 × 1.1 mm.; palatal callus strong *pygmaea*
 Crest weak or wanting 5
5. Northeastern and north central states 6
 Mountain and western states 7
6. Length 2.15 mm., 5 whorls; a distinct palatal callus; 5 or more strong teeth; Me., to Mont. S. to Ohio R. *clatior*
 Length 1.7 to 2 mm., 4½ whorls; no palatal callus; 4 or 5 teeth; Canada to Ill. *ventricosa*
 Length 1.5 mm., 4½ whorls; corneous; New England and New York *bollesiana*
7. 2 or 3 weak teeth; California; length 2 mm. *sterkii*
 4 to 6 stronger teeth 8
8. A deep pit over the lower-palatal fold; auricle bent in; 1-1-2 teeth; Idaho *idahoensis*
 No distinct pit over palatal folds 9
9. Pale colored, corneous; 1-1-2 teeth; Ore. to Alaska *columbiana*
 Cinnamon-brown; Oregon, *andrusiana* S. Cal. *sanbernardinensis*

Vertigo pygmaea (Draparnaud)

Fig. 515: 11, 12.

Pupa pygmaea Draparnaud, 1801, Tableau Moll. Terr. et Fluv. de la France, p. 57.
Vertigo callosa Sterki, 1890, Proc. Acad. Nat. Sci. Phila., p. 31, not of Reuss, 1849.
Pupa (Nearctula) superioris Pilsbry, 1899, Nautilus, 12:103 (near Lake Superior).
Vertigo pygmaea Drap., Sterki, 1892, Nautilus, 6:5; Jahrb. D.M.Ges. 1899, p. 114.—
 Pilsbry, 1919, Man. Conch., 25:96.

The shell is cylindrical-oval, auburn or chestnut-brown, glossy, having only weak traces of striation. Whorls moderately convex, the last having a strong, light colored rounded crest a short distance behind the peristome. Parietal lamella strong but rather short, median; columellar lamella deeply placed, short, ascending inwardly. Both palatal folds are strong, the lower one longer. They stand on a strong callus. Basal fold is very small, rarely absent. There is often a small suprapalatal fold. Peristome narrowly expanded, colored like the shell; the outer lip only slightly incurved.

Length 2 mm., diameter 1.1 mm.; 5 whorls.
 Length 1.8 mm., diameter 1 mm.

Distribution.—Nova Scotia, Quebec and Ontario; Maine to Virginia and west to Ohio. Europe.

The strong, continuous crest behind the expanded lip, and the absence of a distinctly defined upper arc or sinulus of the lip, are its more conspicuous features. *V. gouldi* is a paler, much more sharply striate shell, with weaker crest and distinct sinulus. *V. ventricosa* has a weaker and interrupted crest. Dr. Sterki was the first to recognize this common and widely spread European species in America. Its range in the United States is chiefly northeastern. Oughton writes: "Our records come from Palaeozoic soils of southern Ontario from Lakes Erie and Ontario north to Ottawa (Carleton County) and Bayfield (Huron County). Goodrich (1933) recorded it from Moose Factory, Cochrane District."

***Vertigo andrusiana* Pilsbry**

Fig. 517:9-11.

Vertigo andrusiana Pilsbry, 1899, Proc. Acad. Nat. Sci. Phila., p. 315, fig. 3; Nautilus, 17:131; Man. Conch., 25:109.

The shell is rimate, imperforate, cylindric-oblong, with convexly conic, obtuse summit; cinnamon-brown, becoming paler upwards, the initial whorl gray; somewhat glossy; without noticeable striation, most minutely granulose. The whorls are moderately convex, the last having a rather low but distinct crest followed by a wide, shallow contraction behind the lip; an impressed line over the upper palatal fold terminates at the lip, which is slightly bent in at this point. The aperture has (four to) six teeth: a short, high parietal lamella, a small tubercular angular lamella (sometimes very inconspicuous), a stout, short, columellar lamella which ascends a little inwardly, a small, tubercular basal fold (sometimes wanting) and two well-developed palatal folds, the lower being longer. The palatal folds stand upon a thin, light-colored callus. The outer lip is scarcely expanded, the basal slightly so, the columellar margin dilated.

Length 2.46, diameter 1.3 mm.; $5\frac{1}{2}$ whorls (type, fig. 517:10).

Length 2.35, diameter 1.3 mm.; $5\frac{1}{4}$ whorls.

Length 2.3, diameter 1.3 mm.

Distribution.—Oregon: Douglas Co., F. H. Andrus, type 76380 A.N.S.P. Also northward to Chehalis Co., Washington.

"It stands very near *V. pygmæa*, but is slightly longer, *the crest and palatal callus are less developed*, and there is an angular lamella in the most fully developed examples, which however have the other teeth smaller than in *pygmæa*." (Pilsbry.)

It is likely that the basal fold may be either wanting or present in adult examples of the species. Specimens were taken by Mr. S. S. Berry at Lake Quinault, Chehalis Co., Washington; one before me has a very low angular lamella but no basal fold. The spire has whitish streaks.

Some thousands of specimens were taken by Mr. John A. Allen "about clumps of bushes in a meadow," Oswego, Clackamas Co., Oregon. The

shells (fig. 517:9) are all smaller than the type lot, variable in size and shape, and with the crest weak, or in the shorter individuals wanting. Among many examined, none has an angular lamella. The basal fold is occasionally developed, but more frequently absent. There is a distinct if thin palatal callus except in the quite small individuals. The color is usually darker than cinnamon brown or russet, often with light streaks on the spire.

Length 2.15, diameter 1.2 mm.; 5½ whorls.

Length 1.85, diameter 1.2 mm.; 4½ whorls.

While this Oswego form has characters of *V. columbiana*, *V. pygmæa* and *V. a. sanbernardinensis*, it appears most closely related to *V. andrusiana*.

***Vertigo andrusiana sanbernardinensis* Pilsbry**

Fig. 517:6-8.

Vertigo andrusiana sanbernardinensis Pilsbry, 1919, Man. Conch., 25:111.

The cinnamon-brown shell tapers very little upward to the obtuse, rounded apex; it is weakly irregularly striate. The last whorl is flattened over the lower-palatal fold, a trifle swollen in front of it, but without a crest. Teeth four to six: parietal lamella short, compressed, a small, tubercular angular lamella, even with, or in advance of, its outer end (sometimes wanting). Columellar lamella short but rather massive. Lower-palatal fold strong and rather long, the upper-palatal very much smaller and shorter. (Basal fold small and tubercular, at the junction of basal and columellar margins, and not present in the form selected as typical). There is no noticeable callus between the palatal folds. The outer lip expands very little; it is straightened and slightly thickened internally above the middle.

Length 2.25 mm., diameter 1.3 mm.; 5 whorls.

Length 2.15 mm., diameter 1.2 mm.; 5 whorls (type).

Length 1.9 mm., diameter 1.1 mm.; 4½ whorls.

CALIFORNIA: San Bernardino Mts., 7550 to 7750 ft., in the *ciénaga* below Bluff Lake, (type 118419 A.N.S.P.); that north of the lake, and Bluff Lake meadow; everywhere associated with the local races of *V. modesta*; all collected by S. S. Berry.

This form stands close to *V. andrusiana*, but there is no crest or contraction behind the lip, and no trace of a palatal callus. It differs from *V. columbiana* by the much darker color, by being less thin, and typically by having more teeth. *V. binneyana* is a paler, slightly more slender species, having a more distinct crest, and a deeper external impression over the palatal folds. All of these forms appear to be closely related, and are discriminated with some difficulty.

In the type lot of 27 shells, one has six teeth, one five, wanting the angular lamella; the rest lack either the basal fold or both basal fold and angular lamella.

***Vertigo sterkii* Pilsbry**

Fig. 517:2-5.

Vertigo sterkii Pilsbry, 1919, Man. Conch., 25:112, pl. 11, figs. 2-5.

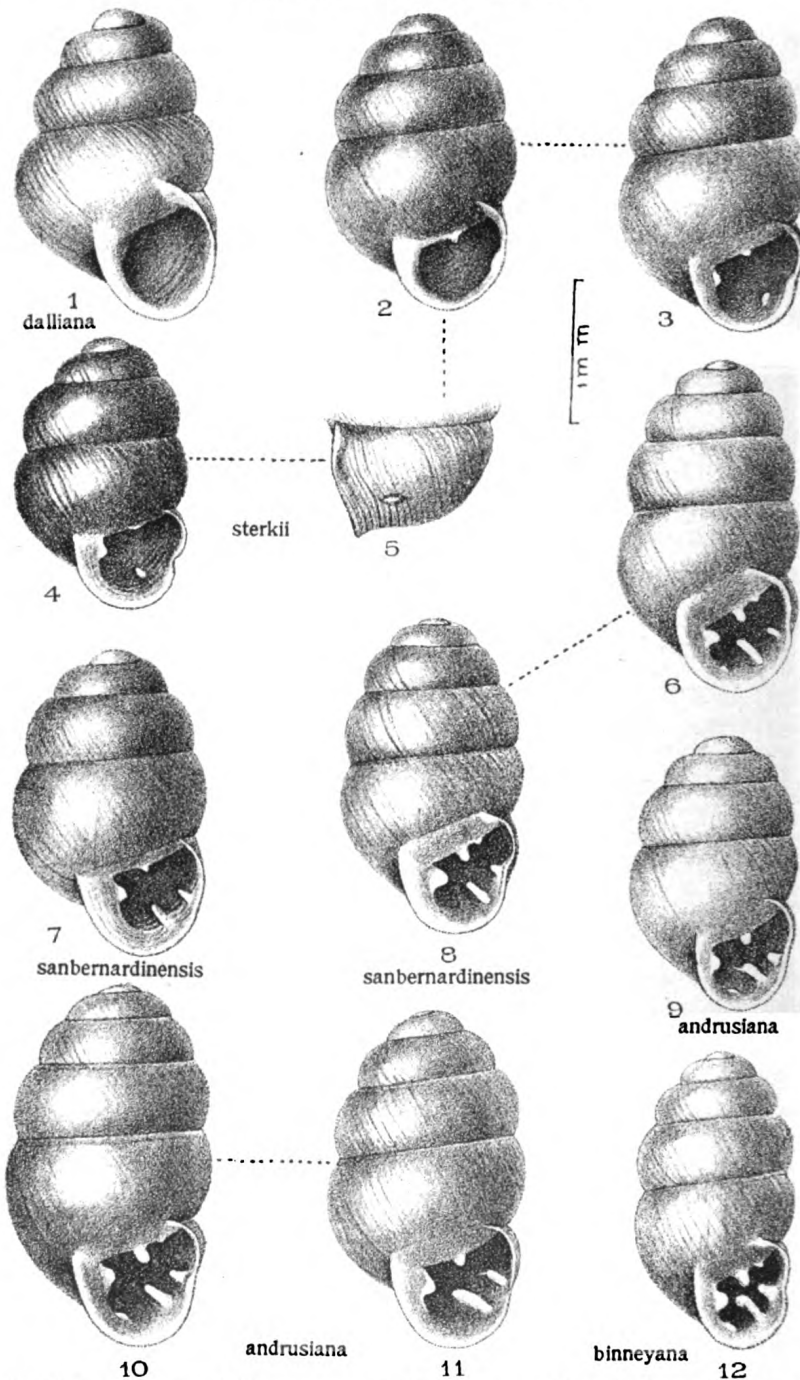


Fig. 517. 1, *Vertigo dalliana*, type, Sterki coll., near Clear Lake, Cal. 2-5, *Vertigo sterkii*, type and paratypes, Tulare Co., Cal. 6, 8, *Vertigo a. sanbernardinensis*, cienega below Bluff Lake; 7, 20 miles N. of Yosemite. 9, *Vertigo andrusiana*, Oswego, Ore.; 10 (type), 11, Douglas Co., Ore. 12, *Vertigo binneyana*, paratype, Helena, Mont.

The shell is imperforate, with a curved umbilical crevice, ovate, chestnut-brown, glossy, slightly striate, but becoming distinctly striate behind the lip. The whorls are moderately convex, the last without any trace of a crest or contraction behind the lip, having a short impression behind the auricle. The aperture has three teeth (or sometimes two). The parietal lamella is low and short. Columellar lamella small, obtuse and deeply placed. The lower-palatal fold is small, tuberculiform (and wanting in some examples). There is no palatal callus. The peristome is thin, brown, and well expanded, having a slight prominence inwardly above the middle of the outer margin.

Length 2.1, diameter 1.25 mm.; 4½ whorls. Type, fig. 3.

Length 2, diameter 1.25 mm.

Length 1.8, diameter 1.2 mm.

CALIFORNIA: Funston Meadow, Kern River, Tulare Co., Type 43706 A.N.S.P.; Onion Valley, Kearsarge Pass, Inyo Co. (J. H. Ferriss and E. Hand, 1916.)

V. dalliana is a more conic, thinner shell, of different color, having more rapidly increasing, more convex whorls, and a larger aperture. Moreover, adult specimens of *V. sterkii* are always toothed. *V. andrusiana* is generally larger, and so far as seen, it always has much larger teeth. *V. tridentata* is a far paler, more slender shell, with smaller aperture, stronger teeth and a distinct auricle.

In both of the localities, *V. sterkii* occurred associated with *V. modesta castanea*—a form also characterized by degeneration of the teeth.

VERTIGO TRIDENTATA GROUP

Species with three or four teeth. Probably the species included are not closely related, but their affinities with other species have not been worked out.

Vertigo tridentata Wolf

Fig. 518: 1-3.

Vertigo tridentata Wolf, 1870, Amer. Jour. Conch., 5:198, pl. 17, fig. 1.—Sterki, 1888, Proc. U.S.N.M. 11:375.—Pilsbry, Man. Conch., 25:106. —Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:78, text figs. (West Virginia).—F. C. Baker, 1939, Fieldbook Illinois Land Snails, p. 106.

The shape varies from ovate to tapering oblong. It is honey-yellow, shading to somewhat browner below, paler above; surface smooth, with only faint indications of striæ, glossy. The last whorl is somewhat flattened externally over the lower palatal fold, and has a rather narrow but generally distinct crest behind the lip. The outer lip projects forward and slightly inward near the middle. Parietal lamella high, rather short. Columellar lamella blunt, directed downward. Lower-palatal fold strongly developed. Upper-palatal fold quite small or sometimes wanting. These folds stand on a more or less distinct palatal callus. Angular lamella and basal fold are never developed.

Length 2.2 mm., diameter 1.1 mm.; 5½ whorls.

Length 2 mm., diameter 1.1 mm.

Length 1.85 mm., diameter 1.1 mm.; 4¾ whorls.

Distribution.—Quebec and Maine, Troy, New York, to New Jersey, eastern Pennsylvania and Jefferson Co., West Virginia (Brooks & Kutchka), west to Clearwater, Minnesota (Sargent), St. Louis Co., Missouri (L. Hubricht), Douglas Co., Kansas (Hanna), and Bastrop Co., Texas (Julia Gardner). Type 58008 A.N.S.P., from Canton, Illinois (J. Wolf).

The light color, tapering form, absence of basal and angular teeth and the small size or sometimes absence of an upper-palatal distinguish this from other American species. Most specimens have the upper-palatal fold developed, either distinct though small, or as a trace; yet in some it is wholly absent.

Mr. Wolf found it "abundant in shady copses on green weeds, climbing as high as three feet from the ground. I collected 12,000 from standing weeds and not one from the ground, although it was searched well to find them."

"In southern Ontario from Lake Erie north to Bayfield, (Huron County) and Green River, (Ontario County). We have two peculiar shells from Pt. Pelee, (Essex County). The size and color of one was characteristic of *V. tridentata*, but the flat outer lip and minute columellar tooth suggested *V. perryi*. The other shell was larger and had a pronounced columellar tooth." (J. Oughton.)

Vertigo perryi Sterki

Page 958, fig. 515:7.

Vertigo perryi Sterki, 1905, *Nautilus*, 19:53.—Pilsbry, *Man. Conch.*, 25:103.

"Shell minute, ovate with the apex rather acute, rimate; thin, transparent, dark olive buff. Whorls $4\frac{1}{2}$, rather rapidly increasing, separated by a moderately deep suture, the last comparatively large, rounded, with a slight impression over the palatal fold; aperture well rounded, truncate, the outer margin barely impressed at the auricle which is marked by a slight angle projecting over the level of the peristome; no callus in the palate. Lamellæ and folds three or four, small, very short, of brownish color: parietal and columellar lamellæ, and lower-palatal, sometimes also an upper-palatal fold. Surface with very fine, irregular striæ, somewhat shining. Alt. 1.5 to 1.6, diam. 1.1 mm.; aperture, alt. 0.6 mm.

RHODE ISLAND: Warwick (J. F. Perry), Type 62.20393 Carnegie Museum. MASSACHUSETTS: Duxbury (W. F. Clapp).

"The present species resembles the low form of *Vertigo ventricosa* Mse. in the shape and size of the shell, but the formation of the aperture and its

Fig. 518. 1-3, *Vertigo tridentata*, Canton, Ill., fig. 2 the type. 4, 5, *Vertigo gouldi cristata*, paratype, Quebec. 6, 8, *Vertigo gouldi paradoxa*, paratype, Woodland, Me. 7, 9, *Vertigo parvula*, type, 270 Sterki Coll. 10, 11, *Vertigo gouldi inserta*, Bear Wallow. 12, *Vertigo hannai*, type, Phillips Co., Kansas. 13, *Vertigo g. coloradensis* (type of *V. columbiana utahensis* St.), Box Elder Co., Utah. 14, 16, *Vertigo g. arizonensis*, type, Mt. Mingus, Arizona. 15, *Vertigo g. basidens*, Bland, N. M.

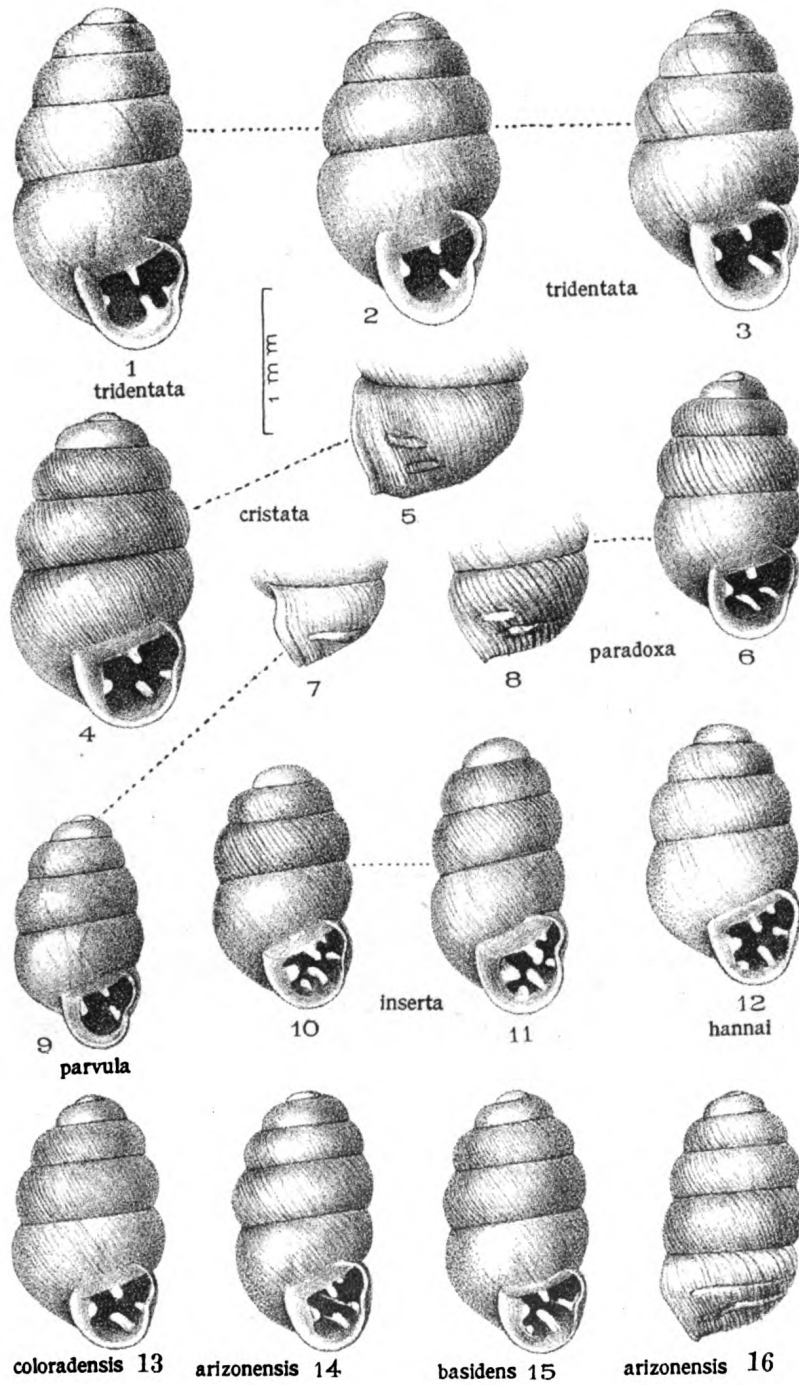


Fig. 518. See bottom of page 966 for legend.

lamellæ and folds is quite different, the color is deeper and the surface less shining. From the other three described, typically three-toothed, eastern *Vertigos*: *tridentata* Wolf, *oscariana* Sterki and *parvula* Sterki, *V. perryi* is also very different; in all of the three, the parietal lamellæ and palatal folds are much larger, longer, and of whitish color; the aperture is higher than wide; the shells are more elevated and of lighter color" (Sterki). *V. perryi* differs from *V. tridentata* by the small size, more fragile, distinctly greenish shell, with broader, more rounded aperture, smaller teeth and dark-edged peristome.

The two localities now known for this strongly distinct species are only about 45 miles apart, and both are close to the sea. The example figured measures: length 1.6, diam. 1.05 mm. In some others the teeth are weaker, and rarely there is the trace of an upper-palatal fold. Often the columellar lamella is hardly visible in a front view. The lower-palatal fold is often developed when the other teeth are scarcely noticeable. The shell is very fragile. At Duxbury, where it was collected by Mr. and Mrs. W. F. Clapp, it lives on grass in a swamp, in wet weather as much as a foot above the ground.

***Vertigo alpestris oughtoni* Pilsbry, new subspecies**

Fig. 519.

Vertigo alpestris var., Oughton, 1940, *Nautilus*, 53:128.

The shortly cylindric shell with rounded summit, convex whorls and well impressed suture, is like *V. alpestris* Alder⁸³ in form, and in the absence of a crest or of any external impressions behind the outer lip; but it is smoother than *V. alpestris*, the shining surface showing only weak, irregular



Fig. 519. *Vertigo alpestris oughtoni*. Scale-line = 1 mm.

⁸³ *Vertigo alpestris* Alder, 1838, *Trans. Nat. Hist. Soc. of Northumberland, etc.*, 2:340.—Jeffreys, *Brit. Conch.*, 1:259.—Pilsbry, 1919, *Man. Conch.*, 25:197 (see for distribution, varieties and synonyms).

striae (*V. alpestris* being distinctly, closely striate, especially on the penult whorl). The color is a dilute, slightly transparent hazel, fading to whitish on the summit. The slightly straightened but not in-bent lip is brown. Teeth are smaller than in *V. alpestris*, those present (typically) being the parietal, a low columellar (which is often wanting), and a small lower-palatal fold (which may be absent). Length 2.1 mm., diameter 1 mm.; 4½ whorls.

NORTHWEST TERRITORY: Baffin Island at Lake Harbor, 60° 50' N., 69° 52' W., "2 lots containing 217 adults from a boggy upland flat where it was associated with *Vertigo modesta* (Say) and *Columella alticola* (Ingersoll)" (John Oughton). Type and paratypes 175399 A.N.S.P. **ONTARIO:** river drift at Fort Severn, Kenora District (Oughton).

Vertigo alpestris is widely spread, from the British Isles and Switzerland to the Amur valley and Vladivostok. It is variable, numerous varietal forms having been named, cf. Manual of Conchology, 25:197-201. One or more of them, such as var. *mitis* Westerlund, of Sweden, have the teeth reduced as in our form, but nothing is known of their sculpture.

In America, *Vertigo alpestris* appears to be represented by a smoother form also deficient in teeth. Mr. Oughton, who discovered it, writes of the Baffin Island lot: "This is the first or second record of this species for the continent. Whorls 4½ to 4¾; length 1.8 to 2.2 mm., average 2.0; diameter 1.1 to 1.2 mm., average 1.2; color light buff to amber brown; the striae usually faint, teeth variable, mostly having but one tooth (a parietal) or a parietal and palatal; no crest behind the lip. The aperture of these specimens varies somewhat in size. The Lake Harbour specimens resemble very closely the single European lot at hand from Boros, Sweden, in the character of the lip, but differ in having a darker brown color, less distinct striation and much more reduced teeth."

In the single Ontario locality Mr. Oughton found the following tooth formulas (the teeth being counted in the order: parietal, columellar, palatal)

0-0-0, 1 specimen	1-1-1, 8 specimens
1-0-1, 2 specimens	1-1-2, 2 specimens
1-0-2, 1 specimen	

It will be seen that two specimens have the tooth formula 1-1-2, typical of *alpestris*. I have no information as to the sculpture of this lot.

***Vertigo parvula* Sterki**

Fig. 518: 7, 9.

Vertigo parvula Sterki, 1890, Nautilus, 3:136.—Pilsbry, Man. Conch., 25: 105, pl. 12, figs. 7, 9.

The shell is minute, subcylindric, tapering very little upwards, the summit obtuse; thin, subtransparent, slightly yellowish, smooth and glossy, becoming finely striate behind the outer lip. The whorls are moderately convex, the last whorl well rounded, slightly impressed behind the projection of the outer lip. The aperture is somewhat triangular, with three teeth: parietal lamella rather short and high; columellar lamella short, steeply ascending inwardly; lower-palatal fold rather high in front, rapidly becoming lower as it recedes, penetrating to the dorsal side. Peristome very little

everted, slightly thickened, and having a distinct callous ridge within. The outer lip projects forward and is slightly bent inward above the middle. Length 1.55, diameter 0.85 mm.; barely 5 whorls.

OHIO: Summit Co. (A. Pettingell). VIRGINIA: at the Natural Bridge (H. B. Baker). TENNESSEE: Limestone Cove, Unicoi Co. (H. B. Baker). Also found by A. G. Wetherby in the mountains of North Carolina, according to Dr. Sterki.

Figures and description are from the type specimen, no. 270 Sterki coll. It is one of the rarest species, known by the small size, cylindrical shape and three well-developed teeth, the lower-palatal being quite long and not marked externally by an impression. The auricle or point of the outer lip projects well forward but is not much bent inward.

It is much smaller than *V. tridentata*, more cylindrical and lighter colored than *V. perryi*, with relatively larger teeth. It is similar to *V. oscariana* in the small size and tridentate aperture, but differs by the absence of a furrow on the back, over the lower-palatal fold, and by the shape of the columellar lamella, which is noduliform in *parvula*. A specimen from Unicoi Co., Tenn., measures 1.4×0.8 mm. It is quite distinct from all of our species.

Vertigo nylanderi Sterki

Page 958, fig. 515:13-15.

Vertigo nylanderi Sterki, 1909, Nautilus, 22:107.—Pilsbry, 1919, Man. Conch., 25:100, pl. 7, figs. 13-15.

Shell rimate, oblong, with a rather acute apex, cinnamon colored, pellucid; whorls $4\frac{1}{2}$ -5, quite convex, with a deep suture; sculptured with somewhat irregular, crowded striæ, except the embryonic whorl; last whorl occupying about one-half of the altitude, gradually narrowed towards the aperture, which is small. Peristome slightly everted, margin not thickened. The outer margin has an indentation barely above its middle, forming a well-marked sinus; behind it the trace of a crest, and behind that a long, deep, furrow-like impression over the palatal folds, ascending obliquely from near the base; no callus within. Lamellæ and folds 6: parietal lamella long and curved; parallel with it is a thin, lamelliform angular, columellar lamella ascending inwardly; palatal folds long, the lower-palatal deep-seated, emerging only about to the inner end of the upper; basal fold small, subcolumellar in position.

Length 1.7, diam. 0.95 mm.

Length 1.6, diam. 0.9 mm.

MAINE: Woodland, Aroostook County (O. O. Nylander). Type 62.20386 Carnegie Museum. ONTARIO: Ottawa, Carleton County; Temagami Provincial Forest, Nipissing District; Onakawana, Cochrane District (Oughton)

By the fine striation it has some resemblance to *V. gouldi* and might be regarded as an extreme form of *V. g. paradoxa*, as Dr. Sterki has suggested to me. The color is more that of *V. bollesiana*. It differs from those, and from all other American species, by the deeper immersion of the long lower-palatal fold, and the deep impressions in the back, over the palatals. Description and figures from a cotype, 98331 A.N.S.P.

VERTIGO GOULDI GROUP

Small shells, mostly less than 2 mm. long, and rarely more, oval or sub-cylindric, usually distinctly, finely and sharply striate, especially on the penult whorl. Parietal, columellar and two palatal teeth moderately developed, angular and basal (subcolumellar) either present or wanting.

Quite a natural group of little vertigos, in which the teeth are less developed than usual in the *ovata* group, but more than in the *modesta* group; there is not the strong tendency to degeneration of teeth seen in the latter.

Key to species

I. Northern and northeastern species, east of the 100th meridian.

1. Shell sharply, finely striate 2
Striation weak and delicate; length 1.5 mm.; New England and Middle States.
bollesiana
2. Lower-palatal fold much more deeply placed than the upper. 3
Lower-palatal not, or little farther in than the upper. 4
3. Angular lamella present; palatals very long; a very deep impression over them outside; Maine. *nylanderi*
No angular lamella; teeth 1-1-3. 5
4. Crest moderate or small; E. Canada to Iowa and N. Ala. *gouldi*
Crest strongly developed; Canada. *gouldi cristata*
5. Length 1.75 mm.; Newfoundland to Mich. *gouldi paradoxa*
Length 2 mm.; external impression deeper; Mo. *gouldi hubrichti*

II. Southern species (Gulf States).

1. Basal (subcolumellar) fold present, teeth 1-1-3 or 2-1-3. *gouldi*
No basal fold; teeth 2-1-2; shortly oval 2
2. Shell 1.8 mm. long, cinnamon colored; Ala. *wheeleri*
Smaller, 1.25 mm.; corneous; Florida Keys *hebardei*

III. Western species (west of the 100th meridian).

1. Shell 2 to 2.3 mm. long; a low crest; parietal and columellar lamellae present, sometimes an angular; 2 long palatal folds. Alpine, N. M. to Ore. *V. concinnula*
Smaller, 1.5 to 1.8 mm. long. 2
2. No angular lamella. 3
An angular lamella present; crest wanting or very weak. 5
3. No noticeable palatal callus; a low crest. 1.7-1.9 mm. long. Mountain forms. ... 4
A strong palatal callus and high crest; 2-1-3 teeth; 1.5 × 0.8 mm. North Dakota.
V. arthuri
4. Teeth 1-1-2, no basal fold. *gouldi coloradensis*
Teeth 1-1-3, a basal present. *gouldi basidens*
5. Teeth 2-1-2, no basal fold. *gouldi arizonensis*
Teeth 2-1-3, a basal present. 6
6. Diameter 1 mm. or more; striation irregular. Western Kansas. *V. hannai*
Diam. under 1 mm. Santa Catalina Mts., Arizona. *gouldi inserta*

Vertigo gouldi (Binney)

Page 958, fig. 515:4, 5, 8.

Pupa gouldii Binney, 1843, Proc. Bost. Soc. Nat. Hist., 1:105.*Vertigo gouldii* Binney, Terr. Moll., 2:332, pl. 51, fig. 2.—W. G. Binney, 1878, Terr. Moll., 5:214.—Pilsbry, 1919, Man. Conch., 25:98.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:78 (West Virginia).

Shell oval to cylindric-oblong, light chestnut colored, closely and *sharply striate*, especially the penult whorl. Last whorl with a crest close behind the lip. Aperture with an upper bay or sinulus, the outer lip flattened or a little inflexed below it, being slightly biarcuate. The teeth are white; angular lamella only rarely present; parietal lamella strong and rather long; columellar lamella strong, a subcolumellar basal fold below it. Two palatal folds strong, rather near together, the lower a little farther inward.

Length 1.75 mm., diameter 1 mm.; 5 whorls.

Length 1.5 mm., diameter 1 mm.; 4½ whorls.

Distribution.—Prince Edward and Magdalen Is., Quebec and Ontario. Maine to Missouri, south to Harlan Co., Kentucky; Marion and Unicoi counties, Tennessee, and northern Alabama.

The very distinctly striate surface is characteristic. The crest behind the lip is not so strong as in *V. pygmaea*. It is rather generally distributed in New England and New York, but more local southward, where it appears to follow the mountains to Tennessee and northern Alabama. According to F. C. Baker (1939) it is not found in Indiana and Illinois. I have not seen specimens from the far western localities which have been recorded, Field, B. C., Helena, Montana, and the Pleistocene of Phillips Co., Kansas. The shells from these places should be compared with *V. g. coloradensis*.

Including the races *paradoxa* and *cristata*, *V. gouldi* inhabits "probably all Ontario. Our records show it ranges from Lakes Erie and Ontario north to James Bay and northwest to Borthwick Lake; widespread but variable. The typical form is rather scarce and I have seen it in abundance only from Hastings County. Those from areas north of Ottawa do not have a well-developed basal (infracolumellar) tooth (dependent on calcium content of soil?)" (J. Oughton).

***Vertigo gouldi paradoxa* Sterki**

Page 967, fig. 518:6. 8; fig. 520.

Vertigo gouldi paradoxa Sterki (in Nylander, 1900, *Nautilus*, 13:103).—Pilsbry, 1919, *Man. Conch.*, 25:99, pl. 12, figs. 6, 8; 1931, *Man. Conch.*, 28:95.—Franzen, 1947, *Trans. Kansas Acad. Sci.* 49:414 (Pleistocene of N. W. Kansas).

The lower-palatal fold is placed decidedly farther in than the upper; a basal (or subcolumellar) fold is often absent. Outer lip straightened. No angular lamella. Length 1.75 mm., diameter 1 mm.

NEWFOUNDLAND: Hannah Head, Humber River, Bonne Bay, Haha Bay and Bar Harbor Hill, Straits of Belle Isle (Bayard Long). Anticosti Island, P. Q. (M.C.Z.). ONTARIO: Ottawa (G. W. Taylor); probably all Ontario, but none seen from counties bordering Lake Erie (Oughton). MAINE: Woodland, Aroostook Co., type locality (Nylander). MICHIGAN: Douglas Lake, Cheboygan Co. (H. B. Baker).

Figured from cotypes, 119007 A.N.S.P., and from a Newfoundland example, Fig. 520. It stands midway between *gouldi* and *nylanderi*, but has shorter palatal folds than the latter, no angular lamella, and is less deeply impressed externally.



Fig. 520. *Vertigo gouldi paradoxa*, Hannah Head, Newfoundland.

***Vertigo gouldi cristata* Sterki**

Page 967, fig. 518:4, 5.

Vertigo gouldii cristata Sterki in Pilsbry, 1919, Man. Conch., 25:100, pl. 12, figs. 4, 5.

"The shell is rather large, about 2 mm. long (1.8 to 2.1); form cylindrical to somewhat oblong, barrel-shaped. Surface striae rather fine. Some distance behind the outer and basal lips there is a rather large, conspicuous crest, which does not extend above the middle; behind it there is a broad flattening or impression over the palatals, the base being narrow there, then becoming rather broadly rounded towards the aperture. A small angular lamella may be either present or wanting. There is no basal ('lower columellar') fold." (Sterki.)

Length 2.1, diam. 1.2 mm. (fig. 4).

QUEBEC: rather abundant (A. W. Hanham). ONTARIO: on Michipicoton R., N. Shore Lake Superior (Ferriss).

A strongly marked race, having the crest as well developed as in many examples of *V. pygmaea*, but without a callus in the palate, and with the sculpture of *gouldi*. Figured from cotype, 119008 A.N.S.P.

***Vertigo gouldi hubrichti* Pilsbry**

Fig. 521.

Vertigo gouldii hubrichti Pilsbry, 1934, Man. Conch., 28:99, pl. 22, figs. 12-14.

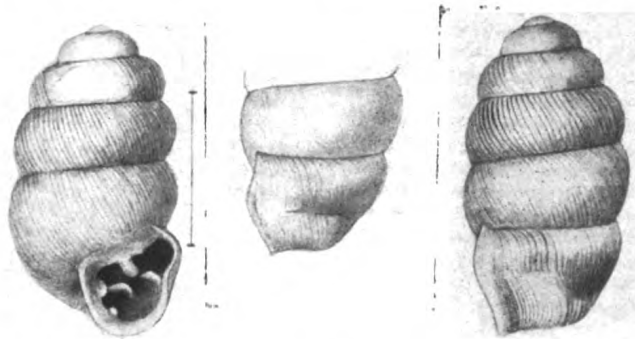


Fig. 521. *Vertigo gouldi hubrichti*, type and paratype.

The shell is subcylindric, larger than *V. nylanderi* Sterki, with a similar long and deep impression over the palatal folds. The lower-palatal is deeply immersed. There is no angular lamella. The basal fold is well developed. The intermediate whorls are strongly, sharply striate as in other forms of *V. gouldi*. It differs from *V. g. paradoxa* by the deep external impression over the palatal folds.

Length 2 mm., diam. 0.9 mm.; 5 to 5½ whorls.

MISSOURI: Loess of Mona, St. Louis Co., type and paratypes 160362 A.N.S.P., collected by Leslie Hubricht.

Vertigo gouldi coloradensis (Cockerell)

Page 967, fig. 518:13; fig. 522.

Pupa coloradensis Cockerell, 1891, British Naturalist, p. 100.

Vertigo coloradensis Ckll., Sterki, 1892, Nautilus, 6:5.—Cockerell, 1897, Nautilus, 10:134.—Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 603.—Pilsbry, 1919, Man. Conch., 25:115; 28:95.

Vertigo columbiana utahensis Sterki, in Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 603.

“Shell brown, shiny, thinnish, translucent to show teeth through from outside, striate, especially on penultimate whorl. Outline oblong-oval, barrel-shaped, apex blunt. Whorls four. Aperture pyriform. Peristome brown, thick, continuous by a well-marked callus on parietal wall. Outer lip not constricted; a crest is indicated behind peristome, but not well developed. The teeth within the aperture are brown, one long one on parietal wall, one on columellar, and two, the lower one largest, on outer wall. Length 1.75, diameter 1 mm.” (Cockerell.)

COLORADO: near Swift Creek, Custer Co. (Cockerell), Type in B.M.

UTAH: Box Elder canyon at 4500 ft. (H. Hemphill). ARIZONA: Pine Canyon, at 7500 ft., and head of Cave Creek canyon, 8000 ft., Chiricahua Mts. (Ferriss).



Fig. 522. *Vertigo gouldi coloradensis*, Type. Cockerell, del.

It differs from *V. concinnula* by the smaller size, from *V. gouldi* by the absence of a basal fold and the coarser striation; typically it is also a trifle smaller than usual in *gouldi*, measuring 1.75 mm. long, 1 wide, while *gouldi* is generally 1.85 to 2 mm. In *V. g. paradoxa* the lower-palatal fold is a little more deeply placed, but the difference is small, and the distinction would be difficult if their ranges were not so widely separated.

A few specimens from the Chiricahua Mountains are slightly larger, 1.9 × 1.1 mm.

V. columbiana utahensis from Box Elder canyon, northern Utah, at 4500 ft. is the same thing. The type 119009 A.N.S.P., is drawn in Fig. 518:13.

***Vertigo gouldi basidens* Pilsbry & Vanatta**

Page 967, fig. 518: 15.

Vertigo coloradensis basidens Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 604.—Pilsbry, 1919, Man. Conch., 25:117, pl. 12, f. 15.

Cylindric-oblong, chestnut-brown, with strongly striate middle whorls, and with a parietal lamella only on the parietal wall, as in *V. coloradensis*; but having a small, short basal fold within the junction of columellar with basal margins; the lower palatal fold is especially long; there is a more or less distinct callus running upward from the outer end of the upper palatal fold; finally, there is a wide and more or less prominent crest behind the lip. Length 1.8, diameter 0.95 mm.

NEW MEXICO: Bland, Bernalillo Co. (Ashmun), type 19467 A.N.S.P. COLORADO: Rio Blanco (Cockerell). MONTANA: Ward (L. E. Daniels). BRITISH COLUMBIA: Field (S. Brown).

The palatal folds, especially the lower, are decidedly longer than in *V. gouldi*. The crest is rather broad and sometimes decidedly prominent, more so than in any closely related form.

Two specimens from Field, B. C. measure: 1.75×1.05 and 1.95×1 mm. Those from Ward, Mont., have the crest especially strong and light colored, and the callus above the upper-palatal fold is quite heavy.

***Vertigo gouldi arizonensis* Pilsbry & Vanatta**

Page 967, fig. 518: 14, 16.

Vertigo coloradensis arizonensis P. & V., 1900, Proc. Acad. Nat. Sci. Phila., p. 604, pl. 23, fig. 9.—Pilsbry, 1919, Man. Conch., 25:117, pl. 12, fig. 14, 16.

"Shell cylindric-oval, rimate, very small; very densely and sharply but most minutely striate; light brown. Whorls convex, the last tapering below, the later half whorl narrow as though pinched at base, flattened over the position of the palatal folds, then rising in a low, hardly noticeable crest, obsolete except near the base. Aperture irregularly truncate-oval, the peristome well expanded, brown. Denticles 5, the parietal lamella high and strong, a minute angular lamella standing near its outer end. Columellar lamella entering obliquely, ascending a little. Upper and lower palatal folds very long, rising conically in the middle, distinctly showing through from the outside, the lower fold being a little stronger and more immersed, its position marked by a depression outside. There is no palatal callus." (Pilsbry & Vanatta.)

Length 1.8 mm., diameter 0.9 mm.; $5\frac{1}{2}$ whorls.

Length 1.7 mm., diameter 0.9 mm.; 5 whorls.

ARIZONA: Mt. Mingus, near Jerome, 8500 ft., Type 119010 A.N.S.P., and on Oak Creek, 40 mi. from Jerome, Yavapai Co. (Ashmun); Bill Williams Mt., Coconino Co.; Graham Mts. and Black River, Graham Co.; Dragoon and Chiricahua Mts., Cochise Co. (Pilsbry and Ferriss). NEW MEXICO: Grants, Valencia Co. (Joshua Baily); Bland, Bernalillo Co. (Ashmun); Mogollon Mts. (Ferriss & Daniels); Black Range (Ferriss & Pilsbry).

This race, which has been found in large numbers, is somewhat narrower than *V. g. coloradensis*, and invariably has an angular lamella. The palatal folds are long, and there is no basal or subcolumellar fold.

***Vertigo gouldi inserta* Pilsbry**

Page 967, fig. 518: 10, 11.

Vertigo coloradensis inserta Pilsbry, 1919, *Man. Conch.*, 25:118, pl. 12, fig. 10, 11.

Similar to *V. g. arizonensis* in size, shape and sculpture, and in possessing a small angular lamella; but the parietal and columellar lamellae are larger and thicker, and there is a basal fold. Length 1.7 to 1.85 mm., diameter 0.9 mm.; 5 whorls.

ARIZONA: many places in the Santa Catalina Mts. between 8500 and 9500 ft., the Type, 109559 A.N.S.P. from Bear Wallow. Mahan Mt., Coconino Co.; Rucker Canyon, Chiricahua Mts.; all coll. by Ferriss.

No other race of *gouldi* has been found in the Santa Catalinas.

***Vertigo gouldi hannai* Pilsbry**

Page 967, fig. 518: 12.

Vertigo martini Hanna & Johnston, 1913, *Kansas University Science Bulletin*, 7:120, pl. 18, fig. 3. Not *V. martini* Sayn, 1911.

Vertigo hannai Pilsbry, 1919, *Man. Conch.*, 25:114, pl. 12, fig. 12.

Shell light brown; ovate; lines of growth faint and oblique. Whorls $4\frac{1}{2}$, well rounded, the sutures well impressed. Apex smooth and white and obtusely pointed. Peristome thin and sharp, slightly expanded, almost no indentation in the upper palatal wall. Aperture semicircular with six teeth. Two on the parietal wall, both of which are lamellar, the angular tooth is the smaller of the two, one columellar in the center of that wall; this tooth is bifid, that portion toward the apex being the larger. One basal tooth, small and nodule-like. Two palatals, both of which are lamellar; the lower one is the larger.

Length 1.77, diameter 1.04 mm. Length 1.63, diameter 1.04 mm.
Length 1.74, diameter 1.04 mm. Length 1.55, diameter 1.04 mm.

KANSAS: Phillips County, along Prairie Dog creek between Norton and the Republican river, Pleistocene (Hanna & Johnston). Type 226396 U.S.N.M.; paratype 119658 A.N.S.P. ILLINOIS: Carlinville, Macoupin Co., Yarmouth interglacial loess (F. C. Baker).

The entire absence or merely indistinct trace of a crest behind the lip, the slighter "auricle" of the latter, and the shorter palatal folds, as well as the somewhat shorter, wider shape, separate this species from *V. binneyana*, which is otherwise similar. It does not agree in detail with any of the mountain forms of *V. gouldi* though closely related to them. The striation is of irregularly, rather widely spaced wrinkles, as strong as in *V. g. coloradensis* but decidedly less regular and less crowded than on the penult whorl of that species. The outer lip is not at all expanded, rather blunt. The parietal lamella is rather long, as in *V. g. coloradensis*. *V. g. hannai* is very closely related to *V. gouldi*, but differs by having slighter striation, a well-developed angular lamella, not a character of great importance, but probably constant in *hannai*.

Vertigo arthuri Von Martens

Fig. 523.

Vertigo bollesiana var. *arthuri* E. von Martens, 1882. Sitzungsber. Ges. Nat. Freunde Berlin, Nr. 9, p. 140.

Vertigo arthuri Martens, Pilsbry, 1919, Man. Conch., 25:121.

"Shell ovate, striatulate, perforate, of 5 rather swollen whorls; the aperture triangular, outer margin *thickened within*; 2 palatal folds, 2 columellars, the upper one larger, and 1 strong parietal. Length 1.5, diam. 0.8, apert. 0.5 mm." (Martens.)

NORTH DAKOTA: Little Missouri (Arthur Krause). Type and paratype 34987 Zool. Mus., Berlin.

"It differs from the type form of the species [*V. bollesiana*] by the strongly thickened outer margin and the somewhat stronger dentition" (Martens).

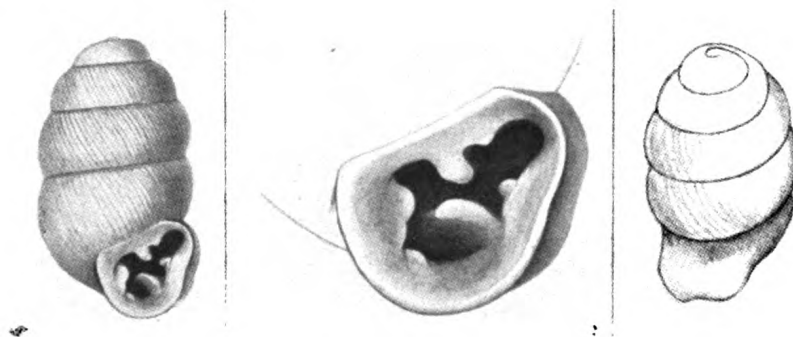


Fig. 523. *Vertigo arthuri*, three views of the type.

The locality is at or near Medora or Little Missouri Station of the Northern Pacific R. R., in Billings County, North Dakota. By the kindness of Dr. Bernard Rensch and the authorities of the Zoologisches Museum der Universität, Berlin, I was able to study the two specimens collected, and to figure the type. The shells are bleached, probably collected from river drift.

It is subcylindric with convexly-conic spire, very obtuse summit; of $4\frac{3}{4}$ moderately convex whorls, the first $1\frac{1}{2}$ smooth, the following finely and rather sharply striate, the striation weaker on the last whorl, which has a *strong, wide crest* behind the lip. The small aperture is somewhat piriform, with a small, tubercular angular lamella⁸⁴ near the rather large and long parietal lamella. Columellar lamella is stout, a convex callus against its lower side. The outer lip is *very heavily calloused* a short distance within; a short upper-palatal fold and a long and deeply entering lower-palatal run inward from the callus. The basal fold is quite small, near the base of the

⁸⁴This angular lamella was overlooked in the original description, but it is present in both of the specimens; small, but distinct under sufficient magnification after the aperture was swabbed out.

columella. Length 1.68 mm., diameter 0.95 mm., greatest length of aperture 0.66 mm.

While this snail is evidently related to the mountain forms *V. gouldi inserta* and *V. g. basidens*, it differs conspicuously by the wide crest behind the lip (highest in the outer-basal position, as in the right-hand figure), and by the very thick palatal callus, in which the palatal folds terminate. The two specimens collected are closely similar. *V. arthuri* appears quite distinct from all of our known vertigines. Though discovered more than sixty years ago, it has not been found by American malacologists, the molluscan fauna of the upper Missouri valley still remaining almost unknown.

***Vertigo concinnula* Cockerell**

Fig. 524: page 991, fig. 531: 9, 10.

Vertigo californica Rowell, Ingersoll, 1875, Bull. U.S. Geol. Surv., 1:128, no description; not of Rowell

Vertigo ingersolli Ancey MS., Cockerell, 1889, Jour. of Conch., 6:64, name only; substitute for *V. californica* Ingersoll not Rowell.—Sterki, 1892, Nautilus, 6:5, with var. *haydeni* Anc. and *accedens* Anc., names only.

Pupa ingersolli Ancey MS., Cockerell, 1891, British Nat., p. 101; reprinted by Pilsbry, 1902, Nautilus, 16:59.

Vertigo concinnula Cockerell, 1897, Nautilus, 10:135.—Pilsbry, 1919, Man. Conch., 25:119.—Henderson, Univ. Colo. Studies, 13:139.—MacMillan, 1946, Nautilus 59:122.

[*P. ingersolli*] var. *accedens* Anc., Cockerell, 1898, Nautilus 11:136.

Shell ovoid-cylindric, very slightly tapering to the blunt apex, somewhat solid and opaque, so that the palatal folds are usually seen only dimly through the shell; irregularly *striate*, most strongly on the penult whorl; cinnamon colored, often with buff flecks. Last whorl decidedly flattened on the outer-inferior part, and with a low wave-like crest behind the lip. Peri-

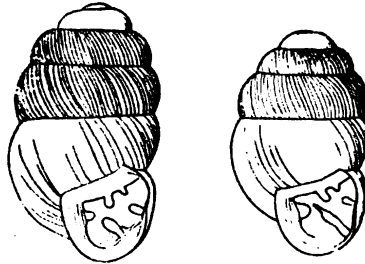


Fig. 524. *Vertigo concinnula*, Willow Creek, Mogollon Mts., N. M.

stome slightly expanded. Parietal margin with a strong, entering parietal lamella in the middle, and usually a small angular lamella. Columellar lamella strong, deeply placed. Outer wall with two rather low, long palatal folds, the lower one longer. Length 2.1 mm., diameter 1.2 mm.; 5 whorls.

OREGON: Wallowa Valley, Wallowa Co (H. Burrington Baker). IDAHO: Bonner, Shoshone, Benawah, Clearwater, and Adams counties (H. B. Baker). WYOMING: 29 mi. south of Jackson (W. O. Gregg). SOUTH DAKOTA: Whistler Gulch, near Deadwood

(H.B.B.). COLORADO: generally distributed at 6-10,000 ft., Type 59095 A.N.S.P., from near Brush Creek, Custer Co., at 10,000 ft. (T. D. A. Cockerell). UTAH: Blue Mts., San Juan Co. (Ferriss). ARIZONA: Mt. Mingus, near Jerome (Ashmun); Bill Williams Mountain (Ferriss). NEW MEXICO: Beulah, Sapello Canyon (Cockerell); Bland, Jemez Mountains and Capitan Mountains (Ashmun); Sacramento Mountains (Viereck); Mogollon Mountains (Ferriss).

The smaller, dull, rather opaque shell, with long palatal folds and long parietal lamella, separate this from *V. modesta* and its varieties. *V. g. coloradensis* and *inserta* are smaller. The specimens from Arizona and New Mexico are of a clearer, more translucent cinnamon color than those from Colorado, and the crest is often well developed; length 2 to 2.3 mm. The same is true of many of the northern specimens, which approach *V. modesta insculpta*, in size, color and sculpture, but differ by having a strong crest. An Oregon shell measures 2.4×1.25 mm.

Ancey's descriptions were published by Cockerell in 1898, too late to affect the nomenclature of the species; but to complete the account they are reprinted here.

"Var. (?) *haydeni* Anc. Testa praecedenti [*ingersolli*] statura formaque simillima, sed dentibus palatalibus 3 parallelis et aequalibus elongatus, nec 2, discrepans. Cunningham Gulch (Ingersoll)."

"Var. *accedens* Anc. Testa typo similis, sed tuberculo parietali distincto prope dentem armata." (Nautilus, 11:136. 1898.)

We need not waste space with further consideration of the involved nomenclature of this species, which has been sufficiently discussed by Cockerell, 1897, Pilsbry and Vanatta, 1900, and by the author, 1902, 1919. The names prior to *concinna* were provided with absurdly inadequate definitions or none.

***Vertigo wheeleri* Pilsbry**

Fig. 525.

Vertigo wheeleri Pilsbry. 1928, in Walker, Terr. Moll. Alabama; Univ. Mich. Mus. Zool. Misc. Pub. No. 18, p. 146, fig. 224; Man. Conch., 28:96, pl. 15, fig. 1.

Obesely oval, the diameter about two-thirds of the length, cinnamon colored, first $1\frac{1}{2}$ whorls pale and smooth, the rest closely and finely striate, striation rather strong about as in *V. g. coloradensis*, somewhat coarser on the penult than on the last whorl. Whorls strongly convex, the last becoming a little flattened peripherally, and having a weak, wide swelling or crest behind outer and basal lips. Five teeth: an angular tubercle, a higher, long parietal lamella, columellar lamella horizontal, rather short; two palatal folds are short. The lip is slightly expanded, the outer margin noticeably straightened in the middle, and in profile view seen to be weakly arched forward there. Length 1.6 mm., diameter 1.05 mm.; $4\frac{1}{2}$ whorls.

