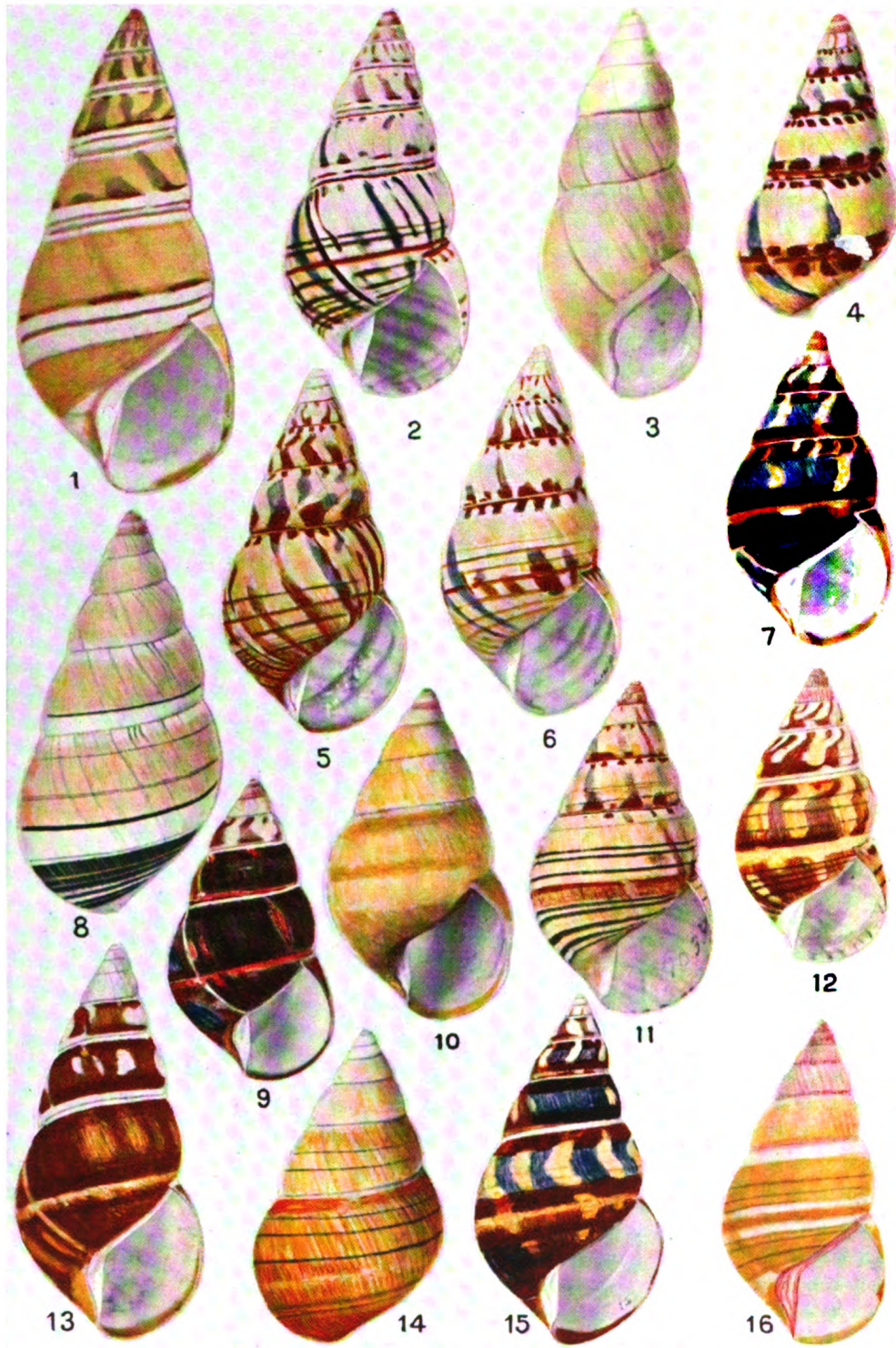


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FRONTISPIECE



1. *Liguus fasciatus graphicus*, Noname Key. 2. *L. f. graphicus* form *lignumvitae*, Lower Matecumbe Key. 3. *L. f. solidus*, Say's type. 4. *L. f. solidus* form *pictus*, Big Pine Key. 5. *L. f. solidus* var. *splendidus*, Lower Matecumbe Key (McGinty coll.). 6. *L. f. solidus* var. *pseudopictus*, Lower Matecumbe Key. 7. *L. f. testudineus* var. *versicolor*, Osteen Hammock. 8. *L. f. graphicus* var. *simpsoni*, Lower Matecumbe Key. 9. *L. f. testudineus* var. *castaneus*, Cox Hammock. 10. *L. f. testudineus* form *ornatus*, Osteen Hammock. 11. *L. f. solidus* var. *dohertyi*, Lower Matecumbe Key. 12. *L. f. testudineus*, Brickell Hammock. 13. *L. f. testudineus* form *marmoratus*, Key Vaca. 14. *L. f. lossmanicus* var. *aurantius*, Pinecrest 5. 15. *L. f. testudineus* var. *barbouri*, Pinecrest 21. 16. *L. f. castaneozonatus* form *roseatus*, Porgee Key.

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MONOGRAPHS

Number 3

LAND MOLLUSCA
OF
NORTH AMERICA
(NORTH OF MEXICO)

By

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of Philadelphia

VOLUME II

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PREFACE

The final volume of this work, having grown beyond the limits originally planned, has been divided into two parts. Part II, expected to appear in 1947, will complete the work.

In order to concentrate bibliographic data as well as to save space, the references to subgenera have often been assembled with those of the genus, and references to subspecific forms may be included with those of the species. The status of each name in such cases is stated on a following page. They are not all intended as absolute synonyms of the genus or species heading the list of references.

The author acknowledges with gratitude the receipt of grants from the American Philosophical Society for aid in the publication of this volume.

The colored frontispiece is due to the generosity of Dr. Jeanne S. Schwengel.

Dr. Horace B. Baker has liberally allowed the use of unpublished drawings, as well as free quotation from his published work.

For help with many details of bookmaking the author thanks Mr. Maurice E. Phillips, editor of the Academy's publications.

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**LAND MOLLUSCA OF NORTH AMERICA
(NORTH OF MEXICO)**

ERRATA

Page 180, transpose the letters a and b on fig. 86 and its line of explanation.

Page 396, last line of the Key: for *orotes* read *orotis*.

SYSTEMATIC TREATMENT (CONTINUED)

Suborder SIGMURETHRA (Continued)

HOLOPODA (Continued)

Family VII. BULIMULIDAE

Bulimulidae Pilsbry, Man. Conch. 10 to 14.

Sigmurethrous, holopod snails having an ovate to cylindrical shell (or rarely helicoid or succineiform). The body reticulation extends with little change to the foot-edges, without trace of pedal grooves. The kidney is short, triangular, its cardiac edge about equal to the pericardium in length, the secondary ureter complete. Lung with a long pulmonary vein without large branches, the reticulation being usually confined mainly to the region near the pneumostome and the area between pulmonary vein and hind gut. The penis passes into epiphallus without externally visible distinction, and the epiphallus is often continued in a flagelliform appendage. The penial retractor is attached terminally or near the end of flagellum or epiphallus. Spermatheca usually upon a long unbranching duct. Jaw composed of vertical or mesially converging imbricating plates concrescent except at their outer edges or throughout, or the surface sometimes appears merely striate or nearly smooth. Radula of helicoid type or variously modified, the central tooth either nearly as wide as the adjacent laterals or somewhat narrower, but not greatly reduced. In the free retractor muscle system the right ocular band arises from the columellar muscle, and the left ocular is united shortly or for some distance with the pharyngeal retractor.

Locomotion, so far as observed, is rhythmic, being monotaxic and direct. Reproduction by small, spherical eggs, so far as known.

Distribution.—This is a South American family of numerous genera, a few of them spreading north into Mexico, the West Indies and our southern states, and others in Australia, Melanesia and New Zealand, thought to have reached there via Antarctica.¹

¹ I have recently reviewed the evidence for *Bulimulidae* in Australia, in *Notulae Naturae* No. 168 (1946). The species of the Australian *Bothriembryon* dissected has the characteristic short, triangular kidney and pattern of lung venation of *Bulimulinae*. with a penis closely similar to that of *Bulimulus*. So far as I could see, none of its structures suggest any other family.

Aillya, a west African genus described by Nils Hj. Odhner, has been referred to the *Bulimulidae*, but in my opinion the distinctly aulacopod pedal groove, the long kidney and other details which need not occupy us here, deny the African genus a place in the present family. It appears to be an outlying member of the *Zonitacea*. The teeth while aberrant in shape of the basal plates, resemble some zonitid teeth. The jaw must be admitted to be of bulimulid type, yet, a plaited jaw is not unknown in *Zonitidae*. A full account is given in Odhner's able paper, *Arkiv för Zoologi*, 19A, no. 20, pp. 9-16, 1928.

The land connection of Africa and Brazil seems to have been a one-way thoroughfare. The African end may have been warped or faulted down before the Brazilian end was in effective operation.

The triangular kidney, its cardiac margin about equal in length to the pericardium, and the pattern of lung venation, as well as the genitalia, separate this family from the Strophocheilidae. The foot-edges are less differentiated than in many holopod snails, the sole tissue not extending upward to form any noticeable foot-fringe. The atrium is always very short, and the vas deferens is superficially bound to the penis. The type of genitalia described briefly above is that of the great majority of the genera. In the genera with reduced shell, which have been segregated as Amphibuliminae, the penis differs, and in *Peltella* the spermathecal duct is short. These genera seem to be terminal members of several lines of shell degeneration. Their structure is still imperfectly known and requires further study.

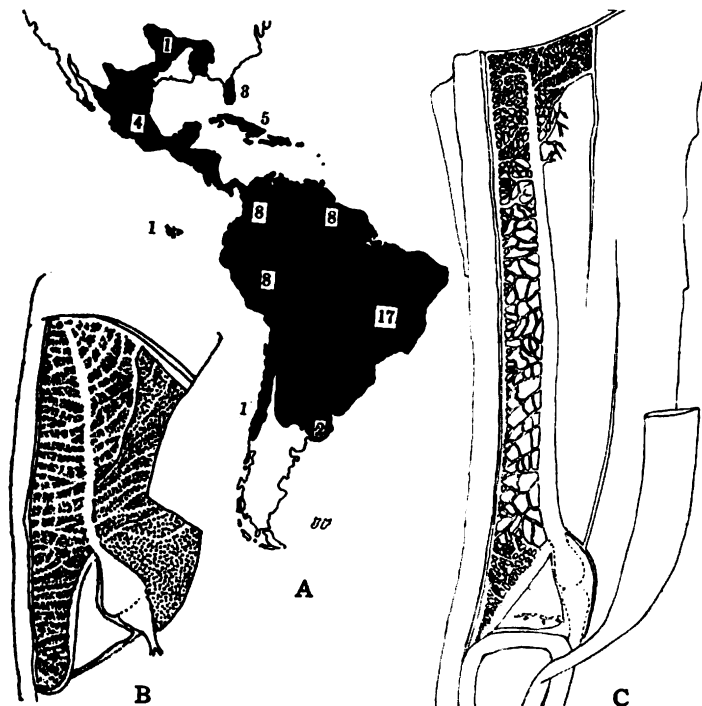


Fig. 1. A, American distribution of Bulimulidae, the number of genera in each area indicated. B, Pallial region of *Bulimulus dealbatus*. C, Pallial region of *Orthalicus jamaicensis*.

Fossil Bulimulidae in the United States have been found only in Florida, in the Lower Miocene Tampa limestone, where one genus, *Hyperaulax* Pilsbry, occurs in the "Ballast Point silex beds." The only living member of this genus known is found on the island Fernando Noronha, east of Brazil.

With the exception of *H. a. wakullae*, all of the species are from the silex beds of Ballast Point, Tampa, Florida. Species as follows:

- HYPERAULAX FLORIDANUS (Conrad). *Bulimus floridanus* Conrad, 1846, Amer. Jour. Sci., Ser. 2, 2: 399.—*Bulimulus longaevus* Ancey, 1881, Le Naturaliste, 3^{me} Année, 1: 414, new name for *B. floridanus* Conr.
- HYPERAULAX HEILPRINIANUS (Dall). *Bulimus heilprinianus* Dall, 1890, Trans. Wagner Free Inst. Sci., 3: 6.
- HYPERAULAX AMERICANUS (Heilprin). *Partula americana* Heilprin, 1887, Trans. Wagner Free Inst. Sci., 1: 115.—*Bulimulus americanus* with var. *partulinus* and var. *laxus* Dall, 1915, Bull. U. S. Nat. Mus., 90: 26.
- HYPERAULAX AMERICANUS WAKULLAE (Mansfield). *Bulimulus americanus wakullae* Mansfield, 1939, Florida Dep. Conserv., Geol. Bull., 15: 70. Tampa limestone, near Wakulla, Florida.
- HYPERAULAX TAMPAE (Dall). *Bulimulus tampae* Dall, 1915, Bull. U. S. Nat. Mus., 90: 26.
- HYPERAULAX BALLISTAE (Dall). *Bulimulus ballistae* Dall, 1915, *ibid.*, p. 26.
- HYPERAULAX STEARNSII (Dall). *Bulimulus stearnsii* Dall, 1890, Trans. Wagner Free Inst. Sci., 3: 7.
- HYPERAULAX TORTILLUS (Dall). *Bulimulus tortillus* Dall, 1915, *ibid.*, p. 27.
- HYPERAULAX REMOLINUS (Dall). *Bulimulus remolinus* Dall, 1915, *ibid.*, p. 27.

Key to genera of North American Bulimulidae, by shell characters

- A. The shell is large (usually more than 40 mm. long) the axis imperforate throughout; with smooth embryonic whorls (in our species). Orthalicinae
- B. Length of aperture more than half that of the shell; ovate, capacious shells
Orthalicus
- BB. Length of aperture less than half that of the shell, which is glossy, white or conspicuously colored*Liguus*
- AA. Shell smaller (usually less than 40 mm. long), the axis perforate (though often closed in the adult stage); with sculptured embryonic whorls (in our species).
Bulimulinae
- B. Embryonic whorls with a minute, even grating of spiral and vertical threads; shell uniform in color or with continuous or interrupted spiral bands or axial streaks*Drymaeus*
- BB. Embryonic whorls axially ribbed; no spiral color markings.....*Bulimulus*

Subfamily BULIMULINAE

Bulimulinae Pilsbry, 1902, Man. Conch., 14, Classification of Bulimulidae, p. ix.

Bulimulidae having the axis perforated, though often closed in the adult stage, the aperture toothless. Jaw with many narrow vertical or mesially converging plates. Genitalia without accessory penial gland; the talon rather long and narrow.

A classification by sculpture of the embryonic whorls of the shell was instituted by the author² as a convenient conchological criterion for classifying the very numerous species of Bulimuloid form, most of them unknown

² *Nautilus*, 9: 112, 1896. *Manual of Conchology*, 10: 126.

anatomically. While of great practical utility, the apical sculpture is not an infallible guide as a generic criterion, being secondary to various anatomical structures. In a few cases the same pattern has arisen in different phyletic lines, and rarely the sculpture has degenerated.

BULIMULUS Leach

Bulimulus Leach, 1815, Zool. Miscellany, 1: 41.—Herrmannsen, 1846, Ind. Gen. Mal., 1: 136, type *Bulimus exilis* Gmel. = *B. guadalupensis* Bruguière.—Pilsbry, 1896, Man. Conch., 10: 125; 1902, 14; xxii.

The shell of *Bulimulus*, in the wide sense, varies greatly in form and texture, but is typically oblong-conic with the umbilicus narrow or closed. The apical whorls are variously sculptured, but never have an even grating of axial and spiral threads, such as characterizes *Drymaeus*.

The jaw (Fig. 3 B) is plaited, the laminae vertical in the middle, not converging to form a triangular area there. The teeth are in nearly straight transverse rows, centrals about as wide as the laterals, tricuspid or with the ectocones reduced; laterals with large mesocone and well-developed ectocone, marginals with the ectocone usually divided (Fig. 3c).

This huge genus extends over most of the American range of the family (Fig. 1), but it divides into many special groups or subgenera localized in various parts of its area. Some of these groups will doubtless be accorded generic rank eventually, but until more of them are investigated anatomically, knowledge of the group would not be advanced by raising the nominal rank of the divisions without new anatomic data.

Subgenus RABDOTUS Albers

Rabdotos Albers 1850, Die Heliceen, p. 164.—Kobelt 1880, Illustr. Conchylienbuch, p. 267, type *Bulimulus dealbatus* Say. Not *Rabdota* Dejean, 1833, Coleoptera. Not *Rhabdota* L. Agassiz, 1846, Nomencl. Zool., pp. 320, 322 (emendation of *Rabdota* Dejean).

Rhabdotos von Martens, 1860, Die Heliceen, p. 218 (as synonym of *Scutalus*; referring to Albers, p. 164).

Orthotomium Fischer & Crosse, 1874, Miss. Sci. Mex., Moll., 1: 473, type *B. suffatus* Gld., Pilsbry, 1897, Man. Conch., 11: 125.

Globulinus Fischer & Crosse, 1874, loc. cit., 1: 475, same type.

Shell umbilicate or rimate, varying from ovate-globose to cylindrical or pillar-shaped; color uniform or axially streaked, *never with spiral color-markings*; opaque. There is a decided apical dimple; the initial $1\frac{1}{2}$ to 2 whorls are sculptured with vertical riblets, the interspaces often minutely striate spirally. Lip often thickened within.

The genitalia of two species are drawn in Figs. 3 A and D. The penis and epiphallus are not differentiated externally, and continue in a long flagellum, the penial retractor attached near or at the end. A sheath envelopes the penis, including the vas deferens. The cavity of the epiphallus, near its lower end, is divided into numerous ducts (Fig. 3 b). The very long duct of the spermatheca is rather distinctly swollen at about the distal third of its length. The talon is narrow, finger-like.



Fig. 2. *Bulimulus alternatus mariae* in aestivation. Nueces County, Texas (Junius Henderson phot.).

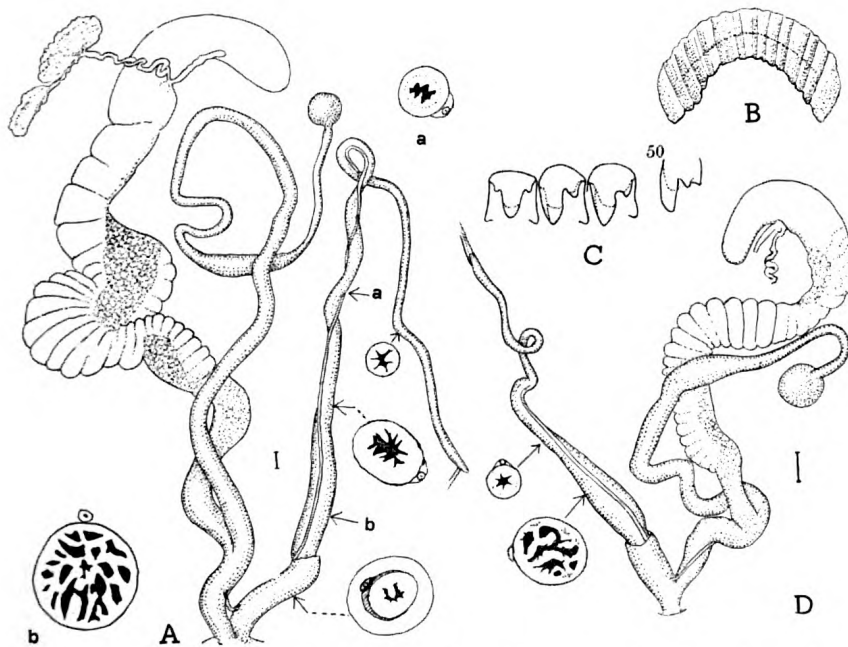


Fig. 3. A, *Bulimulus schiedeanus*, genitalia, with more enlarged sections of penis; High Bridge of the Pecos. B, C, D, *Bulimulus dealbatus mooreanus*, jaw, central, two lateral and one marginal teeth, and genitalia, with more enlarged sections of penis; New Braunfels. Scale lines = 1 mm.

The varying proportions of the genitalia will probably afford excellent specific differences when our whole series is investigated.

Rabdotus does not appear to be directly related to the Galapagos *Naesiotus*, in which most species have similarly ribbed embryonic whorls, as there are certain differences in the genitalia. Just what relation *Rabdotus* holds to Andean *Bulimuli* having similar embryonic sculpture, and to those of eastern South America such as *Protoglyptus* (type *B. chrysaloides* Pils.), remains uncertain, as those forms have not been dissected.

Rabdotus is widely distributed over northern Mexico, the mountainous southern part of Lower California, and the United States from Texas north to Missouri and Kentucky, east to Alabama. They live upon bushes and other vegetation, upon which they aestivate, but they usually hibernate buried a few inches in the soil.

Growth is rapid during wet weather, but of course is wholly suspended in dry seasons. On one occasion I visited San Antonio on April 23rd, finding *B. d. mooreanus* all dormant. Two days of rain followed, and on April 29th I found them in the same place all active, and immature ones had added 3 to 6 mm. of thin flexible shell at the lip edge. In general the solidity of the shell is greatest in regions of low rainfall. Renewed growth often leaves a former lip-rib within, visible in the aperture. It has been termed the "apertural ridge" by MacMillan (*Nautilus*, 57: 98).

The name *Rabdotus* was not accepted in my former consideration of the group on account of the prior *Rabdota* Dejean, but a more recent ruling of the International Commission (Opinion 86) allows the use of both *-us* and *-a* forms of the same root. The name is from 'Ραβδωτος, striped, and should have been transliterated "Rhabdotus".

Bulimulus shells were used by Indians of Texas to make necklaces,³ like the leis of *Achatinella* and *Partula* in Pacific islands.

Key to species and subspecies

I. Alabama and Kentucky to Louisiana, Oklahoma and Missouri

- A. Shell thin, more or less streaked.
 - B. Form rather obese, aperture more than half the length.....*B. dealbatus*
 - BB. Form more slender, aperture half the length or less.....*B. d. ozarkensis*
- AA. Shell rather solid, white with yellowish apex; diameter half the length or less
B. d. jonesi

II. Texas

- A. Outer lip narrowly expanded; diam. less than half the length; smooth; pinkish cinnamon with white streaks. Trans-Pecos, Texas.....*B. pilsbryi*
- AA. Outer lip not expanded.
 - B. Shell small, about 15 × 7.3 mm., aperture less than half the length; smoothish. Big Bend region to El Paso.....*B. pasonis*

³ A Prehistoric rock shelter in Val Verde Co., Texas. Univ. of Texas Bull., no. 3327. p. 118. 1933.

- BB. Shell decidedly larger.
 - C. Shell rather thin.
 - D. Surface smoothish.
 - E. Rather obese; profusely streaked; eastern and central Texas. *B. dealbatus*
 - EE. Whitish or with coffee-colored base; nearly smooth; central Texas *B. d. mooreanus*
 - DD. Surface rib-striate; rather slender..... *B. d. ragsdalei*
 - CC. Shell solid, opaque white or with brown streaks.
 - D. Inside dark brown; columella often toothed; Southern Texas. *B. a. mariae*
 - DD. Inside white to tawny, no tooth; Western Texas.
 - E. Large, 30 to 40 mm. long..... *B. schiedeanus*
 - EE. Smaller, 20 to 30 mm. long..... *B. s. pecosensis*

III. Southern Arizona and New Mexico

- A. Large, 25 to 30 mm. long, rather obese, streaked. New Mexico *B. d. neomexicanus*
- AA. Smaller, up to about 20 mm. long; diameter more than half the length, southern Arizona *B. nigromontanus*
- AAA. Smaller, about 15 × 7.3 mm.; aperture less than half the length; western Texas and New Mexico..... *B. pasonis*

Bulimulus dealbatus (Say) Fig. 4 a-d.

Helix dealbata Say, 1821, Jour. Acad. Nat. Sci., Phila., 2: 159 (Missouri and Alabama).

Bulimus dealbatus Say, Binney, 1851, Terr. Moll., 2: 276, pl. 51, fig. 1; pl. 51a, except upper and lower figs.—Leidy, 1851, Terr. Moll., 1: 229, pl. 15, fig. 1 (anatomy).

Bulimulus dealbatus Say, W. G. Binney, 1878, Terr. Moll., 5: 393, fig. 269, pl. x, fig. e (jaw and teeth); Man. Amer. L. Sh., p. 401, fig. 441.—Singley, 1893, 4th Ann. Rep. Geol. Surv. Texas, p. 309.—Pilsbry, Man. Conch., 11: 128, pl. 17, fig. 1, pl. 18, figs. 27-30, 48 (full references); 1906, Proc. Acad. Nat. Sci. Phila., p. 136, pl. 6, fig. 13.—Walker, 1928, Terr. Moll. Ala., p. 61, figs. 74-77.—F. C. Baker, 1933, Nautilus, 47: 4 (occurrence in Illinois).

Bulimus liquabilis Reeve, 1848, Conch. Icon., 5: pl. 57, fig. 387 (Texas).

Bulimulus dealbatus liquabilis (Rve.) Pilsbry, 1906, Proc. Acad. Nat. Sci. Phila., p. 134, pl. 6, figs. 7-12.

Bulimus confinis Reeve, 1850, Conch. Icon., 5: pl. 86, fig. 643 (Texas).

Bulimulus schiedeanus Pfr., W. G. Binney, 1878, Terr. Moll., 5: 391, fig. 276 (not the description).

The shell is rather wide, globose conic, thin, profusely streaked and mottled with opaque white on a gray or brownish gray ground. The spire is straightly conic, of rather strongly convex whorls, the umbilicus rather large. The interior of the aperture is colored like the outside, with a thin white rim, the columella concave, columellar lip dilated, white.

Length 19.4 mm., diameter 12.6 mm., aperture 10.7 mm.; 6½ whorls. Type.

Length 16.7 mm., diameter 10.5 mm., aperture 8.5 mm.; 6¼ whorls. Nashville.

Length 18.5 mm., diameter 11 mm., aperture 10 mm.; 6 whorls. Warren County, Kentucky.

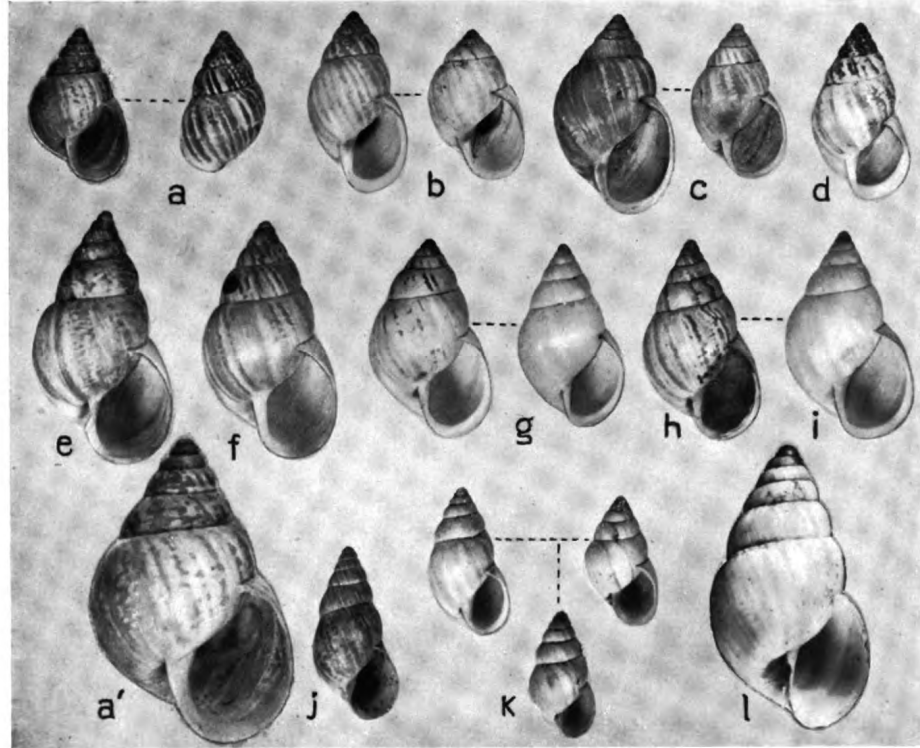


Fig. 4a, a', *Bulimulus dealbatus*, type (a left, and a') and paratype. b, Jackson Co., Texas. c, Lee Co., Texas. d, near Uvalde, Texas. e, *Bulimulus dealbatus neomexicanus*, type. f, Guadalupe Mts. g, *Bulimulus dealbatus mooreanus*, San Antonio; h, DeWitt Co.; i, New Braunfels. j, *Bulimulus dealbatus ozarkensis*, type. k, *Bulimulus dealbatus jonesi*, Green Co., Alabama; l, type of same. (Figs. a' and l $\times 2$, others actual size.)

ALABAMA: Black Bluffs, Tombigbee River, Choctaw County; Duggar Mountain, Cleburne County; Cherokee, Colbert County; Selma, Dallas County; Boligee, Eutaw, Greene County; North of Gallion, Hale County; Little Mount Matthews Hill, Huntsville, Monte Sano, Madison County; Near Demopolis, Marengo County; Mobile, Mobile County; McGee's Station, Barachias, Montgomery, Montgomery County; Hamburg, Uniontown, Perry County; Livingston, Epes, Sumter County; Camden, Wilcox County.

TENNESSEE: Nashville, Davidson County.

KENTUCKY: Warren County.

ILLINOIS: Fountain Bluff, Union County.

MISSOURI: Hannibal, Marion County; Rivermines, Saint Francois County; Chadwick, Christian County. Also Barry, Douglas, Camden and Cooper Counties (Sampson, *Nautilus*, 8: 18).

ARKANSAS: Sulphur City, Washington County.

KANSAS: Shawnee County; Lawrence, Douglas County. From the Kansas river south and west to a line south from Topeka; Burnett's mound, Shawnee Co. (J. B. Quintard); Soldier Creek, in drift. LeBette Co.

OKLAHOMA: 7 miles south of Antlers; Sugarloaf Mountain, LeFlore County; Limestone Gap, Atoka County.

LOUISIANA: near Frierson, DeSoto Parish.

TEXAS: Dallas, Dallas County; Waco, McLennan County; Belton, Bell County; Coryell County; San Marcos, Hays County; Austin, Travers County; Lee County; Atacose River, Live Oak County; Robstown and Corpus Christi, Nueces County.

Say's type lot of three, of which two are figured, the larger selected as type, represents the common form and size in Alabama. Those seen from Tennessee and Kentucky are substantially the same, and some lots from as far west as Kansas and Texas do not seem separable. Specimens from Jackson County, Texas are figured, Fig. 4 b. However, the prevalent form in Texas is larger, and at one time I thought it might be separable as a race *liquabilis*, noticed below.

In prairie districts of Greene County, in western Alabama, the shells are often more elongate and uniform opaque white, as described below under *jonesi* Clench. In other lots, as from a prairie 2.7 miles south of Demopolis, Marengo County, the coloration is typical but the shape varies from normal to elongate. Three measure:

Length 19.3 mm., diameter 11.1 mm., aperture 10 mm.

Length 18 mm., diameter 11.1 mm., aperture 9.9 mm.

Length 18.4 mm., diameter 9.7 mm., aperture 8.4 mm.

The single Illinois record, from Fountain Bluff, Union County, belongs to the typical form. F. C. Baker believes that shells of this place "crossed the Mississippi River from Missouri."

In the form *liquabilis* Reeve (Fig. 4 c) the shell is thin, variable in shape but usually obese, the aperture more than half the total length. Translucent-gray or brownish-gray, more or less profusely marked with opaque whitish ragged streaks as in typical *B. dealbatus*. Interior whitish or colored like the outside.

Length 25 mm., diameter 15.4 mm., aperture 14.8 mm. Lee Co.

Length 25.2 mm., diameter 15 mm., aperture 13 mm. Waco.

This is the form of the humid Austroriparian zone in Texas, as *B. d. mooreanus* is of the arid division. Specimens are before us from the following counties: Dallas, McLennan, Coryell, Bell, Travis, Lee, Hays, Jackson, Nueces, Uvalde, Medina and San Patricio. Also from Limestone Gap, Oklahoma.

The form *liquabilis* differs from *mooreanus* by the predominance of corneous-brown stripes. It is also usually more globose and less smooth. It runs larger than *B. dealbatus*, and is often more globose with less convex whorls, as a general rule, yet there seems to be practically complete intergradation between the races, and some Texas shells, even from as far west as Uvalde County, are not distinguishable from those of Alabama, though many others could not be matched closely from east of the Mississippi. It seems hardly separable as a subspecies.

(*Dealbatus*, whitewashed).

Bulimulus dealbatus jonesi Clench

Figs. 4 k, l.

Bulimulus dealbatus jonesi Clench, 1937, *Nautilus*, 51: 18, pl. 3, fig. 4.

"This form differs from the typical *B. dealbatus* Say by being much thicker in texture and being all white rather than mottled with axial streaks of opaque and translucent areas. In addition, the apex (nuclear whorls) are a pale straw color and somewhat glass-like in appearance. Proportionately, the shell is more attenuated and the whorls somewhat less convex. All remaining characters appear as in the typical form. Length 19.1, width 9.9, aperture 9×5.1 mm. (type). Length 20, width 11, aperture 9.4×5.9 mm. (average of five paratypes)." (Clench).

ALABAMA: Two miles north of West Greene, Greene County (Miss Winnie McGlamery), Type no. 89, Univ. Ala., paratypes 75036 M. C. Z. Prairies between Clinton and West Greene (R. M. Harper & A. F. Archer).

Distinguished by its opaque white color, uniform except for the buff apex, without corneous streaks, the aperture buff within with a white margin, and the spire often a little longer than in typical *dealbatus*. Its differential features are conspicuous in "live" specimens, though hardly noticeable in weathered shells. It calls for further investigation from the anatomic and the ecologic standpoints, as it may turn out to be a species distinct from *B. dealbatus*. Specimens selected to show extremes of shape measure:

Length 18.8 mm., diameter 10 mm., aperture 9.3 mm.; $6\frac{1}{2}$ whorls.

Length 16.3 mm., diameter 9.7 mm., aperture 8.5 mm.; $6\frac{1}{2}$ whorls.

Length 16.3 mm., diameter 8.5 mm., aperture 7.2 mm.; $6\frac{1}{3}$ whorls.

(Named for Dr. Walter B. Jones, State Geologist of Alabama.)

Bulimulus dealbatus ozarkensis Pilsbry & Ferriss

Fig 4 j.

Bulimulus dealbatus Say, Pilsbry, Proc. Acad. Nat. Sci. Phila., 1903, p. 204 (Seligman, Mo.).

Bulimulus dealbatus ozarkensis Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci., Phila., p. 136, pl. 6, figs. 14, 15.

Bulimulus dealbatus Say, Stearns, 1893, Proc. U. S. Nat. Mus., 16: 751 (Stone County, Mo.).

The whole shell, and especially the last whorl, is narrower than in *dealbatus*; the aperture is smaller, ordinarily half the total length or less, and the umbilicus is narrower. The shape is about that of *B. d. ragsdalei*, but the last whorl is not rib-striate, though the spire is weakly so. Coloration as in *dealbatus*. Specimens measure:

Locality:	Seligman	Rogers	Mammoth Spring	Limestone Gap	
Length:	26 mm.	21.6 mm.	21 mm.	22 mm.	17 mm.
Diameter:	13.2 mm.	10.5 mm.	11 mm.	11.3 mm.	9.4 mm.
Aperture:	12.8 mm.	10 mm.	10.8 mm.	11 mm.	9 mm.
Whorls:	7	7	$6\frac{1}{2}$	$6\frac{1}{2}$	6

ARKANSAS: Mammoth Spring, Fulton County; Rogers, Benton County.

MISSOURI: Seligman, Barry County.

OKLAHOMA: Limestone Gap, Atoka Co. Type and paratypes 91358 A. N. S. P.

While only weakly characterized, this form apparently deserves recognition by name. It ranges over a considerable area of the northern and western outliers of the Ozark system.

Bulimulus dealbatus ragsdalei (Pilsbry)

Fig. 5.

Bulimulus ragsdalei Pilsbry, 1890, Nautilus, 3: 122; 5: 39, 48, pl. 2, fig. 3; Proc. Acad. Nat. Sci. Phila., 1890, pp. 63, 296, pl. 5, fig. 3.—Binney, 4th. Suppl., Bull. Mus. Comp. Zool., 22: 191, pl. 2, fig. 9.—Stearns, 1891, Proc. U. S. Nat. Mus., 14: 97.

Bulimulus dealbatus ragsdalei Pils., Dall, 1896, Proc. U. S. Nat. Mus., 19: 374.—Pilsbry, 1897, Man. Conch., 11: 129, pl. 18, fig. 31.—Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 137, pl. 6, figs. 16-24.

“The shell varies from the ovate shape of typical *dealbatus* to a more lengthened and slender form, and is *conspicuously rib-striate*, the striae white on a tawny or white-blotched ground and weaker on the base of the shell. The lip-rib is strongly developed” (P. & F.).

Three adult specimens of the type lot measure: Length 21.5 mm., diameter 10.8 mm., length aperture 10 mm., 6½ whorls. 18.5, 10.3, 9.3 mm., 6½ whorls. 16.5, 8.3, 8 mm., 6 whorls.

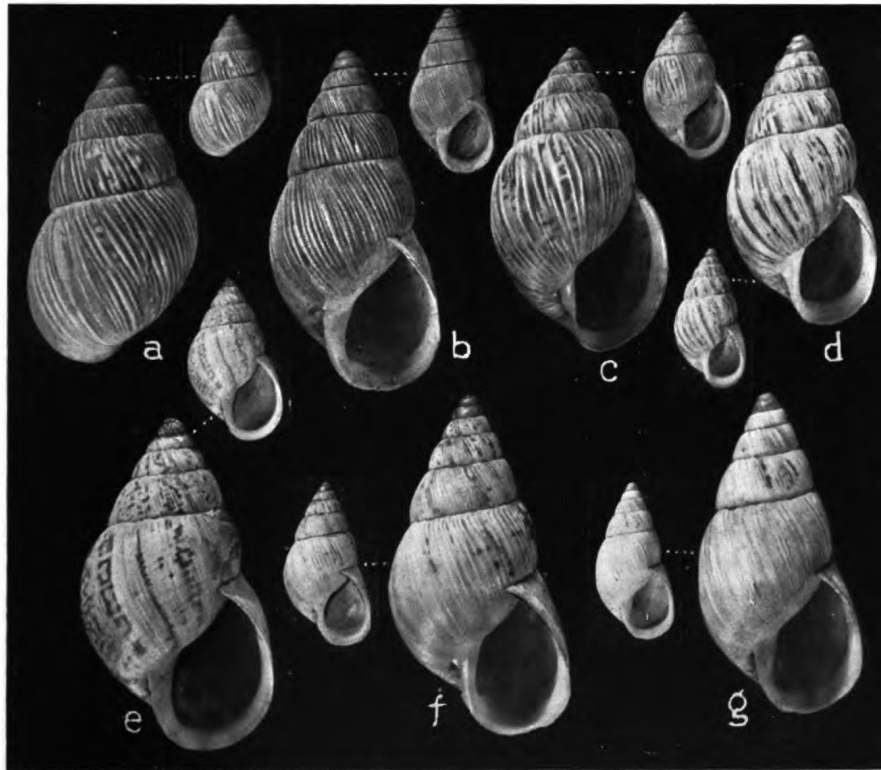


Fig. 5. *Bulimulus dealbatus ragsdalei*, a, b, paratype and type; c, d, highland west of Devil's River; e, f, g, Rio San Filipe. Actual size and $\times 2$.

TEXAS: Dead, more or less bleached shells from the top of the Red River bluff at the southern end of Warren's Bend, twenty-five miles northwest of Gainesville, Cooke

County; a mile north of St. Jo., Montague County (G. H. Ragsdale). Type and paratypes 58380 A.N.S.P. Val Verde County, in high land west of Devil's River and along Rio San Filipe not far from the Rio Grande, in chaparral (Ferriss & Pilsbry); between Sanderson and Langtry, Pecos County; Alpine, Brewster Co.; east of Brackettville, Kinney County, and Nueces River, Uvalde County (Ferriss).

In Val Verde County, several hundred miles from the original locality, the specimens found (Fig. 5 c, d) do not differ materially from those of northern Texas, but the proportions are variable, as in the following measurements of seven specimens from Devil's River:

Length	26.5	20	20	21.5	19	16.5	17 mm.
Diameter	12.5	9.2	10.3	10	10.8	10	8 "
Aperture	12.5	9	10	10.5	10.7	9.3	8 "
Whorls	7½	7	6¾	6½	6	5½	6½

The average size of 78 living shells is about 19×9 to 10 mm.; the largest shell taken, a dead one, is 26.5 mm. long. There is but little variation in sculpture among shells from this place.

Along the Rio San Filipe, not far from the Rio Grande, in chaparral on the east side, we found numerous specimens differing from those of Devil's river by having the rib-striae nearly obsolete on the last whorl except just below the suture (Fig. 5 e, f, g).

Dead, bleached shells were found in abundance on the high land west of Devil's river, but the living ones for some time eluded us. Finally we found them hidden under the dead reversed leaves which thatch the trunks of yuccas, and sometimes under prostrate dead yuccas — retreats they share with the smooth race of *Polygyra texasiana*.

(Named for G. H. Ragsdale, 1846-95, a zoological collector and taxidermist, who first found this race.)

***Bulimulus dealbatus mooreanus* (Pfeiffer)**

Fig. 4 g. h. i.

Bulimus schiedeanus var., W. G. Binney, 1859, Terr. Moll., 4: 129, pl. 80, fig. 8.

Bulimus mooreanus W. G. Binney, Pfeiffer, 1868, Monogr. Hel. Viv., 6: 143.

Bulimulus schiedeanus var. *mooreanus* W. G. Binney, 1878, Terr. Moll., 5: 392, figs. 277-279.

Bulimulus dealbatus mooreanus W. G. B., Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 133, pl. 6, figs. 1-6.

Shell umbilicate, ovate-conic; white above, coffee-with-cream colored below the periphery, or all white, the basal tint absent; sometimes varied with waxen or dark gray streaks, and often showing scattered gray dots which are translucent by transmitted light. Surface smooth, under the lens sometimes showing more or less strongly developed striae on the spire; apex waxen or dark. Interior white. Outer lip often strengthened by an internal white rib.

Length 25.5 mm., diameter 15 mm., aperture 14 mm.

Length 26 mm., diameter 14 mm., aperture 14 mm.

Length 26 mm., diameter 12.5 mm., aperture 12.6 mm.

Length 24 mm., diameter 11.7 mm., aperture 12 mm.

TEXAS: Fort Worth, Tarrant County (Sampson); Athens, Henderson County (Ferriss); San Marcos, Hays County (Pilsbry); Travis, Falls County (Julia Gardner); Georgetown, Williamson County (Averell); Washington and DeWitt counties (A. D. Brown); Austin, Travis County (Pilsbry); Sequin, Guadalupe County (Rehn); New Braunfels, Comal County (Pilsbry); Macdona (Wenzel) and San Antonio, Bexar County (Pilsbry); Fort Bend County (Rehn); near Honda, Medina County (Pilsbry); Victoria, Victoria County (J. D. Mitchell); Uvalde County (Ferriss); Brackettville, Kinney County (Ferriss); Frio County (Singley). Pecos Hills, between High Bridge and San Antonio Highway (Ferriss).

The dimensions vary widely. It is a smaller and much thinner shell than *B. schiedeanus*. It is typically more slender than *B. dealbatus*, smoother, with uniform or only slightly variegated color.

This is the abundant *Bulimulus* throughout central-southern Texas, particularly in the region about San Antonio. It lives in vast numbers in the mesquite chaparral, hibernating in the earth, aestivating upon the bushes, adhering to the bark. It is the only *Bulimulus* found in the greater part of the region it inhabits, and is one of the commonest forms in collections.

In Comal, Guadalupe, Bexar and Medina counties only typical *mooreanus* is known to occur. In Frio County the shells are somewhat more solid and often whiter. In a series of 313 specimens from along the Guadalupe River above New Braunfels (fig. 4 i) I could find but one shell with any of the ragged stripes of *B. dealbatus*. In 165 taken along the river below San Antonio (fig. 4 g) there were 7 with some ragged stripes, at least on the upper whorls. A series of 55 *mooreanus* from Victoria had 4 striped shells. The percentage of intergrading specimens is therefore small.

***Bulimulus dealbatus neomexicanus* new subspecies**

Fig. 4 e. f.

In the mountains of southern New Mexico a form occurs which, with the thin texture, light interior and more or less copiously streaked and mottled pattern of *dealbatus*, differs by its far larger size.

Length 33 mm., diameter 19 mm.; 6 $\frac{3}{4}$ whorls. Burke's Spring.

Length 29.3 mm., diameter 17 mm.; 6 $\frac{1}{2}$ whorls. Burke's Spring.

Length 30 mm., diameter 17.2 mm.; 6 $\frac{1}{2}$ whorls. Guadalupe Mountains.

Length 25 mm., diameter 14.2 mm.; 6 $\frac{3}{8}$ whorls. Guadalupe Mountains.

NEW MEXICO: Burke's Spring, west slope San Andreas Mountains, Type and paratypes 175913 A.N.S.P. Rope's Spring, about 10 miles farther north. Guadalupe Mountains, east of Orange, in several places (Pilsbry & Ferriss, 1922); Picacho, Lincoln County, 5500-6500 ft. (Wharton Huber); cave west of Carlsbad (E. B. Howard).

In some places, as in the Guadalupe Mountains east of Orange, and a lot from Picacho, there are also colonies of shells not larger than some *dealbatus* or *mooreanus*; see last measurement above.

The San Andreas Mountains, N. M., are the farthest west for any *Bulimulus* of the *dealbatus* group. Whether these western *Bulimuli* should form a separate subspecies or be included in *dealbatus* without such distinction is a difficult question. Their area is rather widely separated from that of the eastern herd.

Burke's Spring is about 9 miles east of the Jornada Ranch headquarters, which is 17 miles north of Las Cruces. Rope's Spring is about 10 miles north of Burke's. This western slope of the San Andreas Mountains is very arid limestone, dipping west. Rainfall is said to be normally 8 or 9 inches but often less. This *Bulimulus*, *Holospira roemeri*, *Ashmunella kochi ambliia* and a few smaller land snails were found there.

***Bulimulus alternatus mariae* (Albers)**

Fig. 6 a-d, f.

Bulimus mariae Albers, 1850, Die Heliceen, p. 162.

Bulimulus alternatus mariae Alb., Pilsbry & Ferriss, Proc. Acad. Nat. Sci. Phila., 1906, p. 139, pl. 7, figs. 13-30.—Cockerell, 1891, Journ. de Conchyl., 39: 23, with vars. *intermedius* "Singl." and *albidus* "Taylor."—J. Henderson, 1935, Nautilus, 49: 107.—MacMillan, 1941, Nautilus, 55: 32.

Bulimus alternatus Binney, 1857, Terr. Moll., 3: pl. 51a, 51b.

Bulimulus alternatus Say, in part. Binney, 1878, Terr. Moll., 5, p. 388, figs. 272, 273.

Bulimus binneyanus Pfeiffer, W. G. Binney, 1859, Terr. Moll., 4: 128, based upon Terr. Moll., 3, pl. 51b. Not *B. binneyanus* Pfeiffer, 1858, Malak. Blätter, 4: 229.

The perforate shell is oblong-conic, solid, opaque, white, uniform or with many unequal, partly ragged brown to gray stripes, the interior deep brown (of varying shades). After the costulate embryonic whorls, the surface is smoothish, quite lightly marked with wrinkles of growth. The rather narrow aperture has a light colored internally thickened outer lip, the columellar lip rather widely reflected; an obtuse fold or blunt "tooth" on the upper part of the columella is often weak and sometimes wanting.

Length 27 mm., diameter 15.3 mm., aperture 15 mm. Brownsville.

Length 30.7 mm., diameter 13 mm., aperture 14.5 mm. Brownsville.

Length 31.7 mm., diameter 16.6 mm., aperture 17 mm. Brownsville.

Length 24 mm., diameter 12 mm., aperture 12.7 mm. Brownsville.

TEXAS: Lower Rio Grande and neighboring counties; Brownsville, Cameron Co.; Hidalgo Co.; Starr Co.; Laredo, Webb Co.; Maverick Co.; Corpus Christi, Nueces Co.; Derby, and above Frio, Frio Co.; Atacosa River, Live Oak Co.; Kingsville and Riviera. Kleberg Co.; near Premont, Jim Welles Co., and Falfurrias, Brooks Co.

MEXICO: 25 miles north of Valles, state of San Luis Potosi (A. A. Hinkley); many places in northern Nuevo Leon and Tamaulipas (Edgar Bowles).

It differs from typical *B. alternatus* by the greater solidity of adult shells, the more oblong shape and by frequently having a prominence or "tooth" on the columella.

Professor Cockerell proposed the following arrangement of the forms of *B. alternatus*: 1, with gray or brown markings: a, no tooth on the columella, *alternatus* Say; b, a tooth on the columella, *mariae* Albers. 2, without color markings: a, no tooth on the columella, *albidus* "Taylor"; b, a tooth on the columella, *binneyanus* "Pfr." As the name *binneyanus* is not valid in this connection, *intermedius* Singley Ms. was proposed as a substitute for the white, dentate form, which often occurs in pure colonies. Since all colonies of striped shells contain also pure white ones, with intergradations, and the tooth may be either present or absent among shells of one colony, these categories were not intended as races but as a terminology for the variations.

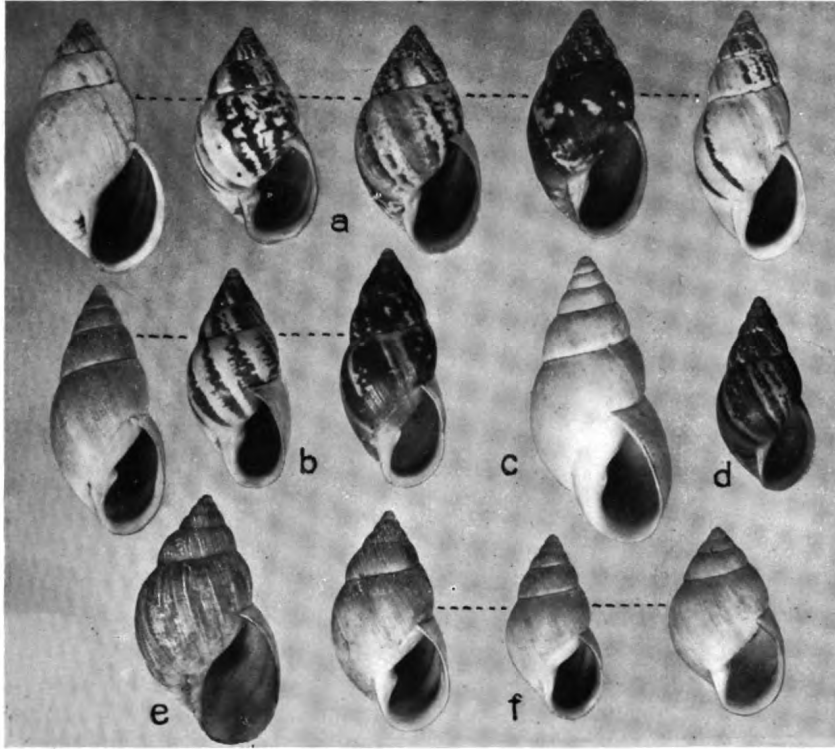


Fig. 6. *Bulimulus alternatus mariae*. a, Brownsville; b, Donna; c, Roma, Starr Co.; d, Rio Grande City; e, *Bulimulus alternatus*, type; f, *Bulimulus alternatus mariae*, Corpus Christi.

This species, like *B. dealbatus mooreanus*, often occurs in great abundance, and sometimes, in aestivation, may be seen "sealed to large cactus, mesquite, coarse grass and shrubs, and on fence posts and telephone poles, even to the very top, in the full glare of the hot sun." Fig. 2.

The habitat of *mariae* was unknown to Albers, but his type, figured by Pfeiffer, is the striped, toothed form common in the lower Rio Grande counties of Texas and the neighboring state of Tamaulipas, Mexico. Brownsville, Texas is selected as type locality. Albers recognized it as new on the twelfth birthday of his daughter Mary, for whom he named it.

Bulimulus alternatus (Say). References to the typical form follow:

Bulimulus alternatus Say, 1830, New Harmony Disseminator, p. 25.—Binney, 1857, Terr. Moll., 3: pl. 51, fig. 1.—W. G. Binney, 1858, Terr. Moll., 4: 126, pl. 80, fig. 1 (copy of Say's drawing).

Bulimulus alternatus Say, Binney, 1878, Terr. Moll., 5: 388, fig. 271.—Pilsbry, 1897, Man. Conch., 11: 132, pl. 25, figs. 50-53.

Bulimus lactarius Menke, Pfeiffer, 1846, Symbolae ad Hist. Hel., 3: 85.—Reeve, 1848, Conch. Icon., 5: pl. 37, figs. 217 a, b.

The typical form of *B. alternatus* is a rather thin shell of light ochraceous buff color, with streaks, usually ragged, of dresden brown, the markings quite variable in different specimens. The reflected columella is nearly white and is not toothed. The outer lip is but slightly thickened. The interior is cinnamon buff with some dark streaks. In weathered examples, like that preserved as Type (25694 A.N.S.P.), and one figured by A. Binney, the shell becomes pale gray with ragged white stripes, and the interior white. A common size is 27×16 mm., but they may be either more slender or more obese. The type (Fig. 6 e) measures 31×18 mm., aperture 17.6 mm.

Typical *alternatus* apparently is not found in Texas. I have collected it abundantly at Monterrey, Nuevo Leon, in the Santa Caterina valley opposite and above the Obispado, mainly on mesquite. As Say gave only the locality "Mexico, Wm. Maclure," I propose to select Monterrey as the type locality.

***Bulimulus schiedeanus* (Pfeiffer)**

Fig. 7 a-d.

Bulimulus schiedeanus Pfeiffer, 1841, Symbolae Hist. Hel., 1: 43 (Mexico).

Bulimulus schiedeanus Pfr., Von Martens, 1893, Biol. Centr. Amer., Moll., p. 239, pl. 15, figs. 12-23.—Pilsbry, 1897, Man. Conch., 11:131.—Clapp, 1915, Nautilus, 28: 132.

Bulimulus patriarcha W. G. Binney, 1858, Proc. Acad. Nat. Sci. Phila., p. 116 (Buena Vista, Mexico).

Bulimulus patriarcha W. G. Binney, 1885, Man. Amer. Land Shells, p. 396, fig. 431.

Bulimulus alternatus hesperius Pilsbry & Ferriss, 1924, Nautilus, 38: 40.

Narrowly umbilicate, ovate-conic, often with the spire rather attenuated above; rather solid and strong, calcareous; white or with some ochraceous streaks; roughly, irregularly but rather lightly striate, not shining. Spire nearly as long as the aperture. Aperture varying from white to ochraceous or tawny inside. Peristome without an internal callous rim. Columella without any prominence or tooth.

Length 31 mm., diameter 17 mm.; length aperture 17 mm. (Pfr. type).

Length 40 mm., diameter 20.5 mm.; length aperture 20 mm.; Terlingua.

Length 34 mm., diameter 20.3 mm.; length aperture 19 mm.; Terlingua.

Length 29 mm., diameter 16.6 mm.; length aperture 16 mm.; Saltillo, Coahuila.

MEXICO: Original locality, Dr. Schiede. Tehuacan, State of Puebla (F. C. Baker, Uhde and others); Laguna de Chapala, Jalisco (Deppe); Villa Lerdo, Durango (Höge); State of Coahuila around Saltillo (Pilsbry). TEXAS: counties along the Rio Grande from Val Verde County to Marfa, Presidio County; at Terlingua, south to the Rio Grande and for about 20 miles northward, Brewster County (Ferriss & Pilsbry).

Most of the Texas specimens seen are pure white outside, white or ochraceous within, but a large lot from the east side of the Pecos high bridge are claret brown inside, like *mariae*, and sometimes have few or many ochraceous streaks externally (Fig. 7 b).

On the Pecos we found them chiefly on agaves. At Buena Vista, south of Saltillo, Coahuila, they were abundant on grass and weeds.

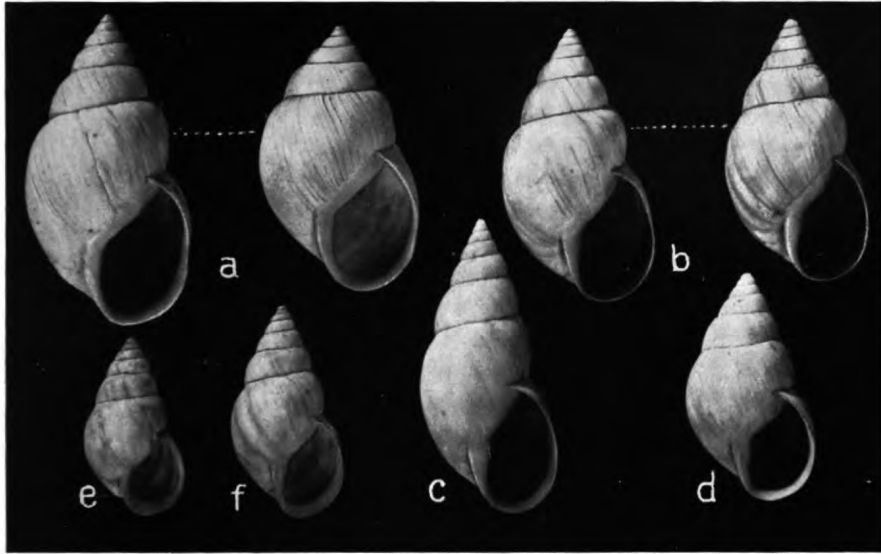


Fig. 7. a, *Bulimulus schiedeanus*, Terlingua; b, east end High Bridge of the Pecos (the right hand figure is type of the synonymous *B. a. hesperius*); c, Langtry; d, Del Rio; e, *Bulimulus schiedeanus pecosensis*, between High Bridge and Del Rio; f, type of *B. s. pecosensis*.

Some of the specimens from Val Verde County approach *B. mariae*, and may possibly be intergrades. Binney's figures, Terr. Moll., 5: 391, fig. 276, are certainly not *schiedeanus*, which does not occur in Washington County, Texas, as there stated.

In general, *mariae* and *schiedeanus* differ as follows:

<i>B. a. mariae</i>	<i>B. schiedeanus</i>
Smaller, more oblong; lip more thickened; columella frequently toothed; often with ragged streaks, at least on the earlier whorls. Mainly east of 100th meridian.	Larger, more conic; lip less thickened within; no columellar tooth; often streaked, but without ragged or mottled streaks. West of 101st meridian.

(Named for Dr. Chr. J. W. Schiede, of Cassel, who traveled in Mexico and collected this species in 1828.)

Bulimulus schiedeanus pecosensis Pilsbry & Ferriss

Fig. 7 e, f.

Bulimulus dealbatus schiedeanus var., Pilsbry, 1897, Man. Conch., 11: 132, pl. 17, fig. 6.

Bulimulus dealbatus pecosensis Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 138, pl. 6, figs. 26, 27

"The shell is *conspicuously calcareous*, whitish with some fleshy or sometimes corneous or ochraceous streaks; upper whorls striate, the last somewhat roughened by irregular growth-wrinkles. Spire long, composed of numerous *short* convex whorls, the suture *nearly horizontal*; apex white or pale; aperture small, usually ochre-tinted in the throat, lip strengthened by a rib within." (P. & F.).

Length	31	29.7	26.5	24	22.8	21	mm.
Diameter	14.8	14	12.8	12	12.7	10.7	"
Aperture	15	14	12.7	10.3	11.5	10	"
Whorls	7 $\frac{1}{4}$	7 $\frac{1}{4}$	7 $\frac{1}{3}$	7 $\frac{1}{4}$	7	7	

TEXAS: About 1 $\frac{1}{2}$ miles southeast of the eastern end of the Southern Pacific RR. High Bridge of the Pecos (Ferriss & Pilsbry), Type 84618 A.N.S.P. West side of the mouth of the Pecos (Ferriss). Seven miles south of Acampo, Shackelford County (Pilsbry & Harvey).

Some specimens of *pecosensis* taken over sixty years ago by Dr. H. C. Wood, probably, as he informed me, from somewhere in the Great Bend of the Rio Grande, were figured in the *Manual of Conchology*.

This race seems distinct by its rather long spire of more strongly convex whorls, by which it differs also from *B. d. mooreanus*.

***Bulimulus pasonis* Pilsbry**

Fig. 8.

Bulimulus dealbatus pasonis Pilsbry, 1902, Nautilus, 16: 32.—Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 138, pl. 6, fig. 25.

The shell is small, umbilicate, slender, the diameter about half of the length; rather thin, cinnamon-buff with streaks and mottling of opaque white (or opaque white or faint pink may predominate, leaving only streaks

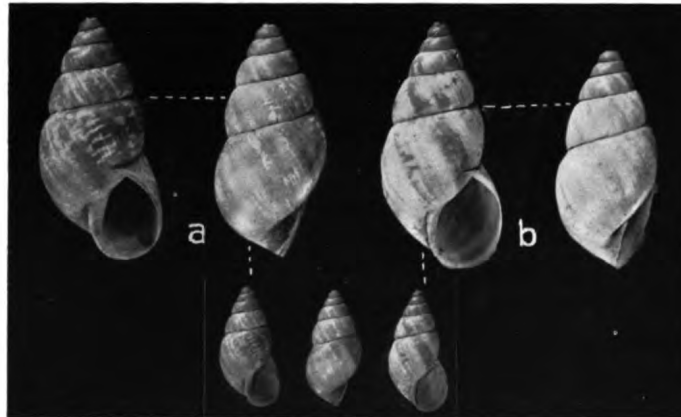


Fig. 8. *Bulimulus pasonis*, a, El Paso, type and paratype; b, Guadalupe Mts., N. M. ($\times 2$ and actual size).

of the darker color). Surface with very little gloss, the first 1 $\frac{1}{2}$ whorls axially ribbed, the remainder nearly smooth. The aperture is small, much

less than half of the length, faintly brown to white within. Outer lip thin, unexpanded, the columellar margin rather broadly dilated.

Length 15.6 mm., diameter 7.5 mm., aperture 6.7 mm.; 6 whorls. Type.

Length 15.8 mm., diameter 7.3 mm., aperture 7 mm.; 6 whorls.

Length 15 mm., diameter 7.3 mm., aperture 7 mm.; 5½ whorls.

TEXAS: Franklin Mountain near El Paso (Ferriss & Pilsbry), Type and paratype 83259 A.N.S.P. South flank Signal Peak. Guadalupe Mts., 6500 ft. (Pilsbry & Harvey); George Hill's bluff, Grand Canyon of the Rio Grande, Brewster Co. (Ferriss). NEW MEXICO: Sacramento Mountains in Alamo Canyon and to at least 20 miles south of Alamogordo (Pilsbry & Ferriss); Guadalupe Mountains in canyons east of Orange (Pilsbry, 1922).

The diminutive size, narrow shape, and short aperture with converging lip-ends, give this species individuality. It has coloration of the *dealbatus* patterns, but varies from streaked or mottled to nearly uniform pinkish white, and I took one albino shell. When originally described it was known by very few examples from a single place, and thought to be an extreme form of *dealbatus*; but I have since collected many specimens in three mountain ranges, finding the size and shape to be quite constant. It is, in fact, one of the most distinct species. In the Guadalupe mountains there is also a large form of *B. dealbatus*.

Bulimulus durangoanus Von Martens (Biol. Centr. Amer., Moll., p. 246, pl. 15, figs. 11, 11a, October, 1893) from Villa Lerdo, State of Durango, appears to resemble *B. pasonis* closely. As it is known by a single shell which I have not seen, no direct comparison has been made.

Bulimulus nigromontanus Dall

Fig. 9.

Bulimulus (alternatus var.?) *nigromontanus* Dall, 1897, Proc. U. S. Nat. Mus. 19: 357.

Bulimulus nigromontanus Dall, Pilsbry, 1897, Man. Conch., 11: 128.—Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75: 96, pl. 1, figs. 3, 4.

"Shell short, wide, white, with 5 whorls, rather rudely striated in harmony with the lines of growth, nuclear whorls 2, neatly, evenly sculptured with fine, usually wavy, minute ribs, the summit with a small central funicular dimple; whorls moderately rounded, the last much the largest, the spire obtusely conical; base full and rounded, with a rather large, deep and subcylindrical umbilicus; outer lip sharp, hardly reflected; pillar lip reflected rather widely near the body around (not over) the umbilicus; body with a thin wash of callus, the outer lip strongly incurved at its junction, giving a somewhat tubular look to the suture; substance of the shell thin, without markings. Length 18, of the last whorl 13, maximum diameter 11 mill." (Dall).

Length 19.6 mm., diameter 11.4 mm., aperture 10.4 mm. Pina Blanca.

Length 17.4 mm., diameter 10.3 mm. Moor Ranger Sta.



Fig. 9.—*B. nigromontanus*.

MEXICO: Summit of Black Mountain, 12 miles south of Monument 77 of the International Boundary, on the right bank of the San Bernardino River, State of Sonora. Type 129993 U.S.N.M.

ARIZONA: Pajaritos Mountains, in Pina Blanca canyon. Also 5 miles north of Moor Ranger Station, Pina Blanca, in a small canyon running east, opposite the main gulch from the Tumacácori Mountains, in a slide on the north slope of a hill of crumbling porphyry (Ferriss and Hinkley, 1919).

The original specimens were in poor condition. Arizona shells (Fig. 9) are whitish under a thin periostracum of dilute chamois tint, sometimes wearing off in streaks. The apex has a deep apical dimple and some rugosity on the tip, close axial riblets then beginning, either straight or slightly sinuous and extending from suture slightly more than half across the whorl, which is smooth or but slightly roughened below them. The neanic growth, smooth but dull, begins midway of the second whorl. The last whorl has a few very low growth wrinkles. The apical sculpture is often weak or lost in adult shells.

It lives in grass and low brush. It is quite distinct from all other *Bulimulus* of Mexico or the United States.

***Bulimulus pilsbryi* Ferriss**

Fig. 10.

Bulimus pilsbryi Ferriss, 1925, *Nautilus*, 39: 25; name corrected to *Bulimulus pilsbryi* in index.

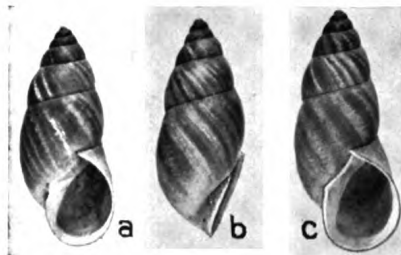


Fig. 10.—*Bulimulus pilsbryi*, type and two paratypes.

“The shell has a narrow, compressed umbilicus, and is slender, the diameter less than half of the length; the outlines of the spire are somewhat convex, the whorls moderately so. The surface is nearly smooth, rather glossy; most of the first whorl irregularly rugose, the second having straight, regular axial riblets; subsequent whorls with weak growth-striae. The color is light pinkish-cinnamon profusely streaked with opaque white, the streaks somewhat ragged (or in some specimens smooth and blending into

the ground-color). The aperture is small, oblique, the outer lip thin, narrowly expanded, the columellar lip broadly expanded; the ends of the lip approach more than usual and are joined by a thin, transparent film” (Ferriss).

Length 27.8 mm., diam. 12 mm., length of aperture 12.5 mm.; $6\frac{1}{3}$ whorls. Type.

Length 28 mm., diam. 12.7 mm.

TEXAS: Sanderson, Terrell Co. (J. H. Ferriss), Type 175851 A.N.S.P.; Housetop Mountain, between Sanderson and Marathon (Ferriss).

By its slender figure and narrow aperture this species recalls some of the Lower Californian forms, such as *B. inscendens* (W. G. B.). It is strikingly unlike other Mexican and Texan species. It seems strange that a species so

distinct has occurred near Sanderson only, other Texan *Bulimuli* being rather widely distributed. However, except along the highway, that part of the state has not been explored for mollusks.

By a pen or typographic error this was originally described as a "*Bulimus*," but in preceding and following paragraphs Mr. Ferriss referred to it as a *Bulimulus*.

DRYMAEUS Albers

Drymaeus Albers, 1850, Die Heliceen, p. 155.—Pilsbry, 1896, Nautilus, 9: 114; 1898, Man. Conch., 11: 182. type *D. hygrophylaeus* (Orb.).

Ostomus Von Martens, 1873, Binnenmoll. Venezuela's, in Festschr. 100-Jährigen Feier Ges. Naturforsch. Freunde zu Berlin, p. 23; 1893, Biologia Centrali-Americana. Moll., p. 191. Not *Ostomus* Beck, 1837.

Bulimulus subgenus *Goniognathmus* Crosse and Fischer, 1875, Miss. Sci. Mex., Moll., 1: 473, type *Bulimus lattrei* Pfr.

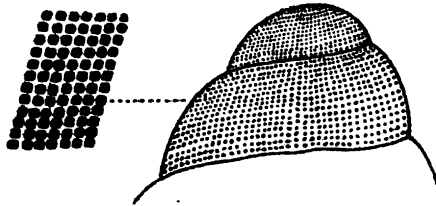


Fig. 11.—Apex of *Drymaeus*.

Shell ovate or oblong with conic spire, umbilicate or imperforate, rather thin; the aperture varying from subtriangular to ovate; lip simple or expanded, the columellar margin reflexed; the apical $1\frac{3}{4}$ whorls have an extremely minute, even grating of axial and spiral threads (Fig. 11).

Jaw thin, composed of subvertical, overlapping laminae soldered together at their inner, free at their outer

edges, generally obliquely converging in the middle, leaving a triangular area of shorter laminae above.

Radula broad, with peculiarly modified teeth, centrals tricuspid or with the cusps concrescent into one; laterals oblique, with three or four large subequal cusps, united toward their bases; marginals not clearly differentiated from the laterals, with the ectocones generally split into several denticles.

The genitalia (Fig. 12 B, C, *D. multilineatus*, F, G, *D. dominicus*) are much as in *Bulimulus*. In both species the flagellum is very short, relative to the epiphallus, with terminal penial retractor. In *D. multilineatus* there is a stout sheath around the penis, but in *D. dominicus* I saw none. The spermathecal duct is shorter than in *Rabdotus*, especially short in *D. multilineatus*. The talon is shorter than in *Rabdotus*.

The radula has very numerous teeth, 79–1–79 in *D. dormani*, 121–1–121 in *D. dominicus*, 144–1–144 in *D. multilineatus*. The central tooth is smaller than the adjacent laterals, bicuspid. The side teeth are not distinctly divided into laterals and marginals. They are oblique, with 3 or 4 cusps, or more on the outer teeth. (Fig. 12 A, *D. multilineatus*).

Distribution.—Tropical and subtropical North and South America. They are arboreal snails.

Drymaeus is widely deployed in tropical South America and has many species in Mexico, but except in the Carribees it is only weakly represented

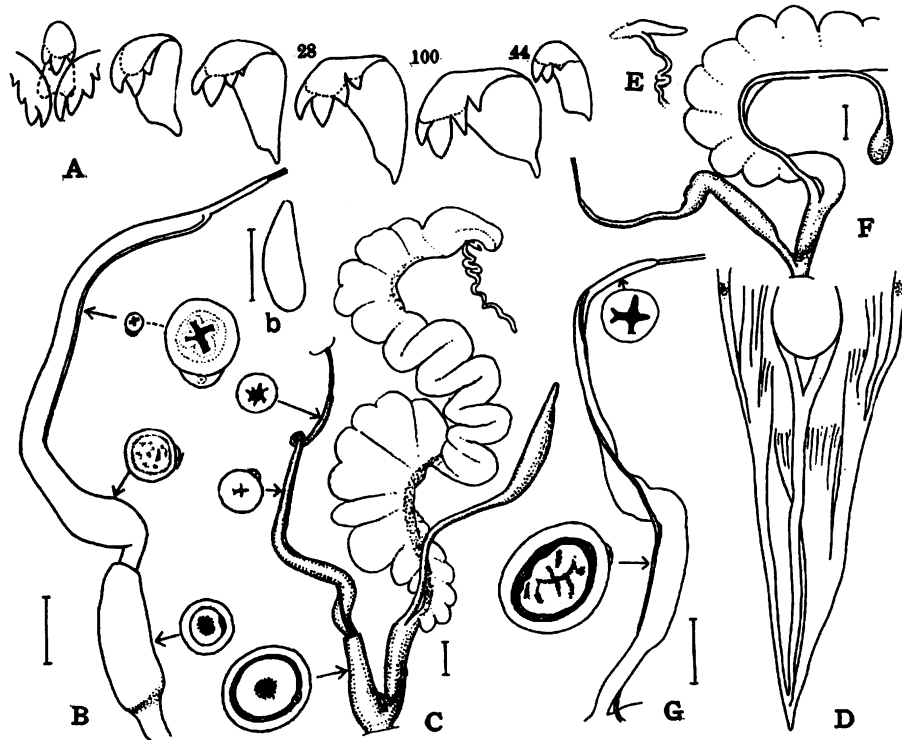


Fig. 12. *Drymaeus multilineatus*: A, teeth, Sugarloaf Key (after H. B. Baker); B, penis, with three transverse sections, and at b, a membranous spermatophore. Lower Matecumbe Key; C, genitalia of another example, with sections of penis; D, free retractor muscles. *Drymaeus dominicus*, Miami, Florida; E, talon; F, anterior parts of genitalia; G, penis of another individual, with two sections.

in the West Indies. The stories of our few species have been full of adventure. *D. multilineatus* must have reached Florida in flotsam from northern South America, together with *Orthalicus*. *D. dominicus* may have been a hurricane-borne waif from Cuba or Hispaniola. Finally, the ancestor of *D. dormani*, which has intimate but specifically distinct relatives in eastern Mexico, apparently reached Florida by migration around the Gulf, in company with *Euglandina*, *Pomacea* and others, in Pliocene times.

The lip is broadly expanded in shells of the typical group of *Drymaeus*, which apparently is not represented in the United States. A species of somewhat similar character, *Drymaeus serperastrum* (Say), occurs in eastern Mexico as far north as Hidalgo, in southern Tamaulipas, and according to W. G. Binney "has actually been found in Texas." As no specific Texan locality was given, and it has not been found in that state by Ferriss, Singley, the author, or anyone to my knowledge since Binney reported it, an occurrence north of the Rio Grande seems highly doubtful and certainly requires further confirmation. It has been described and figured by Binney, 1885, *Manual of American Land Shells*, p. 403, fig. 442.

(*Δρυμαῖος*, forest living.)

Key to Floridian Species of Drymaeus

Shell thin and fragile, translucent

Larger, length about 20 to 32 mm.; central and northern Florida.....*D. dormani*

Smaller, length about 15 to 24 mm.; southern and Eastern Florida....*D. dominicus*

Shell moderately strong, opaque; southern Florida.....*D. multilineatus*

D. DOMINICUS GROUP (Section *Leptodrymaeus*, new section)

The shell is very thin and fragile, ovate-conic, narrowly perforate, 4-banded or plain, the outer lip not or only very slightly expanded. Type *D. dominicus* (Reeve).

(Λεπτος, thin, + *Drymaeus*).

Drymaeus dormani (W. G. Binney)

Fig. 13.

Bulimus dormani W. G. Binney, 1857, Proc. Acad. Nat. Sci. Phila., p. 188, 1859, Terr. Moll., 4: 132, pl. 80, fig. 10.

Bulimulus dormani W. G. Binney, 1878, Terr. Moll., 5: 397, fig. 280, pl. 10, fig. F, pl. 15, fig. J (anatomy), 1892, 4th. Suppl., Bull. Mus. Comp. Zool., 22: 191, pl. 1, fig. 6.—Simpson, Proc. Davenport Acad. Sci., 5: 67; 1906, Nautilus, 20: 24 (Bradenton and Manatee River).

Bulimulus dormani var. *albida* Wright, 1890, Nautilus, 4: 61.—Webster, loc. cit., p. 86.—Cf. Simpson, loc. cit., p. 79.—Maxwell Smith, 1927, Nautilus, 41: 53.

Bulimulus dormani forma nov. *subfasciata* Cockerell, 1891, Zoe, 2: 18.

Drymaeus dormani W. G. B., Pilsbry, 1899, Man. Conch., 12:2, pl. 5, figs. 14-17, with var. *albida* Wright.

“Shell perforated, thin, transparent, shining, elongated-conic, of a very light waxen color, with several regular revolving series of interrupted, perpendicular, reddish-brown patches; suture distinctly marked; apex punctured; whorls 6, rather convex, marked with numerous very fine revolving

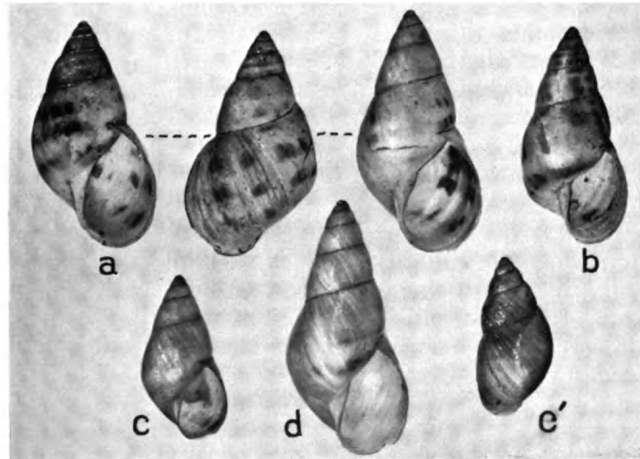


Fig. 13. *Drymaeus dormani*. a, Mayport; b, Buzzard's Roost, near Gainesville; c, c', d, var. *albida*, near Lake Helen.

lines; upper whorls striate, last whorl full, with a hardly perceptible obtuse carina at the upper extremity of the peristome. Length 29 mill.; diameter 12 mill." (Binney).

Length 30 mm., diameter 16.3 mm., aperture 16.3 mm.

Length 32 mm., diameter 15 mm., aperture 15.4 mm.

FLORIDA: Mayport, Duval Co. (J. D. Mitchell); vicinity of St. Augustine (O. S. Dorman, type locality); Seville I. and Tick I., Lake George, Marion Co., and south of Volusia, Volusia Co. (Pilsbry & Johnson); Lake Helen (Webster) and Daytona (F. A. White); Volusia Co. West of Gainesville, Alachua Co. (J. B. Clark); Levy Co. (Ph. Laurent); Crystal River, Citrus Co. (C. B. Moore); Bradenton, Manatee Co. (C. T. Simpson); Caloosahatchee River below Fort Thompson, Lee Co. (C. W. Johnson); Highlands Hammock State Park, Highlands Co. (T. L. McGinty).

In the fullest development of the pattern there are four spiral series or bands of brown spots; a subsutural, two on the upper surface and one below the periphery. The subsutural band is only rarely present. The spots of the two series of the upper surface are often coalescent into axial markings, and those of the basal series often unite into an imperfect band. Specimens from Highlands Hammock State Park are rather slender, 27 × 13.3 mm.; the mainly pale upper bands are irregularly spotted and with occasional darker spots.

It is larger than *D. dominicus* with different color pattern. It occupies a more northern area, above Lake Okeechobee, though in a few places the ranges overlap. Binney reported *dormani* from the under side of palmetto leaves, high above the ground. It is often abundant on orange and grapefruit trees.

Var. *albidus* Wright, Figs. 13 c, c', d, is usually more slender than typical *dormani*, with as many as 6½ whorls; very thin and glossy, whitish-hyaline, somewhat translucent, without markings or with two or three interrupted brown bands, the basal one widest. In another lot from Wright, the tint is pale brownish (Fig. 13 c').

Length 32 mm., diameter 14.7 mm., aperture 15.5 mm. Topotype.

Length 20 mm., diameter 10 mm., aperture 10.4 mm.

FLORIDA: Volusia County, in a hammock near Lake Helen (G. W. Webster) and near Fatio (Maxwell Smith); Bradenton, Manatee Co., associated with typical *dormani* (Simpson).