ALABAMA: Monte Sano, near Huntsville, type 144810 A.N.S.P. (H. E. Wheeler).

At one time it was identified as *V. concinna* (Nautilus, 25:124), but that is larger, with longer palatal folds, though similar in sculpture. *V. wheeleri* has the ventricose figure of *V. hebardei*, but it is larger, less fragile

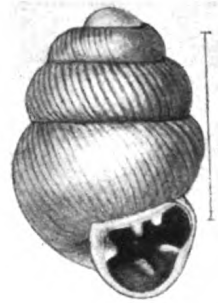


Fig. 525. *Vertigo wheeleri*, Type. Scale line = 1 mm.

and more strongly striate. It is decidedly more ventricose than *V. gouldi*, which moreover possesses a basal fold and generally lacks an angular lamella.

***Vertigo hebardei* Vanatta**

Page 949, fig. 510:4; fig. 526.

Vertigo hebardei Vanatta, 1912, Proc. Acad. Nat. Sci. Phila., p. 445, text figure.—Pilsbry, 1919, Man. Conch., 25:103, pl. 8, fig. 4.—Clapp, Nautilus, 33:141.

The shell is minute, distinctly perforate, very shortly rimate, shortly oval, fragile, corneous; first whorl smooth, the penult irregularly, finely striate, last whorl with few striæ; glossy. The whorls are rather strongly convex, the last not noticeably flattened or grooved, and without a crest behind the lip. The aperture is indistinctly triangular and has 5 teeth: angular lamella very low, half as long as the rather short, high parietal.

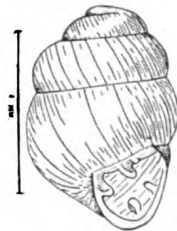


Fig. 526. *Vertigo hebardei*, after Vanatta. Scale line = 1 mm.

The columellar lamella enters deeply and horizontally, its crest slanting downward. The palatal folds are rather short, subequal, the lower being slightly stouter and a trifle farther in. The outer lip is scarcely expanded, somewhat straightened, without a projecting point. Length 1.25 mm., diameter 0.84 mm.; 4 whorls.

FLORIDA: Long Key (Morgan Hebard), Type 106359 A.N.S.P. Pumpkin Key. Big Pine Key, Elliot Key, Porgee Key, Little Palo Alto Key, Noname Key and Lignum Vitae Key (G. H. Clapp).

It is most like *V. bollesiana*, but the shell is shorter, has a distinct angular lamella and no external crest or impression behind the lip.

Vertigo bollesiana (Morse)

Page 958, fig. 515:9, 10.

Isthmia bollesiana Morse, 1865, Ann. Lyc. Nat. Hist. of N. Y., 8:209, figs. 4-6.

Vertigo bollesiana Morse, Binney, 1878, Terr. Moll., 5:215.—Pilsbry, 1919, Man. Conch., 25:101.

Shell minutely perforate, cylindrical ovate, delicately striated, subtranslucent; apex obtuse; suture well defined; whorls four, sub-convex; aperture suborbicular, somewhat flattened on its outer edge; with five teeth, one prominent and rather curved on the parietal margin, two similar in form, the lower one the smaller, on the columellar margin, and two slightly elevated lamelliform teeth within and at the base, peristome subreflected and thickened. Length .065 inch; breadth .035 inch (Morse).

Distribution.—Southern Ontario, north to Lake Temagami: (27 lots.) I have seen this species abundant in only one area, Hastings County (John Oughton). Maine: throughout the State, type loc. Orono. Massachusetts, New Hampshire, New York. (Also reported from Indiana and Michigan, south to Norfolk, Virginia, Morse, and mountains of East Tennessee.)

There is an extremely small crest close behind the lip, and a rather large oblique depression over the palatal folds. The basal fold is subcolumellar in position, and rarely it is absent. As Morse said, it is smaller, lighter-colored and more transparent and delicate than *V. gouldi*, and it is *less distinctly striated*. The teeth are smaller, especially the palatals. Length 1.5, diameter 0.9 mm.; 4½ to 4¾ whorls.

According to Morse, it occurs under dead leaves and on bark, in hardwood groves. It appears to be rare except in Maine. The specimens at hand are from New England and New York. The western records, Michigan, Ohio, Indiana, and those from East Tennessee I have not been able to verify personally. Dr. Sterki wrote that he had no specimens from Michigan and Ohio.

VERTIGO MODESTA GROUP

Moderately large species, 2 to 3 mm. long, without sharp striation (except in *V. m. insculpta* and *V. m. sculptilis*), and *never having a basal or subcolumellar tooth*, the tooth formula varying from 0-0-0 to 2-1-2. Auricle weakly or not developed.

It is a circumpolar boreal group, becoming alpine in temperate latitudes. They are the common vertigines of British America, Alaska, and of the mountain states.

A tendency to reduce or eliminate teeth appears sporadically, in Greenland, Alaska and many places in the West; and as the number of teeth generally varies in the same colony, single specimens may not give a fair

impression of the local race. In dealing with forms of this group, even an expert with Pupillidae may often be perplexed, though specimens of the entire series of named forms may be at hand for comparison.

Key to species and races

1. Shell ovate, the spire tapering strongly; California. 2
Shell cylindric-oblong or cylindric-ovate; 0 to 5 teeth 3
2. Five moderate teeth; Donner Lake, Cal. *allyniana*
Five smaller teeth; San Bernardino Mts. *occidentalis*
No teeth; Lake Co., Cal. *dalliana*
3. Greenland; 0 to 3 small teeth. *hoppii*
Continental North America. 4
4. Surface sharply, finely striate; mountain states. 5
Not sharply striate. 6
5. Teeth very small, 2-1-2 to 1-1-0; Mont. to Ore. *sculptilis*
Teeth larger, 2-1-2; Arizona. *insculpta*
6. No teeth. Alaska, *ultima*; California, *castanea*
Two to five teeth. 7
7. Teeth quite small; California. *castanea*, *microphasma*
Teeth moderately developed. 8
8. Teeth 2-1-2. *parietalis*
Teeth 1-1-2; form stout. *corpulenta*
Teeth 1-1-2 or 1-1-1; form more elongate. *modesta*

Vertigo modesta (Say)

Fig. 527; page 991, fig. 531: 1, 2; fig. 528: 1-3.

Pupa modesta Say, 1824, Long's Second Exped., Appendix, p. 259, pl. 15, fig. 5.

Vertigo modesta Say, Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 600, pl. 23, fig. 2, 3, 6.—Dall, 1905, Alaska, Land and Freshwater Moll., p. 29. Pilsbry, 1919, Man. Conch., 25:123.—Berry, 1922 Canada Dept. Mines Bull., 36, p. 13 (Kananaskis, Alberta; 3-toothed).

Pupa decora Gould, 1848, Proc. Boston Soc. N. H., 2:263.—Binney, Terr. Moll., 5:201.

Vertigo modesta ultima Pilsbry, 1919, Man. Conch., 25:128, fig. 4, 4a.

The cylindric-oblong shell is from tawny to cinnamon colored, glossy, rather weakly striate, the striation more distinct on the middle whorls. The last whorl has a weak crest behind the obtuse, brown outer lip, which expands very little, and is not noticeably caught in to form a sinus. Teeth four, white: the parietal and columellar lamellae and lower-palatal fold subequal, short; the upper-palatal fold smaller. Length 2.6, diameter 1.3 mm.; 5½ whorls.

Distribution.—Labrador, James and Hudson Bays, Lake Superior, westward, over the crest of the Rocky Mountains (Field, B. C.) to Victoria and Nanaimo. Reported locally in Maine, Vermont and Connecticut. Loess of Iowa (Iowa City, Des Moines), Missouri and Kansas (Phillips Co.). Alaska, abundant. The typical *modesta* replaced in the Rocky Mountain system and California by various weakly differentiated races.

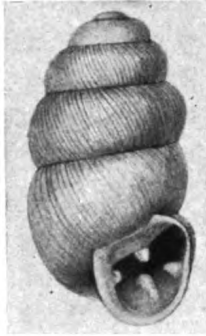


Fig. 527. *Vertigo modesta*, loess of Mona, Missouri.

An imperforate cylindric-oblong or somewhat ovate shell, with short, rather small teeth arranged in form of a cross, or not infrequently the upper palatal fold is wanting, especially in examples from the loess of Iowa. It is widely distributed in the Dominion of Canada and Alaska, and in the loess formation of Iowa and Kansas.

V. modesta differs from typical *V. m. corpulenta* by the more cylindric shell, with one whorl more, but intermediate individuals or lots occur in the West. No specimens having a distinct angular lamella are known from east of the Rocky Mountains.

There are numerous forms and mutations, some of them apparently subspecies characteristic of definite areas; others, such as *parietalis*, often occur associated with various races in the same populations. The subspecific taxonomy is more or less arbitrary.

This is the most abundant and widely distributed species in the north country. The type locality of *modesta* was somewhere near or west of the western end of Lake Superior. *P. decora* also came from the region of Lake Superior. The two names were evidently applied to exactly the same race. A photographic copy of Gould's figure of *P. decora* is given in fig. 528:1.

It is a variable snail. A specimen from Labrador measures, length 1.9, diameter 1.2 mm., and is closely striate on the penult whorl. Specimens from the loess of Iowa are quite variable in form and size. Those figured measure:

Length 2.65, diameter 1.45 mm. (fig. 528:2a, Iowa City).

Length 2.4, diameter 1.35 mm. (fig. 528:2, Iowa City).

Length 2.3, diameter 1.2 mm. (page 991, fig. 531:2, Des Moines).

The smallest of these, fig. 531:2, is rather strongly striate, much as in *V. concinnula*.

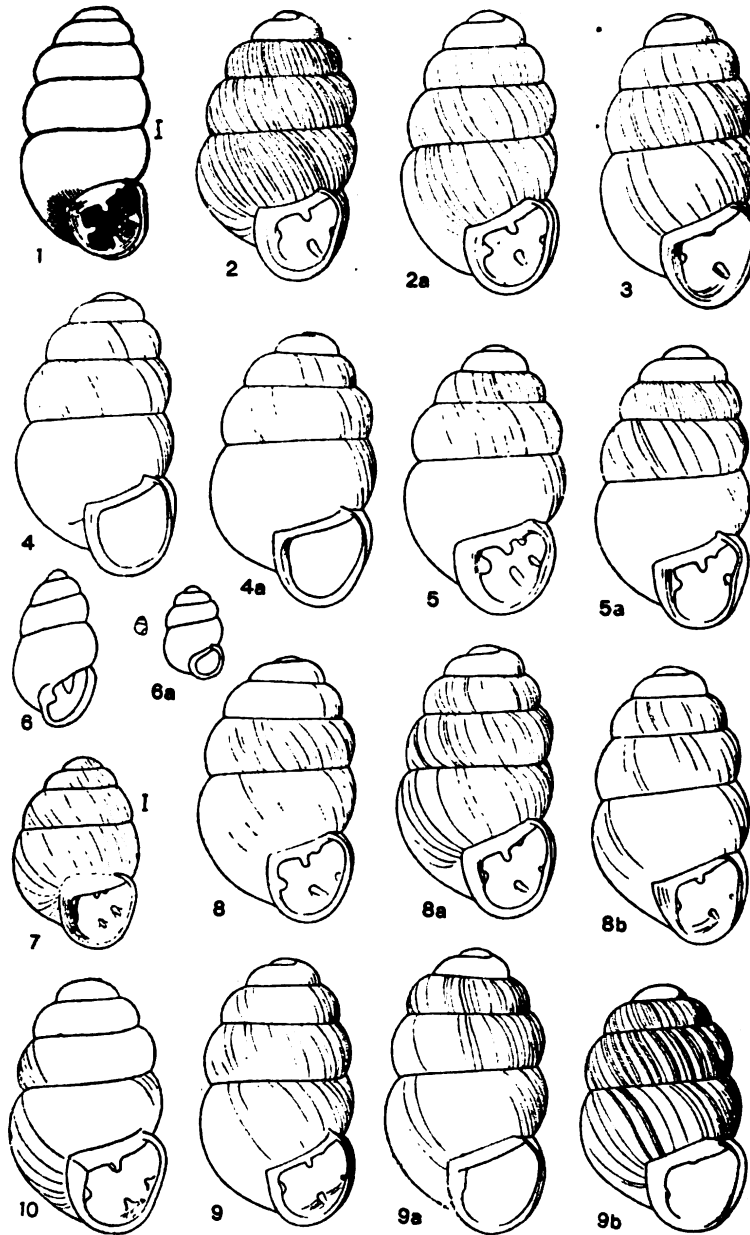


Fig. 528. 1, *Vertigo modesta* (Say), (photographic copy of Gould's original figure of *Pupa decora*). 2, 2a, *Vertigo modesta* (Say), Loess, Iowa City, Iowa, no. 11657. 3, *Vertigo modesta* (Say), form resembling *V. arctica* Wallenb. Length 2.6 mm., Norton Bay, Alaska, no. 79561. 4, 4a, *Vertigo modesta ultima* Pils. Norton Bay, Alaska, no. 79562. 5, 5a, *Vertigo modesta parietalis* Anc., Wickersham's, Miller Peak, Huachuca Mts., Arizona, no. 97509. 6, 6a, *Vertigo m. hoppii* Möller, (photographic copies of

It has been found by Mr. A. A. Hinkley in loess at New Harmony, Indiana, according to Dr. Sterki.

In a series from Dyea valley, Alaska, the size varies from 2.4×1.4 to 2.65×1.4 mm. The crest is rather strong. The teeth vary from typical to slightly larger, and in some of them a small angular lamella is added. The lot is intermediate between *modesta* and mut. *parietalis*, or rather, it includes both forms. A Dyea specimen was figured in Proc. Acad. Nat. Sci. Phila. 1900, pl. 23, fig. 2.

Specimens taken on Norton Bay, Alaska (R. C. McGregor) are deficient in teeth, an upper palatal fold being absent (fig. 528:3), the parietal and columellar lamellae small. Length 2.4 to 2.6, diameter 1.4 mm. It agrees rather closely with the description and figures of *V. arctica* Wallenbaum, described from Lapland, and I have no doubt is identical with the form listed as *V. arctica* from Port Clarence by Westerlund (Vega-Exped. Vet. Arbeten, iv, 153); yet I can but regard it as a form of *modesta*, in view of the fact that it is in the *V. modesta* area, and that a similar deficiency in teeth occurs in forms of *modesta* found in the loess of Iowa and in California.

Whether the north European and Siberian forms, *V. arctica* Wallenbaum, *V. krausseana* Reinhardt and *V. borealis* Morelet are specifically distinct from *V. modesta* need not be considered here, but they are certainly very similar. The latter name is anterior to all of them. Cf. W. G. Binney, Third Suppl., Bull. M.C.Z. 19:185, fig. of topotype of *P. borealis* Morelet.

Vertigo modesta form *ultima* Pilsbry. Fig. 528:4, 4a. On the north shore of Norton Sound, Alaska, Mr. R. C. McGregor obtained an entirely toothless form, having the shape and striation of *V. modesta*, and probably merely a terminal member of the mutation-series represented by the three-toothed form found elsewhere on Norton Sound. Like the latter, it is not distinguishable from the terminal forms of *V. m. castanea* except by the remote locality. It is smaller than *V. arctica extima* of central Siberia, and differs from *V. krausseana* by having no teeth and by the somewhat greater size.

Length 2.6 mm., diameter 1.4 mm.; type 79562 A.N.S.P.

Length 2.5 mm., diameter 1.5 mm.

***Vertigo modesta corpulenta* (Morse)**

Fig. 528: 10; page 991, fig. 531: 3.

Isthmia corpulenta Morse, 1865, Ann. Lyc. Nat. Hist. of N. Y., 8:210, fig. 7.

Pupa corpulenta Mse, W. G. Binney, 1878, Terr. Moll., 5:201.

Vertigo modesta corpulenta Mse., Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 601, pl. 23, fig. 7.—Pilsbry, 1919, Man. Conch., 25:130.—Henderson, Univ. Colo. Studies, 13:137.

Moersch's figures). 7, *Vertigo occidentalis* St. Type specimen. 8, 8b, *Vertigo modesta microphasma* Berry, Bluff Lake, San Bernardino Mts., Cal., no. 104659. 8a, *V. m. microphasma* Berry, Cienaga below Bluff Lake, no. 105767. 9, *Vertigo modesta castanea* St., Mouth of Big Arroyo, Kern R., Tulare Co., Cal., no. 115204. 9a, *V. m. castanea*, Wood's Creek, Tulare Co., no. 115203. 9b, *V. m. castanea*, Onion Valley, Kearsarge Pass, Inyo Co., Cal., no. 115199. 10, *Vertigo modesta corpulenta* (Morse), (photographic copy of Morse's figure.)

Pupa corpulenta Morse var. *parietalis* Ancy, 1887, Conch. Exch., 2:80.—Berry, 1919, Proc. Acad. Nat. Sci. Phila., p. 204 (Glacier National Park, abundant).

Vertigo modesta mut. *parietalis* Anc., Pilsbry, Man. Conch., 25:128.—Henderson, Univ. Colo. Studies, 13:137.

Vertigo modesta microphasma Berry, 1919, Nautilus, 33:48, figs. 1-6.—Pilsbry, 1919, Man., Conch., 25:373.

“Shell rimate perforate, elongate ovate, finely striated, polished, translucent, dark olive brown, apex round, obtuse; whorls four, convex, tumid, wider at the base, aperture large, sub-circular, with four obtuse teeth, one on the parietal margin, one on the columellar margin, and two on the labrum; peristome slightly thickened and reflected. Length, 0.1 inch; breadth 0.6 inch” (Morse).

NEVADA: Little Valley, Washoe Co., type loc., on the east slope of the Sierra Nevada, 6500 ft., above the sea (R. E. Stretch). Also over much or all of the area occupied by the form *parietalis*.

Decidedly more obese than *V. modesta*, of only about $4\frac{1}{2}$ whorls. The crest behind the lip is distinct, and the four teeth are short, the lower-palatal being tubercular or very short. Usual length 2.2 mm., diameter 1.35 mm. to 2.45×1.4 mm. A photographic copy of Morse's figure is given in fig. 528:10.

It is not known whether *corpulenta* occurs as a pure race. In a few small lots examined there are no *parietalis*, but all of the large lots available containing *corpulenta*, have *parietalis* also.

V. modesta form *parietalis* (Ancy). Fig. 531:4; fig. 528:5, 5a. “Shell having two teeth on the parietal wall” (Ancy). The shape varies from that of *corpulenta* to about that of *modesta*; whorls about 5. Teeth 5, there being an angular lamella; and the others are larger than in typical *corpulenta*. The surface is somewhat striate, as in *modesta* and *corpulenta*. Length 2.45 mm., diameter 1.3 mm.; $5\frac{1}{2}$ whorls.

Distribution.—Rocky Mountain region etc., the type from Ogden Canyon, Utah, in coll. Univ. Michigan.

In the Sierra Nevada counties of California *V. modesta* and *parietalis* appear to be rather abundant. They were collected in the valleys of the San Joaquin and King's rivers, Bear and Fish creeks, Fresno County, in many places, by Mr. Ferriss in 1917. In some lots four-toothed forms occurred with *parietalis*, the latter in the majority.

Lots from Pumice Flats, San Joaquin River, Bear Creek and Grouse Meadow, Kings River, are quite distinctly striate, much as in the Arizonan *insculpta*. In one lot from Simpson's meadow, Kings River, there are apparently adult shells having 5, 4 and 2 teeth (columellar and lower-palatal). By individuals these specimens could be referred to *parietalis*, *modesta* and *castanea*.

Other Californian forms of the species are noticed under *occidentalis* and *castanea*.

The size and shape are variable in the same lots. The shorter shells having 5 whorls or even less, the larger fully 5½ whorls.

Length 2.4, diameter 1.4 mm., Miller Pk., Huachucas (fig. 528:5).

Length 2.55, diameter 1.3 mm., Miller Pk., Huachucas (fig. 528:5a).

Length 2.4, diameter 1.3 mm., Boise Co., Idaho.

Length 2.7, diameter 1.35 mm., Boise Co., Idaho.

This form is far more generally distributed than the typical *corpulenta*. In some places, as in Ogden Canyon, Utah, the type locality, the two occur together; but in most localities all of the adult shells are *parietalis*. As forms with the *parietalis* teeth occur in some places associated with both *corpulenta* and with shells having the contour of typical *modesta*, the sub-specific status can hardly be allowed this form. I conclude that *parietalis* is the more primitive stock, and *corpulenta* a mutation thereof, which has not obtained so wide a distribution. Typical *V. modesta* is a more cylindrical form which has mutated from long *parietalis* in the same way by loss of the angular tooth; but as the five-toothed stock is not found east of the Rocky Mountains, where *modesta* has a wide range, the racial distinction may perhaps be retained.

Fig. 531:4 is from an Ogden Canyon specimen.

V. modesta form *microphasma* Berry. Page 984, fig. 528:8, 8a, 8b; fig. 529:1-6. In the high San Bernardino in southern California there is a form which has the subcylindric shape of *parietalis*, with a small crest behind the lip in some examples, none in others. The teeth vary from quite as small as in the type of *occidentalis*, or as in the most fully toothed forms of *V. m. castanea*, to as large as in some *parietalis*; and in some examples there is no angular lamella. Length 2.5 mm., diameter 1.35 mm., or slightly smaller. It seems to be an intermediate stage between *parietalis* and *castanea*, some individuals resembling one, others the other of these races; it may be regarded as a local *parietalis* stock in which the teeth are degenerating, a condition often encountered sporadically throughout the range of the species. Normally of chestnut color, many colonies contain also numbers of albino-shelled individuals, which Mr. Berry has described as *V. m. microphasma*. Similar albino shells occur here and there in other races of *modesta*, sometimes in considerable numbers. Albinism appears to be a mutation of frequent occurrence in the *modesta* group, but always, in my experience, the albinos exist in colonies together with colored shells.

The shell of form *microplasma* is cylindro-conic, rimate, thin, very pale horn color, by transmitted light transparent and colorless. The surface is glossy and distinctly irregularly, obliquely striate, especially on the upper whorls. The number of teeth varies from 2 to 5. The parietal and columellar lamellae are always well developed. In addition there is almost always a well-developed lower-palatal. A smaller, but variable upper-palatal is frequently present, as also a minute angular lamella. All the teeth are porcelain white in color.

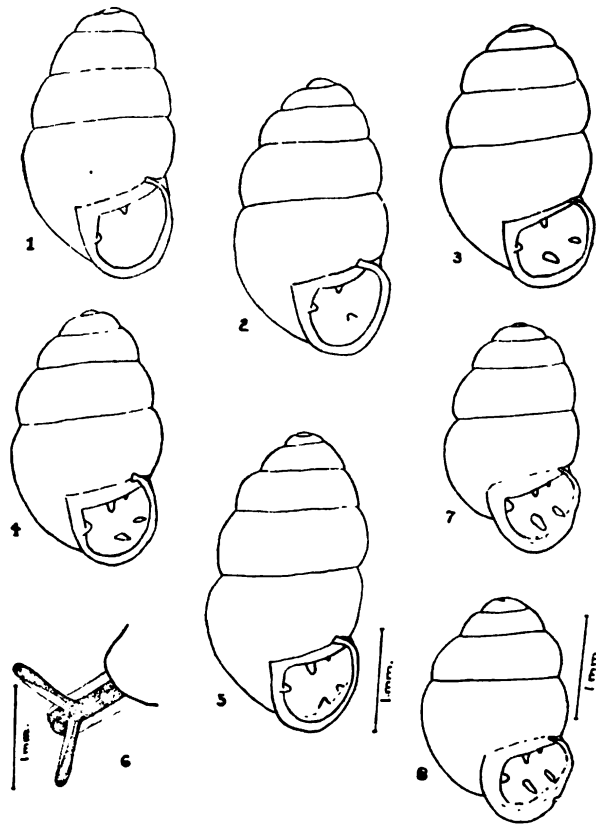


Fig. 529. 1-6, *Vertigo modesta* form *microphasma*. 7, *Vertigo allyniana*. 8, *V. a. zenos*. (After Berry.)

Length of type 2.6 mm., diameter to lip edge 1.5 mm., length of aperture 0.9 mm.; whorls 5.

CALIFORNIA: San Bernardino Mts., 7200-7550 ft. Type from near Bluff Lake, 2740 Berry coll.; paratypes 44788 A.N.S.P.

In 39 specimens from the type locality, one had two teeth, parietal and columellar; fifteen, including the type, have 3 teeth, a lower-palatal being added; nine have 4, and fourteen have 5 teeth.

***Vertigo modesta insculpta* Pilsbry**

Fig. 531: 12, 13.

Vertigo modesta insculpta Pilsbry, 1919, Man. Conch. 25:131, pl. 10, figs. 12, 13.

The shell is similar to *V. m. parietalis* in teeth, but differs by the distinct, rather sharp striation of the penult and antepenult whorls, sometimes also the last. Length 2.6 mm. diameter 1.35 mm.

ARIZONA: Bill Williams Mt., Coconino Co. (Ferriss); Santa Catalina Mts. in many localities, 9000-9500 ft., the type 109547 A.N.S.P., from Mt. Lemon, 9500 ft.; White Mts., Greenlee Co.; Blue River and Rim of Blue Mts., Greenlee Co.; Chiricahua Mts., at head

of Cave Creek and Long Park, about 8000 ft. (Ferriss). NEW MEXICO: Black Range, in the forest zone (Ferriss & Pilsbry. UTAH: Navajo Mt., near the Arizona line (Ferriss).

It differs from the southern form of *V. concinnula* by the larger size and typically shorter palatal folds, yet there is a certain amount of intergradation in both characters. In the Black Range, especially, there are often short specimens, down to 2.25 mm. long. Each of the ranges which ascends into the zone of coniferous forest appears to have either a smaller (*concinnula*) or a larger (*insculpta*) stock, in the average distinguishable, though individuals are often perplexing. The distinction is rather finely drawn, yet such as it is, has been reached after examining some thousands of fresh shells.

Specimens from Bill Williams Mt., in northern Arizona, are particularly sharply striate. They were recorded as *V. concinnula* in Proc. A.N.S. Phila. 1911, 197, but on account of their size, 2.4 to 2.5 mm. long, 1.4 wide, they appear more properly placed here. The specimens from the Chiricahua range, which were formerly recorded as *V. modesta parietalis* and *V. concinnula*, appear to be better placed here. They measure 2.4 to 2.5 mm. long.

At several places in the Santa Catalinas Mr. Ferriss found albino specimens. They have the translucent wax-like texture of *Gastrocopta pentodon* or *corticaria*. In every case they occurred in colonies of cinnamon-brown shells.

***Vertigo modesta sculptilis* Pilsbry**

Fig. 530 a-c.

Vertigo modesta sculptilis Pilsbry, 1934, Man. Conch., 28:100, pl. 24, figs. 2-4.

The shell has rather sharp sculpture on the penult and antepenult whorls of the spire, as in *V. m. insculpta*, but it differs by the *reduced size of the teeth*; small parietal and columellar lamellae and a lower-palatal fold

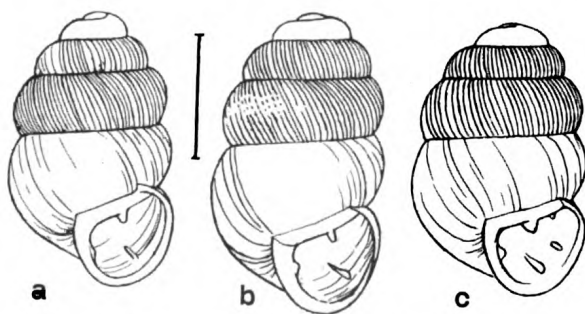


Fig. 530. *Vertigo modesta sculptilis*. Type and paratypes.

being present in the specimen taken as type; in others there may be minute traces of the upper-palatal fold and an angular lamella, but still other examples have only two teeth, no palatal folds being developed.

MONTANA: Type 162884 A.N.S.P., from 2 to 10 miles up Rock Creek, northeast of Garrison (H. Burrington Baker). OREGON: near the head of Wallowa Lake, Wallowa Co., and at Aneroid Lake, about 8 miles south.

Vertigo modesta castanea Pilsbry & Vanatta Page 984, fig. 528:9-9b; 531:5, 6.

Vertigo castanea Sterki, 1892, Nautilus, 6:5, name only.

Vertigo modesta castanea Sterki, Pilsbry & Vanatta, 1900, Proc. Acad. Nat. Sci. Phila., p. 602, pl. 23, fig. 4, 5.—Pilsbry, Man. Conch., 25:132.

Shell oblong or cylindrical-oval, glossy, somewhat translucent; chestnut, sometimes with some whitish stripes. Whorls 4 $\frac{1}{2}$ -5, the last with a moderate crest behind the lip. Teeth very small, placed as in *corpulenta*, the lower-palatal largest, columellar usually developed, parietal very small or obsolete, upper-palatal wanting or minute. Alt. 2.3, diameter 1.4 mm.

CALIFORNIA: Lake Co. (Hemphill); Fish Camp, Fresno Co., (H. Hemphill), Type 11655 A.N.S.P.; Ranger, Panther creek, Wood's creek, Funston meadow on Kern River, Babb Creek falls, Rae Lake, Tulare Co. (Ferriss); Wawona meadow (H. Lowe); Onion valley, Kearsarge Pass, Inyo Co. (Ferriss); Holcomb meadows, east of Sugar Loaf Peak, at 8300 ft., San Bernardino Mts., S. B. Co. (S. S. Berry).

This form was recorded from Lake Co. by Dr. Sterki, but without description. It was first described and figured from Fresno Co. specimens, 11655 A.N.S.P. (Fig. 531:6).

The typical form has three teeth, parietal, columellar and lower-palatal; but there are also specimens in the same lot which lack the palatal, and one without any teeth.

In a lot from Wood's creek, Tulare Co., there are specimens having 3 teeth, 4 teeth (a minute angular lamella being added), and no teeth (page 984, fig. 528:9a), though the shells seem otherwise to be equally mature. As the teeth appear before the lip is fully formed, this variation is clearly not a matter of age. The teeth are best developed in specimens from Rae Lake fig. 531:5), some of which would be referred to *parietalis* were they not associated with others more or less deficient in teeth, or without teeth, but otherwise similar. In this lot the shell is largely whitish, or is streaked with white.

Some lots contain among normally proportioned shells, a few short examples such as page 984, fig. 528:9b, but having the crest and lip of adult character. Two from Onion valley, Kearsarge Pass measure:

Length 2.5 mm., diameter 1.4 mm. (normal).

Length 2.3 mm., diameter 1.5 mm. (Fig. 531:5).

The more cylindrical shape and the distinct crest behind the lip distinguish this race from *V. occidentalis*.

Vertigo modesta hoppii (Möller)

Page 984, fig. 528:6, 6a; 532, left.

Pupa hoppii Möller, 1842, Index Moll. Groenl., p. 4.—Moerch, Amer. Jour. Conch., 4:30, pl. 3, figs. 6-9.

Fig. 531. 1, *Vertigo modesta*, Laggan, Alberta; 2, Loess, Des Moines, Ia. 3, *Vertigo modesta corpulenta*, Ogden canyon, Utah. 4, *Vertigo modesta parietalis*, Ogden canyon. 5, *Vertigo modesta castanea*, Rae Lake, Cal.; 6, type, Fish Camp, Cal. 7, 8, *Vertigo arctica* (after Wallenbaum). 9, *Vertigo concinnula*, type, Custer Co., Col.; 10, Jemez Mts., N. M. 11, *Vertigo occidentalis*, San Bernardino Mts., Cal. 12, 13, *Vertigo modesta insculpta*, Mt. Lemon, S. Catalinas, Ariz.

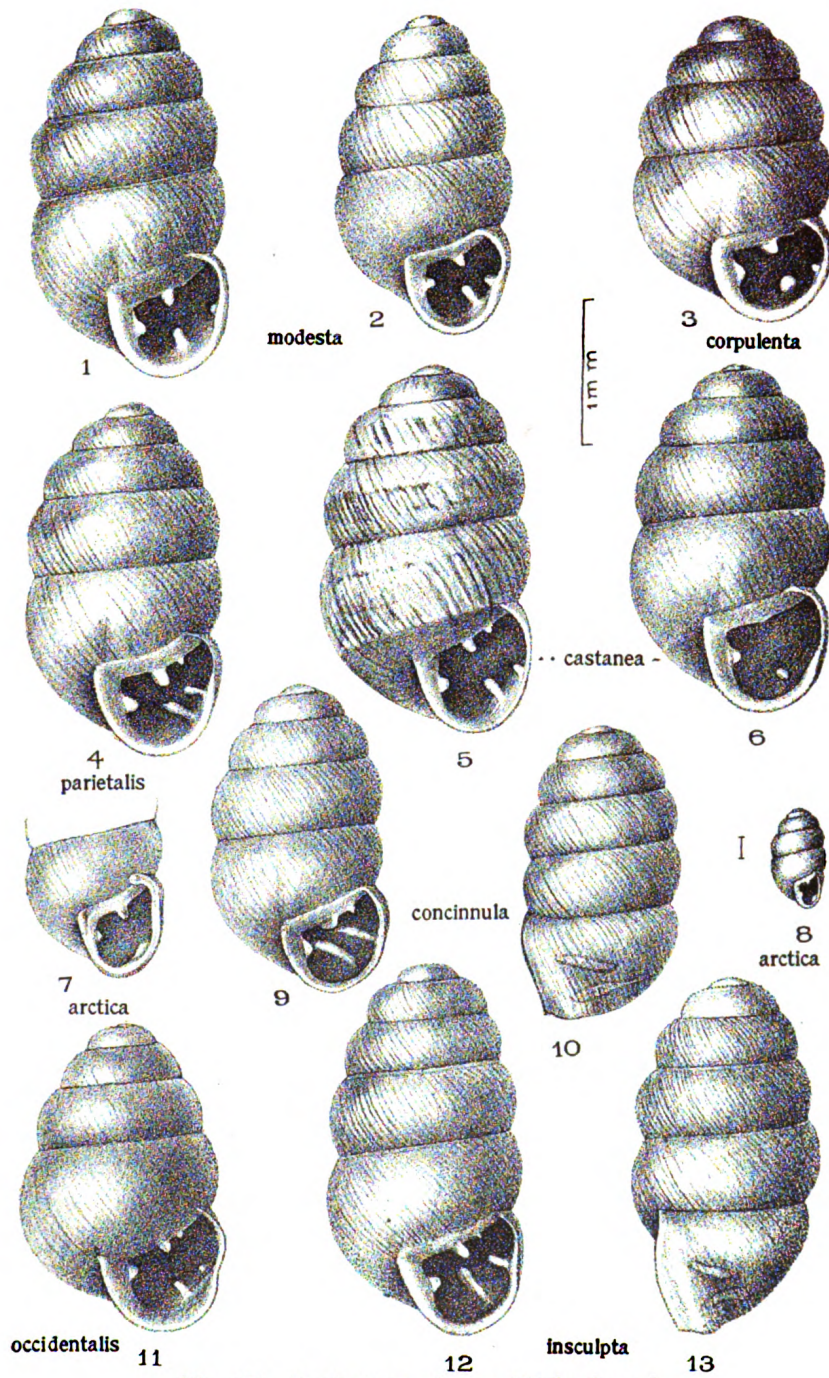


Fig. 531. See bottom of page 990 for legend.

Vertigo hoppii Möller, Pilsbry, Man. Conch., 25:135; 27:216, fig. 13a. Soós and Schlesch, 1924, Ann. Mus. Nationalis Hungarici, 21:98, fig. 2.

"Shell dextral, cylindrical, obtuse, smooth; columella two-toothed. Length 1.2 lines" (Möller).

"Shell subperforate, cylindrical-ovate, thin, very delicately striatulate, with a rather glossy, pellucid brown (often white) epidermis; spire convexly-conic. Whorls 5 or $7\frac{1}{2}$, convex, suture deep, ascending in front; columella with an obtuse fold; parietal wall having a compressed, almost median fold; aperture subtriangular, the peristome a little reflected, the outer lip moderately arched, with a very obsolete denticle in front of the middle. Length $2\frac{3}{4}$, diam. 1 mm." (Moersch). Length 2.4 mm., diam. 1.6 mm.; 5 whorls.

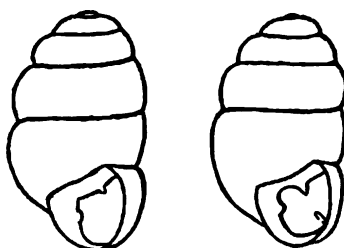


Fig. 532. Left, *V. hoppii*; right, *V. arctica* Wallenb. (After Soós & Schlesch).

GREENLAND: Nisik, in the Kusukfjord; Igaliko; different places in Amaraglik, in the small willow thickets by the ruins; Ekalluit at about 400-500 ft. above the sea (Möller). Kangerdluarsuk in $61^{\circ} 53'$; Nisik, Kavssingvak (fig. 532 left) and Ameralik near Godthaab; Mudderbugton on Disco Island (Soós & Schlesch).

V. hoppii does not seem to be specifically distinct from *V. modesta*, from which it differs tangibly only in the reduction of the teeth. It was the first of the forms of the *modesta* group with degenerate teeth to be described. Evidently the Arctic vertigos of the *modesta* group have been over-divided. The specimen figured has small parietal and columellar lamellae and a minute lower-palatal tubercle. The teeth vary from 3 to 0. Two of Mörch's very poor figures are reproduced on p. 984, figs. 6, 6a.

A variety with "the shell hyaline, glossy, white, destitute of epidermis," based upon "several live specimens with and without teeth, at Amaraglik," was noted by Mörch.

The localities Ungava, Labrador, and Anticosti Island are doubtful, and may possibly refer to some other form of *V. modesta* Say.

V. arctica Wallenbaum (Fig. 531:7, 8, and fig. 532, at right) of northern Europe appears to be very similar to *hoppii*. It was reported from Port Clarence, Alaska, (Vega Exped.). Another similar snail is *Pupa krausseana* Reinhardt (cf. Man. Conch. 25:136), described from the Chukchi Peninsula, Siberia, which has been reported, with some doubt, from Chilcat Inlet, Alaska. *P. krausseana* is considered by Fritz Haas to be a subspecies of

V. modesta (1937, Archiv f. Molluskenkunde 69:11, pl. 3, fig. 32). There is a small parietal lamella, and a few examples show also a weak columellar lamella.

***Vertigo occidentalis* Sterki**

Fig. 531:11; page 984, fig. 528:7.

Vertigo occidentalis Sterki, 1907, Nautilus, 21:90.—Pilsbry, Nautilus, 21:133, pl. 11, fig. 5; Man. Conch., 25:134.—Berry, 1909, Nautilus, 23:75.

The shell is perforate, and shortly rimate, globosely *ovate*, the spire being convexly *conic*, summit obtuse; decidedly wider at the last whorl than at the penult; of a dull hazel color, somewhat glossy, subopaque when adult, of 4½ rather convex whorls, the last having a small external dent over the lower palatal fold, but no ridge or crest behind the peristome. The aperture is rather large, obstructed by five teeth: parietal lamella short, a very small angular lamella near it; columellar lamella about equal to the parietal, rather deeply placed; both palatal folds short, the lower slightly larger. No palatal callus. The outer lip is thin, narrowly expanded, projecting forward above the middle; columellar margin broadly dilated and reflected.

Length 2, diameter 1.25 mm.; 4½ whorls (type, p. 984, fig. 528:7).

Length 2.2, diameter 1.4 mm., aperture 0.95 mm.; 4½ whorls (topo-type).

CALIFORNIA: San Bernardino Mts. at Bluff Lake, 7,550 ft., type 1860 Berry coll.; also Bluff Lake cienega, in the cienega just north, and along the "New England Trail," 7500 ft.; cienega west of Green Valley, 6900 ft. (S. S. Berry).

The original description was from a single specimen, which seems not quite mature, drawn in page 984, fig. 528:7. An older shell from the type locality, fig. 531:11, has the teeth somewhat stronger, particularly the columellar lamella, which is a very low nodule in the type specimen.

The more conic shape and more distinctly perforate base, as well as the smaller teeth, distinguish *V. occidentalis* from *V. modesta parietalis*.

***Vertigo allyniana* Berry**

Page 988, fig. 529:7.

Vertigo allyniana Berry, 1919, Nautilus, 33:51, fig. 7.—Pilsbry, Man. Conch., 25:376.

Vertigo allyniana xenos Berry, 1919, Nautilus, 33:52, fig. 8.

"The shell is minute, short, robust, ovate-conic, thin, dark reddish-brown with only a dull gloss; weakly, irregularly striate. The spire tapers with increasing rapidity from the last whorl to the obtuse apex. The whorls are convex, the last having a shallow but distinct excavation in the palatal region and a weaker one over the upper-palatal tooth, the latter extending to the lip, which thus becomes flattened or very slightly indented on its outer segment. The aperture is pyriform in outline, and would be rather small except for the quite flaring lip, which is little thickened and very fragile at the edge. There are 5 teeth constantly developed in all the material examined. The parietal, columellar, and upper and lower palatal lamellae are well developed, and there is a distinct, though small angular lamella. The columellar is situated well back in the aperture and quite high up on the pillar. The lower palatal is also rather deeply immersed. Length of type

2.1; diameter to lip edge 1.3; length of aperture 0.81 mm.; whorls $4\frac{1}{2}$." (Berry.)

CALIFORNIA: Donner Lake (A. G. Smith, May 30, 1916; 22 specimens). Type 3764 Berry coll., paratypes 44785 A.N.S.P.

"The texture of the shell, as well as the shape, are strongly reminiscent of *V. occidentalis* Sterki, a more weakly toothed species from the San Bernardino Mountains." It differs from *V. m. parietalis* by its more conic shape.

Two paratypes measure 2.18×1.4 mm., and 2.1×1.27 mm. The type of *V. a. xenos* measured in the same way is 2.1×1.45 mm. The latter form seems to be merely a shape-mutation, such is common in lots of *V. modesta* and its races. The color and texture are exactly as in cleaned specimens of *allyniana*. It does not appear to be a valid race. Berry's description follows:

Vertigo allyniana xenos, Fig. 529:8. "With the preceding occurred a single specimen of a very similar form having the same number of teeth, but differing abruptly in its shorter, much more robust and swollen outline, its more transparent, glossier texture, and lighter brown color. The columellar tooth is placed distinctly further down on the pillar, and the remaining lamellae differ slightly from those of the shells described above both in size and position. Length 2, diameter to lip edge 1.5 mm., whorls $4\frac{1}{2}$." Type 4128 Berry Coll.

***Vertigo dalliana* Sterki**

Page 964, fig. 517:1.

Vertigo dalliana Sterki, 1890, Nautilus, 4:19, 39, pl. 1, fig. 2.—Pilsbry, Man. Conch., 25:137, pl. 11, fig. 1.

"Shell conic or ovate-conic, of greenish-horn color, transparent, finely irregularly striate in the lines of growth, polished; whorls $4\frac{1}{2}$, well rounded, with deep suture, rather rapidly increasing, the last occupying about $\frac{3}{4}$ of altit., towards the aperture somewhat ascending on the penultimate. Aperture lateral, somewhat oblique, subovate with just perceptibly flattened palatal margin; margins approximate, the ends protracted; peristome shortly but decidedly expanded, with a very fine thread-like lip near the margin, the same continuing as a very fine callus on the apertural wall inside of the line connecting the ends of the margins; palatal wall quite simple; no lamellae" (Sterki).

Length 2.1, diam. 1.35 mm.

CALIFORNIA: near Clear Lake, Lake Co., Type 62.20383 Carnegie Mus. (Hemphill).

"The specimens before me were fifteen, fresh, remarkably uniform in their whole appearance; all were more or less covered with a dark brown, hard crust of slime and dirt, generally thickest around the aperture. Doubtless this coating is done 'purposely' by the animals, as in many other species also. When cleaned, it shows about the size and shape of a well-grown *Vertigo ovata* Say, but by a good eye or under a glass is at once recognized as something else, by the rounded aperture and the absence of lamellae" (Sterki).

The color is grayish-olive. There is a deep and rather long crevice but no umbilical perforation. It resembles *V. m. occidentalis* closely in shape, but is slightly smaller, greener in hue, and toothless. *V. m. castanea* has a more oval, less conic shape. *V. dalliana* is perhaps a member of the *V. modesta* group, the end product of a tooth-degeneration series. In the *modesta* and *californica* groups there are many forms showing various stages of this process. The type specimen is figured.

VERTIGO CALIFORNICA GROUP (*Nearctula* Sterki)

Nearctula Sterki, 1892, Nautilus, 8:5, type *V. californica*.

Vertigines of cylindrical shape, *without crest* or grooves over the palatal folds, and with no palatal callus; typically having parietal and columellar lamellae, upper and lower palatal folds, but in some forms the teeth have been partly lost, only the parietal remaining, or sometimes the aperture is wholly toothless. Surface generally dull, often rib-striate.

These forms are approached so closely by some of the *V. modesta* group that the distinction is difficult; yet the want of any trace of a crest behind the lip and the dull surface may serve to distinguish the present series from most of the *modesta* group. Moreover, the two groups differ so widely in zonal distribution that a different ancestry is suggested: the *californica* group inhabits low levels, while the *modesta* group is restricted to the colder Canadian and Transition zones, at higher elevations in California, descending to low levels only in the north.

"*Pupa californica* var. *meriodionalis* Sterki" [*sic*], from California, in Hemphill's Catalogue of North American Shells p. 17 (1900), was never described under that name, and its identity remains unknown. Possibly it was a tentative name for *V. c. diegoensis*, the southern race of the group.

Key to species and subspecies

1. Sculpture of rather strong oblique riblets. 2
 Surface striate but not distinctly ribbed; about 2.5 mm. long. Four well developed teeth. *V. rowelli*
2. Aperture having 4 teeth, at least the columellar, parietal and lower palatal well developed. 3
 Aperture having 3 small teeth. Monterey. *V. c. trinotata*
 Aperture having 1 tooth, the parietal, or none. 6
3. About 2.5 × 1.3 mm.; parietal lamella not entering deeply. San Francisco.
V. californica
 Shell smaller or narrower; parietal lamella long, entering rather deeply. Monterey southward, and the islands. 4
4. Shell 2 to 2.5 mm. long. *V. c. longa*
 Shell 1.75 to 2 mm. long; whorls short. 5
5. Sculpture strongly developed. S. Catalina and S. Clemente. *V. c. catalinaria*
 Sculpture weaker and irregular, Cypress Point. *V. c. cupressicola*
6. San Diego southward. *V. c. diegoensis*
 Placer county. *V. c. cyclops*

Vertigo californica (Rowell)

Fig. 533: 1, 2.

Pupa californica Rowell, 1861, Ann. Lyc. Nat. Hist. of N. Y., 7:287.—Binney, Terr. Moll., 5:202, fig. 107.—Sterki, 1890, Nautilus, 4:8, with varieties *elongata*, p. 8; *catalinaria*, p. 9; *trinotata*, *diegoensis*, and *cyclops*, p. 18.

Vertigo californica Rowell, Pilsbry, 1919, Man. Conch., 25:139, pl. 9, figs. 1, 2, with subsp. *trinotata* St., p. 140; *diegoensis* St. and *cyclops* St., p. 141; *elongata* St. and *catalinaria* St., p. 142; *cupressicola* St., p. 143.

The shell is cylindric or long-ovate, the upper third tapering convexly to an obtuse summit; chestnut, the summit whitish; whorls rather strongly convex, the initial $1\frac{1}{2}$ smooth (showing the usual minute granulation under the microscope); the next whorl is finely but sharply rib-striate, after which the riblets become coarse, more oblique, and on the last whorl about one-tenth of a mm. apart. There is no trace of a crest or contraction behind the narrowly expanded outer lip; columellar border is well dilated. Both ends of the lip are somewhat calloused in fully adult specimens. Aperture with four white teeth, the parietal lamella strong and high, lower-palatal nearly as large, columellar and upper-palatal smaller.

Length 2.65, diameter 1.35 mm.; $5\frac{1}{2}$ whorls.

Length 2.5, diameter 1.3 mm.

Length 2.25, diameter 1.25 mm.

CALIFORNIA: San Francisco (Rowell and others). Paratype 59392 A.N.S.P.

In some individuals the upper-palatal fold is quite small, or even wanting in rare individuals. Dr. Sterki mentions seeing traces of an angular lamella in some specimens.

Besides the typical form, which is known to me from San Francisco only, the following local races have been defined.

Vertigo californica trinotata (Sterki)

Fig. 533: 9.

[*Pupa californica*] var. *trinotata* Sterki, 1890, Nautilus, 4:18.

Vertigo californica trinotata Sterki, Pilsbry, 1919, Man. Conch., 25: 140, pl. 9, fig. 9.

"In size not much different from the type, yet a little smaller, and more generally obovate; the striæ are less coarse; the peristome is slightly but distinctly expanded. There is no superior palatal lamella, and the three present are small, the columellar even a trace, or wanting entirely" (Sterki).

Length 2.25 mm., diameter 1.15 mm.; nearly 5 whorls.

CALIFORNIA: Monterey (Hemphill).

Vertigo californica diegoensis (Sterki)

Fig. 533: 8, 11.

[*Pupa californica*] var. *diegoensis* Sterki, 1890, Nautilus, 4:18.

Vertigo diegoensis St., Berry, 1916, Nautilus, 30:83.

Vertigo californica diegoensis (St.), Pilsbry, 1918, Man. Conch., 25:141, pl. 9, figs. 8, 11.

Pupa orcutti Pilsbry, Orcutt, 1915, The Molluscan World, p. 208, no. 3159.

"The diminution of the lamellæ is going on; none but the apertural is left in this variety, and even that is quite small or a mere trace. In size and shape the specimens are not much different from the Monterey form [*cupressicola*], which is an intermediate one" (Sterki).

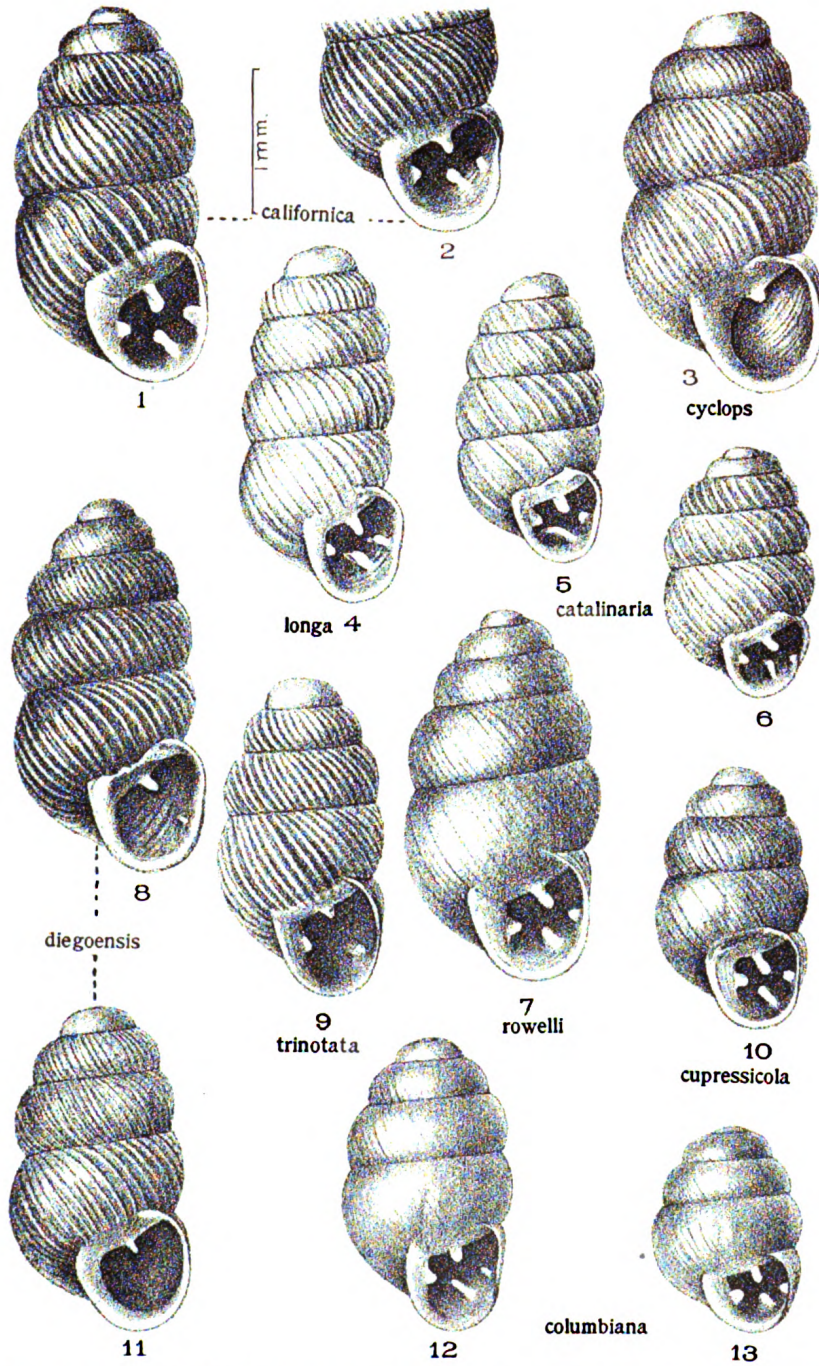


Fig. 533. 1, 2, *Vertigo californica*, paratypes. San Francisco. 3, *Vertigo c. cyclops*, Rocklin, Cal. 4, *Vertigo c. longa*, S. Clemente I. 5, *Vertigo c. catalinaria*, Santa Barbara I.; 6, S. Catalina I. 7, *Vertigo rowelli*, Douglas Co., Ore. 8, 11, *Vertigo californica diegoensis*, San Ramon, L. Cal. 9, *Vertigo c. trinotata*, Monterey. 10, *Vertigo c. cupressicola*, Cypress Point. 12, *Vertigo columbiana*, Vancouver I.; 13, Olympia, Washington.

CALIFORNIA: San Diego (H. Hemphill). Type False Bay near Asher Station (Berry). LOWER CALIFORNIA: San Ramon (C. R. Orcutt).

In the specimens from San Ramon the parietal lamella is sometimes well developed, and there is very rarely a tubercular palatal fold, as in fig. 524:8. A few examples have no teeth whatever. The least decadent individuals of this race have reached about the same stage of tooth-reduction as *V. c. cyclops*, and some specimens are not distinguishable from that; yet as the localities are remote and in regions physically diverse, the resemblance is evidently not due to direct relationship, but to parallel evolution.

Length 2.65 mm., diameter 1.35 mm.; 5½ whorls.

Length 2.35 mm., diameter 1.25 mm.; 5 whorls.

***Vertigo californica cyclops* (Sterki)**

Fig. 533:3.

[*Pupa californica*] *cyclops* Sterki, 1890, *Nautilus*, 4:18.

Vertigo californica cyclops (St.) Pilsbry, 1918, *Man. Conch.*, 25:141, pl. 9, fig. 3.

"Large, conic or ovate conic, or turriculate, umbilicated, rib-like striæ rather strong; whorls 5, well rounded, with deep suture, the last occupying more than ½ alt.; aperture subovate or nearly circular, margins much approximate and the ends protracted, peristome shortly but decidedly expanded; lamella one, apertural [parietal], small. Alt. 2.5; diam. 1.5 mill. For its size, rounded aperture and single lamella I would name this form var. *cyclops*" (Sterki).

Length 2.7 mm., diameter 1.45 mm.; 5 whorls.

CALIFORNIA: Rocklin, Placer Co. (25 miles northeast of Sacramento), (Hemphill).

A paratype is figured. "Some specimens have no columellar lamella, and some have a small palatal fold" (Sterki).

***Vertigo californica longa* Pilsbry**

Fig. 533:4.

[*Pupa californica*] var. *elongata* Sterki, 1890. *Nautilus*, 4:8. Not *P. alpestris* var. *elongata* Sterki, 1883, also a *Vertigo*.

Vertigo californica elongata St., Pilsbry, 1919, *Man. Conch.*, 24:142, pl. 9, fig. 4.

Vertigo californica longa Pilsbry, 1920, *Man. Conch.*, 24:377.

"A little smaller and generally more cylindrical than the type; a part are even long-cylindrical having the appearance of an *Isthmia* [*Truncatellina*]. The coloration is somewhat paler and the lamellae are well formed" (Sterki).

Length 2.5 mm., diameter 1.2 mm.; 6 whorls.

Length 2.25 mm., diameter 1.1 mm.; 5½ whorls.

Length 2.1 mm., diameter 1.2 mm.; 5 whorls.

CALIFORNIA: San Clemente Island (Hemphill), type loc.; Santa Barbara I. (Hemphill).

Fig. 4 is from a paratype. The parietal lamella is *decidedly longer* than in *V. californica*, entering deeply. From the elongate form figured it varies, in the same lots, to much shorter forms. Specimens from Santa Barbara are 2.3 to 2.4 mm. long, or even smaller, 2 to 2.25 × 1.15 mm.

This race is intermediate between *V. californica* and *V. c. catalinaria*.

***Vertigo californica catalinaria* (Sterki)**

Fig. 533: 5. 6.

[*Pupa californica*] var. *catalinaria* Sterki, 1890, *Nautilus*, 4:9.

Vertigo californica catalinaria St., Pilsbry & Vanatta, 1900, *Proc. Acad. Nat. Sci. Phila.*, p. 610. Pilsbry, 1919, *Man. Conch.*, 24:142, pl. 9, figs. 5, 6; 1927, *Proc. Cal. Acad. Sci.* (4), 16:174, pl. 7, fig. 5.

"Small, rather short, pale horn colored; shell thin, delicate; rib-like striae less numerous and relatively larger; the whorls are less high, which gives the shell a different appearance. All lamellae are present and well formed, especially the apertural [parietal]" (Sterki).

Length 1.75 mm., diameter 1.05 mm.; $5\frac{1}{4}$ whorls, to 1.95×1 mm.

CALIFORNIA: Santa Catalina I. (Hemphill), type loc.; also San Clemente I. and Santa Barbara I. (Hemphill). LOWER CALIFORNIA: Guadalupe I. (Hanna).

"In about one-third of the examples a part of the shell is wanting, always on the side of the aperture, so that 3 or even 4 whorls are opened. This can hardly be accidental, and probably that part of the thin shell is worn off by friction in moving" (Sterki).

This race has four well-developed teeth, the parietal lamella being long, as in *V. c. longa*, from which it differs by the smaller size and shorter whorls; it is also more fragile. A paratype is figured (fig. 6), and a longer shell from Santa Barbara Island (fig. 5).

The Santa Barbara Island specimens are somewhat perplexing. Some are typical *catalinaria*, 1.75×1 mm., but also up to 2.15 mm. long, while there are also stouter shells with them, 2 to 2.25 mm. long, 1.15 wide, which do not seem separable from *longa*. If it were not for these examples, I would consider *catalinaria* specifically distinct.

***Vertigo californica cupressicola* Sterki**

Fig. 533: 10.

Vertigo californica cupressicola Sterki, in Pilsbry, 1919, *Man. Conch.*, 24:143, pl. 9, fig. 10.

Small, cylindric, with the riblets distant, irregular and partly obsolete; apertural lamellae and folds relatively larger than in *californica*, the parietal lamella long. Length 1.83, diam. 1.1 mm.; barely 5 whorls.

CALIFORNIA: Cypress Point, Monterey (S. S. Berry, J. C. Paine). Type 118835 A.N.S.P.

Closely related to *V. c. catalinaria*, but differing by the weaker, irregular sculpture. In some examples the spire tapers a little more than in the figured type.

***Vertigo californica guadalupensis* Pilsbry**

Vertigo californica guadalupensis Pilsbry, 1927, *Proc. Cal. Acad. Sci.* (4), 16:174, pl. 7, fig. 4; *Man. Conch.*, 28:97.

The differential characters of this form are that it possesses a distinctly developed angular lamella standing about midway of the length of the long

parietal lamella, and the striation is quite fine, there being about 30 striae in 1 mm. on the face of the last whorl. Length 2 mm.; diameter 1.1 mm.

LOWER CALIFORNIA: Guadalupe Island, collected about 1000 feet above the landing at Northeast Anchorage by G. D. Hanna. Type in Cal. Acad. Sci. coll.

This extralimital race is included here to complete the account of the subspecies of *V. californica*.

***Vertigo rowelli* (Newcomb)**

Fig. 533:7.

Pupa rowellii Newcomb, Ann. Lyc. Nat. Hist. of N. Y., 7:146.—Binney, Terr. Moll., 5:202, fig. 106.—F. H. Andrus, 1897, The Oregon Naturalist, 4:53.

Vertigo rowellii Nc., Pilsbry, 1918, Man. Conch., 25:143, 378, pl. 9, fig. 7.

Shell oblong, tapering to the obtuse summit, olivaceous brown, slightly translucent. Sculpture of thread-like striae, strongest on the penult and next earlier whorls, often partially obsolete on the last. No crest. Four strong white teeth.

Length 2.45 to 2.8 mm., diameter 1.25 to 1.3 mm.; 5½ to nearly 6 whorls.

CALIFORNIA: near Oakland (Newcomb, type loc.); *ciénaga* north of Bluff Lake, San Bernardino Mts. (S. S. Berry); Alameda, Monterey and El Dorado counties, according to W. G. Binney. OREGON: Douglas County (F. H. Andrus). Salem.

With the teeth like *V. californica*, this species differs by its smoother surface. Under a lens there are delicate, irregularly spaced thread-like striae corresponding to the far stronger riblets of *V. californica*.

Two specimens from Oakland, type locality, measure;

Length 2.8 mm., diameter 1.4 mm.; nearly 6 whorls.

Length 2.48 mm., diameter 1.3 mm.; 5½ whorls.

The minute costulation is rather pronounced on the penult whorl. The low, rounded rib-striae are about as wide as their intervals. On the last whorl they become weak, more and irregularly spaced. The long, convexly tapering spire is rather turrated.

F. H. Andrus writes that in Douglas County, Oregon it "is our common species; hundreds of them can be found on every bunch of hazelbrush or mossy tree in favorable localities. I have collected over 500 from one hazel bush and there were more yet. While collecting this species I observed a Western Winter Wren at work on a small myrtle, and when I went to that tree I found no *Vertigo*, though there were plenty on adjoining trees."

COLUMELLA Westerlund

Columella Westerlund, 1878, Fauna Europaea Moll. Extramar. Prodromus, fasc. 2, p. 193, for "*Pupa inornata* Mich."—Pilsbry, 1912, Nautilus, 26:60; Man. Conch. 27:232, monograph.—H. Watson, 1923, Proc. Malac. Soc. Lond., 15:275, anatomy.

Sphyradium (Agass.) Charpentier, Westerlund, 1887, Fauna Paläarktischen Region Binnenconchylien, 3:125.—Sterki, Nautilus, 1896, 10:75.—Hanna, Proc. U. S. Nat. Mus., 41:371 (monograph, anatomy); and of many American and European authors. Not *Sphyradium* as limited by Von Martens, 1860.

Paludinella Lowe, 1854, Proc. Zool. Soc., p. 206, type *P. edentula* Drap. Not *Paludinella* Pfeiffer, 1851.—*Paludellina* Tryon, Struct. and Syst. Conch., 1884, 3:72, error for *Paludinella*.

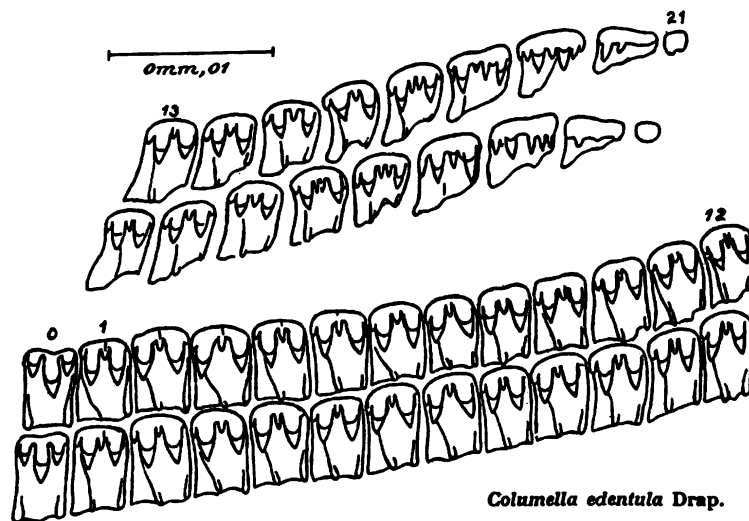
Edentulina Clessin, 1876, Deutsche Excursions-Mollusken-Fauna, p. 208, for *Pupa inornata*. Not *Edentulina* Pfeiffer, 1855 (*Streptaxidæ*).

The shell is cylindric or cylindric-tapering with obtusely conic summit and distinctly perforate axis, brown and nearly smooth, composed of 5 to 9 convex whorls. Aperture sub-basal, semicircular, oblique; peristome thin and sharp, the outer lip not expanded, regularly arcuate; columellar margin dilated.

The foot is short, oval, without pedal grooves, above with a coarse-meshed network of impressed lines. There are no lower tentacles.

Kidney in form of a long slender pouch, the glandular matter evenly distributed over the inner surface, not arranged in longitudinal ridges as usual in Pupillidæ. Ureter direct, opening into the anterior end of the pallial cavity.

Genitalia similar to *Vertigo* in the simple penis, which is rather large, cylindric, without appendix; epiphallus narrow, inserted a little below apex of penis, and bearing the penial retractor about in the middle. The prostate gland is internal. Spermathecal duct is inserted farther posterior than usual.



Columella edentula Drap.

Fig. 534. Teeth of *Columella edentula*, after Steenberg.

Jaw composed of rather wide, flat plates with narrow intervals, solidly united. Tooth formula about 21.1.21., Fig. 534. Centrals tricuspid; laterals bicuspid, the cusps short, subequal; with small interstitial denticles and long basal plates; marginals not distinctly differentiated from the laterals, but having more accessory denticles.

Distribution.—A genus of about 10 species, of which one, *C. edentula*, is widely spread in the Palæarctic Region of Europe and Asia, eastward to Japan. There are four species in North America, one, *C. polvonensis* Pils., as far south as Nicaragua. Three Hawaiian species seem by conchological criteria to belong to the genus.

Columella differs from *Vertigo* chiefly by the subequal cusps of its bicuspid lateral teeth, the wide plates of the jaw, and the thin, sharp, unexpanded lip of the toothless aperture. The anatomy has been investigated by Sterki and Hanna in America and more fully by Hugh Watson and C. M. Steenberg in Europe.

Key to species

1. Length 5 mm. or more; 8½ to 9 whorls. *C. hasta*
Length about 3 mm. or less. 2
2. Length 1.8 to 2.5 mm., 5½ to 6½ whorls; somewhat tapering. *C. edentula*
Length 2.5 to 3 mm., 6-7 whorls; cylindric. *C. alticola*

Columella edentula (Draparnaud)

Fig. 535: 12-17.

Pupa edentula Draparnaud, 1805, Hist. Nat. Moll. Terr. Fluv. France, p. 59, pl. 3, figs. 28, 29.

Sphyradium edentulum Drap., Sterki, 1896, Nautilus, 10:75 (anatomy). Dall, Harriman Alaska Exped., 13:54.—Hanna, 1911, Proc. U. S. Nat. Mus., 41:374, figs. 2-4 (anatomy).

Columella edentula Drap., Watson, 1923, Proc. Malac. Soc. London, 15:275, 279 (anatomy).—Pilsbry, 1926, Man. Conch., 27:242, pl. 30, figs. 12-17.—F. C. Baker, 1939, Fieldbook Ill. Land Snails, p. 109.—Henderson, University Colo., Studies. 4:177, (distribution in Colorado); 1929, same studies, 17:93, fig. 53.—Brooks & Kutchka, 1938, Ann. Carnegie Mus., 27:81 (West Virginia).

Pupa simplex Gould, 1841, Boston Jour. Nat. Hist., 3:403, pl. 3, fig. 21 (Cambridge, Mass.).

Vertigo simplex Gould, W. G. Binney, 1878, Terr. Moll., 5:219, pl. 73, fig. 3.—W. S. Teator, 1890, Nautilus, 4:66 (The Glen, Vassar College, N. Y., Van Ingen).—G. W. Taylor, 1891, Nautilus, 5:92 (Vancouver Island).

The shell is perforate, oblong-ovate, tapering above, cylindric in the lower two whorls, or tapering slightly from the last whorl, the summit rounded; thin; cinnamon or a little darker colored, sometimes having some whitish streaks; glossy, nearly smooth, but under the microscope showing some irregular wrinkles of growth. The whorls are convex, the last two rather strongly so. Aperture oblique, rounded, truncate by the preceding whorl, toothless. Peristome with thin, sharp, unexpanded outer margin, the columellar margin reflected; margins remote.

Length 2.2 mm., diameter 1.35 mm., 6½ whorls. Oswego, Ore.

Length 2 mm., diameter 1.3 mm., 5½ whorls. Oswego, Ore.

Distribution.—Canada, from the Magdalen Islands to Vancouver Island, and north (according to Dall) to Labrador, Alaska and some of the Aleutian Islands. Southward it is commonly found as far as New Jersey, Pennsylvania, Iowa, Montana and Oregon. Alabama at Langdale, Chambers Co., and Evergreen, Conecuh Co., fig. 17 (H. H. Smith).

In some localities, such as Oswego, Clackamas Co., Oregon, and the Magdalen Islands, Gulf of St. Lawrence, the specimens resemble the typical European *edentula* closely. Generally in America the size, especially the diameter, is noticeably smaller than in the typical form of Europe; and there

is some reason for segregating the prevalent form in the eastern states as a local race, *simplex* Gld.

- Length 2.15, diameter 1.1 mm., 5½ whorls. Oxford Co., Maine.
 Length 2.1, diameter 1.15 mm., 6¼ whorls. Clementon, N. J.
 Length 1.85, diameter 1.15 mm., 5½ whorls. Beaver Co., Pa.
 Length 1.8, diameter 1.1 mm., 5½ whorls. Conecuh Co., Ala.

Most of the specimens in almost any lot collected are immature. In some places the full size seems to be rarely if ever attained. Gould's type of *simplex*, measuring 1/15 inch long, 1/30 wide, was either immature or from such a dwarf colony. The surface is nearly smooth, showing irregular and very low growth-wrinkles under the microscope.

This *simplex* form (Fig. 535:15, 16, 17) is about the size of the Caucasian *C. e. nana* Bttg., which from the description and figure would hardly be distinguishable from the American form.

I have seen the small *simplex* form of the species from the states of Maine, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Wisconsin, Minnesota, Alabama and eastern Canada. Oughton reports it in company with the larger *C. edentula* from Moosonee, Ontario. A few lots appear variable or intermediate between the large and small races.

In a few places there is a larger form (fig. 535:14) which agrees with the account of *C. e. var. turitella* Westerlund in shape, but it has a distinctly striate surface. As the specimens are from several rather widely separated places with diverse faunal associations, I do not give them a special name.

Length 2.4 mm., diameter 1.3 mm.; 6½ whorls. Onondaga Co., N. Y.,
 Fig. 535:14.

Length 2.3 mm., diameter 1.3 mm.; 6½ whorls. Ward, Montana.

***Columella alticola* (Ingersoll)**

Fig. 536.

Pupilla alticola Ingersoll, 1875, Bull. U.S. Geol. and Geogr. Surv. Terr., 1:128; 8th Ann. Rep. Hayden Surv., p. 391. fig.

Pupa alticola Ing., W. G. Binney, 1878, Terr. Moll., 5:212, fig. 166.

Sphyradium alticola Ing., Hanna, Proc. U.S. Nat. Mus., 41:373, fig. 2.

Columella alticola Ing., Pilsbry, 1926, Man. Conch., 27:243, pl. 31, figs. 6-8.—Henderson, 1924, Univ. Colo. Studies, 13:140.—Berry, 1922, Vict. Mem. Mus. Bull., 36:14.—W. O. Gregg, Nautilus, 55:143 (head Mammoth Creek, Garfield Co., Utah, 8000 ft. elevation).—F. C. Baker, 1939, Fieldbook Illinois Land Snails, p. 109.—Franzen, 1947, Trans. Kansas Acad. Sci. 49:414 (Pleistocene of N.W. Kansas).

“Shell perforate, straight, two and one-half times as long as broad, densely striate, subtranslucent, chestnut-brown, apex obtuse; whorls 6 or 7, convex, the middle three of the spire equal, causing a parallelism in the sides of the shell, the last noticeably greater, expanding toward the aperture, not closely appressed to the body-whorl; suture deeply impressed; aperture small, oblique, subtriangular, margins connected by a thin deposit, without

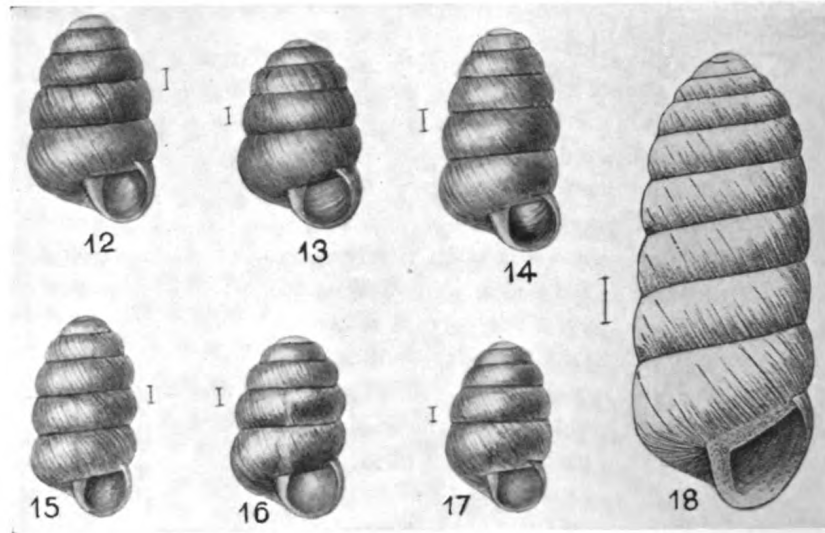


Fig. 535. 12-17, *Columella edentula*; 12, 13, Oswego, N. Y.; 14, Onondaga Co., N. Y.; 15, Clementon, N. J.; 16, Beaver Co., Pa.; 17, Conecuh Co., Ala. 18, *Columella hasta* (after Hanna). Scale lines = length of shell; figures 12-17 drawn to same scale.

internal processes; peristome simple, somewhat reflected over the umbilicus" (Ingersoll).

Length 3, diameter 1.35 mm.; $7\frac{1}{2}$ whorls. National Park, Wyoming. Fig. 536a.

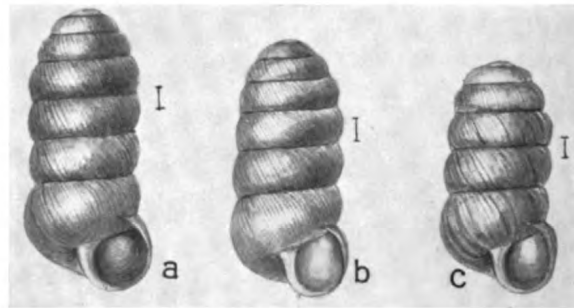


Fig. 536. *Columella alticola*. a, Hot Spring, Wyoming; b, Howardsville, Colorado; c, Banff, Alberta. Scale line = length of shell.

Length 2.8, diameter 1.3 mm.; 7 whorls. Howardsville, Colo. Fig. 536b.

Length 2.5, diameter 1.3 mm.; $6\frac{1}{3}$ whorls. Banff, Alberta. Fig. 536c.

NEW MEXICO: Willow creek, Mogollon Mts. (Ferriss & Daniels); La Belle (Ashmun). ARIZONA: Millers Peak, Huachuca Mts. (Ferriss). COLORADO: Cunningham Gulch (type loc.) and Rio La Plata, 8-9000 ft.; Howardsville (Ingersoll); Estes Park (Ashmun); near Colorado Springs (H. B. Baker); Tolland, Gilpin Co., 8900-9000 ft.

(Cockerell); Florissant, Magnolia and Eldora (J. Henderson); Floyd Hill (Hand); near Ohio City (F. Rohwer); Long's Peak Inn (Spangler). UTAH: Chalk Creek, 7500-8000 ft. (R. V. Chamberlin). WYOMING: Mammoth Hot Spring Nat. Park (Elliott). ALBERTA: Banff (S. Brown); Kananaskis (J. Macoun). BRITISH COLUMBIA: Field (S. Brown); Tobacco Plains, Kootenay River valley (J. B. Tyrrell). *Pleistocene loess*. KANSAS: Long Island, Phillips Co. (Hanna). IOWA: Iowa City and Des Moines; ILLINOIS.

This species is more cylindrical than *C. edentula*, the summit rounded, and when fully developed the last whorl is more swollen than those preceding. It reaches a larger size, and has more whorls. It is cinnamon-brown, like *C. edentula*, sometimes with some whitish streaks. The surface is finely striate, decidedly more so than in typical *edentula*, but not more than in the striate form of that species. All of the whorls are rather strongly convex. Young or small individuals may be recognized by the more cylindrical shape of the spire and the striation, but occasionally their discrimination is difficult. Some of the Colorado records given above may possibly pertain to *C. edentula*.

Whether *C. alticola* is really distinguishable from *C. columella* (Benz), of northern Europe and Siberia, appears to me doubtful, but the whorls are noticeably more convex and the striation a trifle more distinct than in the German loess *columella* compared. The form from Port Clarence, Alaska, referred to *columella* by Westerlund, is unknown to me. Hanna has suggested that some Unalaskan *Columellæ* belong to a new species with the following measurements: Length 2.84, diameter 1.6 mm.

***Columella hasta* (Hanna)**

Fig. 535: 18.

Sphyradium hasta Hanna, 1911, Proc. U.S. Nat. Mus., 41:372, text fig. 1.

Columella hasta Hanna, Pilsbry, 1926, Man. Conch., 27:245, pl. 30, fig. 18.

"Shell more than 5 mm. in height, long and cylindrical. Light brown in color and glossy. Spire greatly elevated but obtusely pointed on the apex. Whorls 8½ to 9, rather flattened on the face and the last subangulated around the periphery. The last six whorls are of about equal diameter; the first three increase rapidly. Lines of growth faint and oblique; apex smooth and white. Aperture somewhat angulated at the base of the columella. Peristome thin and acute, forming a regular curve without an indentation in the upper palatal region such as is present in most of the *Vertigos*. The aperture is very slightly thickened with callus on the inside of the peristome in the basal region. Peristome not reflected and with no callus crest back of the aperture. Teeth and lamellæ entirely absent from the aperture. Umbilicus with a very small perforation. Length, 5.81 mm.; diameter, 2.03 mm." (Hanna).

KANSAS: Pleistocene of Long Island, Phillips County (G. D. Hanna, Edw. C. Johnston).

"This species differs from all others by its much greater size and the relatively smaller aperture." The specimens "occur in deposits of sandy, green marl of undoubted Pleistocene age. With them were large numbers

of other Pupillidæ, as well as other land snails. The entire fauna of the beds is foreign to the region at the present time, but is allied to the present-day Canadian fauna. From this it is supposed that the animals lived just before or during the Glacial epoch." (Hanna.)

It appears to be nearly related to *C. inornata* (Michaud), of France, also apparently a Pleistocene species, now extinct. I have not been able to compare European specimens.

Subfamily NESOPUPINAE Steenberg

Nesopupinæ Steenberg, 1925, Vidensk. meddel. fra Dansk naturhist. Foren., 80:201.

Shell and anatomy are substantially as in the Vertigininæ except that the penis bears an appendix and the retractor muscle is forked. Part of the genera are viviparous.

The few American genera of this subfamily are tropical and subtropical. They are either congeneric with those of the Old World (*Pupisoma*), or seem to be closely related to them (*Bothriopupa* and *Sterkia*), and can only be viewed as stragglers from Asia, probably by the way of the North Pacific route, but the date of their incursion is unknown.

Genus PUPISOMA Stoliczka

Pupisoma Stoliczka, 1873, Jour. Asiatic Soc. Bengal, 42:32, type *P. lignicola* Stol.—Pilsbry, 1920, Man. Conch., 26:19.—H. B. Baker, 1927, Proc. Acad. Nat. Sci., 79:223 (anatomy).

Ptychopatulæ Pilsbry, Proc. Acad. Nat. Sci. Phila., 1889, p. 191; Man. Conch., 9:54, 57, type *Helix caeca* Guppy.

The shell is ovate or globose-conic with obtuse apex, usually perforate, thin; whorls $3\frac{1}{2}$ to $5\frac{1}{2}$, strongly convex. Aperture truncate-rounded; peristome thin, slightly or not expanded, the columellar margin dilated and reflected.

Animal viviparous, having short eye-stalks and no inferior tentacles. Two species have been dissected by H. B. Baker, (1927). His figures of the jaw (fig. 537b) of *P. mediamericanum* Pils. and of the pallial complex (fig. 537c), the genitalia (fig. 4), penis with accessories (fig. 537c) and radula (fig. 537a) of the Mexican *P. comicolense* H. B. B., have been reproduced in Fig. 537. "In *Pupisoma* the orthureter has a recurved duct. The uterus, filled with embryos, is very long but the free oviduct, spermatheca, vagina and prostate are short. The epiphallus enters through a small papilla into the bifid penis, with its appendicular arm poorly demarcated from the short appendix. The branched retractor inserts on the apices of both penial arms (Fig. 537e). The jaw consists of narrow, overlapping plates. All radular teeth are fundamentally tricuspid but develop many accessory cusplets. I am now dubious about the presence of inferior tentacles in *Pupisoma*." (H. B. B.)

Distribution.—Humid tropical and subtropical regions of both hemispheres. They live on the bark and leaves of trees and other plants. About 18 species, three occurring within our limits.

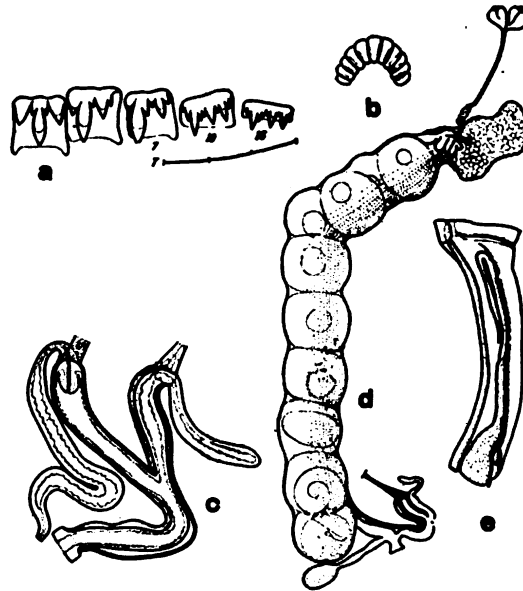


Fig. 537. b, *Pupisoma mediamericanum*, jaw; a, c-e, *P. comicolense*, teeth, genitalia and pallial tract. (After H. B. Baker.)

Key to species

- 1. Shell with minute spiral striae. *dioscoricola*
No spiral striae, the surface pitted-granulose 2
- 2. Umbilicus narrow; Florida. *minus*
Umbilicus wider; Alabama *macneilli*

***Pupisoma dioscoricola* (C. B. Adams)**

Fig. 538: 1-5.

Helix dioscoricola C. B. Adams, 1845, Proc. Boston Soc. Nat. Hist., 2:16 (Jamaica).
Thysanophora dioscoricola C. B. Ad., Pilsbry, Man. Conch., 9:57.
Helix punctum Morelet, 1851, Test. Noviss. 2:9 (Merida, Yucatan).
Helix caeca Guppy, 1868, Proc. Sci. Asso. Trinidad, p. 241.
Microphysa dioscoricola C. B. Ad., Binney, Bull. Mus. Comp. Zool., 19:196, pl. 3, fig. 6 (shell, jaw and teeth).
Pupisoma dioscoricola (C. B. Ad.), Pilsbry, 1920, Man. Conch., 26:36, with *P. d. insignis*, p. 39.
Pupisoma americanum Moellendorff, 1899, Nachr. Bl. d. mal. Ges., 31:91 (Cuenca, Ecuador); cf. Haas, 1937, Archiv f. Mollusk., 69:10.

The shell is globose conic with obtuse apex, perforate, cinnamon-colored, glossy. Sculpture of unequal growth-wrinkles crossed by fine, impressed spiral lines about equally distinct over the whole last whorl; earlier whorls with granose striae or somewhat irregular granulation, partly confluent into striae. The tip of the apex is slightly depressed. The whorls are strongly convex. The aperture is truncate-rounded, oblique. Peristome thin, the columellar margin whitish, dilated triangularly and broadly over the perforation. Columella concave.

Length 1.55, diameter 1.55 mm.; $3\frac{1}{2}$ whorls (fig. 1).

Length 1.95, diameter 1.8 mm.; $3\frac{3}{4}$ whorls (Brownsville).

Distribution.—Florida and southern Texas to southern Brazil; specimens seen from the following localities in the U. S.

FLORIDA: Cayo Tuna, Lossman's Key and Cape Sable on the west coast. Cape Florida, Elliotts, Old Rhodes, Little Palo Alto, Angel Fish, Pumpkin, Largo, Long, Lignum Vitæ and Big Pine Keys, on the east and south. Ft. Lauderdale, Lemon City, Miami, Snake Creek Hammock, 4 miles south of Lakeview, in the Dade Co. mainland; St. Augustine; Homosassa, Citrus Co.; 6 mi. west of Gainesville; Arredonda, Alachua Co.; Marianna. TEXAS: Brownsville (R. D. Camp). Also West Indies, Central and South America; type loc., Jamaica.

This minute snail inhabits a vast area, entirely similar specimens occurring from about 30° N. lat. to about 24° S., in southern Brazil, also Ecuador and in the Galapagos. It is believed that much of the peripheral distribution of species of this genus is due to transportation on plants. It may be inferred that C. B. Adams found this species on leaves of the yam (*Dioscorea*). S. N. Rhoads reported it as "numerous in certain localities [about Miami, Fla.] on the under surface of the leaves of magnolia and of palmetto; on the latter sometimes a score can be taken from a single leaf." Morelet found "*Helix*" *punctum* (fig. 538:13, 14), which seems to equal *dioscoricola*, on leaves of trees.

P. dioscoricola form *insigne* Pilsbry, Fig. 538:6, 7, 8. Sculpture rougher by the presence of coarse wrinkles or low riblets at unequal intervals among the finer growth-ripples; whorls $3\frac{3}{4}$ to nearly 4. Other characters as in typical *dioscoricola*. Length 1.95, diameter 1.85 mm.; nearly 4 whorls.

TEXAS: Brownsville, type of *insigne*, 109013 A.N.S.P. (fig. 538:7). Hidalgo (fig. 6); Atacosa R., Live Oak Co. (Julia Gardner). Mexico: Valles Falls, Ganina River and Choy cave, San Luis Potosi (A. A. Hinkley); Izamal, Yucatan (Heilprin Exped.). Demerara (fig. 8), (R. Swift).

The single example from Demerara has the ribs very strongly developed (Fig. 538:8). Those from San Luis Potosi have very distinct spiral lines, 4 whorls. A few similarly sculptured specimens were found in lots from Miami and Gainesville, Florida, and one was found at Montego Bay, Jamaica; in both cases among typical *dioscoricola*, and having the same number of whorls. It seems to be a form of sporadic occurrence, not a real subspecies.

***Pupisoma minus* Pilsbry**

Fig. 538:9-11.

Thysanophora dioscoricola (C. B. Ad.), Clapp, 1918, *Nautilus*, 31:75, pl. 8, fig. 2.

Pupisoma minus Pilsbry, 1920, *Man. Conch.*, 26:40, pl. 4, figs. 9, 11.

Fig. 538. 1, 2, *Pupisoma dioscoricola*, Montego Bay, Jamaica; 3, 4, San Carlos Bay, Fla.; 5, Trinidad (author's example of "*Helix*" *caeca* Guppy). 6, *P. d. insigne*, Hidalgo, Texas; 7, Brownsville, Tex.; 8, Demerara. 9, 11, *P. minus*, Snapper Creek, Fla.; 10, var. from Crystal River, Fla. 12, *P. michoacanense* Pils., Mexico. 13, 14, "*Helix*" *punctum* Morelet (= *dioscoricola*), Merida, Yucatan (after von Martens). The scale line = actual height. 15, *P. macneilli* Magazine Pt., Ala. 16, 17, *P. mediamericanum* Pils., Mexico. Guatemala.

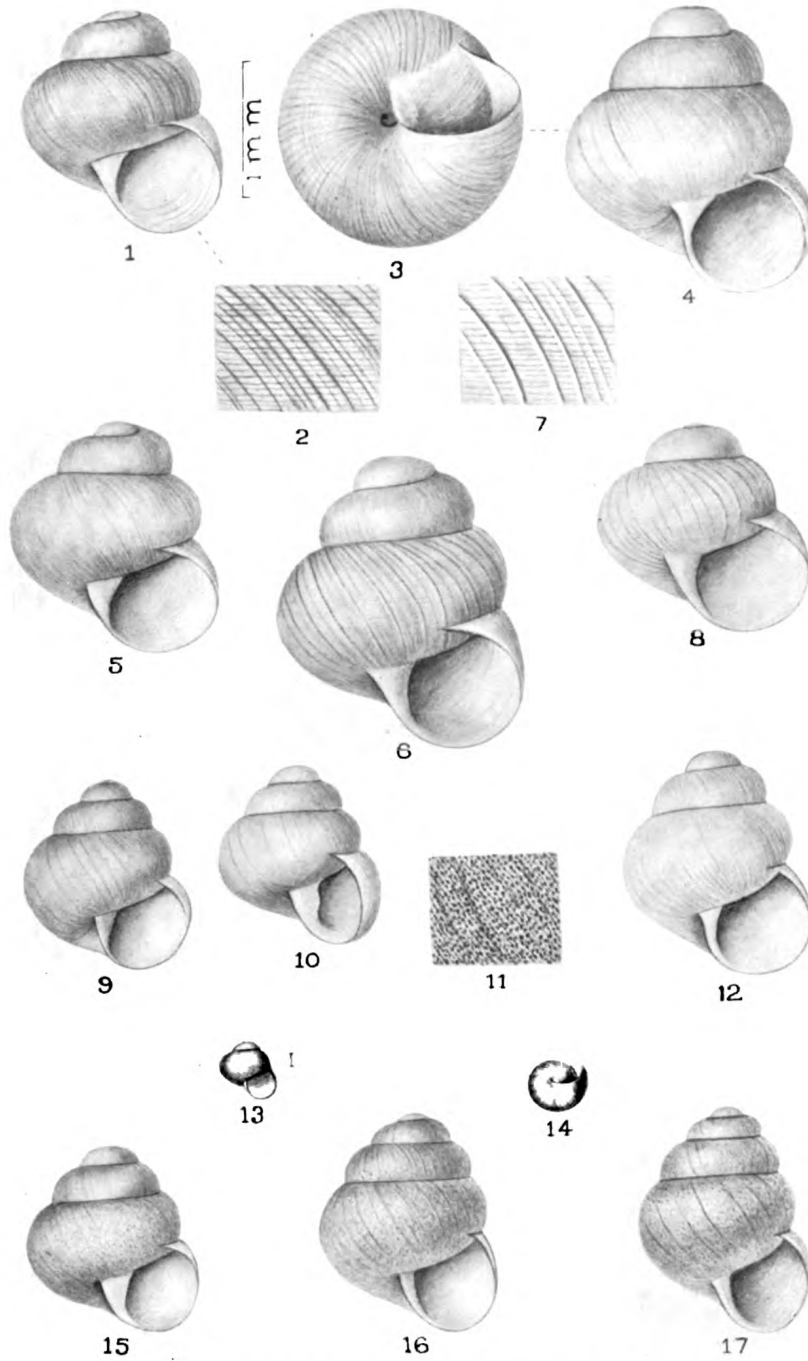


Fig. 538. See bottom of page 1008 for legend.

The shell is very narrowly umbilicate, globose-conic, cinnamon-colored, but slightly glossy. Sculpture of very minute, shallow, confluent pits, or it might be described as densely vermiculate-granose; a few striæ are indistinctly developed but no trace of spiral lines. The whorls are strongly convex. Aperture rounded-oval, excised moderately by the penult whorl. Peristome simple and thin, the columellar margin broadly dilated, half covering the umbilicus.

Length 1.35 mm., diameter 1.23 mm., length of aperture 0.7.; $3\frac{1}{2}$ whorls.

FLORIDA: Chipola R., Marianna; west of Gainesville and Arredonda, Alachua Co.; Homosassa and Crystal River, Citrus Co.; Wacassa R., Levy Co.; St. Augustine; Tick Island, Volusia Co. (Pilsbry & Johnson, 1894); Dade Co. at Lemon City (S. N. Rhoads) and Snapper Creek, south of Coconut Grove, type 113399 A.N.S.P. (Morgan Hebard); Ft. Lauderdale; Coral Gables; near Coot Bay; Cape Sable; Pumpkin Key. JAMAICA: Mandeville, Manchester (A. P. Brown); west of Port Antonio (Henderson). GUATEMALA: Chamá (A. A. Hinkley).

Most of the specimens from Florida were found in leaf and earth siftings. It is readily differentiated from *P. dioscoricola* by the minute size, larger umbilicus, less rapidly expanding whorls, and especially by the sculpture. Half-grown *Bothriopupa variolosa* has similar sculpture, but the first whorl is much smaller and the last less ample, besides differing in form.

The single example from Crystal River (in western Florida about 25 miles below Cedar Keys) has a low prominence on the columella, in an oblique view (Fig. 538:10).

***Pupisoma macneilli* (Clapp)**

Fig. 538: 15.

Thysanophora macneilli G. H. Clapp, 1918, Nautilus, 31:74, pl. 8, fig. 1.

Pupisoma macneilli Clapp, Pilsbry, Man. Conch., 26:41, pl. 4, fig. 15.

"Shell small, globose, with about four well-rounded whorls; suture deep; color chestnut-brown, somewhat shining; surface with faint growth-lines and microscopically granulated; apex obtuse, large, more densely granulated than the body of the shell; widely umbilicate, with the umbilicus extending to the apex and contained about 5 times in the diameter of the shell. Aperture well rounded, slightly oblique; lip thin, partly reflected around the umbilicus. The type measures, alt. 1.5, diam. 1.38, umbilicus 0.29 mm." (Clapp.)

Length 1.3, diam. 1.25 mm.; $3\frac{1}{2}$ whorls (cotype).

ALABAMA: Magazine Point, 8 miles north of Mobile, type in Clapp Coll., Carnegie Mus. Also found at Spring Hill and along the Fowl River, about 3 miles from the coast in the southern part of Mobile Co. (L. H. McNeill); Evergreen, Conecuh Co.

In the cotype figured the umbilicus is contained $5\frac{1}{2}$ times in the diameter. Dr. Clapp's figure shows $3\frac{1}{2}$ whorls, and this is the number counted in the cotype. The umbilicus is larger than in *P. minus* and the aperture is less oblique, this being particularly noticeable in a basal or a profile view.

BOTHRIOPUPA Pilsbry

Bothriopupa Pilsbry, 1898, Nautilus, 11:119, type *Pupa variolosa*; 1917, Man. Conch., 24:226.

The shell is minute (known species $1\frac{1}{2}$ to 2 mm. long), perforate, ovate-conic, of about $4\frac{1}{2}$ convex whorls; *surface minutely and closely pitted*, or *granulose by confluence of the pits*, hardly or not striate. Aperture broadly truncate above, the lip-insertions remote; outer lip slightly, the columellar broadly expanded. Parietal lamella median, curved; a short, horizontally entering columellar lamella and one or two submarginal palatal folds present.

Dr. H. B. Baker has dissected a Jamaican specimen of *B. tenuidens* (C. B. Ad.), a species nearly related by the shell to our *B. variolosa*. It is viviparous. The male organs were very small (page 873, fig. 471:10). Radula has 13.1.13 (7 6) teeth (page 873, fig. 471:9). Central and first laterals subequal, with slender mesocones and 2-4 ectoconal accessories.

Distribution.—Tropical America: six species, in the West Indian region and northern South America.

The pitted or pock-marked surface is characteristic of this genus among American snails, but the Polynesian and oriental *Nesopupae* are similarly sculptured. *Bothriopupa* would hardly be considered distinct from *Nesopupa* Pils., 1900, were it not for the wide geographic separation. However, until a comparative anatomic study can be made of *Bothriopupa*, *Nesopupa* (Pilsbry, 1900) and *Costigo* (Boettger, 1891) nothing would be gained by disturbing the existing taxonomy.

***Bothriopupa variolosa* (Gould)**

Fig. 539.

Pupa variolosa Gould, 1848, Proc. Bost. Soc. Nat. Hist., 3:40; and 1851, in Binney, Terr. Moll., 2:331, pl. 72, fig. 2.—W. G. Binney, 1878, Terr. Moll., 5:199.

Bothriopupa variolosa (Gld.), Pilsbry, 1917, Man. Conch., 24:230, pl. 29, fig. 2, 3.—Bequaert & Clench, 1936, Carnegie Inst. Pub. no. 457, p. 65.

The ovate shell is composed of about $4\frac{1}{2}$ convex whorls. The surface is very closely pitted, or in some specimens the pits are confluent so that it appears covered with an irregular granulation. The peristome is expanded,

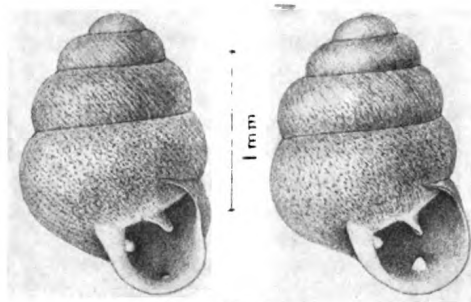


Fig. 539. *Bothriopupa variolosa*, Florida; left, Big Pine Key; right, Little Marco.

not thickened, whitish. The parietal lamella is very high and rather long, curved. Columellar lamella small and placed far within. Lower-palatal fold is tuberculiform and nearly basal in position. There are no other teeth.

Length 1.8 mm., diameter above aperture 1.25 mm.

Length 1.7 mm., diameter above aperture 1.1 mm.

FLORIDA (Bartlett): Big Pine Key (Pilsbry); Little Marco and Morr's I., Collier Co. (C. B. Moore). YUCATAN (Bequaert & Clench).

The station of this very rare snail has not been determined; possibly it lives on mossy trees or rocks, like many of its allies, the *Nesopupae*, or on leaves, like *Pupisoma*.

STERKIA Pilsbry

Sterkia Pilsbry, 1898, *Nautilus*, 11:119; 1920, *Man. Conch.*, 26:49, type *S. calamitosa* Pils.

The shell is minute ($1\frac{1}{2}$ to 2 mm. long, of $4\frac{1}{2}$ to $5\frac{1}{2}$ whorls in known species), perforate, *cylindric* with very short apical cone and *obtusum*; thin, brown, slightly wrinkled or rib-striate. Aperture about as wide as long, the peristome expanded or reflected, brown, thin, terminations remote; angular and parietal lamellæ long, not connected, the angular running to the posterior termination of lip; columellar lamella and 2 or 3 palatal folds present. Type, *S. calamitosa* (Pils.).

Distribution.—Southern and Lower California, and from southern Florida to Guatemala and Guiana.

These minute, blunt-topped pupillids have much the external appearance of the Old World genus *Truncatellina*, but they differ in apertural armature. The teeth of the shell show similarity to the subgenus *Indopupa* of *Nesopupa*, a genus now mainly living in the Pacific Islands and Oriental Region, but in the middle Tertiary also in Europe, associated with *Gastrocopta* and other holarctic genera. Though paleontologic evidencé is lacking, it may perhaps be inferred that the *Sterkiæ* are diminutive descendants of an early Tertiary *Nesopupid* stock which attained a holarctic distribution.

The typical species of the genus are remarkably specialized in teeth. The section *Metasterkia* contains more primitive species.

The living animal has not been observed. It will probably be found to lack inferior tentacles, if our estimate of its affinities is correct. The anatomy is still unknown.

The eastern or Antillean herd is widely remote from that of Lower California; yet we know so little of the minute shells of tropical America that the apparent separation may be due to the deficiencies of our Mexican collections. The genus will probably be found widely spread in the West Indies and shores of the Caribbean Sea.

Key to species

1. Shell distinctly rib-striate; lamellæ and folds large, the inner end of the columellar lamella bent vertically downward (Section *Sterkia* proper). 2
- Shell nearly smooth; palatal folds not very large, all visible in a front view; columellar lamella turned upward within, or horizontal (Section *Metasterkia*) 3

2. Columellar lamella forming a large, vertical plate, visible in the aperture; both palatal folds visible in a front view. *calamitosa*
 Vertical part of the columellar lamella not conspicuous; lower-palatal fold not visible in a front view; upper-palatal very long; base humped. *hemphilli*
3. Columellar lamella median; islands of Southern California. *clementina*
 Columellar lamella situated higher; Florida. *rhoadsi*

STERKIA HEMPHILLI GROUP (Section *Sterkia* s.s.)

Sterkia hemphilli (Sterki)

Fig. 540:5-8, 11, 12.

Pupa hemphilli Sterki, 1890, *Nautilus*, 4:27, 39, pl. 1, f. 6. Binney, 1892, 4th Supplement Terr. Moll., v, p. 192, figs. a, b, c.

Bifidaria hemphilli St. Berry, 1916, *Nautilus*, 30:38, 83.

Sterkia hemphilli (St.), Pilsbry, 1920, *Man. Conch.*, 26:55, pl. 7, figs. 5-8, 11, 12.

The shell is narrowly umbilicate and rimate, cylindrical, brown, resembling *S. calamitosa*; strongly rib-striate after the $1\frac{1}{2}$ smooth initial whorls, the ribs and intervals about equal on the earlier, slightly more spaced on the last whorl. Whorls $4\frac{1}{2}$, strongly convex, the last slightly less convex, impressed over the upper palatal fold, peculiarly swollen or obtusely humped in the middle of the base, the umbilical margin impressed beyond the hump, this impression forming a boss inside (fig. 540:11, 12). Aperture about as wide as long, the outer lip biarcuate, the upper arc shorter and more convex, with a narrower lip than the lower. Angular lamella joining the outer lip, thin, high and nearly straight. Parietal lamella shorter, crescentic, the concavity towards the columella, high and bent outward in the middle, tapering towards both ends, reaching forward to a point opposite the middle of the angular lamella. Columellar lamella consisting of a rather low, horizontal portion curving into a shorter vertical portion descending on the axis, and a less conspicuous but longer branch ascending the axis (fig. 540:5, 12). The upper-palatal fold is rather deeply placed, a high, thin lamina about one-fourth of a whorl long (seen below on the right in fig. 540:6). The lower-palatal fold is oblique, below the inner end of the upper. There is a thin, short suprapalatal fold, not far within, at the lower edge of the sinulus. The peristome is expanded and reflected, pale brown or gray.

Length 1.95 mm., diameter 0.85 mm.

Length 1.6 mm., diameter 0.75 mm.

LOWER CALIFORNIA: bank of San Tomas River (type 62.20384 Carnegie Mus., coll. by H. Hemphill); Point Abreogos (Hemphill, 105486 U.S.N.M.); Ensenada de Todos Santos, under decaying *Mesembryanthemum aequilaterale* (C. R. Orcutt). CALIFORNIA: around San Diego (Orcutt); False Bay, Asher Station, in drift (S. S. Berry); Mesa near Grantville, under prickly pear stems, and Pacific Beach (Orcutt). Waterman canyon, San Bernardino Co., common (Berry).

This minute species is much more complex in structure than *S. calamitosa*, with which it occurs in the Lower Californian stations. The extremes of size are represented in one of the lots from False Bay, near San Diego, 1.6 to 2.05 mm. long.

Sterkia calamitosa (Pilsbry)

Fig. 540:1-4.

Pupa calamitosa Pilsbry, 1889, *Nautilus*, 3:61, pl. 1, fig. 7; Proc. Acad. Nat. Sci. Phila., 1889, p. 411, pl. 12, fig. 16

Sterkia calamitosa Pilsbry, 1920, *Man. Conch.*, 26:57, pl. 7, figs. 1-4.

Sterkia calamitosa martiniana Pilsbry, 1927, *Proc. Cal. Acad. Sci.* (4), 16, 186, pl. 12, fig. 2; *Man. Conch.*, 28:110, pl. 15, fig. 4.

The shell is perforate and rimate, cylindric, obtuse at both ends, thin, somewhat glossy, light brown. First $1\frac{1}{2}$ whorls smooth, corneous, the rest sculptured with close rib-striæ, not quite as wide as their intervals, and somewhat less regular and close on the last $1\frac{1}{2}$ than on the second whorl. There are $4\frac{1}{2}$ to $4\frac{3}{4}$ whorls, the upper ones strongly convex, the last a little less so, its latter part flattened laterally, distinctly impressed over the upper palatal plica, and having a dent-like impression on the base, near the expansion of the lip. The aperture is as wide as long, obstructed by five teeth. Angular lamella slightly curved, the concavity towards the periphery, outer end reaching the lip; its summit is bilobed, there being a median depression. The parietal lamella is of about the same length, but it is higher, more deeply placed and slightly sinuous; its crest is bent towards the angular lamella. The columellar lamella is very large. It consists of a horizontal portion running forward on the parietal wall near the columella, and a broad, vertical portion descending to the base of the axis (figs. 3, 4). The two strong palatal folds stand rather deep within, the upper (seen in profile in fig. 1) being about twice as long as the lower. Peristome is rather broadly expanded and reflected, brown, thin; narrower, somewhat excavated in the sinus; terminations rather remote, joined by an appressed callus.

Length 1.5, diameter .75 mm., $4\frac{3}{4}$ whorls (type).

Length 1.45, diameter .8 mm., $4\frac{1}{2}$ whorls (E. de Todos Santos).

LOWER CALIFORNIA, near the mouth of San Tomas River (Hemphill, type 11602 A.N.S.P.) and Ensenada de Todos Santos (C. R. Orcutt).

This species has not yet been found within our borders. It is related to *S. hemphilli*, but in that form the upper-palatal fold is much longer, the vertical portion of the columellar lamella far less broad, and the angular lamella longer; the lower-palatal fold is wholly immersed, and there are many other differences in structure.

Sterkia calamitosa martiniana Pils. differs by the larger size and longer whorls, and the presence of a suprapalatal tubercle (rarely wanting). It lives on San Martin Island, off Lower California.

Length 1.95 mm., diameter 0.9 mm.; fully 5 whorls. Type.

Length 1.60 mm., diameter 0.9 mm.; smallest seen.

There are a few albino specimens in the lot.

STERKIA CLEMENTINA GROUP (Section *Metasterkia* Pilsbry)

Metasterkia Pilsbry, 1920, *Man. Conch.*, 26:50. Type *S. antillensis* Pils.

Sterkia clementina (Sterki)

Fig. 540: 9, 10, 13.

Pupa clementina Sterki, 1890, *Nautilus*, 4:44 pl. 1, fig. 4.

Bifidaria clementina oldroydi Vanatta, 1916, *Nautilus*, 30:48.

Sterkia clementina St., Pilsbry, 1920, *Man. Conch.*, 26:54, pl. 7, fig. 9, 10, 13.