Var. *subfasciatus* Cockerell was based upon a specimen transitional from *dormani* to *albidus*. It was described as "31 mm. long, very thin, semi-transparent, hardly at all maculate, but fasciate with pale brown about base on body whorl, i.e. an indistinct band at periphery, a broad one below, and the umbilical region brownish." No locality was given, the specimen from W. G. Binney.

Drymaeus dominicus (Reeve)

Fig. 14 a-d.

Bulimus dominicus Reeve, 1850, Conch. Icon., pl. 88, fig. 657 (Santo Domingo).

Bulimus marielinus Poey, 1851, Mem. Hist. Nat. Cuba, 1: 204, 212 (Banes. Mariel, Cuba).

Bulimulus marielinus Poey, W. G. Binney, 1869, Land and Freshwater Sh. N. A., 1: 193, fig. 337; 1878, Terr. Moll., 5: 398, fig. 281; 1885, Man. Amer. L. Sh., p. 408, fig. 450.

Bulimulus hemphilli B. H. Wright, 1889, West Amer. Scientist, 6: 8; 1889; Nautilus 3: 19; 1890, 4: 61.⁴

Drymaeus dominicus Reeve, Pilsbry, 1899, Man. Conch., 12: 3-7 (see for full references and localities).—H. B. Baker, 1922, Occas. Pap. Mus. Zool. Univ. Mich., 106: 10 (teeth of specimen from southern Vera Cruz).

The narrowly perforate oblong-conic shell is very thin and fragile, whitish-transparent with five russet bands; a narrow one bordering the suture, wider ones midway of the upper slope and at the periphery, and two bands, nearer together, on the base. The first and second of these bands are often weak or wanting; the second and third may be interrupted (or sometimes all bands are lacking). Surface glossy, the first two whorls with fine *Drymaeus* sculpture, the following whorls have close spiral punctate lines, the

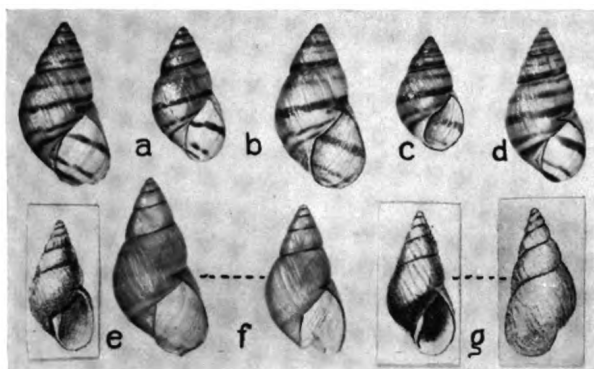


Fig. 14. *Drymaeus dominicus*. a, Miami; b, Royal Palm State Park; c, Long Pine Key; d, Pinecrest hammock no. 55. e, copy of type figure of *B. umbraticus*, after Reeve. f, var. *clarissimus*, Royal Palm Park. g, *B. floridanus*, after Binney, from drawings by G. B. Sowerby.

punctuation disappearing on the last, which is striate spirally. The spire is straightly conic; whorls rather weakly convex, the last well rounded at periphery. The ovate aperture is oblique, the outer lip thin, slightly or not expanded, the columellar lip dilated near its insertion.

Length 22 mm., diameter 11.3 mm., aperture 11.7 mm.; 6 whorls (Miami).

Length 15.3 mm., diameter 8.7 mm., aperture 9.5 mm.; 5 whorls (Caloosahatchie R.).

FLORIDA: Hammock lands between Mosquito Inlet and the ocean, Volusia Co. (B. H. Wright, type locality of *B. hemphilli*); Sebring, Highland Co. (McGinty); Micco, Brevard Co. (F. C. Baker); Ocean Ridge near Boynton, Palm Beach Co. (Pilsbry); Cutler, Dade Co. (C. B. Moore); Lemon City (S. N. Rhoads); Ocean beach, Miami (S. N. Rhoads); Royal Palm State Park and adjacent part of Long Pine Key (L. A. Thurston, C. A. Mosier); Pinecrest hammock No. 55 (Thomas L. McGinty); Fika-hatchee Key, Ten Thousand Islands (C. B. Moore); Sanibel Island (Jeanne S. Schwengel); Caloosahatchie River below Fort Thompson (C. W. Johnson); East end of Upper Matecumbe Key (J. W. Velie).

⁴ Mr. Berlin Hart Wright, when 89 years of age, wrote me that the specimens of *hemphilli* were taken "on the tongue of land between the ocean and Halifax (or Indian) River on a great shell-mound which has now been used for making roads. The only pair found was sent to Mr. Binney. It was on the advice of Mr. Binney that their novelty was assured."

There is considerable local variation in size and markings, the largest and most fully marked being from Miami, Long Pine Key and west to Pine-crest. The degree of interruption of the bands is variable, but in none seen were they regularly interrupted into short spots as in most specimens of *dominicus* from Haiti, Cuba and southern Mexico (see Man. Conch., 12, pl. 5, figs. 24-26; pl. 20, figs. 30, 31). This difference in markings may possibly be thought sufficient reason to segregate all Floridian *dominicus* as a subspecies, *D. dominicus hemphilli* Wright. Some or all bands above the peripheral are very often wanting. In shells from Royal Palm State Park (L. A. Thurston, C. A. Mosier, Fig. 14 f) and the adjacent part of Long Pine Key (H. N. Lowe), there are no distinct bands or spots, the color being transparent cartridge buff (or with four very weak, faintly brownish bands). Four measure:

Length 20 mm., diameter 10.2 mm.; 5 $\frac{3}{4}$ whorls. Miami.
 Length 23.4 mm., diameter 11.5 mm.; 5 $\frac{3}{4}$ whorls. Miami.
 Length 19.5 mm., diameter 9.6 mm.; 5 $\frac{1}{2}$ whorls. Ocean Ridge.
 Length 23 mm., diameter 11.5 mm.; Ocean Ridge.

D. MULTILINEATUS GROUP (Section *Mesembrinus*)

Mesembrinus Albers, 1850, Die Heliceen, p. 157.—Von Martens, 1860, Die Heliceen, p. 214, type *D. virgulatus* (Fér.).

Moderately strong though often thin, opaque *Drymaeus*, with simple, unexpanded lip.

Drymaeus multilineatus (Say)

Fig. 15.

Bulimus multilineatus Say, 1825, Journ. Acad. Nat. Sci. Phila., 5: 120.

Bulimulus multilineatus Say, Binney, 1878, Terr. Moll., 5: 395, pl. 58; 1885, Man. Amer. L. Sh., p. 404, fig. 443.

Drymaeus multilineatus Say, Pilsbry, 1899, Man. Conch., 12: 27, pl. 11, figs. 27-33 (full references, variation and distribution).—Simpson, 1906, Nautilus, 20: 24 (Manatee Co.).—H. B. Baker, 1923, Occas. Pap. Mus. Zool. Univ. Mich., 135: 12, pl. 1, fig. 5 (radula).—M. L. Jaume & P. Borro, 1941, Mem. Soc. Cub. Hist. Nat., 15: 103, pl. 46 (occurrence in Cuba).

Bulimus virgulatus Fér., Leidy, 1851, Terr. Moll., 1: 259, pl. 15, figs. 7, 8 (anatomy). Binney, Terr. Moll., 2: 278, pl. 58 (shell).

Drymaeus multilineatus latizonatus Pilsbry, 1936, Nautilus, 50: 69.

The narrowly perforate shell is thin but moderately strong; several early whorls dark madder blue, the rest opaque ivory yellow, with numerous unevenly spaced axial stripes of chestnut and almost black, and rather narrow spiral bands bordering the suture and in the middle of the base (the latter often wanting), a blackish area around the columella, and on the spire a thin band at the upper third (sometimes present but imperfect on the last whorl also). The first 1 $\frac{3}{4}$ whorls have typical *Drymaeus* sculpture, the rest being nearly smooth. Aperture colored within like the outside. Outer lip thin and sharp, the columellar margin rather broadly dilated.

Length 22.3 mm., diameter 11 mm., aperture 10.3 mm.; 6 $\frac{3}{4}$ whorls. Key West.

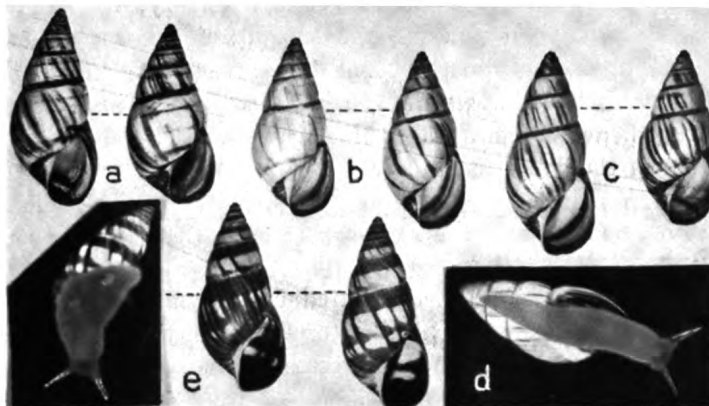


Fig. 15. *Drymaeus multilineatus*. a, Miami Beach; b, Lignum Vitae Key; c, Key West; d, Lower Matecumbe Key; e, form *latizonatus*, Lower Matecumbe Key.

Length 22 mm., diameter 10.2 mm. Lignum Vitae Key.

FLORIDA: east coast and Keys: Arch Creek, 12 miles north of Miami (S. N. Rhoads); Surfside Park, Miami beach near 79th St., Miami (Paul McGinty); Brickell's Hammock. Big Palo Alto Key (C. B. Moore); Upper Matecumbe Key; Lower Matecumbe Key; Lignum Vitae Key; south end Long Key; Grassy Key; Bahia Honda Key; Little Pine Key; Big Pine Key; No Name Key; Summerland Key; Cudjoe Key; Boca Chica Key; Stock Island; Key West. Western Florida at Fikahatchee Key, Horr's Island, near Goodland Point, and Marco Island (C. B. Moore); Manatee Co. (Simpson).

Also: Colombia, Venezuela, Curaçao and Yucatan; recently found in Cuba.

This *Drymaeus* lives on trees, or usually among the leaves on the stems and terminal twigs of bushes, more rarely on herbaceous vegetation, and is often found in considerable quantity. It probably inhabits most keys which have suitable cover, but has not been found in the intermediate group of keys east of Bahia Honda. Say's locality was: "Found by Mr. Titian Peale on the southern part of East Florida." As Peale collected at Miami and on Key West, the former is taken as type locality and No. 162309a A.N.S.P. may be considered a neotype (Fig. 15 a at left). Exactly the same form occurs at Key West. This snail has spread hardly beyond the strictly tropical part of Florida. I think that its occurrence from Collier County northward is owing to transport by human agency, Indian or later.

The upper surface of the living animal is transparent pale gray or fleshy gray, very minutely peppered with white specks. Sole uniform pale dirty buff. In rapid movement the sole shows rather indistinct waves, chiefly in the median part. About seven waves can be counted at one time.

The striping of the shell is variable, from copious to sparse. In some of the examples from Little Pine Key only traces of stripes remain, or rarely none whatever, and there are no spiral bands. In a lot from Lignum Vitae Key the stripes are often decadent (Fig. 15 b). The narrow spiral bands of the upper part of the whorl and the base vary, and are sometimes wanting, as in some lower Matecumbe specimens (Fig. 15 d).

Drymaeus multilineatus form *latizonatus* Pilsbry, Fig. 15 e. Differs from *D. multilineatus* by having the subsutural seal-brown band much wider (2 mm. or more), and the basal dark area covers most of the base, the band above it being wider than in *multilineatus*. The slanting streaks are somewhat heavier than usual in that species, but its chief feature is the exaggeration of the spiral markings.

FLORIDA: East end of Lower Matecumbe Key (T. L. McGinty, Pilsbry, Bales), Type 160880 A.N.S.P. South end of Long Key (Morgan Hebard); Lignum Vitae Key (McGinty).

This form lives intimately associated on the same branches with *D. multilineatus*, but no examples at all intergrading have been found. If they interbreed, as is almost certain, there seems to be complete segregation of patterns.

Doubtful Species of *Drymaeus*

Bulimus floridanus Pfeiffer, 1856, has lingered on in American books⁵ although the name was preoccupied by *Bulimus floridanus* Conrad, 1846, and therefore could not be used if otherwise valid. No Florida shells having the slender form and subangular last whorl of *floridanus* have been found, to my knowledge. Little probability that it will turn up remains; however, Pfeiffer's description follows, with copies of figures drawn by G. B. Sowerby for W. G. Binney (Fig. 14 g).

"Shell narrowly perforate, ovate-turritid, smoothish, gray-hyaline, marked with streaks and spots of opaque white, the spire long-conic, rather acute; whorls $6\frac{1}{2}$, a little convex, the upper interruptedly banded with brown, the last about three-sevenths of the length, subangular below the middle, the base somewhat tapering; columella somewhat twisted, receding. Aperture a little oblique, oval; peristome thin, the right margin narrowly expanded, columellar margin dilated, reflected, nearly adnate. Length $15\frac{3}{4}$ to 17, diameter $7\frac{1}{2}$ mm.; aperture $7\frac{1}{2}$ mm. long, $4\frac{1}{2}$ wide" (Pfeiffer 1856, Proc. Zool. Soc. Lond., p. 330. Florida, Cuming Coll.).

Lt.-Col. A. J. Peile (1929, Proc. Malac. Soc. Lond., 18: 272) writes: "Having recently examined the types of *Bulimus umbraticus* Reeve and *B. floridanus* Pfeiffer, I have no hesitation in uniting them. The former name has precedence over *B. dominicus* Reeve, of which Pilsbry considers *B. floridanus* a synonym, ascribing the species to the genus *Drymaeus*."

It will be seen that while the identity of *floridanus* with *umbraticus* is affirmed by Lt.-Col. Peile, he expressed no original opinion as to the identity with *dominicus*, merely citing the synonymy given by me over 45 years ago in Man. Conch., 12: 4, which was not based upon any comparison of types, and is now believed to be incorrect. It appears that *D. umbraticus* (Reeve), Fig. 14e, with the synonym *B. floridanus* Pfr., is a Central American species, not known to occur in Florida.

⁵ *Bulimulus floridanus* Pfr., W. G. Binney, 1885, Man. Amer. L. Sh., p. 408, fig. 449; 1890. 3d. Suppl., Bull. Mus., Comp. Zool., 19: 201, fig. in text. *Bulimus floridanus* W. G. Binney, 1859, Terr. Moll., 4: 134. Cf. also, Wright, Nautilus 4: 62.

Bulimus vermetus Anthony (1841, cover of Haldeman's Monograph Freshwater Univalve Mollusca, No. 3), from Cincinnati, Ohio, has never been recognized. The description has been reprinted by W. G. Binney (Man. Amer. Land Shells p. 409), who noted that it "is unknown to me, nor during my intimate acquaintance with him [Anthony], lasting for many years, could he give me any information about it."

Subfamily ORTHALICINAE

Orthalicinae Pilsbry, 1897, Man. Conch., 12: 90.

Shell of moderately large size, varying from ovate to oblong-conic, wholly imperforate, with solid axis, the aperture ovate, toothless, columellar lip closely appressed, the lip-ends distant.

Jaw composed of about 15 to 19 broad plates, overlapping or imbricating as usual in Bulimulidae, the median plate or plates not reaching the lower margin. Radula peculiar, the basal-plates short, oblong or quadrate, the cusps short and blunt or rounded, gouge-shaped throughout, or a few median teeth may have pointed cusps.

The pallial organs (Fig. 1 c) are typical of the family. Genitalia (Fig. 16) are characterized by the slender penis usually provided with a small lateral gland, and passing without external differentiation into a long epiphallus, which terminates in a flagellum. On the end of this the penial retractor is attached. The talon is very short and rounded, or reduced to a mere thickening of the duct where it passes into the carrefour.⁶ Oviparous; the eggs are elliptical, brown or whitish, and roughened by granules.

Distribution.—Tropical America. The presence of Orthalicinae in Florida is believed to be traceable to floating trees carrying the snails, and blown ashore.

One of the six South American genera of this subfamily, *Orthalicus*, extends into Mexico and southern Florida. *Liguus* is confined to Cuba, Hispaniola and southern Florida. All Orthalicinae are epiphytic, in dry weather hiding in holes in the trees or sealing themselves to the bark.

This subfamily differs from the *Bulimulinae* in the imperforate axis of the shell at all stages of growth, the broad plates of the jaw and their small number, the highly modified, gouge-shaped teeth, the presence of a penial gland in most species.

ORTHALICUS Beck

Orthalicus Beck, 1837, Index Molluscorum, p. 59.—Herrmannsen, 1847 (Sept. 8), Ind. Gen. Malac., 2: 159 ("typus *Bulimus zebra* Müll.")—Binney, 1878, Terr. Moll., 5: 406. Not "*Orthalicus Beck*," Gray, 1847 (Nov.), Proc. Zool. Soc. Lond., p. 176, type *Helix sultana*.—Rehder, 1945, Nautilus, 59: 29.

Ortalichus Von Martens 1893, Biol. Centr.—Amer. Moll., p. 179 (emendation of *Orthalicus*).⁷

⁶ Fischer figured *Orthalicus longus* with a long talon with terminal swelling. Miss. Sci. Mex. Moll., 1, pl. 19.

⁷ The derivation of *Orthalicus* is obscure, but Von Martens's conclusion that an h was inadvertently transposed in the transliteration of ὀρθάλιχος (a young fowl), certainly seems plausible. The name should have stood "Ortalichus."

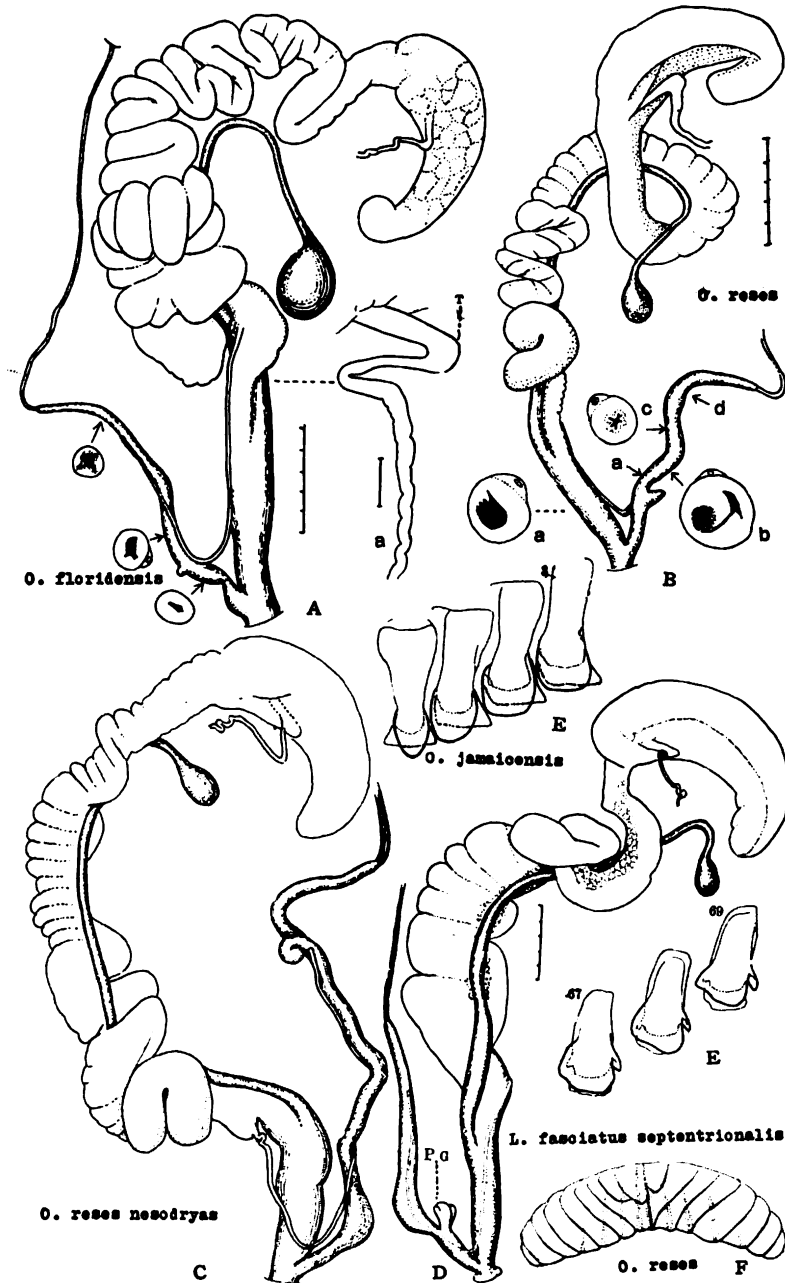


Fig. 16. A, *Orthalicus floridensis*, genitalia; at a a more enlarged outline of upper end of hermaphrodite duct, the vestigial talon at *t*. B, *O. reses*, Stock Island, with successive sections of penis a, b, c. c, *O. reses nesodryas*, Key Vaca. d, *Liqius fasciatus septentrionalis*, penial gland at p. g. E, E, teeth of *Orthalicus jamaicensis*. F, jaw of *Orthalicus reses*. Scale lines = 5 mm.

Orxystyla Schlüter, 1838, Kurzgefasstes Syst. Verz. meiner Conchyliensamml., p. 7, for *undata* Schlüt. = *B. undatus* Brug.—Pilsbry, 1899, Man. Conch., 12: 101.

Zebra Shuttleworth, 1856, Notitiae Conch., 1: 60; type by tautonymy *B. zebra* "Mull." Shuttl.

The shells are moderately large, imperforate, ovate-conic, usually rather thin but strong, composed of 5 to $8\frac{1}{2}$ moderately or slightly convex whorls; apex obtuse, the earlier 2 or 3 whorls smooth; aperture ovate, oblique, rounded below, the lip simple and unexpanded; columella slender, straight or with a moderately convex fold, not truncate at base. Coloration usually of longitudinal, waved or zigzag stripes, sometimes wanting, and more or less modified by three equidistant spiral bands, often weak or interrupted.

TYPE: *Orthalicus zebra* (Müller).

Distribution.—Tropical America. In Florida all of its range is near the sea; it has not penetrated inland like *Liguus*.

The fundamental color pattern is a combination of longitudinal stripes with three spiral bands at equal distances on the last whorl. In some species and races, such as *O. floridensis*, this three-banded pattern stands alone; in others, such as *O. reses*, it is found in combination with stripes; while in the Mexican striped forms without distinct bands, their positions are indicated by a sinuation, angle or spot in the stripes, showing the fundamental impress of the tendency to trifasciation in the organization of the animal. Striped species seem to have a tendency to revert to the three-banded condition.

Growth-rest varices, as the black or dark streaks reminiscent of former peristomes at resting periods are called, are doubtless directly due to climate. Their number and spacing depend upon the two factors of rate of growth of the individual, and the frequency of its partial or complete interruption by dry periods, which check growth and lead to estivation; the dark pigment, which during rapid growth in seasons of humidity is distributed in flames or bands, is concentrated in the narrow lip-streak. Finally growth ceases, the aperture is firmly sealed to the bark of a tree by an epiphragm, and metabolism is reduced to a minimum until the recurrence of wet weather abruptly initiates a new period of growth.

It may prevent confusion to record here the identity of the specimens figured in the most used works on the United States fauna. In Terrestrial Mollusks III and V, pl. 54, the lower figure is *O. reses*; the two side figures are young *O. princeps* (Broderip); the upper figure is unknown, the heavy columella being unlike any species known to me, and apparently abnormal. In Terrestrial Mollusks IV, pl. 77, fig. 13 is typical *O. princeps*; pl. 78, fig. 12 is *O. floridensis*. In the Manual American Land Shells, fig. 480 is *O. princeps*, and the paragraph at the foot of p. 439 beginning "The most beautiful form of the species" also describes *princeps*. Fig. 482 is *O. reses*; fig. 483 is *O. floridensis*, and fig. 484 is correctly labeled *O. melanocheilus* (Valenciennes). In Tryon's monograph, American Journal of Conchology

III, pl. 13, fig. 1 is *O. undatus jamaicensis* Pilsbry; fig. 2 is *O. reses*; fig. 3 is *O. longus uhdeanus* Martens. I have examined Tryon's specimens.

For a consideration of the name used for this genus see Rehder, 1945, *Nautilus*, 59: 29.

Key to species and subspecies

Shell marked with many irregular axial stripes.

Apex white; parietal wall with a pale wash of chestnut or none.....*O. reses*

Apex black; parietal wall dark chestnut colored throughout.....*O. reses nesodryas*

Shell with two or three spiral bands, no stripes.....*O. floridensis*

Orthalicus reses (Say)

Figs. 17; 18 b, c, d.

[*Bulimus undatus* Brug.] *reses* Say, 1830, *New Harmony Disseminator*, Dec. 28.—
Binney, *Complete Writings of Thomas Say*, p. 39.

Bulimus zebra A. Binney, *Terr. Moll.*, 2: 271, pl. 54, lower fig. only.

Orthalicus undatus, var. β , Shuttleworth, *Notitiae Malacologicae*, 1: 63, pl. 3, fig. 5 (Key West).

Orthalicus undatus Binney, 1878, *Terr. Moll.*, 5: 408 (in part).—Simpson, *Proc. Davenport Acad. Sci.*, 5: 67.

Oxystyla undata reses Say, Pilsbry, in part, 1899, *Man. Conch.*, 12: 109, pl. 27, fig. 24 (only).

Zebra undata form *reses* Say, Strebelt, *Mittheil. Naturhist. Mus. Hamburg*, 26: 83, pl. 17, figs. 272, 273.



Fig. 17. *O. reses*, Stock Island.
Maxwell Smith phot.

The shell is rather thin and light, less solid than the Jamaican or Trinidad races of *O. undatus*. White to warm buff, this tint deepening near the lip or behind the later varices; stripes narrower than in *O. undatus*, purplish brown, running with the growth-lines, the stripes and the streaks often interrupted between the bands, and mostly not extending below the lower one; growth-rest varices usually 2 to 4 on the last whorl; three spiral bands, the upper and lower interrupted, are indicated, but weaken with age. Apex white. Aperture showing the varices, bands and streaks vividly inside; columella white, straightened above; parietal callus white, or dilute chestnut in old shells.

Length 56 mm., diameter 31 mm.,
6½ whorls.

Length 42 mm., diameter 25 mm.:
6 whorls.

FLORIDA: Key West, formerly (Raybon, 1904; Rugel, Simpson) Stock Island (G. H. Clapp and many collectors to this time).

Distinguished from *O. r. nesodryas* by its usually less bold striping, the white apex and the pale parietal callus, which has only a light wash of chestnut color or none.

Say defined this form by a comparison with *B. undatus*: "It is rather less ventricose, the longitudinal lines are very slender and pale, and the transverse lines are much more distinct. It inhabits trees on the south point of Florida." This applies to the form of Key West (now I believe extinct there) and the closely adjacent Stock Island. In Manual of Conchology 12: 109, I included in *reses* also the *undatus* of keys eastward, and proposed to consider Sugarloaf Key as the type locality; but these forms do not agree so well with Say's descriptive notes as do those of Key West and Stock Island, which, moreover, is a much more probable source of a specimen collected "on the south point of Florida" in Say's time. I now select Fig. 18 c as a neotype, Say's type being lost. The axial flames came out too dark in the photographic figures, b, c, d.

The genitalia (Fig. 16 b, Stock Island), are about as described for *O. floridensis*. Several examples opened agree in having a tubercular penial gland. Another of the same lot had no gland, but the penis was noticeably swollen as in *O. r. nesodryas*, but not so much. The male organs in all opened are small, as in *O. floridensis*.

(*Reses*, lazy.)

***Orthalicus reses nesodryas* new subspecies**

Fig. 18 a.

Bulimus zebra Orbigny, 1845, Sagra's Hist. Fis. Polit. y Nat. de la isla de Cuba, Moll., 1: 92, pl. 6, figs. 9, 10. Not *Buccinum zebra* Müller, 1774.

Oxystyla undata reses Say, Pilsbry, 1897, in part, Man. Conch., 12: 109, pl. 27, figs. 25, 26 only.

Oxystyla undata undata Pilsbry & Grimshawe, 1936, Nautilus, 50: 19. Not *Orthalicus undatus* (Bruguière), 1789.

The ground-color is white on the spire; shading into chamois on the last whorl; the numerous irregular, waved, axial stripes are dark vinaceous drab or dark grayish-brown, rather wide in the median region of the last whorl, and mostly forked above, and on the penultimate whorl often spread into branching blotches; they partly disappear at the base; blackish-brown growth-rest varices are narrow, usually two or three on the last whorl; three more or less interrupted bands may be seen on some part of the last whorl. The upper one not distinct; they are conspicuous in the mouth. The summit of the first whorl has a dark or blackish-brown comma-shaped or spiral spot. The columella is subvertical, its white edge nearly straight. Parietal wall is rich chestnut-brown.

Length 54 mm., diameter 31 mm.; 6½ whorls. Key Vaca. Type, Fig. 18 a.

Length 61.7 mm., diameter 36 mm. Boca Chica.

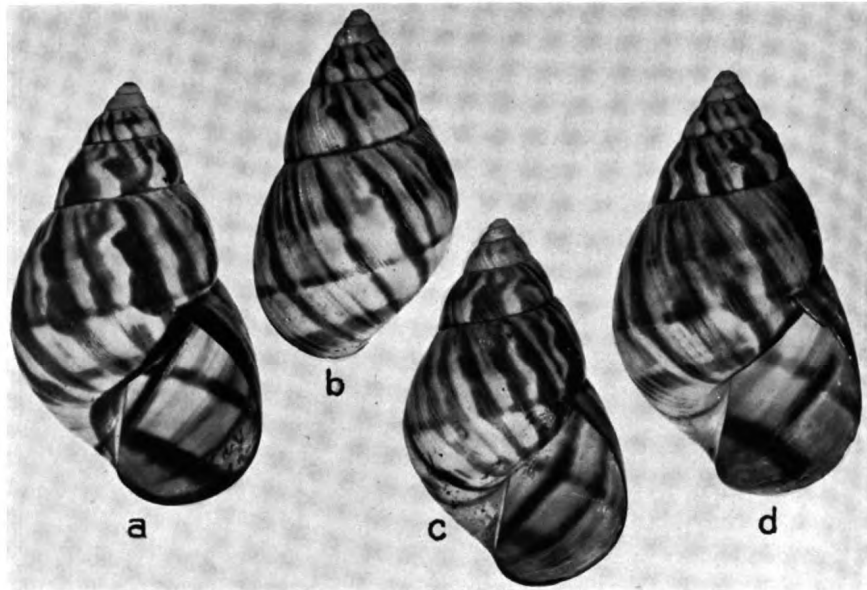


Fig. 18. a, *Orthalicus reses nesodryas*, Key Vaca. b, c, d, *Orthalicus reses*, Stock Island.

FLORIDA: Key West (S. N. Rhoads). Boca Chica (J. S. Raybon, 1904). Sugarloaf Key (Blanes, Pilsbry). Big Pine Key (Pilsbry, Raybon). Little Pine Key (Raybon, 1904). Key Vaca, Type 167102 A.N.S.P. (C. N. Grimshawe, T. L. McGinty, Elizabeth Pilsbry). Grassy Key (Raybon, 1904).

The shell is similar to *O. reses* but the marking is usually bolder, the stripes wider, part of them forked below the suture. The stripes are of a blackish brown color under a faintly bluish "bloom." The parietal callus is rich chestnut colored, thereby differing from *O. reses*, in which the chestnut wash is quite weak when present, and does not extend over the whole callus. The apex is marked with a spiral spot of chestnut.

At one time I thought this race was referable to *O. undatus* (Brug.), but closer study of more material convinces me that they are distinct. *O. undatus* is a more solid shell differing in markings of the base, showing the spiral bands only weakly in the aperture, having a broader brown border in the lip, and in other characters.

Several years ago I dissected a specimen from Key Vaca, and the drawing then made is reproduced in Fig. 16 c. In general it resembles Stock Island *O. reses*, but the penis with epiphallus and flagellum is very much longer than in any of the half dozen *reses* I opened. There was no penial gland, but a decided swelling of the penis where the gland should be. I did not open or section the penis, or note the scale on my drawing, and the preparation was not kept, so that further dissection of Key Vaca *Orthalicus* is

desirable. The proportions of the male end organs, if confirmed, seem to indicate specific difference.

(Νῆσος, ὄρυάς, island wood nymph.)

Orthalicus floridensis Pilsbry

Fig. 19.

Bulimus zebra W. G. Binney, 1859. Terr. Moll., 4: 125. pl. 78, fig. 12.

Orthalicus zebra Müll., Binney & Bland, 1869, Land and Fresh Water Sh. N. A., 1: 216, fig. 370.

Orthalicus melanocheilus Val., Specimens from Indian Key⁸ only, Fischer & Crosse, 1873, Miss. Sci. Mex., Moll. 1: 458.

Orthalicus undatus var., Binney, 1878, Terr. Moll. 5: 410, fig. 286, Key Biscayne; 1892, 4th. Suppl. Bull. Mus. Comp. Zool. 22: 201, pl. 2, fig. 4.—Simpson, Proc. Davenport Acad. Sci., 5: 67.

Orthalicus melanocheilus var. *floridensis* Pilsbry, 1891, Proc. Acad. Nat. Sci. Phila., p. 317, text-fig.; reprinted in Nautilus 8: 37.

Oxystyla undata floridensis Pilsbry, 1899, Man. Conch., 12: 110, pl. 18, figs. 7-13.—Clench, 1940, Nautilus, 53: 122.—Simpson, in Lower Florida Wilds. plate opposite p. 3.6.

Zebra reses heteromorph *melanocheilus* Strebel, 1909, Mittheil. Naturhist. Mus. Hamburg, 26: 84, pl. 17, fig. 267. Cf. also p. 15.

The ovate shell is white, usually shading into cream buff on some part of the last whorl, girt with three cinnamon-brown bands, the upper one

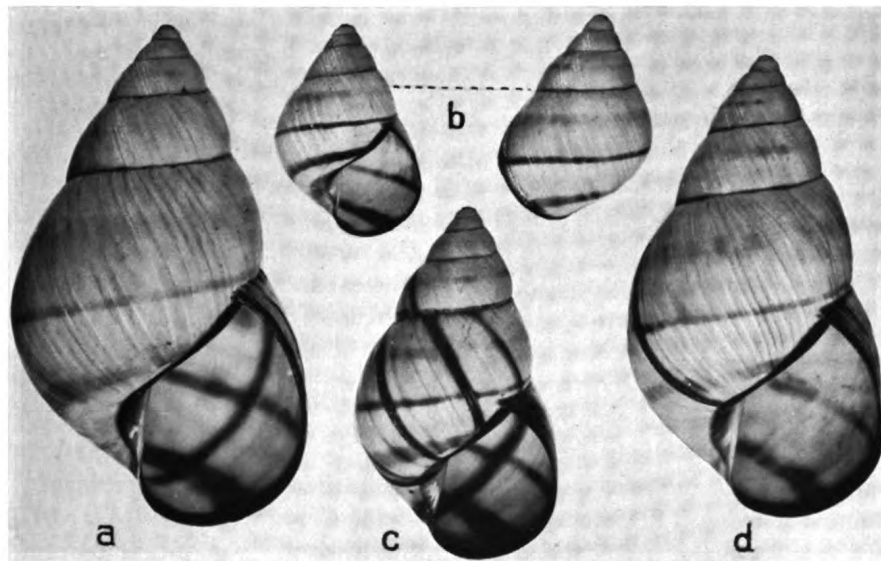


Fig. 19. *Orthalicus floridensis*. a, b, Chokoloskee; c, Flamingo; d, type, Cape Sable.

usually weak or interrupted, and with several black growth-rest streaks; the apex minutely dark. The aperture is white within, showing the bands;

⁸ Indian Key was formerly a stopping place for coastwise vessels. The *Orthalicus* obtained there was probably brought from the closely adjacent Lower Matecumbe.

lip edge and the broad parietal callus are chestnut colored. Columella white, straight.

- Length 58.5 mm., diameter 32.5 mm. Type.
 Length 64 mm., diameter 37 mm. Chokoloskee Key.
 Length 48 mm., diameter 28 mm. Chokoloskee Key.
 Length 71 mm., diameter 40 mm. Pavilion Key.
 Length 52 mm., diameter 31 mm. Pavilion Key.

FLORIDA: Sugarloaf Key, Summerland Key, Big Pine Key and No Name Key (Pilsbry); Lower Matecumbe Key, east end Windley's I., Long Island, Point Charles, Key Largo (C. B. Moore). Chokoloskee Key, Pavilion Key and Seminole Point, on the west coast. Mainland at East and Middle Cape Sable; Flamingo (Simpson, C. B. Moore). Sandy Key (Moore). Type 176086 A.N.S.P., from Cape Sable (Hemphill).

This is by far the most widely spread of our *Orthalicus*, often occurring in abundance. It is quite constant in pattern, without the slightest intergradation with other Florida species.

Genitalia (Fig. 16 A, Seminole Point, Monroe Co.) are characterized by the small size of the male end organs, the penis with the epiphallus and flagellum being only about half as long as the spermatheca and duct. There is a minute penial gland (Fig. 16a, p. g) in form of a simple tubercle. The interior has about four longitudinal ridges in the flagellar appendage; farther down, the ridges become quite weak. The penial retractor is extremely long and slender. The hermaphrodite duct is only weakly convoluted. The talon is reduced to a mere thickening where the hermaphrodite duct enters (Fig. 16a at r). The surface of the albumen gland is rather deeply creased in some examples, much less so in others.

O. floridensis has been known for over eighty years, but its status has been differently estimated by nearly every author mentioning it. W. G. Binney thought it a variety of *O. undatus*, an opinion shared by Von Martens. In 1899, *floridensis* was left by the author as a variety of *undatus*, and the view was expressed that the three-banded forms occur as independent parallel mutations in several striped species (Man. Conch., 13: 102). Fischer & Crosse considered it identical with *O. melanocheilus* (Val.) of the Pacific coast of northwestern Mexico, which is a smaller, narrow shell with small aperture, according to the original figures and specimens seen. Hermann Strebel (1909) considered forms of *Orthalicus* lacking axial flames (and which he termed "heteromorphs"), to be cases of dimorphism. He thought *floridensis* an imported colony of the Costa Rican *O. tricinctus* Von Martens, or of *O. maracaibensis imitator* Pilsbry. None of the European authors had any field acquaintance with *floridensis* or the other species mentioned. Those who have collected *floridensis* have no doubt about its specific validity. In hundreds seen, none are in any way transitional to *undatus*, *reses* or other species. *O. floridensis* is more solid and ventricose, usually larger, than the specimens of *O. maracaibensis imitator* which I have seen. The name *floridensis* (1891) is prior to *imitator* (1899) and *tricinctus* (1893).

The rational way to treat the "*melanocheilus* forms" is as species when there is no intergradation with striped shells. When they seem to intergrade by continuous variation, their status is that of color-varieties or "forms."

Whether *O. floridensis* arose in Florida from the *reses* stock, or is an independent immigrant from South America (cf. *maracaibensis imitator*), remains for investigation. It is far more widely spread than other patterns of *Orthalicus* in Florida.

W. J. Clench has reported the introduction of this species on Sanibel Island, from Sandy Key, off Cape Sable, by Mr. G. K. Kessen. Four specimens were planted on his homestead in 1921, and it survived there in 1945, having spread over some two acres of trees on an old Indian kitchen-midden. The Sandy Key colony was found by Mr. Clench to be extinct in 1933. In the same year he could find no living shells on Pavilion Key.

Shells from Long Island, the east end of Lower Matecumbe and Windley's Key form an incipient local race of the Upper Keys, the shell thin, with short spire. The aperture is larger, its length 60 percent that of the shell. The usual ratio in *floridensis* is 50 to 57 percent, Binney's figure of a specimen said to be from Key Biscayne is apparently this form, but as there is no other record of *Orthalicus* from that key, it is apparently extinct if it ever existed there.

LIGUUS Denys de Montfort

Liguus Montfort, 1810, Conch. Syst., 2: 422, for *L. virgineus* (L.).

Oxystrombus (Klein, 1753, in part, Tent. Meth. Ostracol., p. 32) Mörch, 1852, Catal. Yoldi, p. 21; 1865, Journ. de Conchyl., 13: 270, for *O. fasciatus* Müll.—Pilsbry, Nautilus, 47: 147.⁹

Orthalicinus Fischer & Crosse, 1875, Miss. Sci. Mex., Moll., 1: 436, type *L. fasciatus*.

Shell imperforate, oblong-conic, either thin or solid, the embryonic shell not distinctly differentiated from the subsequent whorls, smooth, or with a few spiral bands of vertical wrinkles; the later whorls smooth, dull or glossy, white or vividly banded or streaked, pink, green and yellow often entering into the color-scheme; the cuticle, when present, very thin and inconspicuous; aperture rather small, ovate, the outer lip acute and unexpanded, columella vertical, and varying from heavy and abruptly truncated at the base to thin and continuous with the basal lip; always simple above.

Genitalia, Fig. 16 D. The right eye retractor lies between penis and vagina. Atrium is extremely short. Penis slender with terminal retractor, inserted on the diaphragm; near the base there is a gland of two or several lobes, and either sessile or on a short peduncle. The vas deferens enters at about the posterior fourth of the penis, and is closely bound to penis and the vagina, which is moderately long. The talon is short, blunt, and a little wider than the carrefour. Spermathecal duct long, the oval spermatheca lodged near the heart.

⁹ *Pseudotrochus* (Klein) Mörch, 1852, Catal. Yoldi, p. 21, has been used for *Liguus*, but the first type designation seems to be the African achatinid *P. alabaster* (Rang), Man. Conch., 16: 220, 1904.

The eggs (of *L. fasciatus*), laid in the ground, are elliptical, with a thin, pale brown, minutely granular, calcareous shell, measuring about 5.2×7.2 mm. to 6×8 mm.

(*Liguus*, from *ligo*, to bind up or bandage, referring to the color bands.¹⁰)

Distribution.—Haiti, Cuba, with the Isle of Pines, southern Florida and the keys. Arboreal, living on the trunks and branches of trees; in Florida inhabiting hardwood groves known as hammocks, scattered island-like in pine woods, sawgrass or swamp. The distribution is therefore more definitely patchy than in ground snails generally.

Liguus is active in rainy or damp weather, and chiefly by night. In fair weather they are usually quiescent by day. During dry seasons, in winter, they seal themselves firmly to the bark, preferably in knot-holes, crotches, under the loose bark of dead trees, or in other protected places. Their food is chiefly, if not entirely, the minute fungi growing on trees. They do not eat chlorophyll-bearing leaves. They occur on a great variety of trees, but prefer those with smoothish bark, such as the mastic (*Sideroxylon*), *Lysiloma*, Jamaica dogwood and many others; often on dead trees still standing.

The eggs are laid in groups of eight or ten buried in the ground or under leaves and forest debris. They are apparently laid at various times of the year; eggs taken at Miami January 26 were about to hatch, and a snail in confinement laid eggs in July.

The shells are often broken by falling, and shells more or less extensively repaired are not uncommon (Fig. 20 c). Say's type of *L. solidus* is a repaired shell. Abnormally shortened shells occur rarely (Fig. 20a). Several

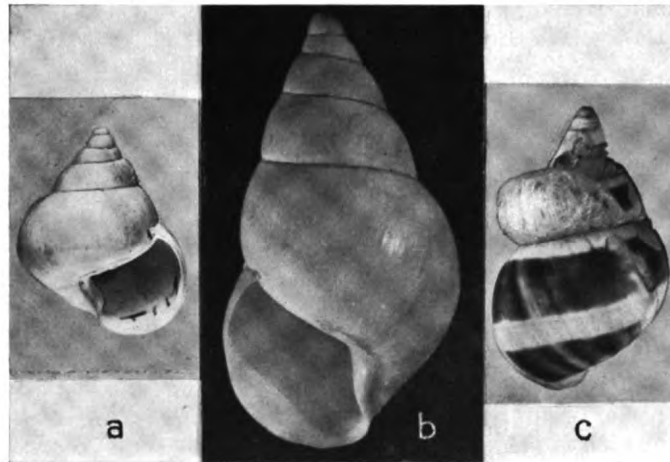


Fig. 20. a, abnormally shortened *Liguus*, Timm's Hammock. b, sinistral *L. f. roseatus* (Maxwell Smith, phot.). c, repaired *L. f. castaneozonatus*, Planter, Key Largo.

¹⁰ The Latin name is pronounced Lig-oo'us, but the anglicized pronunciation or common name in general use is "Lig'-u-us."

sinistral individuals have been found (Fig. 20 b), but they are excessively rare, perhaps of the order of about 1 in 10,000;¹¹ that figured being in the collection of Maxwell Smith.

Enemies.—I have seen no evidence that the tree snails are molested by native birds, but the Florida opossum is a keen *Liguus* hunter, biting the shell in two. Near habitations the introduced rat preys upon them. Being expert tree climbers the rats will doubtless exterminate tree snails in all places accessible to them. Glade fires sometimes make serious inroads on the hammocks; but the amateur collectors remain the greatest menace to the tree snails and will eventually make an end of them.

Structure of the columella.—Thick columella more or less obliquely truncate, and thin, continuous columella, together with intermediate forms, occur in most areas, and with some exceptions (as on Lower Matecumbe and *Lignumvitae* keys) do not appear to be correlated with color or pattern. Figs. 21, a, b.

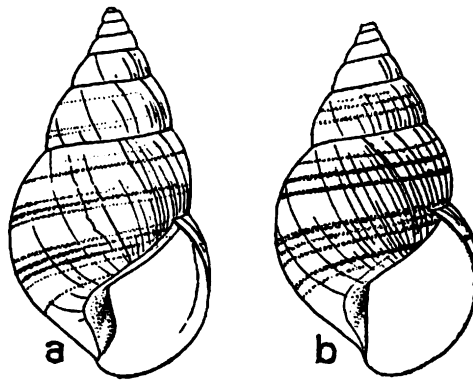


Fig. 21. *Liguus fasciatus losmanicus* from the hybrid colony of upper Key Largo, showing heavy and thin forms of columella.

Coloration of Liguus

The periostracum of *Liguus* is very thin, and pellucid except where marked with green lines. These, when present, are wholly cuticular, and may easily be scraped off with a knife. They are often lost by weathering or abrasion which removes the periostracum, or they may remain only in the band of latest growth behind the lip. Though only "skin deep," these lines are the most persistent color element, appearing in some individuals of nearly every race of *L. fasciatus*. In melanistic varieties they may often be traced as lines of blacker hue or different degree of reflection.

¹¹ Mr. R. F. Deckert informs me that to his knowledge nine sinistral shells have been found: one in Brickell Hammock, four on Long Pine Key, one in Pinecrest and three on Key Largo.

In xanthic shells the yellow color, and brown, black or other dark colors when present, are below the periostracum, in the prismatic layer of the shell. Yellow is usually strongest close to the growing lip, sometimes shading into orange or red there. As growth proceeds, this color fades. Shells collected immediately after the early summer growing season have far richer yellow than those taken in the same place after a long resting stage. Fading of the yellow pigment in living snails is the more remarkable because dry museum specimens usually fade very slowly. There is still some yellow color in Say's type of *L. solidus*, collected in 1825, and during part of that time exposed in a glazed exhibition case.

The brown or blackish pigment is the most permanent, traceable in dead weathered shells after other colors are lost. Brown is often intensified into black. When covered with a film of the white ground color it becomes purplish or bluish.

Rose or pink coloring of the early whorls, generally associated with rose, pink or purple on the columellar callus, is highly characteristic of many races of *L. fasciatus*, being one of the most constant color traits.

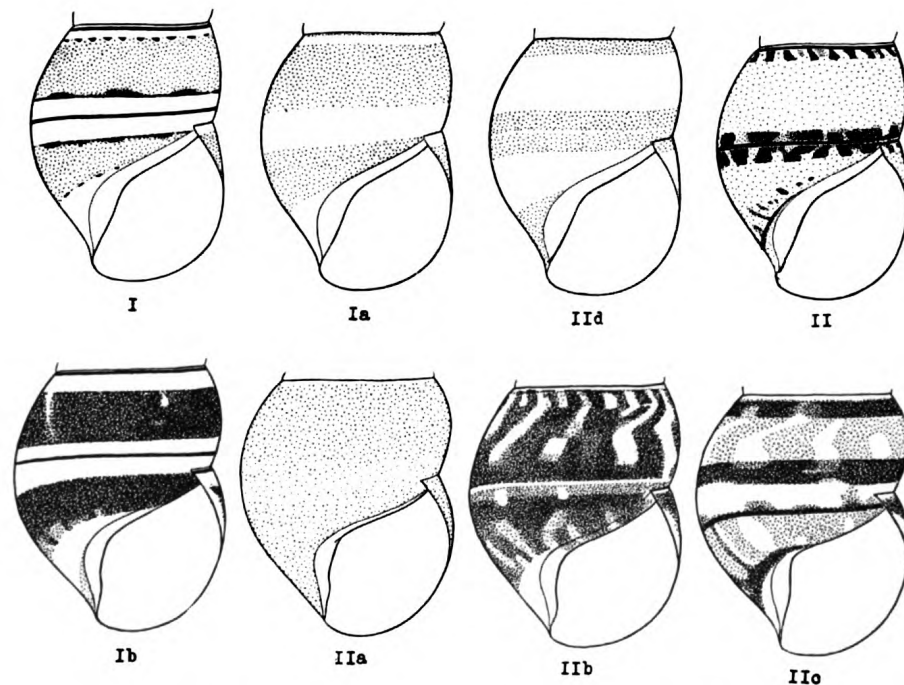


Fig. 22. Color patterns I and II. Shells of the upper line from the Lower Keys; lower line, mainland. I, *graphicus*. Ia, *dryas*. Ib, *castaneozonatus*. II, *pictus*. IIa, *lossmanicus*. IIb, *testudineus*. IIc, *marmoratus*. IId, *solidus*. Light stipple indicates yellow ground, or on fig. IIc, blue markings. Diagrammatic.

Color patterns.—Yellow color and the dark markings upon it may be: (I, zoned pattern) in two zones separated by a white peripheral space, with or without a dark, yellow or pink peripheral line, and with a white space between suture or sutural line and the upper zone, as in Figs. 22: 1, 1a, 1b; or (II, diffuse pattern) where the yellow or dark colors extend to the very narrowly whitish-edged suture, and are crowded against or run across the peripheral line, when this is present, Figs. 11 to 11d. A third albino or albinistic pattern consists of shells with neither yellow, dark colors or pink, the shell being white, with or without the cuticular green lines.

Both the zoned and the diffuse patterns may have the apex and apertural callus either pink or white, and they may have dark markings, as in Figs. 1b and 11b, or only yellow, as in Figs. 1a and 11a. In a few forms of pattern II the yellow ground is not continuous but interrupted by white zones, as in Fig. 11d, which is a photographic "negative" of the *dryas* pattern, Fig. 1a. The designs in dark colors often vary widely in the same race. Interruption of dark axial stripes or flames frequently leaves only series of spots representing the ends of vanished flames, as in Figs. 1 or 11. In pattern II dark spots or flames below the suture are connected with the sutural dark line, if that is present, as in Fig. 11 and 11b. In pattern I they are separated from it by a white space, Fig. 1.

Besides these markings, and independent of them, there are often some bluish streaks or smears following growth-rests, which are otherwise inconspicuous. All patterns are frequently varied by green lines.

In Floridian *Liguus* having yellow or dark color, there is never any doubt about whether a shell belongs to pattern I or II, but since albinos may arise by loss of color in any pattern, their affinities are often uncertain.

These patterns form the most reliable basis for classification of Florida *Liguus*, and lead to the arrangement on page 42. Three grades are recognized: subspecies, forms and varieties.

The *Subspecies* of this list do not intergrade, and by that criterion might be ranked as species were it not that they doubtless interbreed in mixed colonies. In any subspecies the color may vary from fully developed to albinistic, by progressive loss of dark and pink color. The chief stages in this scale of color patterns are distinguished as *Forms*. In most cases the "form" is characterized by peculiarities of pattern, often by the loss of some color factor. Subordinate to the "forms" are placed numerous minor strains here called *Varieties*, many of them intergrading freely, being selected stages of clines, and most of them are of a taxonomic grade which would not be considered worth naming in other genera. They are admitted and defined here only because the names have been introduced into zoological nomenclature and are in common use in collections.

In the following list subspecies are in **SMALL CAPITALS**, forms in *Italic* and varieties in Roman type.

(Solidus group)

Pattern I

GRAPHICUS

Form *graphicus* + *crassus*. Var. *osmenti*. Var. *dryas*.

Form *lignumvitae* + Var. *delicatus* and *innominatus*. Var. *simpsoni*. Var. *dohertyi*.

Pattern II

SOLIDUS

Form *solidus* + var. *solidulus*.
Form *pictus* + var. *pseudopictus* and *splendidus*.

(Castaneozonatus-testudineus groups)

CASTANEOZONATUS

Form *castaneozonatus* + var. *deckerti*, *walkeri*, *miamiensis* and *elegans*.

Form *alternatus*.

Form *roseatus* + var. *lineolatus* and *livingstoni*.

ELLIOTTENSIS¹² + var. *cingulatus*, *eburneus*, *capensis* and *vacaensis*.

TESTUDINEUS

Form *testudineus* + var. *castaneus*, *versicolor* and *clenchi*.

Form *ornatus*.

Form *fuscoflamellus*.

Form *marmoratus* + var. *barbouri*, *gloriasylvaticus*, *floridanus*, *violafumosus*, *nebulosus*.

LOSSMANICUS¹³ + var. *luteus*, *aurantius* and *mosieri*.

MATECUMBENSIS¹⁴

Form *matecumbensis*

Form *subcrenatus*.

(Septentrionalis group)

SEPTENTRIONALIS

The table above may be objected to as not showing all the relationships of the forms. This cannot be done in any linear arrangement. Moreover, taxonomy cannot always represent phylogeny faithfully, especially when hybrid combinations have changed the diagram of descent to an interlacing figure rather than a regularly branching "tree."

The Liguus country

The areas inhabited by *Liguus* shown in the map, Fig. 23, are the following: 1, Lower Keys; 2, Middle Keys; 3, Upper Keys; 4, Atlantic Coastal ridge; 5, South Coast and Cape Sable; 6, Pinecrest and adjacent regions; 7, West Coast islands. The Upper Keys approach the mainland rather closely, the separation of Key Largo from the Atlantic Coastal ridge being

¹² This subspecies is the albinistic race of *castaneozonatus*, but as there is no actual intergradation and the superficial difference is conspicuous, it is allowed subspecific rank.

¹³ This subspecies is merely the albinistic or xanthic *testudineus* which has lost dark and pink colors.

¹⁴ Albino races of uncertain place in the table.

doubtless rather recent. The southern part of the Atlantic Coastal ridge, Cape Sable and the Pinecrest region lie in the everglades, and a great swamp separates them from the West Coast islands. Of these islands, Lossman's is the most widely isolated and its geology (Miami oölite), as well as the Liguus fauna, is distinct from Chokoloskee and the other northern islands. In the latter the tree snails live only on Indian shell mounds, and may have been brought there originally by the Indians.

The hammocks in which the snails live in the above areas vary in size from little thickets shaded by a dozen trees to those of several hundred acres.

The Everglades¹⁵ are a level plain, largely covered with sawgrass, sloping southward from an elevation of about 18 feet at Lake Okechobee. Before artificial drainage they were usually flooded; many of the hammocks were then islands; but canals now carry off so much water that the higher parts are above normal water level, and the hammocks stand in stony plains, in high grass, or, as at Long Pine Key, on a pine-covered island in the everglade.

The Keys are old coral reef rock (Key Largo limestone) west to Bahia Honda. The lower keys, beyond the Bahia Honda Channel, are the Miami oölite, which also forms most of the Atlantic Coast ridge, and east and south of it to the sea. The Pinecrest Liguus region is partly upon older terrain considered to be Pliocene (Tamiami formation). All of the Liguus area is calcareous. It is practically level, and the hammocks support much the same flora of warm temperate and tropical plants, the latter somewhat predominating.

The Keys may conveniently be grouped as Upper Keys, from Biscayne Bay to Lower Matecumbe; Middle Keys, from Long Key to Bahia Honda; and Lower Keys from Little Pine Key, west.

In labelling specimens from the mainland, collectors use the following abbreviations, to which the number of the hammock is added:

LPK, for Long Pine Key. Mapped in Fig. 29.

PC, for the Pinecrest region, south of the Tamiami Trail in the region where it turns northwest, about 40 miles west of Miami. Fig. 43.

CC, for the region north of the Trail, in Collier County and also adjoining parts of counties eastward.

CP, the southern part of the Pinecrest region (from about 6 miles south of the "loop" of the Trail), is known as the Central Plains. It has been only partially exploited; there are no roads. There is still a considerable unexplored area between this district and Long Pine Key. The three divisions of the Pinecrest region are purely arbitrary; there are no natural divisions.

¹⁵ See in this connection, "The Natural Features of Southern Florida, by John H. Davis, Jr., Florida Geol. Surv. Geological Bulletin No. 25, 1943.

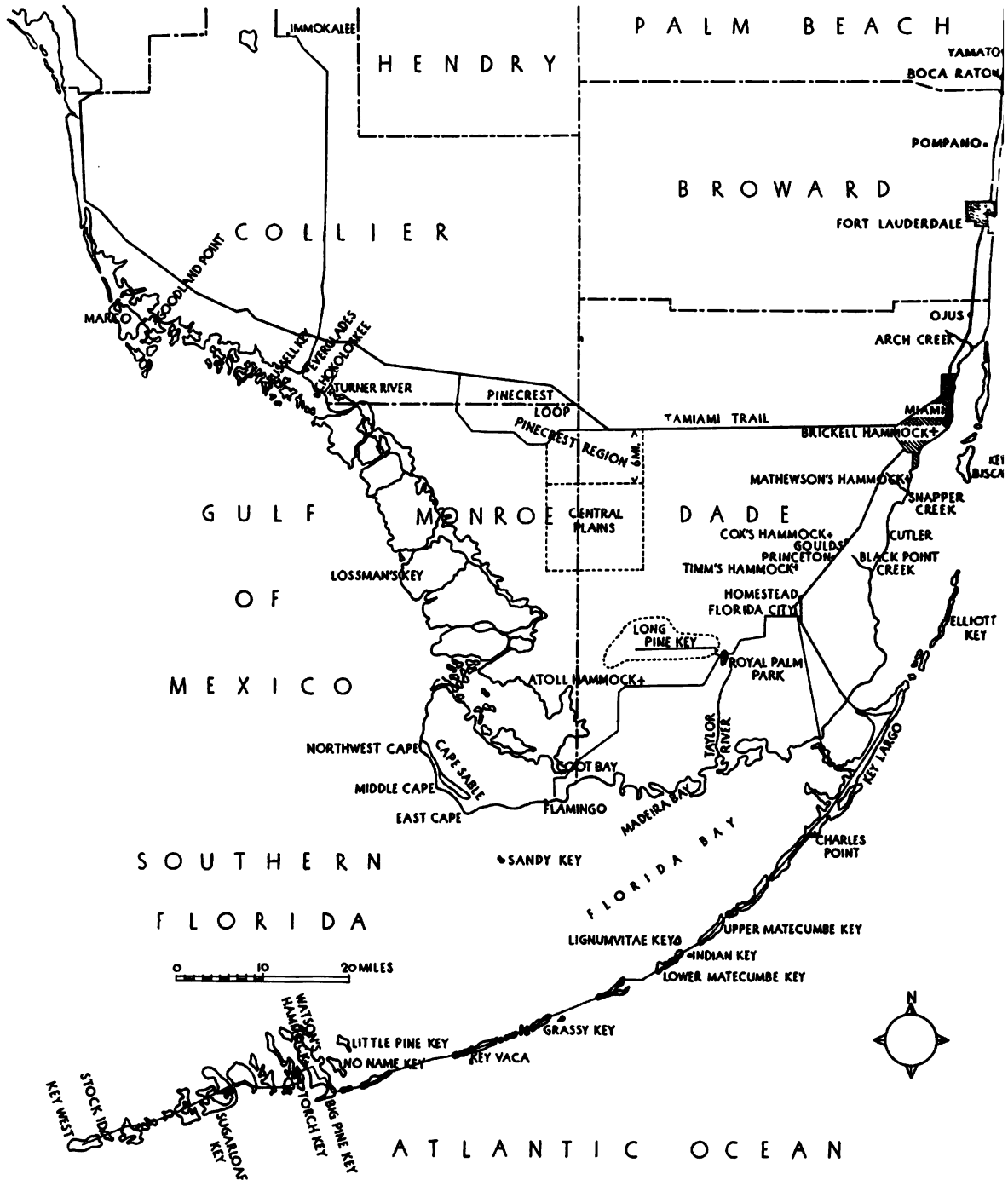


Fig. 23. Area inhabited by *Liguus* in Florida. Shore lines, highways and roads represented by continuous lines. Drawn by Thomas L. McGinty.

The hammocks in these areas have been numbered, very few of them having names, and many collectors write these numbers within the outer lip of each shell. Thus, LPK27 denotes the eastern hammock in Long Pine Key, also known as Palma Vista.

Composition of colonies

Colonies of *Liguus* may be either pure, the hammock containing shells of a single pattern, or mixed, containing two or more. In my opinion, while the composition of colonies is of interest in connection with tracing the previous migrations of the various patterns concerned, it is doubtful whether such statistics have any bearing upon the evolution of races, as some authors have assumed.¹⁶ The patterns present in any colony depend upon what forms were introduced, and in what proportions, when the colony was established. Brickell Hammock at Miami, now destroyed, probably contained more forms than any other. Simpson enumerated 13 distinguishable forms, belonging to the following six subspecies and forms as used in this work: *castaneozonatus*, *roseatus*, *elliottensis*, *testudineus*, *ornatus* and *lossmanicus*. A lot of 361 shells from Brickell Hammock, collected without selection prior to 1932 by the brothers McGinty, comprised the following subspecies, with the number of each:

<i>castaneozonatus</i>	66	<i>testudineus</i>	50
(Var. <i>deckerti</i>)	2	<i>ornatus</i>	36
<i>roseatus</i>	53	<i>lossmanicus</i>	65
<i>elliottensis</i>	61	<i>matercumbensis</i>	3
<i>marmoratus</i>	25		

In the Pinecrest region there may be up to 6 or 7 forms in one hammock, though often not so many, *castaneozonatus*, *roseatus*, *marmoratus* and *lossmanicus*, being of most general occurrence. Three hammocks listed from the McGinty collection have the following races:

PC 80: *castaneozonatus*, *roseatus*, *elliottensis*, *marmoratus*, *testudineus*, *ornatus* and *lossmanicus*.

PC 88: *roseatus*, *elliottensis*, *marmoratus*, *testudineus*, *ornatus* and *lossmanicus*.

CC 13: *castaneozonatus*, various forms, 10; *roseatus*, 6; *testudineus* var. *solisoccasus*, 7; *ornatus*, 8; *marmoratus*, 40; *lossmanicus*, 17; *lossmanicus* var. *aurantius*, 33.

Middle Cape Sable, 85 shells, all collected March 18, 1935, of the following races: *castaneozonatus*, 53; *roseatus*, 2; *elliottensis* (*cingulatus* banding), 15; *testudineus*, 6; *marmoratus*, 6; *lossmanicus*, 3. The hurricane of September of the same year is said to have about destroyed this hammock.

¹⁶ Cf. the study of *Cochlicella acuta*, by Aubertin, Ellis & Robson, Proc. Zool. Soc. Lond., 1930, pp. 1037-1055.

Key Vaca has a rather rich assortment of colors. In a lot of 12 collected alive in 1904 by J. S. Raybon for Mr. C. B. Moore, the shape varies from normal to decidedly elongate. The columella is narrow and weakly sinuate. The lot contains: 3 *L. f. marmoratus* (figured in 1912, pl. 37, figs. 9, 9a, 9d); 2 yellow and 6 white *lossmanicus*, form *luteus* (pl. 37, figs. 9b, 9c), and 1 *ornatus* with the usual external color, but the summit white with brown tip; the columellar callus has conspicuous alazarine pink streaks, a small basal area purple-drab.

T. L. McGinty has furnished the following list of subspecies taken by him on Key Vaca, with the number of each:

castaneozonatus	6	marmoratus	51
roseatus	7	(same, light color).....	3
elliottensis		lossmanicus	45
(Var. cingulatus)	4		
(Var. vacaensis)	20	Total specimens	136

Other keys of the middle group are mostly without *Liguus*, but on Grassy Key the brothers McGinty found a pure colony of *lossmanicus* var. *luteus*.

On Plantation Key they found (1931-1933) a few *castaneozonatus*, *elliottensis*, and one specimen which seems to be *simpsoni*.

The population records have been destroyed in some important hammocks by thoughtless and unscientific collectors, who have planted shells from distant places in hammocks visited later, or bordering highways traversed. Paradise Key has been such a dumping place for *Liguus* not native there. Single examples of *castaneozonatus* and *roseatus* found on Lower Matecumbe are thought to have been imported.

Origin of Florida *Liguus*

All naturalists who have considered the subject agree that our *Liguus* were derived from Cuban stocks of the polymorphic *L. fasciatus* (Müller), brought to Florida sealed to floating trees and cast ashore by high winds or hurricanes.¹⁷ Several such introductions are indicated.

(1) The lower Keys may have been colonized by a single importation bringing the ancestral *graphicus* and *pictus*. An essentially *graphicus* pattern is of common occurrence on the coast of western Cuba, as at Mariel, Cabañas, Puerto Esperanza and westward. Compare the Cuban *L. f. mcgintyi* (a form of *L. f. nobilis* Cl. & Ag.), which has patterns very close to *graphicus*. The *dryas* pattern also occurs at Mariel. The same coast of Cuba affords specimens with white apex and columellar callus. This coast doubtless supplied the *Liguus* of the Lower Keys. I have not seen definitely localized specimens of the exact *pictus* pattern from Cuba, but it may occur

¹⁷ Cf. Pilsbry, 1907, Origin of the Tropical forms of the land molluscan fauna of southern Florida, Proc. Acad. Nat. Sci. Phila., p. 193. Simpson, 1929, Proc. U. S. Nat. Mus., 73, article 20, p. 4. Cf. also: Hurricanes, by Ivan Ray Tannehill, 1943.

there. The other Lower Keys patterns, *solidus*, *dryas*, etc. which are characterized by loss of one or more color factors, may have had their origin in the keys from *graphicus* and *pictus* stocks.

The *Liguus* of Lower Matecumbe and Lignumvitae Keys may indicate former elevation of the whole Middle Key chain at the time or after the *graphicus* and *pictus* stocks had been established on the Lower Keys, permitting them to travel eastward, with subsequent submergence of the keys between Lower Matecumbe and the Bahia Honda channel. The relationship of *lignumvitae*, *pseudopictus* and their allies to the forms of the Lower Keys seems entirely too intimate to have been brought about by a separate colonization from Cuba, where, moreover, these forms are not known.

The races of the lower keys have doubtless always been isolated from the peninsular stocks, and show no intergradation with them. Their intimate relation to *Liguus* of western Cuba allows the inference that these are the latest immigrants in Florida, though there has been time for the evolution on the Keys of several minor forms not occurring in Cuba.

(2) The *Liguus* stock of mainland Florida was probably derived from middle Cuba, along the north coast of Matanzas or Santa Clara provinces, where forms of *fasciatus* somewhat approaching *castaneozonatus*, and of *crenatus*, are known to occur. Our *castaneozonatus* is somewhat paedomorphic, being like young or half-grown *fasciatus*; but an important difference is that the upper color zone is farther from the suture than in the Cuban pattern. The typical color pattern of *fasciatus* is not represented in Florida, and probably is not ancestral to *castaneozonatus* and other mainland races, but rather a collateral line. I have not seen any Cuban shells closely similar to the *testudineus* and *marmoratus* type, but somewhat different forms of our pattern II exist in Cuba. The forms *lineatus* Val., *murreus* Rve. and *flamellus* Clench differ by possessing a dark sutural line, not connected with the flames or spots below, as they are in *pictus*; but they approach our Florida pattern II.

It appears likely that the original mainland importation or importations comprised ancestral forms of the *castaneozonatus*, *testudineus* and *crenatus* stocks. *L. f. septentrionalis* may turn out to be a separate importation; it seems quite unlike other Floridian *Liguus*, but I can not trace it to any Cuban form known to me.

The Atlantic Coastal Ridge seems the most likely landing or landings for the mainland *Liguus*. Very little elevation would allow passage to the Largo group of Keys, and along this east coast ridge the snails could also spread south to Long Pine Key, the Cape Sable region, and northwestward through the Central Plains to the Pinecrest region. Access to such an outlying place as Lossman's Key is more difficult to understand.

All of the peninsular races of pattern I, *castaneozonatus*, *roseatus* and *elliottensis*, with their subordinate forms, may reasonably be thought derived from imported *castaneozonatus*-like ancestors by loss of color factors by mutation. Similarly a single ancestral stock became differentiated to form all of our races of pattern II—*testudineus*, *marmoratus*, *ornatus* and *lossmanicus*.

Throughout a million years or more of Pleistocene time, southern Florida has been built up, interrupted by periods of more or less complete submergence.¹⁸ In the many thousand years, probably, since *Liguus* was introduced, it cannot be doubted that in this unstable region of low relief there have been many changes in the distribution of hammock areas, with isolation of colonies for long periods, leading to the formation of subspecies. Subsequent elevation and spreading of hammocks has resulted in mingling of the herds as we find them today, the subspecies which had been formed in isolation then interbreeding. As hybrids show almost complete segregation of color patterns, the component subspecies of these populations still consist of phenotypically distinct strains, though cytologically composite.

As conditions in the hammocks appear to be quite uniform throughout, ecologic differences which could lead to diversity in the snail populations by direct influence, do not appear to exist, or at least are not obvious. That there is any sexual selection in *Liguus* appears improbable. A number of the clutches of hatching eggs which I have found contained young of more than one color variety. One set of nine eggs deposited in the earth under a bell-jar by a snail of *roseatus* pattern, brought by me from Brickell Hammock, hatched into 4 white young, 2 pink, 2 pink with three brown axial stripes and a brown peripheral line on the last whorl, 1 egg remaining unbroken. There were thus three forms, respectively, *elliottensis* or *lossmanicus*, *roseatus* or possibly *testudineus* (the exact identity uncertain at this stage) and *castaneozonatus*. Further observations are needed.

The *Liguus* most conspicuous on the trees are the white and yellow ones and *castaneozonatus*, and these are usually among the most numerous in

¹⁸ See in this connection, *Geology of Florida*, by C. Wythe Cooke and Stuart Mosson, Florida Geol. Surv., 20th Ann. Rep., 1929. *Late Cenozoic Geology of Southern Florida*, by Garald Parker and C. Wythe Cooke, Florida Geol. Surv., Geological Bulletin No. 27, 1944.

According to C. Wythe Cooke's interpretation of the record (1944, pp. 24-27), southern Florida was deeply submerged during the Sangemon interglacial stage, so that none of the land animals or plants can date back of early Wisconsin time, in the neighborhood of about 50,000 years ago. It may be that this is long enough for the evolution of races such as *Liguus*, differing in little besides color; but it seems difficult to compress the evolution of a number of species of animals and a great many southern Florida plant species into so brief a period. It seems possible that the depth of submergence and the possibility of earlier islands should be reconsidered.

mixed colonies. Whether the cryptic coloration of *L. f. testudineus* and *L. f. marmoratus*, in their various forms, has been an influential factor in their survival is somewhat doubtful. In some Long Pine Key and Pinecrest hammocks the dark shells outnumber other patterns; elsewhere they usually form a small minority.

On the whole, it is not apparent that any form of selection has been a major factor in the evolution of Florida *Liguus*. The races appear to have arisen through isolation, the result of their patchy distribution, as noted above, from new mutations and from gene recombinations, the result of crossing, in hybrid colonies. Loss of one or more components of the color pattern has taken place in some members of all of the main stocks. In albino forms, when yellow, brown and pink have all been lost, it is sometimes difficult, or probably impossible, to trace relationships.¹⁹

I am inclined to believe that in mainland Florida, distribution has been in the main from tree to tree; it is the hammocks which have traveled, rather than, as Simpson²⁰ supposed, the individual snails.

Key Vaca and Grassy Key, western keys of the middle group, have a *Liguus* fauna almost identical with that of middle Cape Sable on the mainland directly north, and entirely unlike that of the keys east or west. In my paper of 1912, p. 440, I suggested that "it seems reasonable to suppose that an extensive tract of land formerly connected these south-central keys with the mainland." If so, it must have been a relatively recent connection, later than the submergence of the middle keys mentioned above. There is a strong southward current past Cape Sable, and it seems possible that a tree well stocked with *Liguus* could have drifted across the bay and made a landing on Key Vaca. Simpson (1929, p. 37) thought that *L. f. marmoratus*, and presumably its associates on Key Vaca, migrated to that key from Cuba, spread along the upper keys and thence to the mainland. This appears improbable, as part of the Key Vaca shells, such as *L. f. marmoratus* and *Orthalicus reses*, are not known to exist in Cuba, and there is no trace of them on the upper keys. The possibility that Indians carried mainland shells to Key Vaca is to be considered.

Subspecific forms and their taxonomy

The richness and variety of coloring in *Liguus* has led to the recognition and naming of many forms or "microsubspecies," in all about fifty names. As already noted, two or several of these may exist in the same hammock, and there is ample evidence that snails of different patterns interbreed,²¹ The hybrids show practically complete segregation, so that the shells of a

¹⁹ Cf. Ricardo de la Torre, 1938, *Nautilus*, 52: 46, who recognized that various Cuban stocks have produced albino races.

²⁰ Cf. Proc. U. S. Nat. Mus., 73, art. 20, p. 18.

²¹ Actual observation of the mating behavior of *Liguus* is still a desideratum.

hybrid colony can be assorted readily into the several patterns or subspecific forms represented, without blending individuals,²² though of course there is variation. In such cases, although several cytologically diverse forms may be present among individuals of each pattern segregated, it does not appear feasible to distinguish between conchologically identical phenotypes in taxonomy.^{22a}

The question arises, what taxonomic status is to be assigned to the distinguishable strains of such polymorphic snails? Many of the named "varieties" (to use a non-committal term), are merely stages in clines (character gradients), such as *luteus* and *aurantius*, stages in the *lossmanicus* cline; *miamiensis* and *elegans*, which are points in a similar variation-series of *castaneozonatus*. Other forms differ in the emphasis on different features of the same pattern. It is not difficult to group many of these forms together, as has been done in the following account, reducing the number of really different races to about eight. For the purposes of this work, these principal strains are ranked as subspecies. It is true that the term subspecies usually has a geographic connotation; subspecies cannot ordinarily be sympatric (that is, two or more in one district). It is quite probable that the now prevalent association in one hammock, or in a single tree, of several subspecies, is a secondary condition of races which had evolved in isolation, and retain their characters when mingled and interbreeding. A group of originally allopatric races have become sympatric by the growth of their hammocks across the former swamps or savannas. The limits of everglade, cypress swamp, pine land and hammock have been continually, if slowly, changing, and the isolation of subspecies is a temporary condition. However this may be, as nomenclature and taxonomy are devices for helping us to comprehend and record the complicated relations of living things, it is perhaps not wise to make our categories too rigid; after all, they are largely subjective. Subspecies evolved in isolation may, and certainly sometimes do, come together with disappearance of former barriers, and *Liguus* seems to be a case in point. It is an aid to clear thinking to admit the chief patterns of *Liguus* as "subspecies," since their characters do not intergrade, and we have no other term which will cover the rather unusual conditions.²³

²² Some named varieties of various subspecies frequently show blending or intergradation of patterns, as *testudineus*, *castaneus* and *versicolor*; *walkeri* and *castaneozonatus*; but this is merely because several stages have been named in the continuous variation of single subspecies.

^{22a} Cf. Camp & Gilly, "The structure and origin of species," *Brittonia*, 4: 334.

²³ In their classification of *Liguus*, Clench and Fairchild have reduced the entire series to three subspecies: *solidus*, *lignumvitae* and *roseatus*. These have the geographic limitation usually claimed for subspecies, but not the zoological qualifications, as some members of the first two are scarcely distinguishable, and their third subspecies contains such a variety of forms that the term subspecies becomes meaningless. Geographic range is an important attribute of a subspecies, but it is not the only essential quality.

Historical

The first information on Floridian *Liguus* was Thomas Say's description of *Achatina solida* in 1825. In 1844 Dr. Binney sent a collector, John Bartlett, to Florida, and in 1852 gave exquisite figures of his finds in *Terrestrial Mollusks III*, plates 55 to 57, representing the forms now known as *solidulus* and *pictus* from the Lower Keys, *castaneozonatus*, *miamiensis* and *mosieri* from the Miami hammock, all under the name *Bulimus fasciatus* Müller.

The study of races and distribution of *Liguus* began in 1912 with the present author's paper, "Variation and Zoogeography of *Liguus* in Florida."²⁴ Various subspecific forms were named, making fifteen in all, classified as subspecies of three species, *L. solidus*, *L. fasciatus* and *L. crenatus*. The first two of these do not hybridize or intergrade in color designs, but no anatomical distinctions have been found. Races which were included in the third, *crenatus*, are now considered to be end terms of several series losing color. All of the subspecies and most of the "forms" were defined in this essay. Later authors have concerned themselves mainly with naming the minor strains called "varieties" in this monograph.

The chief subsequent work was by Charles T. Simpson, whose studies from about 1915 on were brought together in 1929 in his "Florida tree snails of the genus *Liguus*."²⁵ The number of named forms was increased to thirty-five, classified under the same three species, and prefaced by a discussion of their origin and distribution.

In later years a number of brief papers by W. J. Clench, H. G. Frampton,²⁶ Margaret F. Doe (a popular article) and others have appeared. Some of them described varieties of the Pinecrest region, almost unknown before. A list of the named forms was issued by W. J. Clench and G. B. Fairchild in 1939.²⁷ They recognized three subspecies, *solidus*, *lignumvitae* and *roseatus*, of the single species *L. fasciatus*; *roseatus* comprising all of the mainland forms.

Several years ago Thomas L. McGinty, who with his brother Paul L. McGinty has collected in all of the Florida *Liguus* areas, composed a new classification of the races based upon certain characters of the color patterns. Having gone over the whole series with him in Florida, and again in preparing this work, his system appears to be as logical as is attainable in such a complex of forms. With slight alterations it has been adopted in the following pages. An outline is given on page 42.

²⁴ Jour. Acad. Nat. Sci. Phila., 15: 429-471, 3 colored plates and map.

²⁵ Proc. U. S. Nat. Mus., 73, article 20, 4 colored plates and map.

²⁶ Mr. Frampton read a paper on the classification of Florida *Liguus* at the St. Petersburg meeting of the American Malacological Union, 1938, but it has not been published.

²⁷ The Classification of Florida *Liguus*, Proc. New Engl. Zool. Club, 17: 77-86.

In the treatment of *Liguus*, many difficult details have been considered in consultation with Mr. McGinty, whose collaboration is gratefully acknowledged. Indispensable material has been received from Wm. J. Clench, R. F. Deckert, H. G. Frampton, Ralph H. Humes, William Osment, C. T. Simpson, L. A. Thurston and others mentioned in the text. Through the courtesy of Dr. J. H. Beal I had opportunity to examine the Charles A. Mosier collection, now in the Beal-Maltbie Museum at Winter Park, Florida.

Killing and preparing Liguus

Killing *Liguus* by the ordinary method, in boiling water, results in loss of color; the green lines become bronzy or dirty gray. To preserve the natural color care must be taken that no steam or hot water comes in contact with the outside of the shell. Various methods of killing are used. An excellent way is to place the snails, aperture down, on a towel in a tin plate, and expose them in an oven at about 300° for about five to seven minutes. Or the specimens may be placed, aperture up, on dry sand and heated in an oven until dead. They may also be killed in the freezing compartment of a refrigerator, and pulled when partially melted out; but this method requires 12 hours or more. Too much dry heat fades the pink tints. Washing, if required, should be in cool water.