The minute shell is cylindric. The surface shows very weak traces of low, widely-spaced striæ, usually hardly noticeable; color between cinnamon

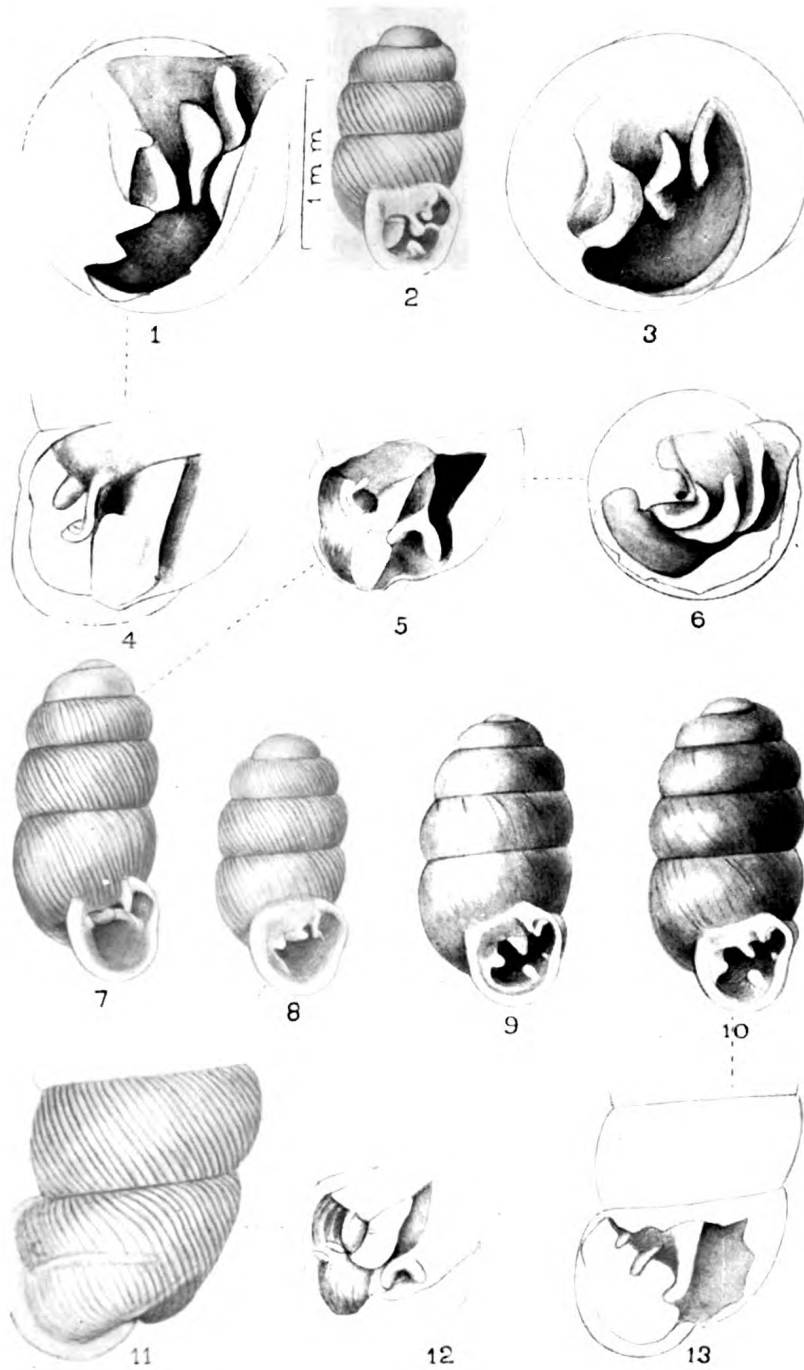


Fig. 540. 1, 3, 4, *Sterkia calamitosa* E. de Todos Santos, L. Cal.; 2. S. Tomas R., L. Cal. 5-7, *Sterkia hemphilli*, nr. Grantville, Cal.; 8, 11, 12, San Tomas R., L. Cal. 9, *Sterkia clementina*, cotype, S. Clemente Island; 10, 13, *Sterkia clementina* (*oldroydi* Van.), S. Barbara Island.

and cinnamon-buff, or paler. There is a distinct but shallow impression over the upper-palatal fold, running to the lip. Peristome a little expanded and slightly thickened at the edge. The angular lamella is longer and much lower than the parietal, its summit depressed in the middle part; it is nearly straight, but curves outward a little to join the outer lip, with a rather thick callous pad at the junction. The parietal lamella is nearly straight. The columellar lamella is short, transverse to the axis, its inner end thick. The upper palatal fold is short, the lower higher, thicker and longer. A basal fold, mentioned in Sterki's description, is not present in the cotype here figured, Fig. 9. It was also absent in Sterki's figure, drawn by himself.

"Alt. 1.9, diam. 0.8 mm.; apert.: alt. 0.6, diam. 0.5 mm." (Sterki.)

Alt. 1.8, diam. 0.9 mm.; 5 whorls. Paratype.

CALIFORNIA: San Clemente Island, type 62.20392 Carnegie Mus.; also Santa Barbara Island (H. Hemphill).

Bifidaria clementina oldroydi Vanatta, from Santa Barbara I., stated to differ from *clementina* by the absence of a basal fold, appears to have no sufficient basis, since this fold is also wanting in some, if not all, San Clemente shells of the type lot of *S. clementina*. The type of *oldroydi* (fig. 540:10, 13) measures: length 1.9, diameter 0.85 mm.; 5½ whorls.

S. clementina differs from other West Coast species of the genus by its relatively small, simple teeth. It is related to the Antillean species and *S. e. rhoadsi*, but the columellar lamella is not situated so high and differs somewhat in shape, the palatal folds are nearer together, and there are more whorls.

***Sterkia eyriesi rhoadsi* (Pilsbry)**

Figs. 541, 542: 3, 6, 7.

Bifidaria rhoadsi Pilsbry, 1899, Proc. Acad. Nat. Sci. Phila., p. 404, figs. 1, 2.

Sterkia rhoadsi Pilsbry, 1920, Man. Conch., 26:52, pl. 6, figs. 3, 6, 7.

The shell is rimate, very minute, cylindric, blunt at the ends, especially above, glossy, clay color, having weak, widely and unevenly spaced wrinkles. Whorls 4¾, the first 1½ smooth, the upper ones very convex, the last a little less so, somewhat compressed over the palatal region, and having a slight impression over the upper palatal fold. The angular lamella is curved, the concavity towards the periphery. It reaches inward hardly to the middle of the parietal lamella, which is longer and higher. The columellar lamella is situated high and ascends obliquely inward. The palatal folds are small, the lower one longer than the upper and a little more deeply placed. The peristome is brown, expanded and reflected. Length 1.85 mm., diameter 0.95 mm., alt. aperture 0.65 mm.; 4¾ whorls.

FLORIDA: Miami, type 77034 A.N.S.P. (S. N. Rhoads); Dismal Key, Lee Co. (C. B. Moore); hammock 1½ miles northeast of Fort Lauderdale (C. T. Simpson in G. H. Clapp coll.).

The teeth are slightly larger in the specimen from Dismal Key, of which an internal view is given (fig. 542:3). At present it is one of the rarest American snails. Only two specimens have been found in the great amount of woodland debris from Florida which has been worked over in this labora-

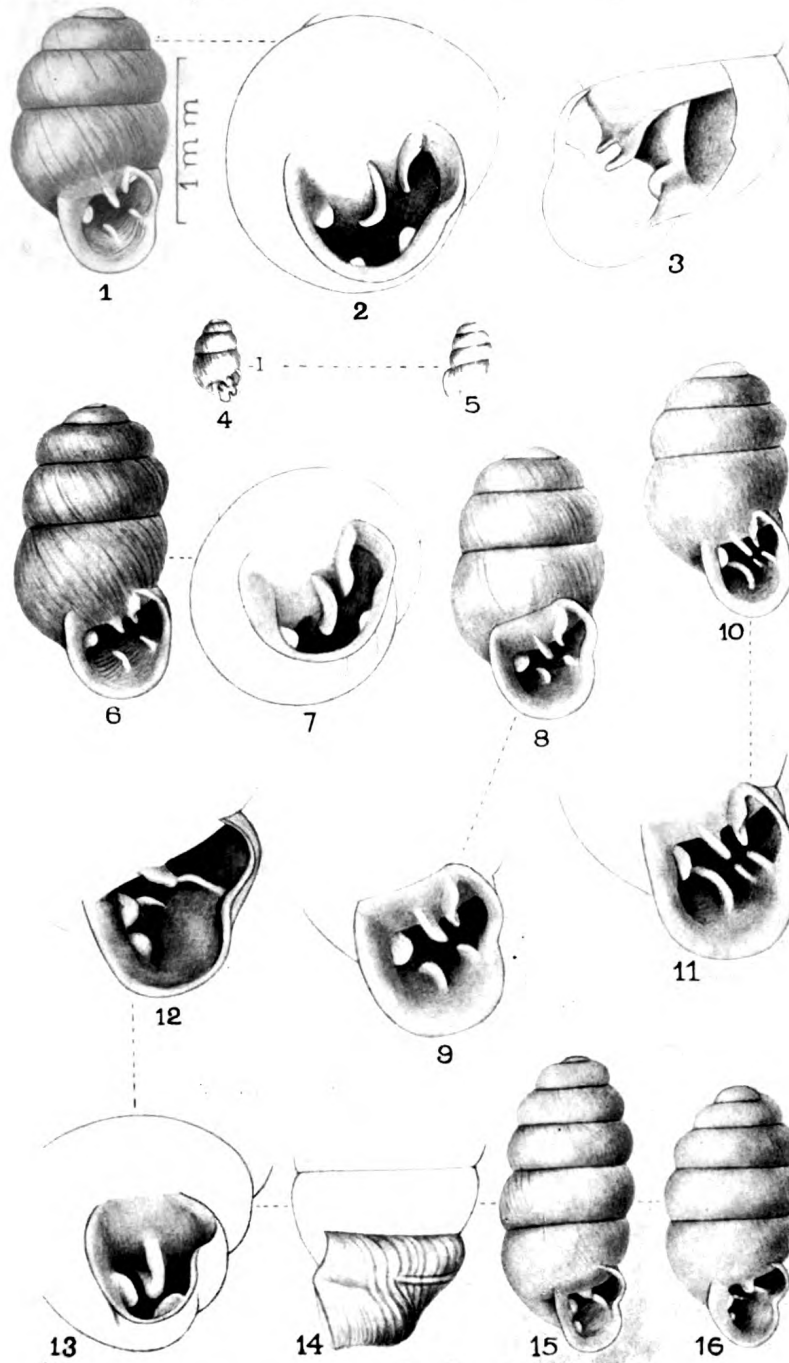


Fig. 542. 1, 2, *Sterkia eyriesi*, Cayenne, French Guiana. 3, 6, 7, *Sterkia eyriesi rhoadsi*, Lee Co., Fla. 4, 5, *Sterkia eyriesi* (Drt), French Guiana, after Drouet. 8, 9, *Sterkia antillensis* Pils. Type. Viñales, Cuba. 10, 11, *Sterkia antillensis* var., Mandeville, Jamaica. 12-16, *Vertigo hinkleyi*, type and paratype.

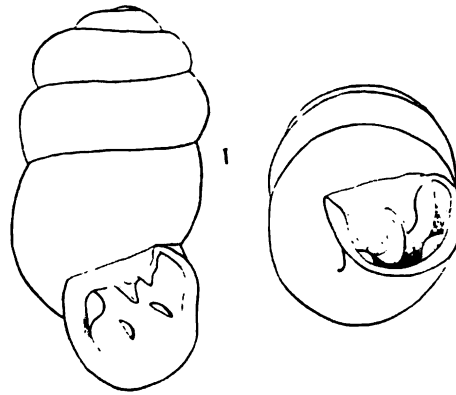


Fig. 541. *Sterkia eyriesi rhoadsi*, Type, Miami, Florida. Size mark = length of shell.

tory. Dr. Clapp found about a dozen in a bushel of rubbish from near Fort Lauderdale, a place on the mainland above Miami.

Very close to *S. eyriesi* (Drouet), which occurs from Guiana to Guatemala, and is figured in fig. 542:1, 2, 4, 5. In *rhoadsi* the shell is a little larger and more slender, with relatively smaller aperture. No actual intergradation in these characters has been observed in the very small number seen; yet it seems unlikely that they will prove of specific constancy when fuller series come to hand.

It resembles *S. clementina* in the relatively smooth surface and moderately developed teeth, but differs by the obliquely ascending columellar lamella and other details of structure.

Family XXI. VALLONIIDAE

Valloniidae Pilsbry, 1900, Proc. Acad. Nat. Sci. Phila., p. 564; 1935, Man. Conch., 28:173.

Acanthinulinae Pilsbry, 1918, Man. Conch., 24: x; 1926, 27:186.

Acanthinulidae Steenberg, 1918: Vidensk. Medd. Dansk. naturh. Foren., 60:14.

Valloniinae H. Watson, 1920, Proc. Malac. Soc. Lond., 14:6.—H. B. Baker, 1935, Man. Conch., 28:191.

Minute orthurethrous snails with perforate or umbilicate shells of few whorls, from discoidal to ovate-conic in form, without internal laminae; often with sculpture of spaced cuticular ribs; the peristome either expanded, thickened or simple; toothless (except in *Spelaeodiscus*).

The oviparous or viviparous animal has a long penial appendix; the retractor muscle forked (except in *Planogyra*). The prostate gland is short and posterior. As in some other genera of minute orthurethrous snails, the terminal male organs are often wanting. The arcuate jaw is thin, with weak, flat vertical folds. Central tooth somewhat or decidedly narrower than the laterals, tricuspid or with ectocones much reduced. Lateral teeth bicuspid; marginal teeth wide, pectinate, with several or numerous narrow cusps, no entocones. Foot sole simple, its margins usually crenulate.

This group is understood in the limits of Steenberg, 1917, and Watson 1920, except that the genera *Pyramidula* and *Pleurodiscus* are excluded, as in Manual of Conchology, 28:177.

The character of being toothless has not, I think, been sufficiently appreciated by those who would unite Valloniidae with the Pupillidae or the Strobilopsidae. Two leading genera, *Vallonia* and *Acanthinula*, are known in many species from the early or middle Paleocene to the present time, without showing traces of teeth or internal laminae. The only toothed member of the family is *Spelaeodiscus*, and here the teeth are not at all of pupillid type, being more like the apertural teeth which have arisen in various stocks of helices, and are evidently a newly acquired structure. It seems likely that the Valloniidae parted from the ancestral pupillid stock before the pentodont pattern of aperture had been acquired by the latter.

Two subfamilies have been recognized by some authorities, but their structural divergence seems insufficient.

Key to genera

- Shell moderately calcified; strongly depressed; with expanded peristome; oviparous. *Vallonia*
- Shell thin, mainly epidermal, with unexpanded peristome;
- Spire nearly flat; oviparous *Planogyra*
- Spire high; ovo-viviparous *Zoogenetes*

VALLONIA Risso

Vallonia Risso, 1826. Hist. Nat. Eur. Mérid., 4:101, sole species *V. rosalia* Risso, in part = *V. costata* Müller⁸⁵.—Sterki, 1893, Proc. Acad. Nat. Sci. Phila., pp. 234-279, monograph.—Pilsbry, 1935, Man. Conch., 28:174, synonymy.—By typographic error, "*Valtonia* Kisse," Ancey, 1881, Le Naturaliste, 1:215, for *Helix pulchella*.

Amplexis Brown, 1827, Ill. Conch. Gt. Brit. and Ireland, Expl. of pl. 41, for *A. paludosus* (= *V. pulchella*) and *A. crenellus* (= *V. costata*), the former designated type, Man. Conch., 28:174.

Amplexus Brown, 1844, not of Sowerby, 1815.

Zurama Leach, in Turton, 1831, Man. Land and Fr.-w. Sh. Brit. Is., p. 64, in synonymy under *Helix pulchella*.—*Zuramia* Leach, Kennard & Woodward, 1926, Syn. Brit. Non-mar. Moll., p. 135, in synonymy.—*Lurama* Leach, Hönigmann, 1910, for *L. pulchella* (Misspellings).

Circinaria Beck, 1837, Index Moll., p. 23.—Herrmannsen, 1847, *Helix pulchella* designated type.

Glaphyra Albers, 1850, Die Hel., p. 87; *H. pulchella* designated type by Pilsbry, 1935, Man. Conch., 28:174

Lucca "Hartmann" Gray, 1840, in Turton's Manual, p. 142. Not of Hartmann, 1821.

The shell is minute, widely or openly umbilicate, depressed, the spire low, convex, of 3 to 4½ rounded whorls, the last usually descending in front; color

⁸⁵ According to Commandant Caziot, Risso's collection contains both *pulchella* and *costata* under the name *Vallonia rosalia*. His figure, pl. 3, fig. 30, evidently represents *V. pulchella*, but the terms of his description, "tours de spire sculptés de petites stries transverses, courbes, égales, élevés", apply to *V. costata*. Like many later authors, he included both in a single species.

very light, uniform; surface smooth, or ribbed along lines of growth. The aperture is oblique, circular or rounded-oval, without teeth or laminae; the peristome continuous or nearly so, expanded or reflected, often thickened within.

The soft parts are transparent-white. Eye stalks are but slightly swollen distally, the eyes black. The lower tentacles are rather short but well developed. The sides are faintly reticulate or granose; no visible pedal grooves. Orifice of reproductive organs near the right ocular tentacle. The sole is undivided, narrow, its length less than the diameter of the shell, and the margin weakly crenulate. In progression two or three advancing muscular waves may be seen at one time traversing the whole sole (or, according to Sterki, four or five). The shell is ordinarily carried poised in the air, tilted towards the right, often more steeply tilted than in figure 543 c. (*V. pulchella* and *V. costata* examined.)

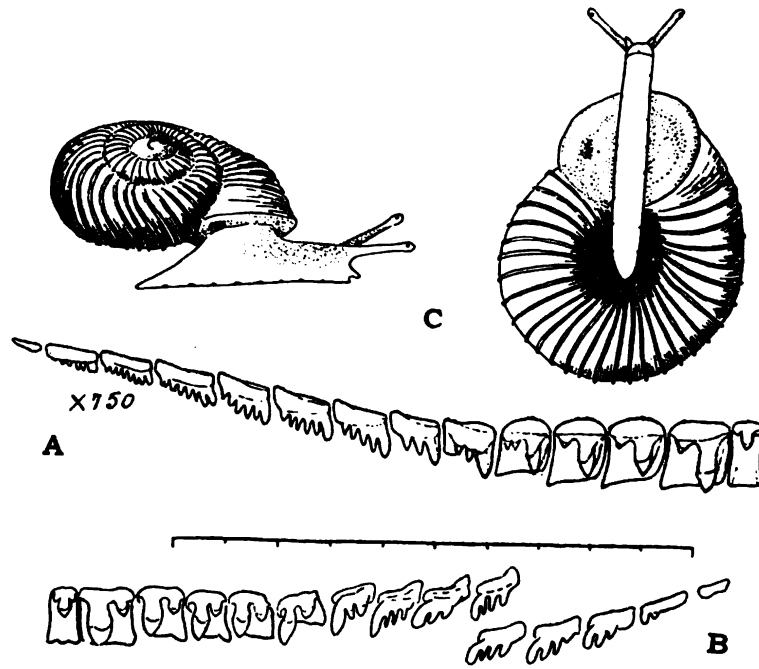


Fig. 543. A, teeth of *Vallonia pulchella*, after Hugh Watson. B, teeth of *V. costata*, after Steenberg. C, *V. costata* from Philadelphia, on a horizontal plane and ascending a vertical surface.

The jaw is arcuate with a slight median projection or none, sculptured with numerous (18 to 25) crowded, low riblets, denticulating the margin.

Radula having 27 to 33 teeth in a transverse row, of which three or four are laterals, two or three transitional to the marginals. Central tooth decidedly narrower than the laterals, tricuspid, the mesocone not half as long as the basal plate. Laterals with large, square basal plates, the mesocones extending to the posterior margin, ectocone small. The first one or two laterals are larger than those following. Marginal teeth are low, wide, multicuspid (Fig. 543 A *V. pulchella*; 543 B, *V. costata*).

The kidney is very long, wide at the base, tapering into the ureter; this is abruptly bent near the anterior orifice, which is a short distance from the mantle edge. The cavity of the kidney has a ring of short longitudinal ridges.

The penis bears the retractor muscle and an appendix at the apex. The appendix is bent in V shape, has a globular sub-basal and oval terminal enlargement. The penial retractor muscle bifurcates, one branch inserted on the epiphallus, the other on the penis. It inserts distally on the diaphragm.

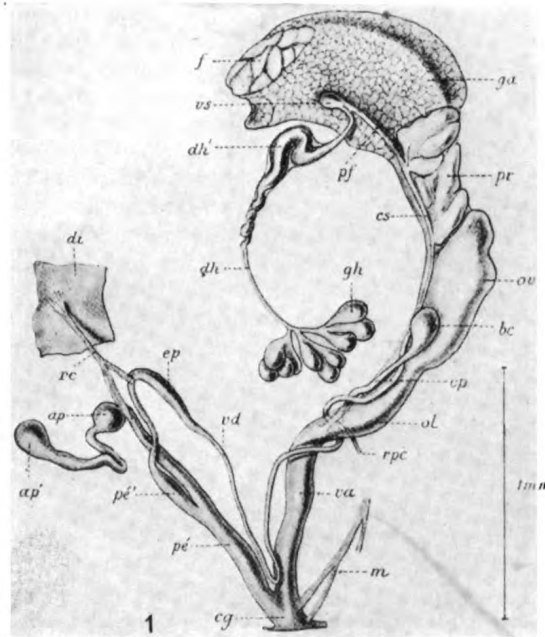


Fig. 544. *Vallonia costata*, genitalia, after Steenberg.

The ovo-testis is imbedded in the liver, composed of three groups of 3 or 4 pear-shaped follicles each. The hermaphrodite duct is much swollen in the lower third. The prostate gland is large. Oviduct not sacculated. The spermatheca is oval on a rather short duct. The vagina is long. As in *Vertigo*, *Zoögenetes* and some other genera, the male terminal organs are sometimes wanting, and *V. pulchella* at least, is able to reproduce without cross-fertilization.

The right eye-retractor passes between the ♂ and ♀ branches of the genitalia.

Distribution.—*Vallonia* comprises about 25 species of minute snails, spread over America north of Mexico, Europe, northern and central Asia, and Japan. As fossils, *Valloniae* are known from the Paleocene, Eocene, Miocene and Pliocene of Europe, and Pleistocene of Europe and America. It is an old group, which was apparently evolved in Mesozoic time, and has changed very little since the Eocene.

They live under wood, stones and bricks, and at the roots of grass in lawns and gardens, and may almost always be found about ruined stone buildings, old walls, and the discarded flower-pots and rubbish accumulating in neglected gardens. With Pupillidae they are washed into streams in great numbers, being among the commonest shells in flood-debris.

The reproductive cycle of *Vallonia* has been studied by Margaret E. Whitney, 1938 (Proc. Indiana Acad. Sci., 47:299-307.) A summary of her observations follows:

" 1. Specimens of *Vallonia pulchella* (Müll.) brought into the laboratory in fall, winter and early spring began laying eggs in from a few days to a week or two. Eggs were not found in any considerable numbers until the middle of May. They were collected from time to time throughout the summer.

" 2. The eggs are laid singly, and under optimum conditions in the laboratory one egg is laid each day and sometimes more.

" 3. Hatching occurs in the laboratory in about 12 days. The juveniles at the time of hatching are well-developed and quite active. One whorl of the shell is completed, and they measure about 0.6 mm. in diameter.

" 4. Juveniles reared in isolation from the egg showed a steady growth under favorable conditions of about 0.2 mm. per week (diameter of the shell) and reached adult size in an average of 59 days. They began laying eggs usually in less than a week after the formation of the peristome. The average diameter at this time was 2.0 mm., the normal adult size.

" 5. Individuals reared in isolation for several succeeding generations reproduced.

" 6. Refrigeration and desiccation have retarding and inhibiting effects on egg-laying and development, but the animals recover rapidly from these effects. Refrigeration is less inhibiting than desiccation. The eggs are very sensitive to desiccating influences. In nature they are deposited in protected places. Juveniles are less susceptible to desiccation than the eggs. With age the juveniles become progressively more resistant to unfavorable conditions.

" 7. In general, this study shows that *Vallonia* is able to reproduce without cross-fertilization, suggesting either parthenogenesis or some form of self-fertilization, and that the reproductive cycle is strongly influenced by environmental factors."

In America, *Vallonia* was first critically studied about fifty years ago by Dr. Victor Sterki, whose three papers cited below, dealing with the shells, radulae and jaws, form the foundation of our taxonomic knowledge of American species.

Some notes on North American forms of *Vallonia*. *Nautilus*, 5:100, 101. January, 1892.

Genus *Vallonia*, in *Manual of Conchology* (2 Ser.), 8:247-261, pl. 32, 33. July 1, 1893.

Observations on *Vallonia*. *Proc. Acad. Nat. Sci. Phila.*, 1892, 234-279, pl. 8. Sept. 12, 1893.

The anatomy and classification of *Vallonia* have been discussed by C. M. Steenberg, 1917 (*Vidensk. fra Dansk. Naturhist. Foren.*, 69:1), by Hugh Watson, 1920 (*Proc. Malac. Soc. London*, 14:6-30), and others.

The species of *Vallonia* show little variety in shape and not much in size, and meticulous attention to details is needed in the identification of the ribbed species.

(*Vallonia*, according to Risso, is the goddess of valleys.)

Key to species

- A. Suture not descending to the aperture, or scarcely so; shell smooth, with faint growth-lines only. Lip strongly thickened within.
 - B. Umbilical spiral regular; outer margin of lip strongly expanding ..*V. pulchella*
 - BB. Umbilical spiral transversely lengthened; outer margin of lip expanding but little*V. excentrica*
- AA. Suture distinctly descending to the aperture; shell ribbed.
 - B. Lip distinctly or strongly thickened.
 - C. Diameter about 2 mm. or less. Canada and northern United States.
 - V. parvula*
 - CC. Diameter 2.5 to over 3 mm.
 - D. 23 to 35 ribs on last whorl; embryonic shell with microscopic spiral lines. Eastern.*V. costata*
 - DD. More numerous ribs, 45 to over 50. Canada, New England and western mountain states*V. gracilicosta*, *V. albula*
 - BB. Lip expanded but thin.
 - C. Diameter about 2 mm.*V. perspectiva*
 - CC. Diameter 2.5 to over 3 mm.*V. cyclophorella*

VALLONIA PULCHELLA GROUP

Shell smooth, with thick lip.

Vallonia pulchella (Müller)

Fig. 545 a.

Helix pulchella Müller, 1774, Vermium terr. et fluv. Hist., 2:30 (Denmark).—Leidy, 1851, Terr. Moll., 1:256, pl. 9, figs. 7-9.

Vallonia pulchella Müll., Binney, 1878, Terr. Moll., 5:344, pl. 17, fig. 1; Man. Amer. Land Sh., p. 77, fig. 39.—Sterki, 1893, Man. Conch., 8:248, pl. 32, figs. 1-5; Proc. Acad. Nat. Sci. Phila., p. 247, pl. 8, figs. A, G, H, I, K, L (jaw and teeth).—Henderson, Univ. of Colo. Studies, 1924, 13:107; 1929, 17:76, fig. 30; 1936, 23:101.—Stearns, 1900, Nautilus, 14:65.—Williamson, 1898, Nautilus, 12:71 (occurrence in California).—F. C. Baker, 1920, Life of the Pleistocene or Glacial Period, p. 388.—Margaret E. Whitney, 1941, Pap. Mich. Acad. Sci., etc., 26:311-338 (hermaphrodite gland and germ cells).

Helix minuta Say, 1817, Jour. Acad. Nat. Sci. Phila., 1:123 (presumably from Philadelphia).

Vallonia minuta Say, Morse, 1864, Jour. Portland Soc. N. H., 1:21, figs. 54-59.

The depressed shell is umbilicate, the umbilicus in its last half turn enlarging to double its former diameter, contained about 4 times in the diameter; corneous and imperfectly transparent, or of somewhat milky tint; the surface glossy, very delicately and minutely striate, the striation stronger and more regular in the umbilicus, the apical whorl smooth. There are 3½ convex whorls parted by a deep suture, which descends only very slightly to the aperture; the last whorl is well rounded, not descending noticeably in front. The aperture is oblique, the peristome rather abruptly expanding, heavily thickened within, and forming about five-sixths of a circle.

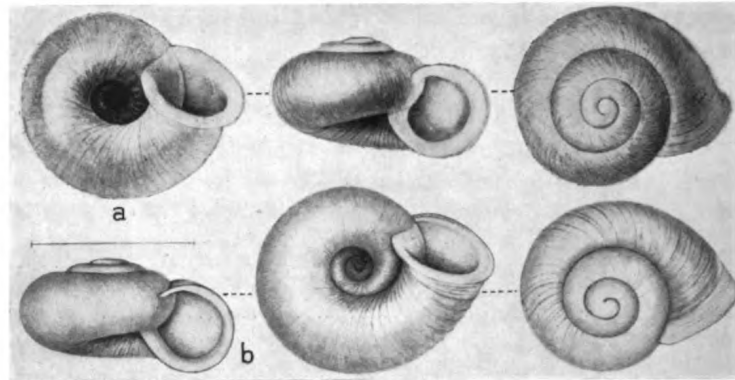


Fig. 545. a, *Vallonia pulchella*, Dutchess Co., N. Y. b, *Vallonia excentrica*, Staten Island. Scale line = 1.8 mm.

Height 1.2 mm., diameter 2.4 mm.

Distribution.—North Africa, Europe, type loc. Denmark. Siberia east to the Amur; North America east of the Rocky Mountains from Nova Scotia, Winnepeg and Pembina south to Sedalia, Missouri and Bowling Green, Kentucky. Introduced locally in Texas, the mountain states, California, Bermuda, Azores and Madeira, Australia, Tasmania and elsewhere. Pleistocene of the Ohio and northern Mississippi valleys (Yarmouth stage to Recent).

It is often found in abundance in lawns and gardens, where shrubbery, bricks, flower pots or the like afford protection from the summer sun and refuge during hibernation. After rain they sometimes crawl abroad in prodigious numbers. Mr. Wheat writes: "In my gardens in the heart of Brooklyn are innumerable *Vallonia pulchella*. I have taken fifty specimens from a space of four inches square. In midwinter sixteen were found packed in a bit of the hollow stem of a plant, the shells fittingly snugly in the orifice, and all occupying a little more than an inch in length. In November I have found them active under half an inch of frozen earth and snow." In Pittsburgh, Pennsylvania, Dr. G. H. Clapp reported instances where *V. pulchella* appeared suddenly, on stone walks after rain, in immense numbers, "literally by millions" (*Nautilus*, 10:143; 14:120).

This tiny snail has a vast geographic range in the Old World but somewhat smaller in America, exclusive of obvious importations. It appears to be indigenous with us, as it is recorded from Pleistocene deposits. In the East it does not appear to live in mountains: I did not find it in the region about Tannersville Valley in the Catskills or in the eastern Adirondacks, and it did not appear in collections made by my friends and myself in the southern Alleghanies.

The western and southern limits of the range of *V. pulchella* remain hazy, partly on account of the uncertain identity of published records. It is certainly known from all of the New England and Middle states, west to Manitoba, Iowa and Missouri, and south to Washington, D. C., and Kentucky. There is no definite Alabama record. In the mountain and west coast states *pulchella* has been widely but very locally spread, probably in the earth on plants from eastern nurseries and florists, but there are few records for *V. excentrica*. As Junius Henderson has noted, "their apparently total absence from unsettled districts is strong evidence that they are not native." Western locality records follow:

MONTANA: Wibaux (H. Squier). WYOMING: Sheridan (J. Henderson). COLORADO: Boulder (Cockerell); Ft. Collins (Henderson); near Colorado Springs, (H. B. Baker). UTAH: Provo (Henderson). OREGON: Phoenix and 2 mi. above Milton (Henderson). CALIFORNIA: "In thickly populated districts probably introduced with grass seed" (Hanna, Bull. Dept. Agric. Cal., 28:310); Redding (R. C. McGregor); Murphey's, Calaveras Co. (H. B. Baker); San José (Mrs. E. A. Bush); San Juan Capistrano creek, Orange Co. (M. E. Caruthers); Santa Barbara and Berkeley (A. G. Smith); Redlands (S. S. Berry); Los Angeles (R. E. C. Stearns, W. O. Gregg); Balboa Park, San Diego (J. L. Baily). TEXAS: Galveston (Pilsbry, 1885). I have not seen the Montana, Wyoming and Utah specimens reported.

Vallonia excentrica Sterki

Fig. 545 b.

Vallonia excentrica Sterki, 1893, Man. Conch., 8:249, pl. 32, figs. 6, 9; Proc. Acad. Nat. Sci. Phila., 1893, p. 252, pl. 8, figs. v. m. (teeth and jaw).—Walker, 1906, Ill. Cat. Moll. Mich., 1:521.—Baker, 1939, Fieldbook Ill. Land Snails, p. 118.—Henderson, 1929, Univ. Colo. Studies, 17:76.—H. Watson, 1920, Proc. Malac. Soc. Lond., 14:28, figs. 6 h, g, j; pl. 1, figs. 1, 6.

Vallonia pulchella Müll. var. *excentricoides* Sterki, A. Weiss, 1894, Nachr. d. m. Ges., 26:154 (Weimarisch-Taubacher Kalktuffbeckens, Pleistocene).

The shell is moderately umbilicate, the umbilicus elongate, rapidly widening in the last third of a whorl; pale corneous, transparent or nearly opaque, with a somewhat oily gloss; *smooth*, or very finely and irregularly striate, the first whorl smooth. The upper surface is slightly convex. The 3 to 3½ whorls increase rather rapidly and are joined by a moderately deep suture, the last whorl being relatively large, well rounded, expanding a little towards the aperture, not descending in front. The aperture is rather oblique. The peristome forms five-sixths of a circle, and is distinctly everted at the lower part only, the outer margin of lip being turned out very much less than in *V. pulchella*; it is strengthened within by a strong, white lip shining through the shell outside. Height 1.1 mm., greatest diam. 2.3 mm., least diam. 1.8 mm.

CANADA: Quebec (A. W. Hanham); Ottawa (F. R. Latchford), and Hamilton, Ont.; Halifax, N. S. (C. J. Cleborne). NEW ENGLAND and the MIDDLE STATES: generally distributed from Maine and the Niagara River to Washington, D. C.; Type 10080 A.N.S.P. from Staten Island, N. Y. OHIO: New Philadelphia (Sterki). MICHIGAN: north to Newaygo Co. (Walker). INDIANA: Lafayette, Tippecanoe Co. (A. F. Satterthwait). ILLINOIS: Urbana, Champaign Co., on the University campus and elsewhere, according to F. C. Baker. OREGON: Phoenix, with *V. pulchella* (Henderson). Also widely distributed in Europe.

This snail can be separated from *V. pulchella* by the more oblong contour of the shell and umbilicus, the last whorl widening more towards the aperture, the basal and especially the outer arc of the peristome but very little expanded and not abruptly, and by the smaller and lower spire. Hugh Watson's figures of British shells show these features accurately, being the best published.

It frequently occurs in company with *V. pulchella*. So far as present information goes, it is less widely distributed westward. Over 70 lots in the collection of the Academy show that its distribution is general from Maryland to Lake Erie and the St. Lawrence River, and in New England. In the field, as well as in collections, *excentrica* is often to be found mingled with *pulchella*, but they can be separated without serious difficulty. Like *V. pulchella*, *V. excentrica* is something of a "tramp". It occurred among *pulchella* from Los Angeles, Cal., collected by Dr. Stearns, and from Phoenix, Ore., taken by Junius Henderson. Joshua L. Baily Jr. found it at Cuernavaca, state of Moreles, Mexico. Specimens have been seen by the author from South Africa and Madeira.

VALLONIA COSTATA GROUP

Shell ribbed, with thick lip; embryonic whorl usually striate spirally.

Vallonia costata (Müller)

Fig. 546.

Helix costata Müller, 1774, Vermium terr. et fluv. Hist., 2:31 (Fridrichsdal, Denmark).

Vallonia costata Müll., Sterki, 1893, Man. Conch., 8:252, pl. 32, figs. 18-22, 27, pl. 33, fig. 54 (apex); Proc. Acad. Nat. Sci. Phila., 1893, p. 259, pl. 8, figs. c, n.—F. C. Baker, 1939, Fieldbook Ill. Land Snails, p. 119, figs.—Henderson, 1924, Univ. Colo. Studies, 13:101 (Rocky Mountain records enumerated and discredited).—Kennard & Woodward, 1926, Syn. Brit. non-mar. Moll., p. 138 (synonymy).—Watson, 1920, Proc. Malac. Soc. Lond., 14:6-28.

"The depressed shell has a rounded umbilicus and slightly convex spire. Color gray or faintly yellowish-corneous, a little translucent; the surface with a somewhat silky sheen, and sculptured with delicate, retractive, radial

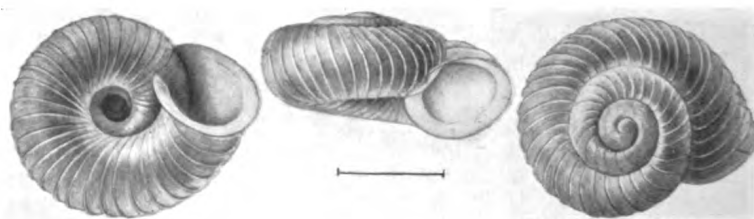


Fig. 546. *Vallonia costata*, Germantown, Philadelphia. Scale line for middle figure = 1 mm.

ribs, about 23 to 35 on the last whorl, the intervals having irregular microscopic striae in the direction of growth lines; embryonic $1\frac{1}{2}$ whorls are microscopically striate spirally. There are $3\frac{1}{2}$ convex whorls united by a deep suture which in front descends to the aperture. The aperture is almost circular, oblique, the peristome well expanded, strongly thickened within except near the upper termination." (Sterki.)

Height 1 mm., diameter 2.5 mm.

CANADA: Quebec (R. Walton). ONTARIO: Fort Frances. MANITOBA: many localities. SASKATCHEWAN: Yonker; Kamsack; Quill Lake; Wynyard near little Quill Lake; Wadema near Foam Lake; Dafoe; Lanigan; Watson; Dalesford; Kelliher; Touchwood; Humboldt; Saskatoon (Mozley, *Nautilus*, 42:14; 43:80). MICHIGAN: Jackson, Livingston, Monroe, Wastenaw and Wayne counties (A. F. Archer); according to Walker, Owosso, Shiawassee Co., Isle Royale and Monroe. ILLINOIS: northern, south to Champaign Co. (F. C. Baker). OHIO: Clark, Miami and Ottawa counties; "Over the state" (Sterki). MARYLAND: Hagerstown. VIRGINIA: Norfolk (L. Hubricht).

EUROPE, and east to the Amur valley; north Africa.

In America *V. costata* was long viewed as a variety of *V. pulchella*, and when recognized it was not distinguished from other American ribbed species prior to Sterki's revision. In Canada it appears to be more generally spread than *V. pulchella*, but it is less common than *pulchella* southward.

***Vallonia parvula* Sterki**

Fig. 547.

Vallonia parvula Sterki, July 1893, *Man. Conch.*, 8:254, pl. 32, figs. 23-26; Sept. 1893, *Proc. Acad. Nat. Sci. Phila.*, 1893, p. 265, pl. 8, fig. r.—Pilsbry, same *Proc.*, 1906, p. 559.—Walker 1897, *Nautilus*, 11:82 (Put-in Bay Island, Lake Erie).—F. C. Baker, 1939, *Fieldbook Ill. Land Snails*, p. 119, figs.

Vallonia americana Ancey, MS., in Sterki, Sept., 1893, *Proc. Acad. Nat. Sci. Phila.*, 1893, p. 266.—Cockerell, Dec. 1893, *Nautilus*, 7:94 (Davenport, Iowa).

Vallonia costata var. *minor* Cockerell, Sterki, Sept., 1893, same *Proc.*, p. 267 (Ontario at Niagara Falls).

"Shell small, widely umbilicated, especially for the last $\frac{1}{3}$ - $\frac{1}{2}$ whorl, quite flat above or with very little prominent apex, thin, horn colored to nearly colorless, with rather fine, dense, membranous ribs (about 30-38 on the last



Fig. 547. *Vallonia parvula*, Joliet, Illinois. Scale line = 1 mm.

whorl), and microscopic, intercrossing lines between them; nucleus with fine revolving lines; whorls a little over 3, slightly flattened above and below the periphery, with a deep suture; the last much wider than the penultimate, rather rapidly expanding toward the aperture and descending only at the suture in front; aperture very oblique, tangential and rather inclined, almost circular with ends of margin much approximate; peristome with a rather

strong, pale horn colored lip. Diam. maj. 2.0 mm., min. 1.6, alt. about 0.8 mm." (Sterki.)

ONTARIO: Niagara Falls (D. B. Cockerell); Oxley (Mary E. Walker). OHIO: Put-in Bay Island (Bryant Walker, J. A. Allen); Sandusky (Sterki). ILLINOIS: Joliet, Type 62.19238 Carnegie Mus., topotypes 11721 A.N.S.P., and Birds' Bridge, Will Co. (J. H. Ferriss); Ottawa, La Salle Co. (Sterki). IOWA: Davenport (Shimek, Pilsbry and others); Bonair, Howard Co.; cited by Sterki from "Eastport, on the Missouri River," but no place of that name found. SOUTH DAKOTA: Lincoln Co. (Over). KANSAS: Wichita (according to Sterki). OKLAHOMA: Fort Gibson (E. W. Hubbard).—TEXAS: Paladora Creek drift, Randall Co. (W. T. Clarke).

It is closely related to *V. costata*, but is conspicuously smaller, diameter 1.6 to 2.1 mm., usually about 1.9 mm., the spire is flatter, the umbilicus wider, and the periphery of the last whorl does not descend in front. *V. perspectiva* is a thinner, more broadly umbilicate shell with thin lip.

A form from Arredonda, Alachua Co., Florida (a place about 7 miles from Gainesville, on the highway to Cedar Keys) is the only *Vallonia* seen from the peninsula. Fig. 548. The shell is similar to *V. perspectiva* in shape and in the sculpture of thin, well-spaced and largely cuticular riblets. Umbilicus contained 3 times in diameter. The last whorl ascends slightly

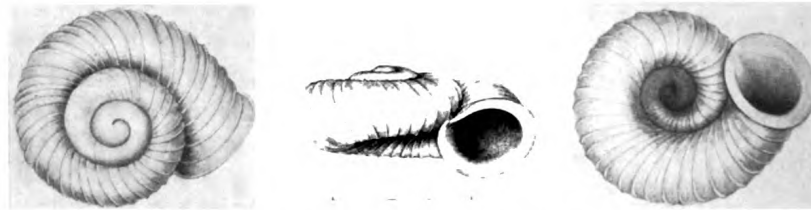


Fig. 548. *Vallonia parvula*, Floridan form, 149295 A.N.S.P. Scale line = 1 mm.

before descending deeply in front. The small aperture is nearly circular. Peristome continuous, well expanded, heavily thickened within, its face nearly flat. Height 0.93 mm., diameter 2 mm.; $3\frac{1}{4}$ whorls.

This shell differs from *V. perspectiva* by the heavily thickened lip. The aperture is smaller than in northern specimens of *V. parvula*, and the peristome is continuous; also the suture descends much more deeply in front; yet it seems so nearly related to *parvula* that I hesitate to separate it, though the latter is geographically remote. It is known to me only by the figured example and specimens in the Florida State Museum. Importation from the north appears likely.

***Vallonia gracilicosta* Reinhardt**

Fig. 549 a.

Vallonia gracilicosta Reinhardt, 1883, Sitzungs-Ber. Ges. Naturforsch. Freunde Berlin, p. 42.—Sterki, 1893, in part, *Man. Conch.*, 8:256, not pl. 33, figs. 48, 49; *Proc. Acad. Nat. Sci. Phila.*, 1893, pp. 269, 278.—Henderson, 1924, *Univ. Colo. Studies*, 13:102; 1936, 23:100.

V. costata var. *montana* Sterki, 1893, *Man. Conch.*, 8:254; *Proc. Acad. Nat. Sci. Phila.*, p. 263.

"Shell flat with little projecting apex, widely umbilicate, whitish-gray in color. Whorls $3\frac{1}{2}$, convex, separated by a deep suture, with fine but distinct, rather crowded ribs; the last whorl slightly angular around the umbilicus, strongly expanding toward the aperture, slightly descending to the same. Aperture moderately oblique, transversely oval, with strongly expanded and broadly white-lipped peristome; upper margin but little, lower margin more strongly curved, almost obtusely angular. Margins at the insertions approaching and connected by a callus. Height about 1 mm., greater diam. 2.5, lesser 2 mm." (Reinhardt).

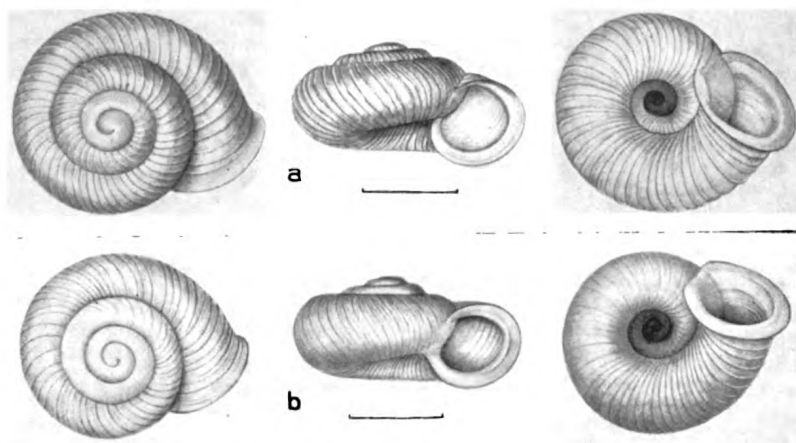


Fig. 549. a, *Vallonia gracilicosta*, Medora. b, *V. gracilicosta* form *montana*, type. Scale lines = 1 mm.

MINNESOTA: Thief River Falls, Remington Co. (L. E. Daniels). MISSOURI: Mona, St. Louis Co. loess (L. Hubricht). SOUTH DAKOTA: Brule, Clay, Custer, Deuel, Harding, Lawrence, Pennington, Washabaugh and Washington counties (W. H. Over). NORTH DAKOTA: Little Missouri River (Type locality; Arthur & Aurel Krause, 1882); Medora, Billings Co. (H. B. Baker); Fort Berthold, McLean Co. MONTANA: Halfmoon Pass, Big Snowy Mts., (S. S. Berry). WYOMING: White Creek Canyon, east of Shell; Hyattville, Bighorn Co.; Boxelder Creek 19 mi. west of Douglas, Converse Co. (J. Henderson). COLORADO: 6 mi. north of Boulder and east of Lyons, Boulder Co. (J. Henderson); Colorado Springs and elsewhere, El Paso Co. (H. B. Baker); 6 mi. below Minturn, Eagle Co.; above Carbondale, Garfield Co.; near Morrison, Jefferson Co.; Boxelder, Larimer Co. (Henderson); "Simpsons Rest" near Trinidad, Las Animas Co. (Pilsbry); Roan Creek, Mesa Co., and near Aspen, Pitkin Co. (Henderson). UTAH: Lagoon Canyon at 5000 ft. (Hemphill); Devils Slide, Morgan Co. (Henderson); west of Innes sawmill, Blue Mts., San Juan Co. (Ferriss). NEW MEXICO: San Miguel Co. in various places (Cockerell, Henderson); near Raton, Colfax Co. (Cockerell); El Rito de los Frijoles, Santa Fé Co. (Henderson); Grant, Valencia Co. (J. Baily Jr.); near Duran, Torrance Co., and drift of Mimbres River above Deming, Luna Co. (Pilsbry). ARIZONA: Laguna Canyon (Ferriss), and drift of Little Colorado River, Holbrook, Navajo Co. (E. H. Ashmun); drift of San Pedro River near Benson, Cochise Co. (Pilsbry). IDAHO: near Lava, and Harkness Canyon, east of McCammon, Bannock Co. (Henderson).

The diameter varies from 2.5 to 2.9 mm. The upper margin of peristome expands very little, the outer and basal margins being well expanded and well thickened. The apex appears smooth in the freshest specimens of the topotypic lot, all drift shells. There are about 45 to 50 ribs on the last whorl. Between them, in the freshest shells, are some fine, partly irregular striae.

It is closely related to *V. costata*, but is usually larger. As Dr. Sterki said: "the whorls, especially the last, are more depressed above, the aperture is more inclined and oblique, the lip much more curved below than above; the shells show distinct ribs, and the membranous ribs upon them are quite small and fine, while in *costata* the ribs are quite small the membranes are, as a rule, coarse. In *gracilicosta* the ribs are more numerous and more oblique, especially as seen from above. The lip in fresh specimens is pure white."

The Northern Pacific Railroad crosses the Little Missouri River at Medora, Billings Co., North Dakota, and here doubtless is where the Krause brothers collected this snail in 1882. Dr. H. B. Baker found it abundant there, in the river drift, with a few of the much smaller *V. perspectiva*.

Vallonia gracilicosta form *montana* Sterki. Fig. 549 b. "Shell rather small and thick, colorless translucent, a little opaque, spire a little elevated; surface with rather crowded rib-striae, but without membranous ribs; last whorl slightly and gradually ascending, not at all or very little descending to the aperture in toto, shortly and decidedly at the suture; lip very strong." (Sterki.)

Height 1.1 mm., diameter 2.4 mm.; 3½ whorls.

Rocky Mountains (E. Hall), Type and paratype 11723 A.N.S.P.⁸⁶ SOUTH DAKOTA: drift of White River, Washington Co. (W. H. Over). NEBRASKA: on Niobrara River, Agate, Sioux Co. (G. K. MacMillan). WYOMING: localities in Bighorn Co. (J. Henderson). COLORADO: near Colorado Springs (H. B. Baker); north of Morrison, Jefferson Co. (Henderson). NEW MEXICO: on a butte near Duran (Pilsbry). CALIFORNIA: Mariposa Big Trees (H. B. Baker).

The well-rounded aperture has the lip more widely spreading in the upper arc than *V. gracilicosta*. It is strongly thickened, especially at the inner rim.

The ribs are worn, almost lost in the paratype, and they are only weakly indicated on the face of the type, being somewhat "restored" by the artist in our left and middle figures, but about correctly shown in the basal view. It is hardly possible to count them, but 50 on the last whorl is a fair estimate. In fresh lots there are similar shells and also some with fewer ribs, more conspicuous when their cuticular edges are unworn.

⁸⁶ In 1862 Elihu Hall collected plants in the eastern Rockies of Colorado from the region of Pike's Peak and northward to around Long's Peak, Lat. 39° to 41°. The *Vallonia* was apparently taken at this time and in the area mentioned.

Except for the heavier lip, its upper margin more flaring in a face view, *montana* differs little, if at all, from *V. gracilicosta*. From the sporadic occurrence of specimens in lots of the latter I believe it to be an ecologic or other form of that common Rocky Mountain snail, and not, properly speaking, a subspecies.

Besides the type lot, which alone was known to Dr. Sterki, we possess typical *montana* from many places, partly recorded above, mainly found in lots of *gracilicosta*, but rarely occurring in pure populations, such as that collected in Sioux Co., Nebraska, by Mr. Gordon K. MacMillan. Usually it has not been thought desirable to attempt the assortment of mixed lots of *gracilicosta* and *montana* in the collection.

Vallonia albula Sterki

Fig. 550.

Vallonia gracilicosta Sterki, July, 1893, in part, Man. Conch., 8:256, specimens from Quebec, pl. 33, figs. 48, 49. Not of Reinhardt.

Vallonia albula Sterki, Sept. 1893, Proc. Acad. Nat. Sci. Phila., p. 263, pl. 8, figs. d, o.

Vallonia sonorana Pilsbry, 1915, Proc. Acad. Nat. Sci. Phila., p. 345, fig. 5.

"The shell is rather large, 2.7-2.8 mm. gr. diam., whitish translucent, with a somewhat elevated spire; whorls $3\frac{1}{2}$ -4; the last whorl and aperture are rather well rounded, the latter resembling that of *costata*. The lip is moderately strong. The ribs of the shell are distinct but small, crowded, about 55 on the last whorl, and bearing fine membranes which give the surface a beautiful silky gloss as in some *cyclophorella*. There are differences in the elevation of the spire and the ascending of the last whorl among the four specimens, as is the case in most other forms." (Sterki.)

Height 1.3 mm., diameter 2.8 mm.; $3\frac{1}{2}$ whorls.

Height 1.2 mm., diameter 2.5 mm. Newfoundland.

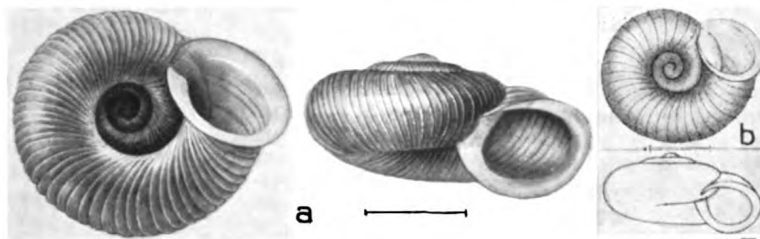


Fig. 550. *Vallonia albula*. a, Big Cranberry Island, Maine. b, St. Joseph, Quebec, after Sterki. Scale line = 1 mm.

NEWFOUNDLAND: Ingarnachois Bay, Bay of Islands and Bonne Bay (Bayard Long). QUEBEC: St. Joseph (A. W. Hanham), Type 62.19236 Carnegie Mus. MANITOBA: Winnipeg (G. H. Clapp). MAINE: Big Cranberry I., near Mt. Desert (H. S. Colton). MASSACHUSETTS: New Bedford (A. D. Brown Coll.). NEW YORK: Ithaca (G. van Ingen). SOUTH DAKOTA: valley of Spearfish Creek, Black Hills, Lawrence Co. (H. B. Baker). WYOMING: Chimney Rock, Albany Co., and Route 16 above Squaw Creek, Big Horn Mts. (Henderson). IDAHO: St. Charles, Bear Lake Co. and Harkness Can-

yon, east of McCammon, Bannock Co. (Henderson). COLORADO: Trinidad, Las Animas Co. (Pilsbry). Boulder, Eagle, Grand, Gilpin, Mesa and Montrose counties (J. Henderson). NEW MEXICO: Arroyo Pecos, Las Vegas, San Miguel counties, and northwest of Santa Fé (J. Henderson). CALIFORNIA: Funston Meadow, Tulare Co. (Ferriss).