Specimens taken during rainy weather contain a great amount of water. They may be kept in a dry place or left hanging in a netted sack for a few days before cleaning. Collectors in the field for several days sometimes make rolls of the specimens, one layer deep, in paper, labelling each bundle outside. They will live a long time thus, and may be transported or shipped home for cleaning. As soon as cleaned, the symbol for locality should be written within the outer lip, or on paper pushed into the aperture. Poorly localized material is almost useless, and localities supplied from memory have often led to serious error.

RACES OF THE LOWER KEYS, LOWER MATECUMBE AND LIGUUM VITAE KEYS

These races are closely related to those of the northern coast of western Cuba, and are not directly allied to any of the mainland stocks.

In the subspecies *graphicus* and its subordinate forms the yellow zones, or the areas having dark color markings, are wider than in the mainland zoned forms, with a narrower light band below the sutural line, approaching the condition in Cuban *L. fasciatus*.

Many of the races of the Lower Keys are now extinct or on the verge of extinction.

Key to subspecies and named forms of the Lower Keys, Lower Matecumbe and Lignumvitae Keys

- A. Shell with dark markings of brown to lavender or violet-slate color.²⁸
 - B. Flames, or upper series of spots, separated by a white space from the dark line at suture; peripheral dark line on a white band, apical whorls pink.
 - C. Rather solid shells, with wide flames on the spire, few dots if any below suture, and none on the last whorl. Lower Keys.
 - D. Ground color yellow, usually no green lines.....*graphicus*
 - DD. Ground color pure white, often with green lines.....*osmenti*
 - CC. Thin, light shells with pale yellow ground.
 - D. Profusely streaked, with a series of dots below suture (sometimes widely interrupted).
 - E. Without green lines; No Name Key.....*innominatus*
 - EE. Having green lines.
 - F. Peripheral brown line clear-cut, on a light ground. Lignumvitae and Lower Matecumbe Keys.....*lignumvitae*
 - FF. Peripheral brown line smeared, L. Matecumbe Key.
dohertyi
 - DD. Sparsely streaked, few streaks or none on last whorl. Lower Matecumbe*delicatus*
 - BB. Spots of the upper series joined to the dark line bordering the suture below; peripheral spots when present concrescent with or smeared across the peripheral dark line.
 - C. Apex pink, no green lines; Lower Keys.....*pictus*
 - CC. Apex white, green lines present, L. Matecumbe Key.....*pseudopictus*
 - AA. Shell without dark markings, though there may be green lines.
 - B. Apical whorls pink.
 - C. Shell solid; Lower Keys.....*dryas*
 - CC. Shell thin and light, with green bands; Lower Matecumbe and Lignumvitae Keys*simpsoni*
 - BB. Apical whorls and columellar callus white. Lower Keys.
 - C. Yellow, of nearly uniform tint.....*solidus*
 - CC. Yellow with white zones above and on base.....*solidulus*
 - CCC. White, sometimes with a bronzy peripheral line.....*crassus*

Liguus fasciatus graphicus Pilsbry Frontispiece, Fig. 1.

Liguus solidus graphicus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 463, pl. 37, figs. 1, 1A.—Simpson, 1922, Nautilus, 35: 73; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 26, pl. 1, fig. 10.

Liguus fasciatus osmenti Clench, 1942, Proc. New Eng. Zool. Club, 19: 69 (Pine Islands, Lower Florida Keys).

Liguus solidus crassus Simpson, 1920, Proc. Biol. Soc. Wash., 33: 126 (Big Pine Key); 1922, Nautilus, 35: 71; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 25, pl. 1, fig. 8.

Liguus solidus dryas Pilsbry, 1932, Nautilus, 45: 106, referring to Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15, pl. 37, fig. 1B.

The shell is solid, usually rather large and elongate with rather flattened whorls. Ground color amber yellow to straw yellow, narrowly white below a dark line which borders the suture, and with a white peripheral band and

²⁸ Green lines are not considered to be dark markings for the purpose of this key.

white or whitish at base, the columellar callus marked with pink; the peripheral white band is divided by a continuous brown line, and bordered above by a darker interrupted line, both showing on two earlier whorls; there are also usually interrupted lines or spots bordering the sutural and peripheral white. The spire has irregular violet-gray flames across the yellow zone, and there may be one or two bluish or glaucous-gray streaks on the last two whorls, following growth-rests. Length 68 mm., diameter 29.5 mm., length aperture 28.5 mm.

Lower Keys, from Little Pine Key to Boca Chica Key, the type, 8021 A.N.S.P., from No Name Key. "Big Pine Key" (Simpson).

There is wide individual variation in the extent of the dark flame markings, which disappear on the later whorls. Simpson justly called this "one of the most magnificent of all the land shells, being large, solid and richly porcellaneous, highly polished and finely painted." The largest specimen seen is 72 mm. long, in C. N. Grimshawe's collection. Rarely the last whorl shows a few green lines.

Var. *crassus* Simpson. Fig. 24d. "Shell very solid, of medium size, with somewhat rounded whorls; columella heavy and decidedly truncated; color a uniform white with sometimes a narrow, bronzy peripheral line; aperture having a strong, white ledge within; axial region white. Length of type, 43, diameter 27 mm." (Simpson).

Watson's Hammock, Big Pine Key (Simpson, 1885), Type in Simpson Coll. According to Simpson, also from Ramrod Key (Frazer).

Charles T. Simpson described *L. solidus crassus* from a single shell in his collection, with the note: "In 1885 I found the type at Watson's hammock on Big Pine Key, a very solid shell with the tip slightly truncated. A shell from Key West was given me by the late Mr. John R. Henderson."

It differs from *L. solidus* by the white color, as in form *osmenti*; the "bronzy peripheral line" mentioned by Simpson is apparently a green line, not corresponding to the brown peripheral line of *graphicus*. As no other specimens have been found, we do not know whether *crassus* was an established form, or only an albino individual of *graphicus*, as seems likely.

Var. *osmenti* Clench. Fig. 24. Shape as in *L. f. graphicus*, but the whorls are usually more convex. Ground color pure white with pink apex and columellar callus. Dark markings as in *graphicus* except that the flame markings and the smears following growth-rests are pale payne's gray; many specimens have in addition one to three green lines above the periphery of the last whorl, one to four below it. Length 54 to 62 mm.; the type 62 mm. long, diameter 27 mm., length aperture 26.5 mm.

Lower Keys in Big Pine Key (William Osment and Ralph H. Humes), Type 137792 M.C.Z., paratypes 179583 A.N.S.P.

This splendid tree-snail is slightly thinner than *graphicus*, though the lip is thickened within, the chief differences being the total absence of yellow in *osmenti*, and the occasional development of green lines on the last half-whorl.

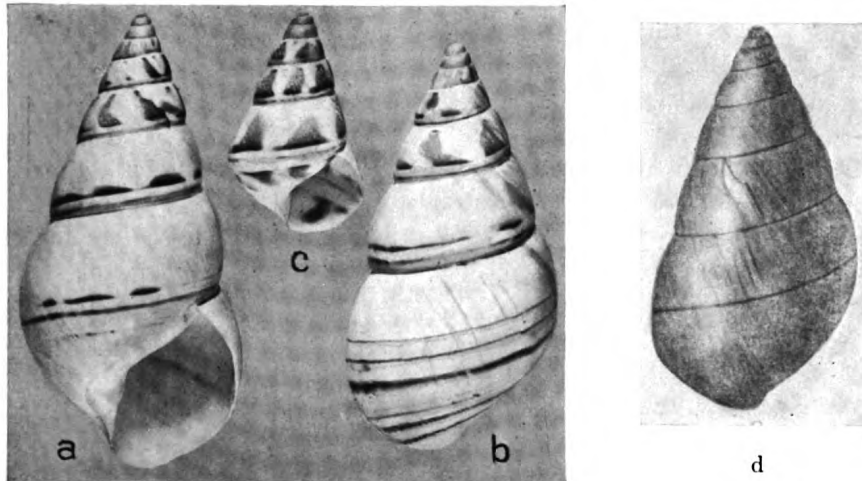


Fig. 24. a, b, c, *Liguus fasciatus graphicus* var. *osmenti*. d, *L. f. crassus*, after Simpson.

Var. *dryas* Pilsbry. Fig. 25. The shell is rather solid, highly polished; after about three pink whorls the color fades to whitish or faintly yellow, the last two whorls having a yellow line bordering the suture, followed by a white band and a broad yellow zone, and a white band above the suture,

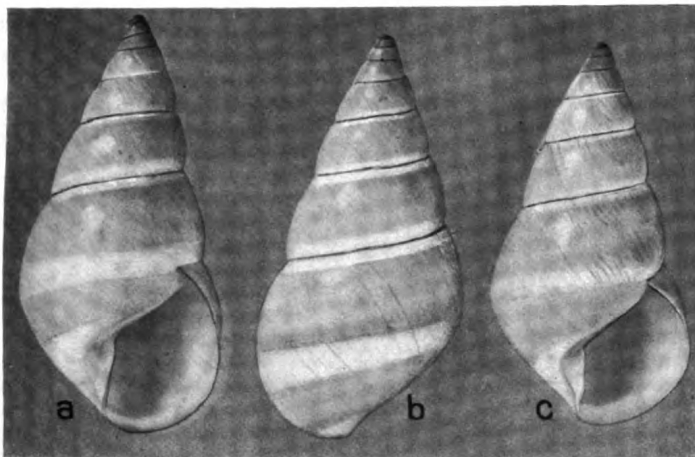


Fig. 25. *Liguus fasciatus graphicus* var. *dryas*. Little Pine Key.

on the last whorl appearing as a peripheral white band; the base with a yellow zone followed by a white band around the columella. Columellar callus pink, usually in sigmoid streaks. Length 49 mm., diameter 26 mm., type. Length 54 mm., diameter 26 mm., Little Pine Key.

No Name Key, with *L. s. graphicus* (C. B. Moore), Type 8019 A.N.S.P. Little Pine Key (Ralph H. Humes).

The last whorl is bluntly angular in front, but this angle is weak in most of the specimens from Little Pine Key. The color is exactly that of *graphicus* minus the dark markings. The dark peripheral line of *graphicus* is typically represented by a faint yellow line dividing the white band in the last third of the last whorl, but this disappears in some specimens. It differs from *graphicus* only by loss of the gene for dark color markings; but as in other cases (*roseatus*, *simpsoni*, *ornatus*, etc.), this results in phenotypes of such different appearance that a special name is convenient.

Form LIGNUMVITAE Pilsbry. Frontispiece, fig. 2; Figs. 26 a-d.

Liguus fasciatus lignumvitae Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 432, 461, fig. 2b, pl. 37, figs. 4-4b (Lignumvitae Key).

Liguus solidus delicatus Simpson, 1920, Proc. Biol. Soc. Wash., 33: 120 (Upper end Lower Matecumbe Key); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 28, pl. 1, fig. 4.

Liguus solidus dohertyi Pflueger, 1934, Nautilus, 47: 121, pl. 13, figs. 2, 3 (Lower Matecumbe Key).

Liguus innominatus Pilsbry, 1930, Nautilus, 44: 32 (No Name Key), Cf. Pilsbry, 1899, Man. Conch., 12: 173, pl. 59, fig. 97, and 1912, Jour. Acad. Nat. Sci. Phila., 15: 404.

The shell is thin and light, polished, with pink apex and pale pink or nearly white columellar callus. Ground color pale sea-foam yellow, varying to white, with white bands as in *graphicus*. Near the summit one or two whorls have pale brown, obliquely axial streaks; following whorls with spot series below and above sutures, and some scattered vinaceous brown flames, the last whorl with vinaceous gray to dull slate-violet axial streaks, irregularly placed, and the usual subsutural and peripheral brown lines. On the basal zone there are numerous grass green or lighter lines, with usually one to three above the peripheral belt (but all green lines are often faded). Length 46 mm., diameter 25 mm.

Lignumvitae Key, Type 8064 A.N.S.P. Lower Matecumbe Key.

On Lignumvitae Key the length is usually under 55 mm., but on lower Matecumbe it sometimes reaches 65 mm. long.

The correspondence between this subspecies and *L. f. innominatus* is so close that their separation seems practically impossible by any character except the green lines and the localities.

The dark markings may be rather copious or they may be sparsely developed, and I collected one shell (Fig. 26d) with no more marking than Simpson's *delicatus*. This with Figs. b, c came from along the path on Lignumvitae Key. There are all stages of decadence of dark markings, fully connecting *lignumvitae* with *delicatus* and *simpsoni*.

Near the western end of Lower Matecumbe the ground color is more distinctly yellow. It is said that one specimen of *lignumvitae* has been found on Windley Key.

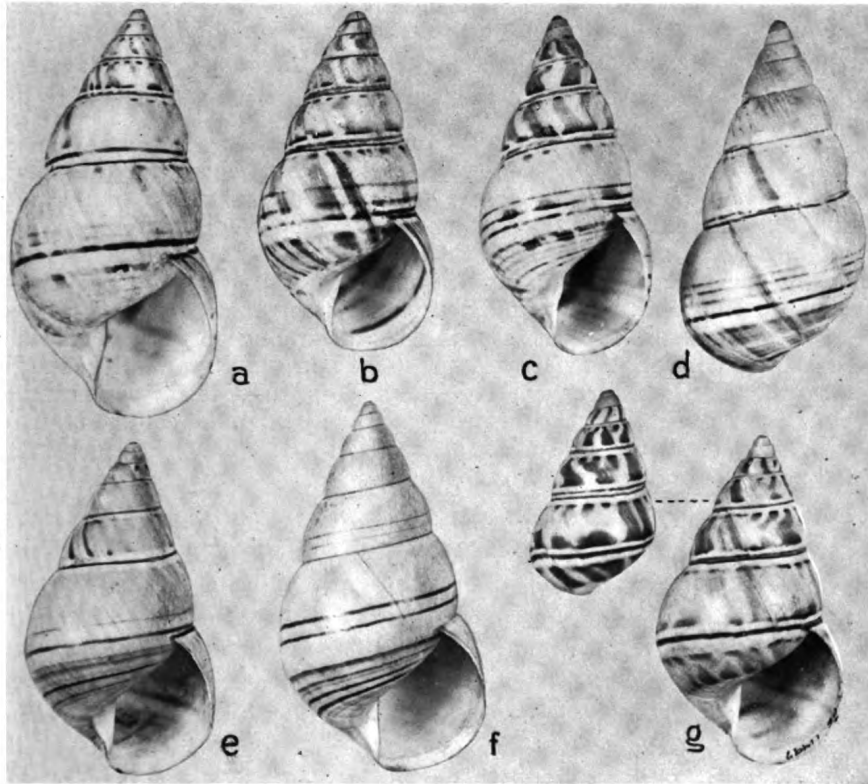


Fig. 26. *Liguus fasciatus graphicus*, form *lignumvitae*, a, hammock 2, Lower Matecumbe; b, c, d, *Lignumvitae* Key. e, *Liguus f. graphicus* var. *delicatus*, Lower Matecumbe. f, *Liguus fasciatus simpsoni*, north end Lower Matecumbe. g, *Liguus f. graphicus*, var. *innominatus*, No Name Key.

On account of its light texture and the separated distribution, I would give this form subspecific rank if it were not that *innominatus* bridges the gap to *graphicus* in both characters.

Var. *delicatus* Simpson. Fig. 26e. Shell similar to *lignumvitae* in being thin and light, with pale pink apex and faintly pink tinged columellar callus, pale straw yellow, with sutural and peripheral brown lines; but the axial streaks are fewer and very much reduced, this being the only feature separating it from *lignumvitae*. Green lines as in that species, or sometimes nearly absent. Length 45 mm., diameter 25 mm. Simpson gives the size as 65 × 28 mm.

Lower Matecumbe Key (Simpson; Paul L. McGinty), Type in Simpson Coll. According to Simpson, also west end of Upper Matecumbe Key (Simpson) and Indian Key (Wurdeman).

“ Usually distinct from the other forms, but an occasional intermediate occurs ” (Simpson). Found only in colonies with *lignumvitae* and *simpsoni*. Whether the little Indian Key ever had resident *Liguus* is somewhat doubtful. It was a settlement, where boats called, and the tree shells may have been brought from nearby Lower Matecumbe.

Var. *dohertyi* Pflueger. Frontispiece. Fig. 11. “ The shell is thin, highly polished; whorls moderately convex, $7\frac{1}{2}$ in number; columella thin, straight and slanting. Texture of very fine growth-lines. Color: Pale straw yellow with faint smoky lavender streaks on the spire. A dark purplish-brown line 1 mm. wide on the periphery, this line becoming a suprasutural line ascending the spire. There is a sutural line of the same color, half a mm. wide. A series of equidistant brown axial streaks, beginning on the second whorl, becoming squarish spots as they descend the spire and gradually enlarging until on the sixth whorl they become mere blurs, these latter ascending the spire and fading out on the fourth whorl. Apex pink, columella white. Length 54.7 mm., width 28.3 mm.; aperture 24×14 mm.” (Pflueger).

Length 47 mm., diameter 25.5 mm.

Lower Matecumbe Key, in a pure colony. Type in Pflueger's collection.

In this form, characters of *lignumvitae* and *pseudopictus* are united. It has a pink apex, and the small spots of the upper series are narrowly separated from the sutural dark line, as in the former, but the smeared band along the peripheral brown line is a feature of *pseudopictus*. It may have arisen from crossing of these, but is now known only in one pure colony.

The number of green lines is variable, but they are usually more conspicuous than in *pseudopictus*, from which it differs also by the weakening of dark blotches at periphery of last whorl, and the presence of a very narrow white space between the sutural dark line and the series of small spots following; but the conspicuous difference is that *dohertyi* has a pink apex.

(Named for Col. Henry L. Doherty, Miami capitalist.)

Var. *simpsoni* Pilsbry. Frontispiece Fig. 8; Fig. 26f.

Liguus solidus lignumvitae, a notable discontinuous variation, Pilsbry, 1912. p. 462, pl. 37, figs. 4c, 4d.

Liguus solidus lineatus Simpson, 1920, In South Florida Wilds, Frontispiece, fig. 3; Proc. Biol. Soc. Wash., 33: 121. Not *Achatina lineata* Valenciennes, 1833.²⁹

Liguus fasciatus simpsoni Pilsbry, 1921, Nautilus, 34: 140.—Simpson, 1929, Proc. U. S. Nat. Mus., 73, art. 20, p. 28, pl. 1, fig. 5.

Shape and texture of the thin, light shell, the pink apex and faintly pink columella are as in *lignumvitae*. Last whorl with sea-foam green zones according to *dryas* pattern, with numerous green lines, which are fewer on the upper zone and show weakly on the penult whorl, the rest of the spire plain. No other markings.

²⁹ *Liguus fasciatus lineatus* (Valenciennes) is a Cuban subspecies of common occurrence in Santa Clara province, at Sancti Spiritus, Zaza del Medio, near Cienfuegos, and elsewhere.

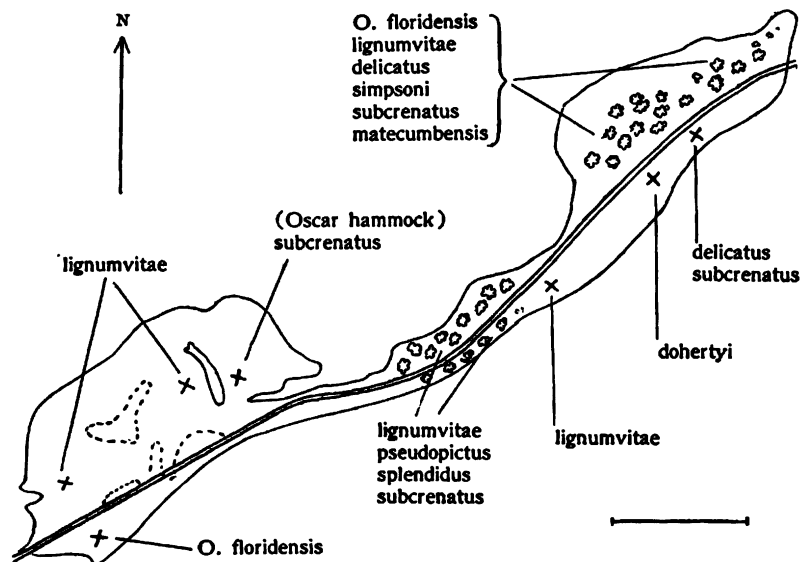


Fig. 27. Distribution of *Liguus* and *Orthalicus* on Lower Matecumbe Key.³⁰ Scale line = 1,000 yards.

Length 45 mm., diameter 24.3 mm. Type.

Length 50.5 mm., diameter 27 mm. L. Matecumbe.

Length 61 mm., diameter 28.5 mm. Lignumvitae Key.

Lignumvitae Key, Type 128063 A.N.S.P.³¹ North end of Lower Matecumbe Key (McGinty, 1931). Plantation Key (T. L. McGinty coll.).

In this form the dark color markings of *lignumvitae* have been dropped out, the ground color and green lines remaining unchanged; but in large lots, such as the McGinty series, transitions may be seen. The yellow ground color is sometimes continuous over the periphery, but often there is

³⁰ The ranges mapped are based on the researches of Mr. Thomas L. McGinty. The hurricane of September, 1935, when the sea swept across the key, destroyed most of the tree snails which had eluded collectors up to that time, and probably the forms restricted to small areas are now gone or on the verge of extinction.

³¹ The text relating to *L. f. simpsoni* in Clench & Fairchild, 1939 (Proc. New Engl. Zool. Club, 17: 81), contains two errors of fact. They state that *L. f. simpsoni* is a "new name for *lineatus* Simpson," but my words were: "I would propose for the shell figured on my plate 37, fig. 4c, the varietal name *Liguus fasciatus simpsoni*, the type being No. 128063 A.N.S.P." My name *simpsoni* was not, therefore, based upon Simpson's work, but upon my own figured shell, described in the second paragraph of p. 462 of my paper of 1912. While I assumed that Simpson's *lineatus* was the same, I have never seen his specimens, therefore chose to name a shell I had myself figured and described.

The locality of this shell is not Porgee Key, as Clench & Fairchild state, but Lignumvitae Key, as given by Simpson in several papers, also by me when describing it, Jour. A.N.S. Phila., 1912, page 462, and on the explanation opposite my plate 37. It does not occur on Porgee Key.

a pale or white band there. The parietal callus is usually only tinted faintly with pink, but sometimes is dark purplish. Old shells sometimes lack the green lines. It is parallel to var. *dryas*, but not directly related.

Var. *innominatus* Pilsbry. Fig. 26g. The shell is thin and light, of convex whorls. It has broad, extremely pale yellow zones situated as in *dryas*, with flames and dark lines arranged as in *graphicus* except that streaks or spots are present on the base in the adult stage. In immature shells there is a zone of squarish dark markings on the base. No green lines. Apex and columellar callus faintly pink. Type 44 × 24 mm., others up to 51 mm. long.

No Name Key (Henry Hemphill, 1882 or 1883), Type 11497 A.N.S.P.

I do not know that this form has been found by any collector since Hemphill. In his collection there are typical specimens from No Name Key (Cal. Acad. Sci. No. 9934), but he had no *Liguus* or other shells from Lower Matecumbe or Lignumvitae keys.³² Except that none of the specimens show green lines, it appears scarcely distinguishable from *L. f. lignumvitae*.

(*Innominatus*, not named, referring to the name of the key.)

Liguus fasciatus solidus (Say)

Frontispiece fig. 3; Fig. 28 a, b.

Achatina solida Say, 1825, Jour. Acad. Nat. Sci. Phila., 5: 122 (southern part of East Florida). Cf. Pilsbry, 1899, Man. Conch., 12: 173, pl. 58, fig. 86.

Liguus solidus (Say), Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 432, 462.—Simpson, 1929, Proc. U. S. Nat. Mus., 73, art. 20: 25, pl. 1, fig. 7.

Liguus solidus solidulus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 403, pl. 37, fig. 2A (Big Pine Key).—Simpson, 1922, Nautilus, 35: 73 (Summerland Key); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 25.

The type shell is solid and strong, polished; narrow, but this shape was evidently caused by an extensive breakage in the middle of the antepenult whorl, resulting in more rapid descent of succeeding whorls. Pale yellow with a white line at suture and an ill-defined pale peripheral band. Apex and columellar callus white. Columella moderately heavy, obliquely truncate at the base.

Length 54 mm., diameter 22.5 mm. Type.

Length 55 mm., diameter 25.6 mm. No Name Key.

Length 63 mm., diameter 30.7 mm. No Name Key.

Key West (T. R. Peale, 1825,³³ Type 11494 A.N.S.P. No Name Key (Pilsbry, 1907). Little Pine Key (Raybon, 1904). Watson's Hammock, Big Pine Key (C. T. Simpson, 1886).

³² I am indebted to Dr. L. G. Hertlein for information on Hemphill's specimens.

³³ Key West is given as type locality because Peale recorded in his journal that there he "collected land shells . . . on the trees, some of them very handsome." He stopped in the lower keys also at Boca Chica Key and Bahia Honda Key, but did not mention land shells. Very old "bones" were taken at Key West by J. S. Raybon and Morgan Hebard in 1904 and by myself in 1907, but they show no color.

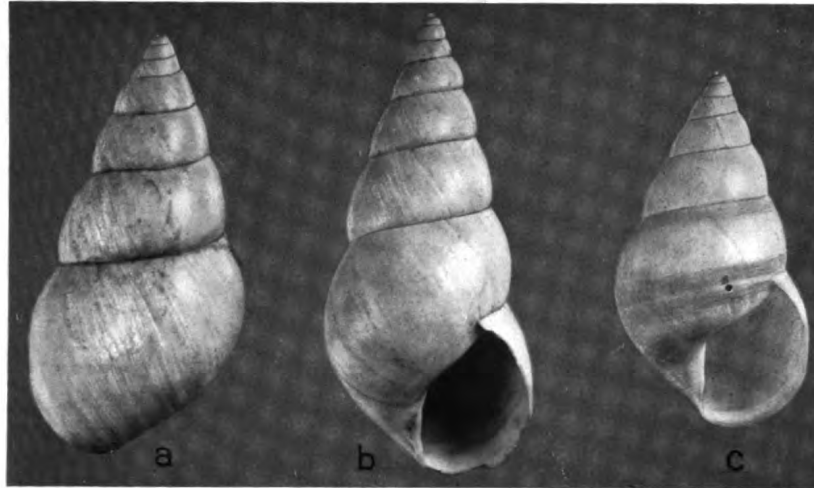


Fig. 28. a, b, *Liguus fasciatus solidus*, Key West. c, var. *solidulus*, Stock Island.

Fig. 28 shows the normal shape, the type, Frontispiece, fig. 3, being distorted by a breakage in youth. It is apparently extinct now, but no doubt it once inhabited the whole lower key group.

Var. *solidulus* Pilsbry. Fig. 28c. Shell is rather thin to moderately solid, polished white with a yellow band below the suture, two contiguous or conerescent yellow bands at the periphery, and a wide one at base. Apex and columellar callus white. Columella straight and rather narrow.

Length 58 mm., diameter 29 mm., $7\frac{1}{2}$ whorls. Type.

Length 45 mm., diameter 25 mm., 7 whorls. Stock Island.

Big Pine Key, Type 8025 A.N.S.P. Stock Island, near Key West, a pure colony, on the Jamaica dogwood (*Ichthyomethia piscipula* (L.)). "Entire chain of the Lower Florida Keys" according to Simpson.

Some shells from the pure colony at Stock Island have only the upper (subsutural) yellow band. Occasionally there are two to eight green spiral lines on the last whorl, but most shells have none. In band pattern (Fig. 22, n d) it is a photographic negative of var. *dryas*.

Form *PICTUS* (Reeve). Frontispiece fig. 4.

Achatina picta Reeve, 1842, Conch. Syst., 2: 87, pl. 178, fig. 10; Proc. Zool. Soc. Lond., pt. X, p. 56; 1849, Conch. Icon., 5, pl. 10, fig. 34 (Cuba).

Liguus solidus form *pictus* (Reeve), Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., (2), 15: 463, 464, footnote 20, pl. 37, fig. 2.—Simpson, 1929, Proc. U. S. Nat. Mus., 73, art. 20, pp. 7, 8, 26, pl. 1, fig. 3.

The shell is rather small, moderately solid, polished, the whorls rather weakly convex. Ground color very pale yellow, the apex pink, columellar callus white or faintly marked with pink. The suture is edged below by a

brown line followed by and connected with a series of small spots; periphery with a double series of contiguous carob brown squarish spots, a brown line (sometimes interrupted) between them; at the base a few spots or none. There are also some light medici blue flames on the spire, and on the last two whorls 3 or 4 streaks across the whorls of the same color, following growth-rests. Columella thin and straight, or in the largest specimen seen, somewhat thickened and obliquely truncate at base (Reeve said of the type: "columella short, scarcely truncated").

Length 43.5 mm., diameter 22 mm.

Length 49 mm., diameter 25 mm.

Big Pine Key, west side (H. A. Pilsbry, 1907).

The elements of the color pattern are essentially those represented in *graphicus*, but differently arranged: in *pictus* the spots along the periphery are closely contiguous to the brown peripheral line, and those below the suture are more fully developed than in *graphicus* and lie close against the sutural brown line.

The locality "Cuba" was given by Reeve, but without mention of collector. He had a single specimen. One of A. d'Orbigny's figures of "*Achatina*" *fasciata* appears to be referable to *pictus* (Sagra's *Historia*, pl. vi, fig. 6), but he says of *fasciatus* generally: "Esta especie habita en la isla de Cuba y las Floridas," and the *pictus* he figured may well have been from the latter locality. It may be noted that on the same plate Orbigny figured *Orthalicus reses*, a shell of the Florida Keys, unknown in Cuba. There are ancient specimens of *pictus* labelled "Cuba" in the Washington and Philadelphia collections, but without definite locality or name of the collector. Some examples of the *Liguus* from Mariel known as *mcgintyi* have a superficial resemblance to *pictus*, but they differ by the presence of a white space between the sutural dark line and the series of spots, also a white band below the peripheral dark line, showing that the similarity is owing to convergence rather than to any direct relationship. While *pictus* may occur in Cuba, no recent collectors have found it so far as I know, and further evidence is needed to establish it as a Cuban snail.

Var. *pseudopictus* Simpson. Frontispiece fig. 6.

Liguus solidus pseudopictus Simpson, 1920, Proc. Biol. Soc. Wash., 33: 122 (Upper end Lower Matecumbe Key); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 15, 29, pl. 1, fig. 9.

Liguus solidus splendidus Frampton, 1932, Proc. Biol. Soc. Wash. 45: 57 (Middle hammock of Lower Matecumbe Key).

The shell is rather thin, with white apex and columellar callus. Later whorls sea-foam yellow, decorated in *pictus* pattern, with the addition of few or many green lines; on the third whorl narrow brown streaks extend across the whorl and somewhat zigzag streaks appear in places as far as the fifth whorl. A series of brown spots below the suture appears on the third

or fourth and on later whorls, together with larger spots above the suture. The last two whorls have a few streaks of light payne's gray. On the last whorl the brown spots are usually concrescent over the peripheral line; the basal markings weak or absent.

Length 50 mm., diameter 36 mm. Type.

Length 60 mm., diameter 30 mm.

Lower Matecumbe Key, in one hammock in the central part of the key, associated with *L. s. lignumvitae*. See Fig. 27.

Except for the white apex, this race scarcely differs from *L. s. pictus*.

In the Var. *splendidus* Frampton, Frontispiece Fig. 5, the irregular brown stripes are more numerous and darker. It was thus described:

"Shell medium to large, very highly polished, elongate, with rather flattened whorls although some specimens have moderately convex body whorls. Entire axial region white. Ground color creamy yellow to lustrous yellowish brown, with dark brown and bluish axial smears on body whorl. Dark brown smears, flecks and flames extending from suture to suture on third, fourth, fifth and sixth whorls but appearing mostly as richly-hued flames on fifth whorl. Squarish and blotchy brown spots on sutures of sixth and body whorls, with sub-sutural spots generally square and spaced regularly, but supra-sutural spots irregular and smeared. Brownish markings occasionally fade into a slaty blue. Distinct reddish brown peripheral line, with rufous smear on basal area. Broken band on area adjoining columella. Palatal lip smooth and unthickened within, columella thin and straight or slanting. Parietal wall uncalloused. Spiral green lines usually present, particularly on basal area. Length 50 mm., width 27 mm., aperture 21 × 12.5 mm." (Frampton).

Lower Matecumbe Key, middle hammock (Frampton), type in Frampton collection. It occurs with *pseudopictus*, in the proportion of about 1 *splendidus* to 50 *pseudopictus*, according to Frampton. See Fig. 27.

RACES OF THE MAINLAND AND THE MIDDLE AND UPPER KEYS

These forms are apparently the oldest of the Florida tree snails, being well differentiated from Cuban forms. The several cases of close resemblance noted by Simpson are probably owing to convergent color evolution rather than direct relationship.

Key to subspecies and the chief minor forms

Note.—As green lines may be either present or absent in nearly all forms, they are not considered in this key unless specially mentioned. In using the key, it is well to have several specimens. Single shells of modified shape or unusual coloration may occur, which cannot be successfully run down. Decide each alternative definitely before passing to those under the next letter.

For convenience the races of Matecumbe and Lignumvitae keys are included here.

- A. Shell having markings of brown or dark color.
- B. Dark markings separated from the suture or sutural line by a white space or band which is sometimes quite narrow.
- C. Markings in the form of streaks of brown, lavender or violet-slate; thin, light shells with pale yellowish ground color. Matecumbe group of Keys.
- D. Profusely streaked, and with a series of dots below suture, green lines generally present; apex and/or columellar callus pink.
- E. Peripheral brown line clear-cut, on a light ground.
lignumvitae
- EE. Peripheral brown line on a smeared brownish band.
dohertyi
- DD. Sparsely streaked, few streaks or none on the last whorl, few dots below suture.....*delicatus*
- C. Dark markings in form of zones (often broken into flames or streaks, or split into bands, or reduced to a few spirally arranged spots on upper whorls only), well separated by a white band or zone from the suture, which may be bordered by a dark or yellow line or none.
castaneozonatus
- BB. Markings (in streaks, spot-bands or irregular) extending up to the thin whitish edge or line which borders the suture.
- C. A band of spots below the suture, the thin, light shell elsewhere more or less striped or streaked. Lower Matecumbe Key.
- D. Apex and columellar callus white.....*pseudopictus*
- DD. Apex and columellar callus pink.....*dohertyi*
- CC. Apex and columellar callus pink or white; mainly in the East Coast ridge to Long Pine Key.....*testudineus*
- CCC. Apex and columellar callus white; Key Vaca to Pinecrest..*marmoratus*
- AA. Shell without brown or other dark markings (aside from green lines, which are often present).
- B. Columellar callus and usually the apex pink.
- C. Shell amber yellow (varying in tone) up to the narrow whitish suture, the periphery often paler. East Coast ridge, Key Largo and Pinecrest.
ornatus
- CC. Shell pale chalcedony yellow nearly to suture, with a whitish peripheral belt and green lines, Lower Matecumbe and Lignumvitae Keys.
simpsoni
- CCC. Shell white or with yellow in one or two broad zones, well separated from the suture; usually a pink or yellow sutural line.....*roseatus*
- BB. Columellar callus and apex white.
- C. Columella concave or straight; shell white or yellowish, often with an indistinct yellow margin below suture; last whorl indistinctly subangular in front.....*matecumbensis*
- CC. Columella straight.
- D. Diameter about half or less than half the length, slender, thin, white or faintly yellowish, aperture small.....*subcrenatus*
- DD. Diameter generally more than half the length.
- E. Yellow (from orange to almost white) throughout, the color extending to the fine whitish sutural line; last two whorls strongly convex.....*lossmanicus*
- EE. Having a yellow zone (*dryas* pattern) or pure white. South-eastern*elliottensis*
- EEE. Snow white, plain or with green lines, thin, capacious; Fort Lauderdale northward.....*septentrionalis*

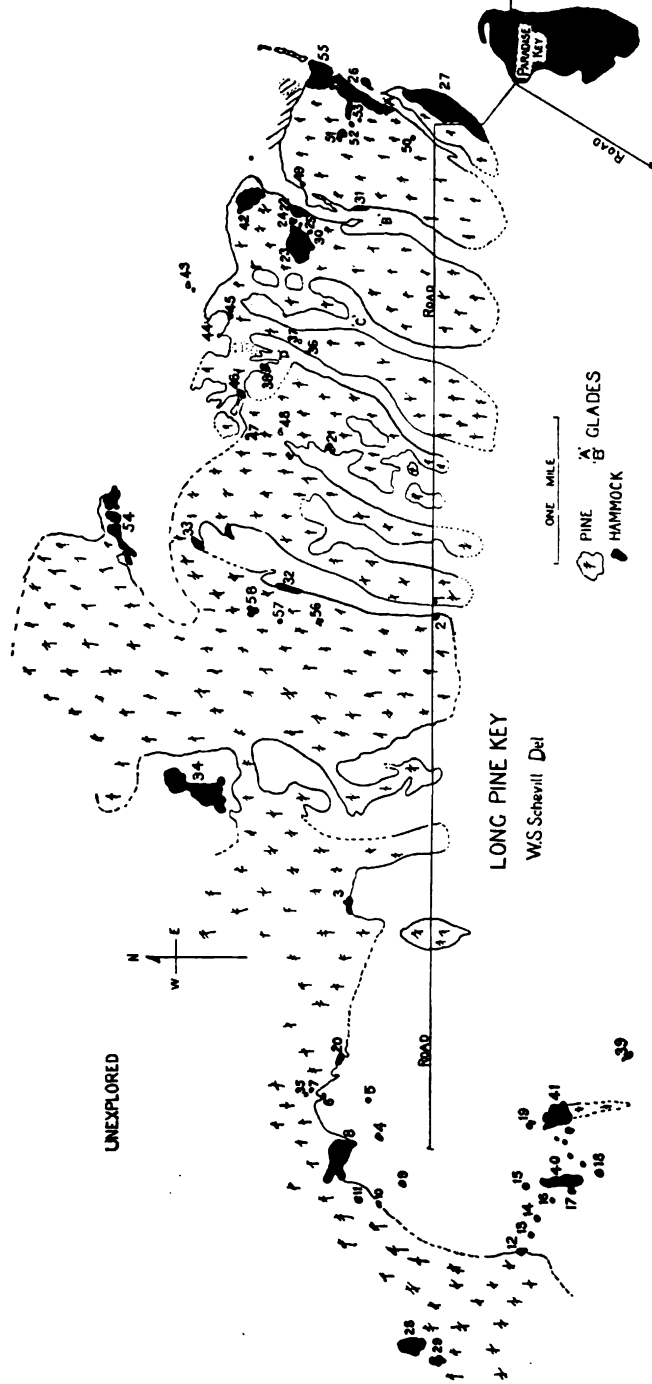


Fig. 29. Map of Long Pine Key, by W. S. Schevill (reproduced by courtesy of Wm. J. Clench).

PATTERN I.—CASTANEOZONATUS GROUP

Liguus fasciatus castaneozonatus Pilsbry

Fig. 30.

L. fasciatus castaneozonatus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 432, 460, pl. 39, fig. 23a type, 23 (Hammock back of Point Charles, Key Largo).

Liguus fasciatus miamiensis Simpson, 1920, Proc. Biol. Soc. Wash., 33: 124 (Miami Hammock); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 33, pl. 2, fig. 4.

Liguus fasciatus walkeri Clench, 1933, Nautilus, 46: 91, pl. 7, figs. 7-9 (Hammock No. 9, Pinecrest region).

Liguus fasciatus deckerti Clench, 1935, Nautilus, 48: 122, pl. 7, fig. 4. (Hammock No. 55, eastern end of Long Pine Key).

Liguus fasciatus alternatus Simpson, 1920, In Lower Florida Wilds, frontispiece fig. 8 (Timm's Hammock, Dade Co.); Proc. Biol. Soc. Wash., 33: 123; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 31, pl. 2, fig. 1.

Liguus fasciatus elegans Simpson, 1920, In Lower Florida Wilds, frontispiece fig. 5; Proc. Biol. Soc. Wash., 33: 123 (small Key east of Whitewater Bay); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 32, pl. 2, fig. 2.

The rather solid shell has pink early whorls and columellar callus, the ground color elsewhere white with chestnut to blackish zones, continuous or interrupted, on upper surface and base (*dryas* pattern), a dark line at suture and often at periphery. Columella usually sinuate at base.

Length 49 mm., diameter 25.5 mm., type.

Length 57 mm., diameter 29 mm., paratype.

Upper Keys, from Elliott's to Upper Matecumbe Key, the Type, 8014 A.N.S.P., from back of Charles Point, Key Largo. Vaca in the Middle Keys. Mainland from Miami to Cape Sable; the Pinecrest region; Chokoloskee and vicinity on the West Coast.

Numerous varieties of this race have been described and named but while they may be distinct enough typically, most of them connect with others through their variations. Typical or subtypical examples can be distinguished by the following:

Key to named forms and varieties of L. f. castaneozonatus

1. Last whorl having one or two dark zones (either continuous, interrupted into blotches or variously split)..... 2
 Last whorl without dark zone or blotches (but there may be brown lines at suture and periphery)..... 4
2. Apex and columellar callus white.....*deckerti*
 Apex and columellar callus pink..... 3
3. Dark zone or zones continuous or broken into angular spots.....*castaneozonatus*
 Zones light brown closely streaked with chestnut, at least on the spire. Timm's Hammock*alternatus*
 Zones on last whorl largely yellow with bordering bands of brown, or variously split*walkeri*
4. Dark zone reduced to angular chocolate blotches on the spire, the last whorl profusely green-lined*miamiensis*
 Dark zone represented by some brown spots or streaks on the third and fourth whorls only, summit conspicuously roseate.....*elegans*

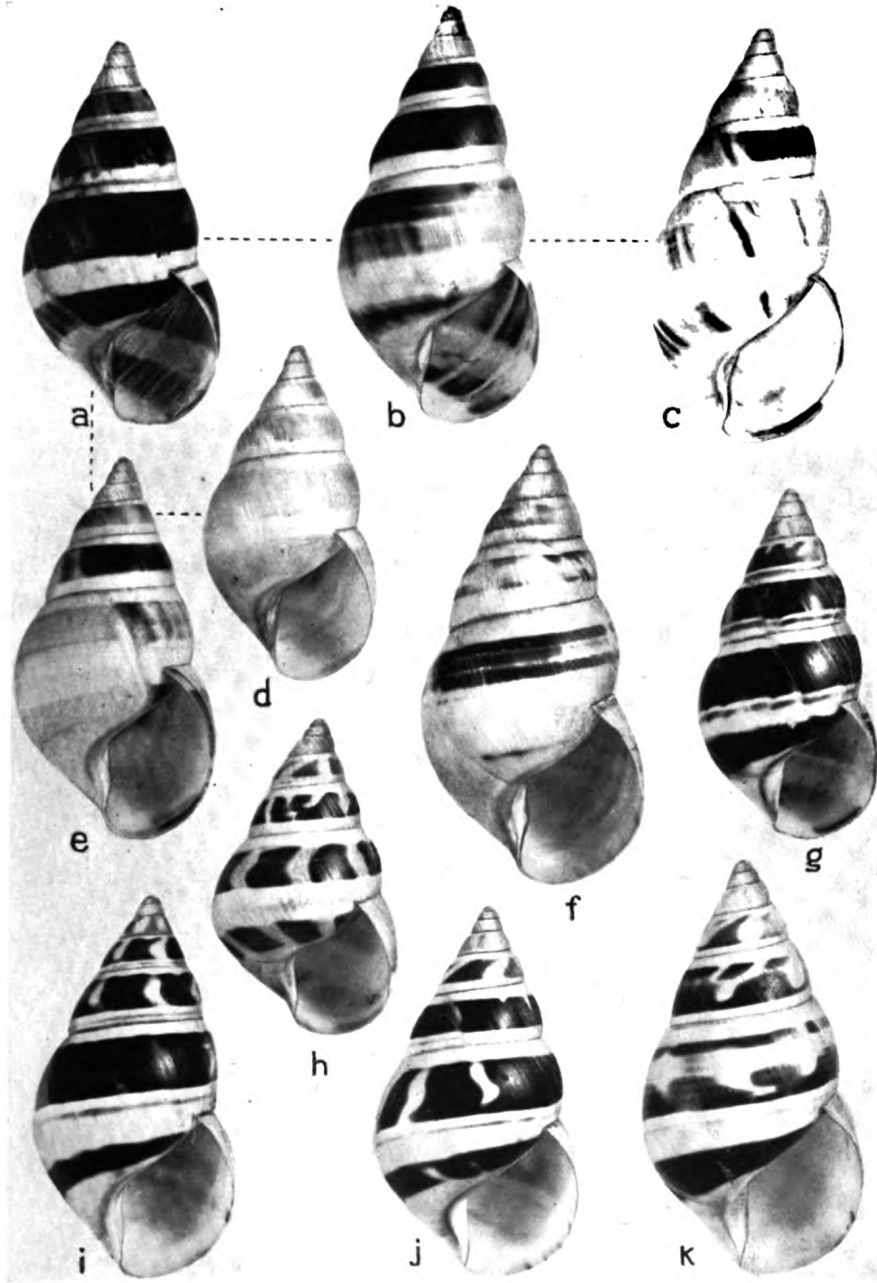


Fig. 30. a-e, *Liguus fasciatus castaneozonatus*, back of Pt. Charles, Key Largo; f, Big Palo Alto Key; g, Chokoloskee; h-k, Cutler, on the East Coast Ridge.

I do not know that the form taken to be typical *castaneozonatus* has been found in pure colonies. In the type locality it occurs with *roseatus* and *elliottensis*. After the 3 or 3½ rose-colored early whorls a few indistinct brown axial streaks usually appear, followed by the dark upper zone which typically is continuous or nearly so, as in Figs. 30a, g, but much more often is broken.

Various stages in decadence of the dark zones are represented in most Key Largo lots, as in Figs. 30 a-e. The zones tend to weaken or disappear on the last whorl or two, either abruptly at a growth-rest, or gradually, the zones fading to pale brown or yellow; sometimes with brown bands remaining at the upper and lower edges of the zones. Green lines are absent, or only faintly present.

Near the north end of Largo, where the associated *roseatus* is of the *lineolatus* variety, the size is usually less and green lines are more often conspicuous.

In hammocks of the East Coast Ridge, from Cutler southwestward, at Cape Sable and Key Vaca in the middle keys, the dark zone is usually cut by white markings into squarish or irregular sections, as in Fig. 30 h-k, and others with more or less dilute or decadent patterns, as in Key Largo *castaneozonatus*. The same patterns occur in some Pinecrest hammocks, such as PC 38, PC 10, and in Collier County.

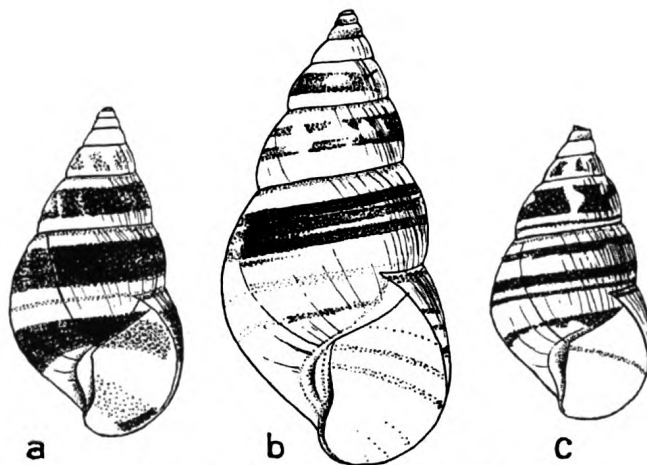


Fig. 31. *Liguus fasciatus castaneozonatus*, Chokoloskee.

In the Chokoloskee *castaneozonatus* colony, where it is associated with *roseatus*, the upper zone is interrupted and largely chestnut colored, not blackish, and the basal zone is generally absent or vestigial in the adult stage. (Fig. 31). Simpson has reported it from Rabbit Key, below Chokoloskee.

In a common form of Brickell Hammock, Miami, var. *miamiensis* Simpson (Fig. 33b), the penult and one or two earlier whorls show a zone

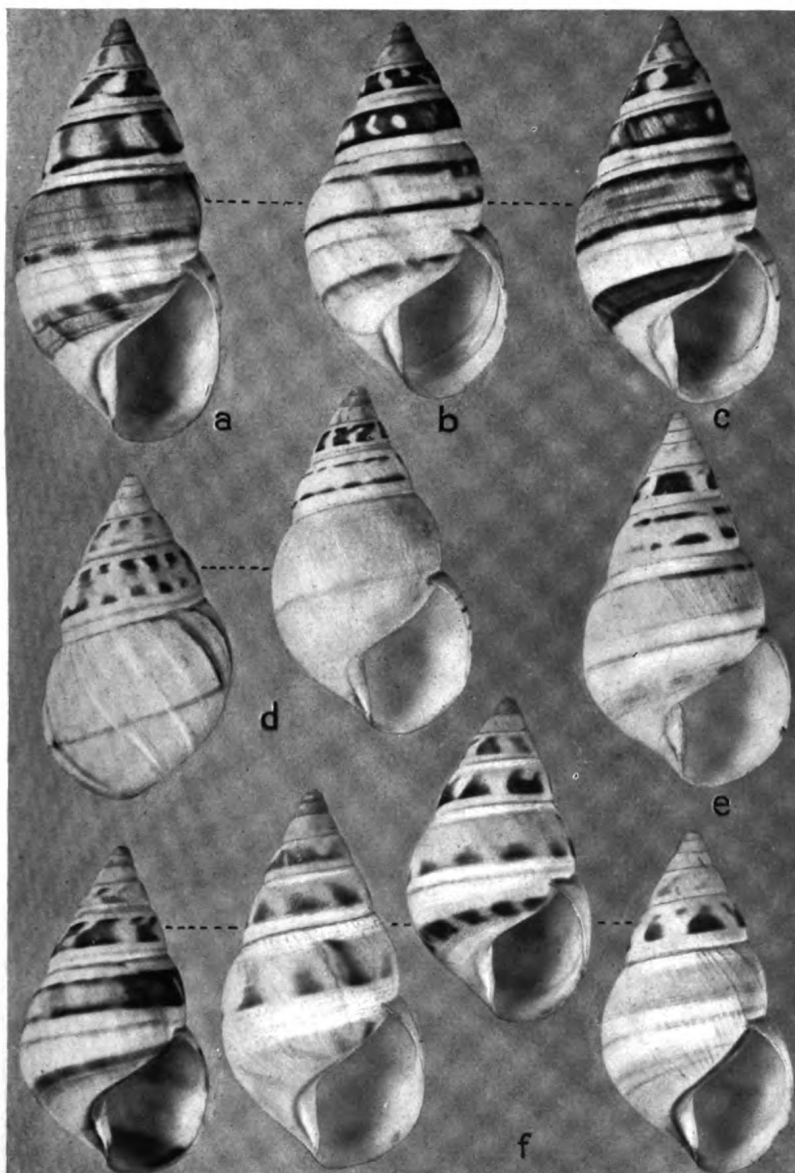


Fig. 32. *Liguus fasciatus castaneozonatus* var. *walkeri*. a-d, Pinecrest, hammock 9; e, hammock 6. f, Long Pine Key, hammock 27 (Palma Vista 2).

of irregular brown blotches on a yellow or white ground, the last whorl without brown markings, but with numerous green lines. This pattern has been reported by Simpson from Ojus to Paradise Key. Some shells with typical *castaneozonatus* bands also occur in the Miami hammock, with all intergrades to *miamiensis*. The specimens of form *livingstoni* Simpson, which he mentions as having brown blotches on early whorls, would apparently be referable to *castaneozonatus* of the variety *miamiensis*, with reduced brown markings. An unusually broad specimen of *miamiensis* was figured in Manual of Conchology 12, pl. 72, fig. 2.

Var. *walkeri*. The prevalent Pinecrest form of *castaneozonatus* has been called *Liguus fasciatus walkeri* Clench (Fig. 32 a-e). It is solid, with pink summit and columellar callus. The upper dark zone has yellow or white ground, with brown to (typically) bluish dark segments, and with blackish upper and lower borders, which persist on the last whorl after the central markings of the zone have disappeared; basal dark band is continuous or interrupted, typically continuing to the lip; but sometimes neither dark zone is present on the last whorl. Peripheral dark line usually present, but sometimes wanting. Green lines are generally found on the last half-whorl.

The Type of var. *walkeri* is 79299 M.C.Z., from hammock PC 9; it occurs also in PC 6, 8, 10, 12, 14, 15, 24, 40 and others. There are specimens completely transitional to *castaneozonatus* of the Long Pine Key patterns, and others in which dark markings are almost vanishing, being reduced to a few small spots on the spire, or only some faint axial stripes on the fourth whorl, as in some specimens from PC 40 and 43.

On Long Pine Key a somewhat modified *walkeri* pattern is found in many hammocks, and it is abundant in some, such as Palma Vista (Fig. 32f) and Osteen. Some shells from Middle Cape Sable and elsewhere have practically the *walkeri* pattern. It is one of the patterns of band decadence to be found in almost any large lot of *castaneozonatus*, and not really worthy of a special name.

The variety called *deckerti* by Clench (Fig. 33a) "is a parallel of *L. f. castaneozonatus* Pils., and differs only in possessing a white lip and columellar region. Length 44.5 mm., width 28.4 mm., aperture 20.8 × 13.4 mm." (Clench). It is from Long Pine Key hammock 55 (adjoining Palma Vista 2, on the north), also found in Cox's Hammock near Gould's and in Brickell Hammock. Named for Richard F. Deckert of Miami. It is not in any sense a race, but merely an individual mutation of excessively rare and sporadic occurrence, in which the factor for pink color has been lost. Probably not more than a dozen specimens are known.

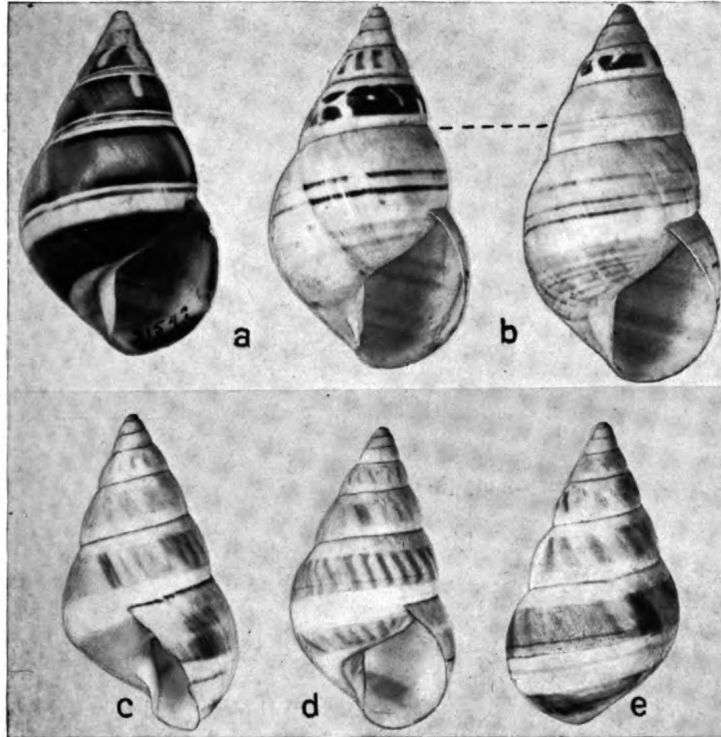


Fig. 33. *Liguus fasciatus castaneozonatus*. a, var. *deckerti*, type. b, var. *miamiensis*, Brickell Hammock. c, d, e, form *alternatus*, Timm's Hammock.

Form ALTERNATUS Simpson (Fig. 33 c, d, e). Shell rather small, moderately solid, with pink summit and columellar callus, white with broad upper and basal zones of light brown closely marked with axial streaks and bars of chestnut; sutural and peripheral brown lines usually present. Type 45×24 mm., but often smaller.

Timm's Hammock, Type in Simpson collection; Black Point Creek (T. L. McGinty).

The brown axial markings are quite variable, often in part smeared. It is a rather rare mutation of *castaneozonatus* which probably arose in the region of Timm's Hammock, where it occurs very sparsely in hybrid colonies only. Specimens from Timm's Hammock were introduced in Paradise Key by Mosier, and it may still exist there.

Var. *elegans* Simpson (Fig. 34 a, b). Rather small (usually 40-47 mm. long), warm white with roseate summit and columellar callus, the third and fourth whorls marked with brown streaks or spots, last whorl without flames or spots, but with sutural and peripheral brown lines, and there are usually some green lines or traces on the back.

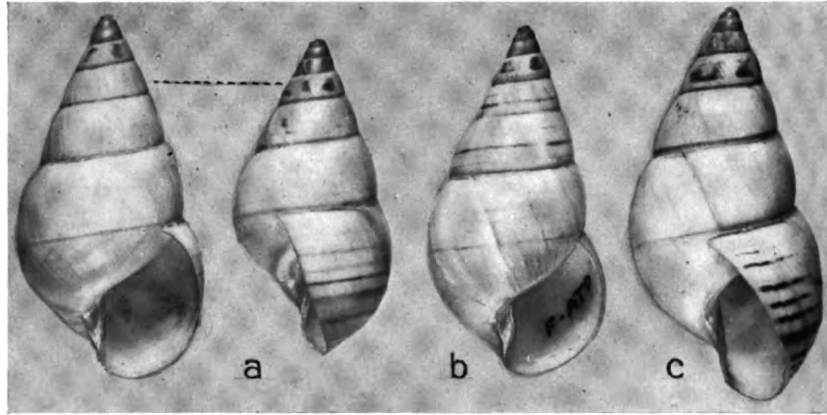


Fig. 34. *Liguus fasciatus castaneozonatus*, var. *elegans*. a, b, Atoll Hammock, c, similar form from Collier county, hammock 13.

Atoll Hammock, near Whitewater Bay, on the north side of road 11 miles southwest of Paradise Key. A pure colony. Type in Simpson collection. It resembles *roseatus* form *lineolatus* closely except by having brown spots on one or two early whorls, vestiges of the *castaneozonatus* pattern; and it is really a transition from *castaneozonatus* toward *roseatus*.

Almost perfectly similar shells occur in the central everglades region, as in hammock CC 13, north of the Tamiami Trail (Fig. 34c). CC 17 has a pure colony of this variety, according to Ralph H. Humes. Simpson mentions *elegans* from Long Pine Key, Miami and Arch Creek; but the examples of *elegans* pattern from these places probably are not directly related to the Atoll Key colony, but are merely parallel stages in loss of brown pattern in *castaneozonatus* × *roseatus* hybrid stocks. Cf. var. *miamiensis*.

(*Castaneozonatus*, belted with chestnut.)

Form ROSEATUS Pilsbry. Figs. 35 a, b, c.

Liguus fasciatus roseatus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 432, 448, pl. 38, figs. 11-12b (Goodland Point, Marco I.).

Liguus fasciatus lineolatus Simpson 1920. In Lower Florida Wilds, frontispiece fig. 2 (Totten's Key); Proc. Biol. Soc. Wash., 33: 125; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 31, (in part; not pl. 2, fig. 8).

Liguus fasciatus livingstoni Simpson, 1920, Proc. Biol. Soc. Wash., 33: 124 (north end Brickell Hammock); Type in Simpson Coll., paratypes 339102 U.S.N.M. and 128131 A.N.S.P.; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 33, pl. 2, figs. 3, 9.

"The ground-color is white, faintly pink tinted. The early whorls, columella, a small part of the base adjacent, and the parietal callus are invariably rose colored. There is a line of pale brown or pink below the suture, and a yellow or pink band at the periphery (usually not well developed before the adult stage in Goodland Point shells, and sometimes

delayed until the gerontic). As the pink of the early whorls fades out, on the fourth or fifth whorl it is replaced by a wide spiral zone, pinkish at first, but changing to yellow, and separated from the sutures by narrower white bands. In some shells the yellow zones are excessively faint. On the last whorl another similar yellow zone on the base becomes visible. The last whorl, or its last half, usually shows few or numerous yellowish-olive or greenish lines, one group above the periphery, another on the base. The columella is usually slender, convex or straight, and continuous with the basal lip below, but sometimes it is strongly truncate. The first embryonic



Fig. 35. *Liguus fasciatus castaneozonatus*, form *roseatus*. a, Russell's Key. b, c, Goodland Point. d, e, var. *livingstoni*, Brickell's hammock, Miami. f, g, var. *lineolatus*, Totten's Key.

whorl is often lost in adult shells.

"The italics above denote characters common to this subspecies wherever found. The yellow zones and greenish lines are inconstant. Greenish lines are only weakly developed in West Florida *roseatus*, and are often lost by fading and loss of the cuticle in living shells. The mutilated apex is a feature of some colonies only."

Length 52 mm., diameter 27 mm.; length of aperture 24 mm. Type.
 Length 50 mm.; diameter 25 mm.; length of aperture 23 mm.
 Length 56 mm.; diameter 28 mm.; length of aperture 25 mm.
 Length 54 mm.; diameter 27 mm. Adams Key.

Form *roseatus* is apparently a derivative of *castaneozonatus* which has lost brown pigmentation, leaving the zones yellow, or wholly losing them.

Key Marco, widely spread, the Type, 8055 A.N.S.P., from Goodland Point.³⁴ Pure colonies also at Horr's Island, Gomez Old Place, Russell's Key, Turner Key, on Turner River, all in Collier Co., and East Cape Sable and Duhurst Hammock, south of Atoll Hammock, Monroe Co. In Dade Co., southeastern Florida, pure colonies of *roseatus* var. *lineolatus* Simpson occur on keys north of Largo: Palo Alto, Totten's, Porgee and Old Rhoads Key.

At Russell's Key (Fig. 35a) there is a form differing by greater solidity. "There is no trace of yellow zones on the dead-white surface at any stage of growth."³⁵ Yellowish-olive lines are often present on the last half-whorl. The *subsutural and peripheral bands are bright pink* and comparatively wide. The columella is of the heavy, straight, truncate type in all young and about 33 per cent of the adult shells, but non-truncate and continuous in the majority of adults. The size varies from length 56, diam. 27 mm. to length 65, diam. 30 mm. The total absence of yellow, even in the young, gives this colony a very distinct appearance. It is an incipient race." (Pilsbry, 1912.)

Pure colonies of the Upper Keys, above Largo.—In this area the *roseatus* are usually smaller than in Collier and Monroe counties, more yellow, and often with the spire more extensively pink.

This has been named var. *lineolatus* Simpson; the type from Totten's Key (Fig. 35 f, g). Also Frontispiece Fig 16, Porgee Key. In the type locality "The shells are rosy white with a large part of the spire beautiful rose color. The last third or half of a whorl is pale yellow, following a growth-arrest. When the change comes later, the yellow is the more marked. In every one of the 43 specimens. the peripheral belt is visible, and it is usually quite conspicuous and bright yellow. In two shells it is

³⁴ The designation of Reeve's Conch. Icon., *Achatina*, figure 22b, as type of *roseatus* in Proc. New England Zool. Club, 17: 83, involves some mental process which I do not understand, as no reference to that figure was made in the original definition of *roseatus*.

Hemphill collected *roseatus* at Goodland Point in 1882. It has been recorded that W. D. Collier about 1873 planted *Liguus* from Middle Cape Sable at Goodland Point, Caximbas and Marco (Nautilus, 34: 140). Simpson (Nautilus, 35: 21) has doubted that the colonies of these islands date from this planting. On all the keys of this Ten Thousand Island region except Lossman's Key, the hammocks occupy aboriginal shell fields or mounds, and probably *Liguus* gained access to them far earlier than the date named, possibly brought by Indians who lived there, and who built up the shell mounds.

³⁵ The young may show somewhat translucent bands in place of the yellow, on the pink early whorls, and there is rarely a trace of them in adult shells.

pink. A narrow pink sutural line is invariable. About 60 per cent of the shells have no greenish lines, and these are numerous on only about 10 per cent. The usual length is about 50 mm., but the largest is 58 mm. long."

Simpson enlarged his conception of this variety in his later (1929) work, to include forms from the mainland, Marco to Cape Sable; but I do not see how to draw the line between these *lineolatus* and *roseatus*.

On Porgee Key (Frontispiece Fig. 16). "The race is similar to that of Totten's Key except that the tendency to xanthism is far more marked. The last 2 whorls are yellow, the last one intensely so. There is a pale border below the pink sutural line and a pale band above and below the wide yellow or pinkish peripheral girdle." The size is from 46 to 56 mm. long.

On Adams Key, a tiny key at the lower end of Elliott's Key, specimens were taken almost exactly like the *roseatus* of Turner Key.

In hybrid populations *roseatus* is generally distributed. On Chokoloskee Key, Monroe Co., it is associated with *L. f. castaneozonatus* only.

Some Key Largo *roseatus* have an almost pure white ground as in Man. Conch., 12, pl. 59, fig. 94, but they usually show yellow zones.



Fig. 36. *L. f. roseatus*, Key Largo.

In some places on Key Largo a form of *roseatus* occurs having a band only about 3 mm. wide on a white ground, in place of the broad yellow zone of typical *roseatus*. Yellow sutural and peripheral lines are more or less evident (Fig. 36). Specimens of *L. f. castaneozonatus* with the zone equally reduced are also found there.

Form *roseatus* occurs in most of the hybrid colonies of Long Pine Key. The shells have two zones of yellow (varying from very faint to pinard yellow and to ochraceous tawny), or the lower zone may be absent. A pinkish peripheral line is sometimes present, but more frequently there is none. Length up to 60 mm. There are also transitions to *castaneozonatus*, doubtless hybrids, showing one or few small spots of chestnut on the spire.

In a small lot (65 specimens) from LPK Hammock No. 3, 4 out of 14 specimens of *roseatus* have the apex pure white. Other forms found there are: *castaneozonatus* 47, *testudineus* form *castaneus* 3, and *lossmanicus* 1.

Form *roseatus* occurs in some Pinecrest hammocks. In PC 46, where it lives with *lossmanicus* and *marmoratus*, the whorls are very strongly convex, color typical.

The variety called *livingstoni* Simpson (Fig. 35 d, e), from the hybrid Miami colony differs from typical *roseatus* only by possessing rather numerous green lines, and by lacking a distinct subsutural line, as well as the

peripheral pinkish line which is usual, though very often lacking, in *roseatus*. The type measures, length 42 mm., diam. 24 mm. It has not been found in a pure colony.

***Liguus fasciatus elliottensis* Pilsbry**

Fig. 37 a.

Liguus crenatus elliottensis Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 447, pl. 37, figs. 3-3b (Elliott's Key).—Simpson, 1929, Proc. U. S. Nat. Mus., 73, art. 20: 39.

Liguus crenatus cingulatus Simpson, 1920, Proc. Biol. Soc. Washington, 33: 123; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 40, pl. 3, fig. 6.

Liguus crenatus eburneus Simpson, 1920, In Lower Florida Wilds, frontispiece fig. 10 (Timb's Hammock); Proc. Biol. Soc. Washington, 33: 122; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 41, pl. 4, fig. 1.

Liguus crenatus capensis Simpson, 1920, Proc. Biol. Soc. Washington, 33: 122 (North-west Cape Sable); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 38, pl. 3, fig. 9.—McGinty, 1936, Nautilus, 50: 71.

The original description, based upon immature shells, follows. "The shells are light, *white with translucent-gray streaks*, sometimes faintly tinted with creamy olive on the last part of the last whorl. There is a very faint yellow sutural line and usually some light yellowish olive-green lines, chiefly basal, and sometimes wanting. The half-grown young occasionally show two *very faint* wide yellow zones, one above, the other below the periphery. In older shells the upper of these bands shows on the penultimate whorl. 18.5 per cent of the specimens are so marked. [But in about forty years since these shells were collected, the yellow has faded, remaining very faintly on only two or three shells of the type lot.] The spire is straightly conic, whorls but slightly convex. Columella thin and simple. Apex and columella invariably white. The aperture is about half (47 to 53 per cent) the length of the shell.

Length 39.5, diameter 21, aperture 19 mm.

Length 37, diameter 21, aperture 19 mm.

Length 35.5, diameter 20, aperture 17.5 mm.

Elliott's Key (C. B. Moore, 1904), Type and figured paratype 8008 A.N.S.P. Angelfish Key (Moore). Various forms referable to *elliottensis* occur at Cape Sable and on the Atlantic Coastal Ridge from Long Pine Key to Fort Lauderdale.

The original lot of 65 shells from near the south end of Elliott's Key was apparently from a colony of small shells, but all collected by Mr. Moore are immature with fragile lip. Adults would probably not exceed 45 mm. long in this place. Mr. Pflueger and others have found larger shells on Elliott's Key, 55 to 61 mm. long (McGinty Collection). They remain somewhat subangular at the periphery, like the type lot, and some of them have a faint yellow zone. The characters of this subspecies are most fully and distinctly expressed in the mainland variety *cingulatus*. It is unfortunate that the prior name for the subspecies was based upon a peripheral form.

Simpson reported *elliottensis* from Old Rhodes Key and "Scott's place" on Key Largo. McGinty found it on the extreme north end of Key Largo.

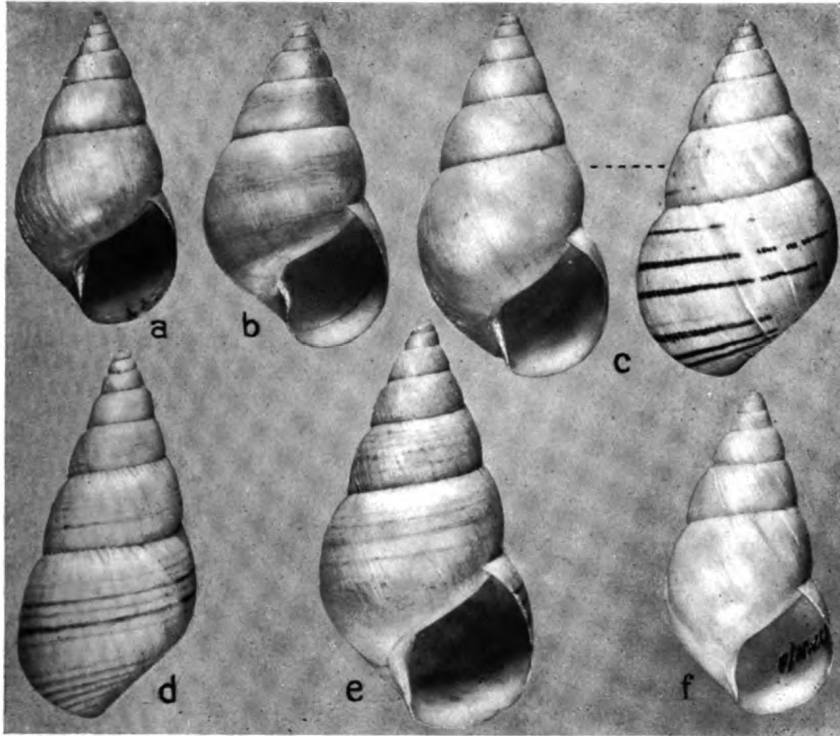


Fig. 37. *Liguus fasciatus elliottensis*. a, type. b, var. *cingulatus*, Brickell Hammock. c, var. *eburneus*, hammock near Paradise Key. d, e, var. *capensis*, paratypes, Northwest Cape Sable. f, Northwest Cape Sable.

Probably Simpson's record of *cingulatus* from "Long Key, of the Upper Keys" was a well colored *elliottensis*; but the distinctions of these varieties though typically definite, disappear in some examples. A specimen from Angelfish Key, Fig. 48b, appears to be this race.

Var. *cingulatus* Simpson. Fig. 37b. White, with a broad yellow zone on the upper surface, another on the base. A few greenish spiral lines are sometimes present. Columella straight, sinuated or obliquely truncate at base.

Length 42 mm., diameter 24 mm. Brickell Hammock.

Length 50.5 mm., diameter 28 mm. Tryon Hammock.

Miami, in Brickell Hammock, Type in Simpson collection. Fort Lauderdale; Timm's Hammock; Paradise Key and in many hammocks on Long Pine Key.

Typically it is zoned with yellow in the *dryas* pattern, but in many collected alive the zones have partly or almost vanished, and the shell

approaches the color of *eburneus*. Fully adult, or at least the largest individuals, lose the blunt peripheral angulation and become rounded peripherally.

Var. *cingulatus* has been taken in pure colonies by R. H. Humes in LPK 78, and by myself in "Tryon hammock" (the third north of a group of three, in the everglade about 2½ miles northward of Osteen Hammock). In both of these lots green lines are wanting or very few. In the hybrid colonies there are usually a few, or sometimes many, green lines. It occurs here and there from Brickell Hammock down the east coast ridge and in some Pinecrest hammocks. Simpson recorded *cingulatus* from Middle and East Cape Sable and Flamingo.

Var. *eburneus* Simpson (Fig. 37c). "Shell rather solid, usually of a somewhat porcellanous texture, obese to rather elongated, with rounded whorls, pure or ivory white throughout or rarely having traces of spiral bronzy lines on the base or at the aperture; columella twisted. Length of type 52, diameter 26 mm." (Simpson.)

"Timb's [Timm's] hammock, type locality; hammocks along the rocky mainland ridge from Long Pine Key to Lemon City and opposite it on the peninsula" (Simpson).

It occurs as a pure colony in the little Hammock No. 4, near the west end of Long Pine Key, but in Timm's and Cox Hammocks and Paradise Key in hybrid colonies. Structure as in form *cingulatus*, the periphery well rounded and columella narrow. In Timm's hammock some show a yellow zone faintly. The varieties *eburneus*, *capensis* and *cingulatus* intergrade fully, yet selected series differ enough to be recognized by collectors.

Var. *capensis* Simpson. Figs. 37 d, e, f. "Shell large, solid, much elongated, with straight sides and somewhat chalky texture; whorls slopingly flattened; sutures not very deep; surface white or slightly greenish tinted on the last whorl, with a few to several spiral lines on the last or last two whorls, those above the periphery green and the basal ones ashy brown; aperture small, rather short, the outer lip not greatly oblique; columella generally thin and straight or only slightly twisted. Length of type 58, diameter 27 mm.; length 60, diameter 26 mm." (Simpson.)

Northwest Cape Sable, Type in Simpson coll.; reported by him also from the Middle and East Capes, near Flamingo, and Cuthbert Lake, 20 miles east of Northwest Cape Sable.

The variety *capensis* is chiefly distinguished by its long shape, the length about double the diameter, and more than twice the length of the aperture. However, there is variation in the contour. A specimen from Middle Cape Sable, figured in my paper of 1912, pl. 38, fig. 16d, is referable to the *capensis* form of *elliottensis*. It measures, length 44 mm., diameter 24.5 mm. Occasional examples have a faint yellow zone above the periphery, as in some *elliottensis*, and when shorter than usual, as in one of those collected

by Simpson at "John Douthell's hammock" near Flamingo, it approaches *cingulatus*. Many individuals show no green lines or yellow zone, being white throughout. Mr. McGinty found snow white shells in one hammock on Northwest Cape, the size small, up to about 45 mm. long (Fig. 37 f). He writes: "We were surprised to find on our visit to the Cape that the green lines associated with this form were almost totally absent. The fringe of hammock at the Cape had been rather thoroughly worked and we were at loss to account for the change in character. In Miami I learned from Mr. Albert Pflueger of a small isolated hammock just to the north of the one we visited in which individuals do have the green lines of Simpson's original lot. Mr. Pflueger tells me that Northwest Cape is not, as supposed, a pure colony of *Liguus crenatus capensis* Simpson, for specimens of the yellow *Liguus crenatus lossmanicus* Pilsbry have been taken."

[?] Var. *VACAENSIS* Simpson. Figs. 46 f, g, h.

"A solid, elongated form which is close to *capensis* but differs by having convex outlines to the spire and fewer green lines" (Simpson, 1920).

"Shell usually large, with convex spire, subsolid to solid, with deep sutures and the last and penultimate whorls slightly flattened, white or shaded greenish with sometimes a few spiral green or bronzy lines on the body or base; texture somewhat porcellanous; columella heavy and twisted or truncated. Length of type 54, diameter 27 mm.; length of large shell 64, diameter 33 mm." (Simpson, 1929.)

Key Vaca, Type in Simpson collection, paratype 339091 U.S.N.M.

"A fine, usually solid, somewhat porcellanous form which generally has the last whorls slightly flattened in the middle but well shouldered. It constantly differs from *capensis* in being less elongated and having a convex spire. I am not quite certain about the mainland specimens." (Simpson.)

Simpson subsequently added the localities "Long Island, Key Largo, Angelfish Key, and Sand Key, Northwest and Middle Cape Sable (?), near Flamingo (?)," but this makes it overlap the ranges of *L. f. elliottensis* and *L. f. matecumbensis*, both extremely similar. Without examining Simpson's series from these places, no certainty can be reached as to what races are involved.

A specimen received from Simpson in 1921, labeled "var. *vacaensis*, type collection" is figured (Fig. 46f). It is white with about 6 greenish yellow lines on the last half whorl, and no yellow below suture. The last whorl is strongly convex below the suture, then slightly flattened above the periphery. The columella is straight, but little thickened, and excised at base. Length 52 mm., diameter 27 mm., oblique length of aperture 24.5 mm., $7\frac{1}{2}$ whorls.

In another Key Vaca specimen (Fig. 46g) collected by McGinty the shell is more solid, columella thicker and more conspicuously truncate, and

there is a narrow yellowish sutural border, such as is often found in *matecumbensis*.

The absence of any vestige of yellow zones, the long *capensis*-like shape, strongly convex whorls and straight, somewhat thickened columella, are the chief characters of *vacaensis*. By the convexity of the whorls this form is like *L. f. lossmanicus*, and the columella also resembles the typical form of that race. However, Mr. McGinty considers *vacaensis* to be a form related to *cingulatus* which has lost the yellow band, and perhaps this is the best disposition of it with present knowledge. The relationship of some albino forms is guesswork, so slight are the indications.

PATTERN II, TESTUDINEUS GROUP

The forms composing this little group are as follows:

- | | |
|--|--------------------|
| 1. Shell copiously marked with brown. | 2 |
| Shell without brown markings..... | 3 |
| 2. Apex and/or columellar callus pink..... | <i>testudineus</i> |
| Apex and columellar callus white..... | <i>marmoratus</i> |
| 3. Apex and/or columellar callus pink..... | <i>ornatus</i> |
| Apex and columellar callus white..... | <i>lossmanicus</i> |

They are related in the following order, *testudineus* being probably the most primitive.

Ornatus—testudineus—marmoratus—lossmanicus.

Two others, *matecumbensis* and *subcrenatus*, are placed here for want of any better place, as their affinities with races having developed color patterns are problematic.

Over thirty years ago, when *marmoratus* and *testudineus* were defined, pink at apex was thought to be an invariable character of the latter, and the ranges of the two, as then known, were well separated. Later research shows that in the typical locality of *testudineus* with pink apex, some specimens occur with the apex white throughout or with a minute brown tip, and the columellar callus white, other markings remaining typical.

Formerly *testudineus* was thought to be exclusively a shell of the Atlantic Coastal Ridge, and *marmoratus* a western race of the Pinecrest region to Cape Sable and Key Vaca. Now *testudineus* has been found in a few Pinecrest hammocks, and *marmoratus*-like shells in certain eastern hammocks, such as Matheson's, where shells very much like some *marmoratus* of Key Vaca have been collected.³⁶ Other localities for *testudineus* lacking pink are Brickell and Cox Hammocks; the var. *castaneus* occurs in Costello

³⁶ These *marmoratus* from Matheson's Hammock, 4 miles south of Coconut Grove, in the Mosier and McGinty collections, were taken by C. A. Mosier about 1920, together with *testudineus*, *ornatus*, *castaneozonatus* and other forms.

Hammock and in LPK 55, with *versicolor* similarly without pink. The color distinction and the geographic limitation are therefore no longer tenable on account of the absence of pink in some specimens of *testudineus*, though holding for a vast majority of the specimens of each race.

Liguus fasciatus testudineus Pilsbry Frontispiece fig. 12; Fig. 38 a-d.

Bulimus fasciatus Brug., in part, Binney, 1852, Terr. Moll., 2: 269, pl. 56, left and lower figs.

Liguus fasciatus testudineus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 457, pl. 39, figs. 20-20f. (South side Miami River.)

Liguus fasciatus castaneus Simpson, 1920, Proc. Biol. Soc. Washington, 33: 126 (Cox Hammock); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 35, pl. 2, figs. 6, 12.

Liguus fasciatus versicolor Simpson, 1920, In Lower Florida Wilds, frontispiece fig. 12 (Long Key, Everglades); Proc. Biol. Soc. Washington, 33: 125; 1929, Proc. U. S. Nat. Mus., 73, art. 20: 34, pl. 2, figs. 5 and 11.

Liguus fasciatus clenchi Frampton, 1932, Proc. Biol. Soc. Washington, 45: 56 (Hammock no. 46, Pinecrest region).

Liguus fasciatus solisoccasus De Boe, 1933, Nautilus, 47: 68, pl. 6, figs. 5, 6 (Hammock CC 6, Collier Co.).

Liguus fasciatus fuscoflamellus Frampton, 1932, Proc. Biol. Soc. Wash., 45: 55.

"The shell varies from rather solid to thin; and the columella may be either callous and truncate or thin and continuous. The apex and columella vary from pink [in the type], to white, but both are usually pale. . . ." The ground-color is usually yellow but varies to almost white. The pattern consists fundamentally of broad, sinuous dark flames which *fork below the white sutural line* producing a tessellated border, often smeared with reddish. The flames terminate in a dark band at the periphery, which is bordered below by a light girdle. The base is radially streaked. Over all of this there are the usual green or olive spiral lines, when these are not lost in general melanism. The principal modifications are as follows: (1) more or less complete interruption of the flames, which remain only as tessellated subsutural and peripheral bands (fig. 38a, b). (2) Modification of the color of the flames, which may be green or blue in the middle, rich brown or black at the end (fig. 38d). (2) Coalescence of the flames, producing black shells with light spots and streaks (fig. 38g-h).

Length 44 mm., diameter 22 mm.

Hammocks along the Atlantic Coastal ridge from Miami to Long Pine Key; forms in the northern Pinecrest and southern Collier County regions, at Middle Cape Sable and Key Vaca. Type 8003, A.N.S.P., from Brickell Hammock (frontispiece fig. 12).

As in *marmoratus*, there is a very thin white or light sutural line. Typically the apical whorls and streaks on the columellar callus are pink, but the color is usually faint, and in some examples, otherwise similar, the apex and columellar region are white. In one lot from Brickell Hammock there are ten with some pink coloring, four without. The apical color is sometimes represented only by brown color on the tip of the first whorl, but in others at least $2\frac{1}{2}$ whorls are flesh pink or darker. In some shells the parietal callus is distinctly pink, but the early whorls are white. These

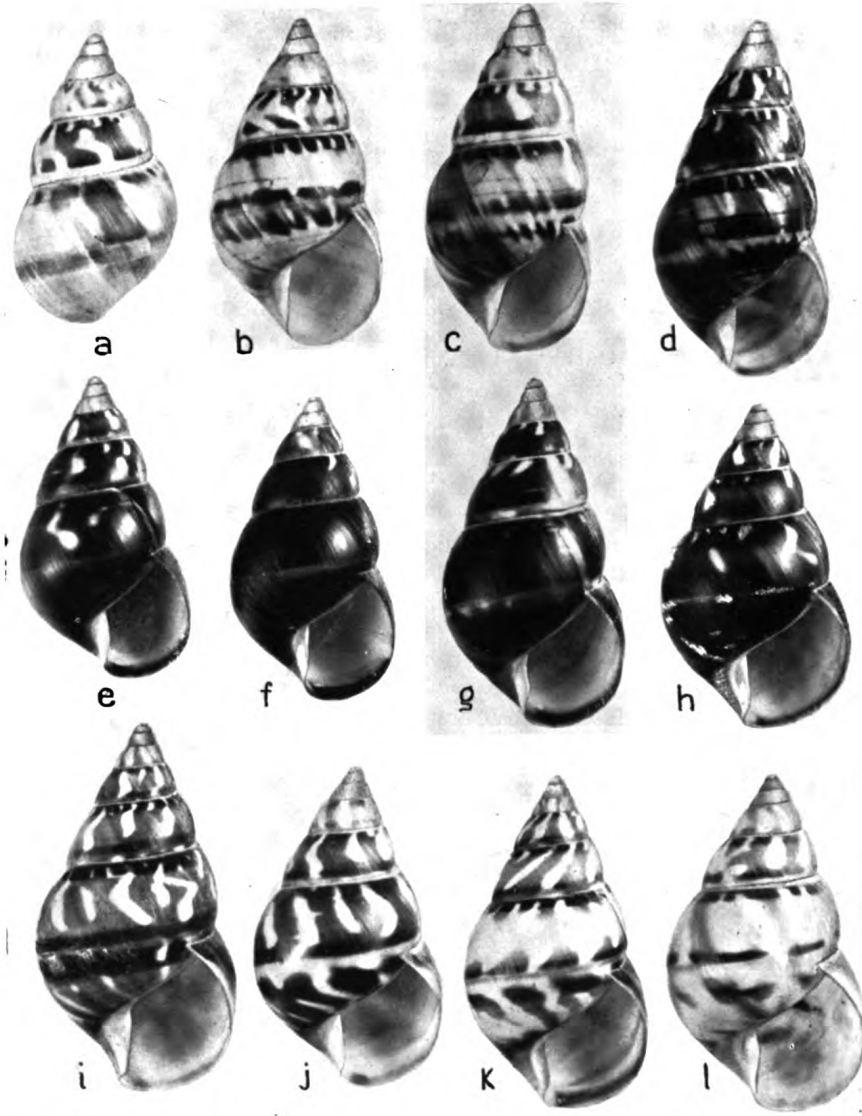


Fig. 38. *Liguus fasciatus testudineus*. a, b, c, d, Brickell Hammock. e, f, var. *castaneus*, Cox Hammock; g, Hammock 72, Long Pine Key. h, i, j, k, l, var. *versicolor*, Osteen Hammock, LPK.

notes apply to Miami (Brickell Hammock) shells. In this hammock the color and pattern vary within wide limits, dark shells, such as fig. 38d, passing through intermediate stages into the variety called *castaneus*.

A white apex in *testudineus* occurs in Brickell Hammock and southward to Timm's. In Long Pine Key, farther down the East Coast ridge, the apex is almost always pink, though rarely white, as in some individuals in LPK 55, having otherwise typical *versicolor* pattern. Where *testudineus* comes in contact with *marmoratus* in a small part of the Pinecrest and Collier County region, the color characters of the two races remain distinct.

L. f. testudineus and its several forms have not been found in pure colonies, everywhere in hybrid populations. Its absence in Key Largo is surprising.

A form of *testudineus* which seems referable to the var. *clenchi* occurs rather rarely on Middle Cape Sable. One was figured in my paper of 1912, pl. 38, fig. 16c. The parietal callus is marked with pink. It has been taken there more recently by McGinty.

Var. *castaneus* (Fig. 38 e, f, Frontispiece fig. 9, Cox Hammock) was originally described thus: "Shell moderately solid, with slightly convex whorls, varying from rich chestnut to almost black, and marked with longitudinal or zigzag yellow flames. Columellar area tinted purplish; apex purplish or whitish. In all except the darkest shells there is a light band at the periphery." (Simpson.)

The type measures: Length, 40 mm.; diameter, 20 mm.

Cox Hammock, near Goulds, Dade Co., the Type in Simpson collection. It is the melanistic end of a cline from *testudineus*, occurring as exceptional individuals in Brickell Hammock, Miami, but becoming abundant farther south, as in Palma Vista 2 Hammock (LPK 26) where it formed 30 per cent of a lot of 1190 collected; varying from typical *castaneus* color to that of *versicolor*, and up to about 50 mm. long.

In Cox Hammock the summit is very pale pink, or white with a brownish-pink apex; but in the larger and usually more variegated shells from Long Pine Key, two to three whorls are flesh pink, the callus at aperture usually showing little pink or none. In some shells transitional to *versicolor* there is an interrupted band of slate-olive to medici blue on the upper surface. Very handsome dark and varied shells were found by Mr. Humes in LPK 72 (fig. 38g).

Var. *versicolor* Simpson (Frontispiece fig. 7; Figs. 38 h-l). "Shell small to medium sized, solid, brilliantly polished, with somewhat rounded whorls; axial region pink or purplish at the tip but usually only slightly colored at the columellar area. The ground color may be greenish to brownish with narrow zigzag axial yellow stripes and blotches, [or it may vary to yellowish, in which case the stripes and blotches are wanting, and it may have a double row of irregular brown spots at the suture and on the periphery.] There is a smoky band with a lighter center at the periphery, and it may be considerably broken up or almost entire. In some shells the general tint is bluish or bluish black. Length of type 38, diameter 22 mm.; length 40, diameter 24 mm." (Simpson.)

Long Pine Key,³⁷ Type in Simpson collection.

The two color patterns mentioned in Simpson's description are typically quite unlike, but they are fully connected in a lot collected in Osteen Hammock. The typical color pattern intergrades fully, also, with the large *castaneus* of Long Pine Key, as in Palma Vista Hammock, where some specimens of the *versicolor* pattern occur among the "*castaneus*".

A sinistral specimen was found in Osteen Hammock.

A Cuban snail known as *L. fasciatus waltoni* Torre, from Cayo Maja, Caibarien, Santa Clara province, is scarcely distinguishable from some blue *versicolor*, probably a case of convergence and not of direct relationship.

Var. *clenchi* Frampton (Figs. 39 a-d). "Shell is medium-sized, sub-solid to barely solid, polished. It is regular in shape, tending to globosity in some specimens. There are seven whorls, moderately convex customarily and strongly convex in globose forms. First nuclear whorl pink, and very faintly so in some specimens; second, third and sometimes fourth whorls white, but usually brownish flecks on fourth whorl. Sutures well impressed.

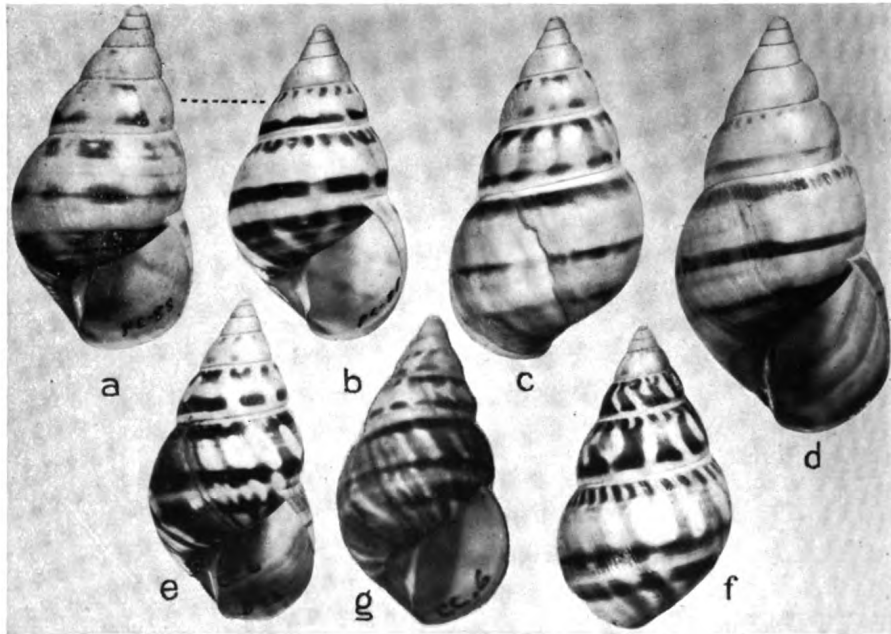


Fig. 39. *Liguus fasciatus testudineus*. a, b, var. *clenchi*, Pinecrest Hammock 88; c, PC 46; d, Pinecrest, Mosier coll.; e, var. *solisoccasus*, paratype, Hammock CC 6; f, Hammock CC 13; g, type figure, after De Boe.

³⁷ Simpson called this "Long Key" in his earlier papers. He stated that *versicolor* occurred "in one large hammock on this key." As it is abundant and typical in Osteen hammock, LPK 23, that may be taken as type locality. It is said that Mosier brought the original specimens to Simpson from that hammock. My fig. 38i is like Simpson's original illustration.

Columella generally whitish, but usually pink at base, moderately truncate and slightly twisted. Palatal lip emarginate in solid forms and smooth in sub-solid ones. Parietal wall thinly calloused. Color pattern: Ground color of rich yellow to faded canary yellow; reddish brown striations on fifth whorl, broadening into blotches and splashes of watery blue, brown and dull red on sixth and body whorls; distinct, very dark brown sub-sutural band averaging 2 mm. in width and narrower, usually broken supra-sutural band. Blending of reddish, bluish and brownish wash gives shell decided rufous cast. Break in general color pattern forms a more or less distinct peripheral zone of ground color in typical specimens. Basal area washed by intensified admixture of blue, red and brown hues, with broken band of same tones on region bordering columella. Faint spiral green lines present on most specimens. Sutures always whitish or yellow. A lighter form of this race, usually a globose shell, is marked only by the brown sub-sutural zone and a broken supra-sutural one, sometimes appearing as mere flecks. The body whorl in this form is marked only by a faded yellowish ground color with an occasional faint reddish brown wash. A ragged-edged reddish brown band invariably is present on the region bordering the columella. A darker form of *clenchi* is similar to *Liguus fasciatus barbouri* Clench, but usually has outstanding green cuticular lines and is always differentiated by the pink apex. This form usually has a deep red peripheral band and blackish basal area." (Frampton.)

Length 45.8 mm., width 27.4 mm., aperture 20.8 × 13 mm.; type.

Pinecrest region, hammock PC 46, Type in Frampton collection. Also in PC 80 and 88 (McGinty).

"Single specimens of this form have been found rarely in various hammocks of the Pinecrest region for some time, but no distinct group was discovered until late in 1931, when R. F. Deckert and the author found a quantity in a hammock located in the northeastern part of the Pinecrest region." (Frampton.)

The occurrence of the *testudineus* type of shell in Pinecrest and Middle Cape Sable was unexpected.

The var. *solisoccasus* De Boe (Fig. 39 e, f, g), from hammock CC 13, seems to be a more profusely streaked form of *clenchi*. Its hammock lies about 3½ miles northeast of PC 46, the type locality of *clenchi*.

The var. *fuscoflamellus* Frampton (Fig. 40) is an excessively rare pattern, of which probably not over 20 examples are known. The type and most other specimens are from Timm's Hammock, near Princeton, Dade Co., one specimen found in Cox Hammock. By the white apex and columellar callus it might be placed in the *marmoratus* series; but Frampton states that "A similar form has been collected, but it differs in that the axial region is pink and flame-like markings are less sweeping in their character." Mr. McGinty also possesses a specimen with pink apex. This suggests relationship to *testudineus*, which also has either pink or white apex, and occurs in the same hammocks. The original description follows.

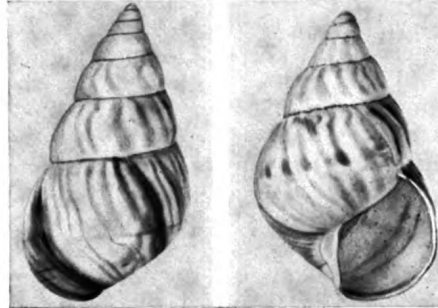


Fig. 40. *Liguus fasciatus testudineus* var. *fuscoflamellus*, Timm's hammock. (Left hand figure from specimen in McGinty collection.)

"Shell solid, elongate and lustrous, with flattened to slightly rounded whorls. Sutures moderately well impressed. Palatal lip unthickened. Parietal wall smooth and bearing merest trace of callosity. Columella slightly twisted and moderately truncate. Color, axial region white, with non-pigmented area of nuclear whorls extending through third whorl. The color pattern consists of flame-like, golden brown axial striations wavering across a rich yellow ground color, giving the effect of alternating brown and yellow flames that extend uninterruptedly from suture to suture on the fourth, fifth and sixth whorls and flash in unbroken order across the body whorl to coalesce in a rufous mass in the region bordering the columella. The brown flames range in color from a dark mahogany to a tone but slightly deeper than the yellow ground color. A well-defined peripheral line of dark purple is present. The brown flames in some specimens assume an occasional bluish hue. There are seven whorls. Sculpture of fine growth lines." (Frampton.)

Length 39.2 mm., width 22 mm., aperture 16.8×10 mm. A paratype measures 44×24.1 mm., and a broader topotype 38×23 mm.

Timm's Hammock, Type in Frampton collection (H. G. Frampton, 1931; A. Pflueger; L. A. Thurston). Cox Hammock (Pflueger).

Form *ORNATUS* Simpson. Frontispiece fig. 10; Fig. 41.

Liguus fasciatus, hybrid, Simpson, 1920, In Lower Florida Wilds, frontispiece, fig. 11.

Liguus fasciatus ornatus Simpson, 1920, Proc. Biol. Soc. Washington, 33: 124 (Paradise Key); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 34, pl. 2, fig. 10.

"Shell subsolid, small to medium size, rather inflated; axial region pink or purplish; surface yellowish, always becoming darker toward the aperture, where it may be deep yellow, orange, pale yellowish brown, or even scarlet; there is sometimes a faint lighter-colored peripheral band and generally a few green or bronze spiral lines on the last two whorls; columella straight or twisted. Length of type 46, diameter 26 mm." (Simpson.)

Paradise Key, Royal Palm State Park, Type in Simpson Collection. Long Pine Key in many hammocks. Key Largo. Brickell Hammock, Miami and down the east coast ridge hammocks. Pinecrest and C. C. hammocks.

Readily known by the pink 3 or 4 early whorls and the old rose streaks on the columellar callus, with generally diffused naples yellow to mustard yellow color, sometimes shading into ochraceous-orange towards the lip, and somewhat paler at periphery. In very few shells the columellar callus is white or nearly so.

Rare examples have some ochraceous-tawny blotches and streaks showing the relationship with *testudineus* (Fig. 41a). *Ornatus* appears to be, indeed, a *testudineus* which has lost the determinant for dark color, and it may with no great violence be included as a 'form' of that subspecies.

It is common in some hammocks, such as Palma Vista. I have taken specimens in LPK 21, 22, 27, 50, 54, 55, 58, and doubtless it occurs in many more, all being hybrid colonies.

A minority of the *ornatus* from Osteen Hammock have only very faint pink or none on the columellar callus, the apex remaining conspicuously

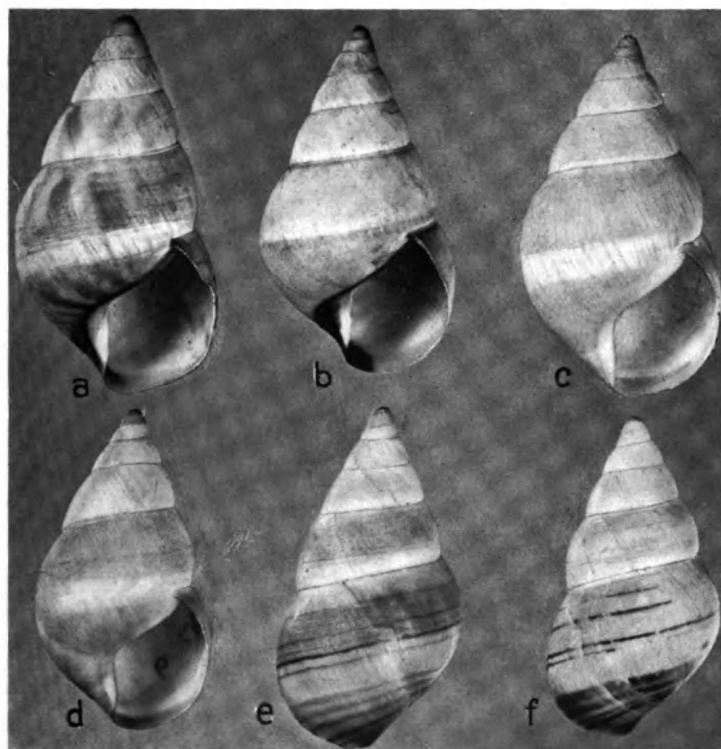


Fig. 41.—*Liguus fasciatus testudineus* form *ornatus*. a, Long Pine Key, hammock 53; b, c, hammock 26 (Palma Vista 2); d, hammock 55; e, hammock 23 (Osteen); f, Pinecrest, hammock 88.

pink. In the Pinecrest region it is known to me by specimens from hammock CC 13 (J. M. Goggin, March, 1933) and PC 88 (H. G. Frampton). These shells have typical external and columellar color of *ornatus*, except that green lines are somewhat more developed, and the early whorls are white to faintly pink, the first whorl having a brown tip, as in some examples of *testudineus*.

It may be significant that hammock CC 13 contains also a form of *testudineus*.

(*Ornatus*, adorned.)

Form **MARMORATUS** Pilsbry. Frontispiece fig. 13; Figs. 42 a-d.

Liguus fasciatus, Key Vaccas variety, W. G. Binney, 1885, Man. Amer. Land Sh., p. 435; 1892, Bull. Mus. Comp. Zool., 22: 201, pl. 1, fig. 5.

Liguus fasciatus marmoratus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 455, pl. 37, figs. 9 (type), 9a, 9d (Key Vaca); p. 453, pl. 37, fig. 10 (Chokoloskee).

Liguus crenatus barbouri Clench, 1929, Nautilus, 43: 18 (Hammock No. 21, Pinecrest region).

Liguus crenatus farnumi Clench, 1929, Nautilus, 43: 19 (Hammock No. 7, Pinecrest region).—*Liguus crenatus marmoratus farnhami* Doe, 1937, Nature Mag., 29: 84, 5th text fig., No. 6.

Liguus crenatus floridanus Clench, 1929, Nautilus, 43: 20 (Hammock No. 8, Pinecrest region).

Liguus crenatus marmoratus violafumosus Doe, 1937, Nature Magazine, 29, p. 83, 4th text-fig., No. 8.

Liguus crenatus gloriasylvatica Doe, 1937, Nature Magazine, 29: 83, 3d text-fig., No. 7.

Liguus crenatus nebulosus Doe, 1937, Nature Magazine, 29: 82, 2d text-fig., No. 4.

Liguus crenatus lucidovarius Doe, 1937, Nature Magazine, 29: 82, 2d text-fig., No. 6.

The shell is usually rather thin, with thin outer lip and narrow, straightened columella (but exceptionally it may be solid, with internally thickened lip and heavy, truncate columella). The early whorls and the columellar callus are white; later whorls with yellow to whitish ground, white sutural line, light peripheral band and a small plain columellar area, elsewhere streaked with brown to black, darker below sutural line and above and below the peripheral band; or the streaks may be merged into a uniform or interrupted melanism.

Length 53 mm., diameter 25 mm.; 7 $\frac{3}{4}$ whorls. Type.

Length 50 mm., diameter 27 mm.; 7 $\frac{1}{2}$ whorls. Topotype.

Length 45.6 mm., diameter 24.4 mm.; 7 whorls. Topotype.

Key Vaca, in the middle Keys, Type 8069 A.N.S.P. Also Middle Cape Sable and throughout the Pinecrest region of the central Everglades; Chokoloskee on the west coast, where it is now extinct.

The type and a paratype of the original lot are decidedly long shells, like part of the specimens of *L. f. lossmanicus* found with them (cf. Pilsbry, 1912, pl. 37, figs. 9 b, c). Others from Key Vaca are of normal shape. When not obscured by melanism. the streaks generally are intensified at

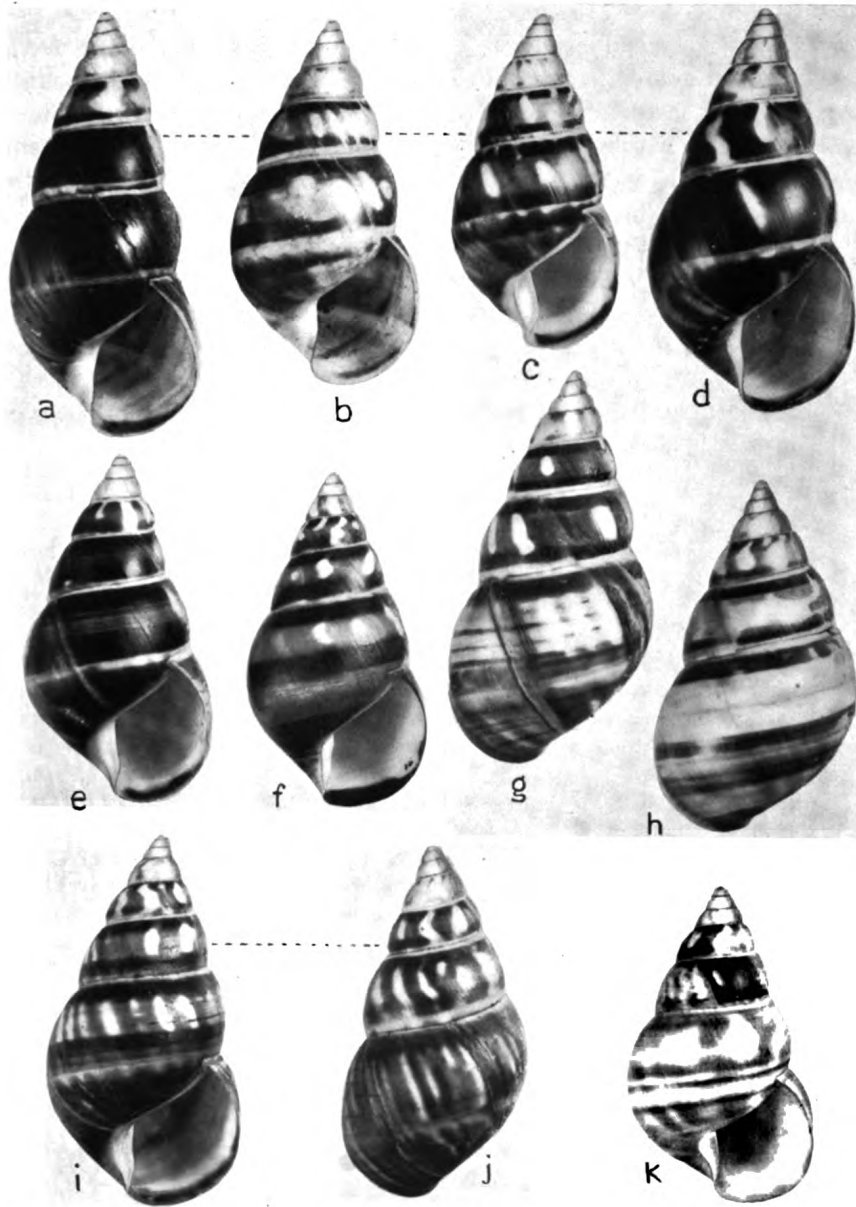


Fig. 42. *Liguus fasciatus testudineus*, form *marmoratus*. a-d, Key Vaca. e-h, var. *barboursi*; e, Pinecrest 16; f, PC 10; g, PC 7; h, PC 7b. i, j, var. *gloriasylvaticus*, Collier Co. 10. k, var. *nebulosus*, Collier Co. 10.

the ends to form dark bands, and sometimes the brown color is partly replaced by bluish tints alternating with spots of the light ground.

Specimens very similar to the darker ones of Key Vaca occur at Cape Sable and on Chokoloskee in the northwestern angle of Monroe County,³⁸ where they are associated with *castaneozonatus* and *roseatus*. The examples taken by Mosier in Matheson's hammock, Coconut Grove, seem to me exactly like Key Vaca *marmoratus*. T. L. McGinty considers those Brickell Hammock to Long Pine Key shells which are like *testudineus* but with white apex and columellar callus, to be *marmoratus*. If he is right in this, then *marmoratus* has a general though very sparse distribution along the East Coast Ridge. But I prefer the view that they are atypical *testudineus*, scattered as they are in populations where the latter is abundant.

Simpson (1929, p. 13) stated that *marmoratus* among other races inhabits "almost the entire range of the Upper Keys," but I have never seen it east of Key Vaca, and have no reason to believe that it occurs on the upper keys.

(*Marmoratus*, marbled.)

The var. *barbouri* Clench (Frontispiece Fig. 15 and Figs. 42 e-h) has the usual white summit and columellar callus of *marmoratus*. It was thus described:

"Color whitish to yellow as a ground with the following arrangement of superimposed colors. A very narrow sutural line of white or yellowish bordered superiorly and inferiorly with a band of very dark brown or black usually as a solid band 1 to 4 mm. in width. A band also exists about the central area of the body whorl. Occasionally the bands are broken into a series of dots or squares usually on the last two whorls. Areas on the whorls between the bands are mottled with gray blue and yellowish or whitish. A very few specimens have the body whorl near the palatal area almost entirely blue black. Basal area gray blue to blue black, region bordering columella banded usually with yellowish just within a band of bluish black. Narrow green spiral lines usually present though not readily perceived in the darker forms. Length 51.5 mm., width 27 mm." (Clench.)

Pinecrest region in most hammocks, the type, 84527 M.C.Z., from hammock No. 21. It occurs in the CC hammock formerly known as PC 31, and perhaps in some others.

This is a common form in most hammocks of the Pinecrest region, extremely variable in details of coloring, from shells as dark as any *marmoratus* (Fig. 42e) to light forms not distinguishable from the variety *floridanus* (Fig. 42h).

A pure colony of very beautiful *marmoratus* was found in the "Binky P." hammock, which lies southwest of PC 55 and nearer than PC 89.

³⁸ Besides the Chokoloskee specimens noticed in my paper of 1912, C. T. Simpson (1929, p. 37) has recorded finding "bones" of what he took to be *marmoratus* in that region; but some doubt remains whether it is native or introduced there.

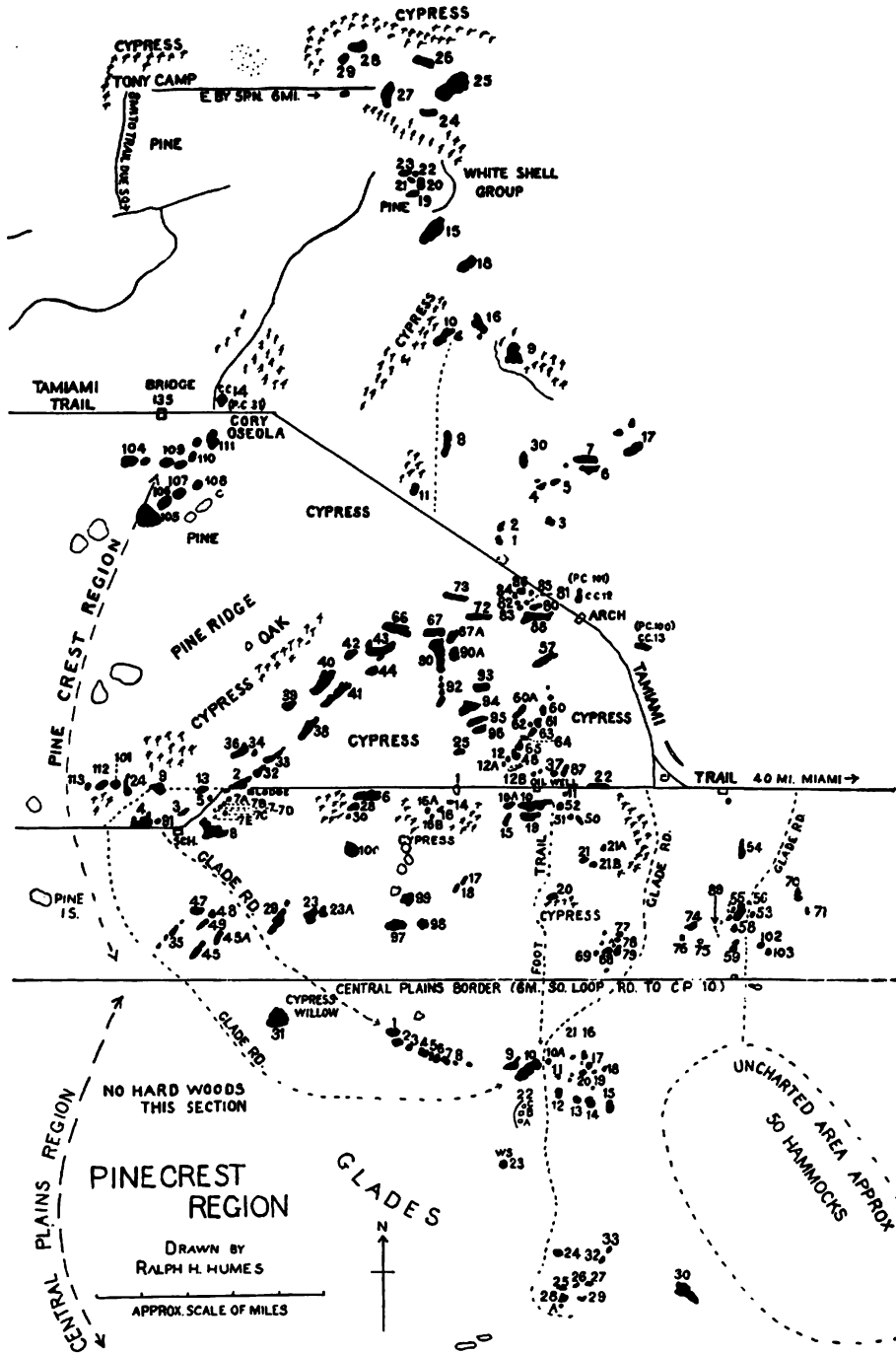


Fig. 43. Sketch-map showing hammocks of Pinecrest and adjacent regions. Drawn by Ralph H. Humes, 1944.

In the variety *gloriasylvaticus* Doe (Figs. 42 i, j) the streaking is closer than in *barbouri* and russet to chestnut-brown predominates to the exclusion of blue. The surface is usually dull. It is from hammock PC 91 (Frampton), an old number CC 10, and the former "PC 31," now in CC. The original locality was thought to be a pure colony, but as Seminoles collected most of the shells, this is not certain. Some hammocks have patterns intermediate between this and *barbouri*. The variety called *nebulosus* (Fig. 42k; Fig. 45a) is a *gloriasylvaticus* with less fully developed pattern. The following lucid account was given: "Nebulosus or blue cloud is a miniature canvas of the colors as reflected at twilight on the Blue Ridge Mountains" (Fig. 45a). No locality given, but similar shells have been taken by McGinty in hammock CC 10.

Var. *farnumi* Clench (Fig. 44a). "First three whorls of spire white. Columella white, twisted, and in a few specimens more or less truncated. Palatal lip slightly emarginate. Parietal lip thinly calloused, inclined to show pinkish due to the dilution of the brown red color underneath, *not due to special reddish pigmentation* as in the *L. fasciatus* group. Sutural area whitish. Color *pattern* similar to var. *barbouri*, color bands of a rather dark mahogany red, areas between of mottled yellow or whitish, and lighter mahogany red. Basal area usually much darker, equalling the color of the juxtasutural bands. Area along the columella sometimes a decided brick red. Spiral lines present, those above the middle of the body whorl more intense. Length 47, width 25 mm., aperture 23×13 mm."

Pinecrest region, hammock No. 7 (J. N. Farnum), also PC 8, scarcely separate from PC 7. Type 84586 M.C.Z.

"Known only from a single small hammock, which is now partially destroyed by fire." Figured from a paratype. Very near some specimens of *floridanus*.

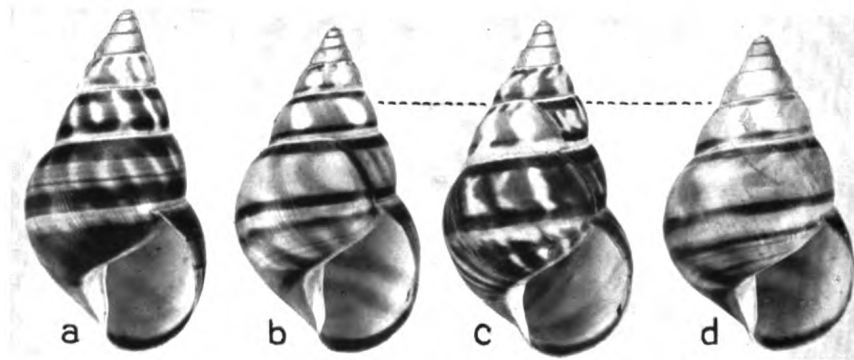


Fig. 44. *Liguus fasciatus testudineus* form *marmoratus*. a, var. *farnumi*. b, c, d var. *floridanus*, Pinecrest 8.

Var. *floridanus* Clench (Figs. 44 b, c, d). Summit and columellar callus white. "Ground color amber yellow, rarely whitish. Color pattern as in var. *barbouri* and var. *farnumi*, the bands mahogany red, mottling either of brownish or gray blue. The mottling color is not well developed, the ground color is decidedly predominating. A bar of brownish or brownish orange is found bordering the columella. Sculpture of only very fine growth lines. Spiral green lines as in other forms. Length 49, width 27.5 mm., aperture 23.5×14.5 mm." (Clench.)

Pinecrest region, hammock No. 8 (J. N. Farnum), Type 84559 M.C.Z.

"A form more or less intermediate in coloration between *L. c. barbouri* and *farnumi*, though exhibiting several characters more or less peculiar to itself. It is far more globose than any other form found at Pinecrest and possesses comparatively little mottling of color between the bands of mahogany brown." (Clench.)

Though typically distinct by the conspicuous straw- to amber-yellow ground and decadence of axial streaks, there are specimens transitional to *barbouri* in pattern and shape. The variety called *violafumosus* Doe (Fig. 45d) is a synonym of *floridanus*. It occurs in a pure colony in hammock PC 28, according to T. L. McGinty. "A light colored form found in PC 9 and 10 is very close to *farnumi*." (T. L. McGinty.)

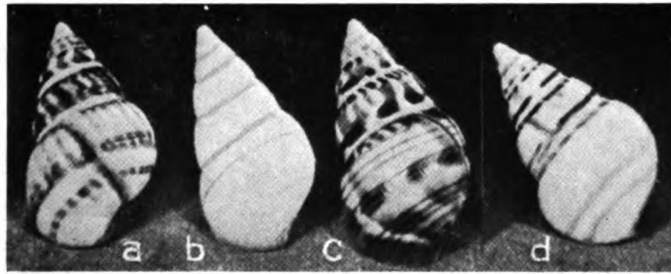


Fig. 45. *Liguus fasciatus* form *marmoratus*. a, var. *nebulosus*. b, *L. f. lossmanicus* var. *luteus*. c, *L. f. marmoratus* var. *lucidovarius*. d, var. *violafumosus* (all about half actual size; after Doe).

The forms figured by Margaret F. Doe as *lucidovarius* (Fig. 45c), and *violafumosus* (Fig. 45d), have not been described or localized. The figure of *lucidovarius* has some resemblance to "*solisoccasus*" (= *clenchi*), but the apex is said to be white in specimens so identified from hammock PC 11. All of these varieties are from the Pinecrest region, the types in the collection of Mr. C. N. Grimshawe of Miami.

In some of the *marmoratus* of the Collier County, Pinecrest and Central Plains region, having the dark pattern more or less decadent, the dark band below the suture is broken into spots in places, thus resembling the eastern *testudineus*.

"We found nothing but *floridanus* ('*violafumosus*') in PC 28 and PC 30 (a small hammock lying southwest of 28, and probably part of it at one time)." (T. L. M.)

***Liguus fasciatus lossmanicus* Pilsbry**

Fig. 46 a, b, c.

Liguus crenatus lossmanicus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 448, pl. 37, figs. 8-8b (Lossman's Key).

Liguus crenatus luteus Simpson, 1920, Proc. Biol. Soc. Washington, 33: 123 (Key Vaca above Conchtown); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 40, pl. 3, fig. 12.

[?] *Liguus crenatus vacaensis* Simpson, 1920, Proc. Biol. Soc. Washington, 33: 122 (Southwest of Conchtown, Key Vaca); 1929, Proc. U. S. Nat. Mus., 73, art. 20: 37, pl. 4, fig. 10.

Liguus crenatus aurantius Clench, 1929, Nautilus, 43: 19 (Hammock No. 5, Pinecrest region).

Liguus crenatus Swainson, Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 456, pl. 39, figs. 20M, 20N.

Liguus crenatus mosieri Simpson, 1920, Proc. Biol. Soc. Washington, 33: 123 (Upper end Brickell Hammock, Miami).

Typically solid, thickened within, with vertical, obliquely truncate columella. "Whorls 7; the last two are usually very convex above the periphery. The aperture is from 46 to 51 per cent of the total length. The white color of the spire may continue on the last whorl or give place to an increasingly deep yellow, paler at the periphery, and separated from the suture by a narrow white line. There are several greenish lines above the periphery, and a group of yellowish-olive lines on the base. These lines are short, rarely exceeding $1\frac{1}{2}$ whorls long." Typically it is matt or without much gloss.

Variation is chiefly in the extent and intensity of the yellow, and in the shape of the columella; a few of the thinnest and palest shells having a thin, straight columella.

Length 55, diameter 30, aperture 27 mm.; largest.

Length 44, diameter 25, aperture 22.5 mm.; type.

Lossman's Key,³⁹ Monroe Co., on the western border of the Ten Thousand Islands, Type 8060 A.N.S.P. Also Collier County (CC 10), Immokalee and the Pinecrest region; Central Plains; Cape Sable; Key Vaca, and the Atlantic Coast Ridge from Long Pine Key to Fort Lauderdale.

The type specimen is thinner than most, having been selected on account of the color, which fades and loses green lines in the heavier, fully adult shells. The ground tint is primrose yellow to barium yellow but it fades with age, and is often lighter or pure white; but the white shells often show a colored strip of new growth behind the lip.

The presence of a very narrow white sutural border is a constant character of tinted specimens, which is lost to sight only in specimens with wholly white ground. The strong convexity of the whorls is characteristic of this race.

³⁹ Clarence Bloomfield Moore, the archaeologist, who visited this key over forty years ago (1904), learned that it was named for a Mr. Lossman, formerly living there. The name has since been corrupted, appearing on some late maps as "Lostman's."

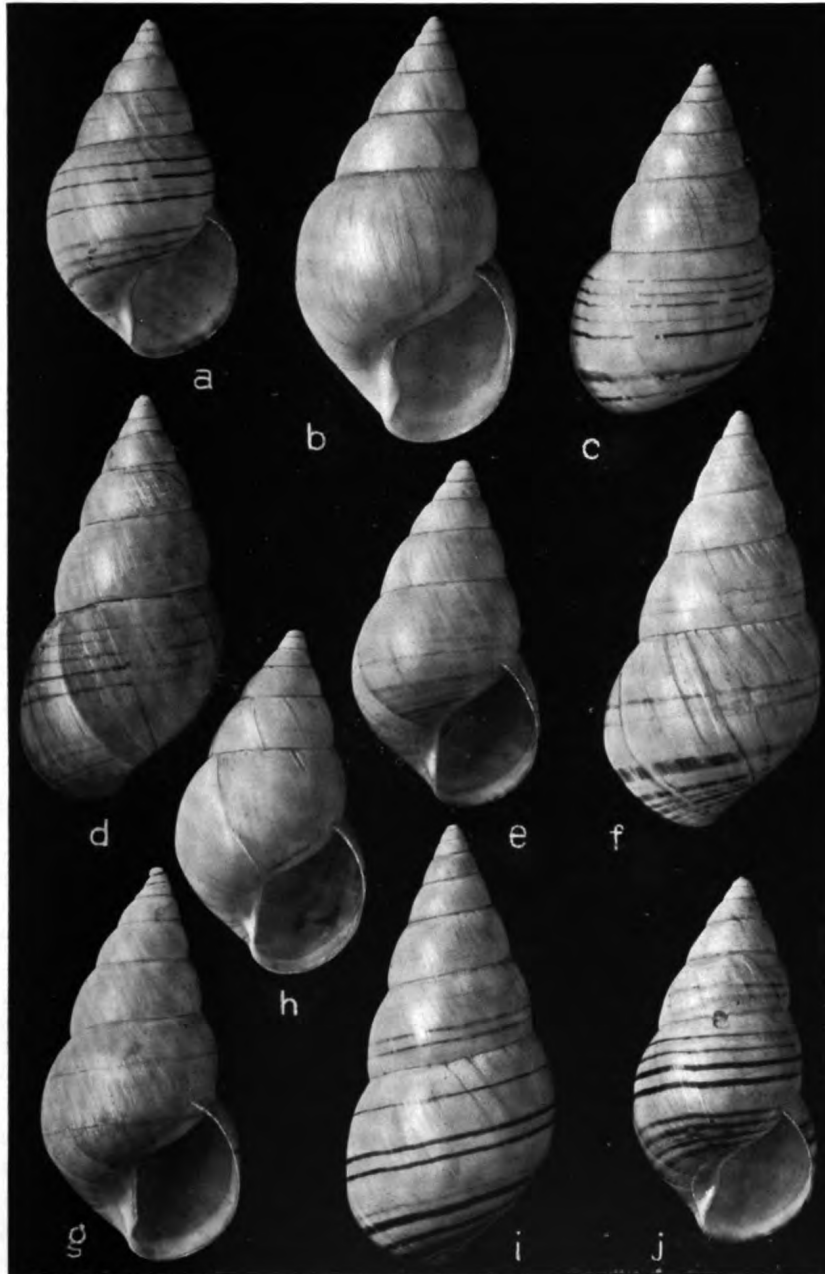


Fig. 46. a, b, c, *Liguus fasciatus lossmanicus*, Lossman Key. d, var. *luteus*, Key Vaca. e, var. *mosieri*, Miami. f, *L. f. elliotensis* var. *vacaensis*, Grassy Key; g, h, Key Vaca. i, var. *mosieri*, Fort Lauderdale; j, Brickell Hammock.

Several local forms based upon degrees of development of color have been named, but their intergradation seems to be complete. *L. f. lossmanicus* is (or was) very abundant on Lossman's Key, where the chief variation is in the development or absence of green lines, and the degree of fading of the very light yellow ground color.

In the Pinecrest region the generally distributed form is of about typical color, being very pale, primrose yellow to white, usually with conspicuous green lines on the last half whorl or only on the latest growth. In specimens seen from PC hammocks 38, 63, 80, 81, 88, collected by Frampton, and CC 13, from J. M. Googin, the columella is rather narrow, but a lot from PC 66 has heavier shells with the columella thickened.

Mr. T. L. McGinty writes: "The Immokalee record is about as far north as the most northerly east coast record for *septentrionalis*. The shells are all white with no banding on any of the eleven collected, but there are green lines on all; some are dull and others shiny, however all are thin. The hammock near Immokalee is very poor, incipient hammock, with much oak, and the food supply is somewhat scanty."

In Pinecrest hammock No. 5 there is a pure colony of the variety *aurantius* Clench (Frontispiece fig. 14), the ground color straw yellow to almost pinard yellow, typically shading into orange or sometimes almost cadmium orange behind the outer lip, and often in bands below the suture and at the base. There are usually several green lines on the upper surface, with yellowish ones below, as in ordinary *lossmanicus*. The surface is matt or without much gloss, as in all Pinecrest *lossmanicus*. Columella white, sinuated or subtruncate at base. Length 51.5, width 29 mm., type, to 45 × 26 mm. or 50 × 26 mm., topotypes.

The color of these beautiful shells varies, and is not deeper than in some topotypes of *luteus*. The varieties *luteus* and *aurantius* differ from *lossmanicus* only in intensity of color. In Long Pine Key and the hammocks northeast, Timm's, and others to Dania, Broward Co., *L. f. lossmanicus* is usually more strongly yellow, often pinard yellow on the last whorl or only behind the lip, but in the same lots it varies to nearly white, with only traces of yellow. In some hammocks, such as Osteen and Powell, the surface is quite glossy, but usually it is nearly matt, as in typical *lossmanicus*.

In LPK 67 (Ralph H. Humes, Feb., 1940) there is a charming pinard yellow form of *lossmanicus* often cadmium orange or almost scarlet behind the lip, as in the Pinecrest *aurantius*; green lines few and weak. The columella is often rather heavy, as in typical *luteus*. These shells in Long Pine Key, the *aurantius* in Pinecrest and *luteus* in Key Vaca, though similar in color, are apparently independent xanthic mutations of *lossmanicus*. Mr. Simpson (1929, p. 40) united them under the name *luteus*.

L. f. lossmanicus, under its several aliases, is often found in pure colonies, as on Lossman Key, Pincrest 66, Immokalee, Long Pine Key 67, Powell Hammock, Lewis & Nixon's Hammock west of Homestead, Lysiloma Hammock, near Goulds; in the last five hammocks it is mostly without green lines; Bryan Grove Hammock, west of Dania. More frequently it is in mixed populations, and then green lines are usually present.

The rather thin Miami region form of *lossmanicus*, with profuse green lines, has been called var. *mosieri* Simpson (Figs. 46 e, i, j). It was thus described:

"Shell variable in size, subsolid, somewhat polished; whorls moderately to well rounded, the earlier ones white or whitish, the last ones darker, often smoky tinted or dirty greenish and having from two to several green or bronzy spiral lines which are wanting at the periphery; columella straight or slightly twisted. Length of type 45, diameter 24 mm.; length of a large shell from Miami 50, diameter 27 mm." (Simpson.)

The color in Brickell's Hammock varies from white to faintly greenish or pale yellow, last whorl with few to many, about ten, green lines, or those on the base may approach a chamois tint. Typically the whorls are rather strongly convex, as usual in *lossmanicus*, but among them are some shells with flattened whorls (Fig. 46e), quite unlike *lossmanicus*, and evidently indicating mixed parentage.

Var. *mosieri* occurs from near Fort Lauderdale to Royal Palm State Park, and was formerly abundant in Brickell Hammock, Miami, the type locality. Found only in hybrid colonies.

Var. *luteus* Simpson (Fig. 46d). Shape, solidity and obliquely truncate columella as in *lossmanicus*, but it is of a deeper yellow color, becoming light orange yellow on the last half whorl, and near the lip often almost deep chrome; sutural line white. Green (to yellowish olive) lines usually present, but few. The type was said to measure 63 mm. long, 25 wide,⁴⁰ a topotype 53.5 × 28 mm. Key Vaca, above Conchtown, Type in Simpson collection.

On Key Vaca, probably in a different hammock, there are thinner, elongate specimens, such as plate 37, fig. 9b of my paper of 1912, typical in color but with the columella quite thin. They are associated with others wholly similar in structure but white, with or without green lines, figured in 1912, pl. 37, fig. 9c.

Mr. Simpson reported var. *luteus* also from the east end of Upper Matecumbe, Key Largo, and on the mainland from Long Pine Key to Dania; also Pincrest. He evidently included various local yellow varieties of *lossmanicus* and probably some other races.

⁴⁰ Probably there was some mistake in Simpson's measurements. In his later paper he gave, "length 63, diameter 18 mm.," also certainly erroneous. His figure represents a shell proportioned like my figured topotype.

Liguus fasciatus matecumbensis Pilsbry

Fig. 47.

Liguus crenatus matecumbensis Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 446, pl. 37, figs. 5, 5A (Western end Upper Matecumbe Key).

"They are small, short and wide, with the mouth relatively large, more than half the shell's length; very thin. White, *more or less yellow tinted at the last whorl*, the yellow tint *continuous over the periphery*, intensified around a small white columellar area; and there is a *narrow golden sutural margin*. Green lines are present, arranged as in *subcrenatus*. Whorls nearly $6\frac{1}{2}$ in the largest specimens, the last obtusely subangular at the periphery.

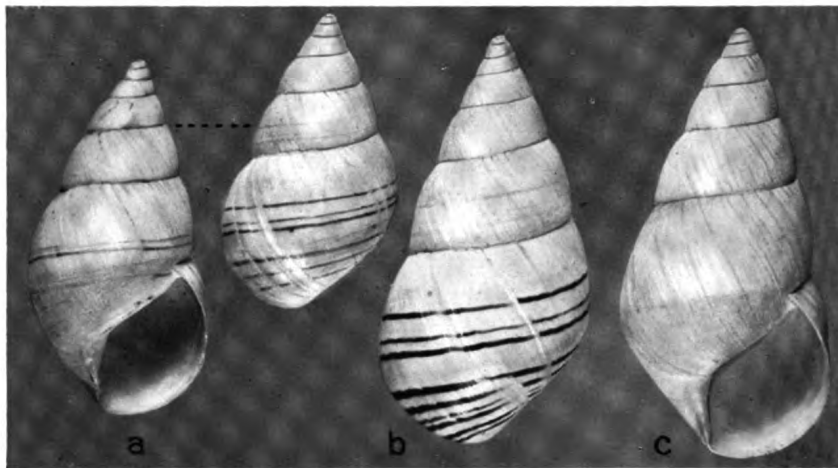


Fig. 47. *Liguus fasciatus matecumbensis*. a, Upper Matecumbe Key. b, Flamingo. c, Coot Bay.

The columella is very thin, and the parietal wall usually has a watery, translucent tenuity in large specimens. Length 39, diam. 22.5, aperture 21 mm.; $6\frac{1}{4}$ whorls." (Pilsbry, 1912.)

Upper Matecumbe Key, the Type 8076 A.N.S.P., being from the western end (C. B. Moore, 1904). Elliott's Key (Pflueger). Mainland at Flamingo (Simpson, McGinty) and Coot Bay, hammock No. 7 (Ralph H. Humes).

This race and the next (*subcrenatus*) appear to be rather isolated, and without definite characters suggesting reference to either of the color patterns characterizing other races. Albino *Liguus* and those with green lines only, are usually chary about revealing their relationships, but these seem to be positively noncommittal. Their place in the series is unknown.

In the original lot of 12, all of the specimens (described above) were immature. Other Upper Matecumbe specimens reach 47×24.5 mm., Fig. 47a, becoming larger and moderately solid. The columella is usually somewhat concave, only weakly or not truncate at base. The blunt peripheral angulation persists in the adult stage, being chiefly noticeable when the shell is held with apex towards the light.

It differs from *L. f. lossmanicus* by the decidedly less convex whorls, the last subangular in front, and by having a yellowish smear or indistinct band bordering the suture, not a white line there, as in *lossmanicus*. Unfortunately this character is not always available as the yellow at suture, never found in *lossmanicus*, is of only occasional occurrence in *matecumbensis*, not on every specimen. The concave columella is usually a characteristic feature of *matecumbensis*, but often it is straight.

On the mainland this race occurs in the Flamingo and Coot Bay hammocks. These shells are usually larger than the Upper Matecumbe specimens seen, and vary from examples similar to those in texture and color, to much heavier forms, up to 58 × 28 mm., green lined on a very faintly sea-foam green ground, shading into yellow at the suture (Fig. 47b), or they may be pure white, with or without green lines (Fig. 47c). The periphery is bluntly subangular in front, and the columella is usually quite noticeably concave and never of the heavy or distinctly truncate type.

The white specimens from the Flamingo district, without yellow at the suture, and marked with green lines or none, have been referred by some collectors to *L. f. subcrenatus*; but they have the shape and texture, the subangular periphery and the concave columella, of *matecumbensis*. I regard them as an albinistic form of that race.

The presence of a Matecumbe *Liguus* on the mainland is not surprising, because during some hurricanes material from that group of Keys may drift across to the neighborhood of Flamingo. In the hurricane of September, 1935, several Galapagos turtles from Lignumvitae Key were cast up on Cape Sable. Probably in some former blow a tree from Upper Matecumbe with estivating *Liguus* drifted across Florida Bay.

Mr. McGinty has recognized *matecumbensis* in a few specimens from Brickell's Hammock, but I do not feel sure of the identification.

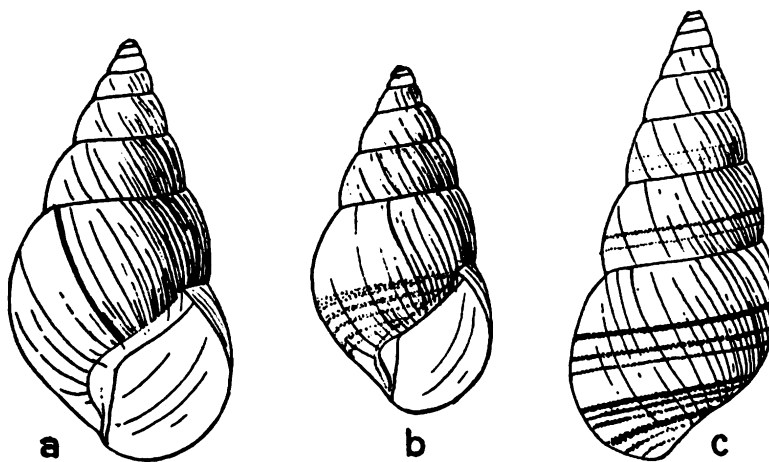


Fig. 48. a, *Liguus fasciatus lossmanicus*, Long Island. b, *L. f. elliotensis*, Angel-fish Key. c, *L. f. matecumbensis* form *subcrenatus*, type.

Form SUBCRENATUS Pilsbry. Figs. 48c; 49.

Liguus crenatus subcrenatus Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 445, text fig. 11, pl. 37, figs. 7, 7A.—Simpson, 1929, Proc. U. S. Nat. Mus., 73, art. 20: 39.
Liguus fasciatus lignumvitae form *subcrenatus* Pilsbry, Clench & Fairchild, 1939, Proc. New Engl. Zool. Club, 17: 81.

The shell is long, and rather slender; rather strong though thin. Surface polished. White with a very faint marguerite yellow tint on the last whorl, typically with about 4 green lines on the base and one or several above the periphery (but there are many specimens without green lines, or with them

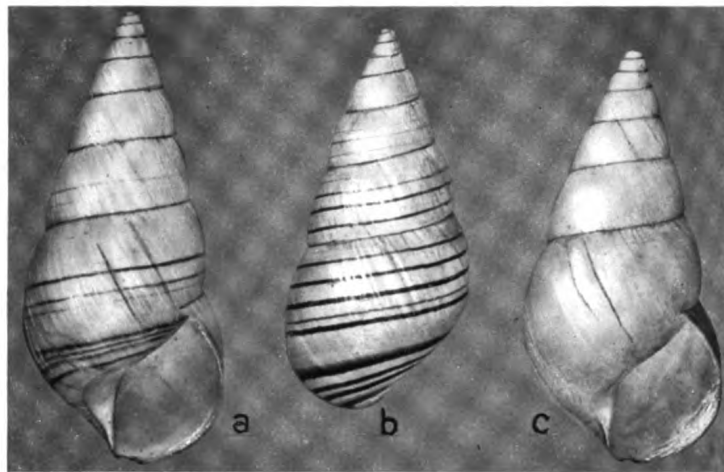


Fig. 49. *Liguus fasciatus matecumbensis*, form *subcrenatus*, Lower Matecumbe Key, a, the type.

very faint, or appearing only on the newest growth behind the lip). There is no yellow smear below the suture in the type (but it is present in a few specimens). The apex and columellar callus are white. Length 57.5 mm., diameter 25.6 mm., length of aperture 24 mm.; 8 whorls. Length 41 mm., diameter 20 mm.; 7½ whorls. Length 60 mm., diameter 28 mm.; 8 whorls.

Lower Matecumbe, Type 8062 A.N.S.P.,⁴¹ from a hammock at northeast end of the Key in a pure colony. It occurs also in most Lower Matecumbe hammocks except that containing *dohertyi*. East end of Windley Key (C. B. Moore).

In the type lot of 42 shells taken in 1904 the shape is slender, periphery rounded, and the aperture, in a front view, occupies little more than one-third of the length. Most of them are from 53 to 60 mm. long. There is

⁴¹ In selecting my plate 37, fig. 7, Windley Key, as representing the type of *subcrenatus*, Clench & Fairchild ignored my prior selection of text-figure 11 of my paper of 1912, p. 446. I would willingly have supplied the catalogue numbers of my types if they had asked for them instead of themselves selecting types of my subspecies regardless of the specimens so designated in our museum or noted in my publication.

no trace of yellow below the suture, and tinted specimens show no white peripheral belt. But in other Lower Matecumbe lots, a pale ill-defined yellow band borders the suture below, and there is a white or pale peripheral zone, as in some from Oscar Hammock. The Windley Key shells seen are exactly like the type lot. Simpson states that he found one 70 mm. long though about a quarter inch had been broken off at the summit.

In describing *subcrenatus* I was inclined to place it close to the Cuban *crenatus*. Clench & Fairchild (1939) thought it a form of *lignumvitae*, the shell having so much the texture and high gloss of that group that the evidence seems about equally divided. However, the penial gland in one dissected is quite unlike that of *lignumvitae*, being sessile with a long attachment to penis, and deeply divided into several lobes as in Cuban *fasciatus*. In *lignumvitae* the gland is pedunculate and only two-parted. However, this gland is often rather variable. McGinty has grouped it as a form of *matecumbensis*, chiefly on account of a faint yellow border rarely present below the suture.

GROUP OF *L. F. SEPTENTRIONALIS*

Liguus fasciatus septentrionalis Pilsbry

Fig. 50.

Liguus crenatus septentrionalis Pilsbry, 1912, Jour. Acad. Nat. Sci. Phila., 15: 447, pl. 37, figs. 6, 6a.—Simpson, 1929, Proc. U. S. Nat. Mus., 73, art. 20: 9, 41, pl. 4, fig. 3.

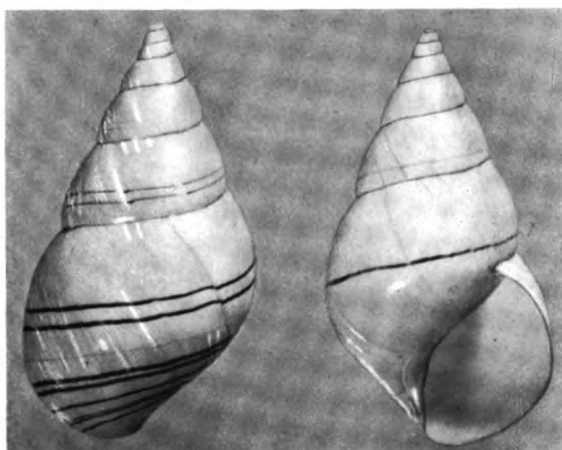


Fig. 50. *Liguus fasciatus septentrionalis*, Pompano.

The shell is rather thin and light, capacious, the periphery indistinctly angular in front; smooth and very glossy. Pure white, sometimes without markings, but usually having one to seven dark green lines, of which one

or two may be above the periphery. Columella rather thin and straight, obliquely excised at base but not truncate, the rather thin parietal callus white. Length 50.7 mm., diameter 28 mm., 7 whorls.

New River below Fort Lauderdale (C. B. Moore, 1904), Type 8005 A.N.S.P. Pompano, Broward Co. Yamato Hammock, Palm Beach Co. (T. L. McGinty, 1937).

This lovely snail is quite unlike any other form of the *crenatus* type, being the most distinct of all mainland races of *Liguus*; directly related to none of them. No closely similar form has been seen from Cuba, it appears to have been evolved in Florida from some early Cuban importation.

It has no trace of yellow or pink. There is often a single green line above the periphery, or also a second line below. In two examples seen there is a third line above. The type specimen shows one line near the aperture on the back. Specimens with more numerous lines are rarer. The "faint malleation" mentioned in the original description is quite exceptional, and is sometimes present in many other subspecies. The periphery in young to half-grown individuals is conspicuously angular. The periostracum is preserved perfect and is highly polished.

It occurs only in pure colonies, which lie north of all other localities for *Liguus* on the east coast.

C. T. Simpson stated that "Near Arch Creek it has hybridized with one of the forms of *fasciatus*, the shells having exactly the shape, markings, and texture of *septentrionalis* but a pink axial region." I have not seen such shells, and doubt whether Simpson's specimens are properly referable to *septentrionalis*. Thomas L. and Paul McGinty also have failed to find any such hybrids near Arch Creek or elsewhere.

(*Septentrionalis*, northern.)

Unrecognized species

Agatina variegata Rafinesque, and *Agatina fuscata* Rafinesque, 1831, Enumeration and account of some remarkable Natural Objects, etc., p. 3, are not recognizably defined. The first is thought to be a *Liguus*, the second perhaps an *Orthalicus*.

"31. *Agatina Variegata*, Raf. 1820. Six spires, smooth, yellowish, variegated with brown spots near the sutures, first spire with some narrow, coloured striae concentric. Nearly two inches, from Louisiana.

"32. *Agatina Fuscata*, Raf. 1822. Eight spires, smooth, reddish. brown, with broad longitudinal black bands on the spires, of a lanceolate flexuose shape. Over two inches, from Texas. Both collected by Dr. Strong." (Rafinesque.)

Mr. Simpson planted Cuban *L. fasciatus* (Müller) in his hammock at Lemon City, about 1914, and in 1918 he thought that they still survived there (*Nautilus* 32: 104).

Family VIII. UROCOPTIDAE

Urocoptidae Pilsbry, Man. Conch., XV, XVI (monograph).

Shell cylindrical, fusiform or turritid-conic (or in one genus, discoidal); composed of many narrow whorls (except in *Pineria*), the early ones generally lost in the adult stage; last whorl adnate or free. Aperture small, circular or squarish; the peristome more or less expanded or reflexed, usually continuous, but interrupted above in some genera. Axis hollow or solid, simple or variously sculptured.

Foot very small and short, united by a long peduncle with the visceral mass, and with the usual holopod structure. Jaw plaited, striate, or smooth. Radula as in normal Holopoda or variously specialized; teeth without entocones. Lung long and narrow, with a long pulmonary vein, but otherwise very weak venation. Kidney narrow, wedge-shaped, about as long as the pericardium. Genitalia simple, the spermatheca on a long duct, ootestis wholly imbedded in the liver.

Locomotion is rhythmic, with few, direct waves, which in the Urocoptinae are lifted from the substrate.

Distribution.—Antilles, southern Florida, northern coast of South America, Central America and Mexico, and the adjacent southwestern United States. They are strictly calcicolous.

This large family is mainly tropical, with very few species within our southern border except in the genus *Holospira*, which has many species from Texas to Arizona.

The diameter of the shell in this family, as in *Clausiliidae* and others of like contour, is measured across the largest portion of the cylinder, not to the edge of the outer lip, as in *Helices* and *Bulimuli*.

It is usually necessary to examine the interior of the shell. This may be done by rubbing the dorsal side of the shell upon a fine file, or a clean oil-stone, until the whole interior is exposed, as in the specimens drawn in Figs. 56, 59 and others. It is not always essential that the whole length of the shell be opened; a hole in the penult whorl is often sufficient in *Holospira*.

This is apparently an autochthonous family of middle America, somewhat related to the Achatinidae, and especially to the Bulimulidae, which evolved in South America.

Our three genera belong to as many subfamilies, as in the following:

Key to subfamilies of Urocoptidae

- A. Columellar axis of shell not hollow or perforate; jaw of many narrow plaits converging to form a triangular area in the middle; the central tooth is narrower and with much shorter cusp than the laterals, the laterals having the ectocones well separated from the mesocones.
 - B. Shell cylindrical, fusiform or conic, the early whorls often lost in the adult stage. Teeth in V-shaped rows. Locomotion peculiar.....UROCOPTINAE
 - BB. Shell conic or cylindro-conic, with entire spire and costulate nuclear whorls; teeth in nearly straight transverse rows.....MICROCERAMINAE
- AA. Columellar axis hollow; jaw smooth or vertically striate. Shell cylindrical with conic, entire summit, and smooth nuclear whorl. Teeth in nearly straight transverse rows, the central as wide and long as the laterals. Locomotion normally rhythmic.....HOLOSPIRINAE

Subfamily UROCOPTINAE

Urocoptinae Pilsbry, 1902, Man. Conch., 15: 105; 16: xxxi.

Jaw thin, of many narrow plaits converging, downward, leaving a triangular area of short plaits in the middle. Teeth in oblique, v-shaped transverse rows, central teeth narrower than laterals and very unlike them in shape, the laterals with broad mesocones widely separated from the ectocones. Axis of shell solid, not perforated at any stage.

This subfamily comprises a great majority of the Antillean species of Urocoptidae.

The locomotion of *Urocoptinae* is direct and of course monotaxic. The muscular waves are rather rapid in movement, narrowly localized, and raise the sole from the supporting surface as in the Pomatiasidae, but the edges of the raised fold are kept in contact, so that the wave appears, when seen through the glass upon which the snail crawls, as a fine light line across the sole. In the slender *Urocoptis turneri* Pils. and *U. pallidula* Torre there is usually only one wave in progress, but sometimes a second one begins before the preceding quite disappears at the anterior end. Our species, *Cochlodinella poeyana*, usually shows two waves in progress at the same time. At first the waves are straight, but as they pass forward the middle part lags a little, so that they become somewhat curved, the concavity forward. This is chiefly noticeable in the larger species. In turning, a wave sometimes starts in from the edge at about the posterior third of the sole, lengthening and reaching the opposite edge as it passes forward (Fig. 51 d, e).

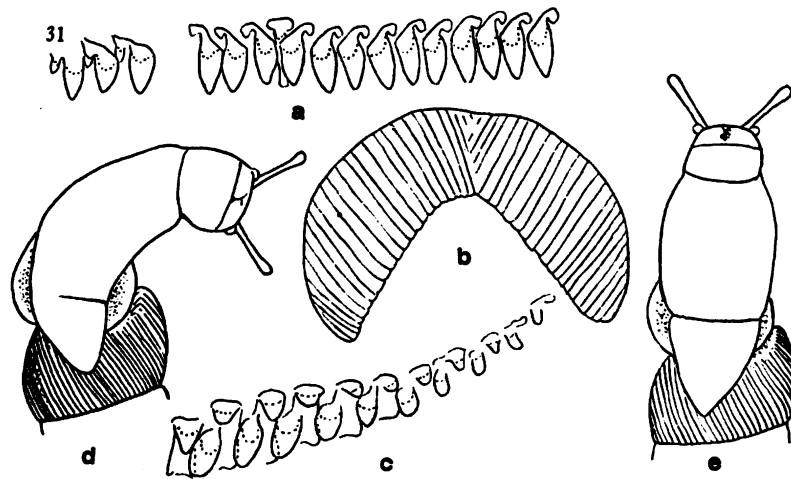


Fig. 51. a, b, *Microceramus pontificus*, teeth and jaw. c, *Cochlodinella poeyana*, teeth. d, e, *Cochlodinella poeyana* in motion, showing waves of the sole.

As the waves move rapidly, the progress of the snail is rather fast for so small a mollusk.

The mode of progression described, though monotaxic, has much in common with the ditaxic Pomatiasidae of the Antilles, most of which also live on limestone cliffs and rocks. In both groups the muscular wave is raised free, so that there is no sliding of any part of the foot upon the substrate, such as there is in ordinary snails. The sliding is between the front and back surfaces of the raised fold. This appears to be an adaptation to easier movement on the minutely roughened and slightly porous surfaces of limestone rocks and cliffs. Moist bodies adhere slightly to these rocks, as I have sometimes tested by touching them lightly with the tongue.

COCHLODINELLA Pilsbry & Vanatta

Cochlodinella Pilsbry & Vanatta, 1898, Proc. Acad. Nat. Sci. Phila., pp. 270, 274.—Pilsbry, 1903, Man. Conch., 15: 175, as a subgenus of *Urocoptis*.

Cylindrella Pfeiffer, in part, and of authors generally before 1902.

Shell similar to *Urocoptis* s. str. in general structure, but small and thin, fusiform or subcylindric, the axis slender and straight, arcuate in the last whorl only. Basal keel rather weak or wanting. Spire truncate (rarely retained entire in exceptional individuals); the rejected whorls numerous, attenuate, apical whorls smooth, bulbous.

The rhachidian tooth is rather wide (much wider than in *Urocoptis*, s. str.), its cusp equal to the ectocones of the adjacent lateral teeth, and the number of teeth in a transverse row is small, 10.1.10 in *C. poeyana*.

Distribution.—Western Cuba and southern Florida.

The general structure of the shell (aside from the axis), the large number of deciduous whorls of the slender spire, and the smooth, somewhat club-shaped earliest whorls, all show close relationship to *Gongylostoma*, and indicate that *Cochlodinella* is a branch of the same stock in which axial lamellae have either never been developed, or have been wholly lost. I see at present no way of determining whether the axis is primitive or degenerate, but the former alternative is perhaps the simpler.

Cochlodinella floridana (Dall), (*Cylindrella floridana* Dall, 1890, Trans. Wagner Inst., 3, pt. 1, p. 13, pl. 1, fig. 6a, 1915, U. S. Nat. Mus. Bull., 90: 30, pl. 1, fig. 4, pl. 2, fig. 3), of the Lower Miocene silex beds, Tampa, Florida, is apparently a member of this group, but the interior has not been examined.

Cochlodinella poeyana (Orbigny)

Fig. 52 a-f.

Pupa poeyana Orbigny, 1841, in Sagra, Hist. Fis. Polit. y Nat. de l'Ile de Cuba, Mollusques, p. 185, pl. 12, figs. 24-26 (Cuba).

Cylindrella poeyana Orb., Pfeiffer, Monogr. Hel. Viv., 2: 380; Conchylien Cabinet, p. 26, pl. 3, figs. 29-31.—Binney, 1878, Terr. Moll., 5: 382, pl. 59, fig. 2; pl. x, fig. R (teeth).

Urocoptis poeyana Orb., Pilsbry, 1903, Man. Conch., 15: 176; with var. *variegata* Pfr., p. 177 (see for references).

Cylindrella variegata Pfeiffer 1842, Symbolae ad Hist. Hel., 2: 60 (around Matanzas).

Pupa (*Siphonostoma*) *lactaria* Gould, 1844, Bost. Journ. N. H., 4: 491. (Matanzas.)

Cylindrella jejuna Gould, 1848, Proc. Boston Soc. N. H., 2: 41; 1851, in Binney's Terr. Moll., 2: 310; 3: pl. 69, fig. 3.

The cylindrical shell tapers somewhat in the upper half or third and is rather broadly truncate, the breach closed by a strongly convex plug. The narrow whorls are slightly to distinctly convex, the last having a low keel at the base, and is very shortly free in front. Sculpture of fine and close,

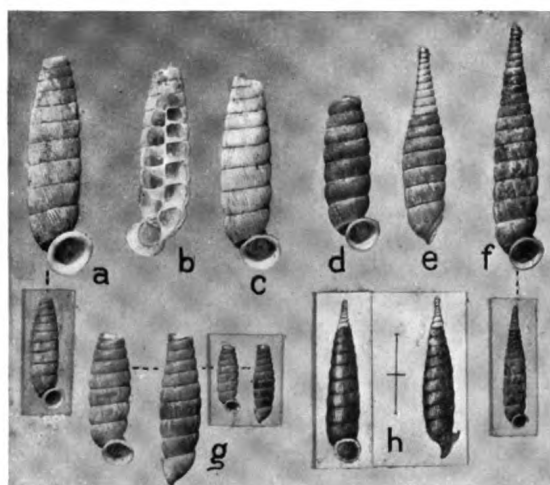


Fig. 52. *Cochlodinella poeyana*. a, Key West; b-f, Miami. g, *C. poeyana* form *jejuna*, specimens from Gould. h, type figures of *jejuna* after Binney-Gould. (Figs. a, f, g, $\times 2$ and actual size; b-c, $\times 2$.)

somewhat oblique, striae. The round aperture is oblique, with a continuous reflected white peristome, which is usually free above, but sometimes in contact with the preceding whorl there. The color is white or pale gray, typically uniform, but often mottled with white or pale brownish angular markings.

Length 14 mm., diameter 3.7 mm.; $8\frac{1}{2}$ whorls. Key West.

Length 10.3 mm., diameter 3 mm.; 8 whorls. Key West.

FLORIDA: Key West; Big Pine Key; Miami and ocean beach opposite; under stones along Miami River; Homestead; Long Pine Key.

Specimens from Miami (fig. 52b-f) are either grayish-white or pale brown, with white striae and with or without some white maculation. They are usually broadly truncate, with about $8\frac{1}{2}$ whorls remaining, the basal keel rather strong. The peristome is either shortly free or rarely adherent

above. In rare cases where the abandoned early whorls have not broken off there are 17 to 19½ whorls, the first one smooth and translucent, very rapidly widening, next several whorls narrower, so that the tip is bulbous. The size varies a good deal.

Length 15.5, diameter 2.8 mm.; whorls 19½ (apex entire).

Length 12.5, diameter 2.8 mm.; whorls 17 (apex entire).

Length 12.5, diameter 3.2 mm.; whorls 9 (truncate).

Length 9.5, diameter 2.8 mm.; whorls 7½ (truncate).

Length 9.5, diameter 2.5 mm.; whorls 8 (truncate).

The white maculation typical of the variety *variegata* is frequently developed.

Form *jejuna* Gould (Figs. 52, g, h). "Shell rather small, fusiform, truncated at apex, quite solid, of a pale horn-color, longitudinally striped with delicate white lines. Spire composed of about nine whorls, though when entire the whole number would be about twice as many; they are convex, and separated by a well-marked suture; the last whorl has a delicate carina, and extends in a short neck. The aperture is bell-shaped, the lip white, continuous, and not in contact with the preceding whorl. Length two-fifths of an inch; breadth about one-tenth of an inch." (Gould.)

Florida (Gould). "This may be a diminutive variety of *C. lactaria* [*poeyana*], a species presenting numerous variations in the length of the neck and the development of the lip. But it seems to be constantly smaller, darker colored, more solid, and with more convex whorls. The peritreme, also, seems never to rest on the penultimate whorl, as is the case in *C. lactaria*." (Gould.)

The National Museum possesses specimens from Gould, No. 119170, received through Isaac Lea, Fig. 52g. They resemble miniatures of *C. poeyana* rather closely. They have distinctly convex whorls, those of *poeyana* being usually less convex or almost flat. However, in some specimens of *poeyana*, such as figs. e, f, the convexity is equal to that of *C. jejuna*. In these examples from Gould the neck is not longer than in *poeyana*. Axis simple. Two measure:

Length 8.7 mm., diameter 2.8 mm.; 7½ whorls.

Length 10 mm., diameter 2.7 mm.; 9 whorls.

There seems to be no tangible differential character except size. I think that it is an ecologic form, without racial significance.

Subfamily MICRO CERAMINAE

Microceraminae Pilsbry, 1904, Man. Conch., 16: 151.

Jaw as in Urocoptinae; radula with very numerous teeth in nearly straight transverse rows, the central tooth in each row narrow, side teeth with long, narrow mesocones and very small ectocones. Shell turrite, with entire, costulate apex and incomplete peristome, the axis solid, not tubular or perforated.

In addition to *Microceramus*, considered below, the other genera of Microceraminae are *Spiroceramus* Pils. & Van., of Cuba, in which there is a strong spiral lamella on the internal axis, and *Pineria* Poey, of the Isle of Pines, which differs by its simpler peristome, which is not at all built forward from the columella; but it is similar in teeth.⁴²

MICROCERAMUS Pilsbry & Vanatta

Microceramus Pilsbry & Vanatta, 1898, Nautilus, 11: 107; Proc. Acad. Nat. Sci. Phila., 1898, p. 231.—Pilsbry, 1904, Man. Conch., 16: 151.

Colobus Albers, 1850, Die Heliceen, p. 177, in part; not *Colobus* Illiger, 1811 (Mammalia).

Macroceramus Binney, 1878, Terr. Moll., 5: 334, not of Guilding.

The shell is shortly rimate or imperforate, cylindrical-turrite or conic, composed of $7\frac{1}{2}$ to 13 whorls; the apex is always entire, the embryonic shell of two whorls, the initial half turn smooth, the rest axially ribbed; succeeding whorls are obliquely rib-striate, or the later ones smoothish; last whorl angular or rounded, the basal keel weak or wanting. The suture is usually crenulate or bordered with papillae. Coloration of brown or corneous spots and streaks on a whitish ground. *The axis is slender, solid and straight.* Peristome expanded, incomplete, being interrupted above.