"The shell is related on one side to *costata*, on the other to *cyclophorella*, and seems to be intermediate. It resembles the latter in its size and general appearance, the umbilicus being rather wide and considerably expanding for the last $\frac{1}{2}$ whorl, the latter distinctly ascending before descending; in the fine dense ribs, which are stronger and sharper on the shell itself and bear smaller membranes than in *costata*, and in the coloration. It has, however, some features allying it to *costata*—the aperture although less transversely elongated, is not circular. The presence of a lip is characteristic, and the peristome is rather abruptly and strongly everted, as in *costata*." (Sterki.)

In Canada, New England and New York this species is readily separable from other vallonias of those regions, but in the mountain states it is often not easy to decide between *albula* and *gracilicosta*, the most obvious distinction being that *albula* has a narrower lip. I am leaving some of our lots from Colorado and other mountain states undecided; there are ambiguous lots, and I have found some errors in the list in Univ. Colo. Studies. 13:103-4. *V. albula* is somewhat intermediate between *gracilicosta* and *cyclophorella*, but differs from the latter by its thickened lip when adult. Umbilicus is contained slightly more than three times in the diameter.

Vallonia sonorana Pilsbry was described from the summit of Big Hatchet Mountain, 8366 ft. elevation, in southwestern New Mexico, and is not certainly known from any other locality. Type 112012 A.N.S.P. The original account follows:

The shell is very broadly, openly umbilicate, width of umbilicus contained about three times in the diameter of shell; whitish corneous. First $1\frac{1}{2}$ whorls smooth, corneous, glossy; following whorls with sculpture of rather delicate riblets about 38-40 on the last whorl, in fresh specimens bearing irregular cuticular extensions; the spaces between ribs delicately striate, the striae irregularly anastomosing. Whorls $3\frac{3}{4}$, strongly convex, rather slowly

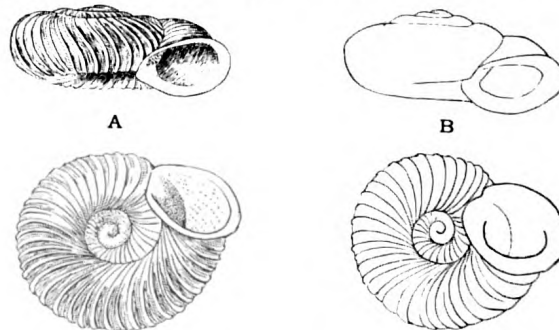


Fig. 552. *Vallonia sonorana*. A, type; B, thick-lipped form.

widening, separated by a deep suture; the last whorl deeply descending close to the aperture. Aperture small, nearly circular, very oblique. The peristome is expanded and reflexed, slightly thickened within (in old specimens strongly thickened); the margins converge strongly and are connected by a very short parietal callus or are continuous, joined by a thin, slightly raised callus. The ample umbilicus is somewhat oblong.

Alt. 1.1, diam. 2.7 mm. (type, fig. 552A).

Alt. 1.2, diam. 2.6 mm. (fig. 552B).

I am now inclined to think *V. sonorana* is a form or race of *V. albula*, though there are some small differences. The zonal ranges of the two appear quite diverse; but as *sonorana* occurs at over 8000 ft., and *Cionella lubrica* was found on the same mountain at a single station, it seems that both are to be viewed as high altitude southern survivors of a Pleistocene fauna. If this view is correct, the name *sonorana* is inappropriate, as it is a Canadian zone, not a Sonoran, stock.

In the type of *sonorana* the umbilicus is wide, slightly over one-third of the diameter, in which it is contained 2.95 times. In a specimen of *albula* measured, it is contained 3.33 times in diameter. About the same ratio, 3.2 to 3.3 times, is seen in Dr. Sterki's figure of *albula*, and in shells measured from two other localities. But some other species show individual variation in size of umbilicus, as much or more than the difference between *sonorana* and *albula*. The main difference is therefore in sculpture, but this also is variable in *V. albula*.

VALLONIA CYCLOPHORELLA GROUP

Shell ribbed, with a thin lip.

Vallonia perspectiva Sterki

Fig. 553.

Vallonia perspectiva Sterki in Sargent, Nov. 1892, *Nautilus*, 6:77 (name only; Woodville, Ala.)—Sterki, July, 1893, *Man. Conch.*, 8:257, pl. 33, figs. 39-45; Sept. 1893, *Proc. Acad. Nat. Sci. Phila.*, p. 271, pl. 8, fig. F, teeth.—Walker, 1928, *Terr. Moll. Ala.*, p. 163, fig. 252.

"Shell small, with very wide perspective umbilicus, widening more in the last $\frac{1}{2}$ whorl, flat, or a little elevated above, with rather dense, somewhat regularly set, moderately strong membranous ribs (about 35 on the last whorl) and with finer striae between them; nucleus without revolving lines; pale horn to colorless, thin, translucent; whorls $3\frac{1}{2}$, gradually increasing, a little flattened above and below the periphery, with a deep suture, the last rounded, comparatively narrow, little expanding toward the aperture, rather rapidly descending *in toto*; aperture very inclined and oblique, almost tangential, transversely (short) ovoid or oblong; peristome continuous, shortly but not abruptly everted except near the suture, without (or with a very thin) lip. Diam. maj. 2.0, min. 1.7, alt. 0.7 mm." (Sterki.)

NEW JERSEY: copse in salt marsh back of Ventnor, Atlantic Co. (Pilsbry).⁸⁷ WEST

⁸⁷ This part of the marsh has now been filled up and built over. The copse was a small dry island, with dense growth of cedar, holly, poison ivy, etc.

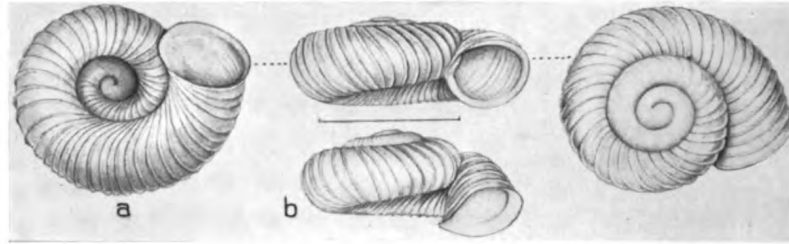


Fig. 553. *Vallonia perspectiva*. a, Woodville, Alabama. b, Eagle Creek, Graham Co., Arizona. Scale line = 1 mm.

VIRGINIA: Franklin, Pendleton Co. (Brooks & MacMillan). ILLINOIS: 4 mi. north of Savannah, Carroll Co. (Baker). MISSOURI: Sedalia, Pettis Co. (G. van Ingen). TENNESSEE: Knoxville (Mrs. Andrews). ALABAMA: Woodville, Jackson Co. (H. E. Sargent). Type locality. MINNESOTA: Clearwater and Rockford according to H. E. Sargent, *Nautilus*, 9:89. NORTH DAKOTA: Drift of Little Missouri River, Medora, Billings Co. (H. B. Baker); Chamberlain, Brule Co. (Henderson). TEXAS: canyon about 15 mi. S.-E. of Amarillo, Potter Co. (J. B. Henderson); Neuces River, Uvalde Co. (Ferriss); Devils River and drift of Pecos River at the High Bridge, Val Verde Co. (Pilsbry). NEW MEXICO: Sacramento Mts., Highrolls, Otero Co. (Rehn & Viereck); Black Range, many places, Grant-Sierra counties (Pilsbry & Ferriss); Silver City, Grant Co. (Ashmun); Swartz P.O. and drift of Mimbres River, Grant Co. (Ferriss & Pilsbry); Mogollon Mts., in Catron and Socorro counties (Ferriss & Daniels); Cuchillo Mts., Sierra Co. (Ferriss); Florida Mts., Luna Co. (Pilsbry & Ferriss); summit of Big Hatchet Mt. 8366 ft. (Pilsbry). ARIZONA: Grand Canyon at Bright Angel and Bass' trails (Pilsbry & Ferriss); many places around Jerome, Drew Co. (E. H. Ashmun); drift of Little Colorado River, Holbrook, Navajo Co. (Ashmun); Graham and Galiuro Mts., and in Graham and Apache counties (Ferriss); Marble Peak, Santa Catalina Mts. (Ferriss); drift of San Pedro River near Benson (Pilsbry); Dragoon Mts., generally spread (Ferriss, Daniels & Pilsbry); Huachuca and Whetstone Mts. (Ferriss); Chiricahua Mts. (Pilsbry). UTAH: Zion National Park (W. O. Gregg).

MEXICO: Sierra de la Breña at 7000 ft., 11 mi. from Pearson, on the road to Pacheco; also on the Rio Piedras Verdes. 5½ mi. above Colonia Juarez; both in Estado de Chihuahua (Pilsbry).

The thin texture, delicate ribs, and the small size, rarely exceeding 2 mm. diameter, the wide umbilicus and the thin expanded and continuous peristome, characterize this widely spread and often abundant little snail. *V. parvula*, of about the same size, has a strongly thickened lip. *V. cyclophorella*, mainly more northern in range, is always larger than *perspectiva*, but is much like it in structure.

It is generally spread in snail country of the southern half of New Mexico and Arizona, but is more local in the northern parts of these states. East of the mountains it occurs sparsely northward into North Dakota. Its distribution in the southeastern states is still quite imperfectly known; specimens and records from east of the Mississippi are remarkably few and scattered. It may occur on the coastal plain from Florida and Georgia to southern New Jersey, but evidence of its presence there is still wanting. The absence of records from the middle and lower Mississippi Valley is a strange feature of the *perspectiva* map, as now known.

Vallonia cyclophorella Sterki

Fig. 554 a-c.

H. pulchella costata form *cyclophorella* (Ancy), Cockerell, 1890, Nautilus, 3:103 (West Mountain Valley, Colorado).

V. cyclophorella Ancy, Sterki, 1892, Nautilus, 5:101 (West Cliff, Colo.); 1893, Man. Conch., 8:259, pl. 32, fig. 29; 33, figs. 34-38; Proc. Acad. Nat. Sci. Phila., 1893, p. 272, pl. 8, fig. E. (teeth).—Henderson, Colo. Univ. Studies, 13:102-104; 17:75; 23:100.

Vallonia cyclophorella septuagentaria Pilsbry & Ferriss, 1918, Nautilus, 31:95.

“Shell rather thin, pale or grayish-horn colored, or whitish translucent; ribs on the shell small, crowded (about 60 on the last whorl), with fine membranes, rather regular, often irregular (as in Man. Conch., Pl. 32, fig. 29), with fine striae between them; nucleus with slight, irregular, nearly obsolete revolving lines; suture moderately deep; last whorl somewhat widening toward the aperture, in its last $\frac{1}{3}$ distinctly ascending (Man. Conch., Pl. 33, fig. 37) then rather rapidly descending, somewhat more at the suture, so that the margins are much approximate; aperture transversely elongate; superior margin markedly less curved than inferior; peristome slightly everted, except near the suture, thin, without a lip. Most specimens are of a rather dull surface, but those from Walla Walla are shining, the shell almost colorless, thin and transparent, and rather large. Greater diam. 2.7, lesser 2.2, alt. 1.2 mm.” (Sterki.)

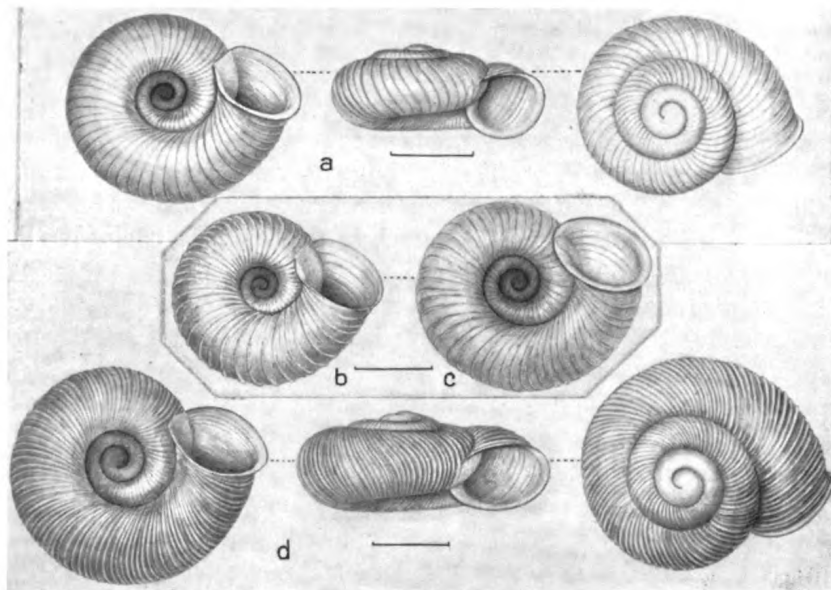


Fig. 554. *Vallonia cyclophorella*. a. North Park, Colorado. b. Colorado Springs. c, Race Creek, Idaho. d. form *septuagentaria*, Tulare Co., California. Scale lines = 1 mm.

NORTH DAKOTA: Medora, Billings Co. (H. B. Baker). SOUTH DAKOTA: Harding and Perkins counties (W. H. Over); Lawrence Co. (H. B. Baker). TEXAS: canyon 15 mi. southeast of Amarillo, Potter Co. (John B. Henderson). MONTANA: Helena (Hemp-

hill); south-facing limestone slope, Garrison, Powell Co. (H. B. Baker). WYOMING: Ft. Bridger, Uinta Co. (Jos. Leidy); Albany, Bighorn, Converse, Fremont, Lincoln, and Uinta counties (J. Henderson); Teton Pass, Teton Co. (A. A. Olsson). COLORADO: 43 localities in the following counties: Boulder, Chaffee, Clearcreek, Custer, Eagle, El Paso, Garfield, Gilpin, Grand, Jefferson, Larimer, Mesa, Pitkin, Rio Blanco, Routt and Teller (J. Henderson, T. D. A. Cockerell, H. B. Baker). UTAH: Cache, Juab, Morgan and Sevier counties (Henderson); Lake Point, Tooele Co. (H. B. Baker); Blue Mts. and Rainbow Bridge, San Juan Co. (Ferriss). NEVADA: Charleston Mt., Lincoln Co. (Ferriss). NEW MEXICO: Colfax Co., 10,000 ft. (Grace Eaton); Jemez Mts., Sandoval Co. (J. Henderson); San Miguel Co., in many places and up to 11000 ft. (Cockerell, Henderson, Mary Cooper and others); San Mateo, Valencia Co.; White Oaks, Lincoln Co.; Clouderoft, Otero Co. (E. H. Ashmun); Grant, Valencia Co. (Joshua Baily Jr.); Sandia Mts., Bernalillo Co. (Maud Ellis); drift of Mimbres River above Deming, Luna Co. and Black Range, Grant-Sierra counties (Pilsbry); on a butte near Duran, Torrance Co., 6800 ft. (Pilsbry). ARIZONA: Kaibab National Forest on Mt. Trumbull, 7000 ft., and in other places; Grand Canyon, numerous localities (Ferriss, Pilsbry); Bill Williams Mt.; Canyon Diablo; Walnut Creek, Winona, Coconino Co.; southern slopes of Navajo Mt. and Betatakin ruins, Western Navajo Indian Res. (J. H. Ferriss). Near Adamana and on Reservation Creek, Apache Co. (Ferriss); Jerome, top of Mt. Mingus, Oak Creek and other places in Yavapai Co. (Ashmun); Holbrook, Navajo Co. (Ashmun); Salt River drift, Tempe, Maricopa Co. (Pilsbry). Santa Catalina mountains in many places (Ferriss). Drift of San Pedro River near Benson (Pilsbry); rim of the Blue Mts., Graham Co., and Wickersham's Rock, Huachuca Mts. (Ferriss). IDAHO: near McCammon, Bannock Co.; St. Charles and near Montpelier, Bear Lake Co. (J. Henderson); Stites, Idaho Co. and near North Lapwai, Nez Perce Co. (H. B. Baker); near Franklin, Franklin Co. (Henderson); Sedarus Pass, southwest of Yellowstone Park, (Henderson). WASHINGTON: Walla Walla (Hemphill); near Blue Lake, Grand Coulee, Grant Co. (J. Henderson). OREGON: above Weston, Umatilla Co., and east side upper Klamath Lake, Klamath Co. (H. B. Baker). CALIFORNIA: numerous localities in Tulare Co., and Inyo Mt., Inyo Co. (J. H. Ferriss); Mariposa Big Trees, Mariposa Co. (H. B. Baker); near Susanville, Lassen Co., and Mill Creek Canyon, San Bernardino Mts. (S. S. Berry).

The thin or only very slightly thickened lip is characteristic of this *Vallonia*, which is nearest to *V. perspectiva*, but always decidedly larger, though variable in size. *V. albula* differs by its distinctly thickened lip, but in some cases it is hard to decide whether a given specimen is *cyclophorella* or slightly immature *albula*.

V. cyclophorella is by far the most generally distributed *Vallonia* of the mountain states. Sometimes it is found associated with *V. albula* or *V. gracilicosta*.

As the figures show, it varies widely in shape, being coiled rather closely so that the umbilicus is contained more than three times in the diameter (Fig. 554 b), or more loosely coiled, umbilicus 2.6 times in diameter (Fig. 554 c). The diameter is usually from 2.6 to 3 mm.; and the descent of the last whorl to aperture is variable in amount, though always marked. In sculpture it may have rather well-spaced, membranous riblets (which, however, are usually somewhat irregular by wear) or a combination of riblets and striae, or riblets may be almost absent, leaving only crowded striae.

The converging margins of the aperture are joined by a quite short callus, and sometimes are continuous as in Fig. 554 c. The lip is expanded and thin, or with a very slight white thickening.

V. cyclophorella was first recognized as distinct by C. F. Ancey, in naming specimens for T. D. A. Cockerell. Cockerell published the name in 1890, with the note: "The ribs in this form are close and delicate, but it seems to me referable to *costata*." This appears to me inadequate, applying better to *gracilicosta*, since *cyclophorella* does not belong to the *costata* group. Moreover, Cockerell's name is ruled out by its quadrinomial form. The first recognizable definition is by Sterki, 1892.

Form *septuagentaria* Pilsbry & Ferriss. Fig. 554 d. A Californian form from Budd's Creek Falls, Tulare Co. (Ferriss, 1915) is a little larger than any other lots of *cyclophorella* seen. The umbilicus is slightly less than one-third of the diameter; spire very low, the first whorl projecting. After the smooth initial $1\frac{1}{2}$ whorls it has close, somewhat unequal, thin, delicate riblets and striae, fully 70 being visible on the base. Height 1.4 mm., diameter 3.2 mm., $3\frac{1}{2}$ whorls. We named this form when the wide variability of *V. cyclophorella* was less known than at present. Whether it is sufficiently detached to merit racial separation remains to be decided on the evidence of further Californian collections.

Doctors Aurel and Arthur Krause, who were in Alaska in 1881-2. collected at Pyramid Island, in the northern Lynn Canal, a ribbed *Vallonia* of 2.5 mm. diameter. Reinhardt, who studied their material (Sitzungs-Ber. Ges. Nat. Freunde, Berlin, 1883, Nr. 3, pp. 36, 42), identified it as *V. asiatica* Nevill. We hesitate to accept as American this central Asiatic species of a difficult and closely inter-related group without further description, figures or specimens of the Alaskan form. It may well have been *V. cyclophorella*, which was not known when Reinhardt wrote.

PLANOgyRA Morse

Planogyra Morse, 1864, Terr. Pulm. Maine, Jour. Portland Soc. Nat. Hist., 1:24, for *P. asteriscus*.—H. B. Baker, 1928, Nautilus, 41:122; 1935, Man. Conch., 28:197, anatomy.

Shell minute, openly umbilicate nearly flat above, fragile, unicolorous brown, of few (about $3\frac{1}{2}$) convex whorls, the periphery rounded at all stages of growth. Embryonic $1\frac{1}{2}$ whorls with indistinct microscopic granulation, the rest with widely spaced cuticular laminae parallel to growth-lines. Aperture nearly circular except for the parietal excision, the peristome either thin or thickened within.

Animal (according to Morse) with stout, club-shaped eye-peduncles. Jaw striate. Radula of *P. asteriscus* with 13.1.13 teeth; central tooth narrower than the laterals, tricuspid, the cusps much shorter than the basal plate. Laterals with the basal plate square, mesocone long, ectocone small. Marginal teeth very broad and short, with one or two minute cusps.

Distribution.—States and provinces bordering on the St. Lawrence and Great Lakes drainage, chiefly in the Canadian Zone; New England; British Columbia to Oregon, west of the Cascade Range.

Dr. H. B. Baker described the anatomy of *P. asteriscus* thus, figured on page 852.

"Animal almost white, with short and stout, darkly pigmented ommatophores; inferior tentacles short, lighter in color. Foot holopod but with serrate line formed by upper edges of lowest row of tesselloid bosses quite prominent; short and broad; sole lanceolate with rounded tip, displaying coarse (3 to its length) pedal waves in locomotion. Mantle collar (Fig. 460:3) thick and swollen, protruding beyond peristome, white and very noticeable; pneumostome guarded by thickenings but without distinct shell-lappets, with anus near inner end. Lung about $2\frac{1}{2}$ times base and $1\frac{1}{2}$ times length of kidney; principal pulmonary vein near orthureter; rectal surface with inconspicuous venules. Kidney about $1\frac{1}{2}$ times base and twice length of pericardium; trabeculae heavy, becoming transverse anteriorly. Orthureter slightly over $\frac{2}{3}$ length of kidney and much narrower although poorly demarcated; walls with weak transverse trabeculae; opening near anterior end; recurved groove apparently open, also transversely trabeculate, extending backwards shortly beyond apex of kidney.

"Ovotestis (fig. 460:1) imbedded about $\frac{2}{3}$ whorls from liver apex, consisting of two lobes with few, obovoid lobules; duct long, greatly swollen, convolute in lower half; carrefour hidden by prostate; talon scarcely represented. No embryos observed in uterus. Walls of free oviduct with longitudinal plicae. Spermatheca ovoid (often more swollen than in figure), imbedded near base of uterine enlargement; stalk medium, columellar in position. Vagina long with structure of free oviduct. Prostate short with few digitate alveoli. Epiphallus (fig. 460:2) swollen with thick pebbled wall; penial papilla scarcely developed. Penis slender; epiphallar arm short; appendicular arm almost filled by a large papilla, through which appendix opens; appendix of medium length, basally swollen with heavy, transversely trabeculate walls, apically enlarged into a thin-walled sac containing vacuolate mucus. Penial retractor arising from diaphragm and inserting around base of epiphallus (except for heavy muscular sheath) appendicular arm is without retractor, although apex of appendix seems to be loosely bound to diaphragm. Atrium quite short, opening very near base of right inferior tentacle.

"Free retractor system much as in *Strobilops* but origin of right free muscle and separation of left free from buccal midway between columellar origin and root of tail. Left free muscle branch to atrium. Digestive system also similar although salivary ducts about as long as glands."

There is a wide hiatus between the eastern and the western species of *Planogyra*.

(*Planus*, flat + *γῦπος*, whorl.)

Planogyra asteriscus (Morse)

Fig. 555 a-c.

Helix asteriscus Morse, 1857, Proc. Bost. Soc. Nat. Hist., 6:128.—Binney, 1869, Land and Fresh-Water Sh. N. A., 1:82, f. 145.—Bland, 1864, Ann. Lyc. Nat. Hist. of N. Y., 8:163, fig. 8.—Morse, 1867, Amer. Nat., 1:546, fig. 43.

Planogyra asteriscus Morse, 1864, Jour. Portland Soc. Nat. Hist., 1:24, f. 50. 52. pl. 2, fig. 5; pl. 8, fig. 53.—H. B. Baker, 1928, Nautilus, 41:122.

Patula asteriscus Morse, Binney, 1878. Terr. Moll., 5:167, fig. 79; pl. 4, fig. c. teeth; 1920, Nautilus, 34:58, fig. 2.—Teator, 1890, Nautilus, 4:66.—Walker, 1895, Nautilus, 9:3.

Pyramidula asteriscus Msc., Pilsbry, 1893, Man. Conch., 9:45.—Johnson, 1915, Fauna of New England, List of the Mollusca, p. 207.

Pyramidula rupestris var. *nylanderi* Morse, 1920, Nautilus, 34:58, fig. 1.

The minute shell is openly umbilicate, the umbilicus one-third of the diameter; fragile, pale brown, imperfectly transparent. Spire slightly convex, nearly flat, the first $1\frac{1}{2}$ whorls indistinctly granular, the rest radially

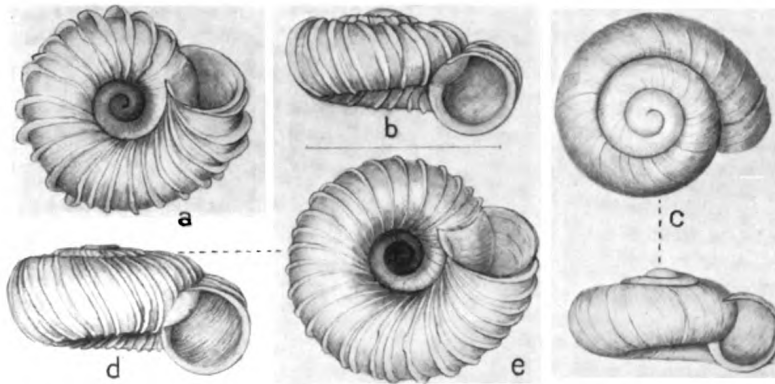


Fig. 555. *Planogyra asteriscus*: a, Bethel, Me.; b, Cheboygan Co., Mich. c, ribless form, Cheboygan Co. *Planogyra clappi*: d, type, Seattle; e, Duncan, Vancouver I. Scale line = 1 mm.

lamellose, the last whorl having 18 to 30 thin, sharp, prominent laminae parallel to the lines of growth, their edges somewhat waved or irregular in dry shells; the intervals sharply, minutely striate and (chiefly on the base) faintly marked with very close, irregular spiral lines. Aperture circular except for the parietal excision; lip usually thin, but in old shells distinctly thickened within basal and columellar margins.

Height 0.9 mm., diam. 1.8 mm. to 1×1.9 mm.; $3\frac{1}{2}$ whorls.

CANADA: Gaspé (E. S. Morse). Quebec (Hanham, Nautilus, 10:99). Smoky Falls, Cochrane District (Whelan & Oughton). North shore of Lake Superior (Lapham); Bloomfield, Prince Edward I., and Grindstone, Magdalen Is. (Bayard Long). MAINE: Caribou and Woodland, Aroostook Co. (Nylander); Winn and Orono (Allen), Penobscot Co.; Bethel, Oxford Co. (Morse), type loc.; Gorham, Cumberland Co. (Morse). MASSACHUSETTS: Salem (Morse). NEW YORK: Adirondacks near Putnam's Camp (E. S. Morse); the Glen, Vassar College, Poughkeepsie (G. van Ingen); Staten Island (E. W. Hubbard in Amer. Mus.) MICHIGAN: Douglas Lake, Cheboygan Co., and near shore of Big Stone Bay, Straits of Mackinac, Emmet Co. (H. B. Baker); Beaver Is. (Walker).

This species is very distinct from other eastern snails by its flat or very low spire and prominent cuticular ribs. Morse found it only in very wet, boggy places. Bayard Long collected Magdalen Island specimens from swampy alder thickets. At Douglas Lake, Michigan, Dr. Baker found *P. asteriscus* "under dead leaves in the strand-line, between the water-soaked

Sphagnum mats of the arborvitae-spruce bogs, and the fringe of low deciduous trees around their borders". At the Straits of Mackinac "it was quite common in the damp swales between the low, fixed sand dunes." It "seems to prefer the deeper layers of fallen leaves."

As Dr. Baker noted, "The high epidermal riblets that characterize the shell of *P. asteriscus* are quite rectilinear in moist (living) specimens, but become wavy when dried." They are sometimes lacking over part of the shell, or rarely may be entirely absent as in Fig. 555 c, which is one of several ribless and imperfectly ribbed shells in a large lot of normally ribbed examples. Such ribless individuals found in Maine, were thought by Professor Morse to be a form of the European *Pyramidula rupestris* (Drap.), which is a larger, more solid and more elevated shell with narrower umbilicus. Morse wrote as follows:

"Forty years ago while collecting land shells alongside the road in Riley, Maine, 17 miles north of Bethel, I found two specimens of a small *Helix*, which at the time I mistook for a variety of *Planogyra asteriscus*, being devoid of the elevated rings following the lines of growth; it was apparently the same size, form and color of *P. asteriscus*. Instead of being found in an alder swamp in wet ground, a common habitat of *P. asteriscus*, it was found in a hard-wood growth on the side of a hill associated with *S. labyrinthica*, *Z. arborea*, *S. exigua* and other common species. . . . Fig. [556, right] represents a specimen of *Pyramidula rupestris* from England. While

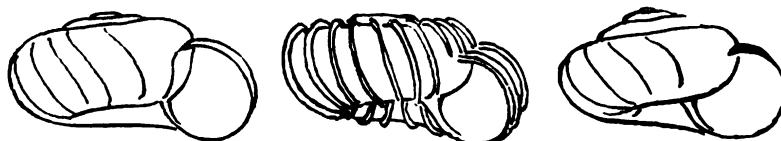


Fig. 556. Left figure, "*Pyramidula rupestris* var. *nylanderi*". Middle, *Planogyra asteriscus*. Right, *Pyramidula rupestris* from England (All after Morse).

showing slight differences, the Maine specimens [Fig. 556 left] must be regarded the same. If it turns out to be an established variety I would like to dedicate it to Mr. Olof O. Nylander, who has done such excellent work in studying and collecting the land and fresh-water shells of northern Maine. It will thus stand *Pyramidula rupestris* var. *nylanderi*."

Having examined one of Morse's specimens, as well as others like it from Michigan, I am satisfied that it is merely a ribless *asteriscus*. This is also Dr. H. B. Baker's conclusion. The spire is raised very little, not more than in some normal specimens of *P. asteriscus*. The umbilicus is wide, contained 2.9 times in the diameter. The surface has fine, low, unequal striae and faint spiral lines.

***Planogyra clappi* (Pilsbry)**

Fig. 555 d. e.

Punctum clappi Pilsbry, 1898, *Nautilus*, 11:133.—J. Henderson, 1929, *Univ. Colo. Studies*, 17:115.

Planogyra clappi (Pils.), H. B. Baker, 1935, *Man. Conch.*, 28:198.

The shell is minute, openly umbilicate, the umbilicus contained 3.4 times in the diameter; light brown. Spire but slightly convex, nearly level. Whorls strongly convex, the initial $1\frac{1}{2}$ microscopically closely granulose, the rest sculptured with strong laminae running with the incremental lines, about 35 on the last whorl, the intervals finely striate, with microscopic spiral lines. Suture strongly impressed. The aperture is very shortly oval, higher than wide, with small parietal excision. Height 1.1 to 1.2 mm., diameter 2 mm.; $3\frac{1}{2}$ whorls.

BRITISH COLUMBIA: Nanaimo (G. W. Taylor); Quimisham District, Vancouver I. (A. W. Hanham). WASHINGTON: Olga, Orcas I. (C. C. Engberg); Brook Valley, Esperance, Snohomish Co. (H. B. Baker); mouth Quillayale River, Boundary Creek and Crescent Lake, near Piedmont, Clallam Co. (Baker); Seattle, Type and paratype 84366 A.N.S.P. (P. B. Randolph); McAleer Creek, King Co. (Baker); Tacoma (Hemphill); Paradise Park and above Longmire, Mt. Ranier, Pierce Co. (H. B. Baker). OREGON: Salem (Hemphill).

The umbilicus is noticeably narrower than in *P. asteriscus*, and the cuticular laminae are more numerous. It is apparently an abundant snail from southwestern British Columbia to northwestern Oregon, west of the Cascade Mountains.

As in *P. asteriscus*, laminae may be almost lacking, or present on the last half whorl only, in some fresh shells. The spire is sometimes noticeably higher than in the type figured.

It has been reported from Tacoma and British Columbia as *Patula* or *Pyramidula asteriscus* in the older literature; cf. Henderson, 1929. In some collections it was formerly confused with *Punctum conspectum*, which has a higher spire and a decidedly narrower umbilicus. According to Dr. H. B. Baker, "The anatomy of animals from near Seattle, Washington, collected Aug. 18, 1929, is very similar to that in *P. asteriscus*."

(Named for George H. Clapp.)

ZOOGENETES Morse

Zoögenetes and *Zoögenites* Morse, 1864, Jour. Portland Soc. Nat. Hist., 1:32, for *Helix harpa* Say.

Acanthinula W. G. Binney, 1878, Terr. Moll., 5:341.

The small shell is thin and elastic, narrowly umbilicate, ovate-conic, higher than wide, of few rapidly increasing, convex whorls, the first two smoothish, the rest having delicate, widely spaced, oblique riblets. Aperture ovate, oblique, the lip thin and simple, dilated near the columellar insertion, margins remote.

The margins of the foot are crenulated; head with crenulated labial processes and short inferior tentacles. Viviparous.

The kidney has the usual pouch-like form, its cavity large, walls having about ten unequal longitudinal ridges within. Ureter long, direct, heavily pigmented anteriorly, the end appearing through the mantle as a black spot.

The penis has a long appendix formed as in the figure, and an epiphallus which is rather thick posteriorly. It has not the two accessory diverticula of *Acanthinula*. Penial retractor forked. Spermatheca little swollen, its duct of medium length (fig. 557).

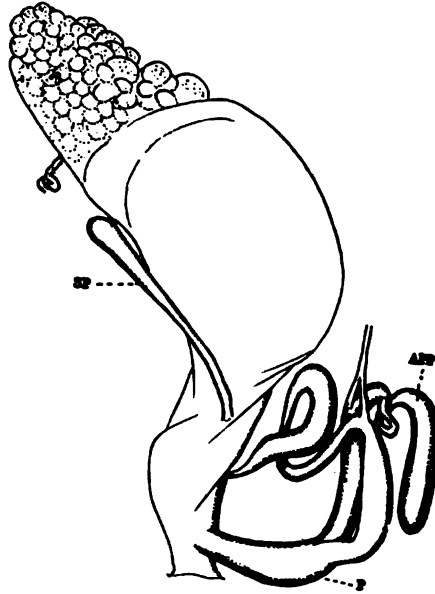


Fig. 557. *Zoögenetes harpa*. app, appendix; p, penis; sp., spermatheca. Uterus is dilated by the contained embryos.

Jaw strongly arched with many weak vertical grooves. Radula with 18.1.18 teeth. Centrals a little narrower than the laterals, tricuspid, the mesocone shorter than the basal plate. Laterals with nearly square basal plates, the mesocones attaining their posterior margins, ectocones distinctly developed; the 6th tooth is similar but with the ectocone bifid; following teeth are marginals with short basal plates, and with 2 ectocones on the inner to 4 or 5 on the outer teeth. The teeth of the middle field have long tubercles or thickenings of the posterior-outer angles of the basal plates (Fig. 558 b).

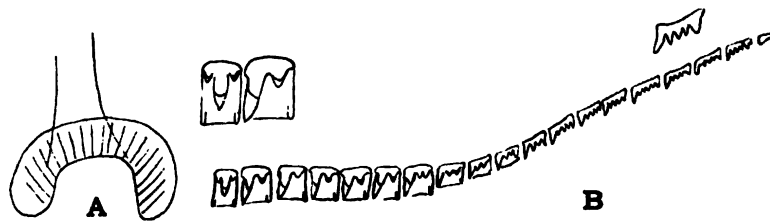


Fig. 558. *Zoögenetes harpa*; A, jaw, and B, teeth of Massachusetts specimen.

The single species of *Zoögenetes* is a boreal snail of Europe, Asia and North America. Its nearest relatives (*Acanthinula* and *Spermodea*) are palearctic genera.

In a long series of *Z. harpa* from Benzie Co., Michigan, undated, none were found with the anterior male organs developed. Fig. 557 was drawn from a September specimen, with well-developed male organs, from High Pines, Duxbury, Mass. Steenberg has noted that anterior male organs were but weakly developed in summer specimens of the related European *Acanthinula aculeata*, but strongly so in mid-October individuals.

(The name *Zoögenetes* signifies that reproduction is by living young instead of eggs.)

Zoögenetes harpa (Say)

Fig. 559.

Helix harpa Say, 1824, App. Long's Exped., 2:256, pl. 15, fig. 1.—A. S. Packard, 1863, Canad. Nat., 8:417.

Acanthinula harpa Say, Binney, 1878, Terr. Moll., 5:342, fig. 226, pl. 52, fig. 3.—Mozley, 1926, Nautilus, 39:124; 1936, Trans. Roy. Soc. Edinb., 58:644 (Siberia).

Zoögenites harpa Morse, 1864, Jour. Portland Soc. Nat. Hist., 1:32, pl. 1, figs. 1-14.—Dall, Harriman Alaska Exped., Moll., 13:12, 21.—J. Henderson, 1930, Nautilus, 43:104; 1936, Univ. Colo. Studies, 23:105, fig. 1.

Zoögenetes harpa Say, Lindholm, Ann. Zool. Mus. Russ. Acad. Sci., 23:309 (distr. in Europe and Asia).—Pilsbry, 1926, Man. Conch., 27:196.—Marsh, 1942, Nautilus, 55:97.—Oldham, 1939, Jour. of Conch., 21:142 (Riffelalp near Zermatt, 7000 ft.).

Pupa costulata Mighels, 1844, Proc. Bost. Soc. Nat. Hist., 1:187 (Portland, Me.).

Helix amurensis Gerstfeldt, 1859, Mém. Ac. Imp. Sci. St. Pétersb., 9:17, pl. 9, fig. 26.

The shell is narrowly umbilicate, ovate-conic, thin, somewhat transparent, olive-green, rather glossy; early whorls nearly smooth, the last two with sculpture of delicate, widely-spaced cuticular riblets or laminae in the direction of growth-lines, about 30 on the last whorl, becoming crowded toward its end. Summit obtuse. Whorls nearly 4, rounded. Aperture oblique, ovate, the lip thin and simple, dilated at the axial termination. Length 3.25 mm., diameter 2.5 mm.

Distribution.—Massachusetts to Labrador and west to Colorado and Alaska; in Asia and Europe from the Chukchi peninsula, Saghalin, lower Amur valley and Lake Baikal to Finland and northern Sweden; Riffelalp, 7000-7300 ft., southern Switzerland; Astrabad, Transcaucasia.

MAINE: Mt. Desert (H. S. Colton); Fairfield, Somerset Co. (B. Long); Buckfield, Oxford Co. (G. A. Allen); Ellsworth, Hancock Co. (J. B. Henderson); Ft. Kent, Aroostook Co. (Nylander); North Haven, Knox Co. (Jackson); Windemere, Waldo Co. (S. S. Berry); Portland (Mighels); Bethel and Waterville (Morse). NEW HAMPSHIRE: Berlin Falls (Morse). MASSACHUSETTS: High Pines, Duxbury (W. F. Clapp); New Bedford (Thomson). NEW YORK: Thousand Islands, Jefferson Co. (Beauchamp). MICHIGAN: Upper Peninsula and Grand Traverse region (B. Walker); Drummond Island region (Marsh); Cecil Bay, Emmet Co. (H. B. Baker). MINNESOTA: "Northwest Territory" (Say); Duluth (W. Stone). WINONA (Holzinger). WYOMING: Shoshone Canyon 1 mi. west of Elephant Head, Park Co. (Marsh & Goodrich). COLORADO: Estes Park, over 8000 ft. (P. Okkelberg). Hillside at edge of Horseshoe Park, Rocky Mountain National Park, Colorado (Goodrich & Marsh). ONTARIO: 1½ miles east of Malachi and near Cygnet Rapids (Mozley); Smoky Falls, Cochrane District (Whelan & Oughton); Rainy River district: Mack Lake; Russell Lake; near Mackenzie Arm, Lake Kahnipimianikok (F. C. Baker). NEWFOUNDLAND: in many places (Bayard Long).

PRINCE EDWARD Is. (B. Long). QUEBEC (Hanham) Gaspé peninsula and New Brunswick (Binney). LABRADOR: Caribou Island (A. S. Packard); Blanc Sablon (B. Long). ONTARIO: Moose Factory, James Bay (Binney); North shore Lake Superior and Great Slave Lake (G. H. Horn). MANITOBA: English River (Binney). ALASKA: Klehini, Chilkat Inlet and valley (Dall); Unalaska (Eyerdam).

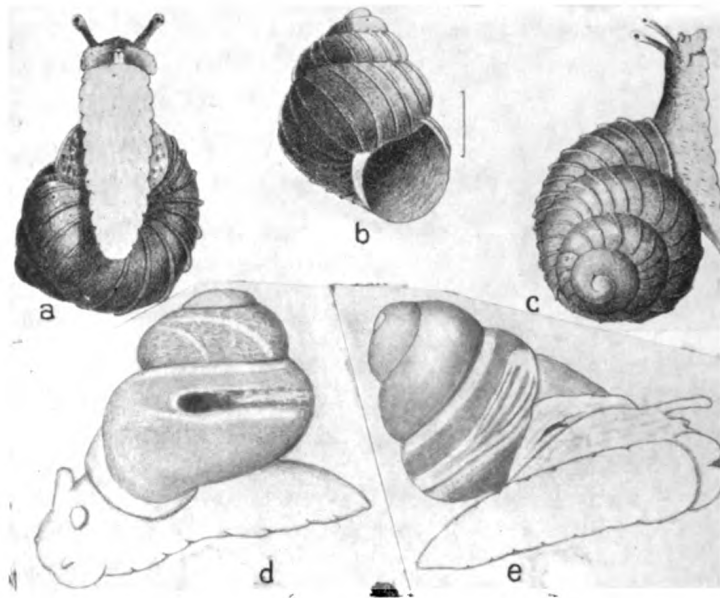


Fig. 559. *Zoögenetes harpa*, a-c, living animal and shell, after Morse; d, e, shell removed, showing kidney and ureter through the mantle. Scale line for fig. b = 1 mm.

A boreal species of three continents, southward only at high elevations (Colorado, Switzerland). The scattered colonies south of Maine appear to be very small and isolated. Dr. G. D. Hanna has recorded "planting" specimens behind the laboratories on St. Paul Island of the Pribilof group in 1916, but two years later did not find any there (*Nautilus*, 32:143).

The embryonic whorls appear smooth, but under the microscope they show an extremely minute, dense and irregular roughness of pits and granules. On later whorls there is some irregularly developed but very low striation between and parallel to the ribs. In some fresh specimens the ribs are unequal, inconspicuous or in part obsolete.

According to Morse it is a hardy snail, hibernating on "leaves just below the surface or secreted in acorn cups or nut shells, not deeply buried like most other snails. The animal is small compared to the size of the shell; body and head slate-color, superior tentacles darker, short, thick, bulbous, eyes large, distinct; foot quite as long as the shell, whitish. Body, disk and mantle are marked with white dots.

"In motion they are exceedingly graceful, at times poising their beautiful shell high above their body, and twirling it around not unlike the *Physa*, again hugging the pretty harp close to the body. The shell when in this last position continually oscillates, as if the animal could not balance it. It rarely ever moves in a straight line, but is always turning and whisking about, and this is done at times very quickly and abruptly."

Charles Oldham, who observed *Z. harpa* near Zermatt, Switzerland, inferred that it "has a life cycle of a year or thereabouts, is born in the summer or early autumn, matures in summer of the following year, then produces young and dies".

Z. harpa was unknown in the mountain states until 1930, when Junius Henderson reported it from Estes Park, Colorado. In 1941 Calvin Goodrich and Phil Marsh found it in Wyoming and Colorado. These Colorado localities, near the 40th parallel, are farthest south for the species.

Family XXII. CIONELLIDAE

Cionellidae Kobelt, 1880, *Illustriertes Conchylienbuch*, p. 216. Cochlicopidae of many authors.

The shell is small, elongate, imperforate, smooth and glossy, subtranslucent, with the ovate aperture longer than wide; lip not expanded, thickened within; parietal wall steeply sloping. Columella slightly sinuate or truncate at base.

Lung with fine capillary reticulation only, no visible branches on the principal pulmonary vein. Kidney long, narrowly triangular, passing into a direct ureter. Pericardium much shorter than the kidney.

Penis with well-developed epiphallus to which the retractor muscle, which is not forked, attaches, and an appendix. The prostate gland is of the long and band-like type. Spermathecal duct of medium length (with a diverticulum in *Cionella*).

The arcuate jaw is delicately and closely plaited. Radula with few (about 20.1.20 to 24.1.24) teeth. Centrals decidedly narrower than the laterals, tricuspid or with the ectocones subobsolete. Laterals bicuspid with quadrate basal plates; marginals with 4 to 6 cusps.

A family of the Palearctic Region, with a single Holarctic genus and two other European genera, *Azeca* and *Spelaeoconcha*. It differs from the Pupillidae mainly by the characters of the shell and by having a long prostate gland.

The two genera *Cionella* and *Azeca* appear to have been evolved in the Cretaceous, as they are represented in Europe from the Paleocene on. The single American species, *Cionella lubrica*, is apparently a Pleistocene immigrant, its first known appearance in the Yarmouth interglacial stage.

CIONELLA Jeffreys

Cochlicopa Férussac, in part, 6 Apr., 1821, *Tabl. Syst. Limaçons*, p. 24 for les Polyphemae Montf. and les Styloïdes, undefined.—Risso, 1826, *Hist. Nat. Eur.*

- Mérid., 4:79, for *C. lubrica* only.—Pilsbry, 1908, *Man. Conch.*, 19:308, "Type *C. lubricus* Müll."—Kennard, 1942, *Proc. Malac. Soc. Lond.*, 25:113.—Hesse, 1922, *Archiv f. Mollusk.*, 54:49, anatomy.
- Cionella* Jeffreys, 1829, *Trans. Linn. Soc. London*, 16:347, for *lubrica*, *acicula* and *elongata* (= *B. octonus* Brug.).—Kobelt, 1880, *Illustr. Conchylienb.*, p. 216, type *C. lubrica*.
- Zua* Leach, in Turton, 1831, *Man. L. & Fr.-W. Shells Brit. Is.*, p. 82, for *Zua lubrica*, in synonymy under *Bulimus lubricus*.—Leach, 1852, *Synops. Moll. G. B.*, edit. Gray, p. 81, for *Z. lubrica*.
- Styloides* Fitzinger, 1833, in part, *Beyträge zur Landesk. Oesterr.*, 3:105, for *S. acicula* and *S. lubricus*.
- Folliculus* Agassiz MS., Charpentier, 1837, *Nouv. Mém. Soc. Helvét. des Sci. Nat.*, 1:14, for *Bulimus lubricus* only.
- Chionella* Jeffr., Swainson, 1840, *Malacology*, p. 335. Misspelling.
- Hydastes* Parreyss, 1850, *Syst. Verzeich. Oesterreich Land- und Fluss-Conchyl.*, in *Berichte ueber die Mittheil. Freunden der Naturwissensch. in Wien*, 6:98, for *H. lubricus* Drap.
- Ferussacia* Risso, W. G. Binney, 1878, *Terr. Moll.*, 5:186.

The shell is oblong-conic or oblong-cylindric, imperforate, smooth and glossy, composed of 5 to 7 slightly convex whorls. Aperture small, ovate, nearly vertical, toothless. Outer and basal lips arcuate, obtuse, thickened within by a callous rim which is continuous to the upper insertion; columella short, concave or straightened, very slightly sinuate at the base; parietal callus very thin throughout.

The foot is rather short, without pedal grooves and no caudal pore. Sole indistinctly tripartite. Kidney long-triangular, passing forward directly into the ureter. Heart much shorter than the kidney. The pulmonary vein has no large branches.

Genitalia with a long appendix on the penis. In the specimen I dissected the appendix is inserted well below the insertion of the penial retractor muscle, but its insertion is distal in Steenberg's figure. This appendix is contracted near the middle, swollen again at the distal end. There is a well-developed epiphallus. The vagina is short. The spermatheca is oval on a rather long duct which bears a diverticulum.

The buccal mass has the usual short form. Salivary glands short, compact, conerescent around the slender oesophagus. There is no crop. The jaw is arcuate, delicately and closely plaited vertically. The radula has 20.1.20 to 24.1.24 teeth. The central teeth are narrow, with a short middle cusp, no side cusps in the radula I examined, but ectocones were present in radulae examined by Binney, Steenberg and Wiegmann. Laterals wide, with square basal plates and a large inner cusp (mesocone); outer cusp small, with a small cutting point only. There are 8 perfect laterals, the 9th or 10th tooth having the ectocone split. The marginals are low and wide, and have both cusps split, forming a pectinate edge of 4 to 6 denticles, decreasing towards the outer teeth.

Distribution.—*Cionella* is a holartetic genus of one widely spread species, and several others closely related have been instituted for East Asiatic forms. About a half dozen fossil species are known in Europe, from Eocene to the present time. The genus is apparently, therefore, one of those evolved in the Mesozoic.

The name is a diminutive of *κίων*, a pillar.

"*Cochlicopa texana* Pilsbry", Zoological Record for 1935, Mollusca, p. 108, was an error of the recorder for *Cochliopa texana*.

Nomenclature.—For the last fifty years or more, this genus has been called *Cochlicopa* (Férussac, 1821), with the genotype *C. lubrica* (Müller). Férussac's *Tableaux systématiques des Animaux Mollusques, . . . suivis d'un Prodrome général*, was issued in parts with the livraisons of his *Histoire*. *Cochlicopa* appeared first on p. 24⁸⁸ in a synoptic table, with *Polyphemae* Montfort and *Styloides* (undefined) given as equivalents. In his development of *Cochlicopa* on subsequent pages the groups of *Polyphemae* and *Styloides* were defined, and among other species the latter contains *lubrica*, which has usually been taken as type of *Cochlicopa*. Mr. A. S. Kennard,⁸⁹ who has made an exhaustive study of Férussac's publications, has shown that the first mention of *Cochlicopa*, on p. 24, was in a part appearing April 6, 1821, while the page where *C. lubrica* occurs came out July 13, of the same year. For this reason, he considers *Cochlicopa* a substitute for *Polyphemus* Montfort, which contained only the species now known as *Oleacina voluta* (Gmelin). With regret we view the passing of *Cochlicopa*. The next name, *Cionella* Jeffreys, is snatched from the graveyard of synonymy.

***Cionella lubrica* (Müller)**

Fig. 560 a. b.

Helix lubricus Müller, 1774, Verm. Hist., 2:104 (Denmark).⁹⁰

Bulimus lubricus Gould, 1841, Invert. Mass., p. 193, fig. 124.—Binney, 1852, Terr. Moll., 2:283, pl. 52, fig. 4.

Cochlicopa lubrica Müll., Pilsbry & Johnson, 1898, Nautilus, 11:127.—Dall, 1905, Harriman Alaska Exped., 13:33.—Pilsbry, 1908, Man. Conch., 19:312.—F. C. Baker, 1920, Life of the Pleistocene, p. 388.—Henderson, 1924, Univ. Colo. Studies, 13:140 (Colorado and Montana localities); 1929, same, 17:94; 1936, same, 23:105, 255.—Chamberlin & Jones, 1929, Bull. Univ. Utah, 19:90.—Mozley, Nautilus, 42:15.

Cionella subcylindrica Linn., W. G. Binney & T. Bland, 1869, Land and Fresh-water Sh. N.A., 1:224; not *Helix subcylindrica* Linnaeus, a *Truncatella*; see Hanley, Ipsa Linnaei Conchylia, p. 379.

Ferussacia subcylindrica Linn., W. G. Binney, 1878, Terr. Moll., 5:187, pl. iv, fig. 8 (teeth); 1885, Man. Amer. L. Sh., p. 194, figs. 199-202 (jaw, teeth and shell).

Zua buddii Dupuy, 1849, Hist. Nat. Moll. terr. et d'eau douce France, p. 330, footnote (États-Unis).

Bulimus lubricoides Stimpson, 1851, Shells of New England, p. 54 (n.n. based upon *B. lubricus* Gould, 1841, Invert. Mass., p. 193). Not *Cochlicopa lubricoides* Fér., Potiez & Michaud, 1838, Galerie, 1:129.

Zua lubricoides Stimps., Morse, 1864, Jour. Portland Soc. Nat. Hist., 1:30, fig. 79, 81, 84, pl. 10, fig. 82 (jaw, teeth and shell).

⁸⁸ I quote pages from the quarto edition of the Prodrome.

⁸⁹ Proc. Malac. Soc. London, 25, *Cochlicopa* on pp. 107, 113, 1942.

⁹⁰ References to the extensive European literature may be found in Pfeiffer, Mon. Hel. Viv., 2-8; Pilsbry, Man. Conch., 19:312; Kennard & Woodward, Synon. Brit. Non-mar. Moll., p. 140.

The shell is imperforate, oblong, the spire gradually tapering to an obtuse apex; thin, smooth, yellowish corneous, subtransparent and very glossy. Whorls $5\frac{1}{2}$ to 6, moderately convex. Aperture subvertical, ovate, toothless; outer lip evenly arcuate, obtuse, bordered with yellow or reddish outside, having a narrow, smooth and continuous callous rib within. Columella somewhat straightened, calloused, often very indistinctly notched or sinuous at its junction with the basal lip. Parietal callus thin, translucent.

Length 5.5 mm., diameter 2.5 mm. Bradford, Pa.

Length 5 mm., diameter 2.2 mm. Chiricahua Mts.

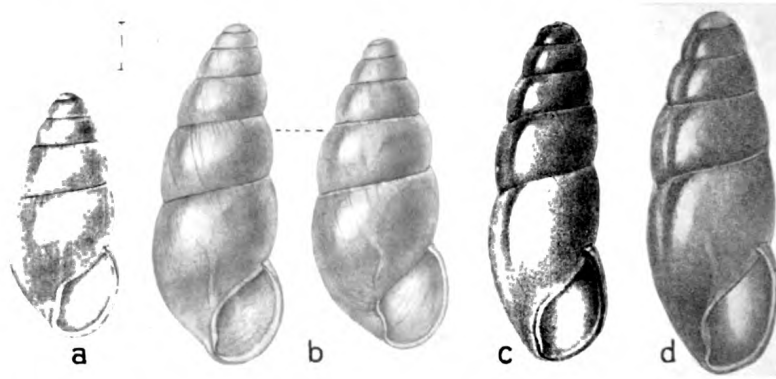


Fig. 560. *Cionella lubrica*. a, Hot Springs, Virginia. b, Coffin Island, Magdalen Islands. c, *Cionella lubrica morseana*, Laurel Creek Gap, Blount Co. Tenn. d, form *appalachicola*, Tuskegee Mt., Graham Co., N. C. Scale line = 1 mm.

Distribution.—Point Barrow, Alaska, and Queen Charlotte Islands to Labrador and Newfoundland, south in the East to Washington D. C. and southern Missouri; in all the Western and Mountain states except California; to the Mexican boundary in Arizona; in the Sierra Madre of western Chihuahua. Pleistocene of Iowa from the Yarmouth interglacial interval on. Also, Europe, northern Asia and Japan. Type locality, Denmark. Varieties in the Appalachian Mountains south to northern Alabama.

More records are needed to map in detail the southern limits of its range in the eastern half of the Union. It occurs throughout the Boreal and Transition zones, and in many places in the upper part of the Carolinian fauna. In Canada Oughton reports it "from the lower Great Lakes to James and Hudson Bays on the north and probably to the Manitoba border: apparently missing in some more or less carefully collected regions, viz., Temagami Provincial Forest, Lake Nipissing and Algonquin Park." Mack Lake, Rainy River district. It is generally distributed in New England and the northern tier of states westward, south on the Atlantic coastal plain to Washington, D. C., and westward to Seligman, Barry Co., in southwestern Missouri. Specimens have been seen from North and South Dakota and Nebraska.

In the mountain states it appears to be generally spread from Montana to northern New Mexico and Arizona. Southward in western New Mexico to the Organ mountains and the Black Range, and in the Big Hatchets at about 8000 ft., in sight of the Mexican border. In Arizona it occurs south to the Chiricahua, Dragoon and Huachuca mountains in Cochise County, to the Santa Catalina and Rincon mountains, and farther west south to Prescott and the mountains of Yavapai Co. In Utah it inhabits from the

Wasatch mountains to Zion Canyon. There is a Nevada record, without exact place. It appears to be well distributed in Idaho. Oregon localities are: Weston, near Milton, Oregon City, Wallowa Lake, Upper Klamath Lake. In Washington it was found by Hemphill at Walla Walla. There is no Californian record so far as I know.

In Mexico I have taken *C. lubrica* in the Sierra de la Breña, west of Pearson, at 7000 ft., and in the Colonia Juarez near Pacheco, both in the state of Chihuahua.

American specimens of *C. lubrica* appear to me to be indistinguishable from European. Both Dupuy and Stimpson named the American form as a species distinct from the European, but assigned no differences. Later, Morse attempted to indicate differential characters, but in large series these supposed differences do not hold.

American shells vary from 5 mm. long to 6.5 mm. The largest, darkest colored shells are from the eastern states, west to Indiana. Those of Arizona are smaller, very pale and thin.

C. lubrica lives among the damp under-leaves in densely shaded places; under wood, such as old board sidewalks; in chinks of stone walls and under stones. According to John B. Henderson (Nautilus, 18:110), they become active in the open six to eight hours before rain, being enviably weather-wise. They are sometimes found congregating in great numbers on stone or concrete walks, as described by G. H. Clapp (1914, Nautilus, 28:94), who found them on a flagstone walk in Sewickley, Pennsylvania, in October and November. See also Nautilus, 60:72, for a similar swarm near Vernon, B. C. Possibly such gatherings are for mating.

***Cionella lubrica morseana* Doherty**

Fig. 560 c.

Cionella (Zua) morseana Doherty, 1878, Quart. Jour. Conch., 1:342, pl. 4, fig. 2.

Cochlicopa lubrica morseana Doherty, Pilsbry, 1908, Man. Conch., 19:316, pl. 49, fig. 42.

Ferussacia subcylindrica L., Sargent, 1895, Nautilus, 8:104.

Cochlicopa lubrica appalachicola Pilsbry, 1908, Man. Conch., 19:317, pl. 49, fig. 43.—Walker, 1928, Terr. Moll. Alabama, p. 165.

"Shell cylindrical, slender, thin, transparent, highly polished, reddish-brown, with slight, irregular lines of growth; whorls $5\frac{1}{2}$, flattened, the last nearly one-third the length; suture little impressed; apex very obtuse; aperture oblong-ovate, widest near base; peristome scarcely thickened; reddish; umbilicus closed; columella perpendicular, meeting base of peristome at something less than a right angle. Foot white, almost translucent; head grayish, with short tentacles. Length 7 mm. sometimes more; diam. 2 mm., aperture 2 mm. long." (Doherty.)

Length 7 mm., diameter 2.2 mm., length aperture 2.3 mm.; $5\frac{1}{2}$ whorls. Laurel Creek Gap, Blount Co., Tenn.

Length 7.2 mm., diameter 2.5 mm.; 6 whorls. Tompkins Co., N. Y.

Length 6.6 mm., diameter 2.4 mm. Tompkins Co., N. Y.

Length 7.1 mm., diameter 2.3 mm.; $5\frac{3}{8}$ whorls. Graham Co., N. C.

MICHIGAN: Douglas Lake, Cheboygan Co. (H. B. Baker); Porcupine Mountains, Upper Peninsula (A. G. Ruthven). NEW YORK: McLean Bogs, near McLean, Tompkins Co., in sphagnum moss (M. D. Leonard). OHIO: Hamilton Co. (Doherty). KENTUCKY: Kenton Co. (Doherty). TENNESSEE: Laurel Creek Gap, Blount Co. (Ferriss);

Knoxville; W. Pikeville; near Jasper, Marion Co.; near Johnson City, Carter Co. (H. B. Baker). VIRGINIA: Natural Bridge (H. B. Baker). NORTH CAROLINA: Tuskegee Mt., Graham Co. (H. E. Sargent); Roan Mt., Mitchell Co. (H. B. Baker). ALABAMA: Woodville, Jackson Co. (H. E. Sargent, type loc. of var. *appalachicola*, No. 73900 A.N.S.P.); also, according to Walker, in Lauderdale, Randolph and Madison counties (H. H. Smith).

Perhaps the large form of *lubrica* recorded by Latchford (*Nautilus*, 10: 102) from Ile d'Orléans, Quebec, is *morseana*, but I have not seen it.

This race parallels *C. l. columna* (Clessin) of middle Europe in shape. Doherty noted these differences from *C. lubrica*: "The shell is longer, more slender, more cylindrical, the whorls flatter, the columella straighter, the apex and base more obtuse, the foot is lighter, the shell darker and less opaque." Moreover, the callous rim of the outer lip is much thinner and narrower in *morseana*.

The distribution northward, within the territory of *C. lubrica*, appears to be sporadic and not easy to explain, as the ecologic conditions of the Michigan and New York colonies are apparently quite unlike those of the southern mountains. It may be that we are dealing with parallel forms not genetically connected. About forty years ago I described the southern Appalachian form as *C. l. appalachicola*. It resembles various greenish European varieties of *C. lubrica*, but is doubtless of independent genesis. Later I doubted whether it could be separated from *morseana*. The original account of *C. l. appalachicola* follows:

Shell more cylindrical than *C. lubrica*, less conic, much thinner, transparent, showing the pillar through; pale greenish corneous. Aperture much narrower than in *C. lubrica*, the lip but very lightly and narrowly thickened within. It differs from *C. l. morseana* in color and by having the aperture somewhat larger. Length 6.4, diam. 2.25, length aperture 2.3 mm.; whorls 5½. Fig. 560d.

H. H. Smith, who collected it in Alabama, writes (1905): "This species is wide spread, but difficult to find. It occurs only in shady and damp places among rocks, especially in clefts where the leaves are not exposed to the sun."

Order BASOMMATOPHORA

Pulmonata in which the eyes are sessile near the bases of the contractile tentacles. Shell spiral or limpet shaped. Ureter a direct forward continuation of the kidney, and opening in the anterior part of the lung. Openings of male and female genitalia separate but contiguous.

Besides the large group of air-breathing freshwater snails, this Order includes various salt marsh, intertidal and littoral, marine to semiterrestrial snails, and the Carychiidae, an inland group which alone concerns us here.

Family XXIII. CARYCHIIDAE

Carychiadae Leach, in part, Jeffreys, 1829, Trans. Linn. Soc. London, 16:324. 362.

Very minute terrestrial snails with long-ovate to cylindric, thin shells of several whorls, the axis and internal whorl-partitions of the spire absorbed in the adult stage; axis perforate or closed; aperture oblong or ovate, the lip usually expanded, often thick; foot rounded posteriorly, not divided; tentacles short and blunt.

This family includes four genera of the northern continents: *Carychium* Müller, of Europe, Asia and North America; *Carychiopsis* Sandberger of the European Tertiaries; the cave snails of the Balkan Peninsula, *Zospeum* Bourguignat; and *Coilostele* Benson, with species in southern Europe, Abyssinia, India, Timor, and a single one, *Coilostele tampicoensis* (Pilsbry), in the Pánuco River valley, eastern Mexico.

The Carychiidae are an early branch of the primitive Auriculid stock, which acquired the minute size and the inland distribution of Pupillidae. It appears to be an adaptation of a sessile-eyed stock to occupy the place now chiefly taken by the Pupillidae, of the stalk-eyed series. The first forms referable to the family are known from the late Jurassic. They are reported from the Cretaceous. In the Paleocene and Eocene, species had become somewhat numerous and of three genera, two of them still existing. *Carychium*, Tertiary and Recent, now has a general holarctic distribution. *Carychiopsis* did not survive beyond the middle Pliocene. *Coilostele*, which appeared characteristically developed in the Eocene of Italy, now has a discontinuous distribution; the present isolation of the scattered herds indicates decadence of a genus once doubtless widespread, like *Carychium*. *Zospeum*, a group of blind snails of the caverns of southeastern Europe, appears also to be a dead end of evolution. The experiment of sessile-eyed land pulmonates seems to have proved rather unsuccessful in the long run.

CARYCHIUM Müller

Carychium O. F. Müller, 1774, Verm. terr. et fluv. Hist., 2:125. Sole species, *C. minimum* Müll.

Auricella Brard MS., Jurine, 1817, Helvetischer Almanach,⁹¹ p. 34. First species, here designated genotype, *A. carychium* = *Carychium minimum* Müller.— Moquin-Tandon, 1855, Hist. Nat. Moll. Terr. et fluv. France, 2:413.

Auriculina Moquin-Tandon, t.c., p. 646. Substitute for *Auricella*.

Saraphia Risso, 1826, Hist. Nat. Eur. Mérid., 4:83. Type *S. tridentata* Risso.

The shell is perforate or rimate, oblong or turritid, pupiform, thin, uniform whitish or corneous and somewhat transparent; composed of 4 to 5½ whorls, the first obtuse, smooth; aperture oval or ovate, the outer lip expanded or reflected, thickened, narrower in its upper third. Columella armed with a low, entering lamella near the base, and a prominent lamella above, which expands within the last whorl. Internal partitions and axis are absorbed in the upper whorls.

⁹¹ No copy of this rare *Almanach* is known to be in America, but a typewritten copy of the natural history articles is in the library of the British Museum.

Distribution.—Holarctic mainly, but extending into the Oriental Region (Philippine Islands, Java), and into the North American tropics (Jamaica, Mexico to Costa Rica).

In addition to the species described herein, the following are known from America:

Carychium minimum Müller, of Europe, has been found in abundance in a greenhouse in Norfolk Downs (Quincy), Mass., by W. F. Clapp, 1912 (*Nautilus*, 26:24). It has been figured by Mina L. Winslow, 1922, in *Occas. Papers Mus. Zool. Univ. Michigan*, No. 128, p. 4, pl. 4, figs. 18, 19.

Carychium exiguum costaricanum Von Martens, 1898, *Biologia Centrali-Americana*, Mollusca, p. 353, pl. 19, figs. 17, 18. San José, Costa Rica. Not seen, and probably related to *C. mexicanum* rather than to *C. exiguum*.

Carychium jamaicense Pilsbry, 1891, *Proc. Acad. Nat. Sci. Phila.*, p. 320, pl. 14, figs. 15, 16; *Nautilus*, 8:63; 10:12.—*Pupa exilis* C. B. Adams, 1849, *Contributions to Conch.*, No. 2, p. 38. Not *Carychium exile* H. C. Lea, 1842, Jamaica. B.W.I.

Carychium bermudense Gulick, 1904, *Proc. Acad. Nat. Sci. Phila.*, p. 415, pl. 36, figs. 11, 12. Bermuda, Pleistocene.

Carychium perexiguum F. C. Baker, 1938, *Nautilus*, 51:128. Meade Co., Kansas, Pliocene.

***Carychium exiguum* (Say)**

Figs. 561 a, b; 562.

Pupa exigua Say, 1822, *Jour. Acad. Nat. Sci. Phila.*, 2:375 (Harrigate, Philadelphia).—Gould, 1841, *Boston Jour. Nat. Hist.*, 3:398, pl. 3, fig. 20; *Invert. Mass.*, p. 191, fig. 122.

Carychium exiguum Say, Gould, 1852, in Binney, *Terr. Moll.*, 2:286, pl. 53, fig. 1.—Binney, 1865, *Land and Fresh-water Sh. N.A.*, 2:6, figs. 5-9.—Pilsbry, 1891, *Proc. Acad. Nat. Sci. Phila.*, p. 319, pl. 14, figs. 1-3, pl. 15, fig. 16; *Nautilus*, 8:63, figs. 1-3.—Clapp, 1905, *Nautilus*, 19:139.—Winslow, 1922, *Occas. Pap. Mus. Zool. Univ. Mich.*, No. 128, p. 3, pl. 2, figs. 8-11, pl. 3, figs. 12-15.—Brooks & Kutchka, 1937, *Ann. Carnegie Mus.*, 25:159.

Carychium cristellum Bourguignat, 1857, *Revue et Mag. de Zoologie* (2) 9:220; *Aménités Malacologiques*, 2:50, pl. 10, figs. 7, 8 (États-Unis).

Carychium euphaeum Bourguignat, 1857, t. c. p. 221; *Amén. Malac.*, 2:51, pl. 10, figs. 5, 6 (États-Unis).

Shell rimate, oblong, whitish-corneous, somewhat pellucid, thin, glossy: spire convexly conic, the penultimate whorl nearly as wide as the last, summit obtuse. Whorls about $4\frac{1}{2}$, convex, those of the spire nearly smooth, the last two whorls more or less, but usually quite weakly, striate. Aperture decidedly over one-third the total length, ovate; outer lip expanded, sinuous, thickened in its lower two-thirds, its upper part narrower, very strongly arcuate. Below the middle of the nearly straight inner margin there is a horizontal entering lamella which within the last whorl becomes higher and waved or undulating on the ventral side, a half whorl in. Near the base of the short columella is a low, obtuse, very obliquely entering lamella, which ascends in a long spiral curve within the last whorl.

Length 1.7 mm., diameter 0.75 mm.

Distribution.—Newfoundland to Colorado, south to Mobile Bay, Alabama, and near Deming, southwestern New Mexico.

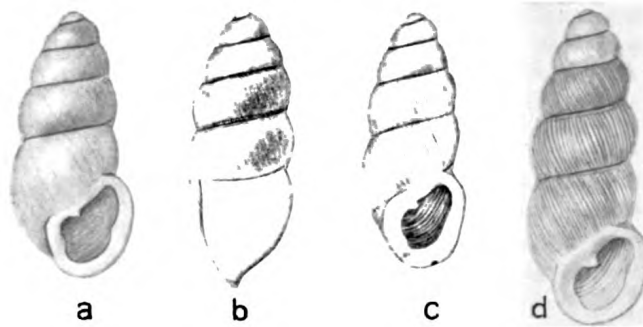


Fig. 561. a, b, *Carychium exiguum*. c, *C. exile*. d, *C. exile canadense*. $\times 20$.

NEWFOUNDLAND: Lomond, Bonne Bay (S. T. Brooks). NOVA SCOTIA: Windsor (Axel Olsson). MARITIME PROVINCES: Prince Edward Is.; Grindstone, Magdalen Is., in larch swamps and alder thickets (Bayard Long). MAINE: in many places from Aroostook Co. south. VERMONT, RHODE ISLAND, NEW YORK, NEW JERSEY and PENNSYLVANIA, generally spread. MARYLAND: Gunpowder Falls (J. L. Baily). D. C.: Washington (E. Lehnert). VIRGINIA: Great Falls (Pilsbry); Eggleston, Giles Co. (B. Long). WEST VIRGINIA: reported by Brooks, *Nautilus*, 49:115, from Romney, Hampshire Co. (MacMillan & Hunt). NORTH CAROLINA: Wilmington (S. N. Rhoads). ALABAMA: Valley Head; Roanoke, Randolph Co. (H. H. Smith); Blakeley, near head of Mobile Bay, Baldwin Co. (C. B. Moore). TENNESSEE: Knoxville (H. B. Baker). OHIO: Kent (G. W. Dean); Oldtown, Greene Co. (A. F. Archer); near Cleveland (J. A. Allen). MICHIGAN: Grand Rapids; near St. Joseph, Berrien Co.; Saginaw; George Reserve, Livingston Co. INDIANA: Henry Co. (Walton); Wabash River, W. Lafayette, Tippecanoe Co. (Satterthwait). ILLINOIS: Joliet (Ferriss). IOWA: Davenport (D. S. Sheldon); Iowa City (Pilsbry); Des Moines (T. Van Hyning). ARKANSAS: Sulphur City (A. J. Brown). NEW MEXICO: drift Mimbres River near Deming (Pilsbry). COLORADO: reported by Junius Henderson, *Nautilus*, 43:104, from woods near a spring a half mile from Steads ranch house, Estes Park, above 8000 ft. elevation (Dr. P. Okkelberg).

Some records of *exiguum* in the older literature may have been based upon *C. exile*. Localities given above are for specimens in A.N.S.P., except the records from West Virginia and Colorado.

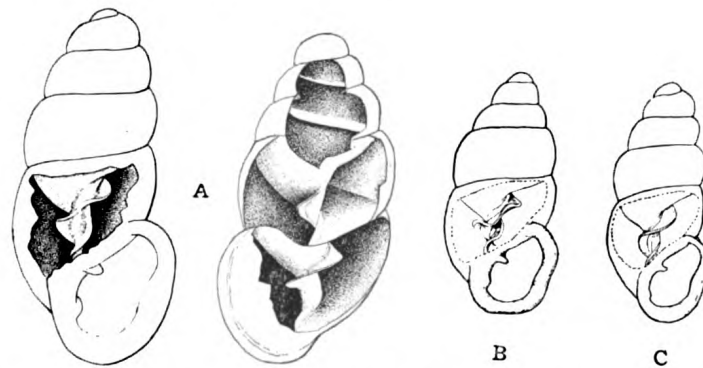


Fig. 562. *Carychium exiguum*. A, Cleveland, Ohio, ventral and dorsal view. B, Ann Arbor, Michigan, after Winslow. C, Edgeworth, Pennsylvania, after Winslow.

C. exiguum lives in the crevices of rotten logs or on dead leaves in moist places, or sometimes it is found in very wet places, such as *Pomatiopsis lapidaria* frequents.

C. exiguum is stouter in figure than *C. exile*, the only species found with it in the northern states, and it is usually smoother, often quite without striation. It varies rather widely in size in the same colony, as Dr. G. H. Clapp has shown, and there is also an imperfect zonal variation in size. Canadian specimens usually exceeding those of Carolinian and Austroriparian faunas; the extreme size observed being from 1.55 mm. long in Alabama to 2.15 mm. in Marquette Co., Michigan (Clapp, *Nautilus*, 19:140). The sculpture too is variable. Some shells are almost smooth, having the faintest growth-wrinkles only, while others in the same lot may be almost as strongly striate as *C. exile*, though less regularly.

It is the presence of such striate shells in several lots from Pennsylvania and New York (Dutchess Co.) which permits us to apply Say's name to this species. Say's description is ambiguous and could be applied to either the present species or *C. exile*, which also occurs within the limits of Philadelphia.

"*P. * exigua*. Shell dextral, tapering, oblong, with minute grooved lines; apex obtuse; whorls five; suture deeply impressed; labium bidentate, superior tooth situate rather beneath the middle of the lip, inferior tooth small, placed on the columella; labrum mutic reflected, but not flattened; umbilicus distinct. Length more than one-twentieth of an inch." (Say).

The terms, "tapering, oblong" apply better to what later authors have called *exiguum*; "with minute grooved lines" to *exile*. Probably Say had both species; but the next authors to describe and figure the species, Gould (1841) and A. Binney, had the stouter species, which the Philadelphia conchologists apparently took to be Say's *exiguum*, at the time H. C. Lea described *C. exile*. In the absence of Say's material, no longer existing, absolute certainty as to what he had is not attainable, and the identification of his early successors is accepted.

The two specific names introduced by Bourguignat seem to have been based upon selected large (*existelium*, length $2\frac{1}{2}$ mm.), and small (*euphaeum*, length $1\frac{3}{4}$ mm.) specimens. The measurement $2\frac{1}{2} \times \frac{3}{4}$ mm. was probably approximate. Both were described as smooth, and without doubt are synonymous with *C. exiguum*, as W. G. Binney concluded (*Terr. Moll.*, 4:178).

Carychium stygium Call

Fig. 563 a. b.

Carychium stygium R. E. Call, 1897, *American Naturalist*, 31:387, pl. 10. figs. 6, 7.—
L. Giovannoli, 1933, *Amer. Midland Nat.*, 14:616, fig. 89.

"Shell minute, white, pellucid, shining; whorls 5 to 5.5 in number, convex above and rather flattened below, apical whorl blunt-rounded in most specimens, occasionally more acute; suture deeply impressed, quite regular; aper-

ture a little less than one-fourth total length of the shell, rather sharply angular above and broadly rounded below, with its plane forming a very

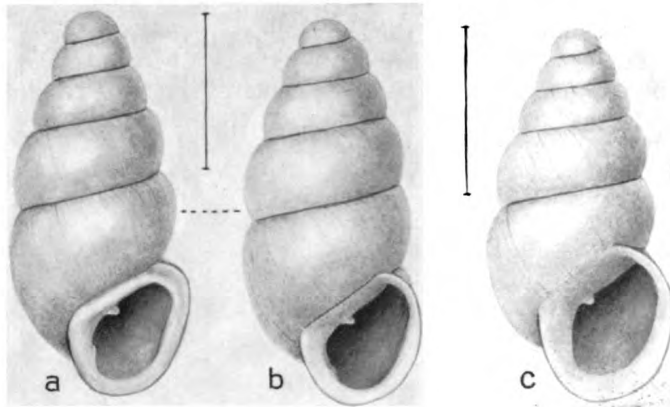


Fig. 563. a, b, *Carychium stygium*, Mammoth Cave. c, *Carychium occidentale*, type, Portland, Oregon. Scale lines = 1 mm

acute angle with axis of the shell; lip reflexed in mature specimens; many examples, but not all, with a sharp, white, and long denticle on the parietal wall near the junction of the upper portion of the apertural boundary; the spire is generally quite regularly and narrowly conical, but the body whorl is somewhat turgid. The length of the shell is 1.5 mm. to 1.85 mm. The aperture is nearly as broad as long" (Call).

KENTUCKY: Mammoth Cave in Mammoth Dome, on wet surfaces of old bridge timbers and on masses of the filaments of a fungus (*Rhizomorpha*) growing on profusion on them (R. E. Call). Type in Call collection, Indiana State University; specimens of original lot in coll. A.N.S.P. no. 68147, and in U.S.N.M. Buzzards Cave and Whites Cave and various places in Mammoth Cave (Giovannoli).

Two specimens from the author are drawn in figs. a and b, the larger measuring 2.44 mm. long, 1 mm. wide, with $5\frac{1}{2}$ whorls. Call's measurement was probably inexact. The old individuals such as fig. 563a have a thick *continuous* peristome. I could not examine the internal lamella as it was broken in my attempts to remove the dried animal. All of those seen have the soft parts dried in. It can be seen that the lamella is not like that of *C. exile* but apparently more like *exiguum* or *nannodes*. The number of whorls is greater than in *C. exiguum*.

Carychium nannodes Clapp

Fig. 564.

Carychium nannodes G. H. Clapp, 1905, Nautilus, 19:91, pl. 3, figs. 7, 8, 9.—Walker, 1928, Terr. Shell-bearing Moll. Ala., p. 174, figs. 277, 278.—Winslow, 1922, Occas. Pap. Mus. Zool. Univ. Mich., No. 128, pl. 5, fig. 23.—Brooks, 1936, Nautilus, 49:115.—Brooks & Kutehka, 1937, Ann. Carnegie Mus., 25:160.

"In shape this species resembles *C. exile*, being long and slender, but differs in being absolutely smooth, *without any trace of growth lines*, even

when magnified to 60 diameters; under high magnification the surface shows a faint granulation; color waxy-white, transparent, the columellar fold showing distinctly through the shell; whorls about $4\frac{1}{2}$, regularly tapering from the bodywhorl to the apex; sutures deep, whorls slightly shouldered; lip wide and well reflected, especially at the columella, where it forms a distinct umbilical chink; outer curve of lip decidedly flattened, hardly thickened within; viewed from the back the lip is more squared below than in *exile* and *exiguum*; upper columellar fold of good size, lower one almost obsolete. Length 1.4 mm., diameter 0.5 mm." (Clapp.)

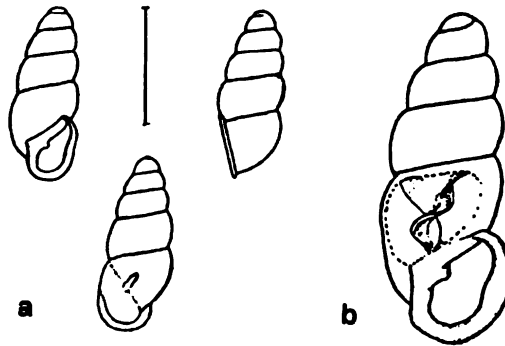


Fig. 564. *Carychium nannodes*, topotypes, after Winslow. Scale line = 1 mm.

The principal lamella within the last whorl is rather small, its edge evenly spiral. The lower or columellar lamella is scarcely more than a cord.

ALABAMA: Monte Sano, about five miles east of Huntsville, Madison Co., abundant among leaves in a shady ditch near the top, elevation about 1600 feet (H. H. Smith), Type 5401 Clapp Coll., paratypes 107911 A.N.S.P. Also Gurley; Florence, Lauderdale Co.; Squaw Shoals, Cohorts and Princeton, Jefferson Co. (Smith.) WEST VIRGINIA: Talcott, Summers Co.; Kingmont, Marion Co.; Mill Point, Pocahontas Co.; Renick, Greenbrier Co. (MacMillan & Hunt); Monroe and Pendleton counties (MacMillan).

***Carychium floridanum* G. H. Clapp**

Figs. 565: 566 F. G.

Carychium exiguum floridanum G. H. Clapp, 1918, Nautilus, 31:73, pl. 8, figs. 4-6.

"Differs from the type [of *C. exiguum*] by its constantly smaller size and the *greatly thickened lip*. The shell is also more tapering, making the last whorl appear swollen. Of 25 shells measured, from 5 different localities, the largest is 1.73×0.81 mm. and the smallest 1.52×0.78 mm., the average being 1.64×0.78 mm.

"Fig. 5, "Snapper Creek Hammock" about 8 miles south of Miami, Fla., measures 1.64×0.72 mm. Length of aperture 0.63, width 0.58 mm. Average of 6 shells, 1.61×0.70 mm.

"Fig. 4, near Coot Bay, Cape Sable, measures 1.73×0.78 mm. Length of aperture 0.69, width 0.63 mm. Average of 6 shells 1.67×0.78 mm.

"Fig. 6, Miami, collected by S. N. Rhoads, measures 1.78×0.86 mm. South side of Miami River, about 2 miles above Miami, average of 6 shells 1.61×0.77 mm.

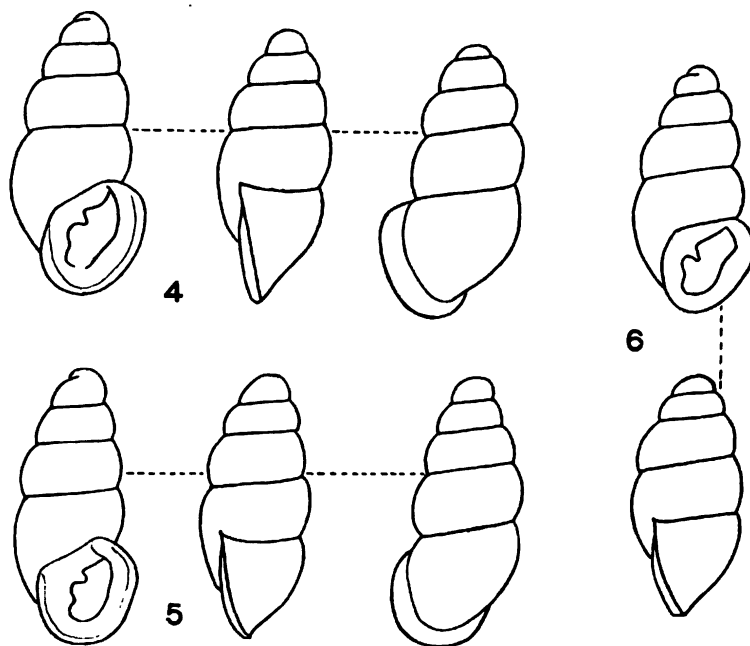


Fig. 565. *Carychium floridanum*. 4, near Coot Bay, Cape Sable. 5, Type, Snapper Creek Hammock. 6, Miami. (After G. H. Clapp.)

"Musa Isle, edge of Everglades at entrance to Miami River, average of 6 shells 1.58×0.79 mm. The Musa Isle shells are more globose than those from the other localities, the diameter being exactly one-half the length." (Clapp.)

Within the last whorl the internal lamella is dilated to the left of the axis (in a ventral view), in form of a steeply oblique, blunt lobe. The axis is weakly spiral (Figs. 566 f, c).

FLORIDA: Itchtucknee River, Suwannee Co.; Gainesville and other places in Alachua Co. (Van Hyning). Homosassa, Citrus Co. (Clapp). Silver Spring (Pilsbry) and Ocala, (Van Hyning), Marion Co. Hitchens Creek and "Mt. Taylor", Volusia Co. (Pilsbry). Kissimmee, Osceola Co.; Wabasso, St. Lucie Co. (Van Hyning). Miami and vicinity (S. N. Rhoads and others). Southeast point of Big Pine Key (Pilsbry). Type from Snapper Creek Hammock, 8 miles south of Miami. No. 8569 Clapp Coll., Carnegie Museum.

The shells from Citrus County show fine striation on the last and penult whorls, the surface being more perfectly preserved than in those from the Miami region, in which I see no sculpture.

It differs from *C. exiguum* by the more heavily thickened lip and the much more emphatic lobe of the principal lamella, which is not so far within as the lobe of *C. exile*. However, the position of the prominent lobe varies somewhat, from ventral to farther towards the aperture. It is most nearly related to *C. exile*.

Carychium exile H. C. Lea

Figs. 561 c; 566 A.

Carychium exile H. C. Lea, 1842, Amer. Jour. Science and Arts, 42:109, pl. 1, fig. 5.—Pilsbry, Proc. Acad. Nat. Sci. Phila., 1891, p. 319, pl. 14, figs. 10-14.—Clapp, 1906, Nautilus, 19:138, pl. 8, figs. 3-5.—Winslow, 1922, Occas. Pap. Mus. Zool. Univ. Mich., No. 128, p. 3, pl. 1.—Walker, 1928, Terr. Moll. Alabama, p. 173, figs. 275, 276.—Brooks & Kutchka, 1937, Ann. Carnegie Mus., 25:157 (localities in West Virginia).

The shell is rimate, slender and long, whitish or clear corneous, thin. Spire long, gradually tapering, its outlines convex, summit obtuse. Whorls 5 to 5½, convex, regularly increasing, the last two *closely, distinctly and regularly striate*. Aperture small, oblique, about one-third the length of the shell. Outer lip slightly expanded, thickened, thickest near the middle. At the junction of the columellar and parietal margins there is a small horizontal lamella, which, one whorl within, *expands into a broad warped plate which ascends almost vertically*, abruptly diminishing again above the plate. Columellar lamella obtuse, ascending in a long spiral curve within, where it is more or less dilated in the ventral side.

Length 1.7 mm., diameter 0.6 mm.

Length 1.75 mm., diameter 0.6 mm.

Distribution.—Maine and Ontario to Manitoba, south to Mobile, Alabama and Texas. In A.N.S.P. from 90 localities in the states of Vermont, New York, New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, Kentucky, Tennessee, Alabama, Ohio, Indiana, Michigan, South Dakota (Clay and Lincoln counties), Arkansas and Texas.

C. exile is readily distinguishable from *C. exiguum* by its narrower contour, smaller aperture and the more regularly and more strongly striate surface; but the internal structure is even more differentiated, the parietal lamella expanding a whorl inward into a great vertical plate. In specimens opened the internal partitions are less extensively absorbed than usual in *C. exiguum*. A further difference is that in *C. exile* the last whorl is built forward so that, in a profile view of the aperture, the lip is even with the ventral convexity of the last whorl. In *C. exiguum* the belly of the last whorl projects decidedly beyond the plane of the aperture. By this peculiarity the occasional striate specimens of *C. exiguum* may readily be distinguished from *C. exile*.

Brooks & Kutchka reported that *C. exile* was taken in thirteen counties of West Virginia. "Within this series, however, the lamellae varied from the form figured as typical of *exile* to a form close to *C. exile canadense* G. H. Clapp. The shorter ones had the leaf-like, deflected portion of the lamella in front of or slightly to the right of the columella; the longer the specimens the farther this deflection occurred from the aperture. Comparing these with our series of *canadense* it was found that almost every step from the *exile* form to the *canadense* form was present." It is slightly narrower than typical, averaging 1.9 × 0.6 mm.

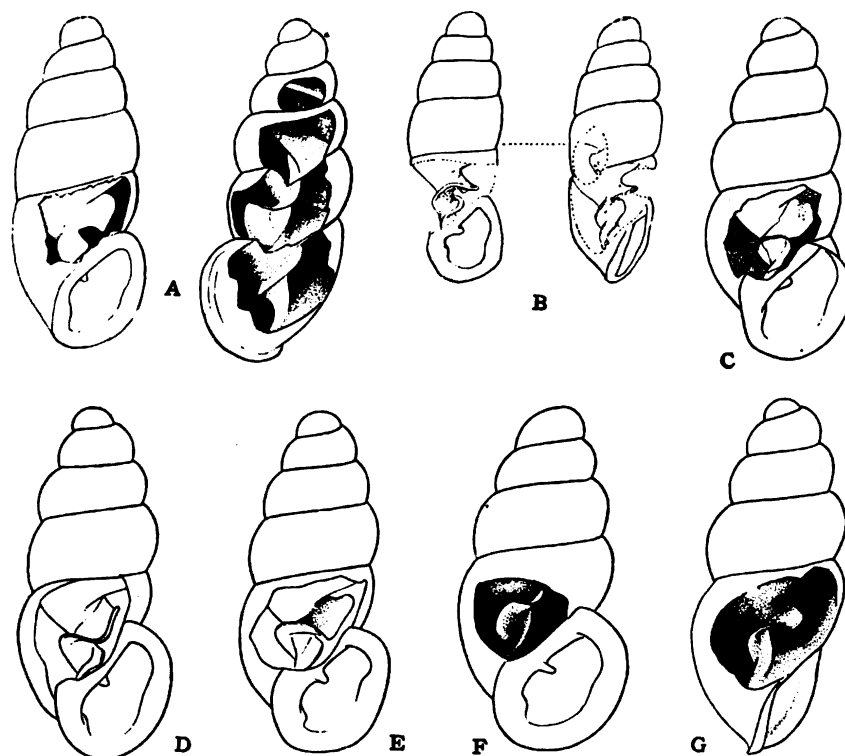


Fig. 566. A, *Carychium exile*, Philadelphia. B, C, *C. e. canadense*, topotype; after Winslow. C, *C. e. mexicanum*, cotype. D, *C. exile*, transitional to *mexicanum*, Guadalupe River above New Braunfels, Texas. E, same, Ouachita Co., Arkansas. F, *C. floridanum*, Citrus Co., Florida. G, same, Snapper Creek Hammock.

***Carychium exile canadense* Clapp**

Fig. 561 d; 566 B.

C. exile canadense Clapp, 1906, Nautilus, 19:139, pl. 8, figs. 1, 2, 6, 7.—Winslow, 1922, Occas. Pap. Mus. Zool. Univ. Mich., No. 128, p. 4, pl. 2, fig. 6, 7.

Shell larger than *C. exile*, length 2.15 mm., diameter 0.75 mm., to length 2 mm., diameter 0.7 mm.; the type 2.1 mm. \times 0.75 mm.

"Folds similar to those of *exile*, but the downward bend occurs farther from the aperture—*i. e.*, after about one and one-quarter turns of the lamella around the columella. In the figure the bend is too far dorsad to be shown in the front view." (Winslow.)

Distribution.—Canadian Zone, Maine and Ontario to Michigan and Manitoba, and reported by Dr. Hanna from Vancouver Island. Type locality, Kennebunkport, Maine.

The long series of measurements made by Dr. Clapp of shells from many localities, shows that this race replaces *C. exile* in the north. "*C. exile* and *C. e. canadense* are found in much drier situations than *C. exiguum*, always, in my experience, some distance from water." (G. H. Clapp in letter.)

Carychium exile mexicanum Pilsbry

Fig. 566 c.

Carychium exiguum var. *mexicanum* Pilsbry, 1891, Nautilus, 5:9; Proc. Acad. Nat. Sci. Phila., 1891, p. 318, pl. 14, figs. 7-9; 1894, reprinted in Nautilus, 8:63, figs. 7-9.—Von Martens, 1898, Biol. Centr.-Amer., Moll., p. 352, pl. 19, figs. 15, 16 (Costa Rica.)

"Shell minute, cylindrical, tapering above to an obtuse apex; waxen whitish, somewhat translucent; whorls $4\frac{1}{2}$, convex, separated by rather deep sutures. Aperture one-third the length of the shell, rather oblique; outer lip expanded, thin above, suddenly becoming very much thickened on its outer portion by a heavy deposit of callus upon its face and inner edge; columellar margin having an obtuse projection (scarcely a tooth) below, and an acute entering fold above. Surface having very delicate oblique striae of growth." (Pilsbry.)

Length 1.9 mm., diameter 0.8 mm., Type.

Length 2 mm. Paratype.

MEXICO: hills around Orizaba, at an elevation of about 500 feet above the town (Heilprin Exped., Type lot 61628 A.N.S.P.), Texolo, V. C. and Diente, near Monterrey (S. N. Rhoads); Tampico (A. A. Hinkley). GUATEMALA: Chama (Hinkley).

The description of *C. e. mexicanum* is introduced above for comparison with the Texan form of *exile*, which resembles *mexicanum* in being smooth or only weakly and irregularly striate. The lobe of the lamella, one whorl within, is squarish, with the edge bent forward, the principal internal lamella being like that of *C. exile*. The lower lamella is broadly expanded on the ventral side, but this is also a character often seen in *C. exile*. It differs from that species by the smooth or nearly smooth surface and the wider figure of the shell. In the original description "very delicate oblique striae of growth" were mentioned, but there is usually only an excessively fine granulation, as in other "smooth" species. The lip is rather heavy, but usually less broad than in the original figure.

Fig. 566 c is a paratype from above Orizaba, opened to show the lamellae. Nearly smooth specimens transitional to *C. exile* are figured from Guadalupe River 4 miles above New Braunfels, Texas, Fig. 566 d, and Kent, Ouachita Co., Arkansas, Fig. 566 e.

It is the tropical representative of the *exile* stock and probably to be considered a southern subspecies of that, intergrading with it in Texas.

Carychium occidentale Pilsbry

Page 1055, fig. 563 c; fig. 567.

[*Carychium*] *exiguum* var. *occidentalis* Pilsbry, 1891, Nautilus, 4:109 (Portland, Oregon).

Carychium occidentale Pilsbry, 1894, Nautilus, 8:63, figs. 4-6.—Randolph, 1896, Nautilus, 9:102 (Seattle, Wash.).

Carychium magnificum Hanna, 1923, Proc. Cal. Acad. Sci. (4 ser.), 12:51, fig. 1.

The shell is conic, of 5 to $5\frac{1}{2}$ strongly convex whorls, smooth (or the last may be lightly striate behind the outer lip). The aperture is about 35 per cent of the total length. Peristome strongly reflected; a narrow arc in the

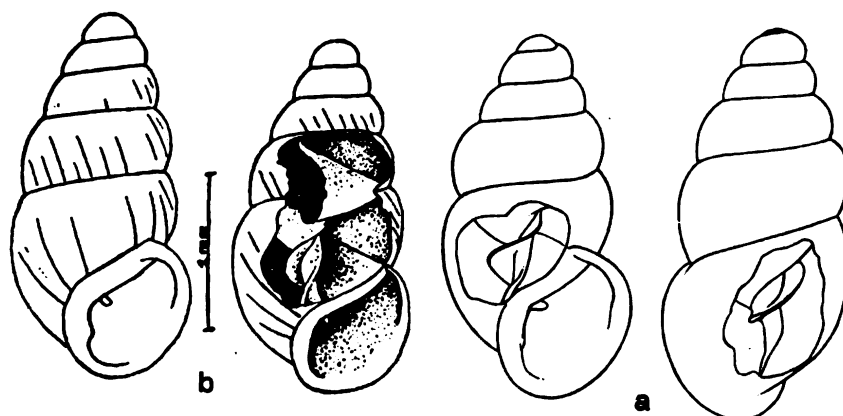


Fig. 567. *Carychium occidentale*. a, near Astoria, Oregon. b, Type figures of *C. magnificentum*, after Hanna.

upper part of the outer margin, other margins moderately wide, with slightly thickened face. Columella sinuate at base. The principal lamella is moderately expanded internally, with evenly spiral edge, widest in the latero-ventral part at about the first third of the last whorl.

Length 2.33 mm., diameter 1.3 mm., length of aperture 0.8 mm. Clatsop Co.

Length 2.17 mm., diameter 1.22 mm. Type, Portland, Oregon.

Length 2.3 to 2.66 mm. McAleer Creek near border of King Co., Wash.

Length 2.15 to 2.4 mm. Lake Crescent, Clallam Co., Washington.

CALIFORNIA: Ragged Canyon, 5 mi. south of Crescent City, Del Norte Co. (E. P. & E. M. Chace). OREGON: Portland, Type 22539 A.N.S.P.; Riverdale, Multnomah Co.; Oswego, Clackamas Co.; Astoria and elsewhere in Clatsop Co. (H. B. Baker). WASHINGTON: Port Ellis, Pacific Co.; Rialto Beach, mouth of Quillayute River; Port Angeles and Lake Crescent, Piedmont, Clallam Co. (H. B. Baker). Seattle (P. B. Randolph) and Lake Washington, King Co.; Brook Valley, Esperance, Snohomish Co. (H. B. Baker). BRITISH COLUMBIA: Duncan, Quamisham District, Vancouver Island (A. W. Hanham).

The regularly tapering spire, thin or but little thickened lip, and the simply spiral, not undulating, internal lamella, are the special features of this western species. So far as known, it is restricted to the humid region west of the Cascades, from northwestern California to Vancouver Island, a distance of nearly 600 miles. It is often found in abundance.

In the absence of measurements of *C. occidentale*, Dr. Hanna described large Vancouver Island specimens as *C. magnificentum*. From the series of some hundreds now in hand, collected by Dr. H. B. Baker and others, it appears that though the types of *C. occidentale* were smaller, it often reaches the size given for *C. magnificentum*. Dr. Hanna's description follows.

Carychium magnificentum Hanna. Fig. 567 b. "Shell white or translucent; whorls five, gradually increasing in size to the last making the shape more decidedly conical than in any other North American species. Sutures deep; growth lines weak; delicate revolving striae in the type and most

specimens. Aperture with the peristome reflected abruptly but without heavy callus on the inside; shorter and broader in proportion to altitude of shell than in *exiguum*. Parietal tooth near the columellar wall and forming outer termination of a high-revolving axial plait (shown in the paratype, which was broken open for the purpose). A low basal protuberance which also continues within the shell as an axial plait but it is lower than the preceding. The axis is dissolved out of the upper three whorls. Altitude, 2.30 mm.; diameter 1.13 mm. Bulk of shell fully twice as great as that of *C. exile canadense* which was found under the same log." (Hanna.)

BRITISH COLUMBIA: Union Bay, Vancouver Island, in woods back of the settlement (G. D. Hanna). Type 689, Cal. Acad. Sci.

"This species is undoubtedly closest related to *C. occidentalis* Pilsbry, which was described from Portland, Oregon, and has been recorded from Seattle, Washington. The shape of the two species is about the same and both are without thickening on the inside of the peristome. Measurements of *C. occidentalis* have not been published but the figures cited are upon a plate where other known North American forms appear. Presumably, all were drawn to the same scale. If so there is no great difference between *occidentalis* and *exiguum* in size. . . . The larger size of *C. magnificum* is its most distinguishing feature but the spiral striae have not been seen in other species." (Hanna.)

Order SYSTELLOMMATOPHORA

Ditremata Fischer, 1883, Manuel de Conchyliologie, p. 447.

Teletremata Pilsbry, 1898, Nautilus, 11:144.

Digonopora Suter, 1913, Man. New Zealand Moll., p. 808.

Oncidiacca and *Soleolifera* Thiele, 1931, Handbuch Syst. Weichtierk., 2:485, 488.

Pulmonata in which the eyes are on contractile (not inversible) stalks; body oval or lengthened, slug-like, the convex or keeled dorsal integument without mantle-cavity or shell, extending down over head and on all sides. Lung posterior, the breathing pore, nephridial opening and anus behind the foot. Male genital opening on right side of the head, the female opening about midway of right side of hyponotum.

This series of slugs, hitherto included in the Stylommatophora under various names, is far more distinct from that group than are the Basommatophora.

Family XXIV. VERONICELLIDAE

Oblong, terrestrial slugs with rounded back and sharply angular lateral borders, the integument being inflexed, forming a flat hyponotum on each side of the long sole. Jaw low, arcuate, formed of vertical, parallel plates. Radula with narrow central and wide lateral teeth, all unicuspid.

A tropical family, represented by one species in Florida.

Vaginulus (Latipes) olivaceus (Stearns). (*Veronicella olivacea* Stearns, 1871, Conchol. Memoranda, 8:1), was described from Nicaragua, but a slug

thought to be the same species was collected by R. E. C. Stearns in 1866, near Lobitos, about 40 miles south of San Francisco. It is believed to have been introduced by commerce, as no further examples have been reported from California. Cf. W. G. Binney, 1885, *Man. Amer. Land Sh.*, p. 160; H. B. Baker, 1925, *Proc. Acad. Nat. Sci. Phila.*, 77:177, pl. 5, figs. 15-17.

VERONICELLA Blainville

Veronicella Blainville, 1817, *Jour. de Physique*, 85, 440, Pl. II, fig. 4, for *V. laevis* Blainv.

Leidyula H. B. Baker, 1925, *Proc. Acad. Nat. Sci. Phila.*, 77:158, new section of *Veronicella* for *V. moreleti* (C. & F.), *floridana* (Leidy) and *kraussii* (Fér.).

“Oval anus protected ventrally by an anterior flap so that the superficial opening is a transverse crescentic slit which usually extends beyond right edge of retracted foot; dorsum usually with two longitudinal dark bands; spermathecal stalk elongate and cylindrical, joined by canalis junctor which enters near base of terminal sac; female opening posterior to middle; hind-gut and genitalia enter body wall in close juxtaposition; verge simply cylindrical or with subspiral ridges acrocaul or practically so, but with orifice surrounded by a granulate, chalky-white glans, retractor short and stout; dart-papilla small with paired retractors.” (H. B. Baker.)

Our only species was doubtless derived from Cuba where it is abundant and generally distributed. Just how a slug could make the sea voyage is not clear, but perhaps among stones and earth held by the roots of a floating tree.

Veronicella floridana (Leidy)

Fig. 568.

Vaginulus floridanus Leidy, 1851, in Binney, *Terr. Moll.*, 1:198, 237, 251, pl. 4.—Binney, 1852, *Terr. Moll.*, 2:17, pl. 67.—W. G. Binney, 1858, *Proc. Acad. Nat. Sci. Phila.*, p. 198, No. 49 (as *V. floridanus*).

Veronicella floridana Binney, W. G. Binney, 1878, *Terr. Moll.*, 5:241, fig. 140, pl. v, fig. P (jaw and teeth).

Veronicella (Leidyula) floridana Leidy, H. B. Baker, 1925, *Proc. Acad. Nat. Sci. Phila.*, 77:167, pl. 4, figs. 12-14 (synonymy, anatomy and distribution); 1928, *Nautilus*, 42:45.

“Animal (contracted in alcohol) elongated oval, about four times as long as broad, the sides very slightly curved, and the extremities circularly rounded; back convex, regularly arched in every direction; surface very slightly wrinkled; color dark ashy gray, mottled with black, with a median whitish line, on each side of which, at about one-third the distance towards the margin, is an ill-defined stripe of black; beneath drab colored; foot occupying about one-third the width; tentacles short, annulated, the lower ones not very distinctly bifurcate. Length two and one-fourth inches; breadth three-fourths of an inch.” (Binney.)

FLORIDA: Metaleechee Key, Charlotte Harbor, type locality; Punta Rassa; Mound Key, Estero Bay; Cape Romano; Lake Worth, Miami and Long Pine Key; Key Largo; Lignumvitae Key; Sugarloaf Key; Key West; Dry Tortugas. CUBA: Generally distributed from Camaguey Province to Pinar del Rio.

This slug, which is doubtless an immigrant from Cuba, is our only representative of a family which occurs almost everywhere in the tropics. *V.*

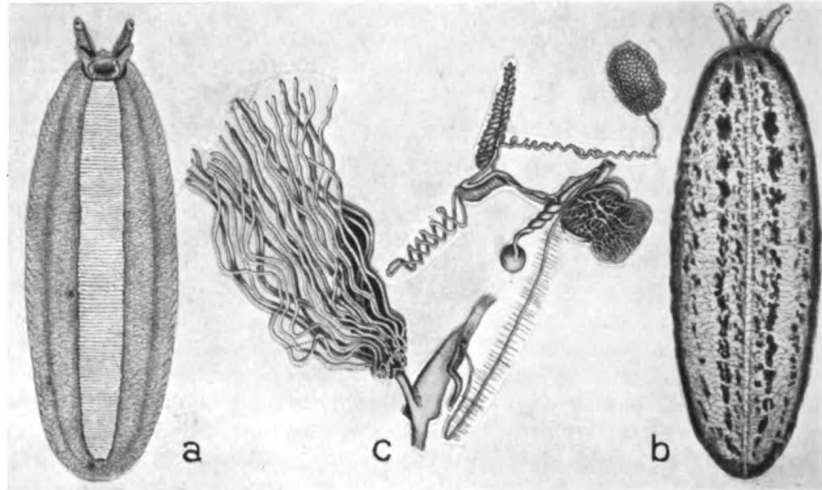


Fig. 568. *Veronicella floridana*. a, b, living animal (after Binney); c, genitalia (after Leidy).

floridana is generally distributed over the Keys, and on the east coast as far north as Lake Worth, on the west to Charlotte Harbor. It is nocturnal, hiding under wood, stones or in crevices during the day, but abroad by night. It is often destructive in gardens, being a voracious feeder.

Subclass PROSOBRANCHIA

Operculate gastropods in which the sexes are separate; mainly aquatic, respiration being by a gill or gills in the mantle cavity, but a few families have become terrestrial, breathing air. These terrestrial families are not directly related, having been derived from as many diverse groups of marine gastropods. The Helicinidae are allied, though by no means closely, to the Neritidae. The Truncatellidae are slightly modified from Rissoidae, and by some malacologists are considered a subfamily of that marine group. The Pomatiasidae are an isolated and doubtless very ancient line, their aquatic ancestral stock uncertain.

The problem of locomotion on dry land has been solved by snails of these families differently, by each family in its own fashion. The Helicinidae have apparently kept their original gliding movement; the Truncatellidae have evolved a stepping or looping gait; and the Pomatiasidae have the foot divided lengthwise, moving by waves raised from the ground, alternately advancing on the two sides.

Order **MESOGASTROPODA**Family XXV. **TRUNCATELLIDAE**

The shell is imperforate, cylindric, of few whorls by loss of the tapering earlier portion, or if entire, elongate and many-whorled. Aperture oval; peristome blunt. Operculum thin, corneous, subspiral.

The animal has a very large, long rostrum and tapering tentacles with eyes sessile at their posterior bases. Foot short. Pallial cavity very large, containing a small gill of many triangular ciliated lamellae. Radula (Fig. 569) with 3-1-3 teeth, the central triangular, unicuspid, with a mesially interrupted row of basal denticles; laterals transverse with few large denticles; marginals having a long body and numerous denticles.

Locomotion is by looping, the oral disc and the foot being advanced alternately. Placed in water they are said to glide in the ordinary manner of gastropods.

Distribution.—Mainly tropical and subtropical regions, *Truncatella* in the strand zone, *Geomelania* inland.

The Truncatellidae are a relatively late adaptation to life in the air, being closely similar to the marine Rissoidae in radula and shell.



Fig. 569. Marginal, lateral and central teeth of *Truncatella pulchella form caribaeensis*, the outer marginal turned outward.

TRUNCATELLA Risso

Truncatella Risso, 1826, Hist. Nat. Eur. Mérid., 4:124.

Fidelis Risso, t.c., p. 121, for *F. theresa* Risso = young *Truncatella*.

Erpetometra Lowe, 1830, Zool. Jour., 5:300, for *Cyclostoma truncatulum* Drap.

Acmea Hartmann, 1821, Neue Alpina, 1:204-12, in part.—Iredale, 1915, Proc. Malac. Soc. London, 11:332. Not the prior *Acmea* Hartmann, 1821, in Sturm's Deutschlands Fauna, vi Abtheil., 5 Heft, pp. 48, 49; cf. Pilsbry, 1926, Nautilus, 40:32.