“Jaw delicate, high-arched, and composed of many narrow, slightly imbricating plates, as in *Urocoptis* and allied genera (Fig. 51, *M. pontificus*).

“Radula rather long, proportioned about as in *Urocoptis*. Teeth closely crowded, in *nearly straight transverse rows*. The central tooth in each row has a very narrow basal-plate and wider cusp, which is somewhat trefoil-shaped, and either with almost no overhanging cutting point (*M. pontificus*, pl. 14, fig. 10), or with ‘three short, blunt cusps, the middle the largest, all three with distinct cutting points’ (according to W. G. Binney). The side teeth are all of one form, having a long, rather narrow inner cusp or mesocone and a very small ectocone. The very indistinct basal-plates seem to be oblique to the cusps in *M. pontificus*. Binney figures them as long and straight in *M. gossei*. The outer teeth are a little shorter and wider. The formula is about 40.1.40 in *M. gossei* of Jamaica, according to Binney; 35.1.35 in *M. pontificus*.” (Pilsbry.)

Type *M. floridanus* (Pilsbry).

Distribution.—Greater Antilles, chiefly in western Cuba; Curaçao; Bahamas; mainland from Central America to Texas; southern Florida; usually living under stones (limestone), coming forth in wet weather.

Microceramus species were formerly included in *Macroceramus* Guilding. Its important distinctive characters were pointed out by the author in 1904. It differs from *Macroceramus* and all *Urocoptinae* in the straight, not V-shaped, rows of teeth of the radula, and in the form of the individual teeth, the inner cusps of which arise near the anterior border of the basal-plate, adjacent to the outer cusp, instead of being carried backward on the

⁴² See Aguayo, 1938, Mem. Soc. Cubana Hist. Nat. “Filipe Poey,” 12: 71.

basal-plate as in all Urocoptinae. Moreover, the cusps are somewhat pointed, not blunt and rounded. It agrees with the Urocoptinae in the fragile, high-arched, plaited jaw with a triangular median part, in the narrow middle tooth of the radula, and in the slender, imperforate internal column of the shell; all these being characters separating *Microceramus* from the Continental groups *Holospira*, *Epirobia*, and the *Eucalodiinae*.

What we now know seems to indicate that *Microceramus* is a relatively unspecialized member of the primitive Antillean Urocoptid stock.

***Microceramus pontificus* (Gould)**

Fig. 53 a.

Pupa pontifica Gould, 1848, Proc. Bost. Soc. N. H., 3: 40.

Cylindrella pontifica Gould, 1851, in Binney, Terr. Moll., 2: 306, pl. 69, fig. 1.

Macroceramus pontificus Gld., Bland, Ann. N. Y. Acad. Sci., 2: 127.—Binney, 1885, Man. Amer. Land. Sh., p. 414, fig. 456.—Rhoads, 1899, Nautilus, 13: 45 (Miami).—Pilsbry, 1904, Man. Conch., 16: 158, pl. 26, figs. 17-20.

Macroceramus kieneri Binney & Bland, 1869, Land and Fr. W. Sh. N. A., 1: 220.—Binney, 1878, Terr. Moll., 5: 385. Not *M. kieneri* Pfr.

Shell shortly rimate, turritid-conic, tapering from the last or the penultimate whorl, rather solid. Whitish, with a cream or brownish tint, marked with a few triangular or lunate brown spots. Surface regularly sculptured with oblique rib-striae, alternate riblets projecting and enlarged into papil-

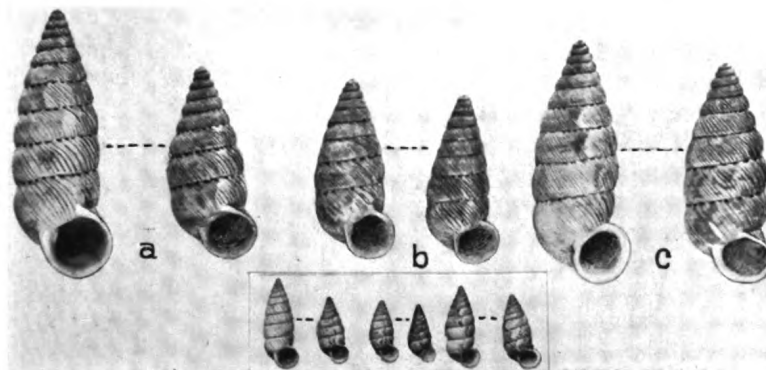


Fig. 53. a, *Microceramus pontificus*, Miami. b, *M. floridanus*, Sarasota Bay. c, *M. texanus*, New Braunfels. $\times 3$ and actual size.

lae at the suture, which is thereby made strongly serrate. Whorls 9 to 11, convex, the last with a low, cord-like keel below, near the aperture. Aperture rounded, the peristome expanded and narrowly reflexed, columellar margin dilated.

Length 12 mm., diameter above aperture 4 mm.

Length 9.5 mm., diameter above aperture 3.7 mm.

Length 8.3 mm., diameter above aperture 3.3 mm.

FLORIDA: Miami, along the river (Rhoads, Pilsbry), type locality. Homestead (M. Hebard). Elliott's Key and Upper Matecumbe Key (McGinty). Key Largo (B. R. Bales). Lignum Vitae Key (C. B. Moore). No Name Key, Little Pine and Big Pine Keys, Summerland Key, Sugarloaf Key (Pilsbry). Key West in several places (Hemphill, Pilsbry and others). Plantation Key, Monroe Co. (Van Hyning). Lossman's Key (C. B. Moore). Homosassa (Van Hyning).

Distinct from other forms of the group by its larger size, coarser sculpture and more conspicuously and regularly toothed suture. It was at one time supposed to be identical with *M. kieneri* Pfr., but is quite distinct. It lives under stones, and was formerly common near the Miami River, in the open pine woods west of Brickell's Hammock (now in Miami and Coral Gables). Probably this was where Bartlett got the type specimens, as it is known that he collected at Miami. The name alludes to its resemblance to a papal mitre.

Microceramus floridanus (Pilsbry)

Fig. 53 b.

Macroceramus gossei Pfr., W. G. Binney, 1878, Terr. Moll., 5: 386, in part, exclusive of description and figure.

Macroceramus floridanus Pilsbry, 1898, Nautilus, 11: 107, name only; 12: 23.

Microceramus floridanus Pilsbry, 1904, Man. Conch., 16: 159, pl. 25, figs. 95-98.

The shell is formed as in *M. pontificus* but is less attenuated near the apex, and is usually smaller. The striation is finer than *M. pontificus*, the sutural papillae lower and blunter, unequal, and less regularly spaced, usually formed by union of two or three striae.

Length 7.8 mm., diameter above aperture 3.1 mm.; 10 whorls.

Length 5.5 mm., diameter above aperture 2.5 mm.; 8 whorls.

FLORIDA: Osprey (Jos. Willcox); Sarasota Bay, type 5027 A.N.S.P.; Goodland Point (Hemphill). Little Key Marco, Fakahatchee Key, Russell's Key, Turner Key, Pumpkin Key, McIlvane's Key, Dismal Key (C. B. Moore). Plantation Key (Van Hyning). Long Pine Key (Mosier). Key Largo (Hebard & Rehn). Lignum Vitae Key (Pilsbry).

This was formerly confused with the Jamaican *M. gossei*. It seems to be generally distributed on the west coast and higher keys of the Ten Thousand Islands, but there are also southeastern colonies on Long Pine Key in the Everglades, on Key Largo, and it is rather abundant in the coconut plantation on Lignum Vitae Key.

Microceramus texanus (Pilsbry)

Fig. 53 c.

Macroceramus gossei Pfeiffer and Binney, in part.

Macroceramus pontificus Gld., Strebel, in part, Fauna etc., 4: 90, pl. 5, fig. 4b.

Macroceramus texanus Pilsbry, 1898, Nautilus, 11: 107 (name only); Nautilus, 12: 23.

Microceramus texanus Pilsbry, 1904, Man. Conch., 16: 157, pl. 25, figs. 1-4.—Strecker, 1935, Baylor Bull., 38: 61.

Microceramus texasianus Pilsbry, Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 158.

The shell is somewhat stouter in figure than *M. floridanus* with similar sculpture. Sutural crenulation irregular; on the lower whorls it is usually in part obsolete.

Length 10 mm., diameter above aperture 3.7 mm.; $10\frac{1}{2}$ whorls.

Length 10.5 mm., diameter above aperture 3.5 mm.

Length 8.5 mm., diameter above aperture 3 mm.

TEXAS: San Marcos, Hays Co. (Pilsbry & Ferriss). New Braunfels, Comal Co., type 60090 A.N.S.P., and vicinity (Singley, Pilsbry, H. B. Baker). Hondo River 2 miles north of Hondo, Medina Co. (Ferriss & Pilsbry). Helotes, Bexar Co., (U.S.N.M.). West Frio canyon, Real Co. (Strecker). Corpus Christi (B. Shimek).

It is similar to *M. floridanus*, but more cylindrical. It inhabits a very different region, being mainly a species of the rocky hill country along the border of the Cretaceous area, usually living under stones.

Subfamily HOLOSPIRINAE

The rather small shell is multispiral, cylindrical (except the discoidal *Hendersoniella*), of closely coiled whorls, the summit conic, entire, all of the whorls retained in the adult stage; the internal axis is hollow. Jaw delicate, vertically striate or smooth. Radula with teeth in nearly straight transverse rows, the central teeth as large as the laterals, unicuspid; central and lateral teeth with broad, obtuse mesocones only, about as long as the basal plates; a small ectocone added on the transitional and marginal teeth (in *Holospira*), but small ectocones are present in *Epirobia*.

Holospira, *Hendersoniella* and *Epirobia* move in the usual manner, by a few rather spreading direct waves, not lifting the sole from the substrate like the Urocoptinae.

HOLOSPIRA Von Martens

Acera Albers, 1850, Die Heliceen, p. 209, not *Akera* Müller, 1776, or *Acera* Cuvier, 1810.

Holospira Von Martens, 1860, Die Heliceen, p. 30, type *Cylindrella pilocerei* Pfr.

Shell of medium or small size, cylindrical, terminating above in a conic spire, retaining all the whorls, rimate or perforate. Whorls 11-21 closely coiled, the first $1\frac{1}{2}$ smooth, the rest either smoothish, striate or ribbed; the suture superficial; last whorl more or less built forward, rounded, without keel. Aperture small, obliquely pear-shaped, rounded or oval, the peristome expanded or reflected, continuous and usually free throughout. Internal column hollow, variously sculptured or smooth.

Distribution.—Southern Arizona and central Texas to southern Mexico. Species numerous, chiefly on the Mexican plateau and the adjacent part of the United States, always on limestone terrain, frequently in very hot and dry places.

(Ὅλος, σπείρα, entire spire.)

In the course of collecting in Texas, New Mexico, Arizona and many states of Mexico, I have never found more than one species of *Holospira* living in a colony, but distinct species often occur in closely adjacent colonies.

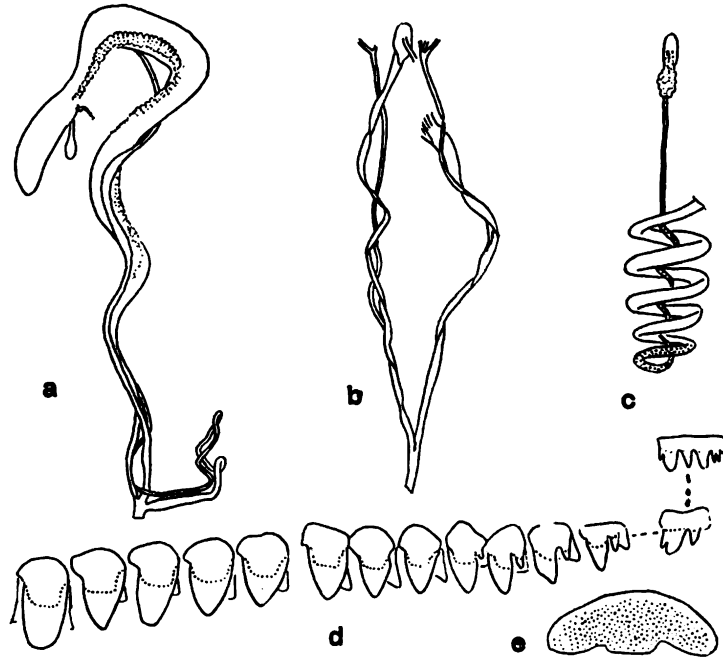


Fig. 54. *Holospira roemeri*: a, genitalia; b, free retractor muscles; c, alimentary tract. *Holospira pilsbryi* Dall: d, teeth; e, jaw.

Pallial organs: The lung is long and narrow. Kidney very narrowly triangular, slightly longer than the pericardium.

Alimentary tract: The buccal mass is small, about twice as long as wide, the oesophagus opening well forward. Salivary glands not united, in *H. roemeri*, rather short, and on short ducts (Fig. 54c). In *H. goldfussi* the ducts are long, according to Strebel. The fore-gut in *H. roemeri* is slender, dark-colored, and follows the pharyngeal retractor, lying thus near the central pillar of the shell. Posteriorly it dilates into the stomach, which fills the greater part of the upper whorl of the cylindrical portion of the shell, and is copiously black-pigmented on its peripheral surface. The hind-gut revolves at the suture, and is white. I could make out but two longitudinal folds of the whole intestine, but from the constancy of the four-folded type, and its distinct development in *Urocoptis*, I may have overlooked a small fold. The liver occupies all the whorls of the cone.

The jaw is thin, arcuate, with a wide median projection below, or none. It is smooth in *H. roemeri* (fig. 54e). In *H. goldfussi* there are distinct plaits toward the ends, and elsewhere a rather irregular somewhat scaly sculpture, according to Strebel. It varies therefore from the smooth, through striated, almost to the plaited type.

The radula is about four times as long as wide, with 20.1.20 teeth in *H. roemeri*, 26.1.26 in *H. goldfussi*. The transverse rows are nearly straight

in the middle, bending forward at the two ends. In the species of typical *Holospira* the teeth are more numerous, 17.9.1.9.17 in *goldfussi*. The cusps are rather short, conic, and those of the outer lateral teeth are not split, there being but two. In all the other species examined the teeth are of substantially the same type, varying in the length of the cusps in the several forms. The central and lateral teeth have single, stout, conic cusps. The transition to marginals is made by the gradual development of an ectocone, at first small and simple, and in the usual position. The outer marginal teeth are short, wide and usually have both cusps bifid, or the outermost ones may be irregularly cusped.

The genital system of *H. goldfussi* has been examined by Strebel and Pfeffer; of *H. nelsoni*, *H. (Metastoma) roemeri* (Fig. 54a) and *H. (Coelostemma) dalli* by myself. In all of them there is an atrium of moderate length; the penis is short, with a very long vas deferens, the retractor muscle (*p. r.*) being inserted at or just beyond the slightly swollen penis, and proximally attached to the floor of the lung as usual. In *H. nelsoni* there are internal folds in the penis, showing through. There are no accessory organs. The spermatheca and oviduct are separate to the atrium in the species I have opened, but in *H. goldfussi*, Strebel figures a capacious vagina. The oviduct is extremely long, the albumen gland small, lying in the volution anterior to that containing the stomach (in *H. roemeri*). The ovispermduct is strongly convoluted but not knotted in appearance. The spermatheca is small and ovate, on a duct as long as the oviduct. This duct is simple in *H. goldfussi*, *dalli* and *roemeri*, but appears to bear a long diverticulum in *H. nelsoni*.

The free retractor muscles are excessively long, attached proximally to the axis at about the junction of the cone with the cylindrical portion of the shell. In *H. roemeri* (Fig. 54b) the left ocular retractor unites with the pharyngeal retractor at about the posterior third of the length of the latter. This band then unites with the columellar muscle near its posterior insertion. The right eye-retractor unites with the columellar muscle at about the anterior third of the length of the latter.

Fossil species referable to this genus are:

HOLOSPIRA LEIDYI (*Pupa?*) (*Holospira?*) *leidy* Meek, 1873, Sixth Ann. Rep. U. S. Geol. Surv. of the Terr. for 1872, p. 517.—White, 1886, Bull. U. S. Geol. Survey no. 34, p. 27, pl. 5 (Figs. 8, 9). From the base of the Bridger or top of the Green River Group, 12 miles south of Fort Bridger, southwestern Wyoming. This species seems to have all the features of *Holospira*, as Meek himself suspected, but until the interior is examined, its exact relation to living species remains uncertain.

HOLOSPIRA GRANGERI Cockerell, 1914, Amer. Mus. N. H. Bull., 33: 102 + *Pupa? leidy?* White, 1886, U. S. Geol. Surv. Bull., 34: 25, pl. 5, fig. 10. Torrejon Eocene, East Fork Torrejon Arroyo, New Mexico; also near Nacimiento, N. M.

Subgenera of Holospira

- 1. Last whorl distorted, appearing sinistral; a fold within the right margin of aperture, but no internal lamellae..... *Metastoma*
- Last whorl straightened and built forward in front; no fold within right margin of aperture 2

- 2. Four lamellae in the penult whorl.....*Holospira* s.s.
0 to 3 lamellae in the penult whorl..... 3
- 3. Rather large opaque white species with relatively long whorls, the slender internal axis bearing a single lamella or none; length in mm. usually exceeding the number of whorls*Haplocion*
Species with short whorls, in number equal to or exceeding the number of mm. in the length; internal lamellae 0-3.....*Bostrichocentrum*

Subgenus METASTOMA Strebel

Metastoma Strebel, 1880, Beitrag Kenntniss Mex. Land- u. Süßwasser-Conch., 4: 80, for *Holospira roemeri* Pfr.

The oblong-cylindric shell of many short whorls is smooth in known species; the last whorl is sinuous, turning to a sinistral position. The internal column is large, about one-fourth to one-third of the shell's diameter, without sculpture or lamellae. Aperture oval, obstructed by a strong fold within the right margin.

The only species, *H. roemeri*, is probably the most widely distributed *Holospira*, ranging from central Texas to the Rio Grande valley in New Mexico, a distance of over 600 miles. Our other species of *Holospira* are very local.

(Μετὰ, στόμα, changed mouth.)

Holospira roemeri (Pfeiffer)

Fig. 55.

Cylindrella roemeri Pfeiffer, 1848, Monogr. Hel. Viv., 2: 382; 1849, in Roemer's Texas, p. 456.

Holospira roemeri Pfr. W. G. Binney, 1878, Terr. Moll., 5: 177, fig. 85.—Pilsbry, 1905, Proc. Acad. Nat. Sci. Phila., p. 220, pl. 26, figs. 10-18.—Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 148.

Holospira roemeri var. *minor* Cockerell, 1898, Nautilus, 11: 136.

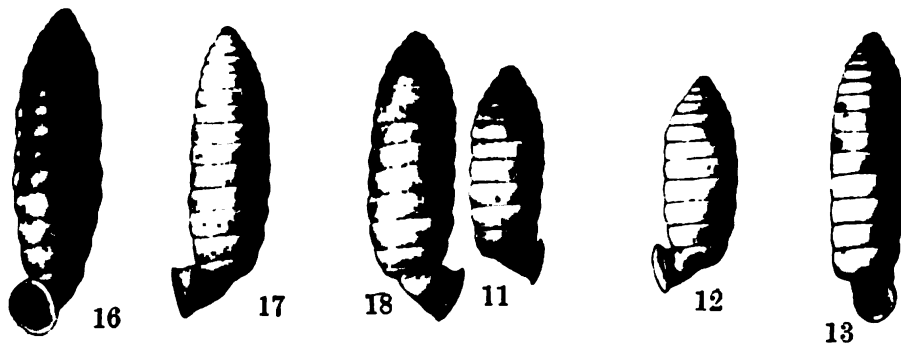


Fig. 55. *Holospira roemeri*. 11-13 near Hondo. 16-18, High bridge of the Pecos. (X about 23.)

Shell rimate or perforate, cylindric, often a little wider above than below, terminating in a rather short cone above; rather thin, pale brown. Surface somewhat glossy, smooth except for light growth lines, but finely

and rather sharply striated on the terminal cone. Whorls $12\frac{1}{2}$ to 14, but slightly convex, the last tapering, strongly carinate beneath, its latter portion sinuous, becoming sinistral, shortly free in front; base excavated, concave. Aperture oblique, oblong, the longest axis parallel to that of the shell, contracted by a callous barrier deep in the throat on the columellar side, and a prominent, angular fold within the right lip. Peristome continuous, free, slightly reflected. Internal column smooth, moderately large, its diameter about one-fourth that of the shell, of nearly equal calibre throughout.

Length 15.7, diameter 4.5 mm.; whorls $13\frac{3}{4}$. Near El Paso.

Length 14, diameter 4.4 mm.; whorls $13\frac{1}{2}$. Near El Paso

Length 13-14, diameter 4.5 mm.; whorls 14. New Braunfels (Pfr.).

Length 12, diameter 3.8 mm.; whorls $12\frac{1}{2}$. New Braunfels.

Length 12, diameter 4.2 mm.; whorls 11. Sacramento Mts.

Length 13, diameter 4.0 mm.; whorls 12. Sacramento Mts.

Length 14.8, diameter 4.0 mm.; whorls $12\frac{3}{4}$. Sacramento Mts.

TEXAS: Comal Co., around New Braunfels (Roemer, type loc.). Helotes, Bexar Co. (C. R. Crosby). Rio Grande in Maverick Co. 8 mi. above Webb Co. line, probably in river drift (Julia Gardner). Near Hondo, Medina Co. (Pilsbry). Frio, Frio Co. (Gardner). Uvalde Co. (Ferriss). Near Spofford, Kinney Co. (T. W. Stanton, U.S.N.M.). Edwards Co. (T. W. Vaughan, U.S.N.M.). Japonica, Kerr Co. (M. Surber, U.S.N.M.). Val Verde Co. in many places (Ferriss & Pilsbry). Howard's Spring, Crockett Co. (Binney). Sanderson, Terrell Co. (Ferriss). House Top Mt. and Marathon; Santiago Park, Brewster Co. (Ferriss). Five mi. north of Van Horn, Culbertson Co.; Franklin Mt., El Paso. (Ferriss & Pilsbry).

NEW MEXICO: Guadalupe Mts. east of Orange, in Lincoln and Eddy counties; Sacramento Mts. in Alamo Canyon, Alamogordo, Otero Co. (Pilsbry & Ferriss). Burke's Spring and Ropes Spring, southwestern slope of San Andraes Mts., Dona Ana Co. (Pilsbry & Ferriss).

An abundant shell throughout its wide range, easily recognizable by the distorted last whorl. It ordinarily varies in length from about 11 mm. long, with 12 whorls (the size of "var. *minor*" Cockerell), to 18.5 mm., 17 whorls. The smallest normal adult seen is 8.5 mm. long, with 10 whorls. Numerous measurements were given by the author, 1905, and by Bartsch, 1906.

Subgenus HOLOSPIRA s. s.

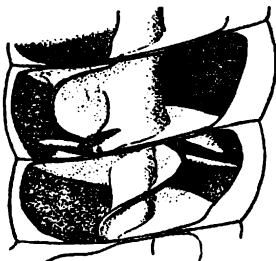


Fig. 56. *H. goldfussi*.

The cavity of the penultimate whorl is obstructed by four strong lamellae, axial, basal, superior and palatal (as in Fig. 56, *Holospira goldfussi*). The whorls are short.

This group, rather numerously represented in Mexico, has a single Texan species.

Holospira goldfussi (Menke)

Figs. 56, 57.

Cylindrella goldfussi Menke, 1847, Zeitschr. für Malak., p. 2.—Bland, 1865, Ann. Lyc. Nat. Hist. of N. Y., 8: 160 (internal lamellae).

Holospira goldfussi Mke., Binney, 1878, Terr. Moll., 5: 177, fig. 86, pl. iv, fig. n.
 —Pilsbry, 1902, Man. Conch., 15: 76, pl. 21, figs. 30-35; 1905, Proc. Acad. Nat.
 Sci. Phila., p. 214, pl. 26, figs. 1-5.—Strecker, 1935, The Baylor Bull., 38: 61.

Shell rimate or perforate, cylindric with a rather long, gradually tapering terminal cone, dull flesh tinted. Surface lustreless, sculptured with strong riblets, which are decidedly arcuate on the lower whorls, straighter and more oblique above; the nepionic $2\frac{1}{2}$ whorls smooth. Whorls $11\frac{1}{2}$ to $14\frac{1}{2}$, the first two very convex, following whorls convex, the last somewhat flattened laterally near the aperture, rounded below, shortly free and produced forward. The upper surface flattened and even concave, a strong, blunt keel at its junction with the outer face of the whorl. Aperture rounded below, truncate above, the peristome white, reflexed throughout, a

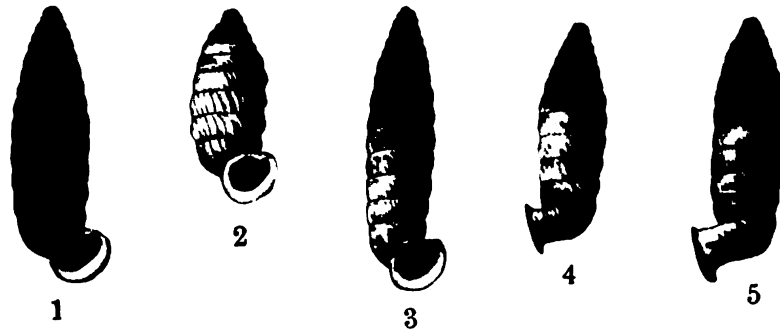


Fig. 57. *Holospira goldfussi*, Guadalupe River above New Braunfels, $\times 25$.

low prominence of the horizontal parietal margin projecting inward near the outer angle of the aperture, which is thereby somewhat spout-like.

The internal column is rather small and cylindrical, of about equal calibre from the penultimate whorl to near the apex. About 4 whorls from the last there arises a slight spirally-running swelling near the anterior partition in each whorl. In the beginning of the penultimate whorl a strong axial lamella is superposed upon this swelling, and runs $1\frac{1}{2}$ whorls down; it increases rapidly, and then diminishes slowly downward, continuing but a little way in the last whorl. A strong, wide, outward-flaring parietal lamella arises with the columellar lamella, and runs about $\frac{3}{4}$ of a whorl. A short basal lamella arises a little later than the preceding two, and extends about $\frac{1}{4}$ of a whorl downward. An acute but rather low palatal lamella arises with the last, and runs about $\frac{1}{2}$ of a whorl. In fresh specimens this is visible from the outside as a whitish line on the front of the penult whorl.

Length 15, diameter 3.6 mm.; whorls $14\frac{1}{2}$.

Length 14, diameter 4 mm.; whorls 14

Length $11\frac{1}{2}$, diameter 4 mm.; whorls 12.

Length 11, diameter 3.5 mm.; whorls 12.

TEXAS: San Marcos, Hays Co.; Comal Creek and Guadalupe River near New Braunfels, Comal Co.; Hondo River 2 miles north of Hondo, Medina Co. (Ferriss & Pilsbry). West Frio Canyon, Real Co. (Strecker). Blanco River (B. F. Shumard, U.S.N.M.).

Like *H. roemeri*, this species belongs to the hill country forming the border of the Lower Cretaceous area in Texas. Mr. Ferriss and the writer found it above San Marcos, Hays County, in the flood-debris of Sinking Spring and on ledges of its bordering limestone cliff. It is abundant under stones at the foot of the cliffs along the Guadalupe River, about six miles above New Braunfels, Comal County. Also nearer the town, in the hills above the head of Comal Creek. It varies a good deal in size:

Length 14, diameter 4 mm.; whorls $14\frac{1}{2}$.

Length 10, diameter 3.9 mm.; whorls $10\frac{1}{2}$.

Though abundant where it occurs, the distribution appears quite limited and local. New Braunfels may be taken as the type locality. There is an old record, Dallas (J. Boll), which seems improbable.

The shell varies a good deal in size and shape. Some specimens are almost exactly cylindric, while others are distinctly swollen above. There is a tendency for the whorls to overhang the suture in some specimens. The internal lamellae vary somewhat in position, but the palatal thread always lies within the front or ventral part of the penultimate volution.

(Named for G. A. Goldfuss, 1782-1848, German palaeontologist who traveled in Texas.)

***Holospira goldfussi anacachensis* Bartsch**

Holospira goldfussi anacachensis Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 123-126, pl. 4, fig. 4.

"Has a lesser number and much more strongly developed ribs than typical *goldfussi*. It has 13 whorls and measures: Length 12.1 mm., diameter of penultimate whorl 3.2 mm.; diameter of tenth whorl 3.7 mm. The penultimate whorl has 22 ribs, the tenth whorl 30." (Bartsch.)

TEXAS: Edwards County: 20 miles north of Brackettville. Anacacho Mountains 6 to 8 miles east of Spofford; Frying Pan Valley 6 miles southwest of Cline, Type 187545 U.S.N.M.; Elm Creek 6 miles above Eagle Pass, Maverick Co. (all in U.S.N.M.) Nueces River, Uvalde Co., on highway to San Antonio (Ferriss).

Specimens from along the Nueces River, Uvalde Co., measure 14.2×3.7 mm., $14\frac{1}{2}$ whorls, to 10.4×3.5 mm., $12\frac{1}{2}$ whorls.

Subgenus HAPLOCION Pilsbry

Haplocion Pilsbry, 1902, Man. Conch., 15: 72, 89, type *H. pasonis* Dall.

Liostemma Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 141, type *H. hamiltoni* Dall.

Moderately large holospiras in which the number of millimetres in the length exceeds the number of whorls; internal axis slender, plain throughout or having an axial lamella in the penult whorl.

Haplocion, having no internal lamella, and *Liostemma*, with a small lamella in the penult whorl, do not appear to be separable as distinct subgenera because in *H. riograndensis* some examples have the distinct vestige

of a small axial lamella, others none. As in *Bostrichocentrum*, the internal lamella is variable in this group. Externally the species are much alike. All are from western Texas and the Mexican state of Chihuahua.

(Ἀπλός, κίων, simple pillar.)

Species of Haplocion

1. An axial lamella, small but well formed, in the penult whorl.....*H. hamiltoni*
Axial lamella absent or rudimentary..... 2
2. Lip broad, flatly reflected.....*H. mesolia*
Lip moderate or narrow..... 3
3. Shell rather stout, diameter about $3\frac{1}{4}$ times in the length.....*H. pasonis*
Shell more slender, diameter about 4 times in the length.....*H. riograndensis*

Holospira hamiltoni Dall

Fig. 58 c, d.

Holospira (Haplostemma) hamiltoni Dall, 1897, *Nautilus*, 11: 38; 1902, *Proc. U. S. Nat. Mus.*, 24: 501, pl. 28, figs. 2, 11.

Holospira (Liostemma) hamiltoni Dall, Bartsch, 1906, *Proc. U. S. Nat. Mus.*, 31: 141.

"Shell slender, polished, spindle-shaped, pinkish-white, with a darker livid apex, and about 13 whorls; nucleus blunt, smooth, later three whorls delicately obliquely striated, central whorls smooth, last whorl with delicate oblique riblets with wider interspaces; aperture projected, rounded, subangular at the right posterior corner, the lip entire, reflected, the pillar rather wide; the last whorl flattened and attenuated. Lon. 19, diam. 5 mm." (Dall.)

Length 22 mm., diameter 9th whorl 5.1 mm., penult whorl 4.4 mm.; $13\frac{1}{2}$ whorls.

Length 20 mm., diameter 9th whorl 4.9 mm., penult whorl 4.2 mm.; 13 whorls.

Length 19 mm., diameter 9th whorl 4.8 mm., penult whorl 4.0 mm.; $12\frac{1}{2}$ whorls.

TEXAS: Rio Grande Mts., Brewster Co., at a height of 3,500 feet, living on *Selaginella lepidophylla* Spring (James M. Hamilton). Type 107759 U.S.N.M.

MEXICO: Rio Conchas, Chihuahua, not far above its confluence with the Rio Grande (B. H. King).

"This species is very much like *H. (Metastoma) semisculpta* Stearns, externally, differing in its smaller and more slender shell and finer and more delicate sculpture of the later whorls near the aperture." (Dall.)

Holospira riograndensis new species

Fig. 58 a, b.

The shell is subcylindric but a little wider where the long, tapering upper third passes into the subcylindric part; the latter tapering very slowly to the last whorl. Whorls of terminal cone are rather strongly convex, the convexity becoming weak on the cylindric portion; the last whorl bluntly subangular around the base, shortly built forward. Initial $1\frac{3}{4}$ whorls smooth, following whorls of terminal cone very finely striate, those of cylindric part nearly smooth, the last two whorls with rather strong, somewhat curved axial ribs, which become closer and straighter on the back of the last whorl. The aperture is small, roundly ovate, the white lip moderately reflected

throughout, a little thickened within. Internal axis is rather slender, tapering anteriorly, smooth, without lamellae, or having a very weak axial lamella in the penult whorl.

Length 20.0 mm., diameter 5.0 mm.; 14 whorls.

Length 20.5 mm., diameter 5.1 mm.; $14\frac{1}{2}$ whorls.

Length 18.2 mm., diameter 5.7 mm.; 13 whorls.

Length 16.0 mm., diameter 5.0 mm.; $12\frac{1}{3}$ whorls.

Length 16.3 mm., diameter 4.5 mm.; 13 whorls.

TEXAS: George Hill's Bluff, Grand Canyon of the Rio Grande, Brewster Co. (J. H. Ferriss), type and paratypes 144362 A.N.S.P. Also at mouth of the Grand Canyon.

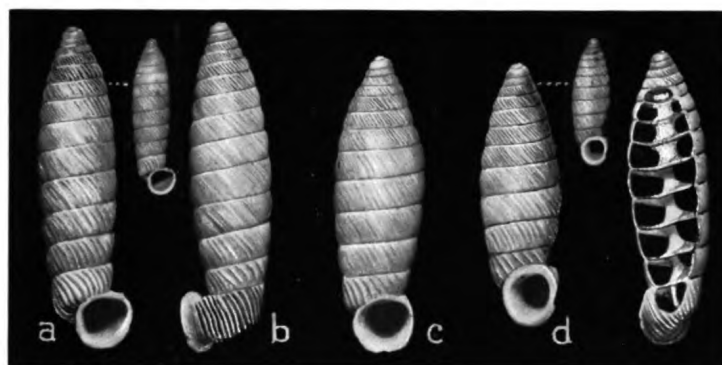


Fig. 58. a, b, *Holospira riograndensis*, type and paratype. c, d, *Holospira hamiltoni*, paratypes. Actual size and $\times 2$.

It is closely related to *H. mesolia*, but differs by the much less broadly reflected peristome. The last three specimens measured above are exceptional individuals.

The shell is externally distinguishable from *H. hamiltoni* Dall only by narrower contour, but internally *hamiltoni* has a quite distinct though small lamella on the axis close to the base in the penult whorl, which I have found constant in 3 specimens, while in *H. riograndensis* a lamella is either absent, as in some specimens opened, or, in others, extremely weak and visible with some difficulty. There is a noticeable though small discontinuity here, which at present seems specific, though further collections may possibly supply intermediate conditions of the axial lamella, and in that case it will become a subspecies of *hamiltoni*.

Specimens from the second locality mentioned above average smaller than the type lot. Three measure: 19×4.8 mm., $13\frac{1}{2}$ whorls; 18×5 mm., 13 whorls; 15×4.8 mm., $11\frac{1}{2}$ whorls. The trace of an axial lamella is barely discernible or is absent in those of this lot opened.

***Holospira mesolia* Pilsbry**

Fig. 59.

Holospira mesolia Pilsbry 1912, Nautilus, 26: 89.

The shell is cylindric-fusiform, of a delicate pink-white tint, the upper part white with blue stains; dead shells white throughout. Whorls 14, the

first $2\frac{1}{2}$ smooth, forming the mamillar embryonic shell, the first whorl rapidly increasing, second swollen, next half whorl very narrow. Subsequent whorls are nearly flat, rather finely but strongly striate, regularly increasing to the 8th or 9th whorl, where the shell reaches its greatest diameter. After

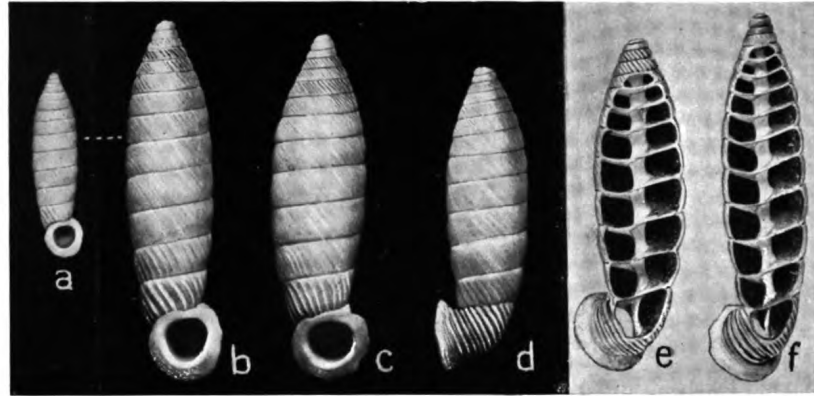


Fig. 59. *Holospira mesolia*. Actual size (at left), and $\times 2$.

that the whorls are nearly smooth, rather glossy, and the shell diminishes slowly in diameter to the base. The last two whorls have retractive axial ribs which gradually increase in strength, and are strongest on the straight part of the last whorl and base. The last whorl is somewhat compressed laterally and projects, carrying the aperture well forward. Aperture is very shortly ovate, almost circular, light brown within. Peristome very broad, flatly reflexed, white. The internal axis is smooth throughout, rather slender, tapering downwards, with a diameter of about 1 mm. in the widest part.

Length 23.5, greatest diameter 6 mm.; whorls 14. Type.

Length 22.6, greatest diameter 6.3 mm.; whorls $13\frac{1}{2}$.

Length 20, greatest diameter 5.8 mm.; whorls $12\frac{3}{4}$.

TEXAS: Sanderson, Terrell Co., on a low limestone ledge along the railroad, elevation 2800-2900 ft. (Morgan Hebard and J. A. G. Rehn), types 107001 A.N.S.P.

This handsome *Holospira* is closely related to *H. semisculpta* Stearns, which was described from a canyon above San Carlos, Chihuahua, a place on the Mexican side of the Great Bend of the Rio Grande. Dr. Dall and Dr. Bartsch have kindly compared specimens with the type of *semisculpta*, and report that the new species "differs in the profile, which in your shell is more contracted toward the base, rendering it spindle-shaped, while the former is more cylindrical. The ribs in yours do not extend over so many of the basal whorls, and the broadly expanded peristome gives it a very distinct appearance. It is doubtless a distinct species."

Holospira pasonis Dall

Fig. 60.

Holospira pasonis Dall, 1895, *Nautilus*, 8: 112.*Holospira (Metastoma) pasonis* Dall, Proc. U. S. Nat. Mus., 19: 348, pl. 31, figs. 4, 5.*Holospira (Haplocion) pasonis* Dall, Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 144.—Pilsbry, 1917, *Nautilus*, 30: 125, pl. 4, fig. 5 (Rio Conchas).

“Shell white, mostly smooth but hardly glossy, of eleven and a half whorls; two and a half smooth, inflated, nepionic whorls, the apex flattish, followed by several whorls which are minutely ribbed in harmony with the incremental lines, the ribbing gradually becoming obsolete over most of the shell but reappearing on the last whorl, especially the basal part, sharper

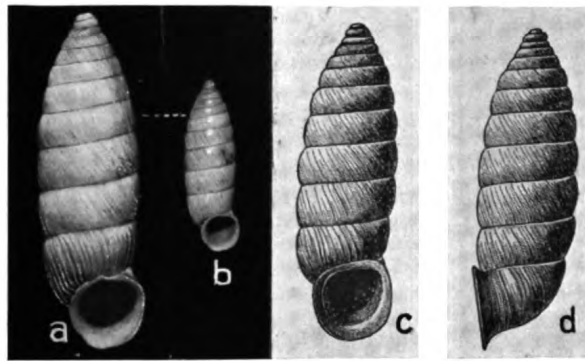


Fig. 60. *Holospira pasonis*. a, b, paratype, $\times 2$ and actual size; c, d, type, after Dall, enlarged.

and somewhat crowded just behind the reflected lip; umbilicus closed or reduced to a minute chink; suture distinct, sutural edge continuing as a keel to the reflected margin of the aperture; aperture very short necked, almost circular, broadly reflected; the pillar, as usual in the genus, tubular above the last whorl, the axis externally simple but somewhat flexuous. Lon. 22.5, max. diam. 6.5 mm.” (Dall.)

TEXAS: Mule canyon, El Paso Co., at an elevation of 4000 ft. (J. A. Singley), Type 129032 U.S.N.M.; also Red Bull canyon, El Paso Co. (T. W. Stanton). Davis Mts. (Russel Hench).

MEXICO: Chihuahua, on the Rio Conchas not far above its confluence with the Rio Grande (B. H. King).

“This species is nearest to *H. coahuilensis* W. G. Binney, which has one or two more whorls, the last two proportionately more attenuated with more extended, sharper and more distant sculpture, and obtusely keeled or compressed base resulting in a much more triangular and narrower aperture. It is not particularly close to any of the other species hitherto described, the *H. semistriata* Stearns being quite distinct. A marked character is the evenly rounded basal part of the whorl just behind the lip.” (Dall.)

Dr. Bartsch gave the extremes of length as 22.3 to 24.7 mm.

Subgenus *BOSTRICHOCENTRUM* Strebel

Bostrichocentrum Strebel, 1880, Beitr. zur Kenntniss Fauna Mexikanischer Land- u. Süßwasser-Conchyl., 4: 77, 80, for *Holospira tryoni* (Pfr.).

Haplostemma Dall, 1895, Proc. U. S. Nat. Mus., 18: 3, type *H. mearnsi* Dall.

Eudistemma Dall, 1895, Proc. U. S. Nat. Mus., 18: 3, type *H. arizonensis* Stearns.

Distomospira Dall, 1895, Proc. U. S. Nat. Mus., 18: 3, type *H. bilamellata* Dall.

Tristemma Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 133, type *H. ferrissi* Pils.

Malinchea Bartsch, 1945, Jour. Wash. Acad. Sci., 35: 94 (substitute for *Tristemma* Bartsch 1906, not of Brandt, 1835).

Short-whorled holospiras, in which the number of whorls is about equal to, or exceeds, the number of millimetres in the length. Internal axis having an axial lamella in the penult whorl, and often with superior and basal lamellae also.

There are some exceptions to the above definition, as in elongate forms of *H. bilamellata*, in which the length in millimeters exceeds the number of whorls, and certain specimens of *H. montivaga* and *H. crossei*, in which lamellae are practically absent.

The type of *Bostrichocentrum*, *H. tryoni* Pfr., of the State of Puebla, is an opaque white, evenly but rather weakly striate species, with a short axial lamella only, and having the whorls of the internal axis a little swollen between partitions. In United States species this swelling is quite weak, or it may be entirely wanting, and there are often accessory upper and lower lamellae in the penult whorl.

The study of long series of many forms has shown that the lamellae in the penult whorl vary in a way it was impossible to foresee at the time when holospiras were so rare that only one or two of a lot could be opened. Very naturally, the number and arrangement of internal lamellae were thought at that time to be of specific and even subgeneric value. No external character is correlated with the number of lamellae. Usually most of the shells of any one colony, though varying internally, resemble each other in size, shape and sculpture, so that each lot has a certain individuality, though all of the characters vary more than is usual among the land snails.

A comparison of the holospiras of the Hacheta Grande range with those of the Chiricahua and other Arizona ranges shows some interesting resemblances and differences. "In both localities the internal lamellae present (in almost every form known by large lots) may be: (1) *superior, axial and basal*, or (2) *axial only*. In Hacheta forms we have also the combination (3) *axial and basal*, which is never found in the Chiricahuan series, where it is replaced by the combination (4) *superior and axial*. Every Hacheta species has, therefore, in different specimens of the same colony, the characters of the supposed subgenera or sections *Bostrichocentrum*, *Haplostemma*, *Distomospira*, and *Tristemma*, while a Chiricahuan species

will belong to *Bostrichocentrum*, *Eudistemma*, and *Tristemma*. In external form and sculpture there are no differences greater than specific between the Hacheta and Chiricahua species."

The variations in the internal lamellae are really less discontinuous than might be supposed by the tables. The axial lamella is invariably present in Arizona species, but it varies in strength and length. The superior lamella may be very strong and over a half whorl long, but in other individuals of the same colony it may be small or barely observable, so that the series from a strong lamella to none is practically a continuous one in some colonies, though usually this lamella is either distinctly developed or wholly wanting. The same statement applies to the basal lamella, except that it is never very large and usually quite small and short when present.

The classification of Mexican holospiras is still inchoate. A certain number of groups seem well established, such as *Holospira* s. str., *Metastoma*, *Haplocion* and *Coelostemma*. The mass of short-whorled forms which are left in *Bostrichocentrum* remains to be arranged. Just where the Mexican species without internal lamellae, such as *H. fusca*, *H. remondi*, *H. minima*, and some others belong is not clear.⁴³ However, all of the United States species herein referred to *Bostrichocentrum* belong obviously to one intimately related series, although they vary from no internal lamellae to three. Whether this series will eventually be left in *Bostrichocentrum* awaits a more detailed study of Mexican species. The former arrangement of Dall, based upon the number and positions of internal lamellae, is without value.

The species of *Bostrichocentrum* are herein arranged geographically, thus:

1. Guadalupe Mts., southeastern New Mexico.
2. Mountains west of the Rio Grande, New Mexico.
3. Habitat unknown.
4. Hacheta Grande Mountains, southwestern New Mexico.
5. Dragoon Mountains, Arizona.
6. Chiricahua Mountains and westward, Arizona.

1. Guadalupe Mountains, New Mexico

Holospira montivaga new species

Fig. 61 b, c.

The shell is cylindrical in the lower 4 whorls (forming more than half of the length), tapering above; thin. General color light pinkish cinnamon, the riblets much paler than the intervals. After the smooth initial $1\frac{1}{2}$ whorls the surface is ribbed, the ribs close, straight and a little oblique on

⁴³ These species are not related to *Haplocion*, where they were grouped in my monograph of 1902. The subgenus *Megaxis* is here proposed for *Holospira fusca* Von Martens, and subgenus *Allocoryphe* for *H. minima* Von Martens; defined in the key in Man. Conch., 15: 89, paragraphs I and II, 1, respectively.

the tapering portion, arcuate and parallel to the axis on the cylindrical whorls, where also they are a little closer. There are about 55 riblets on the penult whorl in the type. The whorls are rather convex, the last be-

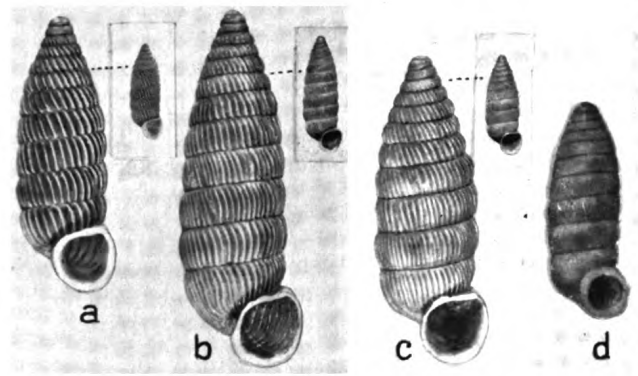


Fig. 61. a, *Holospira montivaga* form *breviaria*, type; b, c, *H. montivaga*, type and paratype, actual size and enlarged. d, *Holospira tantalus* (after Bartsch).

coming straightened and built forward in a short neck. The aperture is broadly ovate, bluntly angular at the upper, outer extremity. The continuous peristome is thin, light buff, expanded, the columellar margin somewhat reflected, parietal margin shortly built forward. The internal axis is rather slender, of about equal diameter throughout, simple, except for the weak trace of an axial fold at the end of the penult whorl (often not perceptible). There is a well developed (or sometimes weak) basal fold within the latter part of the penult whorl.

Length 15 mm., diameter above aperture 4.6 mm.; $13\frac{1}{2}$ whorls.

NEW MEXICO: Guadalupe Mountains east of Orange, the types from a terraced butte in a deep dry canyon (our station 240), about 2 miles south of the PX trail over the mountains. (Pilsbry, 1922.)

By its combination of axial and basal lamellae in the penult whorl this species shows relationship to those of the Big Hatchet Mountains. The axial lamella is only vestigial, and in many specimens so low that it would not be noticed or is really practically absent. This has been observed in *H. crossei* also, where in one lot 25 percent of the specimens had the axial lamella obsolete. There is a great variation in the development of the basal lamella, from rather strong and long to hardly perceptible. Its area lies remote from that of related species.

Holospira montivaga form *breviaria* new form. Fig. 61a. Shell shorter, with coarser costulation, about 40 riblets on the penult whorl. No internal lamellae (in specimens opened).

Length 11.7 mm., diameter 3.8 mm.; $11\frac{1}{2}$ whorls.

Length 12 mm., diameter 4.2 mm.; 13 whorls.

Length 8.5 mm., diameter 3.7 mm.; 10 whorls.

NEW MEXICO: Eastern slope of Guadalupe Mountains near south end, above Walter Glover's ranch house in Pine Spring Canyon, below the rock gateway. (Pilsbry & Ferriss.)

2. Mountains west of the Rio Grande, New Mexico

Holospira regis Pilsbry & Cockerell

Fig. 62 d.

Holospira regis Pilsbry & Cockerell, 1905, Proc. Acad. Nat. Sci. Phila., p. 218, pl. 26, fig. 7.

Holospira (Bostrichocentrum) regis Pils. & Ckll., Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 140.

Shell small, the lower half cylindric, upper half slowly tapering in a long cone to the obtuse apex. Whorls $12\frac{2}{3}$, all convex, the first two smooth, the following whorls of the tapering portion of the spire rather strongly, obliquely rib-striate, the riblets slightly narrower than their interstices; the penultimate and next earlier whorls are more closely and a little more finely sculptured, but on the last whorl the riblets become stronger again. The last half of the last whorl is compressed laterally, sloping to an almost

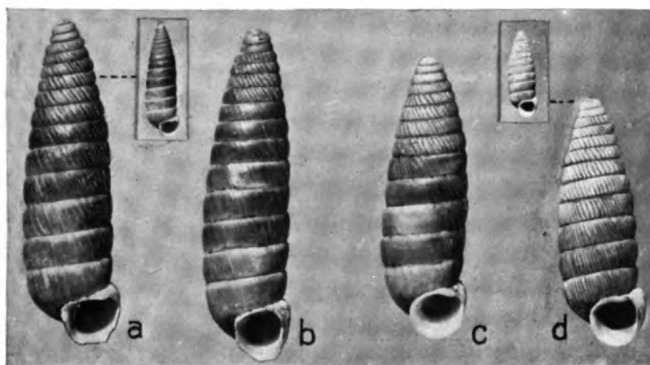


Fig. 62. a-c, *Holospira cockerelli*, Cuchillo Mts. d, *Holospira regis*, type. (Enlarged and actual size.)

subangulate but very obtuse base. Near the end the whorl becomes free, descends a little, and is flattened and excavated above. The aperture is obliquely piriform, its contour being compressed near the upper outer angle. The peristome is free throughout, expanded, the columellar and upper margins a little reflexed. The upper margin is a little dilated inwardly. The axis is small and slender. Near the end of the penultimate whorl there is a short, stout lamella on the axis near the basal wall.

Length 10.8, diam. of cylindric portion 3.3 mm.

NEW MEXICO: near Kingston, Sierra county. (O. B. Metcalfe.) Type 87,208 A.N.S.P.

This species is about the size of *H. chiricahuana*, which, however, differs in the less projecting last whorl, contracted behind the lip, and in the smaller, differently shaped mouth. By the long taper of the summit it is related to *H. cockerelli*, but it differs by the ribbed surface, a character of no great constancy in this group. *H. mearnsi* is larger with more whorls.

Holospira cockerelli Dall

Fig. 62 a, b, c.

Holospira (Haplostemma) cockerelli Dall, 1897, *Nautilus*, 11: 61.*Holospira cockerelli* Dall, Pilsbry, 1905, *Proc. Acad. Nat. Sci., Phila.*, p. 218, pl. 26, fig. 6.—Spence, 1928, *Nautilus*, 41: 98.*Holospira (Bostrichocentrum) cockerelli* Dall, Bartsch, 1906, *Proc. U. S. Nat. Mus.*, 31: 140.

“Shell small, pupiform, blunt-tipped, with two smooth nuclear and about a dozen subsequent whorls; those following the nucleus are rather strongly obliquely ribbed with close-set fine riblets which become fainter over the main body of the spire and reappear again on the last whorl; aperture entire, simple, rounded, but a little angular at the posterior outer corner; the umbilicus closed, the spire gradually enlarging to the eleventh whorl, then slightly attenuated. Alt. 12.5, max. diam. 3.2 mm.” (Dall.)

Length 12.8 mm., diameter 10th whorl 3.8, penult. 3.6 mm., 13½ whorls” (Bartsch).

Shell cylindric below, the upper half forming a long, very slowly tapering cone to the obtuse apex. Whorls 13½, convex, the upper ones more so. The first 2½ form the smooth embryonic shell, the second of them being wider and more swollen than the following one. Post-embryonic whorls of the tapering spire rather strongly rib-striate, the riblets oblique, narrower than the rather wide intervals. On the cylindric portion the riblets weaken to irregular growth wrinkles, but the base and the last half of the last whorl are strongly ribbed again. The last whorl is well rounded below, projects forward but very shortly, and descends to the mouth. The aperture is obliquely rounded-piriform, produced at the upper outer angle. Lip well expanded, the columellar and upper margins narrowly reflexed. The internal axis is slender throughout. There is a short lamella on the axis in the last part of the penult whorl, close to the basal wall.

Length 12.1, diameter 3.5 mm. Kingston.

Length 11, diameter 3.3 mm., 13 whorls. Hermosa.

Length 13.3, diameter 3.6 mm., 14 whorls.

Length 14.3, diameter 3.7 mm., 15 whorls. S. E. of Chloride.

NEW MEXICO: Sierra County on Big and Little Palomas Creek, the Cuchillo Mountains near Chloride, near Hermosa, etc. (Ferriss). Near Kingston (O. B. Metcalfe). The type, 173845 U.S.N.M., found in drift debris of the Rio Grande at Mesilla (T. D. A. Cockerell).

H. cockerelli differs from the related *H. regis* chiefly by the smoothness of the intermediate whorls. Probably the type specimen, found in flood-débris of the Rio Grande, was washed down from the region around Kingston or northward, where the species is abundant.

Mr. Geo. C. Spence has noted a “polystomatous” specimen thus: “This shell which is almost full grown has been fractured by some means and partly repaired, but instead of completely filling up the gap and continuing to use the whole shell the animal has constructed another mouth with fully formed lip rather more than half a whorl above the original aperture.”

3. *Habitat unknown***Holospira tantalus** Bartsch

Fig. 61 d.

Holospira (Haplocion) tantalus Bartsch, 1906, Proc U. S. Nat. Mus., 31: 147, pl. 3, fig. 6.

“Shell small, pupoid, yellowish white. Nuclear whorls one and one-half, well rounded, very minutely granulose. Terminal cone gently tapering, having the sloping whorls somewhat overhanging; whorls of the cylindrical portion of the spire moderately rounded. The entire post-nuclear spire is marked by feeble, obliquely backward slanting riblets, which are better developed and a little more distantly spaced on the terminal cone and the last two volutions than on the middle of the spire. There are about 52 of these riblets upon the third whorl, about 100 upon the seventh and about 85 upon the penultimate turn. Sutures well marked. Periphery of the last whorl slightly angulated. Base short, well rounded, deeply rimate, marked by the little riblets. Last whorl scarcely free, the peristome adnate to the outer wall of the preceding volution. Aperture moderately large, sub-circular, with a decidedly thickened white peristome, which is broadly expanded and very slightly reflected. Internal column slender, straight, increasing gradually in diameter from the last whorl to the early whorls of the terminal cone, smooth, marked only by whitish lines of growth.” (Bartsch.)

Length 10.2 mm., diameter 8th whorl 3.3 mm., penult whorl 3.1 mm.; 11 whorls. The paratype measures 8.3 × 3.2 and 3.1 mm., 11 whorls.

ARIZONA or NEW MEXICO: (Dr. Edward Palmer), Type 29393 U.S.N.M.

Two specimens. They were formerly referred to *H. pilsbryi* Dall, a Mexican species. The specimens “were found among loose shells brought home by Dr. Palmer after a trip through Arizona and New Mexico, but no particular locality could be assigned to it.” (Dall.)

By having no internal lamella on the axis it resembles some specimens of *H. montivaga* and *H. crossei*. The absence of lamellae and the fine external sculpture should serve for its recognition when encountered again.

4. *Big Hatchet Mountains*

The Big Hatchet or Hacheta Grande Mountains are a short range in southern New Mexico in sight of the Mexican boundary. The highest peak, Hacheta Grande, reaches 8371 feet. Several large canyons dissect the range, two, Thompson Canyon and Sheridan Canyon, opening eastward. The rock is limestone. There are no springs, streams or trails in the mountains (at the time of our visit); water has to be hauled in. There is no shade or timber except for a few gnarled pinyons, scrubby cedars and thickets of very small scrub oak on the highest peaks. Higher hills and buttes elsewhere have the characteristic *Fouquieria* flora.

Shells were first collected in this range by Dr. Edgar A. Mearns, U. S. A., then serving on the Mexican Boundary Survey, and described by Dr. W.

H. Dall, 1895. In August, 1910, L. E. Daniels and the author camped in the Big Hatchets for about a week. Mearns' itinerary and our collecting stations have been plotted on a sketch map of the range in my paper of 1915, p. 325.

The *Hacheta holospiras* belong, if we accept the criterion of intergradation, to only one species, for which the prior name is *H. crossei*. Between this species and *H. bilamellata* there is a perfect series of intergrades in size, sculpture and number of whorls; some individuals of an *H. crossei* colony could not be distinguished from *mearnsi*; some *mearnsi* can be exactly matched in a colony of *bilamellata*, or of *media*; and certain slender shells of *bilamellata* would pass as *longa*. The other named forms are more distinct, probably because we did not happen to collect where the intergrading colonies live. The races are therefore based upon the forms dominant in each colony. One might easily define a half dozen species, if only a few shells from each place were in hand; or if the number of internal lamellae was taken to be of specific weight, it might be thought that there are between two and three times that number. For our present purpose we consider the smallest form (*crossei*) and the largest (*bilamellata*) as species, ranking the others as subspecies, though in some cases they are more distinct than these two are from one another. Several thousand shells were collected.

Any *Hacheta* race may have (1) axial, (2) axial and basal, or (3) axial, basal and superior lamellae; and some adult *H. crossei* have: (4) no lamellae. None has the combination axial and superior lamellae unless a basal is also present.

Holospira crossei Dall

Fig. 63 7-7c.

Holospira crossei Dall, 1895, Proc. U. S. Nat. Mus., 18: 4; 1897 *ibid.*, 19: 348, pl. 31, fig. 2.—Pilsbry, 1905, Proc. Acad. Nat. Sci. Phila., p. 217, pl. 26, fig. 8.—Bartsch, 1906, *ibid.*, 31: 137.—Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., 47: 342, pl. 7, figs. 7-7c.

"Shell small, compact, 12-whorled, of a brownish gray color; nuclear whorls 2, smooth, polished, apically blunt, succeeding 4 gradually and evenly increasing, after which the shell is cylindrical; sculpture of pretty even, slightly oblique, rounded riblets, extending from suture to suture and separated by interspaces twice as wide as the ribs; suture distinct; base rounded, with a shallow umbilical chink; aperture simple, slightly oblique, not projecting beyond the periphery of the preceding whorl, the lip slightly expanded in front of a faint constriction, the opening subcircular without internal ridges, the outer anterior part obtusely angular; axis small, regularly increasing to the last whorl, not inflated. Length of shell 11, maximum diameter 4 mm." (Dall.)

NEW MEXICO: Top of Hacheta Grande (Dr. Mearns), Type 129989 U.S.N.M. Scattered over the upper 500 ft. or more of the northern slope to the summit (Pilsbry).

Sixty fully adult topotypes opened, have lamellae as follows:

- (1) No axial lamella, merely a callous or very inconspicuous node on the axis in the penult whorl. 15 specimens.
- (2) Axial lamella in penult whorl short and strong, no other lamellae. 30 individuals.
- (3) Axial lamella short and strong, or rarely weak; a basal lamella within the last half of penult whorl. 12 individuals.
- (4) Axial, basal and superior lamellae in the last half of penult whorl. 3 individuals.

The size runs from 10.5×3.3 mm., $11\frac{1}{2}$ whorls, to 14×4 mm., 13 whorls. In all of the four groups, according to lamellae, specimens occur with the ribs of the penult whorl either strong, weak or obsolete.

The embryonic shell, of slightly over 2 whorls, is smooth and projects nipple-like. The following whorls of the cone are strongly ribbed, but the ribs weaken more or less on the cylindrical part, so that on the penultimate whorl they are often inconspicuous or almost wanting.

At Station 10, on the northern slope of Hacheta Grande Mt., a small series was taken. All of them have the whorls of the cylindrical portion smooth or nearly so, glossy, the cone and the last whorl, or its last half, being ribbed as usual. Of 10 specimens opened, 5 have axial and basal lamellae, 5 axial lamella only.

This lot, by the size of some individuals and the large number (50%) of bilamellate examples, is intermediate between *crossei* and *mearnsi*, as it also is in the elevation of the station. It has a feature of its own in the smooth median whorls, paralleled, however, by some individuals of *crossei* from the mountain top. None of the *mearnsi* seen are so smooth.

Holospira bilamellata Dall

Fig. 63 1-1d.

Holospira (Distomospira) bilamellata Dall, 1895, Proc. U. S. Nat. Mus., 18: 4; 1896, 19: 349, pl. 31, fig. 3.—Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 134.—Daniels, 1912, Nautilus, 26: 41, pl. 5, figs. 8, 9.—Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., 47: 336, pl. 7, figs. 1-1d.

Holospira (Haplostemma) mearnsi Dall, 1895, Proc. U. S. Nat. Mus., 18: 4; 1896, ibid., 19: 350, pl. 31, fig. 1.

Holospira (Distomospira) mearnsi Dall, Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 134.

Holospira bilamellata mearnsi Dall, Pilsbry, 1915, Proc. Acad. Nat. Sci. Phila., 47: 341, pl. 7, figs. 6, 6a.

Holospira bilamellata longa Pilsbry, 1915, same Proc., 337, pl. 7, figs. 2-2b.

Holospira bilamellata heliophila Pilsbry, 1915, same Proc. 47: 338, pl. 7, figs. 3-3c.

Holospira bilamellata insolata Pilsbry, 1915, same Proc., 47: 339, pl. 7, figs. 4, 4a.

Holospira bilamellata media Pilsbry, 1915, same Proc., 47: 339, pl. 7, figs. 5-5c.

“Shell elongate, slender, blunt-tipped, with two smooth nuclear and 15 subsequent whorls; the spire increases evenly to the eighth whorl and then

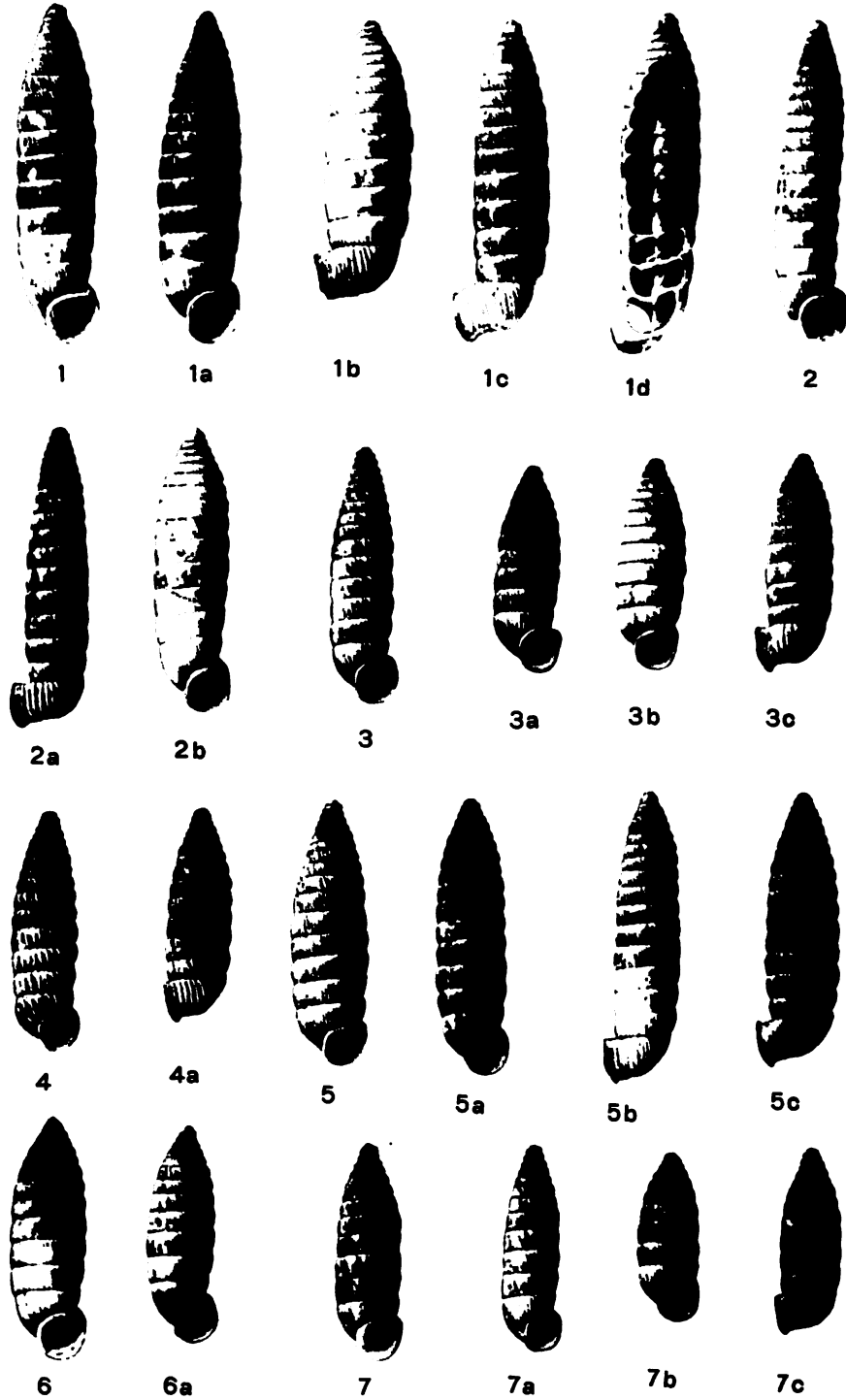


Fig. 63: 1-1d, *Holospira bilamellata*, topotypes. 2-2b, *H. b. longa*, type and paratypes. 3-3c, *H. b. heliophila*, type and paratypes. 4-4a, *H. b. insolata*, type and paratypes. 5-5c, *H. b. media*, type and paratypes. 6-6a, *H. b. mcarnsi*. 7-7c, *H. b. crossi*, topotypes. Figures $\times 2$.

very slowly attenuates; sculpture of slightly oblique, little raised, nearly straight riblets with doubly wide interspaces marked by somewhat irregular lines of growth; the sculpture between the ninth and the last whorl is more or less obsolete, but on the last whorl is strong, crowded, and a little irregular; suture distinct; base a little appressed; umbilical chink small; aperture as in *H. crossei*, but projecting beyond the periphery of the last whorl. Length of shell 20.5, maximum diameter 5 mm." (Dall.)

NEW MEXICO: Big Hatchet Mountains (E. A. Mearns). Type 129990 U.S.N.M. South slope of Daniels Mt., on the east side below the cliffs near the summit, with *Ashmunella mearnsi* and *Oreohelix*, in the pinyon zone (Pilsbry & Daniels).

The species is distinguished from *H. crossei* chiefly by its greater size. It was found by Mr. Daniels and the writer in great abundance at Station 5, on the east side of Daniels Mountain under the cliffs close to the summit, with *Ashmunella mearnsi* and *Oreohelix*, in the pinyon zone. In most of the shells the external ribs weaken or disappear on the penultimate and one or two earlier whorls, but in some they continue to the last, as in the type lot of *bilamellata*.

Sixty examples from Station 5 opened give the following data:

- (1) One lamella, the axial. 13 specimens = 21 $\frac{1}{3}$ %.
- (2) Two lamellae, axial and basal, 41 specimens = 68 $\frac{1}{3}$ %.
- (3) Three lamellae, superior, axial and basal, 6 specimens = 10%.

The size in this colony runs from 14.2 × 4.1 mm., 13 $\frac{1}{3}$ whorls, to 23 × 5 mm., 19 whorls.

I believe that the type lot was taken by Dr. Mearns at or near our Station 5 on Daniels Mt., where Mearns camped, and not on Hacheta Grande. Specimens we took there agree exactly with some of the type lot received from Dall.

Holospira bilamellata form *mearnsi* Dall (Fig. 63: 6, 6a). "Shell small, compact, with 14 whorls, of which 2 are nuclear, polished, and smooth; blunt above, gradually increasing to the ninth whorl and subsequently slightly attenuated; sculpture and aperture much as in *H. crossei*, the base slightly appressed and the ribs closer and more prominent than on the previous whorls; umbilicus not conspicuous; aperture projecting somewhat beyond the preceding whorl, the peristome hardly reflected, subtriangular, little thickened, without folds; axis small, subcylindric, with a strong, short lamella near the base in the penultimate whorl. Length of shell 14.5, maximum diameter 4.5 mm." (Dall.)

NEW MEXICO: Hacheta Grande Mt. (Mearns), Type 129991 U.S.N.M. On the eastern slope (Pilsbry & Daniels).

"This species resembles *H. crossei* in general appearance, but is larger, with more projecting aperture, and frequently has an intercalary raised line dividing the interspaces of the ribs axially. The specimens are of a whitish color." (Dall.)

Of 10 specimens opened, 3 had an axial lamella only, which is very weak in two of them; 7 have axial and basal lamellae.

The size in this lot runs from 11.3×4 mm., 12 whorls, to 17×4.5 mm., 15 whorls.

These shells connect *H. crossei* and *H. bilamellata*. Specimens of intermediate size agree exactly with one of the type lot of *mearnsi*, kindly lent from the National Museum. The smallest shells are indistinguishable from *crossei*, while the largest could not be separated from small *bilamellata*. Yet the colony as a whole has a certain individuality by its intermediate size, and as the form has been named, we let it stand as a convenient place for *crossei-bilamellata* intergrades. It is attached to *H. bilamellata* rather than to *H. crossei*, because the prevalent form, in the small lot opened, is bilamellate. All of the shells were collected in one spot where the writer sat resting. A large quantity could have been gathered had time and strength permitted. A few specimens are quite finely striate, while others are rather coarsely ribbed, like the type of *mearnsi*; still others being intermediate in sculpture. The sculpture in some shells becomes very much weaker on the penult and next earlier whorls.

H. mearnsi served as monotype of the subgenus *Haplostemma* Dall, characterized by the possession of an axial lamella only. Bartsch, opening another specimen, found a basal lamella also, and concluded that that lamella had been broken away in opening the original specimen. Since some fully adult examples are known to have an axial lamella only, it is likely that Dall's original diagnosis was correct for the specimen he opened, while Bartsch also was right as to the shell he examined and which I have seen.

Holospira bilamellata form longa Pilsbry. Fig. 63 2-2b. Slender and pillar-like, the diameter contained four times or more in the length; whorls of the cone and last whorl costulate, 3 to 5 intermediate whorls usually smooth or nearly so. Aperture projecting laterally and forward; usually 3 internal lamellae, in the *beginning* of the penultimate whorl, therefore ventral in position, the superior lamella generally very strong, and larger and longer than the basal.

Length 19.6, diameter 4 mm.; whorls 17.
 Length 19.2, diameter 4 mm.; whorls $18\frac{1}{2}$.
 Length 18.7, diameter 4 mm.; whorls $17\frac{1}{2}$.
 Length 17.9, diameter 3.9 mm.; whorls 17.
 Length 17.1, diameter 4 mm.; whorls 17.
 Length 17, diameter 4.25 mm.; whorls $15\frac{1}{2}$.
 Length 17, diameter 3.9 mm.; whorls $15\frac{1}{2}$.
 Length 16.8, diameter 4.2 mm.; whorls 15.
 Length 16.3, diameter 4 mm.; whorls $15\frac{1}{2}$.

Station 4, on the south slope of Daniels Mt. near the summit (Pilsbry and Daniels). Type and paratypes 112,269, A.N.S.P.

Out of 20 shells opened, 16 have three lamellae and 4 have two, the axial and basal. The pillar-like shape, numerous whorls, and prevalence of a superior lamella, as well as the deeper position of the lamellae, are individually variable characters, yet in the aggregate they may suffice to define a race in this group.

These holospiras live among rocks where there is very little xerophytic vegetation and the heat is terrific. The type lot was picked up at about the same elevation as Station 5, but there the exposure is less calorific; the sparse pinyons and the cliffs afford shade, so that the soil retains some moisture.

Holospiras were seen scattered over a large area below and around Station 4.

Holospira bilamellata form *insolata* Pilsbry. Figs. 63 4-4a. "The shell is slender, with a rather long terminal cone; *very strongly ribbed throughout*; composed of many ($13\frac{1}{2}$ to $17\frac{1}{2}$) short, convex whorls, the last very shortly free in front. Peristome narrow, only very slightly expanded. Only the axial lamella developed in 14 out of 16 individuals opened, the other two having axial and basal lamellae."

15.5 × 3.6 mm.; whorls $17\frac{1}{2}$.	13.5 × 3.8 mm.; whorls 15.
15 × 3.8 mm.; whorls $16\frac{1}{2}$.	13 × 3.7 mm.; whorls $14\frac{1}{2}$.
14.9 × 3.5 mm.; whorls $16\frac{1}{2}$.	13 × 3.3 mm.; whorls $15\frac{1}{2}$.
14.8 × 3.8 mm.; whorls $16\frac{1}{2}$.	12.25 × 3.25 mm.; whorls 14.
14.5 × 3.6 mm.; whorls $15\frac{1}{2}$.	12 × 3.9 mm.; whorls $13\frac{1}{2}$.
14 × 3.8 mm.; whorls $15\frac{1}{2}$.	11.8 × 3.9 mm.; whorls $13\frac{1}{2}$.

NEW MEXICO: Southeastern slope of mountain south of Hacheta Grande Mt. (Pilsbry & Daniels).

This form differs from *crossi* and *earnsi* by the more slender shape, long terminal cone, more numerous whorls and strong sculpture. It agrees with *bilamellata* in having many whorls, but differs by its slender form, longer cone, the prevalence of unilamellate shells, etc. *H. b. heliophila* stands nearest to *insolata*, but in that race the bilamellate form predominates. It is more conspicuously ribbed than any of the other Hacheta races.

Holospira bilamellata form *heliophila* Pilsbry. Fig. 63 3-3c. "The shell is small, rather slender, with a long cone; *strongly costate throughout*; usually having axial and basal lamellae within the middle part of the penultimate whorl. Peristome well expanded in the basal and columellar margins, but scarcely so near the upper angle."

(1) One lamella, the axial. 3 specimens = 15%.

14.2 × 3.8 mm.; whorls 16.
13.3 × 3.7 mm.; whorls $15\frac{1}{2}$.
13 × 3.9 mm.; whorls $14\frac{1}{2}$.

- (2) Two lamellae, axial and basal. 13 specimens = 65%.
- | | |
|-----------------------------|-----------------------------|
| 14.8 × 4 mm.; whorls 15½. | 14 × 3.7 mm.; whorls 15½. |
| 14.8 × 4 mm.; whorls 15. | 13.8 × 3.9 mm.; whorls 14½. |
| 14.6 × 4 mm.; whorls 15½. | 12.6 × 3.8 mm.; whorls 13½. |
| 14.2 × 3.9 mm.; whorls 15½. | 11.5 × 4 mm.; whorls 12½. |
| 14 × 3.9 mm.; whorls 15. | |
- (3) Three lamellae, superior, axial and basal. 4 specimens = 20%.
- | |
|-----------------------------|
| 13.9 × 3.7 mm.; whorls 15½. |
| 13 × 4 mm.; whorls 14. |

NEW MEXICO: Northern and eastern sides of "Teocalli Butte," at the base of the cliff (Pilsbry & Daniels). Type and paratypes 112265 A.N.S.P.

Twenty shells opened out of a series of over 250 show that the bilamellate form predominates. The largest shell noticed is 14.9 mm. long, the smallest 11.5 mm. There is rather wide variation in sculpture, but a large majority of the shells conform to fig. 3a in this respect.

Holospira bilamellata form *media* Pilsbry (Fig. 63, 5 to 5c). The shell is cylindric with a long terminal cone; composed of many closely coiled, convex whorls, all after the embryo rather strongly, sharply costulate; buff-whitish except where darkened by the presence of the soft parts, the last whorl shortly projecting; peristome narrowly expanded. Internal lamellae one to three, but axial and basal most frequent.

Seventy-five individuals opened from the type locality have internal lamellae as follows:

- (1) An axial lamella only. 22 individuals = 29½%.
- (2) Axial and basal lamellae, 48 shells, 64%.
- (3) Superior, axial and basal lamellae, 5 shells, 6⅔%.

The size runs from 12 × 4 mm., 12½ whorls, to 18.5 × 4.25 mm., with 17½ whorls.

Southern and western portions of Sheridan Canyon, Type No. 112,268 A.N.S.P., from Station 3, at the base of a cliff near the mountain top, facing the mouth of Sheridan Canyon, in company with *Oreohelix ferrissi*.

This form stands nearest to *H. b. mearnsi*, but the striation is sharper, not partially effaced on the later whorls, and the cone is in the average longer. The habitats of *mearnsi* and *media* are rather remote from one another, and several other forms inhabit territory between them.

The specimens from Station 12 are more like *mearnsi*, the sculpture being weak on the penultimate and next earlier whorls. Out of 11 opened, 2 have one lamella, axial; 9 have two lamellae, axial and basal; 1 has three lamellae, axial, basal and superior.

Station 2 is on the northern slope of one of the ravines east of and running from Teocalli Butte, at the foot of an irregular projecting bench of limestone. It is much the lowest station where shells were found in the

Hachetas. The shells are partly as rough as those from Station 3, but some approach those of Station 12. Out of 21 shells opened, 15 have two lamellae, axial and basal; 6 have three lamellae, axial, basal and superior.

In size the shells from Stations 12 and 2 are about equal to those from the type locality.

5. *Dragoon Mountains*

These low mountains are formed of a complex of limestone and igneous rock, the granites forming wild labyrinths of narrow gorges abounding in cliffs and falls, separated by inaccessible crags and spires, which gave refuge to the Apaches fifty or sixty years ago. The limestones are accessible enough, though rather abrupt. The range stands 25 to 30 miles west of the northern part of the Chiricahua (Dos Cabezas) Mountains and east of the Whetstone Mountains. All the forest had been cut before 1900 for mine timber. At the time of our visit the mountains were almost as bare as the Dos Cabezas. The malacology was first investigated by Ferriss, Daniels and Pilsbry in October, 1910, and a report published in 1915. Our collecting stations have been plotted on a map in our paper of 1915, p. 366.

***Holospira danielsi* Pilsbry & Ferriss**

Fig. 64 1-3a.

Holospira danielsi Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 373, pl. 14, figs. 1-5a.

The shell is cylindrical, the upper fourth (or third) tapering to the slightly mamillar, obtuse summit. Tilleul-buff, becoming darker towards the summit. Nearly $2\frac{1}{2}$ embryonic whorls are smooth; then slightly retractive axial ribs appear, rather low and delicate on the first neanic whorl, after which they become strong, widely separated, oblique (retractive) on the conical portion, still more widely spaced and vertical on the cylindrical portion of the shell, where the summits of the ribs are more or less irregular from breakage due to being in part hollow there. On the penultimate whorl there are 13 ribs (more or less). On the last half of the last whorl the ribs become closer (or many may be interposed). The whorls are rather strongly convex, the last one tapering downwards, being compressed below the periphery; base rimate but not perforated. The last fourth of the last whorl is somewhat straightened but not built forward beyond the level of the ventral face of the shell. Aperture rounded-ovate. Peristome narrowly expanded except at the upper outer angle, where it is simple and obtuse. The axis is rather slender, subequal except at the ends. In the last part of the penult and first part of the last whorl there is a strong, short, obtuse columellar lamella close to the base; a parietal lamella, much longer and usually strong (and frequently a smaller basal lamella). Length 11.5, diam. 3.5 mm.; $12\frac{1}{2}$ whorls.