Choristoma De Cristofori & Jan, 1832, Catalogus rerum nat. in mus. Josephi De Cristophori et Georgii Jan, Mantissa, p. 5, sole species *Ch. truncatula* Drap.

Shell imperforate, cylindric, truncate, of few (usually $3\frac{1}{2}$ to $4\frac{1}{2}$) convex whorls, by loss of the tapering early whorls. The first $2\frac{1}{2}$ whorls are smooth, forming the embryonic shell with obtuse apex, following whorls axially ribbed, those of the adult shell ribbed or smooth. The aperture is ovate, peristome continuous, somewhat expanded. Operculum corneous, subspiral.

Truncatella usually lives above ordinary high tides among stones, seaweed, and other strand debris, but never far from the sea. It is really an

amphibious animal. The Rev. R. T. Lowe kept a specimen of *T. truncatula* about five weeks in a tin box without water, then fourteen weeks in a lace bag wholly immersed in seawater.⁹² The specimens drawn in Fig. 570, with others, lived without water in a stoppered glass jar on my laboratory table thirty-seven days from the time they were collected. A few of them died, but most were finally killed in an unsuccessful attempt to preserve them extended. Notes on the locomotion made at that time by Dr. A. P. Brown and the author follow:

“After they are left to themselves for a short time, the animal protrudes the operculum, with the foot and proboscis, which latter at once begins to feel about until it encounters some firm substance, when the foot is fully protruded. The foot is a squarish pad of about 1 square millimeter in area. The proboscis may be extended to $1\frac{1}{2}$ mm. or more. It is waved to and fro until it encounters the surface over which the animal moves, bending downward at the same time. The foot, when fully protruded, is attached firmly to the surface moved over; the proboscis is then raised and waved about again, and crawling commences. The progression begins by a stretching forward of the proboscis, its tip is then applied to the surface moved over, and this tip flattens out until nearly the size of the foot. If the proboscis secures a firm attachment, the foot may now be released, and either drawn up to the attached proboscis by sliding the edge of the foot along the surface, or the entire animal may be supported upon the proboscis and the foot raised clear of the surface and drawn up to the proboscis, when its edge will rest on the surface moved over. Perhaps more often the foot is raised anteriorly and slid forward upon its posterior edge up to the attached proboscis; the position assumed by the body of the animal being now the same as when it is retracted into the shell. Starting from this position, the method of progression may be described as follows: The square pad of the foot is turned down anteriorly until it is firmly attached to the surface moved over, simultaneously the attachment of the proboscis is released and this is moved to find another attachment; as soon as this is found the firm attachment of the proboscis is effected again; then the entire shell is hitched forward as the foot is lifted and brought up in contact with the under side of the proboscis. In case the foot is lifted clear of the surface moved over, the posterior edge of the foot touches the surface first; if not lifted clear of the ground, this edge is slid or dragged over the surface until the foot comes up to the under

Fig. 570. *Truncatella bilabiata*. 1, proboscis and foot both in contact with the ground, the front part of foot being raised preparatory to forward movement. 2, near the end of the forward step of the foot, the shell trailing far in the rear. 3, end of the forward step of proboscis, the shell trailing far behind. This position is slightly anterior to that shown in fig. 1. 4, 5, *Tropicorbis obstructa geoscopus* (Pils. & Brn.). Antigua. 6, *Truncatella bilabiata*. End of forward step of the foot, the shell pulled forward. This position is slightly later than that shown in fig. 2. Drawn by the author.

⁹² Zoological Journal, 5:300-302.

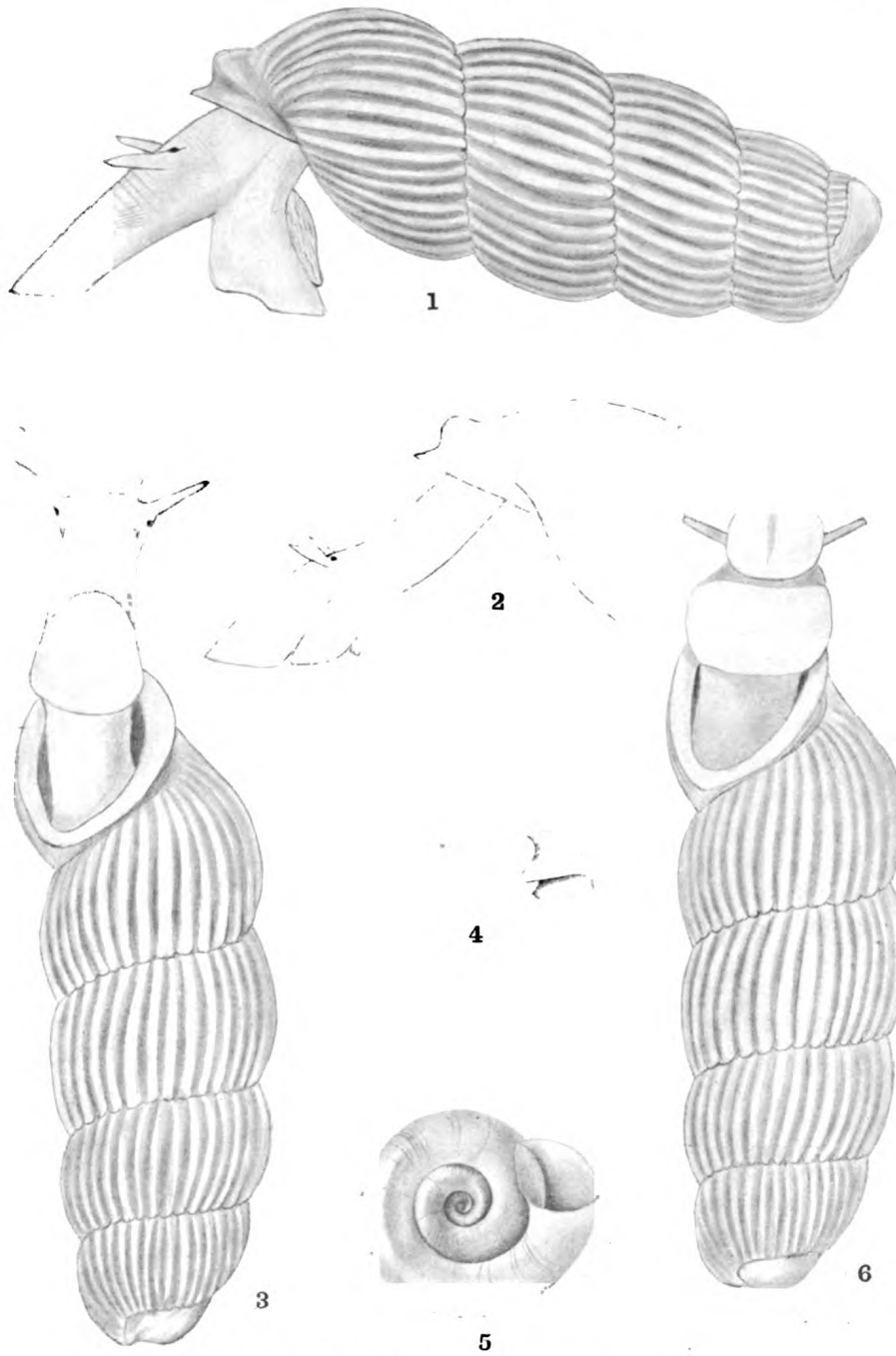


Fig. 570. See bottom of page 1066 for legend.

side of the proboscis. Its posterior edge is then applied to the ground, and, as the proboscis is loosened and raised, the foot turns down until it is firmly in contact with the ground, and the waving about of the proboscis and its final attachment proceeds as before.

“The entire cycle of movements comprising the ‘step’ is executed in four seconds or less, so that the animal will make 15 to 17 steps in a minute when advancing steadily in one direction; and in these 15 to 17 steps it will have moved over 20 to 25 mm. of surface. But it frequently happens that the proboscis does not secure a firm attachment, and, when the step is attempted, the proboscis slides back to the foot and the body is not advanced at all. The proboscis is then raised and waved about, another step is attempted, and generally succeeds. The animal may thus move forward in a straight line or it may take quite an erratic course. The shell sometimes rests upon the operculum, sometimes it is simply dragged along the ground; and it is jerked forward when the foot is raised, sometimes supported upon the operculum, but quite as often not. The muscles controlling the movement of the foot and of the proboscis can evidently act quite independently of each other.

“The external soft parts of *T. bilabiata* are very pale cartridge buff. There is an ill-defined, flesh-tinted spot on the proboscis, caused by some colored body, perhaps the radula and its sack, shining through. The proboscis has faint annular wrinkles.

“Compared with other land operculate snails we have seen alive, *Truncatella* is remarkable for the small size of the foot and the extraordinary development of the proboscis.”

The locomotion of *Pomatiopsis lapidaria* (Say) has some resemblance to this, but it differs in details, and is not so well adapted to land travel. In the air its tentacles lie limply on the head, not held erect as in *Truncatella*.

As minute young of not over two whorls occur with the old ones, I presume that the eggs are laid and the young develop on land; but no observations covering the ovipositing and early stages have come to my notice.

Key to species of *Truncatella*

- Shell having a strong rib behind the outer and basal margins of the peristome.
 Ribs strong, about 15 on the last whorl. *T. clathrus*
 Ribs moderate, more than 20 on the last whorl, or sometimes partially effaced. *T. bilabiata*
- Shell without a distinct rib behind the peristome.
 Atlantic and Gulf species; shell ribbed throughout, or smooth except below suture. *T. pulchella*
 California species.
 Shell ribbed throughout. *T. simpsoni*
 Shell smooth. *T. californica*

Truncatella clathrus Lowe

Fig. 571 c.

Truncatella clathrus Lowe, 1830, Zool. Jour., 5:303.—Reeve, 1842, Conch. Syst., 2, pl. 182, fig. 3.—Pfeiffer, 1856, Monogr. Auriculaceorum Viv., p. 195.—Pilsbry, 1900, Trans. Conn. Acad., 10:506, pl. 42, fig. 13 (Bermuda).—Clapp, Nautilus, 14:130.—Vanatta, Nautilus, 21:103; 26:31, 33, 34.

The tapering-cylindric shell is very solid, buff, of $3\frac{1}{2}$ to 4 moderately convex whorls. Sculpture of smooth, rounded axial ribs not quite as wide as their intervals, 13 to 16 on the last whorl; no spiral striation. There is a prominent varix behind the lip. The aperture is ovate; peristome narrowly expanded, thickened within, continued as a thick callus across the parietal wall.

Length 4.7 mm., diameter 2 mm.; 4 whorls.

Length 4.5 mm., diameter 1.8 mm.; $3\frac{1}{2}$ whorls.

Length 4.0 mm.; $3\frac{1}{2}$ whorls.

FLORIDA: Key West (Hemphill); Sugarloaf Key, Torch Key (Pilsbry); Indian Key (G. H. Clapp); St. James, Pine Island, Lee Co. (C. B. Moore); Captiva Island (Mrs. M. Hicks). Also Bermuda (Heilprin, Verrill); St. John (Robert Swift); Porto Rico and St. Thomas according to Shuttleworth. The original locality was unknown.

It is much more coarsely ribbed than other Floridan species, and it is not known to be so generally spread on the Keys, though found as far up the west coast as Captiva Island.

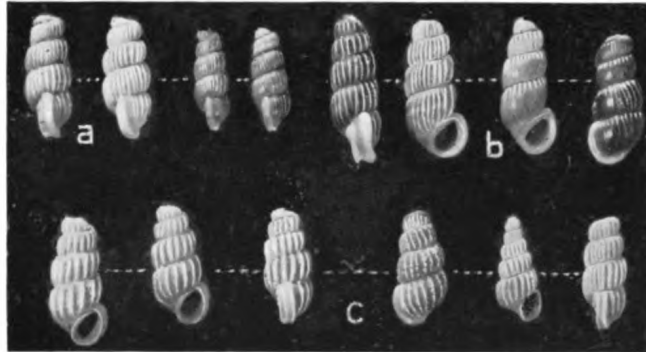


Fig. 571. *Truncatella bilabiata*. a. Torch Key; b. Lignum Vitae Key. c. *Truncatella clathrus*, Sugarloaf Key

Truncatella bilabiata Pfeiffer

Figs. 570: 1-3, 6, 571 a, b.

Truncatella bilabiata Pfeiffer, 1840, Wiegmann's Archiv Naturg., 5te Jahrg., 1:253; 1846, Zeitschr. f. Malak., 3:187; 1856, Monogr. Auriculaceorum, p. 192.—Kuester, Syst. Conchyl. Cab., p. 7, pl. 1, fig. 27-31.—W. G. Binney, 1865, Land and Fresh-water Sh. N. A., 3:99, fig. 199.—Pilsbry & Brown, Proc. A.N.S. Phila., 1914, p. 426, pl. 14, figs. 1-3, 6 (locomotion).

The shell is slightly tapering cylindric, dilute tawny or salmon buff to whitish gray, rather solid. About 4 ($3\frac{1}{2}$ to $4\frac{1}{2}$) whorls remaining are quite convex, the last having a strong white rib preceding the outer and basal lip margins, which are narrowly expanded. Sculpture of many rounded riblets about as wide as their intervals, 22 to 28 on the last whorl. They are some-

times partly obsolete on the latter part of the last whorl. The peristome is continued as a thick, rounded callus across the parietal wall.

Length 5 mm., diameter above aperture 1.8 mm.

Length 4 mm., diameter above aperture 1.6 mm.; $3\frac{1}{2}$ whorls, Key Largo.

FLORIDA: Atlantic coast at Micco and Rockledge. On the Keys seen from Key Largo, Tavernier Key, Long Island, Bahia Honda, Summerland, Big Pine, Sugarloaf, Boca Chica, Key West. On the west coast, Monroe Co. at Mormon Key, Rabbit Key, Lossman's Key, Pavilion Key. Collier Co. at Fakahatchee Key, Key Marco, Blue Hill, Little Marco, Buttonwood Key, Turner River Key. Lee Co. at La Costa Is., Starvation Key, Punta Rassa, Cayo Tuna in San Carlos Bay, Mound Key in Estero Bay, Captiva Island, St. James, Pine Island, and Dismal Key. DeSoto Co. at Little Gasparilla Island, Pinellas Co. at Mullet Key, St. Petersburg, Pass-a-Grille, Clearwater Island, and Tarpon Springs. Levy Co. at Cedar Keys. CUBA: right bank of the mouth of Canimar River (Gundlach, type loc.). West Indies, generally distributed; Bermuda.

Like other truncatellas, this snail is extremely variable in size and sculpture. The crest behind the lip varies from very high to quite small, those seen from near the type locality having a crest like our third fig. or somewhat larger, but no Cuban examples seen have it as large as in Fig. 571 a. The sculpture may be entire, or on the later whorls it may remain only near the suture, the rest of the whorl being smooth and polished. These partly smooth shells usually occur under the same stones with totally ribbed ones.

Shells in which the peristome is shortly free from the preceding whorl occur in some West Indian lots.

Truncatella pulchella Pfeiffer

Fig. 572 b. c.

Truncatella pulchella Pfeiffer, 1839, in Wiegmann's Archiv f. Naturg. 5te Jahrg. 1:356; Dec. 1846. Zeitschr. f. Malak., p. 186.—Kuester, Syst Conchyl. Cab., p. 10, pl. 2, figs. 11-15.—W. G. Binney, 1859, Terr. Moll., 4:189, pl. 75, figs. 1, 9, 10; 1865, Land and Fresh-water Sh. N. A., part 3, p. 92.

"The shell is usually scarcely rimate, truncate when adult, elongate, cylindric, gradually tapering above; with a glassy luster, amber-yellow or almost colorless and translucent; finely ribbed, the riblets low, thread-like, somewhat narrower than the intervals and nearly straight. The 4 to $4\frac{1}{2}$ whorls are pretty high, slowly increasing, convex, joined by an even, impressed suture, the last whorl in front about a half higher than the penult; compressed to a short keel below, which appears as the continuation of a seam-like callus behind and parallel to the peristome, and ending without a bend in the anterior half of the whorl. The aperture is rather wide, but little oblique, and nearly elliptical; the peristome simple, somewhat expanded, roundly advanced below, whereby the base of the aperture forms an indistinct spout. Lip margins are connected by a thick, whitish callus. Operculum thin, corneous. Height 2 to $2\frac{1}{2}$ lines, breadth $\frac{3}{4}$ to $\frac{1}{2}$ lines.

"This species often occurs with very indistinct ribs, or ribs are wholly wanting on the convexity of the whorls, and visible only as lengthened papilla-like projections below the suture." (Kuester.)

FLORIDA: Brickell's Hammock, Miami; The Keys to Key West; on the west coast north to Tarpon Springs; Cedar Keys. TEXAS: Indianola (Dr. Hubbard); Corpus Christi (C. D. Orchard).

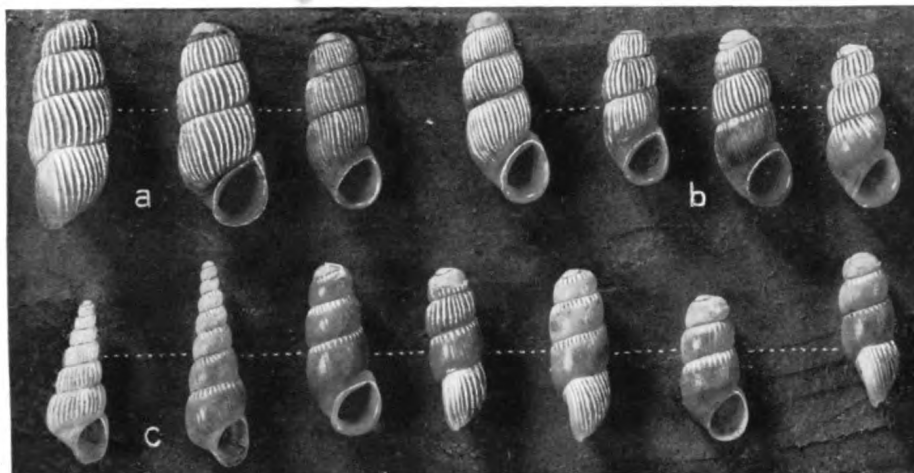


Fig. 572. a. *Truncatella pulchella* form *caribaeensis*, Key Largo. b. c. *T. pulchella*, Lignum Vitae Key.

CUBA: shore at Matanzas (Pfeiffer, type loc.). West Indies generally.

This is a common species on the Keys and up the west coast of the peninsula, and there are Texan specimens in the Philadelphia collection, those from Indianola probably taken 80 or 90 years ago.

It varies from completely ribbed to forms in which the ribs are effaced on the convexity of the last whorl, or on all the whorls; but so far as seen there are always some traces of riblets below the suture in some part of the shell. Length usually 5 to 6 mm.

In Floridan specimens the peristome is nearly in a plane, not so much advanced in the outer-basal arc as indicated in Kuester's figures of the typical Cuban form.

Truncatella pulchella form *caribaeensis* Reeve. Fig. 572a. (*Truncatella caribaeensis* Sowerby Mss., Reeve, 1842, *Conchologia Systematica*, 2:94, pl. 182, fig. 7.—Kuester, *Syst. Conchyl. Cab.*, p. 9, pl. 1, figs. 35-37.—Pfeiffer, 1856; *Mon. Auric. Viv.*, p. 185.—W. G. Binney, 1865, *Land and Fresh-water Sh. N.A.*, part 3, p. 98.—*Truncatella succinea* C. B. Adams, 1845, *Proc. Boston Soc. Nat. Hist.*, 2:12.

The cylindrical shell tapers slightly, having $3\frac{1}{2}$ whorls remaining; ferruginous, or more or less dilute cinnamon-bluff, or chamois tinted. The whorls are moderately convex, the last descending shortly but steeply in front, plain or a little contracted behind the slightly everted lip; at the base there is a rounded white ridge or blunt carina. Sculpture of many rounded, nearly straight riblets which vary from about equal to their darker intervals to distinctly narrower, about 34 on the last whorl. Aperture ovate, the continuous peristome somewhat expanded and in a plane. Length 7.5 mm., diam. above aperture 2.8 mm. Key Largo.

As *T. caribaeensis* has usually been considered to be a species distinct from *T. pulchella*, we give a separate description and references. It differs from *pulchella* chiefly by its larger size; but the series examined from the Keys and elsewhere varies so gradually that no definite point for separation of the lots is evident. *T. pulchella* is here accepted as a polytypic species, including *caribaeensis* and *succinea*.

The type figure represents a specimen of maximum size and completely ribbed, such as Fig. 572a. The locality was left to be inferred from the name, and Grand Bay, Guadeloupe is here selected as type locality, with No. 59131 A.N.S.P. as neotypes. These specimens being closely similar to Fig. 572a.

***Truncatella stimpsoni* Stearns**

Fig. 573 b.

Truncatella stimpsoni Stearns, 1872, Proc. Cal. Acad. Sci., 4:249, pl. 1, fig. 5.—Orcutt, 1885, Proc. U.S. Nat. Mus., 8:44; 1919, Nautilus, 33:65.—Moellendorff, 1897, Nachrbl. d. m. Ges., 29:31.—Fred Baker, 1902, Nautilus, 16:42 (San Martin Island).—Pilsbry, 1927, Proc. Cal. Acad. Sci. (4), 16:187, pl. 7, figs. 10, 12-14.—Baily, 1935, West Coast Shells, p. 206, fig. 193.—Lowe, 1913, Nautilus, 27:27.

“Shell cylindrical, solid, light reddish horn-color, or amber; shining, slightly decreasing in size towards apex; closely and strongly longitudinally ribbed, the ribs even, regular and interrupted only by the suture; upper whorls wanting, remaining whorls, 4; aperture oval, somewhat oblique, slightly angulated above; peristome continuous, thickened and moderately angulated at its junction with the body whorl. Length of largest specimen, .22 inch; length of aperture, .06 inch.” (Stearns.)

Length 4.5 mm., $3\frac{1}{2}$ whorls, to length 5.2 mm., $4\frac{1}{2}$ whorls.

CALIFORNIA: False Bay, near San Diego (H. Hemphill), Type in U.S. Nat. Mus. paratypes 10553 A.N.S.P.; La Jolla (Orcutt); The Isthmus, S. Catalina Island (Pilsbry). LOWER CALIFORNIA: San Gerónimo Island (H. N. Lowe); San Martin Island (Fred Baker).

This species differs from *T. californica* by being distinctly ribbed. There is often a low crest separated from the lip by a narrow groove, both being weak or obsolete in many specimens.

It appears to intergrade with *T. californica* in a small number of specimens. In a lot of several hundred *californica* from the Isthmus, Santa Catalina Island, there were about a dozen *T. stimpsoni*, and a few specimens intermediate in sculpture.

A related but probably distinct form is *T. guadalupensis* Pilsbry, from Guadalupe island, off Lower California (*T. stimpsoni guadalupensis* Pilsbry, 1901, Nautilus, 15:83; *T. guadalupensis* Pilsbry, 1927, Proc. Cal. Acad. Sci., 4th Ser., 16:176, pl. 7, fig. 11).

***Truncatella californica* Pfeiffer**

Fig. 573 a.

Truncatella californica Pfeiffer, 1857, Proc. Zool. Soc. London, p. 111; Monogr. Pneum. Viv., 2:7.—W. G. Binney, 1859, Terr. Moll., 4:28, pl. 79, figs. 20, 22; 1865, Land and Fresh-water Sh. N.A., 3:100, fig. 202.—Fred Baker, Nautilus, 16:41.



Fig. 573. a, *Truncatella californica*, two at left, San Diego; following two Santa Catalina I. b, *T. stimpsoni*, San Diego.

Truncatella gracilentia Proc. Acad. Nat. Sci. Phila., 1858, nude name.⁹³

The shell is slightly tapering, cylindric in shape, and buff in color, rather thin. The $3\frac{1}{2}$ to 4 whorls remaining are strongly convex and lightly impressed close below the rather deep suture; the last with a very small rib paralleling the lip, chiefly noticeable at the base. The polished surface shows weak traces of striae. The aperture is ovate, being somewhat narrower posteriorly. The peristome is slightly expanded and a little thickened, continuous in a thick callus across the parietal wall. Length 4 mm. with $3\frac{1}{2}$ whorls, to length 5.3 mm., $4\frac{1}{3}$ whorls.

CALIFORNIA: San Diego, type locality. The Isthmus, Santa Catalina Island (Pilsbry, 1925). LOWER CALIFORNIA: San Martin Island (Fred Baker).

The smooth surface and strongly convex whorls characterize this species, which has often been collected in the neighborhood of San Diego, but records elsewhere are very few.

* * * * *

***Truncatella subcylindrica* (Linnaeus)**

Helix subcylindrica L., 1767, Systema Naturae (12), 1:1248 (Europae borealis). Cf. Hanley, 1855, Ipsa Linnaei Conchylii, p. 379.

Truncatella truncatula (Drap.), Verrill, 1880, Amer. Jour. Sci., 20:250; Proc. U.S. Nat. Mus., 3:376; Trans. Conn. Acad. Sci., 5:525, pl. 58, figs. 8, 8a, 8b.

Truncatella truncata (Montagu), Johnson, 1915, Fauna of New England no. 13, in Occas. Pap. Boston Soc. Nat. Hist., 7:111; 1934, Proc. Bost. Soc. Nat. Hist., 40:97.

Truncatella subcylindrica Linnaeus, Pilsbry, 1902, Nautilus, 15:119. Not *T. subcylindrica* of Gray, W. G. Binney, W. H. Dall and others.

The shell is similar to the most slender and smoothest specimens of *T. pulchella*, or *T. californica*. As there is no record of its occurrence on our shores since Verrill found it in 1880, its status as a resident is uncertain. Verrill's note follows:

"This species was found by the writer, living in considerable numbers, and of all ages, among the docks at Newport, R. I., July 1880. It occurred among decaying sea-weeds thrown up at high-water mark, both among the vegetable matter and on the under side of stones.

⁹³ On an unnumbered page of the Proc. Acad. Nat. Sci. Phila., for 1858, in errata to a catalogue of American terrestrial mollusks, W. G. Binney gave the entry: "Page 198, after No. 48 [*Truncatella californica* Pf.] add 48a *T. gracilentia*." In 1859 Binney (Terr. Moll., 4:29) stated that *Truncatella gracilentia* was a name given by Gould before he knew that Pfeiffer had named the species.

"Common on the coasts of Europe in similar localities. Perhaps introduced on this coast by shipping, but it may have been hitherto overlooked. It was associated with *Assiminea grayana* and *Alexia myosotis*."

Family XXVI. POMATIASIDAE

Pomatiasidae Thiele, 1929, Handbuch der Systematischen Weichtierkunde, 1:127.

Annulariidae Henderson & Bartsch, 1920, Proc. U.S. Nat. Mus., 58:49.

The shell is top-shaped to long conic, often losing the earlier whorls in the adult stage, usually with axial and often spiral sculpture. The rounded aperture has a simple or variously expanded peristome. Operculum spiral, usually with an external calcareous layer.

The rather short foot is divided by a median furrow lengthwise. The head has a moderately long muzzle and round tentacles, the eyes shortly raised, at their external-posterior bases. Air-breathing; there is no gill in the mantle-cavity. Radula is rather long, taenioglossate, of seven plates in a transverse row, the outer ones very broad with numerous cusplets.

Locomotion ditaxic, rhythmic, the waves raised from the substratum, advancing alternately on the two sides.

Distribution.—Tropical and subtropical; most abundantly represented in the West Indies, two species in southern Florida. They are calcicoles.

The locomotion of Pomatiasidae has been described and illustrated by the author (Proc. Acad. Nat. Sci. Phila., 1910 p. 522) and more fully by A. P. Brown (Nautilus, 24:85); part of his account being quoted below. These observations were made on Jamaican species; but *Chondropoma dentatum*, which I have observed in action, has entirely similar locomotion.

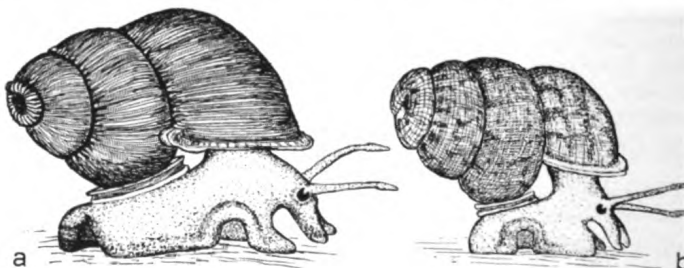


Fig. 574. a, *Colobostylus bronni* (C. B. Ads.) and b, *Adamsiella irrorata* Gloyne, in motion. After A. P. Brown.

"Unlike most snails, the *entire* under surface of the foot is not applied to the surface upon which they move, but *they walk on the edges of the foot only*. The foot, when retracted into the shell, folds down the median line of the under surface; and, when protruded for walking, this same form is retained, so that ordinarily only the two outer surfaces are involved. A wave of contraction, lifting a portion of this edge of the foot, proceeds from

the posterior to the anterior, the waves moving forward alternately on the two margins of the foot, and with its advance, first on the right side and then on the left side, producing a swaying gait that is characteristic of the movement of all the land operculates [of this family]. The wave movement is quite independent in the two sides of the foot, and this is easily seen when the animal is examined from the under side, when crawling over a surface of glass. As the wave passes off at the anterior end of the foot on one side the succeeding wave begins at the posterior end of the other side, and thus the animal acquires the waddling or swaying gait characteristic of this type of movement. As the wave passes off anteriorly a part of the foot is lifted and moved forward; as the wave appears at the posterior end a part of the foot is lifted and moved forward also, so that seen from the front or rear especially, the animal seems to be walking upon stumpy legs, and the movement recalls that of an elephant seen from the rear. The trail made, when moving over dry surfaces (as the animals normally have to when in their native habitat), is double, only the edges of the foot being involved, and this double trail may always be seen when these snails are actively moving about.

“When moving, the shell is carried balanced on the operculum, and to obtain this balance requires some care on the part of the animal, but once the shell is adjusted to the proper position the animal moves evenly, the shell swaying from side to side from the passage of the alternate waves of contraction of the foot. The balancing of the shell on the operculum was common to all of the species examined, and undoubtedly it seems to distribute the weight more evenly on the foot, at the same time raising the shell quite clear of the surface on which the animal is moving.”

In the Old World subfamily Pomatiasinae the front and back surfaces of the raised waves of progression remain in contact, sliding upon each other, and the snout, while distinctly emarginate in front, is not decidedly forked.⁹⁴

In American genera, subfamily Chondropomatinae, so far as known, the waves are open, and the rostrum is distinctly forked in front. There is no invariable difference in the radulae of these subfamilies.

Subfamily CHONDROPOMATINAE

CHONDROPOMA Pfeiffer

Chondropoma Pfeiffer, 1847, *Zeitschr. f. Malak.*, 4:109.—Petit de la Saus-saye, 1850, *Jour. de Conchyl.*, 1:38, *C. sagra* d'Orb. Designated type.

The shell is umbilicate, oblong-conic or turbinate, often truncate in the adult stage; with sculpture of axial threads or axial and spiral threads. Peristome without breathing pore or tube. Operculum cartilaginous with some calcareous granules on the outer face.

⁹⁴ This is the case in *Pomatias*, at least; in other Old World genera the conditions are unknown.

The single species of Florida is closely related to *C. auberianum mayense* Torre & Bartsch, of the north coast of Cuba east of Matanzas.

C. dentatum is type of the subgenus *Chondropomorus* Henderson & Bartsch, 1920, characterized by having the "shell elongate-conic, marked by both axial and spiral threads, the axial threads being gathered into tufts at the summits of the whorls."

Chondropoma dentatum (Say)

Fig. 575 a, b, c.

Cyclostoma dentatum Say, 1825, Jour. Acad. Nat. Sci. Phila., 5:125.—Binney, Terr. Moll., 2:348, pl. 62.

Chondropoma dentatum Say, Pfeiffer, 1852, Mon. Pneumonoporum Viventium, 1:286.—W. G. Binney, 1865, Land and Fresh-water Sh. of N.A., 3:96, figs. 192-194.

The shell is narrowly umbilicate, oblong-conic, truncate, about 4 moderately convex whorls remaining in the adult stage. Surface matt; ground-color dull red, chamois, pinkish buff or cartridge buff, uniform or having several (three to six on the last whorl) narrow interrupted bands, or spiral

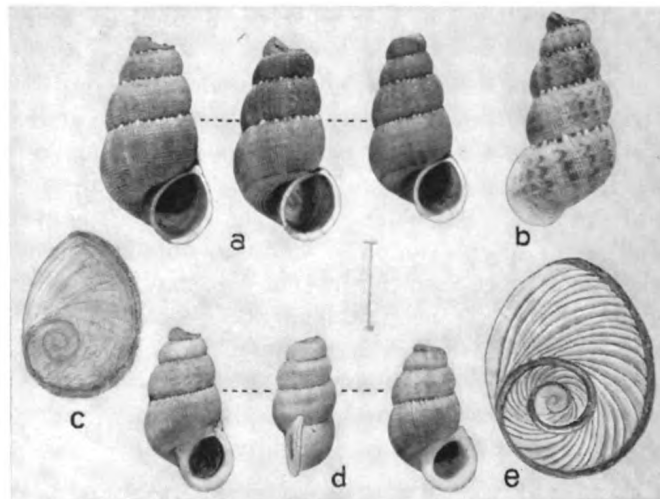


Fig. 575. *Chondropoma dentatum*. a, Little Pine Key; b, Key West; c, operculum. *Opisthosphon bahamensis*, d, e, shells and operculum, Key West. Scale line for shells = 5 mm.

series of small spots aligned axially, sometimes with a dark band at the periphery, or there may be vertical series of reddish dots or crescents. Sculpture of fine axial threads about as wide as their intervals, and lighter than the ground color, uniting by twos or threes into prominent but unequal tufts at the suture. There are also lower, more widely spaced spiral threads, which become coarser at the base. The aperture is ovate, angular above. Peristome white, very little expanding, somewhat thickened.

Length 11.7 mm., diameter 6.3 mm.

Length 10 mm., diameter 5.5 mm.

FLORIDA: all of the Keys to Key West, which is here selected as type locality, No. 170426 A.N.S.P. beings taken as neotype. Mainland, on the Atlantic coastal ridge, from Miami to Long Pine Key. Near Gordon's Pass, Monroe Co.; a single dead shell found at Naples, Collier Co. (J. L. Baily, *Nautilus*, 54:32).

OPISTHOSIPHON Dall

Opisthosiphon Dall, 1905, Proc. Malac. Soc. London, 6:209.—Torre & Bartsch, 1941, Proc. U.S. Nat. Museum, 89:162.

The shell is ovate to cylindro-conic, usually truncate, about 4 whorls remaining, with sculpture of axial and sometimes spiral threads. Aperture shortly oval or nearly round, the peristome double, at the posterior angle produced in a short, erect or recurved breathing tube, which opens into the cavity of the whorl by a minute pore.

The operculum (Fig. 575 e) has a calcareous layer of retractively slanting lamellae which do not quite reach to the outer edge of the chondroid plate, and are not united at the outer ends.

Type *O. bahamensis* "Shuttleworth" Pfeiffer.

Opisthosiphon bahamensis (Pfeiffer)

Fig. 575 d, e.

"*Cyclostoma bahamense* Shuttleworth, on labels in Cuming and Bland collections." Pfeiffer, in synonymy of—

Ctenopoma bahamense "Shuttleworth", Pfeiffer, 1865, Mon. Pneumon. Viv., supplement, 2, p. 115.

C'hoanopoma (Ctenopoma) bahamense Shutt., Pilsbry, 1896, *Nautilus*, 10:96 (Key West).

Opisthosiphon bahamensis Shuttl., Dall, 1904, *Smiths. Misc. Coll.*, 47:450; 1905, Proc. Malac. Soc. London, 6:209.—Clench, 1935, *Mem. Soc. Cubana Hist. Nat.*, 12:314.

Opisthosolen bififormis var. *bahamensis* Shuttl., Dall, 1905, in Shattuck, *The Bahama Islands*, p. 42 (Nassau, N.P., Andros, Abaco); corrected to *Opisthosiphon bahamensis* in Errata preceding the general index.

The shell is perforate, oblong-conic, truncate, about 3½ to 4 moderately convex whorls remaining in adults. Surface matt, cartridge buff to dull reddish, uniform or with narrow, interrupted light brown bands. Sculpture of close riblets narrower than their intervals, nearly every one terminating in a compressed enlargement sharply denticulating the suture. There are a few very weak spiral cords around the umbilicus, but spirals are scarcely visible on the rest of the shell. The aperture is broadly oval. Peristome broad and flat, with a slightly projecting inner rim. Behind the upper angle the peristome is built up in a hood-like tube, more or less recurved, and opening through a minute pore a short distance within the upper angle of the aperture.

Length 9.2 mm., diameter 5.1 mm. Key West.

Length 7.8 mm., diameter 4.4 mm. Key West.

FLORIDA: Key West (Dr. W. H. Rush, U.S.N., 1897). BAHAMAS: type locality New Providence.

Dr. Rush collected this species in some numbers, but unfortunately I did not get the exact locality from him, and I do not know that any later collector has found it.

The Florida specimens are very light buff with or without faint interrupted bands. None of them reach as large a size as most of the New Provi-

dence shells seen, though equally small individuals occur exceptionally in the Bahamas.

W. G. Binney in 1865 (Land and Fresh-water Shells of N.A., part 3, p. 97, fig. 195) figured a specimen of the Cuban *Rhytidopoma rugulosum* (Pfr.) said to have been found in Florida, without more definite locality. None are known to have been taken since.

* * * * *

Adelopoma costaricense Bartsch and Morrison, a minute (2.3 mm. long) pupiform, round-mouthed snail with ribbed surface, has been found at Charleston, South Carolina. A specimen identified as this Central American species was found in a light trap for insects set near the edge of a marsh on the grounds of the wartime Stark General Hospital, northeastern outskirts of Charleston. Whether the little snail went into this trap on its own or was carried there by some flying insect to which it clung, cannot be decided. Recorded by Fritz Haas, July 1947, *Nautilus*, 61:33. It was not stated whether the trap had previously been used elsewhere.

Order ARCHAEOGASTROPODA

Family XXVII. HELICINIDAE

Helicinadae Guilding, 1828, *Zoological Journal*, 3:528.

Helicinidae Gray, 1842, *Syn. Brit. Mus.*, p. 91.—Wagner, 1902-1911 *Die Familie Helicinidae*, in *Syst. Conchyl. Cab. (n.F.)*, 1 (monograph).—H. B. Baker, 1922, *Proc. Acad. Nat. Sci. Phila.*, 74:29-67 (radula); 1926, *Same Proc.*, 78:35-56 (anatomy).

The shell varies from strongly depressed to conic, is composed of rather few whorls, and is imperforate, the umbilical region occupied by a callous pad. The operculum has a thin or moderate calcareous layer, and is mainly concentric, or it may be paucispiral. The radula is rhipidoglossate. The foot is rather broad, not divided. Locomotion is rhythmic and retrograde (in species of *Helicina* examined).

Distribution.—Tropical and north temperate America; eastern border of Asia, from Japan south; many islands of the Pacific.

This mainly tropical family, of about twenty genera and many species, is represented within our limits by five species belonging to three genera.

Key to species of Helicinidae

Surface with distinct, retractively axial striation.

Shell minute (diam. 2 to 2.5 mm.), strongly depressed; southern Florida.

Lucidella tantilla

Shell larger (diam. 6 to 8 mm.), subglobose; Central and Northern States.

Hendersonia occulta

Surface smoothish, or with very minute, forwardly descending corrugation.

Spire highly conic; height and diam. nearly equal; diam. 8 to 11 mm. southern Texas. *Helicina chrysocheila*

Spire of medium height; diam. exceeding height.

Shell globose, with broadly rounded periphery, diam. 7.5 mm. or less; a blunt projection at the base of columella.

Lip not much thickened. *Helicina orbiculata*

Lip very thick. *Helicina o. tropica*

Shell very obtusely subangular at periphery, the shape somewhat approaching trochiform; no distinct tooth at base of columella. Southern Florida.

Helicina clappi

HELICINA Lamarck

Helicina Lamarck, 1799, Prodrome nouv. Class. Coquilles, Mém. Soc. Hist. Nat. Paris, 1:76; 1801, Syst. An. sans Vert., p. 94. Type *Helicina neritella* Lam., based upon Lister, pl. 61, fig. 59.

The shell varies in form from subglobose to depressed, sometimes biconvex with carinate periphery; having a conic but usually short spire of few whorls. The aperture has a straight inner margin, and an expanded or thickened peristome, the widely separated ends of the lip united by a callus, which spreads as a heavy pad over the axial region. The internal partitions of the spire are absorbed.

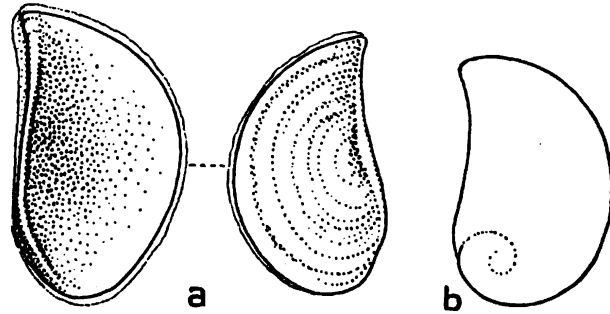


Fig. 576. a, *Helicina orbiculata tropica*, external and internal views of operculum. b, *Hendersonia occulta*, external outline of operculum.

The operculum is approximately semicircular but the upper end somewhat narrowed, the lower end rounded, parietal margin nearly straight. External face somewhat concave, with a sigmoid ridge close to the straight margin. Increment concentric, the nucleus about midway of the length near the sigmoid ridge (Fig. 576a, *H. orbiculata tropica*).

Distribution.—Tropical and subtropical America.

Locomotion is rhythmic and retrograde. *Helicina* glides evenly like most land snails. The rather broad foot is indistinctly tripartite, the median locomotive band only showing numerous rather close muscular waves, which move from the front backward.

Paleontology.—*Helicina* is a somewhat abundant fossil in the Lower Miocene silex bed at Ballast Point, Tampa, Florida. The species appear to belong to the *Oligyra* group.

Helicina ballista Dall, 1890, Trans. Wagner Inst., 3:3 pl. 1, fig. 2, 2a.

Helicina ballista tampae Dall, l.c., p. 4.

Helicina posti Dall, 1915, U.S. Nat. Mus., Bull. 90, p. 113, pl. 5, fig. 7.

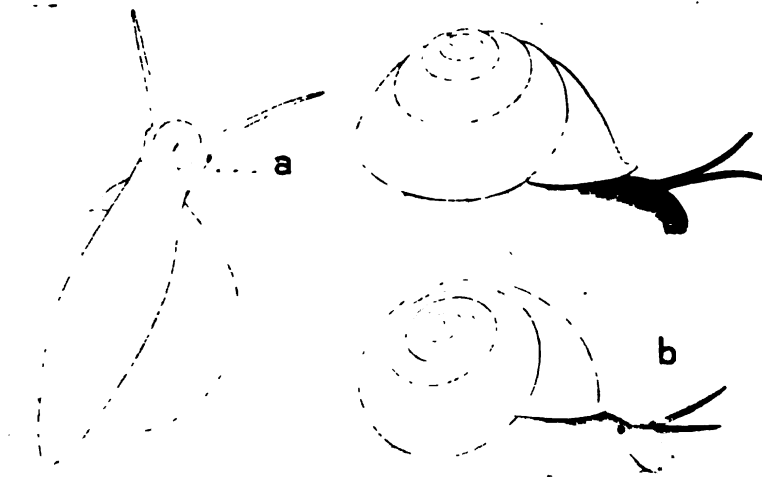


Fig. 577. Living helicinas. a, *Helicina clappi*. b, *Helicina orbiculata*.

Subgenus HELICINA s. str.

***Helicina clappi* Pilsbry**

Figs. 577 a, 578 a, b, c.

Helicina orbiculata clappi Pilsbry, 1909, *Nautilus*, 23:90.—Vanatta, *Nautilus*. 26:18-21, 32-34.

The shell is less globose than *orbiculata*, tending to a more trochiform shape, the last whorl being very obtusely subangular at the periphery. The outer lip is more broadly expanded, thin, and there is only a weak angle or none at the junction of columella and basal lip. The color is white, very pale citrine, white with two red bands, or uniform red, the lip and apex pale.

Height 8 mm., diameter 9 mm.

Height 7 mm., diameter 8 mm.

Height 6.1 mm., diameter 7.3 mm.

FLORIDA: Atlantic coastal ridge from Palm Beach to Royal Palm State Park. The Keys; seen from Lower Matecumbe, Lignum Vitae, Long Key, Noname Key, Big Pine, Sugarloaf, Snipe Key, Boca Chica, Key West. On the west coast seen from Cape Sable, Fakahatchee Key, Key Marco, Collier Co. and from Evans plantation on the Manatee River, Manatee Co.; Cedar Keys (Hemphill in U.S.N.M.).

The back is blackish, tentacles and rostrum gray, decidedly darker than in *H. orbiculata*; the foot elsewhere transparent whitish.

On the east coast the known localities for *H. clappi* are not numerous. In 1899 I took specimens in what is now the city of Palm Beach. It has been found at Lake Worth, and in Broward County at New River. It is abundant around Miami, the type locality (Type no. 77065 A.N.S.P.) its occurrence at Cedar Keys is remarkable, that being widely detached from other known localities.

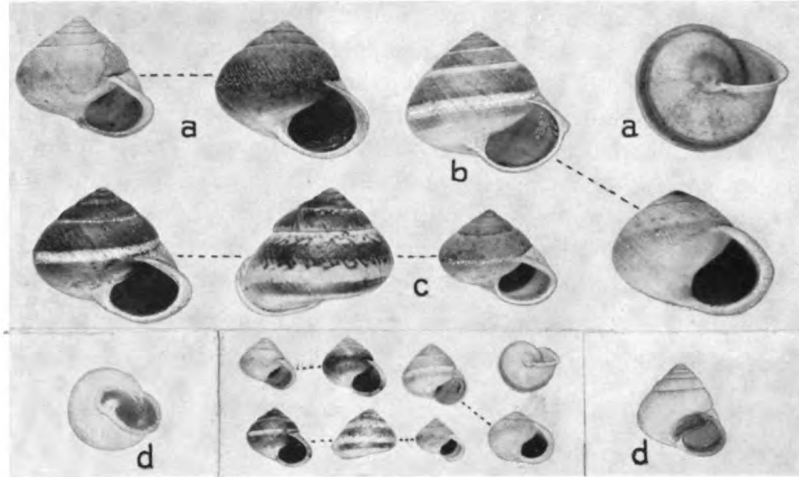


Fig. 578. *Helicina clappi*. a, Miami; b, Brickell's Hammock, Miami; c, Royal Palm State Park. Enlarged and actual size. d, d, *Helicina chrysocheila*, after Binney.

This helicine was identified many years ago with *H. subglobulosa* Poey (Memorias Hist. Nat. Cuba, 1:115, 120, pl. 12, figs. 17-21; Trinidad, Cuba). It is certainly very similar to that, but it is more elevated than typical *subglobulosa*, with white lip and a white or very light apex.

In 1905 Dall (Smiths. Misc. Coll., 47:451) reported from Key Biscayne a specimen of *Helicina fasciata* Lam., which had been in the National Museum nearly fifty years. This shell cannot now be found, and if correctly identified was probably adventitious.

Helicina chrysocheila Binney

Fig. 578 d, d.

Helicina chrysocheila Binney, 1851, Terr. Moll., 2:354, pl. 74, fig. 4 (no locality given).—W. G. Binney, 1865, Land and Fresh-water Sh. N.A., 3:110 ("Texas, G. Wurdeman," in U.S.N.M.).—Von Martens, 1890, Biol. Centrali-Americana. Mollusca, p. 33.—R. E. C. Stearns, 1893, North American Fauna, No. 7, p. 282 (Texas).

"Shell broad conic, or pyramidal, thin, shining, pale yellow, with the surface finely shagreened with microscopic, punctured lines. Spire elevated, whorls five, moderately convex, the last one somewhat flattened at base and indistinctly angular at the periphery. Aperture large, very oblique, semi-oval, the diameters about equal; the lip broadly everted, especially at its middle portion, narrow and simple at its columellar junction, of a golden-yellow color; labial callus extended, of a deep orange color. Axis one-third of an inch; diameter two-fifths of an inch." (Binney.)

TEXAS: near the mouth of the Rio Grande (William Lloyd, U.S.N.M. 123167). MEXICO: Gonzales, Tamaulipas (R. W. Jackson); El Abra (A. A. Hinkley) and many other places in San Luis Potosi (Pilsbry); Tampico (W. G. Binney).

This species is larger than *H. orbiculata* or *H. o. tropica*, smoother, and with a much more elevated spire. The ground color varies from white to

light pink, and there is sometimes a purplish to reddish band on the upper surface. It is variable in size from height 9 mm., diameter 8.3 mm., to height 11 mm., diameter 11.5 mm. The golden color of the peristome fades somewhat after death. The interior of the aperture varies from coral red to light yellow, and shows the external band when present. Some specimens are pure white, outside and within. The operculum is kaiser brown or a little redder, with a very strong sigmoid rib. These notes are from Mexican shells (states of Tamaulipas and San Luis Potosi), as I have not seen Texan shells. Unfortunately the locality records for Texas are rather indefinite. Ferriss, who collected in the southern corner of the state, did not find it.

Subgenus OLIGYRA Say

Olygyra Say, 1818, Jour. Acad. Nat. Sci. Phila., 1, part 2, p. 283, for *O. orbiculata* only.

Olygyra Say, 1819, Third Amer. edit. Nicholson's British Encyclopedia, 4, tenth page of art. Conchology.—H. B. Baker, 1922, Proc. Acad. Nat. Sci. Phila., 74:43; 1926, 78:39.

Orbiculata Wagner, 1905, type *H. orbiculata* Say (cf. Baker, 1922, p. 43).

This group comprises globose helicinas of Mexico, the southern United States and Bermuda.

The spelling "*Olygyra*" was apparently a clerical error, since Say himself corrected it to *Oligyra* in 1819, the name being from *ὀλίγος, γυρός*, few whorls.

Helicina orbiculata (Say)

Fig. 579 a-e.

Olygyra orbiculata Say, 1818, Jour. Acad. Nat. Sci. Phila., part 2, p. 283.—H. B. Baker, 1922, Proc. Acad. Nat. Sci. Phila., 74:44.

Helicina orbiculata Say, American Conchology, pl. 46, figs. 1, 2, 3.—Gould in Binney, 1852, Terr. Moll., 2:352, pl. 73; pl. 74, fig. 3.—W. G. Binney, 1865, Land and Fresh-water Shells N. A., part 3, Smiths. Misc. Coll., 144:108, fig. 217.—Wagner, Syst. Conchyl. Cab., Helicinidae, p. 301, pl. 61, figs. 1-6.⁹⁵—Pilsbry, 1909, Nautilus, 23:89 (subspecies).

Helicina hanleyana Pfeiffer, 1848, Proc. Zool. Soc. Lond., p. 122; 1852, Mon. Pneum. Viv., 1:376; Conchyl. Cab., p. 38, pl. 9, figs. 7, 8 (New Orleans, Sallé).

Helicina suborbiculata Say is an unpublished name cited as a synonym of *H. orbiculata* by Wagner, l.c.

The shell is globose with low, conic spire, of about $4\frac{1}{2}$ weakly convex, slowly increasing whorls, the last one broadly rounded peripherally. The surface has little gloss, shows some faint striation, and frequently there are a few weakly impressed spiral lines, widely spread, two or three being above the periphery of the last whorl. Under strong magnification a fine forwardly descending crinkling is seen in places, but usually this is rather indistinct. Color warm white or buff, often with cinnamon bands above and below the periphery, and fading towards suture and base, or cinnamon

⁹⁵ Wagner (l.c., p. 390) in his explanation of plate 61, states that figs. 1-5 are specimens from Woodville, Alabama, and fig. 6 is from Texas. These localities were transposed; figs. 1-5 are the Texan *H. o. tropica*, while fig. 6 agrees with *H. orbiculata* from Woodville, Alabama.

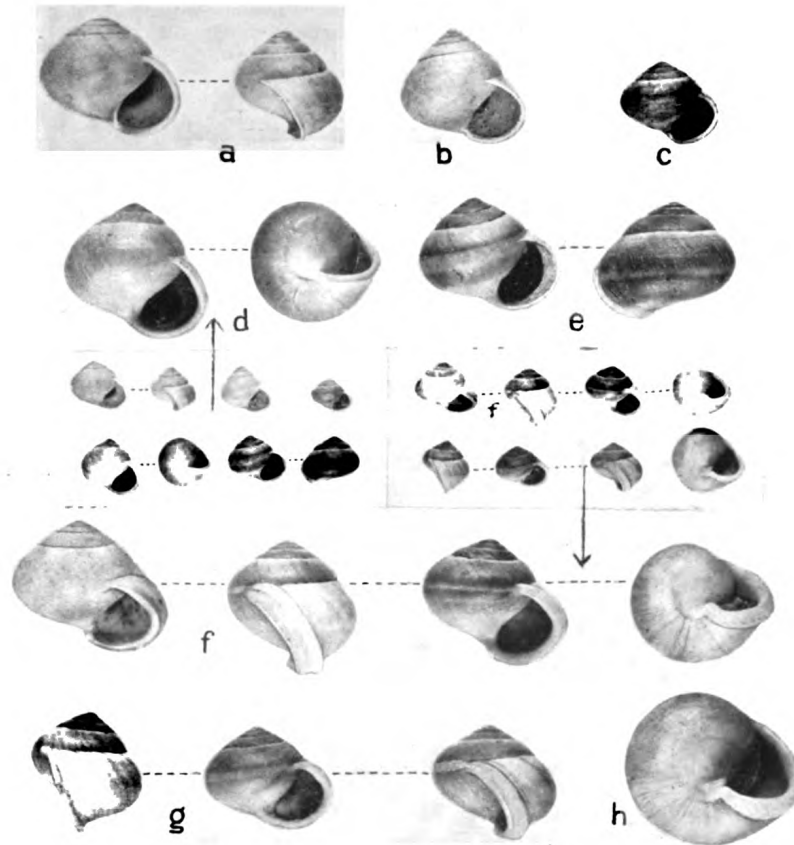


Fig. 579. a-c, *Helicina orbiculata*. a, type and paratype; b, Tick Island, Volusia Co., Fla.; c, Jackson Co., Miss.; d, Blount Springs, Ala.; e, Monte Sano, near Huntsville, Ala. f-h, *Helicina orbiculata tropica*. f, San Marcos, Texas; g, Chadwick, Missouri; h, Devil's River, Val Verde Co., Texas. Actual size and enlarged.

with white peripheral band. The aperture is half round, the peristome is very slightly expanded, somewhat thickened within and on the face; having a forwardly projecting angle or blunt tooth at the junction of the columella with the basal margin.

Height 6.6 mm., diameter 7.5 mm. Paratype.

Height 6.0 mm., diameter 6.7 mm. Type.

Height 4.6 mm., diameter 5.4 mm. Tick Island, Florida.

Height 5.9 mm., diameter 6.8 mm. Tick Island.

FLORIDA: Oystershell hammocks near the mouth of the river St. John (Say). Type and paratypes 10573 A.N.S.P. Over 70 lots show distribution all over the state, and on many Keys, from Key Largo to Key West. GEORGIA: St. Simons I. ALABAMA: all over the state. TENNESSEE: near Watertown, Wilson Co.; Chattanooga; Jasper, Dove and Kimball counties; Kelly Cove, Marion Co.; Pikeville Bledsoe Co. MISSISSIPPI: Vicksburg, also fossil in loess. LOUISIANA: Frierson, DeSoto Parish; Nachitoches; Grand

Isle, Jefferson Parish; New Orleans. ARKANSAS: Eureka Springs, Carroll Co.; Magnet Cove, Hot Springs Co.; Mabelvale, Pulaski Co. MISSOURI: Chadwick, Christian Co.; Fox Creek Gap, St. Louis Co. OKLAHOMA: 7 mi. south of Antlers.

Besides the variation in color to be seen in most populations, there is some sporadic local variation in size, some lots being all small, probably traceable to ecologic conditions.

In some southwestern localities, such as Vicksburg, Mississippi, recent specimens measure 6.2 to 7.4 mm. in diameter, and some have the thick *tropica* lip.

***Helicina orbiculata tropica* Pfeiffer**

Fig. 579 f-h.

Helicina tropica "Jan." Pfeiffer, Syst. Conchyl. Cab., p. 37, pl. 4, figs. 9, 10; 1852. Monogr. Pneum. Viv., p. 374.

Helicina orbiculata tropica "Jan" Pfr., Pilsbry, 1896, Proc. Acad. Nat. Sci. Phila., p. 534; 1906, same Proc., p. 125.—E. P. Cheatum, 1934, Nautilus, 47:147 (on trees).

Helicina subtropica, mentioned by W. D. Averill, Sept. 1886, Conchologists Exchange, 1, no. 3, as a synonym of *H. tropica* Jan. said to = *H. orbiculata*.—J. A. Singley, Nov., 1886, Conch. Exch., 1:26 as = *H. orbiculata*.

The shell is more solid than *H. orbiculata*, usually either white or pink, sometimes with a pale peripheral band. Peristome much thicker, typically having a bevelled thickening beyond the reflected lip.

Height 7.5 mm., diameter 8.4 mm.

Height 6.0 mm., diameter 7.7 mm.

ARKANSAS: Blue Mountain Station, Logan Co.; Rogers, Benton Co. (Pilsbry); Sulphur City, Washington Co. (A. J. Brown); Rocky Comfort, Little River Co. (J. H. Ferriss). OKLAHOMA: Limestone Gap (Pilsbry). TEXAS: throughout the eastern part of the state, west at least to a line from Montague Co. to the mouth of the Pecos River. Seen from the following counties: Bell, Bexar, Bowie, Brazoria, Burlison, Cameron, Comal, Dallas, Fayette, Fort Bend, Fort Bowie, Frio, Galveston, Grayson, Guadalupe, Harris, Hays, Hidalgo, Houston, Lee, Live Oak, McLennon, Medina, Montague, Nueces, Travis, Uvalde, Val Verde, Victoria. MEXICO: in the states of Coahuila, Tamaulipas and Nuevo Leon.

Although the race *tropica* has its fullest development in the Cretaceous terrain of Texas it also extends eastward into Tertiary areas. Collectors recognize that specimens not distinguishable from *orbiculata* are sometimes found in *tropica* territory. There is no hard and fast line between them. But the difference between *orbiculata* and *tropica* is not solely a matter of pH, for in wholly calcareous tracts in Florida and Alabama the helicinas retain their typical *orbiculata* characters. The modification is correlated with geographic range, therefore of subspecific significance.

Professor E. P. Cheatum writes: "*H. o. tropica* is one of the most abundant species of terrestrial gastropods occurring in Dallas County, Texas. After a light shower one can collect hundreds of individuals that are creeping over weeds and grasses in many pasture lands. Since it is a snail that is especially hardy and has a great resistance to drouth, individuals appear to be as abundant in exposed areas as in protected woodland regions. The

writer has frequently observed a tendency of this species to ascend trees. Ordinarily the animal does not get more than five or six feet above the ground. However, a recent field trip to a sparsely wooded region six miles southwest of Dallas, revealed a 'tree-climbing' colony of *H. orbiculata*. Hundreds of snails were found attached to the bark of hackberry (*Celtis occidentalis*) and cedar elm (*Ulmus crassifolia*) trees. Some had only begun their ascent of the trees, whereas others had attained a height of approximately 12 to 14 feet above the ground."

LUCIDELLA Swainson

Lucidella Swainson, 1840, Malacology, pp. 194, 330. Monotype *L. aureola* (Fér.).—H. B. Baker, 1922, Proc. Acad. Nat. Sci. Phila., 74:53 (radula).

Trochiform or depressed helicoid with strong, or at least distinct, spiral sculpture (or in the subgenus *Poeniella*, axial sculpture). Axial callus rather small, the surface slightly concave around it. Operculum with very thin calcareous layer, concentric, with the nucleus subcentral or near the straight side.

Distribution.—Tropical America.

Subgenus POENIELLA H. B. Baker

Poeniella H. B. Baker, 1923, Occas. Pap. Mus. Zool. Univ. Mich., No. 137, p. 23, type *H. (plicatula) christophori* Pils. (1897), from St. Kitts.

"The shell sculpture consists of axial instead of spiral riblets." (H.B.B.)

Lucidella tantilla (Pilsbry)

Fig. 580.

Helicina tantilla Pilsbry, 1902, Nautilus, 16:53; 1905, Nautilus 19:38 (Duck & Grassy Keys).—Vanatta, 1912, Nautilus, 26:32, 34.—Walker, 1917, Nautilus, 31:57 (Long Key).

Lucidella tantilla Pils., Clapp, 1913, Nautilus, 27:63 (Bimini Islands); 1921, 34:108 (Chokoloskee Key).—Ramsden, 1914, Nautilus, 28:50, pl. 2, fig. 5 (Cuba).

Lucidella (Poeniella) tantilla Pilsbry, Clench, 1937, Proc. New Engl. Zool. Club, 16:77 (Great Abaco and other islets of the Little Bahama Bank); 1942, Proc. New Engl. Zool. Club, 19:56 (Bimini Islands).

The faintly yellowish, minute shell is strongly depressed, biconvex with rounded periphery, slightly concave around the nearly flat axial callus; of 3½ moderately convex whorls which increase slowly to the last, which is about twice the width of the preceding. The suture is rather deeply impressed. Surface glossy, very minutely and regularly striate, the striae fully as wide as their intervals, which show weak traces of spiral striation in quite fresh shells. The oblique aperture is semirotund. Peristome slightly expanding, thickened and blunt, its face rounded; the basal margin straight. The axial callus is rather small, minutely pitted. Height 1.35 mm., diameter 2.5 mm.

FLORIDA: Palm Beach⁹⁶ (Pilsbry), Type 77349 A.N.S.P. The Keys: seen from Pumpkin Key (Clapp), Long Island (Morgan Hebard), Lignum Vitae Key (Pilsbry),

⁹⁶ A single dead specimen was gathered in June, 1899, with other small land shells, in undisturbed woodland about a quarter mile from the Atlantic beach, a place now long time within the city. I believe that there is no other record from the Atlantic coastal ridge, though it probably occurs south to Miami.

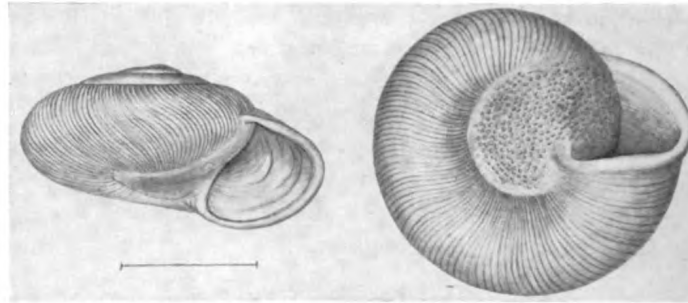


Fig. 580. *Lucidella tantilla*. Scale line = 1 mm.

Lower Matecumbe (Van Hyning), Long Key (Hebard), Duck Key and Big Grassy Key (C. B. Moore), Summerland Key and Big Pine Key (Pilsbry), Stock Island (Van Hyning). CUBA: between La Victoria and Nimfitas, Monte Toro, Guantanamo (Chas. T. Ramsden). BAHAMAS (Clapp, Clench).

This is the smallest species of *Poeniella*, some adults scarcely over 2 mm. in diameter. It is distinguished further by its very fine though clear-cut striation, and the absence of any tooth or projection of the basal lip.

It is probably a hurricane-borne waif from Cuba, though as yet reported from only the eastern province of that island.

HENDERSONIA A. J. Wagner

Hendersonia A. J. Wagner, 1905, Denkschrift K. Acad. Wissensch., 77:364, for *H. occulta* only; 1907, Syst. Conchylien Cabinet (n. F.), 1, Heft 209, Helicinidae, p. 8.—H. B. Baker, 1922, Proc. Acad. Nat. Sci. Phila., 74:41; 1925, same Proc., 77:273; 1926, same Proc., 78:35 (anatomy).

The somewhat depressed shell has a conic spire of $4\frac{1}{2}$ to 5 flattened, slowly and regularly increasing whorls. The periphery is acutely carinate in the neanic stage, the carina often more or less obsolete on the last whorl. Sculpture of sharp, close, retractively axial striae. Operculum with a very thin calcareous layer and a spiral baso-columellar nucleus (Fig. 576 b).

Type *Helicina occulta* Say.

Distribution.—Upper Mississippi Valley east to the Alleghanies in Pennsylvania and North Carolina, for *Hendersonia* proper; but the subgenera *Waldemaria* and *Miluna* in Japan and China.

Hendersonia occulta has been considered, on the basis of its paucispiral operculum and its radula, to be one of the most primitive members of its family. "It seems that *Hendersonia* is a primitive genus, which once had a wide holarctic distribution, but which survives in only a few localities in Asia and North America" (H. B. Baker).

Paleontology.—Since the diagnostic characters of *Hendersonia* are expressed in the operculum and soft parts rather than in the shell, the generic

reference of fossils is not a matter of positive demonstration. However, I have not much doubt that the following species belong here.

• **HENDERSONIA EVANSTONENSIS** (White), Paleocene of southwestern Wyoming. (= *Helix evanstonensis* White, U.S. Geol. and Geogr. Surv. Terr., Bull. 4, p. 714.—*Helicina evanstonensis* Russell, 1931, Bull. Amer. Paleont., No. 64, p. 14, pl. 2, figs. 1-6).

HENDERSONIA OREGONA (Hanna), John Day Lower Miocene, Oregon. (= *Helicina oregona* Hanna, 1920, Univ. Oregon Pub., No. 6, p. 4.)

Hendersonia occulta (Say)

Fig. 581.

Helicina occulta Say, 1831, Transylvania Jour. of Medicine, 4:528; Amer. Conch., No. 5, pl. 46, figs. 4-6.—Binney, 1851, Terr. Moll., 1:182; 2:356, pl. 74, figs. 1 (recent), 2 (fossil).—W. G. Binney, 1865, Land and Fresh-water Shells N.A., Part 3, p. 111.—Leland, 1869, Amer. Jour. Conch., 5:118.—Tryon, 1870, Amer. Jour. Conch., 4:12 (Lexington, Va.).—Witter, 1883, Mollusca of Muscatine County and vicinity, p. 24 (Eldora, Ia.).—R. E. Call, 1887, Bull. Washburn College, 2:18 (S. Pittsburg, Tenn.).—Holzinger, 1888, 16th Ann. Rep. Geol. and Nat. Hist. Surv. Minn., p. 491.—Pilsbry, 1896, Proc. Acad. Nat. Sci. Phila., p. 491; 1900, same Proc., p. 116 (Tennessee); 1897, Nautilus, 11:46.—G. T. Marston, 1890, Nautilus, 3:113 (Wis.).—Walker & Pilsbry, 1902, Proc. A.N.S. Phila., p. 421.—B. Shimek, 1904, Proc. Davenport Acad. Sci., 9:173; 1905, Jour. of Geol., 13:232; 1919, Proc. Iowa Acad. Sci., 26:385; 1930, Nautilus, 43:111.

Hendersonia occulta (Say), H. B. Baker, 1922, Proc. Acad. Nat. Sci. Phila., 74:41; 1925, same Proc., 77, 273; 1926, same Proc., 78:35 (anatomy).

Helicina oculina Say, D. D. Owen, 1852, Rep. Geol. Surv. Wis., Iowa, and Minn., p. 132. (Misspelling.)

Helicina oculata Say, R. E. Call, 1881, Amer. Nat., 15:586, 784. (Misspelling.)

Helicina rubella Green, 1832, Doughty's Cabinet Nat. Hist. and Rural Sports, 2:291 (Hills of western Pennsylvania).

Helicina occulta rubella Green, Morrison, 1928, Nautilus, 43:45 (Crawford Co. Wis. in "Driftless area").

Pleistocene (loess) form.—The shell is somewhat depressed but with conic spire, rather solid, of $4\frac{1}{2}$ to 5 nearly flat whorls which increase slowly, the suture scarcely impressed. Surface dull, with sculpture of rather sharp, fine striae after the smooth embryonic whorl. The periphery has a more or less sharply traced keel, which may extend to the end of the whorl, or the last third or half of the whorl may be narrowly rounded, only faintly or not keeled (but the periphery is always acutely keeled in immature stages). The aperture is oblique, subtriangular to semicircular. The peristome is narrowly expanded and strongly thickened, with rounded face. The axial callus is rather small, level with the base. The type being fossil, shows no color.

Height 5.5 mm., diameter 6.9 mm. Type.
 Height 4.8 mm., diameter 6.0 mm. New Harmony.
 Height 5.0 mm., diameter 6.7 mm. New Harmony.
 Height 4.6 mm., diameter 6.3 mm. Des Moines.
 Height 4.1 mm., diameter 5.6 mm. Des Moines.
 Height 6.0 mm., diameter 7.7 mm. St. Louis Co., Mo.

"The fossil specimens, of which the writer has examined several thousand from nearly a hundred different localities in the northern Mississippi and Missouri valleys, range from 5 to 7.25 mm. diameter, the average being about 6 mm." (Shimek.)

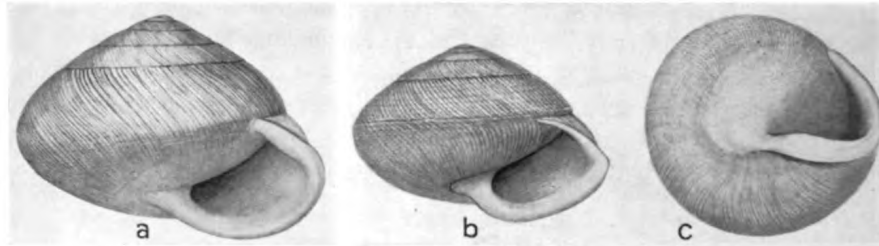


Fig. 581. *Hendersonia occulta*, Limestone Cove, Tennessee.

In recent specimens the matt surface of the shell is generally a dull cinnamon-rufous, rufous, or sometimes varying to apricot buff or to naples yellow. The peripheral keel may be as distinct as in the loess shells, or it may be more or less obsolete on the last half whorl.

Height 6.0 mm., diameter 8.0 mm. Greene Co., Pa.
 Height 4.0 mm., diameter 6.6 mm. Unicoi Co., Tenn.
 Height 4.2 mm., diameter 6.0 mm. Iowa City.
 Height 5.7 mm., diameter 7.2 mm. Iowa City.

PENNSYLVANIA: Alleghany Co. at Wildwood, and Cayuga (S. H. Stupakoff); bluffs above Allegheny River near Sandy Creek and on Youghiogheny River near Coulter (C. B. Wurtz); Crucible, Greene Co. (Wurtz). VIRGINIA: Rockbridge Co. at Lexington (R. Walton) and Natural Bridge (Pilsbry, H. B. Baker); Grottoes, Augusta Co. and 6 mi. south of Fort Royal (J. P. E. Morrison); Wythe Co. 12 mi. south of Pulaski (Clench and Archer). NORTH CAROLINA: Mt. Mitchell (Walker & Ferriss); Hollow Poplar Twp., Mitchell Co. (A. G. Wetherby). TENNESSEE: Limestone Cove, Unicoi Co. (H. B. Baker); Rowan Creek, Cade Cove (Ferriss); Claiborne Co. (L. Hubricht); Byrdstown, Pickett Co. (W. G. Parris); Harriman, Roane Co. (S. N. Rhoads); South Pittsburg, Marion Co. (R. E. Call). ILLINOIS: Athens Menard Co. (E. Hall). WISCONSIN: Sheboygan (I. A. Lapham); Whitefish Bay north of Milwaukee (Leland); Du Pere, Brown Co. (Marston); Crawford Co. (Morrison). MINNESOTA: Stockton; Winona, Winona Co. (Holzinger); Chatfield, Fillmore Co. (Univ. of Minn.). IOWA: Hardin County, near Eldora; Linn County, north of Cedar Rapids; Johnson County, north of Iowa City; Howard County, northwest corner, along Upper Iowa river; Winneshiek County, Plymouth Rock, Kendallville Bluffton, Decorah, etc.; Allamakee County, along the Upper Iowa; Clayton County, southcentral part; Dubuque County, northwest corner; Delaware County, northeast corner; Lee County; Madison County, southwest of Winterset (Shimek).

Localities given above are all for Recent specimens. *H. occulta* was somewhat less widely distributed⁹⁷ but apparently abundant in Pleistocene times (see below), but it has now a conspicuously discontinuous range, the areas very small, though often abundantly populated. There has been very little local differentiation, but the specimens from western Pennsylvania localities, from Natural Bridge of Virginia, and Mt. Mitchell, North Carolina, average rather large, while those from Harriman, Tennessee, are all small, down to 6.1 mm. diameter, and the Recent shells from Iowa are of medium and small size.

⁹⁷ The record of former distribution has been preserved only in loess areas, probably but a part of its former range.

It lives on well-shaded, leafy and rather humid slopes, on limestone terrains so far as I have collected it. At Iowa City it is preyed upon by *Haplotrema concavum*, which gains access to the animal by cutting a hole in the shell in front of the aperture.

H. occulta has a somewhat extensive literature which has been admirably summarized by Shimek in four papers cited above, which contain also his own wide-spread observations.

H. occulta was described from loess fossil specimens from south of New Harmony, Indiana (Type No. 10600 A.N.S.P.). Some authors have given subspecific standing to the Recent form, but as Shimek held, there is no adequate basis for such rank. The most that can be said is that the average size of living specimens is a little greater, but the overlap in shell diameter of living and loess populations includes a very large majority of the specimens. The largest loess specimen I have measured is only 0.3 mm. smaller than the largest Recent shell. In some marginal Pleistocene localities such as New Harmony, Ind., St. Louis, Mo., and Dyersburg, Tenn., the fossil shells are as large as any living ones. That the Iowa loess shells average slightly smaller is apparently due to a dryer climate there in interglacial times. The prominence of the keel on the last whorl varies about equally in living and fossil specimens.

The distribution of *H. occulta* as a Pleistocene fossil has been investigated by Dr. Shimek, from whose paper of 1919 the following extracts are quoted.

"The northern limit of the fossils, so far as observed, is approximately indicated by a series of loops drawn from Ponca, Nebraska, to Carroll, Des Moines, Colfax, Iowa City, Muscatine, and Davenport, Iowa; Rock Island and Joy, Illinois, and Sullivan County, Indiana. The fossils have been found at all the border localities mentioned in this discussion, and at many points within that border.

"Westward the fossils extend into eastern Nebraska (as far as the writer has been able to determine) to a line drawn from Ponca through West Point, Bruno and Lincoln to Peru. Numerous collections of loess fossils have been made by the writer west of this line, notably at Beemer, Howells, Clarkson, Milligan, Abie, Atlanta, Oxford, North Platte, etc., but not a single *Helicina* was found among them.

"The species is rather abundant in the loess along Missouri river from near Sioux City, Iowa, and Ponca, Nebraska, to St. Joseph, Missouri, at some localities being more common on one side of the river, and at some on the other. It also extends back from the river, especially along the larger tributaries, for many miles,—in Nebraska to the line indicated, and in Iowa to an irregular curve drawn from Hamburg to Carroll, and thence to Sioux City and Westfield. The latter curve practically forms the eastern limit

of the main body of the Missouri valley loess on the east side of the river in Iowa, and our species has been found in every county within that area south of Sioux City.

“South of the Iowa line the loess is more clearly limited to the bluffs of the Missouri valley. The species is common in Atchison county, Missouri, at Peru, Nebraska, and St. Joseph, Missouri, and extends thence locally along the Missouri to St. Louis county, Missouri. It has been reported specifically from Jackson, Howard (Sampson), Cooper (Sampson), and St. Louis counties, being designated as a “Pleistocene” fossil by Sampson.

“The known southern limit of the fossil form has been extended along the east side of the Mississippi almost to the south line of Tennessee.

“Not only is our species common at Hickman, Kentucky, but the writer collected numerous specimens in Tennessee, at Dyersburg, Ashport bluff, near Covington, and at Fulton. The Dyersburg specimens range from 6 to 8 mm. in greater diameter, thus equaling the largest recent specimens reported by Walker and Pilsbry from Mount Mitchell, North Carolina. Below Dyersburg the species is less common, and ranges from 6 to 7.5 mm. in diameter. It should be noted that *H. orbiculata*, the southern species, was not found in any of the Tennessee localities here cited.”

ADDITIONS AND CORRECTIONS

Having lived long, I have experienced many instances of being obliged, by better information or fuller consideration, to change my opinions, even in important subjects.—B. FRANKLIN.

VOLUME I

P. vii, fifth line from bottom: for XVIII, read XVI. Last four lines: for XIX, read XVII.

P. x, for p. 203, read 263, and for p. 205, read 265.

P. 4, for Subgenus *Cryptomphalus* (Ag.) Charp., read

Subgenus CORNU Born

Cornu Born, 1778, Index rerum naturalium Musei Caesarei Vindobonensis, pars 1, Testacea, p. 371, for *Cornu copiae* Born (= scalariform *Helix aspersa* Müll.), figured on unlettered plate.

This name was not used in my text because I thought that a genus founded on an abnormal specimen was invalid. However, nothing in the International code seems to exclude such names.

Since the publication of the first volume of this work, a thorough investigation of the dates of the several parts of Férussac's *Prodrome* and *Histoire* has been made by Mr. A. S. Kennard (Proc. Malac. Soc. London. 25: 12-14, 105-118). This is important because knowledge of all the facts, not accessible hitherto to taxonomists, leads to some radical changes in nomenclature. Generic and subgeneric names hitherto credited to Férussac prove to be untenable or of different application, now that their history is fully known.

Férussac has been a major nuisance in nomenclature. A systematist without insight; his originality was exercised in proposing a host of names, largely superfluous, and for heterogeneous assemblages of species.

P. 12, for *Theba* Risso, read:

HELICELLA Férussac

Cf. Kennard, 1941, Jour. Conch. 21:265; 1942, Proc. Malac. Soc. London, 25:115. Type *Helix subdentata* Fér.

P. 13, line 1: for *Theba pisana* read **HELICELLA PISANA** (Müller).

Family II. **JACOSTIDAE** n.n.

This name replaces *Helicellidae*, this work 1:14.

P. 21, for *Helicella*, substitute **JACOSTA** Gray, March 1, 1821, London Medical Repository, 15:236, for *H. Jacosta albella* Drap. = *H. explanata* Müller.

P. 22, for *Helicella elegans*, read **Jacosta elegans** (Gmelin).

P. 23: delete the paragraph relating to *Cochlicella acuta* Müll.

P. 24. Family III. HELMINTHOGLYPTIDAE

This family includes Xanthonycidae Strebel & Pfeffer, 1880, (Beitrag mexikanischer Land- und Süßwasser-Conchyl. Theil IV, p. 25), which is the earliest family name based upon a member of the group, but it is objectionable as applied to a very aberrant genus, not typical of the family. The name Cepolidae was used by the author in 1934 (Proc. Acad. Nat. Sci. Phila. 86:7) as practically equivalent to the "Belogona euadenia" of the classification of 1895 (Man. Conch., Index to the Helices, p. 125), and was thus more comprehensive than Helminthoglyptidae.

P. 26, for *Cepoliinae*, read *Cepolinae*. This term was first used by H. B. Baker, 1939, Nautilus, 52:143.

P. 33. In the second and third paragraphs the genus *Monadenia* was divided into two groups which were defined. The second of these groups has since been named as a subgenus *Corynadenia*, Berry, 1940, Bull. Southern Cal. Acad. Sci., 38:204, Type *Helix hillebrandi* Newe.

The following species and subspecies were described by Berry in Jour. of Entom. and Zool., March, 1940. As the figures are in outline they do not show features of pattern and sculpture, which are among the chief differential characters.

Monadenia marmoratis Berry, l.c. 32:3, figs. 1, 2. $\frac{1}{4}$ to $\frac{1}{2}$ mile south of Marble Valley Ranger station, Marble Valley, Siskiyou Co., Cal., at about 5900 feet.

Monadenia rotifer Berry, l.c. 32:5, figs. 3, 4. Trail $\frac{1}{2}$ mile west of Whiskey Camp, Salmon Mountains, Siskiyou Co., Cal., 1 imperfect bleached specimen only.

Monadenia callipeplus Berry, l.c. p. 6 figs. 5, 6. Tompkins Creek, one mile above mouth, alt. 2300 feet, a single specimen.

Monadenia cristulata Berry, l.c. p. 7, figs. 7, 8. Above Pleasant Valley Lakes, Siskiyou Co., Cal., alt. ca. 5800 feet.

Monadenia chaceana Berry, l.c. p. 9, figs. 9, 10. Among woods half way up a spur of Badger Mountain on west side of Shasta River Canyon, not far above it, Siskiyou Co., Cal.

Monadenia fidelis scottiana Berry, l.c. p. 11, figs. 11, 12. Kelsey Creek, 1 to 2 miles above mouth. Siskiyou Co., Cal. Also taken on Middle fork of Kelsey Creek, Canyon Creek and Middle Creek.

Monadenia fidelis callidina Berry, l.c., p. 13, figs. 13, 14. "Dad's Camp", south side Klamath River across from Requa, Del Norte Co., Cal. Also other localities in Del Norte and Humboldt counties.

Monadenia fidelis smithiana Berry, l.c. p. 14, figs. 15, 16. South side of Smith River, 2 mi. below Hiouchi bridge, Del Norte Co., Cal., and elsewhere on the same river.

Monadenia infumata alamedensis Berry, l.c. p. 15, figs. 17, 18. No type loc. given, but range stated to be south of San Pablo Bay and Sacramento River.

P. 61, line 16 from bottom, *Monadenia hillebrandi*: for 250, read 25.

P. 90. Helminthoglyphta californiensis (Lea). "Found at several localities north of Monterey in the sand dunes, the farthest north being at Marina Beach, 10 miles north of Monterey, and I have collected it at 3 points south of Point Lobos, the southernmost being just south of the mouth of the Little Sur River, about 15 miles south of Point Lobos. Our best collecting, both as to number of specimens and size of shells, was in the sand dunes about 3 miles north of Monterey (E. P. Chace, Nautilus, 55:65).

P. 93, line 12 from bottom: delete the comma after U.S.N.M.

P. 110: insert *H. a. humboldtica* Berry after no. 6, *H. a. pomoensis*.

P. 140, lines 5 and 6 from bottom: delete "south side San Juan Grade, Montgomery Co.", which belongs to *H. d. consors* Berry, which may be a form of *sequoicola*.

P. 141, line 2 of text: for (Fig. 71b), read (Fig. 70b).

P. 222, for *Micrarionta tryoni carinata* Hemphill, read *Micrarionta tryoni hemphilli* (Hannibal). Cf. *Epiphragmophora kelletti hemphilli* Hannibal, 1911, Bull. Southern Calif. Acad. Sci., 10:54, new name for *H. tryoni* var. *subcarinata* Hemphill, preoc.

P. 267: above *Sonorella*, add:

SONORELIX Berry

Sonorelix Berry, 1943, Trans. San Diego Soc. N. H., 10:8, type *Micrarionta borregoensis* Berry.

"Sonorelline snails having a pale, waxy-porcellaneous, umbilicate, helicoid shell, ornamented by a peripheral brown band of varying prominence. Embryonic shell sculptured by a variably developed subretiform papillation.

"Hermaphrodite system lack a dart-sac, mucus-glands, or other accessory amatory organs on the female side; vagina very long; spermathecal duct robust, of moderate length, the portion of the duct distad to the junction with it excessively short. Epiphallus short, stout, bearing a well-developed caecum [flagellum]; penis abruptly set off and enlarged from the epiphallus, thence narrowing either suddenly or more regularly to the aperture, concentrically ridged or folded within, and provided with a short conical verge; retractor inserted on epiphallus". (Berry.) Berry's figures of genitalia are reproduced in Fig. 582:3 to 8.

This group differs from *Sonorella* only by having a well-developed flagellum, and a diverticulum on the spermathecal duct, *Sonorella* having only an extremely short flagellum and no diverticulum. These differences are usually not characters of much significance in helicid morphology; yet in the large number of *Sonorellas* dissected, there are no transitional species.

Sonorelix appears to be a link partially filling the gap between *Sonorella* and *Micrarionta*.

"Other described species which appear to share to a considerable extent in the characteristic sculpturing of the embryonic whorls noted in the type-species of *Sonorelix* are *ora* (Willett), *carrizoensis* (Willett), *rixfordi* (Pilsbry), *aetotis* (Berry), *depressispira* (Berry), *harperi* (Bryant), *orcutti* (*orcuttiana* Bartsch), *avawatzica* (Berry), *baileyi* (Bartsch), *eremita* (Pilsbry) and *melanopylon* (Berry). Of these the first, as I shall shortly endeavor to show, very definitely belongs here, being an immediate ally of *borregoensis*, and *rixfordi* likewise possesses essentially the same type of reproductive system. The relationships of *avawatzica* also lie near. Most or all of the others I believe are likewise likely to belong to *Sonorelix*." (Berry.)

P. 273, before Subgenus *Sonorella* s. str., add the following:

Subgenus MOHAVELIX Berry

Mohavelix, Berry, 1943, Trans. San Diego Soc. N. H., 10:6, type *Micrarionta micrometalleus* Berry.

"Shell small, thin, subdiscoid, with a wide perspective umbilicus, the periostracum crudely granular-papillose throughout, except for the embryonic sculpture of numerous rather sharply cut, elongate, pointed papillae, arranged in forward-descending series and sometimes confluent into nearly solid decurrent lines.

"Hermaphrodite system with epiphallus weakly differentiated, but equipped with a minute adnate caecum [flagellum]; penis very robust, in length about equal to the similarly robust vagina, abruptly and definitively set off from the epiphallus, its apical portion strongly bulbously expanded around the heavy, cylindrical base of the relatively large, elongate, conical papilla or verge. Retractor inserted on distal part of epiphallus." (Berry.)

The single species is *Sonorella micrometalleus* (Berry). Vol. 1, p. 273. Fig. 582:1, 2.

P. 412. A study of Hemphill's *Oreohelices* from northern Utah to Oregon and Washington, by G. Dallas Hanna and Allyn G. Smith, appeared in Proc. California Academy of Sciences (4 ser.), 23:381-392, pl. 33-36. Dec. 29, 1939. They tentatively consider *intersum*, *fragilis* and *variabilis* to be species distinct from *strigosa*. It is to be consulted for the new descriptions and figures of Hemphill's types, together with estimates of their racial value by two experienced observers, and also for other new data on northwestern species.

P. 429. *Oreohelix strigosa depressa* (Ckll.). David T. Jones, 1940, has published a study of the anatomy and distribution (Bull. Univ. Utah., vol. 31, no. 4, pp. 43, 17 figs.). Histologic figures of the mantle margin and some other structures are given.

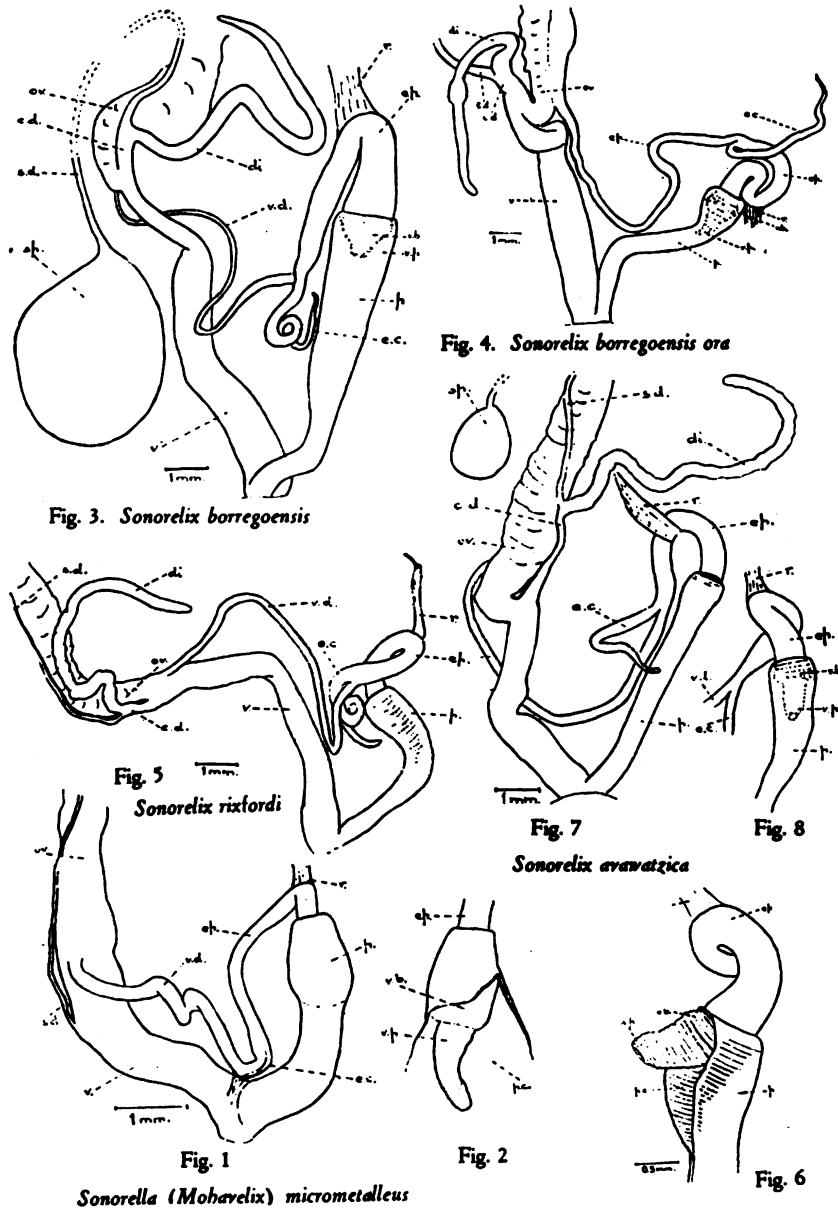


Fig. 582. 1, *Sonorella micrometalleus*; 2, penis of same opened to show verge. 3, *Sonorelix borregoensis*. 4, *Sonorelix b. ora*. 5, *Sonorelix rixfordi*; 6, penis of same opened, showing verge. 7, *Sonorelix avawatzica*; 8, penis of same, verge represented by stippled line. (After Berry.)

P. 435. The reference for *Oreohelix s. depressa* form *carnea* Hemphill is: *Patula strigosa* var. *carnea* Hemphill, June, 1890, *Nautilus*, 4:15.

P. 445. *Oreohelix strigosa* form *iowensis* Pils. was contained in the Shimek collection, now in U.S.N.M., from loess of Copperas Creek, Illinois, opposite Muscatine, Iowa, collected by F. M. Witter (J. P. E. Morrison, *Nautilus*, 56:104).

P. 496. *Oreohelix jugalis* (Hemphill). A definite locality has been supplied by Allyn G. Smith, who collected it in piles of water-worn boulders near the west bank of Salmon River one mile north of Riggins, Idaho (Proc. Cal. Acad. Sci., 4th ser., 23:538).

P. 499. *Oreohelix jugalis intersum* (Hemphill). Found by A. G. Smith in lava rock-slides facing east, north of the highway, several hundred yards from the Little Salmon River, about 3 miles south of Riggins, Idaho.

P. 534: before *Oreohelix handi* insert the following:

***Oreohelix parawanensis* Gregg**

Fig. 583.

Oreohelix parawanensis W. O. Gregg, 1940. *Nautilus*, 54:95, pl. 8 upper figures.

"Shell rather small, depressed, sublenticular, with a moderately carinate periphery and a perspective umbilicus. Whorls $4\frac{1}{3}$, convex below the suture, prominent in the middle and then flattened above the keel. In the final third of the last whorl there is a pronounced fading out of the keel so that the peristome is nearly circular. Peristome simple and connected by a faint callus over the parietal wall. The last third of the body whorl descends slightly bringing the suture line below the keel of the preceding whorl. All



Fig. 583. *Oreohelix parawanensis*, after Gregg. Actual size and $\times 2$.

whorls visible in the umbilicus which is contained about $3\frac{1}{2}$ times in the diameter of the shell. The entire shell is marked by radial striations, with faint spiral striations over the base of the body whorl. There is a suggestion of spiral sculpture on the second whorl. A fairly well marked band of chestnut-brown above and one close below the keel are present while the rest of the shell varies from cinnamon-brown at the apex to a light buff on the later portion of the body whorl. Height 5.4 mm., diameter 10.5 mm., umbilicus 3.0 mm." (Gregg.)

UTAH: rock slide on southwest slope of Brian Head, Parawan Mountains, Iron Co. Type 176907 A.N.S.P., Paratypes 324 Gregg Coll.

" This species seems nearest related to *O. eurekaensis*, located some 160 miles to the north, and *O. handi*, located about the same distance to the southwest. From *eurekaensis* it is readily distinguished by its large umbilicus and by its keel which is more prominent except on the last third of the body whorl. It is smaller than *handi*, has a larger umbilicus, is less strongly carinate and has its sculpture less strongly developed.

" The location was above the timber line and I was surprised to find associated with it a number of snails from the lower wooded altitudes. Other species associated with it were: *Vallonia gracilicosta* Reinhardt, *Vallonia cyclophorella* Ancy, *Oreohelix strigosa depressa* Cockerell, *Microphysula ingersolli* Bland, *Pupilla blandi* Morse, *Pupilla hebes* Ancy, *Vittrina alaskana* Dall, *Zonitoides arborea* Say, and *Discus cronkhitei cronkhitei* Newcomb." (Gregg.)

P. 540, line 16: for Fig. 286, read Fig. 296.

P. 591, above Subgenus *Daedalochila* Beck, insert:

Subgenus POLYGYRISCUS new

Very small snails having the general form of *Polygyrae* of the *septemvolva* group; the aperture having a marginal parietal tooth and an obliquely entering lamina within the outer margin; Peristome continuous, expanded. Type *Polygyra virginiana* Burch.

This very peculiar snail is probably not nearly related to *Polygyra*, but is left in that family temporarily. It is somewhat similar to *Entodina*, which is strongly striate and has no lamina within the outer wall of the mouth; but in the related genus *Systrophia* (*S. stenostrepta*, *S. ortonii*) there is a lamina, shorter than that of *Polygyriscus*. Whether any affinity is indicated remains to be seen.

***Polygyra virginiana* Burch**

Fig. 584.

Polygyra virginiana P. R. Burch, 1947, *Nautilus*, 61:40, pl. 3, figs. 1-6.

" Shell discoidal, umbilicus very shallow, spire not prominent, dorsal and ventral surfaces almost parallel; whorls slightly more than four, regularly increasing in size, a swelling on the last third of the ventro-lateral surface of the body whorl, a deep groove opposite it on the dorsal surface extending backward 1.4 mm., the end of the last whorl breaking away from the preceding whorl at an angle of about 60° and extending outward about 1.0 mm.; rib striate with four prominent spiral lines 0.3 to 0.35 mm. apart becoming more prominent toward the aperture with less prominent lines between them, all spiral lines more or less papillate; whorls rounded, lip white and slightly reflected; aperture heart-shaped, 1.3 × 1.0 mm. with V-shaped parietal tooth; a white fold 1.4 mm. long and 0.2 mm. high extends inward along the outer wall, beginning about 0.3 mm. from the aperture; a transverse callus on the parietal wall 0.4 mm. long and 0.1 mm. high fits into the arch formed by the fold; color of shell wood brown. Diameter 4.2 mm., height 1.4 mm.; 4.6 whorls". (Burch.)



Fig. 584. *Polygyra virginiana*, upper figure the type, after Burch; lower figures a paratype, scale line = 1 mm.

Twelve specimens found vary in size from 3.9×1.3 mm., 4.2 whorls, to 4.4×1.3 mm., 4.5 whorls.

VIRGINIA: found in sifted soil from weathered Elbrook limestone (Cambrian) in a cut on a country road in Pulaski County, opposite the city of Radford, (Montgomery County). Type in U.S.N.M., paratypes 183550 A.N.S.P.

"Comparison with *P. cereolus* showed the new shell to be much smaller and to have fewer whorls. Instead of a lamina on the parietal wall there is a fold on the outer wall. The last whorl is swollen on the latero-ventral side like *P. c. carpenteriana* (Bld.). Unlike *P. cereolus* it shows raised spiral lines on all the whorls and a callus in the base. . . . No live specimens were found. The collecting station was approximately sixty feet above New River at an elevation of 1800 feet, and two feet below the topsoil containing living plants. Along with it and in the topsoil were the weathered shells and living individuals of thirty or more Recent species of such genera as *Retinella*, *Paravitrea*, *Haplotrema*, *Gastrocopta*, *Ventridens*, *Mesomphix*, *Anguispira*, *Helicodiscus*, *Mesodon*, *Triodopsis* and *Pomatiopsis*." (Burch.)

P. 608. *Helix pustula* Fer., date is not 1822 but 1832 (livr. 22).

P. 618, line 7: for Valde Co., read Uvalde Co.

P. 639: *Stenotrema*. It should be mentioned that *Polygyra* approaches *Stenotrema* in some species. Thus *P. leporina* has similar apertural conformation and axial fulcrum, differing mainly by the different apical sculpture and fewer whorls.

P. 651, line 23. Cape Girardeau (Sampson) is probably an error. *S. labrosum* is a more western species.

P. 656: syn. of *Stenotrema stenotrema*: *Helix convexa* "Raf." Fér., 1823. Hist., livr. 21, pl. 50a, fig. 3. Not of Link, 1807.

P. 663, line 22. Winona is in Winona Co., Minn.

P. 663, line 2 from bottom: for Hawamba, read Itawamba Co.

P. 674: *Stenotrema maxillatum*. The plate within the basal lip is probably a prolongation of the margin of the interdenticular sinus.

P. 676: *Stenotrema leai* (Binney). This name must be used in place of the well-known *S. monodon*, since the *Helix monodon* Fér., which I had thought dated from Férussac's Tableau Syst. Limaçons, was far earlier, having been proposed by Férussac père in 1807, Essai d'une methode conchyliologique, pp. 112, 120, as a substitute for *Helix unidentata* Drap. *Helix leai* "Ward" Ms. was defined by A. Binney, 1841, Boston Jour. N. H., 3:362.

Dall's Moose Factory record (p. 678) for this species, seems to be quite erroneous, as other collectors have not found it there, or at Smoky Falls a hundred miles southwest. It is not uncommon in counties near Lake Erie, going as far as Middlesex, Oxford and Brant counties. Along Lake Huron it is known from Goderich, Huron Co., Bruce Co. and Fitzwilliam I., Manitoulin Is. Co. Calvin Goodrich has discussed the type locality of *H. monodon* Rackett, which he thinks may have been in Georgian Bay (Nautilus, 54:78).

P. 680, line 25: for Hawamba, read Itawamba.

P. 680 line 28: for Pickers, read Pickens.

P. 683 line 37: Ingham, not Ingraham Co.; Leelanau, not Leelanan.

P. 688: *Stenotrema fraternum inperforatum* (Pils.). The Missouri records are regarded by Mr. Hubricht as undoubtedly erroneous.

P. 709, line 2: delete Gladwell Co.

P. 724, line 7: for Sequoia, read Sequiota.

P. 724, line 10: for Hearcy, read Searcy Co.

P. 725, line 18 from bottom: for Harrisonburg, read Harrisburg.

P. 725, line 9 from bottom: Walnut Shade, Taney Co. is in Missouri.

P. 726, line 5 from bottom: for Jackson and Cape Girardeau counties, read Jackson, Cape Girardeau County.

P. 727: *Mesodon elevatus*. 1832 instead of 1822 at end syn.

P. 728, line 10 from bottom: for Davison, read Davidson.

P. 749. *M. appressus*: *Helix linguifera*, in place of "date uncertain", read 1823.

P. 755. *Mesodon sargentianus* form *heterodoxus* was omitted in the list on p. vi, and in the Index.

P. 772, line 10 from bottom: for Davison, read Davidson.

P. 772, line 15: delete Burke Co.

P. 792, last line of references under *T. tridentata*: "*Triodopsis lunula* Rafinesque" was mentioned first as a synonym of *tridentata* Say by Férussac, 1821, Tabl. Syst. fam. Limaçons p. 34.

P. 806, line 6: for West Williams, Norfolk Co., read St. Williams, Norfolk Co.

P. 808, line 15 from bottom: Fayetteville, Washington Co. is in Arkansas.

P. 822, line 24: for Nachitoches Parish, read DeSoto Parish.

P. 824: *Triodopsis denotata* (Fér.). 2nd citation under *H. denotata*: add 1823, cover, livr. 19. *T. scabra* also on cover, and both said to equal *H. palliata* Say. The name *denotata* therefore preceded *notata* and will replace that.

P. 836, line 12: for Mackay Lake, Algoma District, read McKay Lake, Carleton Co.

P. 836, line 27: for Cumberland County, read Allegany Co., near Cumberland, Md.

P. 844: *Triodopsis dentifera* (Binney). The distribution in Ontario, according to Oughton (*in litt.*) is as follows: specimens in coll. Roy. Ont. Mus. Zool.: Nipissing district, Smoke Lake (Algonquin Park). Lennox and Addington Cos. Denbigh. Russell Co., Casselman. The locality "Ottawa" (p. 845) was an error for Ottawa district. The range as known follows the Ottawa River drainage.

Add to synonymy: *Mesodon dentiferus* var. *major* Ancy, 1887, Conch. Exch., 1:55. This name was applied to a specimen from mountains of east Tennessee, "Diam. 28 mm.; of a darker color and furnished with more impressed revolving lines than the northern form of the species" (Ancy).

P. 852, line 1. The locality St. Joseph, Buchanan Co., Mo. recorded for *T. divesta* was based on a depressed *T. multilineata*, according to D. K. Gregor, who saw the specimen.

P. 875, last line: for "eastern Montana", read western Montana.

P. 877: *Allogona profunda* (Say). The variation of *A. profunda* and the race *pleistocenica* and their distribution in Pleistocene deposits were fully discussed by F. C. Baker, 1934, in Amer. Midland Nat., 15:178. Add to last line of synonymy: *Helix richardi* Lamarek, 1822, Anim., s. Vert., 6, pt. 2, p. 72.

P. 892: before *Vespericola* insert:

***Allogona lombardii* A. G. Smith**

Fig. 585

Allogona lombardii A. G. Smith, 1943, Proc. Cal. Acad. Sci. 141, 23:545, pl. 48, figs. 1-4.

"The shell is large and heavy, approximately the size and texture of medium-sized *A. townsendiana* (Lea), moderately elevated, with from 5½ to 6½ whorls, the last one tumid. Nuclear whorls one and one-half to two, glossy, smooth except for fine transverse ribbing in the vicinity of the suture. Umbilicus small, contained from ten to thirteen times in the major diameter of the shell. Sutures well impressed. Aperture semi-lunate, the peristome heavy, white, strongly reflected, the edge slightly rolled back. Some shells have a subobsolete basal tooth or short basal lamella near the columellar end of the peristome. Sculpture consisting of transverse sinuous ribs, most prominent on the body whorl, closely though variably spaced, and generally extending continuously across the whorls. Closely set, wavy, spiral stria-

tions, generally present above and below, are strongest near the summits of the whorls, although on many shells these striations are subobsolete. Malleations absent. Color ranging from a dark bistre-brown to a light buff-brown, shells of darker color predominating. Ridges of the transverse sculpture in the darker specimens are light buff, serving to set them off in a most striking manner from the darker ground-color of the shell. Surface of fresh shells shining but not highly polished. Diameter 27 mm., height 19 mm., whorls $5\frac{3}{4}$." (A. G. Smith.)

IDAHO: along Meadow Creek $1\frac{1}{2}$ mi. south of Selway Falls, Idaho Co., elevation 1900 feet. Type. C.A.S. Type coll. No. 7893 (G. Dallas Hanna). Also, $4\frac{1}{2}$ mi. southwest of Selway Falls at 5800 feet.

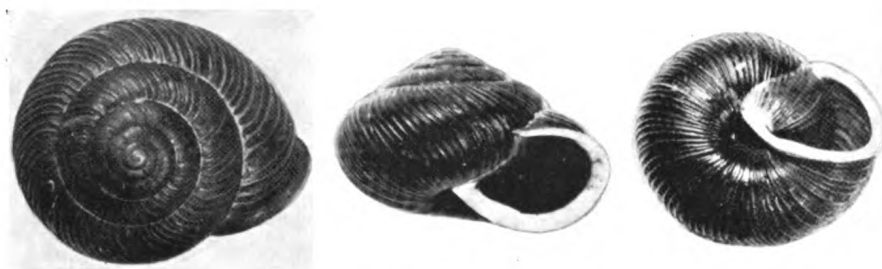


Fig. 585. *Allogona lombardii*, after A. G. Smith. Enlarged.

"At both localities where this remarkable snail was collected it was found along with the race of *A. ptychophora* just discussed. No intergrades between the two were taken, and because the shells of the large, robust, heavily-ribbed form present so different an aspect, it is given status as a separate species.

"Compared with *A. townsendiana* (Lea), a snail found only in humid coastal region west of the Cascade Mountains, it is about equal in heavy shell texture and nearly equal in size. Also, it is more elevated, has a smaller umbilicus, more prominent transverse sculpture, and differs further in the complete lack of malleations.

"The shells of *lombardii* tend toward a relatively elevated spire, only five out of a total of twenty on which specific notes were made having the spire depressed. In this same group of twenty, the basal tooth is subobsolete in nine shells, in two the tooth is quite strong, while in the remaining eleven shells there is hardly a suggestion of a tooth or none at all.

"In older shells the epidermis, which is thin, becomes worn off. In senile specimens often there is hardly any of it left. Two or three extremely light yellowish specimens, possibly xanthic, were taken, one being the largest shell in the following table of measurements, which demonstrates the range in size of the species.

Largest: Maj. diam. 29.2 mm., height 18.6 mm.
 Most elevated: Major diam. 24.8 mm., height 18.1 mm.
 Most depressed: Maj. diam. 28.0 mm., height 17.8 mm.
 Smallest: Maj. diam. 24.2 mm., height 16.9 mm.
 Average of 20: Maj. diam. 26.6 mm., height 18.5 mm.

“Spacing of the transverse ribbing is quite variable, being as small as 0.5 mm. in some shells to 1.0 mm. in others, while occasional spacing of as much as 1.6 mm. occurs. On individual specimens a considerable difference in rib spacing exists. All ribs are not continuous across the body whorl and in some shells occasional ribs begin well below the suture and even at the periphery. Some ribs are broken and in others a tendency towards branching may be noted, although these are minor sculptural features.” (A. G. Smith.)

(Named in honor of Mr. M. E. Lombardi, a patron of the California Academy Expedition to Idaho.)

P. 903: transfer third paragraph from bottom to p. 901, under *V. hapla*.

P. 904, line 13: for “tract”, read trace.

P. 962. Under description of *Ashmunella angulata*, the dimensions for height and diameter were transposed.

P. 992. Under NEW MEXICO, for “Capello Canyon”, read Sapello Canyon.

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P. 59, footnote 31, last paragraph: for Porgee Key, read Totten's Key.

P. 93, line above fig. 45: for PC 9 and 10, read CP 9 and 10.

P. 108, 9th line from bottom: for Fig. 78c, read Fig. 80e.

P. 428, line 24: for *Janulus stephanophora*, read *Janulus bifrons* Lowe.
 Cf. *Nautilus*, 60:96.

P. 492. The heading “Subgenus *Striatura* s. str.”, was misplaced; it belongs on p. 495, before *Striatura milium*.

P. 494. Fig. 271 should be credited to H. B. Baker.

P. 500, 4th line from bottom: for Luther, read Lothar.

P. 504: for *Vitrina angelicae*, read *Vitrina pellucida angelicae* Beck. L. Soos and H. Schlesch dissected this snail (*Ann. Mus. Nat. Hungarici*, 21:96, fig. 1. 1924), concluding that it is not distinguishable from *V. pellucida* Müll. Probably it is not a valid subspecies.

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