ARIZONA: Dragoon Mountains, Cochise County, from Tweed Canyon to the northern end of the range, on limestone, under stones, dead agaves, sotols, etc. Type locality Station No. 2, Tweed Canyon, Type 112199 ANSP. (Ferriss, Pilsbry and Daniels.)

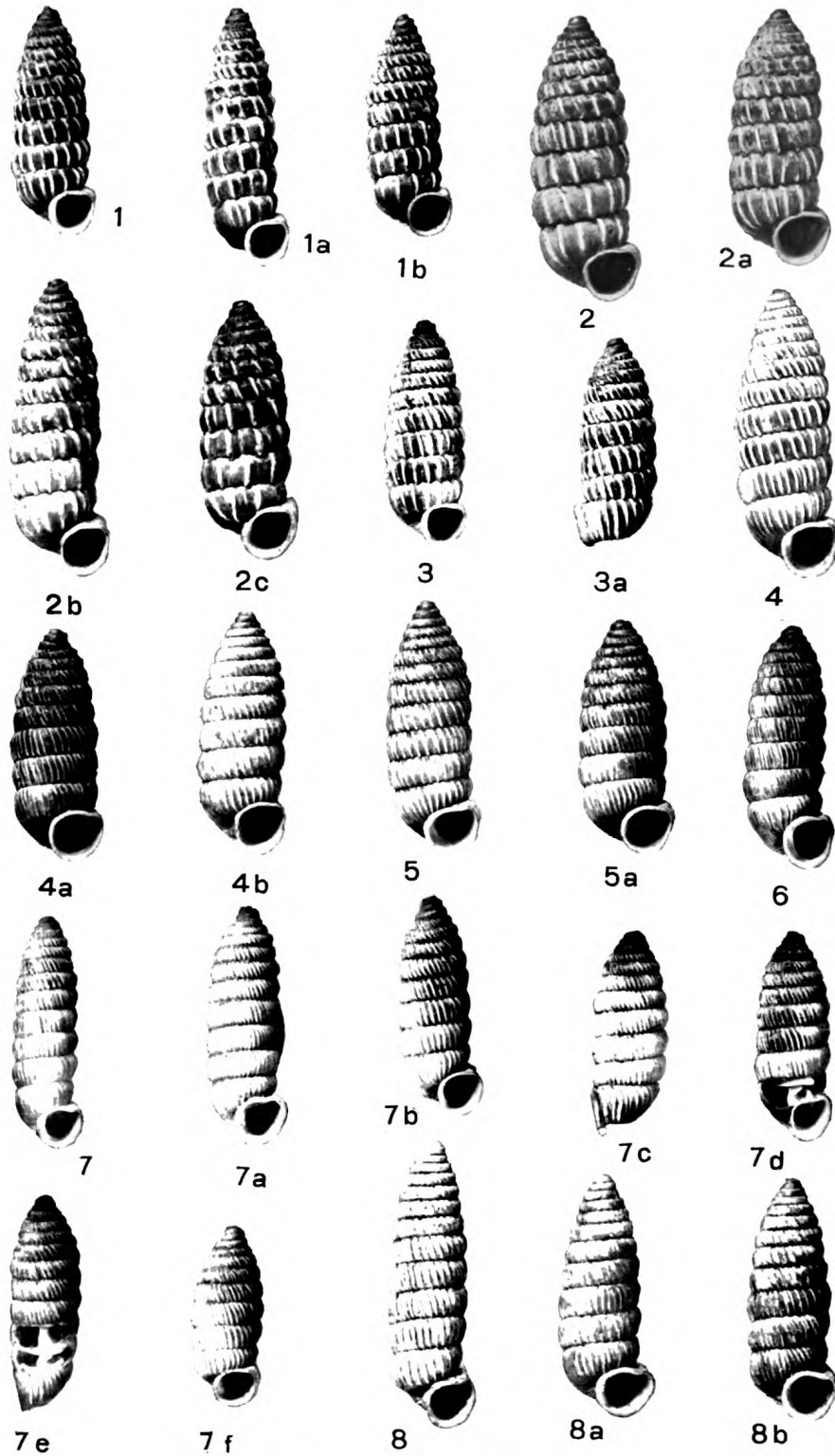


Fig. 64. See bottom of page 137 for legend.

They live on the most exposed, hottest slopes, often in great profusion, but are not found on the mesa, where *H. campestris* occurs.

This beautiful snail is very distinct from all of our species by its strong, rude, widely-spaced ribs. One of the northwest Mexican holospiras, *H. minima*, has the same type of sculpture, though less coarse than in the typical *H. danielsi*, which is the most strongly costate species known. *H. chiricahuana* also has strong ribs, but the spire tapers more slowly.

Like other Arizonan holospiras, the internal lamellae are variable, two or three (parietal and axial, or parietal, axial and basal) being developed, or sometimes only the axial. Otherwise the chief variation is in the number of ribs, and also in size.

In the type lot the smallest shell noticed measures 8.2×3.2 mm., with 10 whorls. The trilamellate shells, forming 45 per cent in the lot measured, are slightly outnumbered by those with two lamellae, but this may be accidental. Three lamellae predominate in the larger shells, two in the smaller.

The sculpture is less variable in this lot than in some others. Ten specimens, taken at random, have 10, 12, 12, 13, 13, 13, 15, 17, 17, 17 ribs on the penultimate whorl. These fairly represent the lot, so far as can be told without extensive counting. None counted have more than 17 ribs (see Fig. 64, 1, 1a, 1b).

Twenty specimens of the type lot opened, taken at random, measure as follows:

Length	Diameter	Whorls	Lamellae	Length	Diameter	Whorls	Lamellae
12	3.6	13	2	11	3.3	12	3
11.7	3.7	13	3	10.8	3.3	11½	3
11.5	3.4	12½	3	10.5	3.2	12½	2
11.3	3.3	12½	2	10.2	3.7	12	2
11.2	3.5	12	3	10.2	3.3	12	2
11.1	3.3	12	2	10.2	3.3	12½	2
11	3.8	11½	3	10.2	3.2	12	2
11	3.4	12½	3	10.2	3.1	12	3
11	3.3	12	3	10	3.2	11½	2
11	3.3	12½	2	9.7	3.2	11½	2

Higher up there are colonies typical in sculpture and others with more numerous ribs. Thus at one station on the summit of the ridge around the basin of upper Tweed Canyon, two out of fifteen opened have 3 lamellae (both having many ribs), and three have only the columellar lamella (ribs few). The rest, including both many- and few-ribbed shells, have 2 lamellae.

Length 12.5, diam. 4.1 mm.; whorls 12½; lamellae 3; ribs 21 on penult whorl.

Length 12.3, diam. 4 mm.; whorls 12½; lamellae 3; ribs 24 on penult whorl.

Length 12.3, diam. 4 mm.; whorls 12½; lamellae 1; ribs 15 on penult whorl.

Length 10.7, diam. 4 mm.; whorls 11½; lamellae 2; ribs 30 on penult whorl.

Length 10.2, diam. 3.5 mm.; whorls 11½; lamellae 1; ribs 12 on penult whorl.

Length 9.5, diam. 3.5 mm.; whorls 11; lamellae 2; ribs 15 on penult whorl.

Fig. 64. 1-1b, *Holospira danielsi*, type and paratypes, Station 2. 2-2c, Station 39. 3-3a, Station 18. 4-4b, *H. danielsi*, variety, Station 12, a peak on eastern rim of amphitheatre. 5-5a, Station 40, north end of range. 6, *Holospira campestris cochisei*, Station 21. 7-7f, cotypes, Station 16. 8-8b, Station 27. Enlarged.

On a peak farther north these characters are as follows:

Length 12.3, diam. 4 mm.; whorls 12½; lamellae 1; ribs 27 on penult whorl.
 Length 11.5, diam. 3.7 mm.; whorls 11½; lamellae 2; ribs 16 on penult whorl.
 Length 11.3, diam. 3.9 mm.; whorls 12½; lamellae 1; ribs 29 on penult whorl.
 Length 11.2, diam. 4 mm.; whorls 12; lamellae 2; ribs 38 on penult whorl.
 Length 10.8, diam. 4.2 mm.; whorls 11½; lamellae 2; ribs 16 on penult whorl.
 Length 10, diam. 3.9 mm.; whorls 11½; lamellae 1; ribs 21 on penult whorl.

“Specimens from the southeastern part of the upper amphitheatre of Tweed Canyon have *only one or two lamellae* (parietal and axial), those with one slightly predominating. The parietal lamella is moderate or small when developed. They are also perceptibly stouter in figure than the types, and the number of ribs is, in the main, greater.” (P. & F.)

Between the crest and the foothills at the north end of the range some colonies have more numerous ribs than in those further south, 37 to 43 on the penult whorl (Fig. 64 4-5a). Other colonies are typically ribbed, but the shells are larger than the typical form, stouter, with few, strong and widely separated ribs. Only the axial lamella developed. (Fig. 64, 2 to 2c.)

Length 13.3, diam. 4.8 mm.; whorls 13; ribs 15.
 Length 14.5, diam. 4.1 mm.; whorls 13½; ribs 19.
 Length 12.1, diam. 4.1 mm.; whorls 12; ribs 12.

Details of the conditions in numerous other colonies were given in our paper of 1915.

Holospira campestris Pilsbry & Ferriss

Fig. 65: 1-2.

Holospira campestris Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 378, pl. 15, figs. 1-1d, 2.

The shell is shortly rimate, cylindric, with very short terminal cone and mamillar apex. 2½ embryonic whorls smooth (the last half whorl very narrow), following whorls closely and finely striate, the striae of the conical portion narrower, hence appearing more widely spaced than those of the cylindric portion, on which they are as wide as the intervals. On the penult whorl there are about 70 striae. The last whorl is decidedly compressed below the periphery, tapering downwards, somewhat more coarsely sculptured on the latter part. It is shortly rimate and built forward shortly from the preceding whorl. All of the whorls are very strongly convex. The aperture is angular at the upper outer part, elsewhere rounded. Peristome narrowly expanded. Axis cylindric, in the latter part of the penultimate and first part of the last bearing a stout axial lamella. There is also a long and strong parietal or superior lamella, and sometimes a basal lamella. Length 11.5, diam. 3.7 mm.; whorls 12.

ARIZONA: mesa at western foot of the Dragoon Mountains at Station 26, along a “wash” or gully at the south fence of the Fourr ranch. Type 112214, ANSP. Also other places in the same vicinity (Ferriss, Pilsbry and Daniels).

Other specimens of the type lot (Fig. 65 1-1d) measure as follows. All but one of the specimens opened have two lamellae, one having three.

12 × 3.9 mm.; whorls 12.	10 × 3.6 mm.; whorls 11½.
11.8 × 3.9 mm.; whorls 12½.	9.3 × 3.6 mm.; whorls 10½.
11 × 3.8 mm.; whorls 12.	7.8 × 3.3 mm.; whorls 9½ (a dwarf).
10.6 × 4 mm.; whorls 12.	

“ At Station 25, foothills west of the Fourr ranch (Fig. 65: 2) the shells are smaller, with sculpture like the type. The peristome *adheres* for a short distance to the sculpture whorl, or is *very shortly* free. The columellar lamella is within the front of the last whorl; *parietal lamella when present is very small, and most specimens lack it.* They are very uniform in size and sculpture, in a long series taken.” (P. & F.)

Length 8.7, diam. 3.2 mm.; whorls 10 ; lamellae 1.
 Length 8.5, diam. 3 mm.; whorls 10½; lamellae 2.
 Length 8.1, diam. 3 mm.; whorls 10½; lamellae 2.
 Length 7.9, diam. 3.2 mm.; whorls 9½; lamellae 1.
 Length 7.9, diam. 3 mm.; whorls 9½; lamellae 1.
 Length 7.5, diam. 3.1 mm.; whorls 9½; lamellae 1.
 Length 7.5, diam. 3.1 mm.; whorls 9½; lamellae 1.
 Length 7 , diam. 3.1 mm.; whorls 9 .

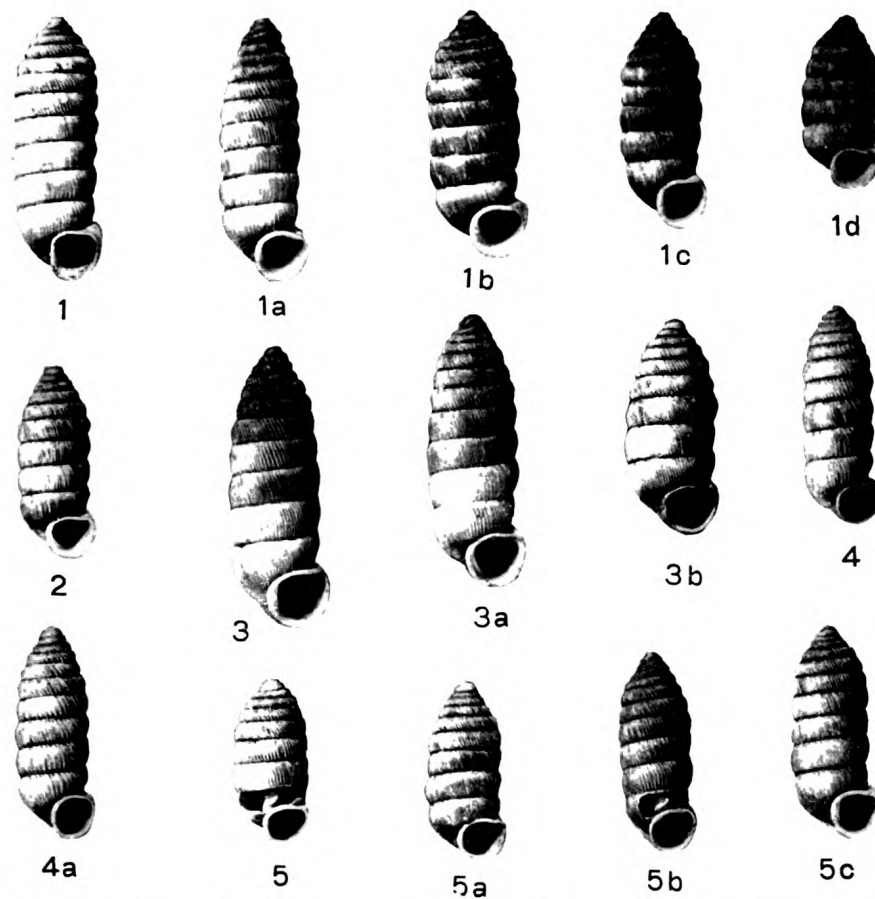


Fig. 65. 1-1d, *Holospira campestris*, type and paratypes. 2, Station 25. 3-3b, *Holospira millestriata*, type and paratypes. 4-4a, Station 36. 5-5c, Station 37.

Holospira campestris cochisei Pilsbry & Ferriss

Fig. 64: 6-8b.

Holospira campestris cochisei Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 370, 379, pl. 14, figs. 6-8b.

“Similar to *campestris*, but more slender, with fewer ribs (28 to 40 on the penultimate whorl in the type lot), the intervals wider. Internal lamella three, the parietal *very long and strong*.” (P. & F.)

Length 10.5, diameter 3.3 mm.; whorls 12; lamellae 3.

Length 10, diameter 3.1 mm.; whorls 11½; lamellae 3.

Length 9.8, diameter 3.1 mm.; whorls 11½; lamellae 3.

Length 9.7, diameter 3.1 mm.; whorls 11; lamellae 3.

Length 9.6, diameter 3.1 mm.; whorls 11; lamellae 3.

Length 9.3, diameter 3.1 mm.; whorls 11; lamellae 3.

Length 8, diameter 3.1 mm.; whorls 10; lamellae 3.

ARIZONA: Dragoon Mountains, along the sides of an arroyo or gully on the mesa within the wide mouth of Tweed Canyon, Station 16; type and paratypes 112219, A.N.S.P. Also Stations 17, 19-23, and 27, all in Tweed Canyon.

The type locality, Station 16 (Fig. 64 7-7f), is on the sloping sides of the arroyo, which is about 15 feet deep, and meanders across the mesa. Near the mountain the gully deepens to 30-40 feet, the sides become sub-vertical, and *Holospira* disappears. The mesa is grassy with some bunches of bear grass. There are some small oaks, juniper, catclaw, etc., in the arroyo. The shells are found under dead sotol and sometimes stones, etc. They reappear just below the igneous dyke near the base of the mountain, Station 17, but do not cross the dyke. Here the shells resemble types of *H. c. cochisei* except that they are more finely, closely ribbed, ribs 45 to 50 on the penult whorl. Ten specimens opened are trilamellate in the penult whorl.

Holospira millestriata Pilsbry & Ferriss

Fig. 65: 3-5c.

Holospira millestriata Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 380, pl. 15, figs. 3-5c.

The shell is shortly rimate, tulleul-buff, composed of about 11½ convex whorls, of which the last 5 form the cylindrical, those preceding, the conical portion. Embryonic 2 whorls smooth, somewhat nipple-like, the second whorl becoming very narrow. Succeeding whorls of the cone somewhat more sharply striate than the cylindrical portion, upon which the striae are very fine and close; typically about 90 fine, close striae on the penultimate whorl. The latter part of the last whorl is slightly compressed and has slightly coarser, sharper striae. The aperture is carried very shortly free, is not calloused within, and has a narrowly reflexed lip. Within the latter part of the penultimate and first part of the last whorl there is a rather stout, obtuse lamella on the axis. No lamellae on the upper or basal walls of the cavity. Length 12, diam. 4 mm.; 11.5 whorls.

ARIZONA: Dragoon Mountains, south of Tweed Canyon, the types from Station 7, the summit of a limestone ridge separating the head of “Cataract Gulch” from the next

canyon opening westward, south of Tweed Canyon (Ferriss, Pilsbry and Daniels, October, 1910). Type 112225. A.N.S.P. Also taken as far south as Middlemarch Canyon. It occurs under stones, in places where there is no shade.

H. millestriata is related to *H. campestris*, from which it differs by having more numerous, finer striae, and by the absence of internal lamellae on the parietal and basal walls of the cavity, in a long series of shells opened. Its range is separated from that of *H. campestris* by the ridge of igneous rock which runs from Cochise stronghold along the south side of Tweed Canyon westward to the mesa; no holospiras being found on this ridge, as far as we know. The isolation of the two species seems, therefore, to be complete.

The type locality, Station 7, is on the divide, a ridge above an abandoned mine and cabin. It may be reached by ascending "Cataract Gulch" from Tweed Canyon, but much more easily along the mountains eastward, as the gulch is rather a neckbreaker. The specimens are quite uniform in sculpture. Length up to 12.2 mm., and very rarely as short as 9.3 mm., with 10 whorls (fig. 65 3, 3a, 3b). Out of twenty topotypes opened, one has a weak, hardly perceptible trace of the superior lamella, the others having the axial lamella only.

The species is quite constant in hundreds of shells collected from many colonies, but in two stations in small hills on the mesa eastward of Middlemarch Canyon there is notable variation. In over a hundred shells opened from all the colonies only this one has any trace of a superior lamella.

On small limestone hills eastward on the mesa of Middlemarch Canyon, the shells are smaller than typical *millestriata*, and vary from the typical fine ribbing to somewhat coarser (Fig. 65: 4, 4a, the prevalent form), and a few are as coarsely sculptured as *H. campestris cochisei*, the coarsest having 48 ribs on the penultimate whorl. The proportions of diameter to length also vary a good deal, as shown in the figures and measurements. All the specimens opened have a single lamella, the axial.

Length 9.5, diameter 3.6 mm.; whorls 11.

Length 9.1, diameter 3.3 mm.; whorls 10 $\frac{3}{4}$.

Length 9.6, diameter 3.1 mm.; whorls 11.

Length 9.2, diameter 3.5 mm.; whorls 10 $\frac{1}{2}$.

Length 8, diameter 3.2 mm.; whorls 10.

Another colony near the preceding, consists of very small shells. (Fig. 65: 5 to 5c.)

Length 9, diameter 3.2 mm.; whorls 10 $\frac{1}{2}$.

Length 7.2, diameter 3.2 mm.; whorls 9 $\frac{1}{2}$.

It is evident that *H. millestriata*, which is very constant in the mountains, varies in size, proportions and sculpture in the different ecologic conditions of the lower, more arid mesa.

6. *Species of the Chiricahua, Mule, Huachuca and other mountains west to the Santa Cruz River Valley, Arizona.*

It is somewhat doubtful whether so many species and subspecies will eventually be recognized in this area. The lines of subspecies and *formae* seem too finely drawn in some cases.

Holospira chiricahuana Pilsbry

Fig. 66: 5-8.

Holospira chiricahuana Pilsbry, 1905, Proc. Acad. Nat. Sci. Phila., p. 219, pl. 26, fig. 9; pl. 27, fig. 26-29; text fig. 4.—Pilsbry & Ferriss, 1910, *ibid.*, p. 127, pl. 14, figs. 5-8.

Holospira (Bostrichocentrum) chiricahuana Pils., Bartsch., 1906, Proc. U. S. Nat. Mus., 31: 140.

Holospira chiricahuana ternaria Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 128, pl. 14, fig. 1-4.

Holospira chiricahuana optima Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 129, pl. 14, figs. 13-15.

Holospira chiricahuana gracilis Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 130, pl. 14, figs. 9-12.

Shell imperforate, shortly rimate, cylindric, the upper half tapering; thin, pale brownish-corneous. Whorls 11 to 12, all convex, the first slightly bulging and wider than the second, both smooth, the following whorls sharply sculptured with close riblets a little narrower than their intervals. The last whorl is compressed laterally, tapering downward, the base prominent and white. It is very shortly straightened and a little contracted in front, not carrying the aperture in front of the ventral plane of the shell, though the peristome is very shortly free. The aperture is shortly ovate, nearly round, the peristome very narrowly expanded. The axis is moderately large and of nearly equal calibre throughout, and at the end of the penultimate and beginning of the last whorl there is a low, short obtuse lamella below the middle on the axis.

Length 10 mm., diameter 3 mm.; whorls 12.

Length 8.5 mm., diameter 2.9 mm.; whorls 11.

Length 8 mm., diameter 2.7 mm.; whorls 11.

ARIZONA: Chiricahua Mountains, in Cave Creek valley.

The spire of this shell tapers more gradually than in our other species. The riblets are strong and uniform throughout in all of the specimens.

The type locality of *H. chiricahuana* is on the steep slopes of a small dry ravine or wash tributary to Cave Creek, below and near the entrance of the cave. The slope faces the south and is composed of very steeply dipping friable calcareous shale and earth formed by its decomposition, with sparse vegetation, agave, sotol and bear grass. Dead shells are scattered in profusion, and the living ones lurk under bunches of dead bear grass, etc. The colony is about one-eighth of a mile long and perhaps 100 yards wide. This is also the type locality of *Oreohelix chiricahuana*.

The additional locality, "Fort Bowie," given in our original account, was evidently owing to some mixture of labels or specimens in the course of Ferriss' first hasty midwinter trip. Thorough search by both of us in

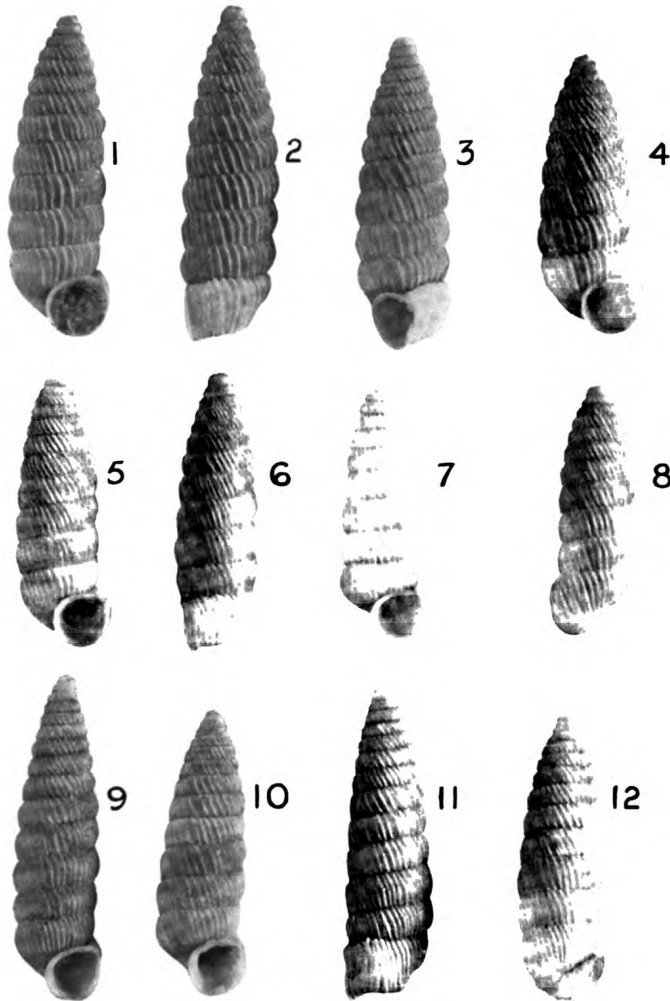


Fig. 66. 1, 2, 3, 4, *Holospira chiricahuana* form *ternaria*. 5, 6, 7, 8, *H. chiricahuana* topotypes, cave in Cave Creek. 9, 10, 11, 12, *H. chiricahuana* form *gracilis*.

1906 showed that it does not occur there. The large specimen represented in pl. 27, fig. 26, of our paper of 1905, was probably not from the type locality, but picked up somewhere else in Cave Creek Valley.

A majority of the specimens (82 per cent of 50 opened) have a superior or parietal lamella from $\frac{1}{4}$ to $\frac{1}{2}$ of a whorl long, on the roof of the penultimate whorl near its end, above the aperture or on the front side; but in some (18 per cent) this is wanting. In those of the type lot formerly opened it was absent or very weak, but in others of the type lot, as well as in many topotypes opened, this lamella is more or less strongly developed.

The interior of the outer lip is very heavily thickened with a white callus within. The extremes of size in the lot of 50 topotypes opened, taken at random, are 8×2.9 mm., $10\frac{1}{2}$ whorls, and 10.8×3.1 mm., $12\frac{1}{2}$ whorls.

Holospira chiricahuana form *gracilis* Pilsbry & Ferriss. Fig. 66: 9-12. The shell is more slender and tapers more slowly than the type of *chiricahuana*, and has more whorls. It is more slender than *H. c. optima*. Only the axial lamella developed in 19 out of 20 specimens opened, the other one having a strong superior lamella also.

Found at our Station 10, on the crest of a narrow ridge, a spur from the south wall of Cave Creek Valley, which terminates in a high conical hill standing not far from the creek. This is the only colony of the species found south of Cave Creek, the others being north of the creek. One colony of small extent.

Thirty specimens measure from 9.9×2.9 mm., $12\frac{1}{2}$ whorls, to 11.7×3.1 mm., 14 whorls.

Type, 99698 A.N.S.P., is 11.7 mm. long, 3.1 mm. wide, 14 whorls.

Holospira chiricahuana form *optima* Pilsbry & Ferriss (Fig. 67). The shell is larger and tapers perceptibly more slowly than *H. chiricahuana*, with more whorls, and only one internal lamella, the axial, in 20 specimens opened. Length 14.5 mm., diameter 3.7 mm.

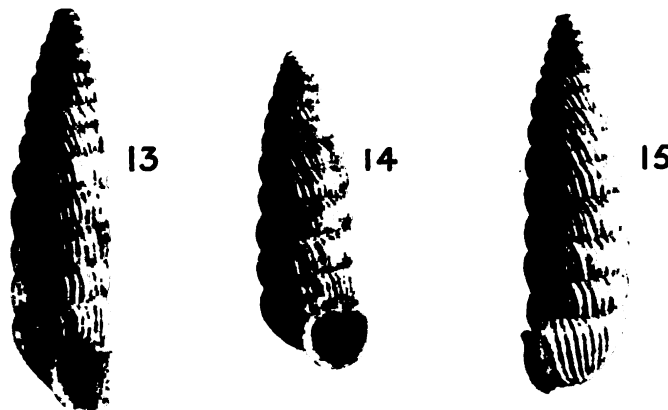


Fig. 67. *Holospira chiricahuana* form *optima*, type (13) and paratypes (\times about 3.7).

ARIZONA: Chiricahua Mts., at base of the north slope of the ridge where *H. c. gracilis* was found, close to the stream, under stones (Pilsbry & Ferriss), Type and paratypes 99697 A.N.S.P.

About 75 specimens taken. The extremes of size in 35 measured are: Length 11.2, diameter 3.3 mm., $13\frac{1}{2}$ whorls, and 14.5×3.7 mm., $14\frac{3}{4}$ whorls. The larger size of the shells might be thought due to the more humid and shaded situation than that inhabited by the typical form, were

it not that *Holospira* prefers hot and arid places and does not exist at all in damp situations.

Holospira chiricahuana form *ternaria* Pilsbry & Ferriss (Fig. 66: 1-4). At the end of the penultimate whorl there are usually three internal lamellae: parietal, axial and basal. Shell usually larger with more whorls, but otherwise as in the type.

12.2 × 3.4 mm.; whorls 13 $\frac{1}{2}$.	10.3 × 3.1 mm.; whorls 12 $\frac{1}{2}$.
11 × 3.2 mm.; whorls 12 $\frac{1}{2}$.	10.8 × 3.1 mm.; whorls 12 $\frac{1}{2}$.
11.1 × 3.3 mm.; whorls 12 $\frac{1}{2}$.	9.4 × 3.1 mm.; whorls 11.

Chiricahua Mountains at Station 6, about half way up the northern slope of a long ridge which projects into Cave Creek Valley from the western border. Type 99699 A.N.S.P.

Fifty-three specimens were taken from a single small colony. Out of 20 opened, 17 have three internal lamellae and three have only one, the axial.

Holospira cionella Pilsbry

Fig. 68.

Holospira cionella Pilsbry, 1905, Proc. Acad. Nat. Sci. Phila., p. 217, pl. 27, figs. 30-33.—Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 140.—Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 122, pl. 12, figs. 1, 2.

Holospira cionella intermedia Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 123, pl. 13, figs. 1-14.

The shell is very shortly rimate but imperforate, cylindric with a short terminal cone, corneous-white. Whorls 11 $\frac{3}{4}$ to 12 $\frac{1}{2}$, convex, the first 2 $\frac{1}{2}$ smooth, second whorl narrow, the first wider and bulging. Subsequent whorls are sharply and closely ribbed throughout. The last whorl is compressed laterally, tapering downward, the base white, rounded and prominent; it is contracted, descends a little, and is shortly free in front. The aperture is very shortly ovate, the peristome thin and narrowly expanded. The axis is moderately large and cylindric, with a low, blunt lamella at the end of the penultimate and beginning of the last whorl.

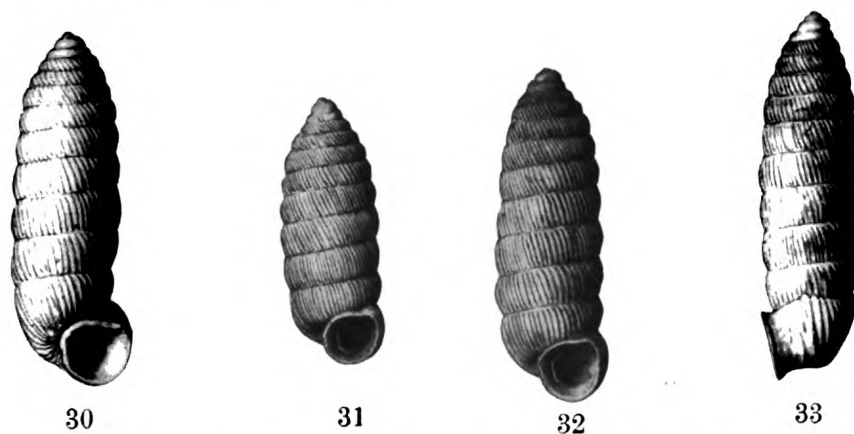


Fig. 68. *Holospira cionella*, type and three paratypes, enlarged.

The figured type (Fig. 68) is a cylindric shell, evenly and rather finely but strongly rib striate, the striae not weaker on the later whorls; they are coarser on the swelling behind the contraction preceding the lip. Out of 11 shells of the type lot opened, 9 have an axial lamella only; 2 have axial and superior or parietal lamellae. When originally describing this species only a few specimens were opened, and all happened to have one lamella only. The four specimens figured in Fig. 68 measure as follows (the first may be considered type):

Length 12 mm., diameter 3.1 mm.; whorls $12\frac{1}{2}$. Type.

Length 11.3 mm., diameter 3.25 mm.; whorls 12.

Length 11 mm., diameter 3.25 mm.; whorls 12.

Length 8.7 mm., diameter 3 mm.; whorls 11.

ARIZONA: Chiricahua Mts. on Bull Hill and Quartzite Peak, near Old Fort Bowie (Ferriss & Pilsbry), Type 87117 A.N.S.P. Type locality illustrated in Vol. I, p. 318, fig. 146.

The type of this species came from near Old Fort Bowie. The fort stands on the narrow and low neck which unites the Dos Cabezas range with the Chiricahuas proper. Only the adobe walls now stand; only the soldiers' graves remain to be guarded! The ridge has here a minimum elevation of 5,500 feet. About a mile south Mr. Dixon's place lies in the valley east of two conical peaks, locally known as Bull Hill and Quartzite Peak, the former of cherty limestone formation. *Holospira cionella* is found on the slope of Bull Hill facing the fort, the exact spot being along a tiny gully which crosses the trail to the fort. This place is indicated on the right at (3) in the photograph reproduced in Vol. I, p. 318. It probably has an elevation of 6,000 to 6,200 feet. Another colony is on the lower slope of Quartzite Peak, toward Dixon's house, also indicated in the photograph at (2). Specimens from this place agree closely with the original types of *cionella*.

Bull Hill. Specimens from the locality facing the Fort are all smaller than the types, though a few individuals of the original lot, such as Proc. A. N. S. P. 1905, pl. 27, fig. 31, are entirely similar. Out of 20 specimens opened, 5 have 2 lamellae, axial and superior, 15 have one lamella, the axial. The smallest measure 7.2×3 mm., $9\frac{1}{2}$ whorls.

Goodwin's Canyon, near Lawhorn's ranch, not far south of Nine-mile Water Hole, is the locality of a small series taken by our guide Mort Wien. They are decidedly wider than Fort Bowie *cionella*, and have either two or three lamellae in the few examples opened. The largest and smallest measure:

Length 11, diameter 3.5 mm.; whorls $12\frac{3}{4}$.

Length 10, diameter 3.5 mm.; whorls $11\frac{1}{2}$.

Some specimens of similarly wide shape, but with only the axial lamella, in a few opened, were taken by Mort Wien "a half mile from Dos Cabezas Cave."

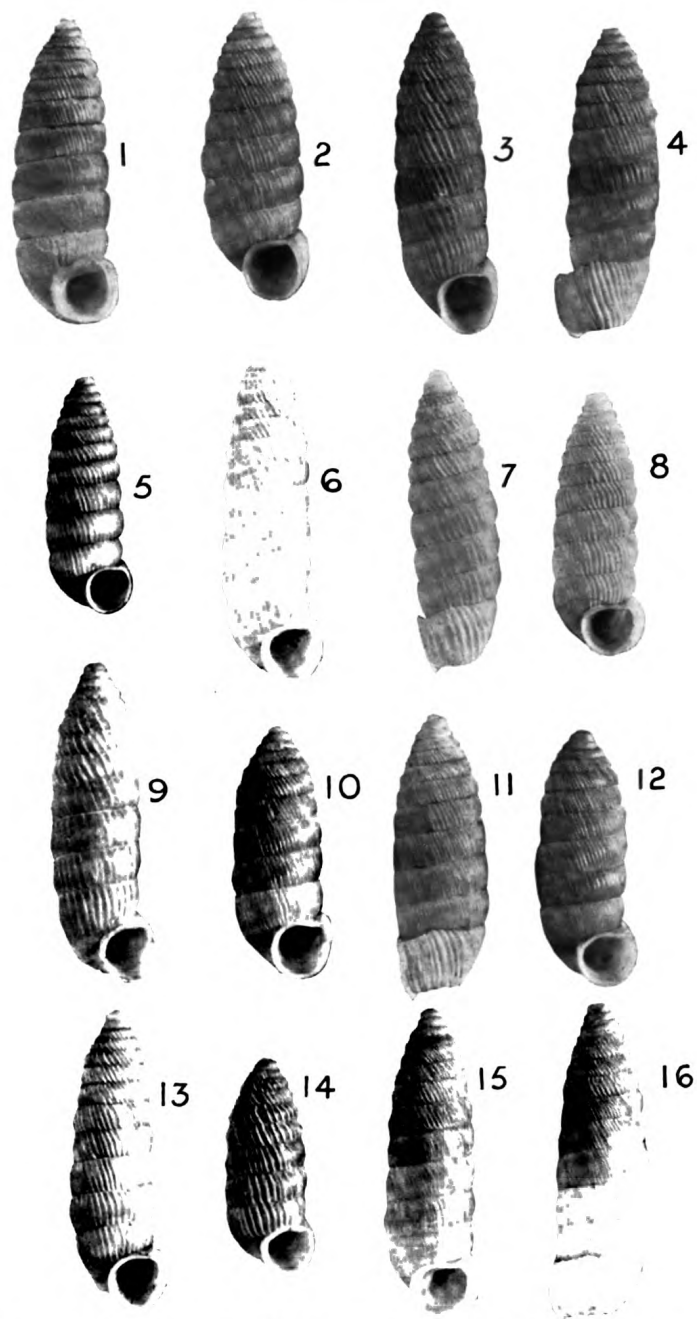


Fig. 69. 1, 2, *Holospira cionella intermedia*. White Tail Canyon, Station 4. 3 (type), 4, 5, Box Canyon of White Tail. 6, 7, 8, Box Canyon of White Tail, another colony. 9, 10, 11, 12, forms from head of Onion Creek. 13, 14, Below Station 5, White Tail Canyon. 15, 16, *H. cionella capillacea*, southeast side of White Tail Canyon.

Holospira cionella form *intermedia* (Fig. 69: 1-14).

The head and southern slope of White Tail Canyon are inhabited by a race closely related to *C. cionella*, but remarkably polymorphic. The internal lamellae vary from one to three, but in most colonies there are one or two, the former number predominating. The sculpture is always coarse on the cone, but on the cylindric part it may be coarse, partially effaced, or fine, in specimens of the same colony, while in some other colonies one or other of these conditions may be developed separately. The White Tail series deserves far more study than we have been able to find time for.

The shell differs from *H. cionella* by the perceptibly longer taper and coarser striation of the terminal cone, and slightly greater development of the basal crest. In the form selected as type (Fig. 69: 3) the ribs continue throughout, but in many examples of the same lot they weaken more or less on the penultimate and next earlier whorls. The callus within the aperture is very heavy.

There is variation in sculpture in the type colony, some examples being strongly striate throughout, but in most the striae are weaker on the penult whorl. Fig. 69: 3-5 represent shells from the type colony. Thirty-seven specimens of this lot opened measure from 9×3 mm., two lamellae, axial and superior, to 13×3.9 mm., one lamella, the axial. Of shells with the riblets weak on penult whorl, 10 had one, 3 had two and one three lamellae. Of those with the ribs strong throughout, 18 have an axial lamella only, 5 have axial and superior lamellae. The conditions as to lamellae are similar in lots opened from several other colonies, as given fully in our paper of 1910, pp. 125-127.

It is abundant in the heads of White Tail Canyon and down as far as the mouth of Indian Creek. Type locality on the south side of the "box" of White Tail Canyon. Type (Fig. 69: 3) No. 99,684 A.N.S.P. It also was taken at many other collecting stations, marked on the map on p. 75 of our paper of 1910, most or all of these colonies being of considerable extent, although the gathering in each case was made in a small area. It was taken also in Jhu Canyon, Turkey Creek and Limestone Mountain. All of these stations are on limestone.

Holospira cionella capillacea Pilsbry & Ferriss

Fig. 69: 15, 16.

Holospira cionella capillacea Pilsbry & Ferriss, 1910. Proc. Acad. Nat. Sci. Phila., p. 127, pl. 13, figs. 15, 16.

Similar to *intermedia* except that the intermediate whorls are very finely, closely striated; only the axial lamella developed, in a few opened. Length 11.7 to 12, diameter 3.5 mm.

ARIZONA: Chiricahua Mts., White Tail Canyon, Station 10, about half way to the summit of the ridge, below cliffs (Pilsbry). This colony is the only one found in igneous rock (rhyolite). Type, 99727 A.N.S.P.

Sonorella micra and *Ashmunella lepiderma* occur in the same vicinity. *Holospira* was very scarce.

***Holospira arizonensis* Stearns**

Fig. 70: 1-4.

Holospira arizonensis R. E. C. Stearns, 1890, Proc. U. S. Nat. Mus., 13: 208, pl. 15, figs. 2, 3.—Bartsch, 1906, *ibid.*, 31: 134.—Pilsbry, 1905, Proc. Acad. Nat. Sci. Phila., p. 216.—Pilsbry & Ferriss, 1910, *ibid.*, p. 118, pl. 11, figs. 1-4.

"Shell dextral, elongately cylindrical, pupiform, dingy white to pale horn color, translucent. Number of whorls twelve to thirteen. Slightly convex, the sutures distinctly defined. The upper or six or seven whorls rather abruptly tapering towards the obtuse apex, which has a slightly twisted and rather a papillose aspect. The last whorl is curved under and constricted back of the mouth, forming an umbilical notch. The apex and following whorl are smooth; the three or four succeeding whorls sharply and somewhat obliquely plicated longitudinally, the median and following whorls becoming somewhat obscurely sculptured other than by distinct growth lines. The basal whorl is strongly sculptured below, and back of the mouth, and obtusely angulated underneath. Aperture ovate, slightly angulated anteriorly, somewhat effuse, rimmed and projecting." (Stearns.)

Length 12.8 mm., diameter at 10th. whorl 4.2 mm., 12 whorls (Bartsch).

ARIZONA: Dos Cabezas Cave,^{43a} Dos Cabezas Mts., Cochise Co. (Vernon Bailey). Type 104392 U.S.N.M. Also in immediate vicinity of the cave (Mort Wien).

Fresh shells are pale corneous brown, glossy, bluish and subtransparent in places on the intermediate whorls. First $2\frac{1}{2}$ whorls smooth; following 6 whorls sharply striate, the striation gradually disappearing, so that two or three whorls preceding the last are smoothish. The last whorl is dull, coarsely striate, its outer wall flattened and tapering to the base, which is a little gibbous and rounded. Its latter part is straightened and runs forward shortly beyond the preceding whorl, the upper wall descending slightly. Otherwise it is not noticeably contracted behind the aperture. The outer lip is narrowly expanded and revolute, and is lined within with a rather thin white callus.

One living specimen seen is an albino, pure white with some bluish spots.

The axial lamella is strongly developed, superior lamella variable, but usually strong and extending through the last half of the penultimate whorl. Basal lamella variable, usually wanting, but sometimes strong. Twenty specimens opened give the following data:

Three lamellae: superior, axial and basal (15%), 3 specimens, length 13.5 to 14 mm., diameter 4 mm., $12\frac{1}{2}$ to $12\frac{3}{4}$ whorls.

Two lamellae, superior and axial, 13 specimens (65%), varying in length from 11.3 to 14.8 mm., $11\frac{1}{2}$ to $13\frac{1}{4}$ whorls.

One lamella, the axial, 4 specimens (20%), 11.3 to 12 mm. long, $11\frac{1}{2}$ whorls.

^{43a} It is stated that Mr. Vernon Bailey collected the types in the cave. They had doubtless been carried there by wind or mice. This accounts for the broken condition of all but one specimen of the type lot. No Arizonan *Holospira* lives in caves or shaded or damp places. They live in dry and sunny situations.

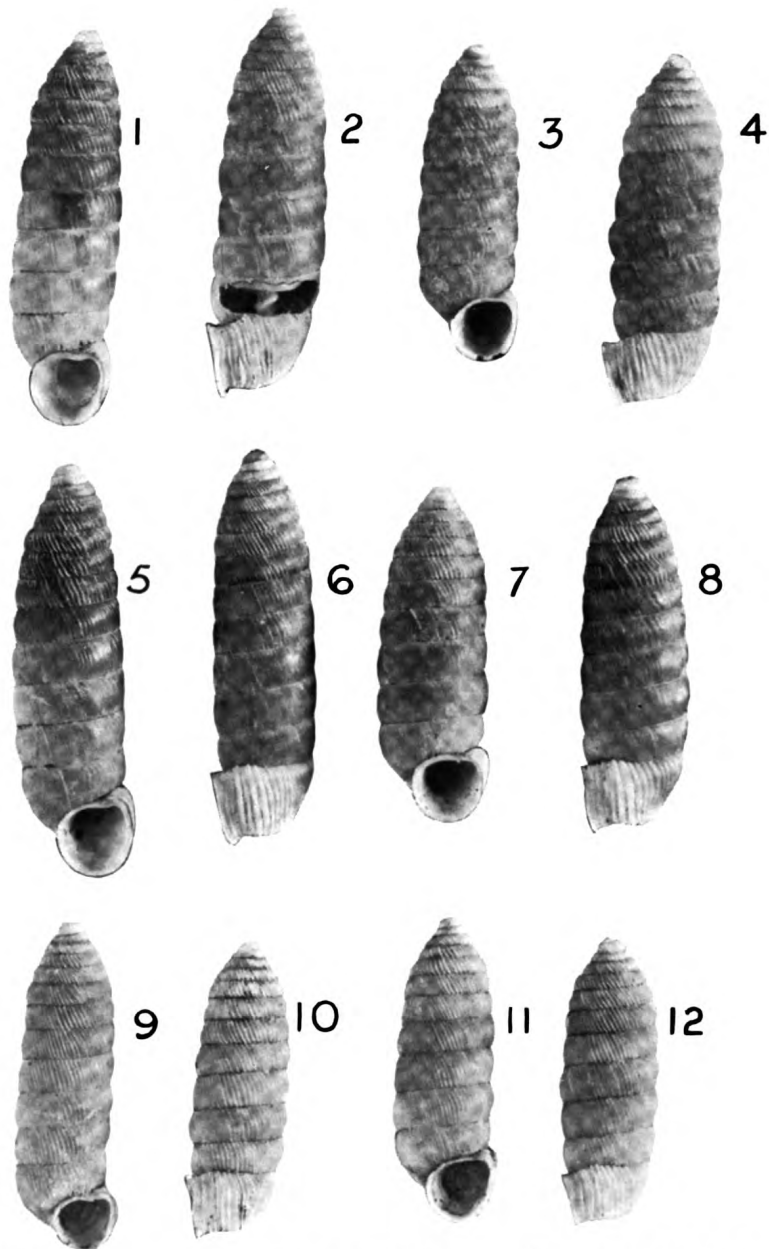


Fig. 70. 1, 2, 3, 4, *Holospira arizonensis* Stearns. Topotypes from around Dos Cabezas Cave. 5, 6, 7, 8, *H. arizonensis emigrans*, head of west branch of Big Emigrant Canyon. 9, 10, 11, 12, form from Station 2, Big Emigrant Canyon.

Holospira arizonensis emigrans Pilsbry & Ferriss

Fig. 70: 5-12.

Holospira arizonensis emigrans Pilsbry & Ferriss, 1910, Proc. Acad. Nat. Sci. Phila., p. 119, pl. 11, figs. 5-8.

"The shell is in the average more slender than *arizonensis*, with more numerous whorls; striation slightly finer, and often extending weakly upon the smoother lower whorls; the last whorl has a broad contraction behind the lip, preceded by an opaque white, *very coarsely striate*, inflation; base opaque white, projecting more than in the type; callus within the outer lip is very heavy. Color dull corneous brown, like the type."

Length 14 mm., diameter 3.7 mm., 14 whorls. Type.

ARIZONA: Chiricahua Mts., head of Big Emigrant Canyon, in the region of pinyon pine groves. Type 99701 A.N.S.P. from Station 1; also taken at several stations eastward in the same neighborhood.

The head of Big Emigrant Canyon is cut into numerous small ravines, the northern slopes of which are wooded with pinyons. The rock is limestone. Here *Holospira* was found in large numbers. In the type lot of some hundreds, 25 specimens, taken at random, were opened and measured, having:

Three lamellae: superior, axial and basal (16%), 4 specimens.

Two lamellae: superior and axial (24%), 6 specimens.

One lamella, the axial (60%), 15 specimens.

The size runs from 11×3.9 mm., $11\frac{1}{2}$ whorls, to 15.1×3.9 mm., 16 whorls.

At Station 2, at the bottom of the canyon (middle branch), a few dead specimens sharply, but very finely, striate throughout were found (Fig. 70: 9, 10, 11, 12). On the tapering cone and basal whorl the striae are coarser. At the head of this branch a small series (about 25) of similar shells was found. They are hardly distinguishable from *H. cionella*. *Holospira* colonies are scattered profusely all over the head slopes of Big Emigrant Canyon.

Holospira arizonensis mularis Pilsbry & Ferriss

Fig. 71.

Holospira arizonensis mularis Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 386, pl. 15, figs. 8-8e.

The shell is very shortly rimate, cylindrical, with short terminal cone, wood brown or avellaneous, the last half of the last whorl opaque white; composed of $10\frac{1}{2}$ to $13\frac{1}{2}$ whorls, the first two smooth. The last half of the second and first half of the third whorl are narrower than the preceding and following whorls, as usual, and the apex projects somewhat nipple-like. Following whorls of the cone are quite convex, and are sharply, closely and obliquely striate. On the cylindrical portion the whorls are only weakly convex, and gradually lose the striae, so that the penultimate and often one or two earlier whorls are smooth or nearly so, the last half-whorl becoming strongly, sharply striate again. The last whorl is compressed laterally on the back but becomes rounded near the aperture, preceding

which it is somewhat contracted. The aperture is rotund-ovate, peristome shortly free of the preceding whorl, and quite narrowly expanded. Internal axis rather small, in the last part of the penultimate and the beginning of the last whorl bearing a moderate, obtuse lamella. Typically there are no other lamellae, but in a small number of specimens a superior lamella, or superior and basal lamellae are developed, both very weak.

Length 13.1, diameter 4.2 mm.; whorls 12.
 Length 13.6, diameter 3.9 mm.; whorls 13½.
 Length 13.8, diameter 4 mm.; whorls 13.
 Length 12.2, diameter 4.2 mm.; whorls 11½.
 Length 10.2, diameter 4 mm.; whorls 11.
 Length 9.3, diameter 3.9 mm.; whorls 10½.

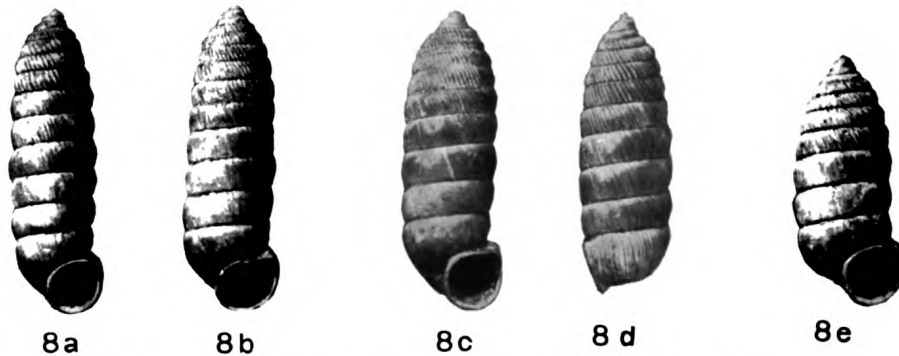


Fig. 71. *Holospira arizonensis mularis*, type and paratypes (\times about 3).

ARIZONA: Mule Mountains west of Bisbee, at about 6,000 to 6,500 feet elevation (Pilsbry and Daniels), Type 112236 A.N.S.P.

The Mule Mountains stand between the southwestern outliers of the Chiricahua Range and the Huachuclas, and are much lower than either, the highest summits about 7,000 feet. The greater part of the group is igneous rock, but the Escabrosa Ridge, running along the western and southern borders, is limestone. Collecting was done in the vicinity of Bisbee and Warren, August 29 and 30, 1910, by Daniels and Pilsbry.

The northern slope of the Escabrosa Ridge, or mountain side on the left, ascending the first left-hand ravine on the Tombstone Road, above Bisbee, is the home of this *Holospira*. Extensive burning of the brush has narrowed their range and decreased their numbers, at least for the time, so that the series collected was not large. Some very small scrub oaks remain in places; there are three species of agave, some sotol and bear-grass, a few cylindropuntias and many herbaceous plants.

Out of 20 shells opened, 18 have the axial lamella only; one has also a small superior or parietal, and one has superior and basal lamellae, both very low and small.

This is a larger and longer species than *H. ferrissi*, and further distinguished by the smooth later whorls and deficient internal lamellae. The Chiricahuan *H. arizonensis* Stearns differs chiefly by having the internal lamellae larger.

Holospira arizonensis mustang Pilsbry & Ferriss

Fig. 72: 17.

Holospira arizonensis mustang Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75: 98, fig. 17.

Related to *H. arizonensis mularis*, but more slender; summit usually somewhat more slowly tapering; back of the last whorl more coarsely and more irregularly ribbed. Axis having a stout, blunt lamella. Smaller than typical *H. arizonensis*.

Length 12, diameter 3.5 mm.; 13½ whorls.

ARIZONA: Mustang Range, Pima Co., on the north side of tower, eastern peak, Station 153 (1918); also the following Stations of 1919: 287, a limestone hill east of 286; 332, main gulch of north slope of the largest mountains west of Dan Mathew's ranch house, and 333, the next gulch eastward (Ferriss). Type 131003 A.N.S.P., from Station 153.

Holospira whetstonensis Pilsbry & Ferriss

Fig. 72: 15.

Holospira whetstonensis Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., p. 98, fig. 15.

The shell is imperforate, long, cylindric with a rather tapering terminal cone about one-fourth the total length; light flesh colored. Sculpture of strong riblets throughout after the two smooth apical whorls; riblets narrower than the intervals, 40 on the penult whorl in the type specimen. The

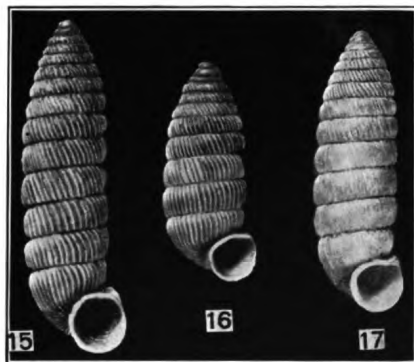


Fig. 72. 15, *H. whetstonensis*. 16, *H. whetstonensis arata*. 17, *H. arizonensis mustang*. All enlarged.

whorls of the cone are strongly convex, later whorls moderately so, with a well impressed suture. The last whorl is flattened laterally, sloping to the base, is contracted and very shortly free in front. The small aperture is rounded with part of the upper margin straightened. Internally there are one to three lamellae. The type having an axial lamella only.

Length 14.2, diameter 3.7 mm.; 14½ whorls. Type.

Length 11.5, diameter 3.6 mm.; 13 whorls.

ARIZONA: Whetstone Mts. (J. H. Ferriss), Type 131007 A.N.S.P. Also Empire Mts., Cochise County.

This species resembles *H. cionella* and *H. chiricahuana*. The latter has a longer terminal taper, passing imperceptibly into the cylindrical part. *H. cionella* is a smaller species with finer sculpture. Out of 7 specimens from the type locality opened, 2 have an axial lamella only, 4 have axial and basal, and one has axial, basal and parietal. Several opened from the other two stations have the axial lamella alone.

The specimens from Station 293 are similar to those from 304, the type station; but at 305 the shells are smaller, extremes measuring:

Length 11.3, diameter 3.7 mm.; 12½ whorls.

Length 9.5, diameter 3.6 mm.; 10½ whorls.

A few opened have an axial lamella only.

Some were taken in the Empire Mountains, on the north side of a large limestone peak 1½ miles northwest of the Total Wreck mine. Specimens small, only an axial lamella present.

***Holospira whetstonensis arata* Pilsbry & Ferriss**

Fig. 72: 16.

Holospira whetstonensis arata Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., p. 99, fig. 16.

The shell is smaller, especially shorter than *whetstonensis*, with a shorter neck, but having similar strongly cut riblets, coarser than in *H. ferrissi*; the terminal cone longer than in *ferrissi*. There is an axial lamella lateral in position.

Length 9.3, diameter 3.5 mm.; 11½ whorls. Type.

Length 9.8, diameter 3.3 mm.; Topotype.

Length 8.5, diameter 3.2 mm.; Topotype.

Length 10.9, diameter 3.2 mm.; 12 whorls. Station 153.

Length 9.4, diameter 3.7 mm.; 10½ whorls. Station 153.

ARIZONA: Mustang Mts., on the eastern dome of the range. (J. H. Ferriss), Type 131005 A.N.S.P.

***Holospira ferrissi* Pilsbry**

Fig. 73.

Holospira ferrissi Pilsbry, 1905, Proc. Acad. Nat. Sci. Phila., p. 215, pl. 27, figs. 22-25; 1909, p. 512; Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., p. 96.

Holospira (Tristemma) ferrissi Pils., Bartsch, 1906, Proc. U. S. Nat. Mus., 31: 133, fig. 9.

Holospira ferrissi caneloensis Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75: 97, fig. 12.

Holospira ferrissi monoptyx Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75: 97, fig. 13.

The shell is rimate but imperforate, short and cylindrical, rather thin, and very pale brownish-corneous. Whorls 9½ to 11, the first whorl wider than the second, both of them smooth; all the rest of the whorls are regularly, evenly and closely rib-striate, the riblets as wide as their intervals or



Fig. 73. *Holospira ferrissi*, type and paratypes. (X about 4.)

a little narrower, except on the last whorl, where the sculpture is a little coarser and irregular. The whorls are all convex, the last 4 or 5 forming the cylindric portion, the preceding whorls forming the terminal cone, which is about one-third the total length of the shell. The last whorl is pinched or compressed laterally, but the very short straight "neck" is full again, and carries the aperture very shortly free. The aperture is rounded, but a little irregular, the upper margin being somewhat straightened. The thin peristome is narrowly expanded. The internal pillar is rather large and of equal calibre in the cylindric portion of the shell. At the end of the penultimate and beginning of the last whorl there is a short, strong and blunt lamella on the pillar below the middle, a low, short lamella on the parietal wall and another on the basal wall. There is no palatal fold. Length 7.5 to 9, diameter 3 mm.

ARIZONA: Manila mine, near the northwest end of the Huachuca range (J. H. Ferriss). Type A.N.S.P. 87115. Also foothill a mile east, and a deep canyon a mile farther north; also in the western dome of the Mustang range (Ferriss).

This is a very short, thick-set species, unlike others previously known in its internal armature, but it is now recognized that various species are trilamellate in the penult whorl. The even ribbing and short terminal cone are characteristic. *H. arizonensis* differs in being slightly larger with more whorls, and the riblets are subobsolete on the cylindric portion of the shell. Many, but not all, specimens have 3 internal lamellae, and the whorls are ribbed throughout. Ten topotypes opened have lamellae as follows: Axial lamella only, 5 specimens; axial and basal, 2 specimens; axial, basal and parietal, 3 specimens.

Form 2. — At Station 271, a deep canyon 1 mile north of the Manila mine hill, at a dolomite cliff facing northwest, two lots were obtained. These generally have the riblets weak on the penult or on two whorls, and the lamellae within are reduced. 15 opened from one lot and 11 from another have lamellae thus:

Axial only	10 specimens	10 specimens
Axial and basal	4 specimens	0 specimen
Axial, basal and parietal	1 specimen	1 specimen

An identical form was taken at Station 306 on the western dome of the Mustangs. Most of the specimens opened had an axial lamella only, but one had 3 lamellae.

Holospira ferrissi form *monoptyx* Pilsbry & Ferriss (Fig. 74: 13). The shell has the short, compact shape of *ferrissi*, but differs by having the costulation weaker on the penult and face of last whorl, and in numerous specimens opened there is but one lamella, a strong axial.

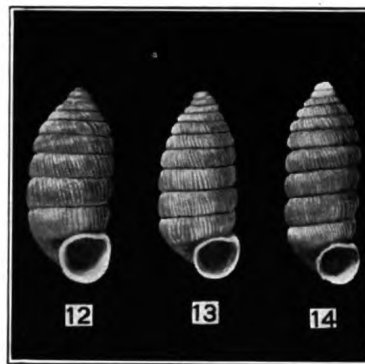


Fig. 74. 12. *Holospira ferrissi* form *caneloensis*. 13, *H. ferrissi* form *monoptyx*. 14, *H. ferrissi* form *fluctivaga*.

Length 8, diameter 3.3 mm.; $10\frac{1}{2}$ whorls. Type.

Length 7.2, diameter 3.25 mm.; $9\frac{1}{2}$ whorls.

Length 8.7, diameter 3 mm.; 11 whorls.

ARIZONA: Mustang Mountains, in a limestone slope facing east, near Dan Mathew's ranch. Type 131009 A.N.S.P., paratypes in coll. Ferriss.

This form resembles *H. f. caneloensis*, and certain specimens are not externally distinguishable; but in numerous examples opened, none had any lamellae other than axial.

Holospira ferrissi form *caneloensis* Pilsbry & Ferriss (Fig. 74: 12). "The shell has the short contour and small size of typical *ferrissi*, but the sculpture is slightly finer, and becomes *obsolete* on the antepenult to last whorls, strengthened again on the last half whorl. The three internal lamellae are strongly developed."

Length 8, diameter 3.5 mm.; 10 whorls. Type.

Length 7.2, diameter 3 mm.; 10 whorls. Station 290.

Length 9.8, diameter 3.5 mm.; $11\frac{1}{2}$ whorls. Station 290.

ARIZONA: Canelo Hills: limestone hills west of the Duquesne road at Station 239. Type 131010 A.N.S.P., paratypes in Ferriss collection. Also three miles west of the road.

Three internal lamellae are present in all opened of the type lot, but at the second Station some of the apparently quite adult shells had only the axial lamella. Probably not really distinguishable from *H. ferrissi*.

Holospira ferrissi fossor Pilsbry & Ferriss

Fig. 75: 6-6b.

Holospira ferrissi fossor Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 387, pl. 15, figs. 6-6b.

The short, cylindric shell is ribbed throughout, with about 47 ribs on the penultimate whorl. The last whorl is conspicuously flattened on the back, then gibbous (the gibbosity internally filled with white shell substance) and contracting to the aperture, the basal crest rather conspicuous. These features are more conspicuous than in *H. ferrissi*. There is an obtuse axial lamella in the front of the last whorl, and typically no other lamellae; but three specimens out of 20 opened show a weak parietal lamella also. The color is wood brown or avellaneous with the usual white patch on the last whorl.

Length 8.7, diameter 3.3 mm.; $10\frac{1}{2}$ whorls (type).

Length 6.4, diameter 3.3 mm.; $8\frac{1}{2}$ whorls (shortest shell).

Length 9.8, diameter 3.6 mm.; $10\frac{1}{2}$ whorls (largest shell).

Length 9.3, diameter 3.3 mm.; $10\frac{3}{4}$ whorls (slender shell).

ARIZONA: Mule Mountains, on slopes of a limestone peak about 2 miles east of Warren (Pilsbry and Daniels). Type 112238. A.N.S.P.

While the sculpture of this species is coarser than that of typical *H. cionella*, yet there are some equally coarse individuals of the latter. Cf. also *H. campestris*.

The town of Warren lies lower than Bisbee and is separated from the plain by a range of hills which reach about 5,500 feet elevation. On the northern and northwestern slopes of one of these, about two miles east of the town, this *Holospira* is very abundant. We found them in August living in mellow earth under stones, in "nests" of about six to twenty or more, usually standing vertically, apex up, and buried in earth up to the summit.

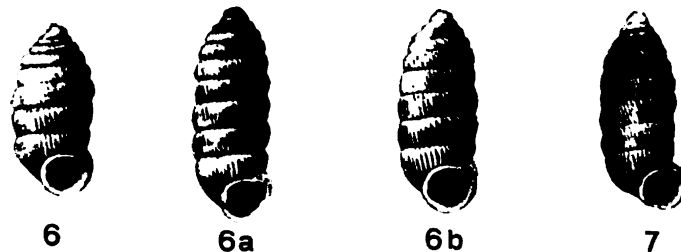


Fig. 75. 6-6b, *Holospira ferrissi fossor*, type and paratypes. 7, *Holospira ferrissi sanctaerucis*, type. Enlarged.

Holospira ferrissi fluctivaga Pilsbry & Ferriss

Fig. 74: 14.

Holospira ferrissi fluctivaga Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75: 98, fig. 14.

The shell is cylindric with a short, conic, somewhat mucronate summit; much like *H. ferrissi*, from which it differs by having the later whorls decidedly more convex. There are about 8 riblets in 1 mm. on the penult whorl. In the back and right side of the penult whorl there is a very strong and long parietal lamella, a strong, blunt axial, and a rather low basal fold.

Length 8.3, diameter 3.15 mm.; 10 $\frac{3}{4}$ whorls.

ARIZONA: Debris of the San Pedro River near Mammoth, Pinal Co. (Ferriss). Type 131008 A.N.S.P. Also near Benson, Cochise Co. (Pilsbry, 1910).

It stands close to *H. f. sanctaerucis*, but differs by the greater convexity of the whorls of the cylindric portion of the shell.

Holospira ferrissi sanctaerucis Pilsbry & Ferriss

Fig. 75: 7.

Holospira ferrissi sanctaerucis Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 388, pl. 15, fig. 7.

The shell is similar to the most slender and fine-ribbed examples of *H. ferrissi* in form and sculpture, except that the apical whorls are more mucronate. The three internal lamellae are lateral in position, strongly developed, especially the superior one, which is a half-whorl long.

Length 8.5, diameter 3.2 mm.; whorls 11 $\frac{3}{4}$.

ARIZONA: Valley of the Santa Cruz River, above Tucson (Pilsbry), Type 112239. A.N.S.P., found in flood debris of the river a short distance above the Congress St. bridge, Tucson.

This is some distance west of any other record of *Holospira* in the United States. In Mexico the genus extends to the Gulf of California. The lamellae are much stronger than in any shells of *H. ferrissi* which we have opened.

Although there cannot be much doubt that this race inhabits some limestone hill not far from the river, we failed to find it in the limited time we spent in the neighborhood. It may have floated many miles, as the river merits that name in time of flood, though usually reduced to a chain of infrequent pools or an insignificant rivulet. The term river, in the arid belt, refers to the bed and banks rather than to the water, which is often conspicuous for its absence during a great part of the year.

Family IX. CERIONIDAE

Family characters and distribution are those of *Cerion*, the single genus, *q. v.*

The cylindric, many-whorled shell in this family resembles that of the least specialized Urocoptidae except for its solid, opaque texture. This is an adaptation to life on sunny shores. The kidney is about equal to, or not much longer than the pericardium, as in Urocoptidae and Bulimulidae.

Other chief structural peculiarities are: (1) The restriction of the ureter to an excessively short retrograde tube near the anterior end of the kidney. (2) The plain lung, with branchless pulmonary vein. (3) The penis continued in a blind sac beyond the entrance of the epiphallus, which is extremely long. (4) The usual presence of a long branch or diverticulum of the rather long spermathecal duct. Finally, (5) the absence of a talon.

The practically absent ureter and plain lung suggest the orthurethrous structure, but in those forms the kidney runs forward uninterruptedly into the ureter, which opens forward, though with a retrograde thread from its margin. This is quite unlike the condition in *Cerion*, where there is an excessively short but retrograde tube, arising at the side of the summit of the kidney (*C. incanum*) or a little farther down (*C. glans*).

This family is doubtless an old Antillean group, which may have been derived from the same stock as the Urocoptidae, but is very distinct from that family by the vestigial ureter, the strong, smooth jaw, the wide central tooth of the radula and various features of the genitalia. It is an isolated group.

CERION Röding

Cerion Röding, 1798, Mus. Boltenianum, p. 90—Dall., 1894, Bull. Mus. Comp. Zool., 25: 121. *C. vulgare* Röding = *C. uva* (L.) designated type.—Pilsbry, 1901, Man. Conch., 14:174 (monograph).

Pupa Lamarck, 1801, Syst. Anm. s. Vert., p. 88, for *P. uva* L., only.

Cerium Link, 1807, Beschreib. Nat. Samml. Univ. Rostock, 3 Abth., p. 131, for *C. uva* and *C. bidens* Gmel.

Puppa Montfort, 1810, Conch. Syst., 2: 298, for *P. uva*.

Puparia Rafinesque, 1814, Précis des Découverts, p. 28. New name for *Pupa* Lam.

Cochlodonta Férussac, 6 April, 1821, new name for *Pupae* Lam. and *Cereales* Fér., the latter a nude name. Cf. Kennard, 1942, Proc. Malac. Soc. Lond., 25: 113.

Canistrum O. Fabricius, 1823, Fortegnelse, p. 90. Cf. Kennard, *ibid.*, p. 114, *C. uva* L. designated type.

Strophia Albers, 1850, Die Heliceen, p. 202; not *Strophia* Meigen, 1832.

Shell solid, opaque, white, uniform or marbled or axially streaked with brown; cylindric with conic summit and entire apex; the embryonic shell of 2 to 2½ smooth whorls; in all 8-13 closely coiled, nearly flat whorls. The internal axis is slender, straight, perforate in early whorls, often solid in the last whorl. Aperture short, ovate, vertical, the lip thickened, expanded or reflexed. A spiral columellar fold and a parietal tooth usually are present in recent species.

The foot is rather short, its upper surface finely reticulate, and without trace of pedal grooves.

Lung plain except for the pulmonary vein, which terminates near the anal angle. Kidney slightly longer than pericardium, having an extremely short ureter near the anterior end, and no secondary ureter (Fig. 76G).

Genitalia (Fig. 76H) having a short penis with terminal retractor inserted on the diaphragm; the epiphallus entering near its middle or base.

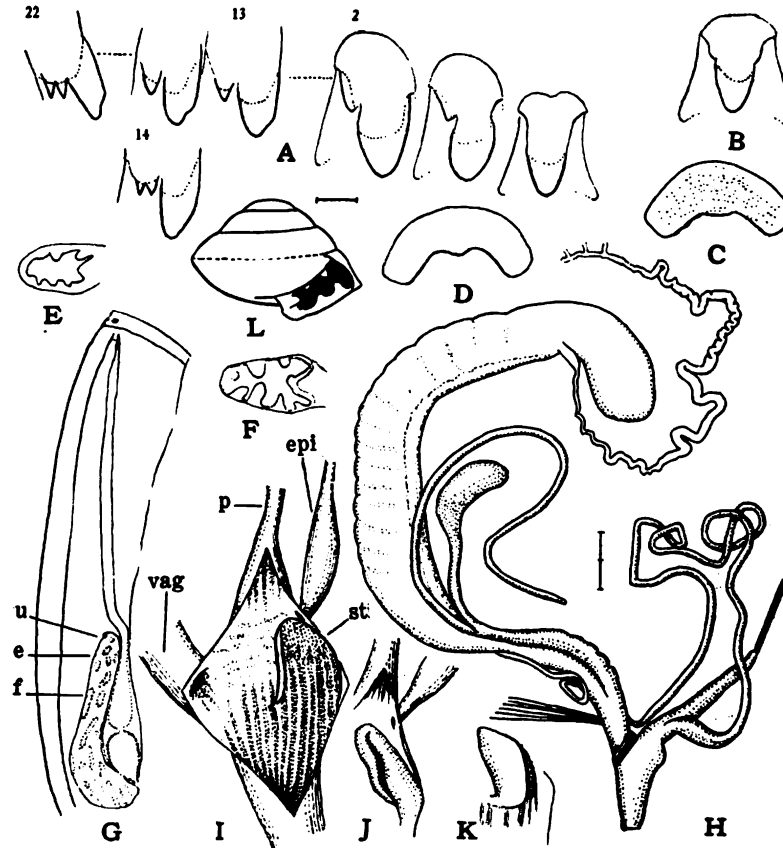


Fig. 76. *Cerion incanum*. A, parts of a half row of teeth. B, central tooth of another individual. C, D, jaws of same two specimens. E, section near anterior end of kidney, at point marked e. F, section farther back, at f. G, pallial complex, semi-diagrammatic. H, genitalia, scale line = 2 mm. I, atrium and base of penis opened to show stimulator spread open. J, K, stimulator folded as normally carried, and side view of same. L, young shell, scale line = 1 mm.; epi, epiphallus; p, penis; st, stimulator; u, opening of the ureter; vag, vagina.

Atrium and base of penis containing a large stimulator (Fig. 76 I, J, K). Vagina short, having a retractor muscle from the right ocular band. Spermatheca on a rather long duct which bears a long branch (rarely wanting). No talon.

Jaw arched, strong, smooth, with more or less distinct median projection (Fig. 76 C, D). Radula with 20.1.20 to 30.1.30 teeth in nearly straight transverse rows. Central tooth about as wide as or wider than the laterals, with equally long mesocone; ectocones are present in some species, absent in others. Laterals bicuspid. Marginal teeth shorter with the ectocone usually split (Fig. 76 A, B). The oesophagus is very long, spirally following the retractor muscles coiled around the axis. Stomach about a whorl long.

Free retractor muscles are independent to their posterior insertions except the right tentacular and tail retractors which are shortly united posteriorly. A band from the right tentacular retractor attaches to the vagina.

Distribution.—Florida Keys, Bahamas, Greater Antilles from Cuba to the Virgin Islands (but not in Jamaica), and southward in the Cayman Islands and Curaçao; species numerous.

Cerion is confined to the sea coast above tides, usually beyond reach of ordinary spray, though occasionally penetrating a half mile or so inland into a different plant association. Their occurrence is distinctly patchy, in large or small colonies, though in some cases the populations of single species extend with interruptions for miles. They live on or among bushes, grass or other herbage, being especially fond of the sea grape. They often aestivate fully exposed to the sun. They are inactive by day, moving about and feeding at night and in rainy weather.

Young shells of this genus often have the aperture contracted by teeth, formed a short distance within the lip-edge, and subsequently absorbed in most cases. Two of these teeth are upon the parietal wall, two within the basal lip, and one upon the columella, the latter being the end of the continuous columellar plait, and present in the young of all species. In species having such teeth, they are not present in all individuals or at all stages of growth, but only appear at intervals. In *C. incanum* the teeth are most fully developed in quite young stages, Fig. 76L, representing a shell of 4 mm. diameter, 3½ whorls. Teeth are often still weakly present in shells of seven or eight whorls, 10 mm. high. The inner basal tooth persists longest.

Palaeontology.—A fossil but typical specimen of *C. incanum* was found by Mr. Paul L. McGinty on the top of the dyke in material excavated at Ortona Locks of the Caloosahatchee River, associated with Pliocene species. At that place the Caloosahatchee marl is thinly overlaid by the Pleistocene Fort Thompson formation. It is therefore possible that this *Cerion*, as well as the *Goniobasis*, Planorbidae, Unionidae etc., which have been collected from the dyke west of Clewiston, may be of Fort Thompson age. However, the excavation at Ortona Locks was deep, and the material found with the *Cerion* at the top of the dyke was all apparently the Pliocene Caloosahatchee marl species.

The following fossil lower Miocene cerions belong to the subgenus *Eostrophia* Dall (1890, Trans. Wagner Free Inst. Sci., 3: 12), characterized by the absence of teeth, other cerions having columellar and parietal teeth more or less developed. Probably *Eostrophia* should be accepted as a genus.

CERION (EOSTROPHIA) ANODONTA (Dall). *Strophia anodonta* Dall, 1890, Trans. Wagner Inst., 3: 13. Lower Miocene. Tampa limestone, "silex beds," at Ballast Point, Tampa, Florida. Also localities in Hillsborough and Wakulla counties (Mansfield, 1937, Florida Geol. Bull., 15: 70).

CERION ANODONTA FLORIDANUM Dall. Same reference and locality.

These species were part of an insular fauna of Antillean type which was submerged in the lower Miocene, becoming extinct. They were therefore not ancestral to any recent cerions.

Cerion was based upon a structurally and geographically outlying species, *C. uva* (L.) of Curaçao. The species from farther north have been divided into ten "subgenera" of unequal value, based upon characters of the apertural teeth, form and sculpture. Until a thorough anatomic study of these is made, our single species may be placed in the subgenus *Strophioops* Dall, 1894. It has the short parietal tooth, but not the sculpture, of *Maynardia* Dall, 1894.

The anatomy of *Cerion* has been investigated by Dr. Joseph Leidy (1851, in Binney's Terr. Moll., I); the present author (1901, Man. Conch., 14: 176); Paul Bartsch (1920, Carnegie Inst. Wash., Pub. 282); and by Karl Richter (1926, Jenaische Zeitsch. Naturwiss., 62: 277-342). W. G. Binney has published on the dentition, and there are some strange anatomic figures in C. J. Maynard's publications. Of these, Richter's work on the anatomy and histology of *Cerion glans* is the most complete and reliable. The figures and text relating to pallial organs in the works of Leidy and of Bartsch are inaccurate.

(*Κηπιον*, honey-comb, alludes to the resemblance of *C. uva* to an old-fashioned bee-hive.)

***Cerion incanum* (Binney)**

Fig. 77.

Pupa incana Binney, 1851, Terr. Moll., 1: 109 (name only) 1852, *ibid.*, 3, pl. 68.—Leidy, *ibid.*, 1: 230, 259, pl. 15, figs. 2-4 (anatomy).—W. G. Binney, 1859, Terr. Moll., 4: 141, with var. *fasciata*, p. 206, pl. 79, fig. 17.—Pfeiffer, 1868, Monogr. Hel. Viv., 6: 289, with var. *variegata*, based upon W. G. Binney, 1859.

Pupa maritima Pfeiffer, Gould, 1851, in Binney, Terr. Moll., 2: 316; *P. incana* Binney on p. 318. Not of Pfeiffer.

Strophia incana Binn., W. G. Binney, 1878, Terr. Moll., 5: 220, pl. 68; text figs. 125, 126; 1885, Man. Amer. L. Sh., p. 484, with "var. *fuscata*," error for *fasciata*.

Strophia fasciata Maynard, 1889, Contrib. to Sci., 1: 133 (Key Vaccas).

Cerion incanum Binn., Pilsbry, 1902, Man. Conch., 14: 213, with form *vaccinum*, p. 215, pl. 29, figs. 51.—Simpson, 1905, Nautilus, 18: 137 (Baker's Haulover).—Bartsch, 1920, Carnegie Institution of Washington, Pub. No. 282, pp. 7-13, 49, pl. 1, figs. 1-6; pl. 6, figs. 1-3 (anatomy); pl. 54-56 (shells); pl. 57-59 (crosses with *C. viaregis*).

Cerion incanum saccharimeta "Blanes," Pilsbry & Vanatta, 1898, Proc. Acad. Nat. Sci. Phila., p. 477, fig. 5.

Pupa detrita "Shuttleworth," Pfeiffer, 1854, Malak. Blätter, 1: 205, pl. 3, figs. 9, 10 (Key West).

The shell is solid, shortly rimate, cylindric, white, or with a bluish tint, the summit more or less buff or flesh tinted; often with some fleshy or gray streaks on later whorls. There are 9 to 12 nearly flat whorls, the surface nearly smooth except at the last half whorl, which ascends slowly and

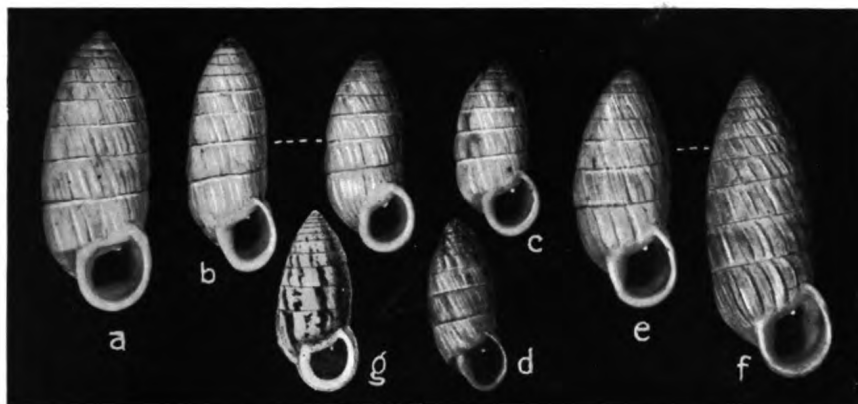


Fig. 77. *Cerion incanum*, a, Virginia Key, Biscayne Bay. b, Key West. c, d, form *vaccinum*, east end Key Vaca. e, f, form *saccharimeta*, Sugar Loaf Key. g, form *fasciatum*, after W. G. Binney.

often has some axial ribs. The ovate aperture is white or light brown within. Lip white, narrowly reflected, the columellar margin a little wider. The columella has a small tooth at its inner edge. Parietal callus thin, bearing a short entering tooth removed from the parietal margin.

Length 27.2 mm., diameter above aperture 11 mm.	Key West.
Length 25.5 mm., diameter above aperture 10 mm.	Key West.
Length 20 mm., diameter above aperture 9 mm.	Key West.
Length 35.3 mm., diameter above aperture 13.5 mm.	Virginia Key.
Length 24.4 mm., diameter above aperture 10.4 mm.	Virginia Key.
Length 29 mm., diameter above aperture 11.6 mm.	Boca Chica Key.
Length 25.2 mm., diameter above aperture 9.5 mm.	Boca Chica Key.
Length 21 mm., diameter above aperture 8.5 mm.	Big Pine Key.
Length 31 mm., diameter above aperture 10.5 mm.	Big Pine Key.

FLORIDA: Dry Tortugas (Wm. R. Taylor); Key West; Stock Island (Pilsbry); Boca Chica Key (Pilsbry); Snipe Key (Brown & Fowler); Sugar Loaf Key (C. B. Moore); Cudjoes Key (Brown & Fowler); Summerland Key (Pilsbry); Torch Key (Pilsbry); Big Pine Key (Pilsbry); Bahia Honda Key (Pilsbry); No Name Key (Pilsbry); Key Vaca (M. Hebard); Little Pine Key (Pilsbry); Grassy Key (Brown & Fowler); Long Key (Moore, Hebard). Lignum Vitae Key (Pilsbry). Lower Matecumbe Key (B. R. Bales). Indian Key, Windly's Island and Long or Cantation I. (C. B. Moore). Biscayne Key (Hebard, Moore). Boca Grande Key (Brown & Fowler). Miami Beach (S. N. Rhoads, L. A. Thurston). Baker's Haulover, head of Biscayne Bay (C. T. Simpson 1905). BAHAMAS: Gun Cay, at the western edge of the Bahama Bank.

The size, and especially the length, vary widely within most colonies. There is also variation in the degree of marking with gray or brown streaks. At Key West, the type locality, *C. incanum* occurs abundantly between the

salt ponds and the northern shore. The shells are white, flesh-tinted or bluish, with several apical whorls light brown. Frequently there are a few rather ill-defined livid spots, more numerous on the cone. The variation in size is great: 30×11 ; $25 \times 8\frac{1}{2}$; 22×10 ; $17 \times 7\frac{3}{4}$ mm. The last whorl is often irregularly wrinkled, almost subcostulate. Figures are from Key West examples. The following forms of *C. incanum* have been named, but they have little significance.

The form *fasciatum* W. G. Binney (Fig. 77g) is distinctly marked with brown stripes. Binney's locality was Key Biscayne. Entirely normal white *incanum* also occurs on that key. There is a set of 12 "dead" specimens of *fasciatum* in the Academy from Shamrock Point, west side of Mustang Island, near Port Aransas, Texas, collected by F. W. Wood, 1929.

On the east end of Key Vaca a small variegated form was taken by J. W. Velie in 1876. The color is "fleshy white more or less suffused or clouded with flesh-color, and sparsely or copiously streaked with livid spots." This was called form *vaccinum* Pilsbry (Fig. 77d).

The form *saccharimeta* 'Blanes' Pilsbry & Vanatta, Figs. 77 e, f, was based upon large, slightly bluish white shells with pale gray apical whorls, the following whorl very finely, sharply striate. There are irregularly developed low, widely spaced riblets on the last one or two whorls. The apical cone tapers more slowly than in typical *incanum*.

Length 35 mm., diameter 13.5 mm.

Length 38.2 mm., diameter 13 mm.

Length 28.8 mm., diameter 12.5 mm.

It is from Sugarloaf Key (F. E. Blanes); Type and paratypes 73483 A.N.S.P. In other lots collected on that Key the shells are normal *incanum*.

Specimens from Cudjoe Key (B. R. Bales, 1941) have the scattered riblets as in *saccharimeta*, with the size and shape of *incanum*, being therefore of intermediate character. "We looked for a long time in the usual places for cerions, on dead stumps, tree trunks, at the base of shrubs, on dead driftwood, etc., but did not find a single specimen until we began to rake over the dead leaves that had accumulated at the bases of dwarf mangrove saplings. The cerions were sealed tightly to the under sides of dead leaves and completely concealed. All were on the ground." (B. R. Bales.)

Notes on the anatomy of *C. incanum*.—The pallial cavity (Fig. 76g) is long and narrow. The lung is plain except for the wide pulmonary vein which runs to the upper-anterior angle of the lung. The kidney is a little longer than the pericardium, wider posteriorly, thin-walled, showing the irregular ridges of glandular tissue through. These ridges do not nearly fill the cavity of the kidney (Fig. 76 e, f). The ureter is an extremely short, circular tube at the side of the apex towards the hindgut. There is no secondary ureter.

The genitalia (Fig. 76h) open below and behind the right eyestalk. The atrium is rather long, having a projection caused by the internal stim-

ulator. The penis is rather short, tapering, with terminal retractor which is inserted on the lung floor. The epiphallus enters it by a simple pore very near the base of the penis, which is thus continued beyond it as a blind sac having internally plicate walls. The atrium also is plicate internally, and near the passage into the penis it bears a large stimulator, shown spread out in Fig. 76i at st. This is in the form of a fleshy lobe, carried with the sides folded together, as in Fig. 76j, k. The epiphallus is swollen, being thick-walled near its entrance into the penis, then narrow and complexly folded (the snarl being partially pulled out in Fig. 76h), and passing into the vas deferens at the crotch. The vagina is short. Duct of the spermatheca moderately long, bearing a very long branch or "diverticulum." The ovotestis is imbedded in the lobes of the liver, in the terminal cone of the shell. The hermaphrodite duct is large and tortuous above, becoming narrow and less twisted before passing into the rather large carrefour. There is no talon. Albumen gland and the nearly smooth uterus have no peculiar features. A strong retractor muscle from the right ocular band attaches to the base of the vagina, winding around it and inserted on the side of the atrium opposite the penis.

The jaw is rather variable in form (Fig. 76 c, d), and shows some indistinct vertical and longitudinal striae, but these are probably in its texture, not on the surface. The radula has 26.1.26 teeth in the specimen drawn (Fig. 76A). The centrals are nearly as wide as long, with a broad, rounded mesocone about as long as the basal plate (but in another lot the central is shorter and wider, fig. 76B). Laterals with rounded mesocone and short ectocone. Marginal teeth similar but shorter, with mesocones having a slight tendency to be emarginate, the ectocones larger, occasionally bifid. The outer marginals have one or two cusps, or none.⁴⁴

(*Incanus*, quite gray.)

West Indian cerions transplanted to Florida Keys

At various times the following species have been recorded as planted on Florida Keys by Dr. Paul Bartsch. The sources of specimens planted follow the names.

- C. casablanca* Bartsch, Andros, Bahamas.
- C. viaregis* " " "
- C. crassilabris* (Shuttl., Sowb.) Puerto Rico.
- **C. n. sp. of johnsoni* group.⁴⁵ Mariel, Cuba.
- C. sculptum* (Poey). Mariel, Cuba.
- **C. mumia* (Brug.) Marianao, Cuba.
- C. chrysalis* (Fér.) Cabanas Fort, Cuba.
- C. tridentatum* Pils. & Van. Rincon de Guanabon, Cuba.
- C. uva* (L.). Curaçao.
- **C. undescribed*. San Salvador, Bahamas.

⁴⁴ W. G. Binney's figure of the teeth of *C. incanum* (1828, Terr. Moll., 5. pl. v. fig. A. copied in Man. Conch., 14. pl. 47. fig. 35) shows a very wide central tooth with strongly developed ectocones. It must have been drawn from some other species. Bartsch's figure (1920, pl. 1. fig. 6) omitted the overhanging cusps, as in all of his figures of *Cerion* teeth. They appear at a slightly higher focus than his figures represent.

⁴⁵ *C. johnsoni* is common at Mariel.

The identity of the specimens of entries starred has not been made clear. *C. chrysalis fastigatum* (Mayn.) and *C. marielinum* Torre, found on Garden Key, evidently occur under other names in Dr. Bartsch's list.

Plantings have been made on seven keys, mentioned below, most abundantly on the Tortugas.⁴⁶ No information has been published on the fate of colonies planted on the middle and upper Keys except Tea Table and Indian Key, see below.

It is hoped that the interesting native snail faunas of other keys will be left undisturbed.

In 1912 cerions were planted as follows:

Cerion viaregis Bartsch, Fig. 79d (Carnegie Inst. Washington Pub., 282, 1920, pl. 7-31, fig. 21 the type; from along Kings Road, Bastain Point, Andros). Transplanted in 1912 to the following Keys: Second Ragged Key north of Sands Key, Tea Table Key (where no cerions could be found in 1938), Duck Key, Newfound Harbor Key (found to be in flourishing condition in June, 1924), Boca Grande Key, Tortugas at Garden Key and Loggerhead Key.

Cerion viaregis Bartsch, Fig. 79d (Carnegie Inst. Washington Pub., 282, 1920, pl. 7-31, fig. 21 the type; from along Kings Road, Bastain Point, Andros).



The history of some of these colonies up to 1919 together with observations on the characters of the shells in the first two generations have been given by Bartsch in *Experiments in the breeding of Cerions*, Department of Biology, Carnegie Institution of Washington, Vol. XIV, Pub. No. 282, 1920. It appears that in 1919 pure colonies showed but little if any divergence from the parent stocks. Where the ribbed *C. viaregis* hybridized with the smooth native *C. incanum*, at Newfound Harbor Key, a heterogeneous progeny resulted, consisting of all grades of sculpture between the two parent species, together with numerous specimens copiously marked with brown, as in *C. incanum* form *fasciatum*. This is a normal result, as crosses between distinct species are known in other cases to produce conspicuously polymorphic progeny in the second (F_2) generation; the parent species differing by many genes, allow many combinations among the gametes.

In 1924 Dr. Bartsch added Cuban cerions to the Tortugas populations.

"A sufficient series [was collected] of a strongly spirally striated new species of *Cerion* belonging to the *Cerion johnsoni* group at Mariel, where also a large number of *Cerion sculptum* likewise, though less strongly, spirally striated, were gathered. In addition to these, *Cerion mummia* from Marianao and *Cerion chrysalis* from Cabanas Fort and *Cerion tridentatum* from Rincon de Guanabon were collected and planted at the Tortugas as follows: 500 *Cerion mummia* from the point at Miramar, Cuba; 500 *Cerion chrysalis* from near Cabanas Fort, Cuba; 500 *Cerion sculptum* from near the lighthouse at Mariel, Cuba; 125 *Cerion* n. sp., young specimens, from a little east of the point at Mariel, Cuba; 500 *Cerion tridentatum* from Rincon de Guanabon. These were planted on the west and north side of the parapet at Fort Jefferson on Garden Key, each duly marked with a stake and tag.⁴⁸

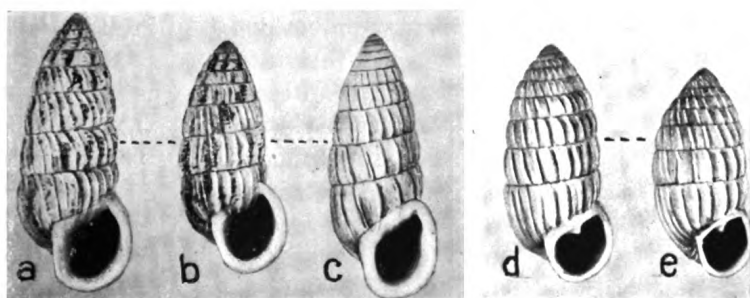


Fig. 78. a, b, c, *Cerion fastigatum*, Garden Key. d, e, *Cerion casablancae*, Garden Key.

C. viaregis and *C. incanum*, and *C. tridentatum* and *C. incanum*, were planted in 1924 on opposite extremities of the seaside leg of the Fisheries station grounds at Key West.

⁴⁸ Carnegie Inst., Year Book No. 23, 1924, p. 187.

Cerion uva (L.) from Curaçao. Planted on Loggerhead Key, Tortugas, in 1916, but in 1924 said to be "on the verge of extinction."

No specimens referable to *C. mumia* (Brug.)⁴⁹ or *C. viaregis* Beh. have appeared in the collections made in 1941 by Dr. Bales or Mr. McGinty on the Tortugas.

Cerion chrysalis fastigatum (Maynard). Fig. 78 a, b, c. Found abundant on Garden Key in 1941, both white and maculate. The cone of the shell is smooth, of flattened whorls. The last 3 or 4 whorls are costate. Parietal tooth is very low or wanting. Doubtless descendants of the 1924 planting.

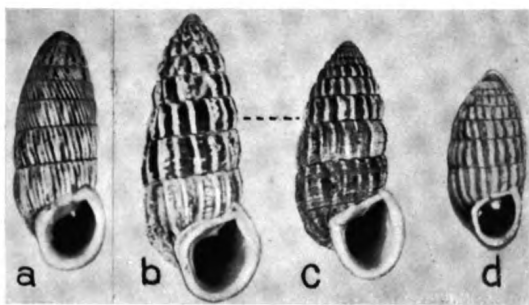


Fig. 79. a, *Cerion striatellum*, Ponce, Puerto Rico. b, c, *Cerion sculptum* form *marielinum*, Garden Key. d, *Cerion viaregis*, type, after Bartsch.

Cerion sculptum (Poey), form *marielinum* Torre,⁵⁰ Fig. 79 b, c, Garden Key, Tortugas. A subcylindric, ribbed species with the strongly convex whorls of the cone ribbed and the later whorls often with engraved spiral lines though there are many specimens without them. Color vinaceous drab with ivory or whiter ribs. Abundant on Garden Key in 1941. This also must have been planted in 1924.

Cerion tridentatum Pilsbry & Vanatta. Fig. 80. Specimens from Rincon de Guanabon, Cuba, were planted on Garden Key in 1924. They remain abundant and are variable, passing by continuous variation from the smooth typical form, which is rare on Garden Key, to the finely ribbed forma *costellata*, illustrated in Fig. 80, b, c, d. Teeth are typically as in Fig. 78e, but they vary somewhat individually. This species is type of the subgenus *Paracerion* P. & V., 1895.

⁴⁹ I do not know what species Dr. Bartsch had in mind as *C. "mumia."* The identification of *Bulimus mumia* of Bruguière has always been extremely dubious. It can be settled only by examination of the type, if extant.

⁵⁰ Torre in Pilsbry, 1927 *Nautilus*, 40: 75, pl. 1, fig. 10. Lighthouse at Mariel, P. del R., Cuba. The type, 141505 A.N.S.P., has only faint traces of spiral lines, but they are well developed in others of the same lot. Though of much longer figure than *C. sculptum* (Poey), it is probably not specifically distinct.

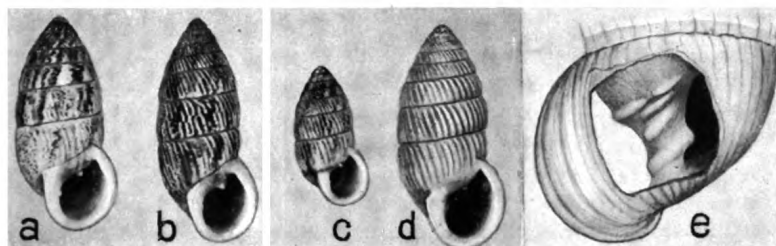


Fig. 80. *Cerion tridentatum*, Garden Key, Dry Tortugas; at e the back opened to show arrangement of teeth.

These experimental plantings appear to indicate that the shell features characterizing species of *Cerion*, are not changed by any direct action of such ecologic factors as may have been altered by their transplantation. Or at least, in the short time since they were transplanted, no obvious change is observable.

Family X. ACHATINIDAE

Sigmurethrous snails with the central tooth of the radula very narrow (with few exceptions), its cusp small or absent, the lateral teeth tricuspid or bicuspid, marginals similar or split into many denticles. Jaw plaited, striated, or rarely smooth. Shell ovate, turritid or cylindric, well developed and capable of containing the entire soft parts; the columella frequently truncated below.

This large group of mainly tropical snails is made up of several series of genera, as arranged in *Manual of Conchology*, Vol. 18, 1906, and with some changes in Thiele's *Handbuch*, 1931. Though the shells of these divisions are rather distinct in appearance, and there is great anatomic diversity, yet really differential definitions of the major divisions are not easy to frame. Conspicuous structures, such as kidney form, foot structure, teeth and shells do not seem to fall together to form consistent groups. Probably some of these characters, such as the transverse kidney in *Opeas* and *Cecilioides*, a modification of the triangular type of kidney, have arisen independently in more than one of the phyletic lines.

These problems, however, lie rather beyond the limits of this work, since none of the species appear to be indigenous members of our fauna, all being thought to be immigrants during the period of European occupation. For the present, then, we leave all in the family Achatinidae, accepted in a wide sense.

The Achatininae, comprising large, ovate or oblong shells, usually with conspicuous stripes, having an oblong kidney extending well forward of the pericardium, and a strictly holopod foot, are not represented here, being exclusively African.

SUBULININAE

Stenogyrinae Pilsbry, 1905, Man. Conch., 17: viii; 1907, 18: vii.

Subulinidae Thiele, 1931, Handbuch der Syst. Weichtierk., 1: 549.

The shell is turritid or cylindric, usually unicolored, rarely having darker streaks, no zigzag markings. No internal lamellae. Apex globose in our genera. Axis slender, solid or nearly so. Columella either truncate or continuous with basal lip. Jaw vertically striate or plaited. Radula with narrow central tooth, the short cusp simple or with side point.

RUMINA Risso

Rumina Risso, 1826, Hist. Nat. Eur. Mérid., 4: 79, for *R. decollata* only.—Pilsbry, 1905, Man. Conch., 17: 211.

Stenogyra of many authors, not Shuttleworth.—Binney, 1878, Terr. Moll., 5: 191.

Shell perforate, cylindric or tapering, 4 to 7 whorls remaining in adults in which the summit is truncate and closed by a spiral convex septum; about 8 to 10 whorls having been lost by successive breakages. Aperture subvertical, ovate, the outer lip simple, obtuse; columella vertical, slightly concave, continuous with the basal lip; columellar margin reflexed. Apex globular, smooth, fine striae appearing on the third whorl; young shells (Fig. 82c) with concave lateral outlines.

Genitalia (Fig. 81e). The penis is a rather slender sack, with terminal retractor and vas deferens, the latter superficially imbedded in its integument. Internally the upper third is granulose and with two strong pilasters between which the vas deferens opens by a simple pore. The middle third has profusely folded wall, and the anterior third few folds. The vagina is longer than the penis; duct of the spermatheca short.

The pallial organs resemble those of *Limicolaria* and *Achatina* in the type of venation of the lung, but differ in the much shorter, triangular kidney (*k*), which is somewhat longer than the pericardium. The secondary ureter (*s.u.*) is closed (Fig. 81a).

The right ocular and tentacular muscles are united proximally with the columellar muscle. The pharyngeal retractor unites with the left ocular band (Fig. 81c). The retractor of the penis is a branch of the right ocular band. The salivary glands are united around the oesophagus (Fig. 81b).

The jaw is arcuate, with rather weak vertical striae.

The radula (Fig. 81d, after W. G. Binney) has a narrow tricuspid central tooth, and tricuspid laterals. The marginal teeth are formed by suppression of the entocone, being thus bicuspid.

The eggs are globular, white, and about 2.5 mm. in diameter.

Rumina decollata (Linnaeus)

Fig. 82.

Helix decollata Linnaeus, 1758, Syst. Nat., (10) p. 773 (in Europa Australi).

Stenogyra decollata L., Binney, 1878, Terr. Moll., 5: 193, fig. 98.

Bulimus decollatus L., Pfeiffer, Monogr. Hel. Viv., 2: 152; 8: 130.—Binney, Terr. Moll., 2: 280, pl. 50, fig. 1. Leidy, *ibid.*, p. 259, pl. 15, figs. v, vi (anatomy).

Bulimus multilatus Say, 1823, Jour. Acad. Nat. Sci. Phila., 2: 273.

Rumina decollata L., Pilsbry, 1905, Man. Conch., 17: 212.—Pilsbry & Ferriss, Nautilus, 28: 11.—Garth, 1924, Science, 60: 83 (learning a maze).

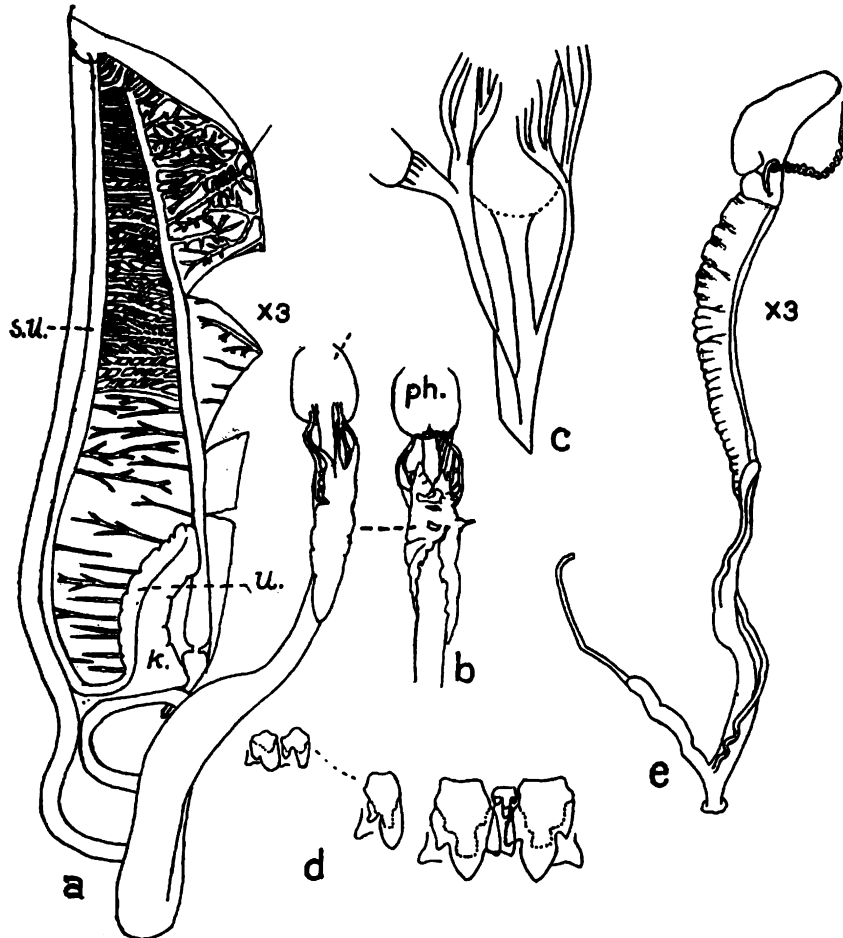


Fig. 81. *Rumina decollata*. a, pallial complex and alimentary canal $\times 3$; b, salivary glands from below; c, free retractor muscles; d, teeth (after W. G. Binney); e, genitalia $\times 3$. k, kidney; ph, pharynx; sp, spermatheca; su, secondary ureter; u, ureter (drawn by E. G. Vanatta).

Shell narrowly rimate, cylindric or cylindric-tapering, truncate and closed by a spiral convex plug at the summit; rather thin, glossy, pale flesh-tinted or whitish, the young light brown. Surface irregularly striate, distinctly so below the suture, more or less malleate, and usually showing some spiral lines or vertical punctures. 4 to 6 whorls usually remain in adults; they are but slightly convex. Aperture ovate, the outer lip simple, more or less thickened within; columella vertical, nearly straight, its edge reflexed above, almost closing the minute umbilical crevice.

Length 26, diameter 11 mm.; $4\frac{1}{2}$ whorls. New Orleans.
 Length 22.5, diameter 10 mm.; 4 whorls. New Orleans.
 Length 30, diameter 10.5 mm.; $5\frac{1}{2}$ whorls. San Antonio.

Distribution.—Mediterranean region, in Europe, Asia and Africa.

NORTH CAROLINA: Greenfield Lake, Wilmington (J. L. Baily, Jr., 1940). **SOUTH CAROLINA:** Charleston (Stephen Elliott, 1822). **FLORIDA:** Pensacola, Escambia Co. (Van Hyning, 1938). **GEORGIA:** Savannah (G. H. Clapp, 1933). **ALABAMA:** Mobile L. H. McNeill, 1912; Demopolis, Marengo Co. A. F. Archer, 1935). **MISSISSIPPI:** Bay St. Louis (Baily, 1940). **LOUISIANA:** New Orleans (Ferriss, 1906). **TEXAS:** Dallas (E. P. Cheatum, 1933; Austin (A. Olsson); Schulenberg, Fayette Co. (J. A. Weber); New Braunfels (H. B. Baker, 1929); Missions near San Antonio, Corpus Christi and Del Rio (Baily, 1940); Brownsville (Ferriss, 1913).

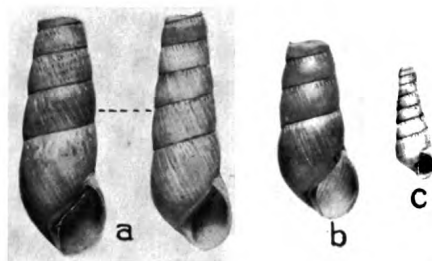


Fig. 82. *Rumina decollata*. a, near San Antonio. b, New Orleans; c, young shell retaining the globose apex.

This common snail of the Mediterranean region is now widely spread, being found in Bermuda, Havana, many places in Mexico and in our southern states. It appears to thrive wherever imported in the South, usually urban or suburban, in gardens and uncultivated plots. Binney writes: "It is very voracious in its habits. I kept a number of individuals received from Charleston a long time as scavengers, to clean the shells of other snails. As soon as a living *Helix* was placed in the box with them, one would attack it, introduce itself into the inner whorls, and completely remove the animal. Leaving a number of *Succinea ovalis* Gld. with them one day, the former disappeared entirely in a short time. The *Stenogyra* [*Rumina*] had eaten shell as well as animal." It eats vegetable matter also.

SUBULINA Beck

Subulina Beck, 1837, Index Moll., p. 76.—Gray, 1847, Proc. Zool. Soc. Lond., p. 177, 178, type *Bulimus octonus*—Herrmannsen, 1849, Indices Gen. Malac., 2: 522.—Pilsbry, 1906, Man. Conch., 18: 71, 220.—H. B. Baker, 1927, Occas. Pap. Mus. Zool. Univ. Mich., 182: 2 (anatomy).

Shell *imperforate* at all stages of growth, narrow, turreted, or subulate, thin, corneous or brownish, usually more or less translucent; apex obtuse, rounded, the embryonic shell either smooth, plicate below the sutures or vertically ribbed. Last whorl angular or rounded at the periphery. Aperture small, oblique, ovate, the *columella concave above, obliquely or abruptly truncate at base*. Eggs oblatly spheroidal with calcareous shell.

Distribution.—Tropical America and Africa; one species, *S. octona*, widely spread by commerce.

Subulina octona has been described by Wiegmann. The jaw varies from finely and coarsely striate (Fig. 83i) to plaited, the latter condition due apparently to immaturity. The radula has from 30,1,30 to 36,1,36 teeth (Fig. 83a). The middle tooth has a well-developed cusp with more or less distinct traces of side cusps, especially in embryos, indicating a primitively tricuspid condition. The lateral teeth are tricuspid, and pass gradually into the marginal type. The latter remain tricuspid, but often the ectocone is split on the outer teeth.

The kidney is long, triangular, somewhat curved, 6 or 7 mm. long, 1.8 wide at the base. It is about half as long as the lung and three or four times the length of the pericardium. The secondary ureter is closed throughout.

The genitalia (fig. 83h) are remarkable for the great development of the female organs, with poorly developed or rudimentary male organs. In immature shells of 6 mm. length there are eggs in the uterus, while the penis, etc., is very little developed, suggesting that the female organs precede the male in functional activity. The small penis is simple, as in *Rumina*, with a terminal retractor [see below]. The uterus contains several—at most four or five—subglobular, hard-shelled eggs 2 to 2.1 mm. in diameter, the anterior ones containing embryo shells, Fig. 83f. The spermatheca has a very short duct.

The right ocular retractor passes between the branches of the genitalia.

Dr. H. B. Baker states that "The actual penis consists of three regions: a flagellar appendix, a long, slender region, and a swollen base inside of the heavy sheath. The apical appendix is about $\frac{1}{4}$ the length of the entire organ, it has thick, internally plicate walls and a quite large cavity, which opens into the lumen of the penis on one side of the penial papilla. The vas deferens enters the penial wall a little above the base of the flagellum and opens into the cavity of the penis through a rather elongate papilla. The slender region of the penis is about $\frac{2}{3}$ of its length and has a relatively large, simple lumen with quite thin walls. The basal portion forms the remaining $\frac{1}{4}$ and is 4 or 5 times the diameter of the slender region; it develops a large lumen and thick, muscular walls, which are completely folded internally. The penial retractor is over half as long as the entire copulatory organ, arises from the diaphragm near the base of the uterus, and inserts on the apex of the flagellum. This complicated apparatus appears to be a remarkably efficient structure instead of a vestigial one, as suggested by Weigmann (pp. 214-5); nevertheless, I am inclined to agree with him that this species is probably protandrous."

***Subulina octona* (Bruguière)**

Fig. 83.

Bulimus octonus Bruguière 1792, *Encycl. Méth.*, 1: 325.

Subulina octona Brug., Pilsbry, 1906 *Man. Conch.*, 18: 222, pl. 39, figs. 28-37, 39; *Nautilus*, 6: 107 (greenhouse in Philadelphia).

Shell imperforate, thin, translucent, yellowish-corneous, turrite, regularly tapering to the obtuse summit, very glossy, irregularly wrinkle-striate. Whorls 9 to 11, quite convex, parted by a deep and in places irregularly crenulate suture, the first $2\frac{1}{2}$ or 3 whorls regularly crenulated by a series of short, fine subsutural folds. Aperture small, ovate, somewhat oblique;

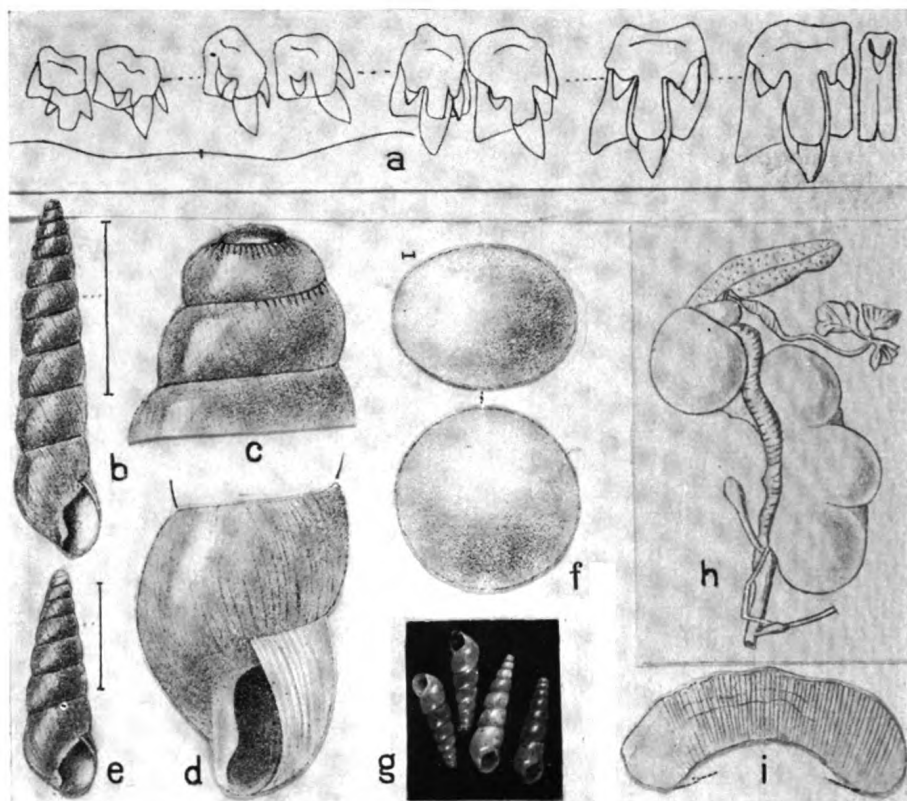


Fig. 83. *Subulina octona*. a, teeth; b, c, d, e, shells, enlarged; f, two views of egg; g, shells, actual size. h, genitalia (the penis imperfectly developed or decadent); i, jaw. (Figures a, h, i after Wiegmann.) Scale lines = actual size.

outer lip thin; columella concave above, obliquely and deeply truncate at its base. Length 17 mm., diameter 4.3 mm.; 9 whorls. Miami.

Distribution.—Tropical America; introduced in Africa, Ceylon, East Indies, etc.

FLORIDA: Brickell's Hammock, Miami (S. N. Rhoads, 1899; Richard F. Deckert, 1930). Little River (C. C. Allen, 1921). Coral Gables (E. A. Andrews, 1937).

The large size and distinctly but not abruptly truncate columella are characteristic. Besides its occurrence in Florida, where it was doubtless introduced on palms or other plants, it occasionally turns up in greenhouses in the northern states. It was found in Horticultural Hall, Fairmount Park, Philadelphia, before 1895.

In *S. octona*, reproduction begins before the shell has attained two-thirds its maximum size, and usually several eggs may be seen through the shell within the penultimate whorl. The egg-capsules are hard-shelled, white and flattened, measuring 1.8×1.5 mm. (Fig. 83f.)

LAMELLAXIS Strebel & Pfeffer

Lamellaxis Strebel & Pfeffer, 1882. *Beitrag Mex. Land- u. Süßwasser-Conch.*, 5: 109.—H. B. Baker, 1945, *Nautilus*, 58: 85, type *L. mexicanus* (Pfr.).

Opeas and *Leptinaria*, in part, of authors.

The small, perforate shell is turrated, with an obtuse, rounded, nearly smooth apex, and convex, variously striate whorls. Aperture rather small, without parietal lamella. Peristome thin, with the columellar margin expanded or reflected, its face typically tapering downward and bearing a low spiral fold, giving the inner edge an obliquely truncate or excised outline (but in the subgenus *Allopeas* the columella is rounded, smooth, and curves continuously into the basal margin).

The kidney is triangular, a little longer than the pericardium, its base extended to, or nearly to, the hindgut. Ureter complete.

The right eye retractor lies in the peni-oviducal angle; penial apex is bifid, with a caecum alongside of epiphallus, near apex of which the vas deferens enters. The penial retractor arises from (or near) the tail retractor. Radula with lateral teeth tricuspid, this condition continuing nearly to the outer edge.

Anatomic research has shown that the long series of snails formerly included in *Opeas* is not homogeneous. *Opeas* proper has been restricted by Dr. H. B. Baker to species agreeing with its type, *O. pumilum*. "*Lamellaxis* is separated from *Leptinaria* and expanded, as a genus to cover most of the species which have usually been included in *Opeas*. Although the simple, straight columella of *Allopeas* is very different from the spirally thickened axis of *Lamellaxis* s. s., almost every intergradation occurs in intermediate species." (H. B. Baker.)

Lamellaxis in its original limits contained only tropical American species having a small spiral axial lamella causing the basally somewhat excised columella to appear more or less decidedly truncate. None of these species are known to live in cultivated grounds where they are likely to be expatriated.

Another group of snails, numerous and widely spread, was formerly included in *Opeas*. They are similar in internal anatomy to *Lamellaxis*, but the whorls increase less rapidly, the outline thus being less conic, and the columella is either only slightly truncate (*Eutomopeas*), or continuously curving into the basal margin (*Allopeas*). Part of them are highly adaptable forms and have been spread by commerce over the whole tropical world. Carried with plants, they are often found in hothouses. This series is for the present considered to be a subgenus of *Lamellaxis*.

Subgenus ALLOPEAS H. B. Baker

Allopeas H. B. Baker, 1935, *Nautilus*, 48: 84, type *Lamellaxis gracilis* (Hutton).

Shell with relatively simple, straight columella. It is nearly equivalent to *Opeas* of authors before 1945, as in *Man. Conch.*, vol. 18, exclusive of *O. pumilum* and its immediate allies.

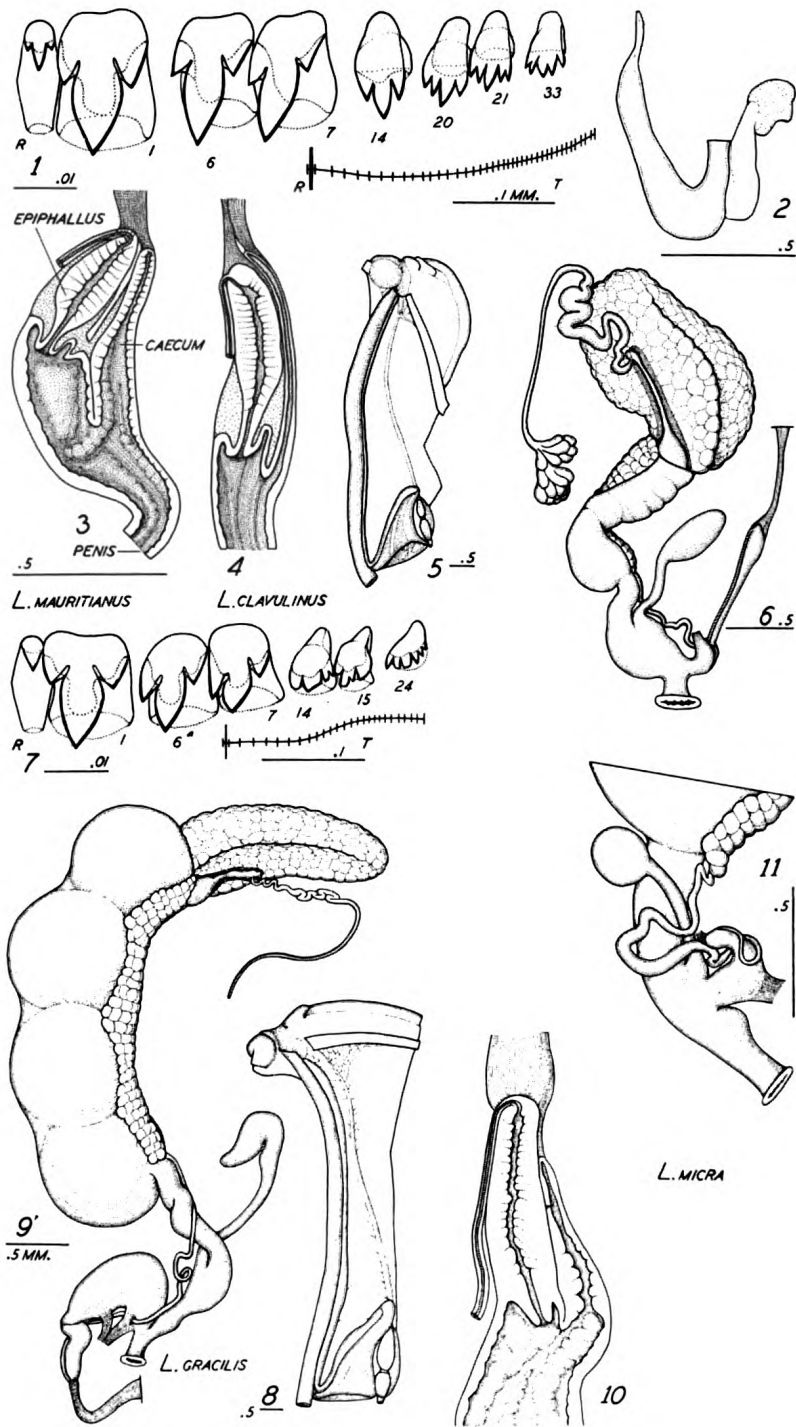


Fig. 84. See bottom of page 177 for legend.

Lamellaxis gracilis (Hutton)

Fig. 85 f, g.

Bulimus gracilis Hutton, 1834, Jour. Asiat. Soc. Bengal, 3: 93, 84.*Opeas gracile* Hutton, Pilsbry, 1906, Man Conch., 18: 125, 198.—Pilsbry & Bequaert, 1927, Bull. Amer. Mus. N. H., 53: 459 (distribution mapped).—Wheeler & Archer, 1938, Nautilus, 52: 29.*Achatina subula* Pfeiffer, 1839, Wiegmann's Archiv f. Naturgeschichte, 1: 352 (Matanzas and Havana).—H. H. Smith, 1912, Nautilus, 25: 114 (Mobile).*Stenogyra subula* Pfr., Binney, 1878, Terr. Moll., 5: 195, figs. 97, 99, pl. iv, fig. p (teeth); 1885, Man. Amer. Land Sh., p. 426, fig. 473 (Mobile).*Bulimus octonoides* Orbigny, 1841, Moll. Cuba, 1: 177, pl. 11, figs. 22-24.*Lamellaxis (Allopeas) gracilis* (Hutton), H. B. Baker, 1945, Nautilus, 58: 88 (anatomy).

The shell is minutely perforate, thin, slender, regularly tapering to the small, slightly obtuse apex. Very pale gray. Whorls moderately convex. Sculpture of distinct arcuate striation. Aperture oval, rather long; columella straight, reflected. Length 10 mm., diameter 3 mm.; 8 whorls.

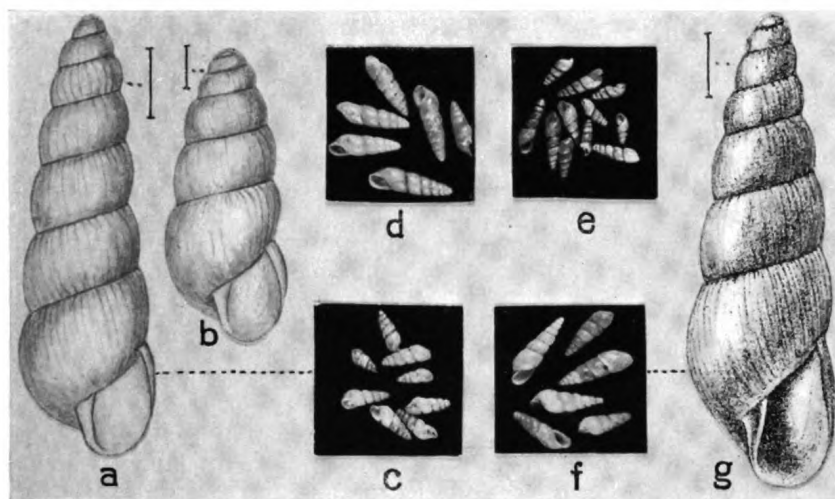


Fig. 85. a, b, c, *Lamellaxis micra*, Miami. d, *L. mauritanus*, Chicago. e, *Opeas pyrgula*, Philadelphia. f, g, *Lamellaxis gracilis*, Key West and Cuba. Figures c, d, e, f, actual size. Scale lines = actual length.

Fig. 84. *Lamellaxis*. 1-3, *L. (Allopeas) mauritanus*, Mauritius, collected in 1906 by W. F. Webb (A.N.S.P. 91186). 1, radula: central with 1st lateral, 6th with 7th, 14th, 20 with 21st and 33rd teeth; also line of right half of transverse row (T) with widths of central and all teeth indicated. 2, spermatophore from vagina. 3, optical section of apical 4 of penis and epiphallus. 4-7, *L. (Eutomopeas?) clavulinus*, Royal Botanical Garden, Edinburgh, Scotland, collected by A. R. Waterson. 4, optical section of apical 4 of penis and epiphallus. 5, internal view of pallial complex. 6, dissected genitalia. 7, radula: central with 1st lateral, 6th with 7th, 13th with 14th, and 24th teeth; also line of transverse row (T) as in fig. 1. 8-10, *L. (Allopeas) gracilis*, San Juan, Puerto Rico, collected June, 1922. 8, internal view of pallial complex. 9, dissected genitalia (ovotestis omitted). 10, optical section of apical 1/3 of penis and epiphallus. 11, *Lamellaxis (Leptoepas?) micra*, Marianao, Cuba, collected June 14, 1926; penis and terminations of female genitalia. (Drawn by H. B. Baker.)

Distribution. — Tropics of both hemispheres, abundant in cultivated districts.

SOUTH CAROLINA: Bennett's Mill, Charleston (Wm. G. Mazyck). GEORGIA: Savannah (G. H. Clapp, 1914). FLORIDA: Key West (Binney; S. N. Rhoads, 1905; Pilsbry); Fort Dallas⁵² (Cooper, in Binney, 1865). ALABAMA: Mobile, low land near the river (H. H. Smith); Birmingham, in a vacant lot, 16th St. and 10th Ave. (H. E. Wheeler & A. F. Archer, 1938). LOUISIANA: City Park, New Orleans (Rhoads, 1905).

This is perhaps the most widely ranging of all land snails. It was first described from Mirzapur, in the Ganges valley, but it is now so ubiquitously diffused that its original patria is uncertain. I think it probably indigenous in tropical America.

Its chief characters are the straight, high spire, very equable and moderate convexity of the whorls, the distinct and decidedly arcuate striation, usually appearing a little puckered below the suture, and the long aperture. In many lots a slender and a stouter form occur together. Local variation is chiefly in size and number of whorls. The Charleston specimens seen are small, about 8 mm. long, with 7 whorls.

Dr. H. B. Baker has given the following anatomical description, Fig. 84: 8-10. "Animal similar to *Leptinaria unilamellata*, but foot relatively small, although also with only one irregular pedal groove. Lung about 4.5 times as long as its base or 4 times length of kidney, which is over 1.5 times its base or $1\frac{1}{4}$ times length of large pericardium. Ototestis of 5 lobes. Talon very shortly recurved. Carrefour quite long. Uterus more elongate, swollen by 4 to 10 large, white shelled eggs. Spermathecal sac fusiform. Vagina swollen. Vas deferens entering apex of epiphallus. Penis slender with enlarged apex when extended, but capable of almost complete retraction into heavy basal sheath that receives branch of right lateral retractor; epiphallus terminating in short vergic papilla; appendicular caecum (along side of epiphallus) lanceolate, with thick tessellate wall and with apex some distance below that of epiphallus. Penial retractor connected by anastomosing fibers with right lateral muscle; inserting on loop of vas and on apices of both epiphallus and appendix. Atrium opening about midway between base of right ommatophore and anterior margin of visceral stalk. Columellar retractor gives off left retractor near origin, right one shortly below, and spreads out into tail fan, which gives off penial retractor. Left retractor gives off heavy buccal muscle near root of tail and divides into left ommatophoral, inferior tentacular and a few weak bands to side of foot. Right one gives off tentacular retractors and spreads out to side of foot, atrium and basal penial sheath. Right eye muscle in peniovidual angle."

Lamellaxis micra (Orbigny)

Fig. 85 a, b, c.

Helix micra Orbigny, 1835, *Magazin de Zool.*, p. 9; *Voy. Amér. Mérid.*, *Moll.*, p. 262, pl. 41, figs. 18-20.

Opeas micra Orb., Pilsbry, 1906, *Man. Conch.*, 18: 193.

Bulimus octonoides C. B. Adams, 1845, *Proc. Boston Soc. N. H.*, p. 12. Not of Orbigny, 1841.

⁵² Now Miami, see footnote 54, p. 179.

Stenogyra octonoides "d'Orbigny" Binney, 1878, Terr. Moll., 5: 194, pl. 53, fig. 4.⁵³

Lamellaxis micra (Orb.), H. B. Baker, 1945, Nautilus, 58: 90.

The shell is perforate, and tapers regularly to the very obtuse apex. The first 2 or 2½ whorls are smooth; then *widely spaced thread-like striae* appear in high relief on the weakly striatulate surface, and are usually strongest near the suture above. On the last whorl the striae became less emphatic and closer. This description applies to well-sculptured shells; very often the striae are much weaker, almost obsolete except immediately below the sutures; and in most lots there are intermediate forms also. Length 7 mm., diameter 2.3 mm.; 6½ whorls. Miami.

Distribution.—Bolivia to Mexico and the West Indies.

FLORIDA: Tortugas; Key West; Miami.⁵⁴

The whorls are shorter than in *L. gracilis*, with uneven sculpture.

Lamellaxis mauritianus (Pfeiffer)

Fig. 85 d.

Bulimus mauritianus Pfeiffer, 1852, P. Z. S., pt. 20, p. 150.

Opeas mauritanum (Pfr.), Pilsbry, 1906, Man. Conch., 18: 133.

Lamellaxis (Allopeas) mauritianus (Pfr.), H. B. Baker, 1945, Nautilus, 58: 89 (anatomy).

The shell is very glossy, only weakly striate, and the spire has distinctly convex outlines, being wide above, with the subcylindric contour Pfeiffer mentions. This characteristic shape is much less noticeable in young and immature shells. The outer lip is moderately arched forward. Length of an adult shell 11.5 mm., diameter 3.4 mm., aperture 3.3 mm.

Distribution. — Mauritius, type locality. Hothouses in various places, Illinois, New York, Washington, D. C., etc.

This snail has been carried on plants or otherwise over the tropics and into greenhouses. Its original home is unknown.

Dr. H. B. Baker dissected specimens from Mauritius. Fig. 84: 1-3. "Animal similar to *L. gracilis* but kidney triangular, about ¾ as long as its base and about 1½ times pericardial length. Uterus with 3 eggs (diam. 1.3 mm.). Spermatheca with shorter stalk and with ovoid basal swelling. Vagina with more globose enlargement, which in one animal contained 3 spermatophores with fusiform horny capsules. Penis with thinner basal sheath; lower .6 slender with internal pilasters; apical .4 swollen; epiphallus shorter and stouter than appendicular caecum, which reaches penial apex. Radular formula 22 + 17 + 1 + 39, with 97 rows; outer teeth with elongate backs, retaining tricuspid fascies although multicuspoid."

Lamellaxis clavulinus (Potiez & Michaud)

Fig. 86 a.

Bulimus clavulinus Potiez et Michaud, 1838, Galerie Moll. Mus. Douai, 1: 136.

Opeas clavulinum (P. & M.), Pilsbry, 1906, Man. Conch., 18: 135.

⁵³ Binney credited this species to Orbigny, but *Bulimus octonoides* of that author is the Cuban snail Pfeiffer described as *Achatina subula*, now known as *Lamellaxis gracilis* (Hutton). In 1845 C. B. Adams used the name *B. octonoides* for another species, in ignorance of Orbigny's earlier use of the same name.

⁵⁴ "Fort Dallas," mentioned by Binney as a locality for this and some other species, was situated in what is now the heart of Miami, near the mouth of Miami River on the north side, about a hundred yards west of the Brickell Avenue bridge. The old blockhouse was removed to Dallas Park (Ralph H. Humes *in litt.*).

Lamellaxis (Tomopeas?) clavulinus (P. & M.), H. B. Baker, Nautilus, 58: 89 (anatomy).

Opeas kyotoensis Pilsbry, 1904, Proc. Acad. Nat. Sci. Phila., p. 638: and as var. of *clavulinum*, Man. Conch., 18: 136, pl. 21, figs. 3-6.

Bulimus (Stenogyra) johanninus Morelet, 1877, Jour. de Conch., p. 333, pl. 12, fig. 3 (Comoro Is.)—Pilsbry, Man. Conch., 18: 153.

[?] *Subulina urichi* Smith, 1896, Jour. of Conch., 8: 235, from Trinidad.

The shell is openly perforate, pale yellowish-corneous; striate but the sculpture is decidedly weaker than in *L. gracilis*; glossy. The sides slope almost straightly, but are a little convex near the obtuse apex. The upper part of the spire is wider than in *L. gracilis*. Whorls 7, moderately convex; the suture slightly irregular but not crenulate. Aperture about as in *L. gracilis*. Length 7 mm., diameter 2.4 mm.

Distribution.—Bourbon Island, type locality, and other islands of the Indian Ocean; Japan; Hawaii; Phipps conservatory, Pittsburgh, Pa.

The individual whorls are shorter than in *L. mauritanus*, and the angle between parietal wall and columella is not nearly so wide. In the latter species this angle is much as in *L. gracilis*.

Dr. H. B. Baker dissected specimens sent under the name *Leptinaria urichi* from hothouses in the Royal Botanical Garden, Edinburgh, Scotland, which "agree very closely with Dr. Pilsbry's *Opeas clavulinum*." Fig. 84: 4-7.

"Animal similar to *L. gracilis* but lung about 3.5 times as long as its base or length of kidney, which is a little longer than its base or length of pericardium. Free oviduct considerably shorter, vagina relatively larger and basal sheath of penis less extensive. Uterus may contain 4 eggs. Penial retractor arising from connective tissue above tail fan although connected with it. Penis long and slender; epiphallus .2 total length and slightly shorter than very attenuate caecum. Radular formula 25 + 1 + 25, with 87 rows; central unicuspid; laterals squarish; outer teeth mainly with tricuspid fascies but with spatulate cusps."

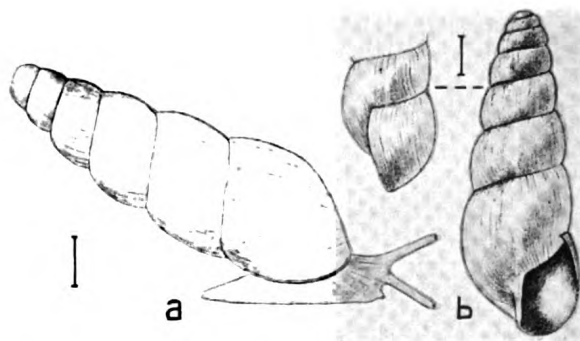


Fig. 86. a, *Lamellaxis clavulinus*. b, *Opeas pyrgula*. Scale lines = 1 mm.

OPEAS Albers

Opeas Albers, 1850, Die Heliceen, p. 175.—Von Martens, 1860, Die Heliceen, p. 265, type *Stenogyra goodalli* Miller.—Pilsbry, 1906, Man. Conch., 18: 123, in part.—H. B. Baker, 1927, Occ. Pap. Mus. Zool. Univ. Mich., No. 182, p. 8; 1945, Nautilus, 58: 85.

The shell is small, thin, turrite, usually perforate, with obtuse, rounded apex and convex or flattened whorls, uniform corneous or yellowish. Embryonic whorls smooth. Aperture small, ovate, the outer lip thin, usually arched forward, columella straight or concave, not sinuous, the columellar lip reflexed, curving into the basal lip and not toothed or truncate below. Oviparous, the egg-capsules large and spheroidal.



Fig. 87. Teeth of *Opeas pumilum* (after H. B. Baker).

The radula of the genotype, *O. pumilum* (Fig. 87) has 12-9-1-9-12 teeth. "The central has three conical cusps which project only a short distance beyond the heavy support; its base is coffin-shaped as in most Subulininae. The inner laterals are tricuspid and almost symmetrical. The teeth gradually decrease in size out to the 6th, and then more rapidly diminish out to the 10th, which develops an accessory ectocone. Beyond this, they become shorter but relatively broader and develop numerous, minute cusps. In the central and lateral regions the transverse rows are almost straight, but they curve obliquely anteriorly near the 7th tooth." (H. B. Baker.)

The jaw is composed of numerous narrow overlapping plaits, well cemented together.

The kidney is shorter than the pericardium, much wider than long, extending to the hindgut (Fig. 88). For other anatomic characters, see below, under *O. pyrgula*.

Type *Stenogyra goodalli* Miller = *O. pumilum* (Pfr.).

Distribution.—Tropical and subtropical in both hemispheres. Some species colonize freely. They occur under stones and vegetable debris and in the humus around plants, frequently in abundance.

Species few. As there is no definite conchological difference between *Opeas* and many species now placed in *Lamellaxis*, the exact number of species properly referable to *Opeas* is not known.

***Opeas pumilum* (Pfeiffer)**

Fig. 88: 4.

Helix goodalli Miller, 1822 Ann. Philos., n. s. 3: 381. Not *Helix goodalli* Férussac, 1821.

Opeas goodalli (Miller), Pilsbry, 1906, Man. Conch., 18: 200.

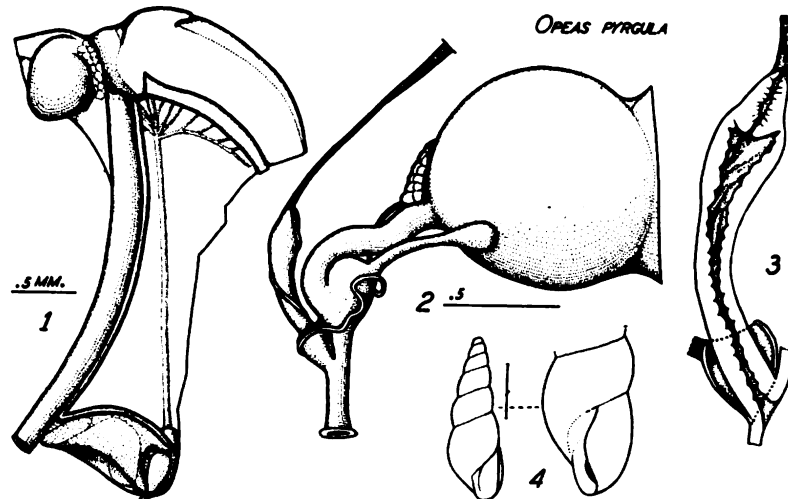


Fig. 88. *Opeas pyrgula*, Philadelphia (A.N.S.P. 44024), collected May 22, 1919, by E. G. Vanatta. 1, internal view of pallial complex. 2, penis and terminations of female genitalia (including lower half of uterus, with one egg). 3, optical section of penis and epiphallus, from mount in glycerin jelly. Drawn by H. B. Baker. 4, *Opeas pumilus*, shell.

Bulimus pumilus Pfeiffer, 1840, Archiv. Naturg., p. 252.

Opeas pumilus (Pfr.). Pilsbry, 1910, Nautilus, 24: 31.—H. B. Baker, 1927, Occas. Pap. Mus. Zool. Univ. Mich., 182: 8, pl. 21, fig. 3 (teeth); 1945, Nautilus, 58: 86.

The shell is very minutely perforate, straightly conic, with a very obtuse apex. The surface is not very glossy and is densely, sharply sculptured with irregular and rather strong striae very deeply curved, or arcuate. The outer lip is thin, and so much retracted above as to appear incised at the suture. The aperture is well rounded below, and the columellar lip is reflexed.

Length 6 mm., diameter 2 mm., length aperture 2 mm., whorls $6\frac{1}{2}$.

Length 5.3 mm., diameter 1.9 mm.; $6\frac{1}{2}$ whorls.

Distribution. — Tropical America. FLORIDA: Dismal Key, Collier Co. (Clarence B. Moore). Also in greenhouses in Pittsburgh, Chicago, and doubtless elsewhere.

Known by its narrow shape, sharp, arcuate sculpture and strong retraction of the outer lip to the suture. It is a good traveler, now widely spread. Originally described under the homonym *H. goodalli*, from around pineapples grown under glass in Bristol, England.

Opeas pyrgula Schmacker & Boettger

Fig. 85 e; 86 b.

Opeas pyrgula S. & B., 1891, Nachrbl. d. Malak. Ges., 23: 179, 180 (Kobe, Japan).—Pilsbry, 1906, Man. Conch., 18: 173.—H. B. Baker, Nautilus, 58: 86 (anatomy).

Opeas pumilus Pfr., Vanatta, 1919, Nautilus, 33: 31.

The shell is very narrow. The last two or three whorls are much flattened, only slightly convex, but parted by deep sutures which are more or

less crenulated in places by the short slender striae below them, the rest of the surface being only rather weakly wrinkle-striate. The columella is concave, widely reflexed above. The outer lip is only very weakly arched forward.

Length 8 mm., diameter 2.2 mm., 7 whorls (Savannah).

Distribution.—Japan, type locality, Kobe; China. GEORGIA: Savannah, in a park (Jas. B. Clark, 1923). PENNSYLVANIA: Northern Philadelphia in house yards (E. G. Vanatta, 1917-1934).—VIRGINIA: Norfolk (Leslie Hu- bricht, 1944).

It resembles *O. pumilum* in shape, but the striation is weaker, nearly straight, and the outer lip only slightly arched forward. The length is usually 7 to 8 mm.

Of the Philadelphia colony Mr. Vanatta wrote: "This snail has been living in the decayed boards of fences at the rear of houses in the 1800 blocks of North 17th and N. Willington streets for some time. I found the first specimen in 1917, and collected eight others April 30 and May 22, 1919. The colony is in the built-up part of the city, at the sides of a cemented alley and not near any hothouse. . . . They are quite active in daylight after a rain." Numerous specimens were taken by Mr. Vanatta up to 1934, and it is probably still to be found in that neighborhood, which was an area of vegetable gardens up to about 1870. This occurrence shows remarkable endurance, since Philadelphia has temperatures frequently below freezing during five months of the year, and in mid-winter occasionally below zero, with abundance of snow and ice.

The body of a living animal (Fig. 86b) is far shorter than the shell, amber yellow colored, the tentacles paler, the eyes very small and gray. Inferior tentacles are short but distinct. Surface is coarsely reticulate.

In Savannah Mr. Clark found it in March under leaves in a park.

Dr. Baker dissected Philadelphia specimens taken by Mr. Vanatta in his yard May 22:

"Anatomy (Fig. 88: 1-3) similar to *Neosubulina scopulorum* but pedal grooves better marked. Anal lobe of mantle glands crescentic, not markedly deflecting end of rectum. Lung about 3 times as long as its base or 5 times length of kidney, which is little over $\frac{1}{2}$ as long as wide and shorter than pericardium. Uterus very short in non-pregnant animals, but may be greatly swollen by 2 large eggs with white shells. Spermathecal stalk with shorter basal swelling which scarcely protrudes from pear-shaped vagina. Penis with a short muscular sheath around base; internally with ellipsoid epiphallic sac less than $\frac{1}{4}$ as long as penis proper and with almost no penial papilla. Columellar retractor gives off: (1) almost immediately, a heavy left retractor, which soon divides into buccal and left free retractors; (2) some distance below, the right free retractor and (3) continues as broad tail fan, from which arises long penial retractor. Each free retractor gives off: (1) lateral muscle to sides of foot (right one also to cloaca and around

penis); (2) inferior tentacular and (3) continues as eye retractor (right one through penioviducal angle). Jaw evidently composed of numerous narrow overlapping plates, with denticulate margins, but are well connected together (as in *Neosubulina*). Radula formula $10 + 8 + 1 + 20$, with 71 transverse rows; teeth very similar to *O. pumilum*."

Subfamily FERUSSACIINAE

Ferussacidae Bourguignat, 1833, Hist. Malac. Abyssinie, p. 120.—Pilsbry, 1908, Man. Conch., 19: 211.

Ferussaciidae Hugh Watson, 1928, Jour. Conch., 18: 239.

Cf. *Ferussaciinae* H. B. Baker, 1945, Nautilus, 58: 85.

Sigmurethra having a short transverse kidney extending to the hindgut, which it follows some distance forward, an anal gland at the upper angle of the mantle edge, and a well developed suprapedal groove and foot fringe. Jaw thin, crossed by many well united folds. Radula essentially achatinid (see below). Shell oblong or lanceolate, with blunt apex, smooth and glossy, unicolored.

This group, comprising about half a dozen well-marked Eurasian genera, has for many years been considered a family distinct from the Achatinidae. Perhaps that rank may be sustained; but its more important characters, such as the conspicuous suprapedal groove, the transverse kidney, the anal gland, and to some extent the penial structure, are approached by one or another genera which do not appear separable from the Subulininae.

Coilostele Benson, which has been associated with these snails, belongs to the Carychiidae. Mainly a Mediterranean group, from Spain to Asia Minor, also at Aden, it has one species, *C. tampicoensis* (Pilsbry), in the Pánuco river valley, eastern Mexico.

CECILIOIDES Férussac

Cecilioides Férussac, 1814, Mém. Géologiques, p. 48, for *Bulimus acicula* Bruguière.—Hugh Watson, 1928, Jour. of Conch., 18: 217 (anatomy and affinities).

Caecilioides Herrmannsen, 1846, Ind. Gen. Malac., 1: 150 (emendation).—Pilsbry, 1909, Man. Conch., 20: 1.—W. Wächtler, 1929, Archiv Molluskenk., 61: 1 (habits); Zeitschr. Morphol. u. Oekol. Tiere, 13: 359 (anatomy and relationships).

Caecilianella Bourguignat, 1856, Revue et Mag. de Zool., 8: 378.—Binney, 1878, Terr. Moll., 5: 189.

Macrospira Guilding, Swainson, 1840, Treatise on Malacology, pp. 171, 173, 335, for "*M. octona* (*Helix octona* Auct.)" and *aperta* Guild. Cf. Pilsbry, 1931, Nautilus, 44: 140, *M. octona* (= *Cecilioides acicula*) designated type.⁵⁵

Styloides Fitzinger, 1833, Syst. Verzeich., p. 105 (type here selected, *S. acicula*).

The shell is imperforate, very small and slender, very narrowly lanceolate, with obtuse, rounded, smooth apex; smooth, fragile, transparent

⁵⁵ Swainson's first definitions of *Macrospira* (Malac. pp. 171, 173) seem to apply far better to *Subulina* than to *Cecilioides* or *Geostilbia*, neither of which has the spire "excessively long and cylindrical," and the "aperture short, nearly round." If it be held that Swainson intended "*Bulimus octonus* instead of "*Helix octona*" (which is different, and at best is a species of dubious identity), then *Macrospira* would become a synonym of *Subulina*, as Herrmannsen thought.

(weathering to opaque white); aperture usually less than half the total length, piriform; outer lip arching forward in the middle, acute; columella concave, more or less distinctly truncate at base, usually somewhat caloused.

Animal with the usual two pairs of tentacles, but no eyes. The foot has a well-marked foot-fringe, cut off by a conspicuous horizontal suprapedal groove on each side; below it a much narrower pedal groove runs along the foot-fringe and forms the limit to which the ciliated epithelium of the sole extends.

The lung is plain, even the main pulmonary vein can be seen only close to the heart. The kidney does not extend forward beyond the pericardium, but curves behind it in such a way as to surround the first part of the aorta. It extends across the base of the lung in a comparatively narrow band to the hindgut, where it bends abruptly and passes forward nearly half way to the mantle edge. There is a large gland of unknown function in the mantle edge immediately above the respiratory orifice.

The hermaphrodite gland consists of a single large follicle. There is no talon. The penis is somewhat as in *Opeas* (Fig. 88: 3) but the posterior broad or epiphallic part is longer, projects as a penis-papilla into the cavity, and there is a pocket in the muscular wall on the right side.

The jaw is thin and flexible, light brown, rather strongly arched, and crossed by numerous slightly irregular folds (about 26 in *C. acicula*).

The radula has $10.5.1.5.10 \times 81$ teeth in *C. acicula*. Central tooth small and narrow, with a short mesocone flanked by a minute vestigial ectocone on each side. Lateral teeth tricuspid, the endocones much shorter than mesocone. Marginal teeth with extremely short serrate cusps, of 6 or 7 minute denticles.

Distribution.—Western and southern Europe, southern Asia; various forms in the tropics of both hemispheres.

Cecilioides is a calciphilous burrowing snail, often reported as found in graves and on disinterred bones or skulls. It is said to be occasionally found in greenhouses, carried about with potted plants. For figures of the anatomy with a full account and a discussion of its affinities, the beautiful papers of Hugh Watson (1928) and of Walter Wächtler (1929) should be consulted. The partial summary given above is taken from Watson's paper.

***Cecilioides acicula* (Müller)**

Fig. 89 a.

Buccinum aciculum Müller, 1774, Verm. Hist., 2: 150.

Caecilianella acicula Müll., Binney, 1878, Terr. Moll., 5: 190, figs. 95, 96.

Caecilioides acicula Müll., L. E. Adams, 1890, Jour. of Conch., 9: 297, living animal. —Wächtler, 1929, Zeitschr. Morph. Oekol. 13; Arch. Molluskenk., 61: 1-14, ecology. Cf. also, Wächtler, 1935, Zool. Jahrb. (Systematik), 67: 117-194, anatomy of *Ferussacia*.

Cecilioides acicula (Müll.), Hugh Watson, 1928, Jour. of Conch., 18: 217-243, pl. 5, anatomy, etc.

The shell is very slender, thin, transparent, polished and smooth except under a high power, when fine spiral striae appear. The spire tapers regularly. Apex blunt and rounded. The $5\frac{1}{2}$ whorls are compressed, nearly flat.

Aperture narrowed and acute above, rounded at base. Columella slightly calloused, abruptly truncate at its union with the basal margin of the lip. Length 4.5 mm., diameter 1.2 mm.

Distribution.—Central and western Europe; imported in Bermuda and elsewhere.

PENNSYLVANIA: Mill Creek, near Black Rock Road, Bryn Mawr, Montgomery Co. (J. L. Baily, Jr., 1933). FLORIDA: (Bartlett, according to A. Binney).

The specimens from Princeton, N. J., collected by A. D. Brown, and reported as *C. acicula* by W. G. Binney, turn out to be *C. aperta*; or at least this is true of those in A. D. Brown's collection; I have not seen the specimens he gave to Binney. Dr. Baily found the Pennsylvania specimens in drift debris of a small creek, probably washed out of some garden. These are the only American specimens I have seen. The record for Florida (Bartlett), given by A. Binney, has not been repeated in about a hundred years since Bartlett collected there.

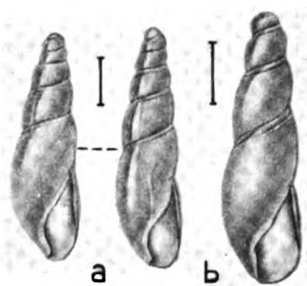


Fig. 89. a, *Cecilioides acicula*. b, *C. aperta*. Scale line = 1 mm.

Subgenus GEOSTILBIA Crosse

Geostilbia Crosse, 1867, Jour. de Conchyl., p. 184, type *G. caledonica* Crosse.—Pilsbry, 1909, Man. Conch., 20: 43.

The shell is imperforate, very small and slender, thin and fragile, narrowly lanceolate with obtuse, rounded, smooth apex; smooth, translucent. Aperture piriform, less than half the total length. Outer lip thin, arching forward in the middle. Columella concave, continuous with the basal lip, being separated therefrom only by a slight sinuation, not an abrupt truncation.

Like *Cecilioides*, *C. aperta* is blind. According to W. G. Binney, the jaw is low arched, of 22 broad ribs, which appear more separated than in *C. acicula*. Radula with 14.4.14.14 teeth shaped much as in *C. acicula*, but the central with small, distinct ectocones. Marginal teeth "very low, wide, with two low, wide cusps, each bearing several irregular, blunt cutting points."

Distribution.—Tropics of both hemispheres.

While part of the Old World forms are clearly identical with our West Indian species, some others appear to be distinct, and in that case are apparently indigenous in the eastern tropics; still, the distribution pattern resembles that of species spread by commerce, including localities scattered in Africa, Comoro Islands, Mauritius, India, Philippines, New Caledonia, Hawaii and elsewhere.

The jaw and teeth do not appear to differ much from *Cecilioides* proper, but the anatomy is not further known. Quite possibly *Geostilbia* and the minute *Karolus* may turn out to be generically separable from the European *Cecilioides*, but there seems no advantage in assuming this in advance of the evidence.

***Cecilioides aperta* (Swainson)**

Fig. 89 b.

Macrospira aperta Guild., Swainson, 1840, Treatise on Malac., p. 335, fig. 97 c. f.

Geostilbia aperta E. A. Smith, 1895, Proc. Malac. Soc. Lond., 1: 307.

Achatina gundlachi Pfeiffer, 1850, Zeitschr. f. Malak., p. 80.

Geostilbia gundlachi Crosse, 1873, Jour. de Conchyl., p. 355.

Coecilianella gundlachi Pfr., W. G. Binney, 1876, Ann. Lyc. N. H. of N. Y., 11: 152, 185, pl. 13, figs. D, G, H, I (jaw and teeth).

Caecilioides (Geostilbia) gundlachi (Pfr.), Pilsbry, 1909, Man. Conch., 20: 43.—Clapp, 1915, Nautilus, 28: 131.

The shell tapers regularly to the very obtuse, rounded apex. There are 5 whorls, very obliquely coiled, quite convex, and parted by an impressed suture. The last whorl is evenly convex. The aperture is ovate, effuse at the base; the outer lip arches forward strongly in the middle. The columella is a little concave, and near the base is obsoletely truncate. In most fully adult shells the columella has a rather heavy callus which passes up over part of the parietal wall. The color is pale corneous-brown, or sometimes almost clear corneous. There is no spiral striation. Length about 4 to 5 mm.

Distribution.—West Indies generally.

FLORIDA: south side Miami River about 2 miles up (J. B. Henderson, 1914); Coral Gables. NEW JERSEY: Princeton (A. D. Brown, prior to 1878), probably in a greenhouse or garden.

The less tapering spire and more strongly convex whorls, as well as the form of the columella, separate this from *Cecilioides acicula*.

Though a multitude of tropical plants now grow in and about Miami, the locality where Henderson took this snail in 1914 was then uncultivated wilderness. That the snails had been introduced on garden plants therefore seems doubtful. Shells very similar to this species have been found in many places in the Old World tropics. Some of them appear to be specifically identical with *G. aperta*, being apparently emigrants from the West Indies, carried on the roots of plants. They have been given many names in their new homes.

Family XI. OLEACINIDAE

The spiral shell is imperforate, elongate, with rather small or narrow aperture, unexpanded peristome and either entire, truncate or sinuous columella. The rather long and narrow foot is holopod, without pedal grooves. The kidney is triangular, or secondarily elongate, being produced backward and laterally, but it does not extend forward of the pericardium. Ureter complete. No jaw. Radula with narrow centrals, the side teeth having long, curved and tapering mesocones (and rarely ectocones). Genitalia with or without an epiphallus; talon wanting.

Distribution. — American tropical and subtropical regions; Mediterranean region; Upper Cretaceous to Pliocene of Europe.

This family of rapacious snails has numerous genera and a large number of species in the West Indies, Central America and Mexico.⁵⁶ *Euglandina* has the widest range, extending into our Gulf states, and southward into Brazil and Peru.

As fossils, Oleacinidae have a long history in Europe, but very brief in America, where *EUGLANDINA ROSEA* (Fér.) is not uncommon in the Caloosahatchee Pliocene. The only other member of the family yet found is Lower Miocene: *SIGMATAXIS TAMPÆ* (Dall).—Tampa limestone, lower Miocene, in the "Silex bed," Tampa, Florida. (*Spiraxis? tampæ* Dall, 1915, Bull. 90, U. S. Nat. Mus., p. 31.—Mansfield, 1937, Florida Geol. Bull., 15: 72, pl. 1, fig. 1). The generic position is not certain, as the single specimen known is imperfect.

EUGLANDINA Fischer & Crosse

Euglandina Fischer & Crosse, 1870, Mission Sci. Mexique, Moll., 1: 97.

Glandina Binney, 1878, Terr. Moll., 5: 81, and of most authors, not *Glandina* Schumacher, 1817.

[?] *Pfaffia* Behn, 1845, 225ste Versammlung deutscher Naturf. u. Aerzte, 2te Abth., p. 131, for an unidentified species.

The shell is usually of large or moderate size, oblong, fusiform or ovate, typically with striate or decussate surface and without distinct varices (but in some forms the surface is smooth, and sometimes varices are present). Columella abruptly truncate at the base; outer lip unexpanded, simply arched forward or straight. Whorls 6 to 9.

Type *E. aurata* var. *lignaria* (Rve.). Distribution, American mainland, from Brazil to Texas, Florida and South Carolina.

Euglandinas are active, rapacious snails, living in the haunts of ground-snails, upon which they chiefly feed. *Euglandina rosea*, which I kept in captivity, perceived its prey from a distance of eight inches, whether by sight or odor is unknown. Gliding rapidly toward it, when within striking

⁵⁶ The older genera and species are described and illustrated in Pilsbry, 1907-8, Manual of Conchology, vol. 19. For the extensive later anatomic and taxonomic work, see H. B. Baker, 1941, Nautilus, 54: 134; 55: 24, 51 (outline of classification) and 1943, Proc. Acad. Nat. Sci. Phila., 95: 1, with the references there given.

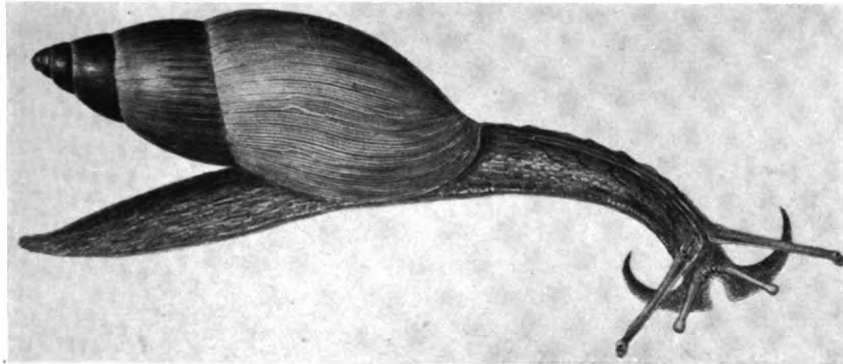


Fig. 90. *Euglandina rosea* (after Binney).

distance the *Euglandina* lunged swiftly, seizing the snail by the back. The almost instantaneous withdrawal of the victim into its shell did not loosen the hold of the *Euglandina*, which quit the repast only after the greater part had been devoured. In one instance, *E. rosea* was occupied eight hours in eating a large *Helix* (*H. vermiculata*), the fore part of the body being thrust into the aperture of the *Helix* so far that the peristomes of the shells were brought in contact. The stomach of *Euglandina rosea* frequently contains entire shells of small *Helices* which have been swallowed whole. The swift movements of *Euglandina* in attack contrast with the deliberation of most land snails.

Euglandina vanuxemensis (Lea) is a large central and south Mexican species for which Lea gave the locality Mexico. It reaches a length of 60 to 100 mm. Gould in Binney, Terr. Moll., 2: 299, 3, pl. 62, figured it and added the locality "Texas," without mentioning any authority for that state. W. G. Binney (1878, Terr. Moll., 5: 83) stated that it was "actually found in the Texas region," but that he had seen only the specimen figured on his father's plate, which he reproduced. It may well be dropped from our United States list pending confirmation of the ninety-five year old record.

Our species fall into two subgenera. In *Euglandina* s. str. (*E. rosea*) the right eye retractor lies in the atrial angle, between ♂ and ♀ branches of genitalia. In subgenus *Singleya* (*E. singleyi*), that muscle band lies free, to the left of genitalia. The other species have not been dissected.

Subgenus EUGLANDINA, s. str.

Euglandina rosea (Férussac)

Figs. 90, 91, 92.

Polyphemus glans Say, 1818, Jour. Acad. Nat. Sci. Phila., 1: 282. Not of Denys de Montfort, 1810.

Helix rosea Férussac, 1821, Tabl. Syst. Limaçons, p. 50, no. 356.

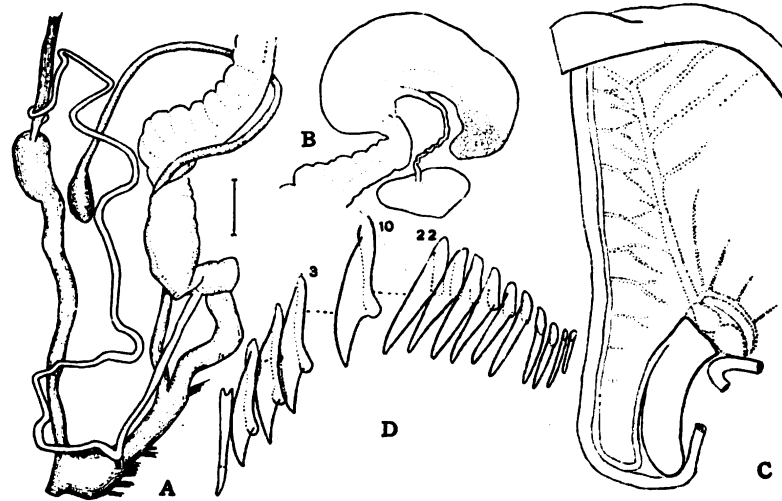


Fig. 91. *Euglandina rosea*. A, B, genitalia, a section omitted, scale line = 5 mm. C, pallial region of an immature individual. D, parts of a half row of teeth.

Glandina truncata Say, 1831, Amer. Conch., 2 pl. 20.—Leidy, 1851, Terr. Moll., 1: 258, pls. 14, 16.—Binney, 1851, Terr. Moll., 2: 301, pls. 59, 60, 61, fig. 2, 62, fig. 2.—W. G. Binney, 1878, Terr. Moll., 5: 84, pl. i, fig. A (teeth).

Glandina truncata var. *abbreviata* Von Martens, 1860, Die Heliceen, pp. 26, 29.

Glandina parallela W. G. Binney, 1857, Proc. Acad. Nat. Sci. Phila., p. 189; 1859, Terr. Moll., 4: 140.

Glandina truncata var. *ovata* Dall, 1890, Trans. Wagner Free Inst. Sci., 3, pt. 1, p. 19.

Glandina truncata var. *macer* Dall 1890, *ibid.*

Glandina truncata var. *minor* W. G. Binney, 1885, Man. Amer. Land Sh., p. 475.—Rhoads, 1899, Nautilus, 13: 46.

Euglandina rosea Fér., Pilsbry, 1907, Man. Conch., 19: 191.—J. B. Henderson, 1907, Nautilus, 21: 7.—Walker, 1928, Terr. Moll., Alabama, p. 124, fig. 187.

The shell is oblong with regularly tapering spire and blunt apex. Spire and interior some tone of pink, usually fading to buff-pink in the collection; the last whorl from buff-pink to light ochraceous buff. Surface glossy, the first 3 whorls, more or less, smooth, the rest irregularly sculptured with longitudinal striae, having deeper grooves at short intervals; without spiral lines. Suture uneven but not denticulate. Whorls moderately convex. Aperture more than twice as long as wide, thickened and pink within, the columella rather deeply concave.

Length 63.0 mm., diameter 25.0 mm.; aperture 32.7 mm.; 7 whorls. Levy Co.

Length 76.0 mm., diameter 27.5 mm.; aperture 37.5 mm.; 7 whorls. Palatka.

Length 64.0 mm., diameter 22.3 mm.; aperture 28.3 mm.; 7 whorls. St. Petersburg.

Length 49.5 mm., diameter 21.0 mm.; aperture 28.5 mm.; 6 whorls. St. Petersburg.

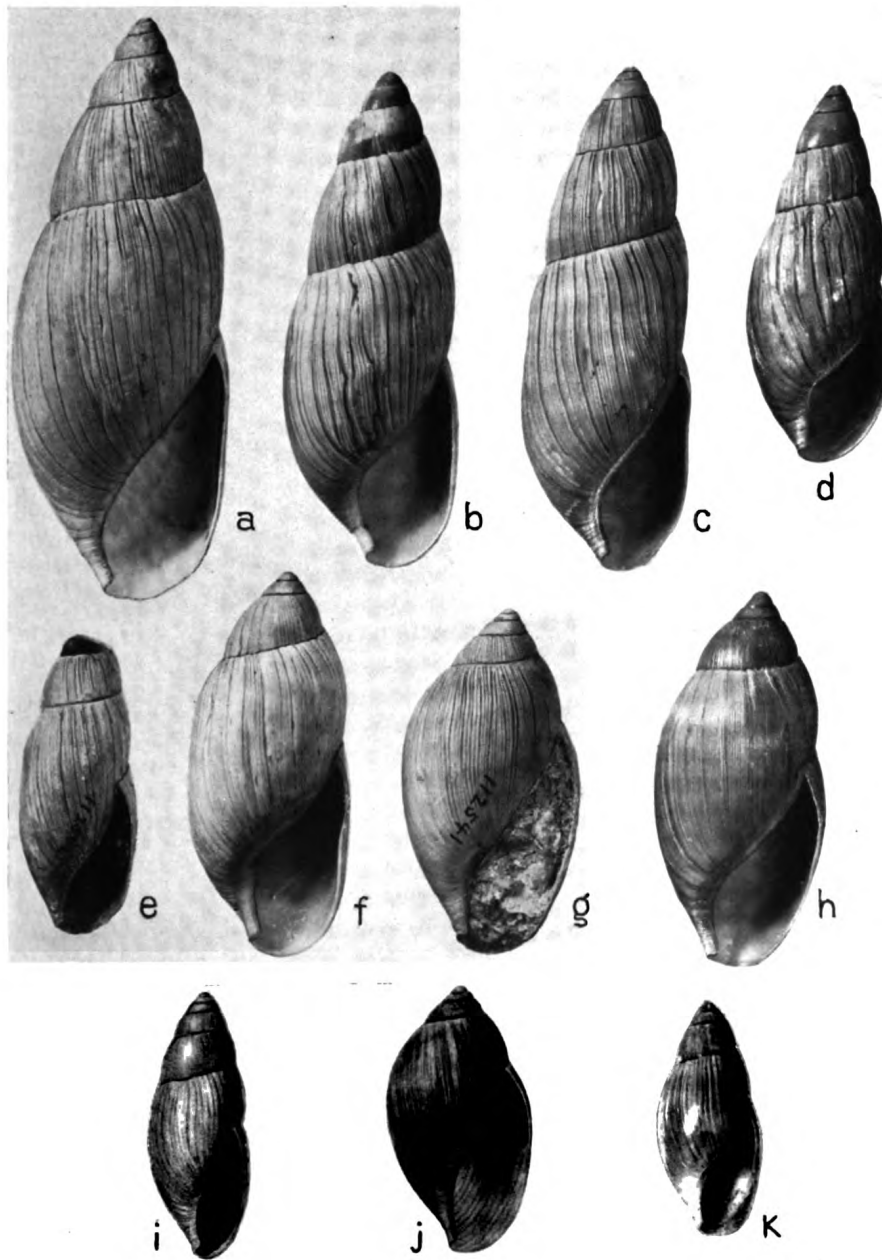


Fig. 92. a, *Euglandina rosea*, near Palatka; b, Lake Maggiore, near St. Petersburg; c, form *parallela*, Orlando. d, *E. rosea*, Russell's Key. e, form *macer*, Caloosahatchee Pliocene. f, *E. rosea*, Lake Maggiore. g, var. *ovata*, type, Caloosahatchee Pliocene. h, *E. rosea bullata*, Lake Ponchartrain. i, *E. rosea* f. *minor*, after Binney. j, *E. rosea bullata* $\times 2$, after Gould. k, *E. rosea* var. *minor*.

SOUTH CAROLINA: Yemassee. GEORGIA: Macon; Hutchinson's Island opposite Savannah; St. Simon's Island; Glynn Co.; Columbus, Muscogee Co. FLORIDA: throughout the state. ALABAMA: Southern half of the state, in the following counties: Baldwin, Barbour, Bibb, Choctaw, Clarke, Crenshaw, Conecuh, Dale, Elmore, Geneva, Greene, Lee, Macon, Mobile, Montgomery, Perry, Pike, Wilcox (Walker). MISSISSIPPI: Vicksburg; mouth of Mary Walker Bayou; and Jackson, Jackson Co. LOUISIANA: City Park, New Orleans; Bayou Macon, Franklin Parish; Little Bayou Pigeon, Iberia Parish; Sorrel Bayou and Big Alabama Bayou, Iberville Parish; Forest, Grand Isle, West Carroll Parish.

The beautiful pink color of many fresh shells fades in the dry specimens. The large, solid examples are commonly found in damp places, under logs or other cover near the water. The small ones, form *minor*, in dry places, such as shell mounds, and on the keys.

The several generic names used for this species have been discussed in Manual of Conchology, 19: 175. The specific name *truncata* Gmelin, long in use, belongs to a quite different South American *Euglandina* which Férussac confused with our species, as explained in Man. Conch., 19: 191. However, he referred also to Say's "*Polyphemus glans*", giving the locality *Les Florides* on Say's authority. Subsequently he published figures of the Florida form, to which the name *rosea* has been restricted. Say mentioned collecting it on the Sea Islands of Georgia and in Florida; St. Augustine, one of the places where Say collected it, may be taken to be the type locality. It was reported from Texas without definite locality or collector, but in the last sixty years or more, collectors have not found it in that state.

According to Ingram & Heming, the oval-oblong eggs are of nearly uniform size, measuring 4.25 mm. in length and from 3 to 3.25 mm. in width (Fig. 93a). The egg shell is brittle and hard; no inner egg membrane is present. The egg shell is extremely rough, and is quite porous. The young break through the egg shell by means of the radula. A circular opening (Fig. 93a) is first filed, then enlarged by the radula until a third of the egg shell is cut away (Fig. 93b). This done, the young emerges.

W. M. Ingram and W. E. Heming observed the feeding of *Euglandina* from Fort Myers, Florida, in captivity at Ithaca, N. Y. Of various snails offered, only *Mesomphix inornatus* and *Anguispira alternata* were devoured. The others left undisturbed.

"The predatory snail in approaching the *M. inornatus* lifted its head and anterior foot region in the air and moved them from side to side. This weaving back and forth continued for 60 seconds; during this time the greatly elongated lips were moved from side to side. Finally the *Euglandina* touched the body of the food snail, whereupon the latter contracted into its shell. The *Euglandina* then employed its anterior foot region to turn the *Mesomphix* shell over on its spire. This done, the predator entered the aperture of the food snail's shell; the posterior foot region serving to hold the rest of the body firmly to the substratum. As soon as the *Euglandina* thrust its head into the *Mesomphix* shell aperture it began to feed with a piston-like motion, apparently forcing its head firmly against the soft

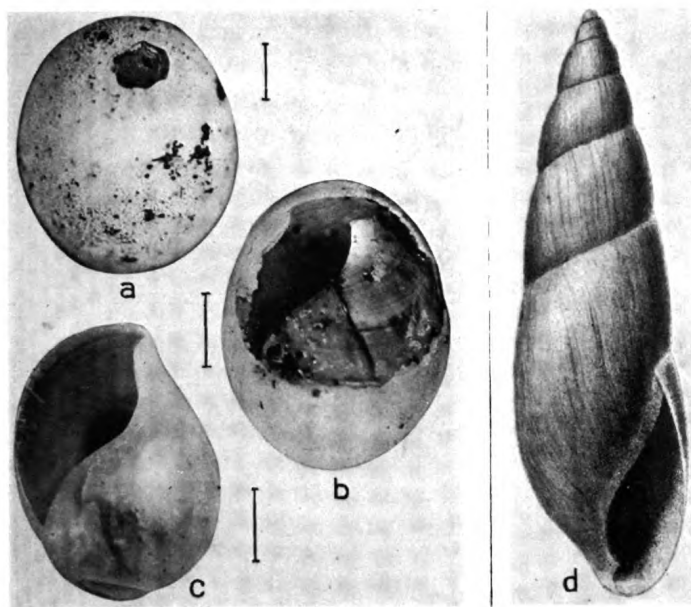


Fig. 93. *Euglandina rosea*. a, Egg showing initial opening cut by radula of young within its eggshell; b, Egg three hours later, showing egg shell cut away, revealing the young snail within; c, Newly hatched young which emerged about 6 hours after the initial opening had been made in the egg shell (after Ingram & Heming); d, *Euglandina rosea* form *macer*, type, actual size (after W. G. Binney). Scale lines = 1 mm

parts of the prey so that the radula could obtain a firm purchase. The piston motion was accompanied by a lateral movement, indicating that the *Euglandina* was working from the columellar region outward, and then back again. Because of the thinness of the *M. inornatus* shell, the feeding could be observed without great difficulty. As the body of *Mesomphix* was gradually consumed the *Euglandina* worked further into the shell. Finally the columellar muscle of the *Mesomphix* was torn loose and the entire upper visceral mass was observed to disappear into the buccal cavity of the *Euglandina*. The feeding process took 40 minutes from the time of entrance until all of the body of *Mesomphix* had disappeared.

"It seems likely that the sense of smell is well developed in *Euglandina* and possibly serves this animal in locating food. When the *Mesomphix* was placed in the terrarium with the carnivore, the latter was 10 inches removed and was fully contracted within its shell. In 3 minutes the *Euglandina* was active, and was moving toward the *Mesomphix*. A similar phenomenon was observed when one *A. alternata* was placed in the terrarium; the *Euglandina* was again contracted and motionless, 6 inches away from the *Anguispira*. In five minutes it became active and moved toward the food snail."⁵⁷

⁵⁷ Extracted from *Zoologica*, 27: 81, July, 1942.

The named varieties *parallela*, *macer*, *abbreviata* and *ovata* are merely selected examples from clines of continuous variation, and have no taxonomic status. Thus, figures 92b and f represent specimens of one lot from Lake Maggiore near St. Petersburg, Florida, others being of intermediate shapes. Var. *minor* is an ecologic variety, occurring in dry and maritime situations with little humus. Whether *bullata* has any racial standing is doubtful, but here it is left for further investigation.

Var. *parallela* W. G. Binney, Fig. 92c. Shell solid, long and narrow, with the sides flattened. Occurs with typical *rosea*. Type 56×20 mm. according to Binney. A specimen from Orlando figured measures 65×21 mm., aperture 29 mm.

Var. *macer* Dall. Fig. 92e, 93d. Very long, 75×20 [should be 22] mm. Caloosahatchie Pliocene and also recent in Florida. This variety was defined only by a reference to W. G. Binney, *Terrestrial Mollusks*, 4, pl. 80, fig. 9 ("Florida"), copied in our Fig. 93d, and Dall's measurements quoted above, which were evidently taken from that figure, which thus represents the holotype. The only Caloosahatchie Pliocene specimen Dall had is a much smaller, broken shell photographed in Fig. 92e.

Var. *abbreviata* Von Martens, "agrees with the ordinary *truncata* in the coarse rib-striation, absence of spiral lines, irregular suture and the reddish color, but differs by the much shorter spire with the same width. Length 42 mm., diameter 20 mm., length of aperture 25 mm., width 11 mm.; 6 whorls." (Von Martens.) Probably not differing materially from var. *ovata* Dall (Fig. 92g type) from the Caloosahatchie Pliocene, also recent in the same region. Said to measure 44×25 mm., and thus wider than *abbreviata*.

Var. *minor* (W. G. Binney). Fig. 92i, k. Much smaller than *rosea*, thinner, usually paler, with the striation less irregular. Length 33 mm., diameter 13 mm., aperture 17 mm. (*ex icone*). Length 39 mm., diameter 16 mm. Lemon City.

Distribution.—From the Georgia Sea Islands to Key West; Miami may be taken as type locality. There are intermediate sizes, and it is evidently an ecologic form rather than a true subspecies. It lives generally in dryer places than the large, solid *rosea*, and the range given above is discontinuous.

Since these contour varieties occurred in the Pliocene and are still found associated in the present populations, it would seem that the variation in shape has little or no significance in evolution.

***Euglandina rosea bullata* Gould**

Fig. 92 h. j.

Glandina bullata Gould, 1848, Proc. Bost. Soc. N. H., 3: 64; in Binney, Terr. Moll., 2: 298, pl. 62a.—W. G. Binney, 1878, Terr. Moll., 5: 86.—Hinkley, 1889, Nautilus, 3: 83.

"Shell elongate ovate, ventricose, widest a little behind the middle, very light and thin, and so translucent as to show the whole of the pillar by transmitted light, very pale horn-color, tinged with rusty brown towards the aperture, shining, and marked longitudinally with fine, rounded striae. Whorls five, tumid, the last composing about seven-eighths of the shell; suture delicate, not strongly impressed. Aperture two-thirds the length of the shell, narrow lunate, somewhat dilated by the moderate arching of the pillar margin, the lower third of which takes the direction of the axis; pillar margin covered by a delicate lamina of white callus. Length of axis one and a half inches; breadth four-fifths of an inch." (Gould.)

Length 48.2 mm., diameter 22 mm., length aperture 29 mm. L. Ponchartrain.

LOUISIANA: Region of New Orleans (E. R. Beadle). Happy Jack, Mississippi delta region (Miss M. L. Hays). Saint Landry Parish (W. G. Binney). New Orleans (J. B. Clark). Lake Ponchartrain (E. B. Bartram). Jones Landing, Bayou Boeuf, Franklin Parish (C. B. Moore). Jefferson Island, Iberia Parish (H. G. Richards).

"This species differs from *G. truncata* in its extreme tenuity and transparency, which is not in consequence of immaturity, as is shown by the callus on the pillar lip; it is much more inflated, the spire proportionally shorter, slightly modified by the suture, and with two whorls less; the pillar is much less arched than in *G. truncata*, where it actually curves to the right and forms an extensive sinus on the pillar margin: the striation, also, is twice as fine, and the coloration is much paler. Quite a large number of specimens, obtained at different times, have been examined, all of which agree in their characters." (Gould.)

Though this Louisiana race differs from *rosea* by its short spire, long aperture and lighter texture than typical *rosea*, there are specimens somewhat intermediate in these qualities. Gould's type was apparently immature. Specimens listed under *rosea* from Vicksburg, and from various other Louisiana localities, seem intermediate in form, and may equally well be called either *bullata* or *rosea*. Cf. also, *ovata* Dall.

***Euglandina texasiana* (Pfeiffer)**

Fig. 95 c.

Achatina texasiana Pfeiffer, 1857, Novit. Conch., 1: 82, pl. 22, figs. 11, 12; 1859, Mon. Hel. Viv., 4: 641.

Glandina texasiana Pfr., W. G. Binney, 1859, Terr. Moll., 4: 140; 1878, Terr. Moll., 5: 87, fig. 9 [?]; 1883, Bull. Mus. Comp. Zool., 11: 137 (Louisiana).

The shell is narrowly oblong, with the spire a little convexly conic, the summit quite obtuse; rather thin; pinkish buff, glossy. Whorls $6\frac{1}{2}$, rather weakly convex. Nearly 3 whorls are smooth, the rest finely, regularly striate, the striae weak below the middle of the last whorl. No spiral striation. Suture impressed, even. The aperture is about half of the length, more or less; narrow, the columella concave.

Length 29.0 mm., diameter 10.5 mm., aperture 16 mm. (Pfeiffer).

Length 33.2 mm., diameter 12.0 mm., aperture 18 mm.

Length 31.5 mm., diameter 11.5 mm., aperture 16 mm.

TEXAS: Brownsville, Cameron Co.

This is a far smaller shell than *E. singleyana*, with less concave columella and no spiral striae. Its distribution in Texas appears to be limited to the neighborhood of Brownsville. It ranges south in Mexico to Tampico and Valles, in the state of San Luis Potosi.

***Euglandina exesa* Cockerell**

Fig. 94.

Euglandina exesa Cockerell, 1930, Proc. Colorado Mus. Nat. Hist., 9, no. 5, p. 52.

"Shell white, moderately shining, elongate, fusiform, with seven whorls, remarkable for the rather narrow form, elongate spire and the conspicuous flattening of the outer surface of the last whorl. The first two whorls are smooth, but otherwise the shell presents numerous strong longitudinal plicae, about six in two mm.; crossing these, very irregularly, are weak revolving striae, but without the use of a lens the surface does not appear decussated. The region just below the suture is not modified in any way.

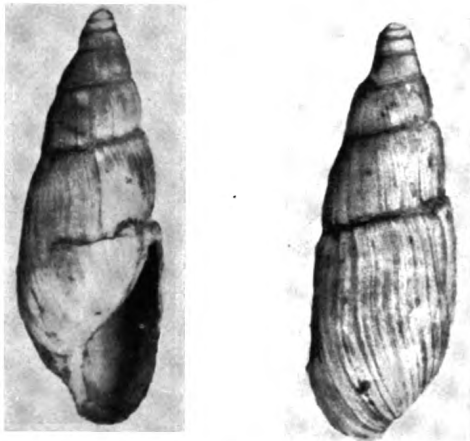


Fig. 94. *Euglandina exesa*, reduced; actual length 71 mm. (After Cockerell.)

Length 71 mm. (originally somewhat larger, about 16 mm. of the last whorl, measured along the suture, being broken away); length of spire 43 mm. (37.5 to upper end of aperture as preserved); length of aperture (as preserved) about 35 mm.; maximum width about 24.5 mm.; width along suture above penultimate whorl 17.2 mm." (Cockerell.)

TEXAS: Old-filled limestone crevice deposit about 350 feet below surface, at a cinabar mine about 90 miles south of Alpine.

"The shape of the last whorl, with its flattened outer face, suggests the form from Zimapan, Mexico, figured by von Martens as *E. coulteri* (Pfeiffer). The spire is conspicuously more slender than in *E. coulteri*. The lateral compression of the last whorl also appears (even rather more pronounced) in the living *E. rosea parallela* (W. G. Binney), but that is only

55 mm. long, and has a quite different spire. The average length of *E. rosea* (Férussac), according to Binney, is 37 mm., but it may reach 100 mm. [?]

"It is perhaps not impossible that the shell now described represents a race or extreme variation of *E. rosea*, but the general aspect is so different that it deserves a special name. It is presumably an extinct species, perhaps ancestral to *E. rosea*, now living in Texas. It was found with fragmentary bones of *Bison*, *Equus* and *Ovis*. The age is probably Pleistocene." (Cockerell.)

E. rosea is not known to occur in Texas. It has no spiral striae, and is probably not directly related to *E. exesa*, which may be nearer *E. immemorata*.

(*Exesus*, worn out, exhausted.)

***Euglandina immemorata* Pilsbry**

Fig. 95 d.

Euglandina immemorata Pilsbry, 1907, Man. Conch., 19: 192, pl. 24, figs. 46, 47.

The shell is rather slender and long, thin, corneous, the spire slender, rather straightly conic, apex obtuse. The apex is small; first 2½ whorls convex, smooth; the later whorls sculptured with striae which are thread-like on the spire, wrinkle-like on the last whorl, quite unequal in size, some of them enlarged at the suture, forming an irregular but rather strong denticulation. Below the suture there are faint traces of spiral striae in some places. Whorls 7, moderately convex, the last more rapidly descending. Aperture small, vertical, bluish-white inside. The outer lip arches forward in the middle. Columella moderately concave, truncate as usual. Length 39 mm., diameter 14.5 mm.; length of aperture 18 mm.

TEXAS: Exact locality unknown. Type 11777 A.N.S.P.

This species is represented in the collection of the Academy by a specimen received from Mr. W. G. Binney under the name of *G. texasiana*, and another in the A. D. Brown collection labeled *G. albersi*, both bearing the locality "Texas." It has some resemblance to *Euglandina turris* (Pfr.), but differs by the irregular and coarser sculpture. It is quite unlike *E. texasiana* in sculpture and the shape of the spire, and appears more like the much larger *E. exesa* than either of our other *Euglandinas*. Possibly it may turn up in the Big Bend region, which is still in large part unexplored for shells. In the absence of recent or definite locality data, it must be regarded as a dubious member of our fauna.

(*Immemoratus*, unrecorded.)

Subgenus SINGLEYA H. B. Baker

Nautilus, 55: 52. 1941. Type *E. singleyana*.

***Euglandina singleyana* (W. G. Binney)**

Fig. 95 a, b.

Glandina truncata De Kay, Roemer, Texas, p. 456

Glandina decussata Desh., Binney, 1878, Terr. Moll., 5: 86, not the figures; 1885. Man. Amer. L. Sh., p. 351, exclusive of description and figs.

Glandina decussata Binney, 1890, 3d Suppl. Bull. Mus. Comp. Zool., 19: 194, 226, pl. 9, fig. 6 (teeth).

Glandina singleyana W. G. Binney, 1892, 4th Suppl., Bull. Mus. Comp. Zool., 22: 163, pl. 1, fig. 4.—Singley, 1893, 4th Ann. Rep. Geol. Surv. Texas, p. 302.

Euglandina singleyana W. G. B., Pilsbry & Ferriss, Proc. Acad. Nat. Sci. Phila., 1906, p. 143.—Pilsbry, 1907, Man. Conch., 19: 189, pl. 24, figs. 48-51.—J. K. Strecker, 1929, Contrib. Baylor Univ. Mus., No. 18, p. 12 (eggs, etc.).—H. B. Baker, 1943, Proc. Acad. Nat. Sci. Phila., 95: 9, pl. 2, figs. 21, 22 (anatomy).

The shell is quite elongate, thin, of a dilute pecan brown color, glossy. The spire has convex outlines and a very obtuse rounded apex. The first $2\frac{1}{2}$ whorls are convex and nearly smooth, but under a strong lens very fine, faint growth-lines are visible; then stronger striae appear, and on the fifth

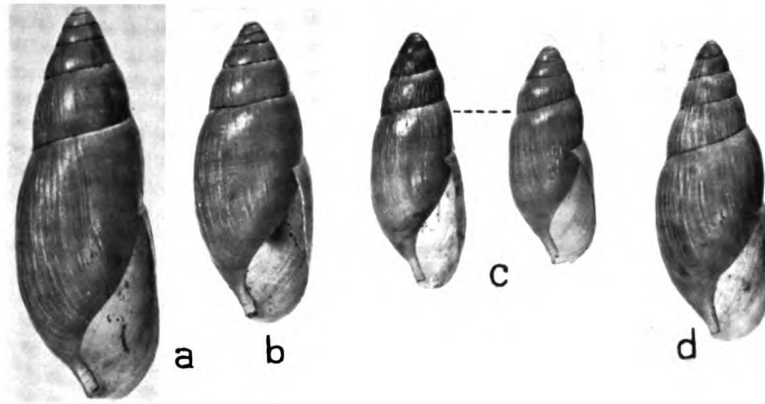


Fig. 95. a, *Euglandina singleyana*, New Braunfels. b, San Antonio. c, *Euglandina texasiana*, Brownsville. d, *Euglandina immemorata*, type.

whorl spiral sculpture begins weakly. The last whorl has fine, close, unequal longitudinal striae, rather sharp above, but weakening to irregular wrinkles below the periphery; these striae are imperfectly cut into long grains by spiral impressed lines, which gradually weaken below the periphery, and almost wholly disappear near the base. Whorls $6\frac{1}{2}$ to $7\frac{1}{2}$, moderately convex, the last descending more rapidly. Suture pale-edged, a little irregular but not crenulated. The outer lip is straightened above; columella strongly concave.

Length 39, diameter 15, aperture 21.5 mm. San Antonio.

Length 51, diameter 18, aperture 26 mm. New Braunfels.

TEXAS: Austin, Travis Co.; Victoria Co.; San Marcos, Hays Co.; New Braunfels, Comal Co.; San Antonio (type loc.), Maedona and Helotes, Bexar Co.; near Hondo, Medina Co.; High Bridge, near mouth of the Pecos, etc., Val Verde Co. Also reported by J. A. Singley from Guadalupe, Goliad, Gonzales, Caldwell and Frio counties, and by A. J. Kim from Atacosa county.

Differs from eastern species and *E. texasiana* by having fine spiral sculpture. *E. texasiana* is a much smaller, more slender shell. *E. immemorata* has a finely crenulate suture and a less concave columella.

It is usually found under stones and dead wood. Strecker reported it as taken in Bexar Co. by Mr. Roy Quillin mostly under ground, sometimes to a depth of a foot under the rotting hearts of stumps. The eggs are white, measure 5×7 mm., and as many as 26 are laid by one snail.

Dr. H. B. Baker dissected animals collected June 24, 1929, near New Braunfels. It is "like *E. rosea* but: Brownish head darker near median pale stripe. Lung with variable brown spots or bands. Ovotestis with 5 conic lobes. Vagina (V, Fig. 96a) and lower third of free oviduct (UV') internally with coarse axial folds, which are broken by transverse ones towards uterus. Penis (P) internally with 13 wavy axial plicae at base, which branch into 31 towards apex. Atrium opening near front edge of visceral stalk. Radula (Fig. 96b) with 71 teeth in 57 rows; 10th (longest) 1.6 times length of first; ribbon 13.5 mm. long. Right eye muscle free from genitalia."

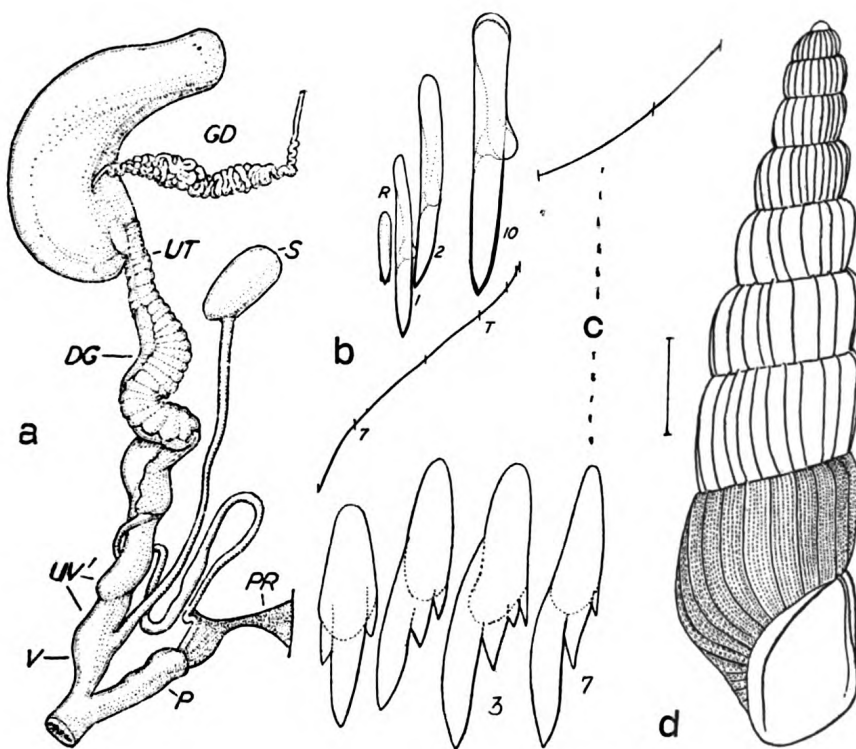


Fig. 96. a, *Euglandina singleyana*, genitalia; b, teeth. c, *Varicella gracillima floridana*, teeth; d, shell, sculpture finished on last whorl only. Figs. a-c after H. B. Baker. Scale line = 1 mm.

VARICELLA Pfeiffer

Varicella Pfeiffer, 1855, Malak. Blätter 2: 172.— Von Martens, 1860, Die Heliceen p. 30, type *V. leucozonias* (Gmel.).

Oleacinidae with the post-nepionic whorls of the oblong or turrite shell sculptured with occasional varices or varix-lines, more or less conspicuously differentiated from the other sculpture, and often preceded by dark streaks. Embryonic shell of 2 to $3\frac{1}{2}$ whorls, smooth or ribbed. Aperture less than half the total length, the outer lip narrowly expanded or simple, columella more or less strongly truncate at the base.

Subgenus MELANIELLA Pfeiffer

Melaniella Pfeiffer, 1859, Mon. Hel. Viv., 4: 465.—Kobelt, 1880, Illust. Conchylienbuch, p. 276, type *acuticostata* Orb.

Pichardiella Fischer, 1887, Jour. de Conchyl., p. 200, substitute for *Melaniella* Pfr.—Pilsbry, 1907, Man. Conch., 19: 50 (monograph).

Small, slender Varicellas with low sigmoid varices and higher longitudinal ribs, which are narrower than their distinctly striate intervals; the pupiform or subcylindric embryonic shell is striate, composed of $2\frac{1}{2}$ to $3\frac{1}{2}$ long whorls, with exserted summit. Columella arcuate or straight, ranging from distinctly truncate to nearly entire at the base. Radula with well developed central teeth, all the teeth very minute and not varying much in size.

Distribution.—Greater Antilles, southern Florida. These snails live under stones and rubbish, and are usually solitary.

For anatomy and taxonomy of the large West Indian genus *Varicella* and its numerous subgenera, see H. B. Baker: 1941, Nautilus, 55: 25.

Varicella gracillima floridana Pilsbry

Fig. 96 d.

Achatina gracillima Pfeiffer, Gould in Binney, 1851, Terr. Moll., 2: 293, pl. 53, fig. 3.

Stenogyra gracillima Pfr., W. G. Binney, 1878, Terr. Moll., 5: 195; 1885, Man. Amer. L. Sh., p. 426, fig. 474.

Varicella gracillima var. *floridana* Pilsbry, 1907, Man. Conch., 19: 57.

Varicella gracillima floridana Pils., H. B. Baker, 1926, Occ. Pap. Mus. Zool. Univ. Mich. No. 167, p. 10, pl. 19, fig. 97 (teeth).

The shell is imperforate, very slender, thin, of weakly convex whorls. Suture deeply impressed. Sculpture of nearly straight narrow axial ribs, about 25 on the last whorl, with very fine close parallel striae, 6 to 8 in each interval. Very pale brown or "corneous" in color. Aperture long oval, the outer lip arching forward a little, receding at the base. Columella somewhat calloused, often slightly excavated at its base.

Length 7.5 mm., diameter 1.6 mm.; $8\frac{1}{2}$ whorls. Miami.

Length 6.1 mm., diameter 1.5 mm.; 8 whorls. Key West.

FLORIDA: Key West, Type 53316 A.N.S.P.; Boca Chica, Sugarloaf, Summerland, Big Pine, Little Pine, Bahia Honda, Noname, Lignum Vitae and Long Keys. Long Pine Key in the Everglades. Coconut Grove; Brickell's Hammock and along Miami River, and on the ocean beach, Miami. Arch Creek. Ojus (T. L. McGinty).

This shell is very unlike all others of our fauna. Typical *V. gracillima* (Pfr.) is a west Cuban species occurring from Sancti Spiritus and Matanzas to Pinar del Rio. It has fewer ribs than *floridana*, and fewer striae in the intervals.

Dr. Baker examined the teeth (Fig. 96c) of "one dried specimen from Sugarloaf Key, Florida, A.N.S.P. 100022, collected by Dr. H. A. Pilsbry. Radular formula at least 12-1-12; transverse rows chevron-shaped. Central: asymmetrical, tricuspid; central cusp much the largest, left lateral cusplet more prominent than right. Laterals: all similar in form, mainly tricuspid; inner cusp developed into a broad, heavy blade quite unlike the needles of the preceding groups [*Spiraxis*, *Pseudosubulina*], outer cusps aculeate. Three of these outer cusps are sometimes present in individual laterals, quite regardless of their position in the rows. The radular differences between *Melaniella* and *Varicella* s.s. are the tricuspid central of the former and the more numerous cusps of its laterals." (H. B. Baker.)

Family XII. HAPLOTREMATIDAE

Selenitidae Fischer, 1883, Man. de Conchyl., p. 456.

Circinariidae Pilsbry, 1898, Nautilus, 11: 127.

Haplotrematidae Baker, 1931, Proc. Acad. Nat. Sci. Phila., 82: 405.

Characters as in *Haplotrema*.

This family of rapacious holopod snails was grouped by the author in the superfamily Agnathomorpha (1908, Manual of Conchology, 19: x). Later Dr. H. B. Baker, in a revision of the North American species, estimated the affinities of Haplotrematidae similarly (1931, Proc. Acad. Nat. Sci. Phila., 82: 407). He writes: "anatomical data show that *Haplotrema* is a very aberrant group of agnathomorphous Holopoda. Its jaw and the central of its radula are clearly vestigial; its aculeate outer teeth approach those of the Streptaxidae. The covert entocones on the inner teeth in most of the subgenera are very different from the raised entocones that are the usual type on asymmetric pulmonate teeth. Also, in most groups of the Stylommatophora, the entocones are lost before the ectocones. Another peculiar feature is the marked differentiation of the albumen gland into a double organ. As will be detailed later, the genitalia show considerable diversity in the various groups in *Haplotrema* but, as a rule, an epiphalloid chamber is developed in the penis (like in most Holopoda) and not from the vas deferens (as in most Aulacopoda). A horny spermatophore has only been observed in *H. concolor*. Apparently some of the species are oviparous while others are ovoviviparous, but only a few of them have been sufficiently investigated."

The foot has no trace of pedal furrows. The sole has no longitudinal division and is not folded longitudinally on retraction. In progression it shows a few direct muscular waves (five seen in *H. concavum*), extending from side to side.

HAPLOTREMA Ancey

- Macrocyclis* Binney & Bland, 1869, Land and Fresh Water Sh. N. A., 1: 53. Not *Macrocyclis* Beck, 1837, as restricted by Herrmannsen.
- Mesomphyx* Gray, 1841, Syn. Contents Brit. Mus., 43d edit., p. 127, name only; Proc. Zool. Soc. Lond. Nov., 1847, p. 172, *Helix concava* designated type (misspelling of *Mesomphyx* Rafinesque).
- Selenites* Fischer, 1878, in Shuttleworth's Notitiae Malac., 2: 8. Not *Selenites* Hope, 1840 (Coleoptera).
- Haplotrema* Ancey, 1881, Le Naturaliste, 1: 453, for *Selenites duranti* Newc.—H. B. Baker, 1931, Proc. Acad. Nat. Sci. Phila., 82: 405.
- Hoplobienia*, *Haplotrema* and *Hoptotiema* W. G. Binney, 1885, Man. Amer. L. Sh., pp. 86, 474, 516. Misspellings of *Haplotrema*.
- Circinaria* Beck, Pilsbry, 1898, Nautilus, 11: 127, and of other American authors up to about 1920. Not *Circinaria* Beck, 1837, as restricted by Herrmannsen, 1847.

The heliciform and usually much depressed, umbilicate shell is generally light colored, with tubular whorls, slightly thickened or narrowly expanded peristome, the upper lip margin usually somewhat straightened or curved downward. Embryonic whorls almost smooth, the later whorls with growth striae or wrinkles and usually some impressed spiral lines.

“Lower lip protuberant and bifid. Foot with thick epidermis and coarse tessellation; head especially elongate; pedal grooves absent although ventral row of tessellae may present a fairly even dorsal edge; sole undivided. Pedal gland almost as long as sole; consisting of two ribbon-like strands of glandular tissue separated by a large duct; external orifice under lip and above anterior margin of foot.

“Mantle collar thick and broad; right neck lappet fairly large; left and left accessory ones widely separate and quite small. Lung wall with prominent principal, columellar and anterior mantle veins, but these receive (or give off) very few or short, major tributaries (or branches); minor venation consisting of a very fine, diffuse network. Kidney elongate triangular. Ureter sigmurethrous; limb along kidney slender; external opening in posterior corner of lung wall; limb along hindgut represented only by a thickened zone on lung wall along left side of hindgut. Anus near inner end of pneumostome.

“Ovotestis consisting of a variable number of clumps of alveoli, which are imbedded near base of apical hepatic lobe; duct often swollen and convoluted. Albumen gland differentiated into an apical, cream colored, coarsely alveolate region above talon and a basal, whitish, less coarsely alveolate series of swellings. Uterus elongate. Free oviduct with heavy wall and with prominent longitudinal plications internally. Spermatheca of long type; sac imbedded some distance to left of albumen gland (usually beyond first limb in S-loops of hindgut); stalk columellar in position but looped across base of sperm-oviduct. Vagina bound to body wall by heavy fibers. Prostate of long type. Vas deferens caught into penioviducal angle by right ommatophoral muscle (retractor of inferior tentacle always free) or only held in place by right pallial and lateral pedal nerves; fastened along side of penis; descending limb rarely (*vancouverense* and *minimum*) swollen like an epiphallus; penial papilla scarcely differentiated. Penis (except in *vancouverense*) with a short, apical, apparently epiphalloid compartment and a long, principal chamber. Penial retractor arising from diaphragm (except in *sportella*); inserting near penial apex.

"Mantle retractor stronger than in any other group I have studied; loosely connected at origin to principal (left) columellar muscle. Columellar retractor gives rise to (1) heavy buccal muscle which is almost free. (2, 3) exceptionally heavy right and left free retractors near origin and (4) continues as remarkably thin but broad, caudal fan. Each free retractor gives rise to a tentacular muscle (which soon divides into ommatophoral and inferior tentacular retractors) and continues as very heavy lateral retractor, which is connected by anastomosing fibers with the one on the opposite side. [During retraction, in which the lateral retractors must play a major role, the foot shortens greatly so that it plugs up the aperture in a peculiar manner.]

"Jaw reduced to a narrow, crescentic plate with a median point on the cutting edge. Buccal mass elongate, without distinct cartilages. Radula with relatively few, inverted chevron-shaped, transverse rows. Central vestigial or absent. Remainder of teeth aculeate; inner ones increasing and outermost decreasing in size; innermost teeth (except in subgenus *Austroselenites*) with peculiar entocoines⁵⁸ which are usually covered by the inner rim of the quite broad mesocone; majority of teeth unicuspid and slender. Salivary glands lanceolate, usually about as long as buccal mass and usually (in U. S. species) fused both above and below oesophagus (not simply pressed together as in most pulmonates); right gland more anterior; ducts about as long as glands. Oesophagus thin walled. Stomach crescentic, about $\frac{1}{2}$ whorl in length; receiving two hepatic ducts near apical end. Intestine with usual limb along stomach and large S-loops imbedded in anterior lobe of liver.

"Nervous system with short (usually very short) commissures but fairly long pleural and pedal connectives; cerebral ganglia very weakly lobed into pleural and pedal gyri; left parietal and abdominal ganglia fused (*concarum* and *vancouverense*) or separate (*duranti*); pedal nerves to sole numerous; penial nerve arising from right cerebral ganglion." (H. B. Baker.)

Type: "*Selenites*" *duranti* (Newc.).

Helix belcheri Pfeiffer, 1845, of unknown locality, has been associated with this genus, but the type in B. M., examined by J. R. Le B. Tomlin, proved to be a young *Streptaxis apertus* Martens, see *Nautilus*, 45: 20, 1931.

The classification of this genus is that of Dr. H. B. Baker, who published a beautiful study of the group in 1931,⁵⁹ with a supplement in 1941.

⁵⁸ "In 1930, I retained the term 'entocoine' for the peculiar and very variable denticle under the principal cusp on some inner radular teeth of *Haplotrema*. But, since the true entocoine disappears first in most pulmonates that approach carnivorous dentition, it may actually be the mesocone, which would make the principal cusp an ectocone, homologous with the one that, on the laterals of the Spiraxinae, about equals in size the mesocone, but, in most Oleacinidae, completely disappears. The compounded term 'under-cusp' seems self-explanatory and obviates any decision." (H. B. Baker, 1941.)

⁵⁹ *Proc. Acad. Nat. Sci. Phila.*, for 1930, pp. 405-425, published January 29, 1931.

Key to Subdivisions of Haplotrema

- A. Right ocular retractor in penioviducal angle; cloaca with stimulator
 Subgenus *Haplotrema* s. s.
- B. Cloacal orifice close to base of right ommatophore; shell small and thin with epidermal riblets; coastal region of southern and Lower California
 Section *Haplotrema* s. s.
- BB. Cloacal orifice distant from base of right ommatophore; shell large and heavy with relatively weak growth wrinkles; eastern U. S. and southern Canada
 Section *Geomene*
- AA. Right ocular retractor free from genitalia.....Subgenus *Ancotrema*
- B. A penial diverticulum present; a vestigial under-cusp on first side tooth, absent from others; Southern California.....section *Greggiella*
- BB. No penial diverticulum.
- C. Penial retractor arising from diaphragm; radular central unicuspid; shell with closely-spaced spiral striations (often obsolescent); Pacific coast
 Section *Ancomena*
- CC. Penial retractor arising from left side of columellar muscle; radular central with more than one point; shell with more widely spaced spirals; Pacific coast north of central California.....Section *Ancotrema* s. s.

Key to Species of Haplotrema

- A. Shell small, diameter 5 to 8 mm. Southern California and islands.
- B. With irregular thread riblets; diameter about 5 mm. Santa Barbara I.
 H. durante
- BB. With coarse, sharp but rather low riblets; diameter 6.7 to 8 mm.; Santa Barbara south.....*H. caelatum*
- BBB. Finely striate; 5.7 to 6.5 mm.; Catalina I.....*H. catalinense*
- AA. Larger, the diameter 9 mm. or more
- B. Eastern States, diameter 11 to 22 mm.....*H. concavum*
- BB. Western species.
- C. Closely rib-striate; central and southern California.
- D. Diameter 9.5 to 11.5 mm.; central and interior California
 H. alameda
- DD. Diameter 14 to 16 mm.; San Diego region.....*H. transfuga*
- CC. Rather sharply, closely striate, at least on the spire.
- D. Diameter 11 to 22 mm.; northern California north....*H. sportella*
- DD. Diameter 11 to 13 mm.; upper margin of lip bent down in a strong lobe; northern California.....*H. voyanum*
- CCC. Striation wrinkle-like, irregular.
- D. Diameter 9 to 13.5 mm.; striation weak; Alameda to Shasta counties, California.....*H. keepi*
- DD. Diameter 14 to 22 mm.; central California.....*H. minimum*
- DDD. Diameter 22 to 32 mm.; northern California to Alaska.
 H. vancouverense

Subgenus HAPLOTREMA s. s.

HAPLOTREMA DURANTI GROUP

Haplotrema durante (Newcomb)

Fig. 97.

Helix durante Newcomb, 1864, Proc. Cal. Acad. Sci., 3: 118.—Cooper, 1892, Zoe, 3: 17.

Macrocyclus durante Newc., Binney, 1878, Terr. Moll., 5: 94, fig. 13; 1885, Man. Amer. Land Sh., p. 85, fig. 49.

Selenites durante Newc., Mazyck, 1886. Proc. Elliott Soc., Charleston, 2: 114, right text figs.; Proc. U. S. Nat. Mus., 9: 460, same text figs.

Haplotrema durante durante (Newc.), H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 409, pl. 33, fig. 5 (teeth).—M. W. Williams, Jour. Ent. and Zool., 32: 21.

The shell is small, discoidal with flat spire, rather thin; matt, olive-buff to a very pale gray, widely umbilicate, the umbilicus contained 3 times in the diameter. Whorls somewhat convex, the first two smooth, the rest dis-

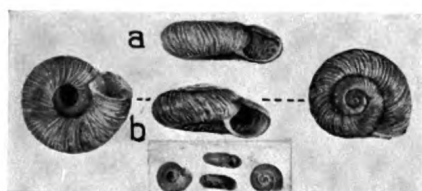


Fig. 97. *Haplotrema durante*, Santa Barbara Island. Enlarged and actual size.

tinately striate. Aperture with well-curved outer and basal margins, the upper margin straightened. Diameter 5.2 mm., height 1.8 mm.; $3\frac{1}{4}$ whorls.

CALIFORNIA: Santa Barbara Island (Newcomb, Hemphill). Santa Cruz Island at Scorpion Harbor, Pelican Bay, Cañada del Puerto and Prisoner's Harbor (M. W. Williams).

The irregular rib striation is coarser than in *H. catalinense* but much finer than in *H. caelatum*, which is a larger, mainland species.

"The radula (Fig. 98: 5) of a dried-in topotype has been examined; its formula is (10-11) + (3-4) + 1 + 14 with 35 transverse rows. The central is vestigial but bears at least one cusp, which may be bifid or may be accompanied by weak lateral points. The inner 3 or 4 teeth have small entocoines below the level of, or under the mesocoines. The outer teeth are simply aculeate." (H. B. Baker.)

Haplotrema durante continentis H. B. Baker

Fig. 98: 1-4, 6, 7.

H. (Haplotrema) durante continentis H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 410, pl. 33, figs. 1-4, 6, 7.

"Shell (Fig. 98: 1-3) similar in sculpture and texture to typical *duranti* but with slightly more elevated and more regularly wound spire. Altitude of aperture 62 (1.56 mm.); diameter of aperture 126 (1.97 mm.); umbilicus 2.7 times in major diameter. Height 2.53 mm., diameter 5.44 mm." (Baker).

CALIFORNIA: Under rocks in arroyos on slopes of Big Grizzly Peak, back of Berkeley, Alameda Co. Type A.N.S.P. 152672. Also from hills back of Haywards and from near Lagunitas, Marin Co. (H. B. Baker.)

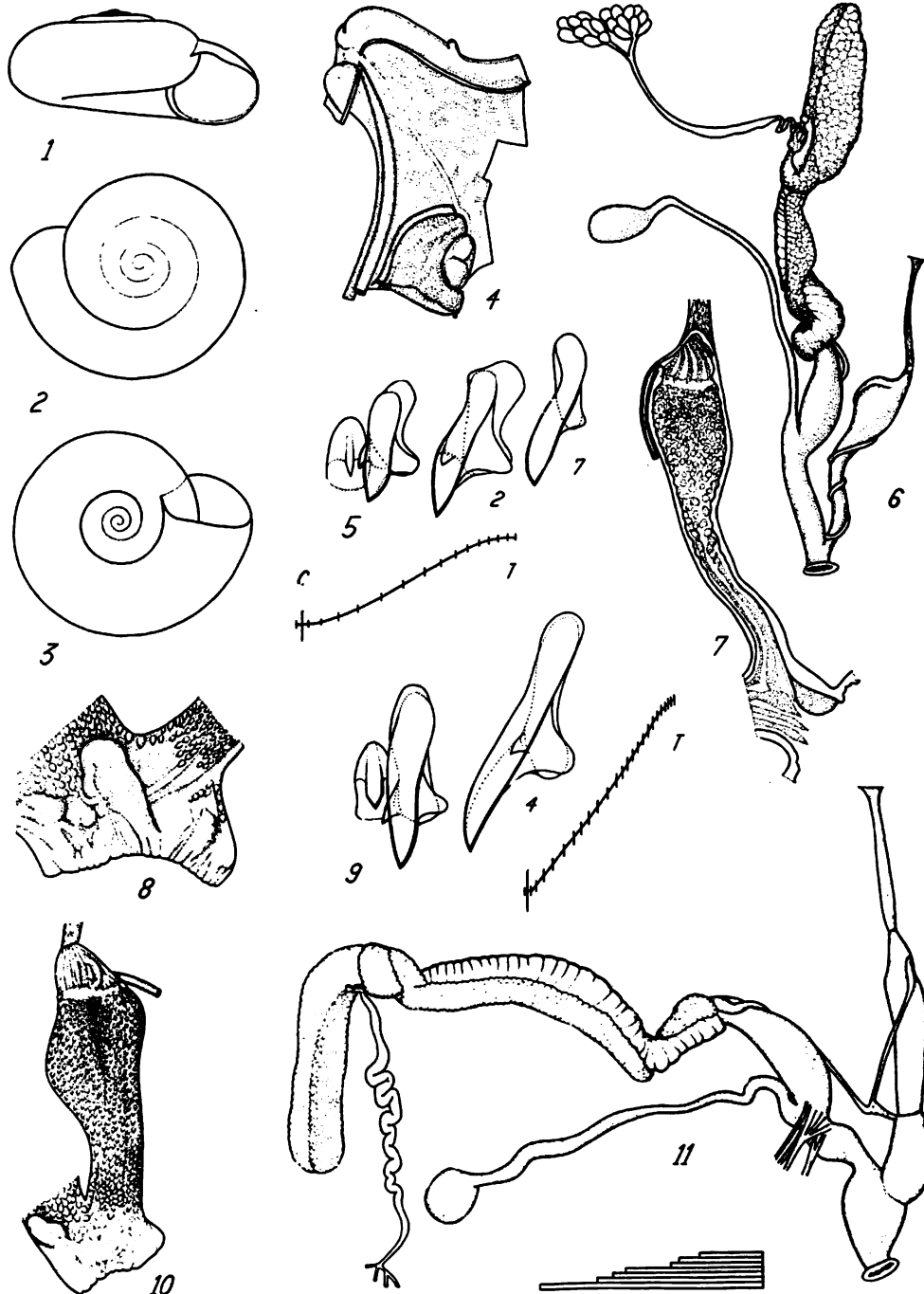


Fig. 98. See bottom of page 207 for legend.

In some small specimens (diameter 3.5 mm.) from Pacific Grove (S. S. Berry), the spire is scarcely higher than in *H. durante*. Similar shells have been found east of Haywards, Alameda County (H. B. Baker).

It differs from typical *durante* in about the same manner that *Hawaiiia minuscula neomexicana* differs from *alachuana*. The anatomical notes are mainly founded on specimens from near Haywards (July 22) but paratypes have also been examined.

“Foot whitish, quite broad, obtusely rounded posteriad. Mantle collar (Fig. 98: 4) wide and heavy; right neck lappet large, left and accessory left ones small and subequal. Lung wall about $2\frac{1}{2}$ times as long as its base or length of kidney; blotched with black. Kidney about $1\frac{1}{2}$ times as long as its base or length of pericardium.

“Ovotestis (Fig. 98: 6) consisting of two small clumps of alveoli; duct stout, convoluted terminally; apex of talon differentiated as a spherical, white knob. Uterus elongate, scarcely sacculate. Free oviduct large, with thick walls and coarse internal pilasters. Vagina elongate, without definite muscular collar. Vas deferens slender, caught into penioviducal angle by right ommatophoral retractor; wound spirally around penis; opening lateral without penial papilla. Apical penial chamber (Fig. 98: 7) demarcated by a low transverse fold; transverse, with a short projection inside penial retractor. Principal penial chamber internally with small, closely-packed, pointed papillae in apical third, much coarser and more widely spaced projections in middle third and longitudinal folds in basal third. Cloaca short, with a heavy lateral fold which may represent a stimulator; external opening below and a short distance behind base of right ommatophore.

“Salivary glands about $\frac{2}{3}$ as long and ducts quite as long as buccal mass. Jaw thin and transparent. Radular formula is (9-10) + (4-5) + 1 + 14, with 35 rows; teeth similar to those of typical *durante*. Nervous system with cerebral and buccal ganglia relatively very large (as usual in small species); cerebral commissure short but distinct; left parietal demarcated from abdominal ganglia.” (Baker.)

Haplotrema catalinense (Hemphill)

Fig. 99.

Selenites durante var. *catalinensis* Hemphill, 1890, in Binney, 3d. Suppl., Bull. Mus. Comp. Zool., 19: 221.

H. (Haplotrema?) catalinense (“Hemphill” W. G. Binney), H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 411.

“Shell widely umbilicate, depressed, white, transparent when fresh; whorls 4, flattened above and below, with fine oblique striae; spire planulate; aperture transversely rounded; peristome simple, acute; extremities approached and joined by a very thin callus in fully matured specimens. Greatest diameter, $\frac{1}{4}$ inch; height, $\frac{1}{16}$ inch.” (Hemphill.)

Fig. 98. 1-3, *Haplotrema durante continentis*, type shell; 4, pallial complex. 5, *H. durante*, radula of topotype. 6, 7, *H. durante continentis*, genitalia and diagram of penis and cloaca. 8, *H. concavum*, Unicoi Co., Tenn., cloaca and bases of vagina (left) and penis (right), cut open and pinned out. 9, *H. alameda*, Niles Canyon, Alameda Co., radula and diagram of half row of teeth; 10, same, penis, cloaca and base of vagina cut open; 11, genitalia. (After H. B. Baker.)



Fig. 99. *Haplotrema catalinense*, Santa Catalina Island. Enlarged and actual size.

“My little shell differs from the typical *duranti* in its greater size, smoother surface, broader umbilicus in specimens of the same size, but principally in its transparent shining surface. It is larger than the largest *duranti* that I have seen, but not so large as the costate variety of that species described by Mr. Mazyck as distinct under the name of *S. coelata*.” (Hemphill.)

Diameter 6.3 mm., height 4.3 mm.; $3\frac{3}{4}$ whorls.

Diameter 5.7 mm.; $3\frac{3}{4}$ whorls.

CALIFORNIA: Santa Catalina Island.

The striation is noticeably finer than in *H. durante*, and the size a little greater, up to 6.5 mm. diameter. Color and the nearly flat spire about as in *duranti*.

HAPLOTREMA CONCAVUM GROUP (Section *Geomene* Pilsbry)

Geomene Pilsbry, Apr. 22, 1927, Proc. Cal. Acad. Sci., 16: 169, tod. *Helix concava* Say.

Proselenites Thiele, December ?, 1927, Abh. Senckenb. Nat. Ges., 40: 312, 313.—H. B. Baker, 1928, Nautilus, 41: 124, type *Helix concava* Say. Cf. Baker, 1941, Nautilus, 54: 132.

Haplotrema concavum (Say)

Fig. 100.

Helix concava Say, 1821, Jour. Acad. Nat. Sci. Phila., 2: 159.—Leidy, Binney's Terr. Moll., 1: 258, pl. xii, figs. 9-11 (anatomy).

Macrocyclis concava Say, Morse, 1864, Jour. Portland Soc., 1: 12, pl. v, lower fig.—Binney, 1878, Terr. Moll., 5: 92; 1885, Man. Amer. L. Sh., p. 199, fig. 209.

Haplotrema (Geomene) concavum concavum (Say) H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 411, pl. 33, fig. 8; with *H. c. minus* Anc., p. 412.

Helix planorboides “Raf.”, Férussac, 1821, Tabl. Syst. Limaçons, p. 41, No. 211 (nude name); 1832, Hist., pl. 82, fig. 4.—Deshayes, 1850, in Fér., Hist., p. 87.

Helix dissidens Deshayes, 1850, in Fér., Hist., p. 97, pl. 84, figs. 1, 2 (North America).

Selenites concava var. *minor* (Canada); var. *major* (Tennessee); var. *albina* (Cincinnati), Ancy, 1882, Le Naturaliste, 4^{me} année, 2: 111.

Circinaria concava Say, Pilsbry, 1900, Proc. Acad. Nat. Sci. Phila., p. 133 (southern Alleghanies); 1903, *ibid.*, p. 204; 1906, *ibid.*, p. 557 (Missouri, Arkansas).—Sampson, 1913, Trans. St. Louis Acad. Sci., 22: 101.—H. B. Baker, 1912, Nautilus, 26: 3 (small form, Michigan).

The shell is depressed with spire but slightly convex, umbilicus broadly open; primrose yellow to marguerite yellow or more whitish, glossy, smoothish, irregularly striate, sometimes showing some fine spiral lines. Whorls

convex, the last well rounded, slightly or not descending in front. The aperture is rotund-lunate. Peristome narrowly expanded in the outer and basal margins, usually brownish or rust tinted; upper margin somewhat straightened or slightly depressed. The thin parietal callus has a slightly thickened yellowish edge.

“Greatest width seven-tenths of an inch” (Say).

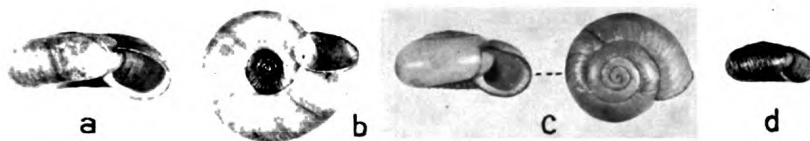


Fig. 100. *Haplotrema concavum*. a. Lookout Mt. Alabama; b. Mt. LeConte, Tennessee; c. Philadelphia; d. *H. c.* forma *minor*, McKay Lake, Carlton Co., Ontario.

Height 6.4 mm., diameter 13.3 mm.; 5 whorls. Hull, Quebec.
 Height 5.3 mm., diameter 11 mm.; $4\frac{1}{2}$ whorls. Carlton Co., Ont.
 Height 6.1 mm., diameter 13.5 mm. Sidney, Maine.
 Height 6 mm., diameter 11.8 mm. Sidney, Maine.
 Height 6.8 mm., diameter 13.3 mm. Cazenovia, N. Y.
 Height 8.4 mm., diameter 17.5 mm. Philadelphia, Pa.
 Height 7 mm., diameter 15.2 mm. Philadelphia, Pa.
 Height 9.5 mm., diameter 20 mm. Mt. LeConte, Tenn.
 Height 9 mm., diameter 21 mm.; $5\frac{1}{2}$ whorls. DeKalb Co., Ala.
 Height 9 mm., diameter 19.6 mm. Cross Co., Ark.
 Height 7.7 mm., diameter 16 mm. Chattahoochee, Fla.

Distribution.—Humid division of eastern North America, north to shortly beyond the 45th parallel in Maine, Canada and Michigan, west to Iowa, western Missouri and Arkansas, south to non-peninsular Florida, Mobile Bay, Alabama, and in loess, Natchez, Mississippi.

CANADA: Hull, Quebec; Ottawa and Toronto, Ontario. MAINE: Somerset, Kennebec, Oxford and Sagadahoc counties. MICHIGAN: to the Upper Peninsula. MISSOURI: Throughout the state. ARKANSAS: Cross Co.; Magazine Mt., Logan Co. MISSISSIPPI: Vicksburg and Natchez, in loess. FLORIDA: Chattahoochee, Gadsden Co.

This is a common snail in suitable country from Iowa and Arkansas eastward. A few marginal localities are mentioned above, but its westward and southwestward limits are not known in detail.

“Specimens from Carter and Unicoi Co., Tenn., have been dissected. Mantle collar broad and heavy; right neck lappet large and prominent; left and left accessory lappets very small and subequal. Long about 3 times as long as its base or $2\frac{1}{2}$ times length of kidney. Kidney almost twice as long as its base or length of pericardium.

Hermaphroditic duct coarse and convoluted; talon clavate. Spermatheca recurved apically so that large sac lies against diaphragm in principal haemocoel although stalk passes through aortic loop. Vagina without well-developed muscular collar. Vas deferens slender; caught into penioviducal

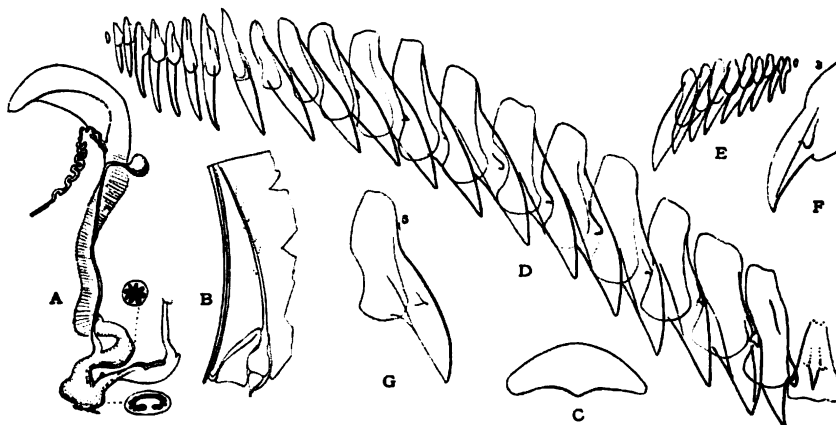


Fig. 101. *Haplotrema concavum*, Burlington Co., N. J. A, genitalia, with sections of free oviduct and atrium showing stimulator; B, Pallial complex; C, outline of jaw; D, half row of teeth; E, marginal teeth in normal position; F, G, teeth isolated to show under-cusps.

angle by right ommatophoral retractor; penial opening on side opposite flagellum. Apical chamber of penis short, with internal, convoluted folds. Principal chamber with short flagellum; internally with closely packed papillae that develop horny, claw-shaped tips. Penial retractor arising half way up diaphragm. Cloaca (Fig. 98: 8) very thick walled and swollen laterally to form a heavy boss (actually the base of stimulator); internally with heavy, longitudinal folds and a large, epiglottis-shaped stimulator; external orifice on side of foot below anterior edge of body stalk. Nervous system much as in *H. vancouverense*." (H. B. Baker.)

Its depressed shape, tubular whorls and glossy, greenish to pale yellow or "corneous" surface easily distinguish this from associated snails. Its range is widely separated from that of the western haplotremes.

The shell varies widely in size. Ancy named Canadian specimens of 11 mm. diameter var. *minor*; specimens from Ottawa are 12 to 13.5 mm. Similar small shells occur in various places in Maine; Morse refers to Oxford Co., Maine specimens as "exceedingly dwarfed" but gave no dimensions. H. B. Baker gave the size of the largest found on the north shore of Burt Lake, Cheboygan Co., Michigan, as 5.3×11.9 mm., $4\frac{1}{2}$ whorls. The dwarfing is attributed by Baker to the influence of unfavorable conditions at the northern limit of its range.

Ancy's var. *major*, diameter 21 mm., is a large example of the southern Alleghanian form. The size intergrades so completely throughout that subspecies based upon dimensions could only be quite arbitrarily limited; but there is no objection to the use of the terms "form" *minor* or *major*, to express extremes of a continuous variation series or cline.

Subgenus ANCOMENA H. B. Baker

Ancomena H. B. Baker, 1931, Proc. Acad. Nat. Sci. Phila. 81: 406, 408.

Type *Haplotrema vancouverense* (Lea).

The following key is from H. B. Baker.

Key to Species of *Ancomena*

- A. Penis with short flagellum; vagina without muscular collar; adult shell usually less than 10 mm. in diameter, with weak growth wrinkles and fine but sharp spirals; central to northern California.....*H. keepi* (Hemphill)
- AA. Penis without flagellum; vagina with muscular thickening (at least); adult shell usually more than 10 mm. in diameter.
- B. Vagina with muscular thickening; vas deferens slender; apical (epiphalloid) penial chamber well differentiated; principal penial chamber lined with closely packed thorn papillae; cloaca with stimulator; shell with relatively more distinct sculpture (diameter less than 17 mm.)
- C. Anatomy unknown; shell usually more than 14 mm. in diameter, with strong growth threads but with weak spiral striae; coastal southern California.....*H. transfuga* ("Hemph." W. G. B.)
- CC. Shell usually less than 14 mm. in diameter, typically with stronger spiral striae.....*H. alameda* Pilsbry
- D. Anatomy as described; shell with strong growth threads; Alameda Co., California.....*H. alameda alameda* Pils.
- DD. Shell with weaker growth threads; Tulare Co., Cal.
H. alameda fieldi Pils.
- BB. Vagina with shining muscular collar; vas deferens swollen like an epiphallus; principal penial chamber without thorn papillae internally; cloaca without stimulator; shell with weak growth wrinkles and spirals (or more than 20 mm. in diam.)
- E. Vagina short, almost covered by large collar; apical penial chamber about $\frac{1}{2}$ length of penis, with insertion of retractor at its apex and entrance of vas deferens near middle of its side; shell smallish with depressed whorls and weakly undulate peristome; coastal region of central California
H. minimum (Ancey)
- F. Spire low; shell diam. less than 15 mm. typical form
- FF. Spire low; diam. more than 15 mm.
form *occidentale* ("Hemph." W. B. G.)
- FFF. Spire distinctly elevated.....form *kelseyi* (Hemphill)
- EE. Vagina elongate, with relatively small collar; penial retractor inserting on vas deferens, which is continuous with apex of penis; apical penial chamber not differentiated; shell typically larger, usually with more evenly rounded whorls and more markedly undulate peristome; Oregon to Alaska and west to Idaho.....*H. vancouverense* (Lea)
- G. Shell smaller (less than 25 mm. in diam.) with very weak sculpture (apparently intergrading with that of *H. minimum*).....form *vellicatum* (Forbes)

HAPLOTREMA CAELATUM GROUP (Section *Greggiella* H. B. Baker)

"*Greggiella*, type *H. caelatum*, differs from *Ancomena* in its penial diverticulum, which is reminiscent of *Salasiella* and *Oleacina*, in its simpler radula, and in the heavy and angular, but low riblets on its smaller shell." (H. B. Baker, 1941, *Nautilus*, 54: 131.)

Haplotrema caelatum (Mazyck)

Fig. 102.

Selenites caelata Mazyck, 1886, Proc. Elliott Soc., 2: 114; 1887, Proc. U. S. Nat. Mus., 9: 460, left fig.

Selenites "coelatura Mazyck," as synonym of *Macrocyclus duranti*, Binney, 1890, 3d Suppl., Bull. Mus. Comp. Zool., 19: 204 ("var. *coelata*" below figure); cf. also p. 221.

Haplotrema caelata (Mazyck) S. S. Berry, 1928, Jour. of Entom. and Zool., 20: 80.

H. (Haplotrema?) caelatum (Mazyck), H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 411.

Haplotrema (Greggiella) caelatum (Mazyck), H. B. Baker, 1941, Nautilus, 54: 131, pt. 9, figs. 1, 2.

"Shell small, depressed, brownish horn-color, with very coarse, rough, crowded, sub-equidistant, irregular ribs, which are obsolete at the apex; whorls 4, rounded, somewhat inflated below, gradually increasing, the last

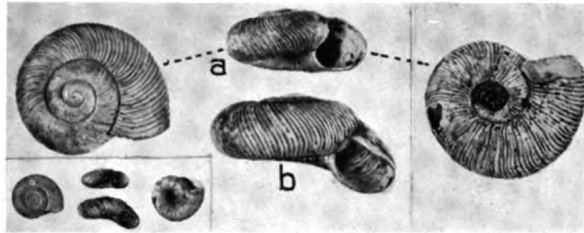


Fig. 102. *Haplotrema caelatum*. Right and left figures, San Diego; central figures, Millard canyon, Pasadena. Enlarged and actual size. (Connecting lines incorrect.)

not descending at the aperture; suture impressed; umbilicus wide, clearly exhibiting all of the volutions; aperture almost circular, slightly oblique; peristome simple, its ends approaching and joined by a very thin, transparent, whitish callus, through which the ribs are distinctly seen. Greater diameter 4 mm.; height $1\frac{3}{4}$ mm." (Mazyck.)

Diameter 6.9 mm., height 2.8 mm.; 4 whorls. San Diego.

Diameter 8 mm., height 4 mm. Near Pasadena.

CALIFORNIA: Santa Barbara (L. G. Yates, type loc.); Haywards, Alameda Co. (W. H. Dall). San Diego, among brush (Hemphill). Millard Canyon, back of Pasadena (Pilsbry), along Los Angeles River, Los Angeles Co. (W. O. Gregg).

LOWER CALIFORNIA: San Antonio Canyon about 5 mi. north of Johnson's Ranch (a few miles north of Cape Colnett, near the coast) (S. S. Berry). San Tomas River (Hemphill).

It is larger than *H. duranti*⁶⁰ with much coarser sculpture and a slightly more elevated, though still low, spire.

"The figured animals were collected Dec. 6, 1931, by Dr. W. O. Gregg (for whom the subgenus is named), under willow trees, along Los Angeles River, near Glendale, California. Animal similar to *H. alameda* but foot lighter; lung with large black blotches. Ovotestis (omitted from Fig. 103: 1)

⁶⁰ Mazyck gave the diameter as 4 mm., no doubt by error or from a young shell, as that is less than *H. duranti*. His size-mark for the figure is about 6.7 mm. long.

with 7 small, fan-shaped lobes of few clavate alveoli visible, in basal half of apical liver lobe. Epiphallic chamber (E) more constricted at base. Penis (P) with a white diverticulum (PL) and containing a subapical stimulator-papilla (outlined at PP). Atrial stimulator (outlined at YD) quite large; atrial opening not far from inferior tentacle. Radular formula (f. 2): 25 + 1 + 25; 50 rows counted; central without definitely free cusp; vestigial under-cusp on second tooth but absent from all others." (H. B. Baker.)

(*Caelatus*, carved.)

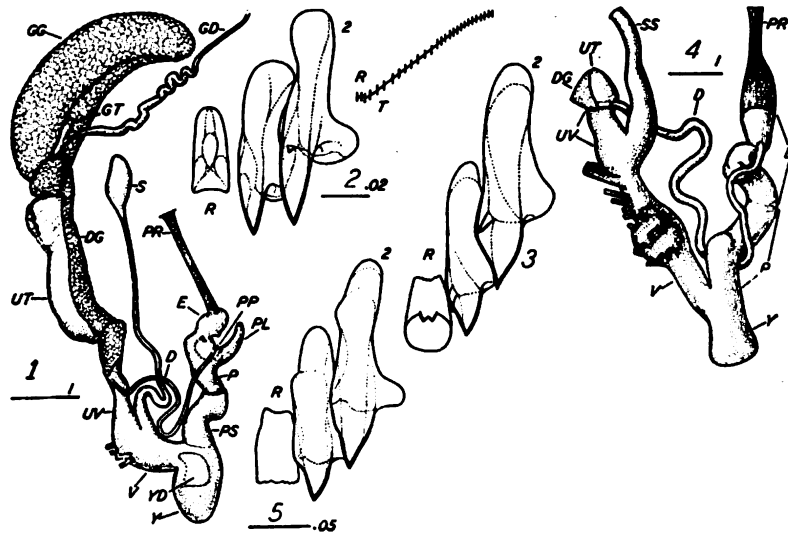


Fig. 103. 1, 2, *Haplotrema caelatum*, genitalia and teeth. 3, 4, *H. voyanum*, teeth and genitalia. 5, *H. transfuga*, teeth (after H. B. Baker.)

***Haplotrema keepi* (Hemphill)**

Fig. 104.

Selenites vancouverensis var. *keepi* Hemphill, 1890, *Nautilus*, 4: 42.—Binney, 4th. Suppl., *Bull. Mus. Comp. Zool.*, 22: 163, pl. 2, fig. 5.

H. (Ancomene) keepi Hemph., H. B. Baker, 1930, *Proc. Acad. Nat. Sci. Phila.*, 82: 412, pl. 34, figs. 4, 5, 10.

"Shell umbilicated, greatly depressed, thin, smooth, shining, transparent, scarcely marked by the delicate wrinkles; very light horn color; whorls over four, somewhat flattened above and beneath, and scarcely descending at the aperture; spire flat, not rising above the body-whorl; suture well impressed; umbilicus moderately large, exhibiting most of the volutions; aperture transversely subcircular, wider than high; lip simple, thickened, sinuous above, very slightly reflected at the base, ends scarcely approached. Width 5/16 inch, height 2/16 inch." (Hemphill.)

- Diameter 9.8 mm., height 3.9 mm. Alameda Co.
- Diameter 9 mm., height 3.3 mm. Alameda Co.
- Diameter 13.5 mm., height 5.5 mm. Redding.

CALIFORNIA: Hills near Oakland, Alameda Co. (Hemphill, type loc.). 1 mi. west of Cold Creek Fish Hatchery, between Blue Lake and Ukiah, Mendocino Co. (G. D. Hanna). Redding, Shasta Co. (R. C. McGregor).

The umbilicus is contained about $3\frac{1}{2}$ times in the diameter. Sculpture of weak, minute wrinkles of growth and fine incised spirals, visible only under a strong lens.

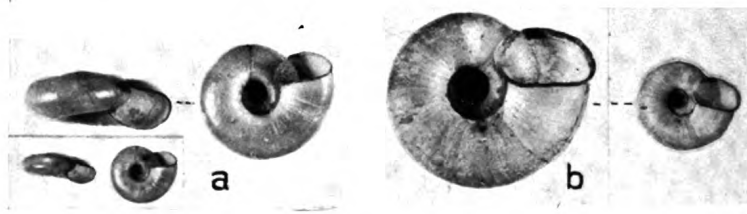


Fig. 104. *Haplotrema keepi*. a, paratypes from Hemphill, Alameda Co.; b, Redding. Actual size and $\times 2$.

"The dissections are founded on dried-in animals from one mile west of Cold Creek Fish Hatchery, between Blue Lake and Ukiah, Mendocino Co.; these were generously sent me by Dr. G. D. Hanna from the collection of the California Academy of Sciences.

"Foot whitish, obtusely rounded posteriad. Mantle collar deep; left neck lappet long but slender; left accessory very small. Lung wall with close network of coarse dark lines.

"Free oviduct (Fig. 108: 10) quite short. Spermathecal stalk with two ellipsoid basal swellings, upper of which contained a soft tadpole-shaped mass that may be a sperm packet. Vagina long, without muscular collar. Vas deferens slender, entering penis just above flagellum. Apical penial chamber about $\frac{1}{3}$ length of penis, with short flagelloid caecum near its middle and entrance of vas deferens slightly above; lower half with longitudinal folds, upper half with close papillae. Principal penial chamber very long, weakly demarcated at apex by internal series of chevron-shaped folds; wall thick with longitudinal or oblique, internal folds and with apparently a few scattered papillae.

"Jaw (Fig. 108: 4) narrowly crescentic. Radular formula (Fig. 108: 5) is (9-10) + (8-9) + 1 + 18 with 37 transverse rows; inner teeth with well developed entocones." (H. B. Baker.)

***Haplotrema transfuga* (Hemphill)**

Fig. 105.

Selenites vancouverensis var. *transfuga* Hemphill, 1892, in Binney, 4th. Suppl., Bull. Mus. Comp. Zool., 22: 165.

Haplotrema transfuga "Hemph." W. G. B., H. B. Baker, 1930. Proc. Acad. Nat. Sci. Phila., 82: 414 (type loc. San Diego); 1941, Nautilus, 54: 131; pl. 9, fig. 5 (anatomy).

"Shell very much depressed, planulate, broadly umbilicated, of a dirty white color; whorls $3\frac{1}{2}$ or 4, flattened above, more rounded beneath, with regular strong rib-like striae; suture well impressed, becoming deeper and channel-like as it approaches the aperture; aperture hardly oblique, slightly

flattened above, with a tendency to a corresponding depression below; lip simple, roundly thickened internally, its terminations approaching, forming in some specimens a short columellar lip, joined by a heavy raised callus in very adult specimens. Height $3/16$ inch, greatest diameter $9/16$, lesser $7/16$ inch." (Hemphill.)

Height 5.5 mm., diameter 16 mm. (San Diego).



Fig. 105. *Haplotrema transfuga*. San Diego.

CALIFORNIA: San Diego (Hemphill), type in Hemphill Coll., Cal. Acad. Sci.

BAJA CALIFORNIA: Todos Santos Bay (Hemphill). La Mision Valley about 35 miles south of Tia Juana (W. O. Gregg).

The size, plane spire, wide umbilicus and fine rib-striation distinguish this species.

"Animal (collected April 20, 1940, by Dr. W. O. Gregg, in La Mision Valley, Baja California) similar to *H. alameda* Pilsbry. Spermathecal sac long ellipsoid; free oviduct with slender apical region and more abruptly swollen base. Internal folds of apical penial chamber more papillate. Radular formula (Fig. 103: 5): $13 + 6 + 1 + 19$; 35 rows counted; central without evident cusp; under-cusps without definitely free points but represented by thickenings on inner 6 teeth, under and apparently fused to under-sides of principal cusps. The divergences in genitalia between *H. transfuga* and *H. alameda* might be due to differences in contraction, but the radular ones seem slightly more important." (H. B. Baker.) The areas of the two species are widely separated.

(*Transfuga*, a deserter.)

Haplotrema alameda Pilsbry

Fig. 106.

Haplotrema alameda Pilsbry, 1930, Nautilus, 44: 67, pl. 5, fig. 6.—H. B. Baker, 1930.

Proc. Acad. Nat. Sci. Phila., 82: 414, pl. 23, figs. 9-11.

Haplotrema alameda fieldi Pilsbry, *ibid.*, fig. 7.

"The shell is discoidal, the upper surface nearly flat, base broadly umbilicate. Color, cartridge buff to marguerite yellow. Whorls about four, slowly increasing to the last, which is very wide. Sculpture of fine, close rib-striae, and in places some microscopic spiral impressed lines. The strongly oblique aperture is wide. Peristome slightly thickened, narrowly expanded outwardly and a little reflected basally, the upper margin curving downward moderately. Height 4 mm., diameter 11.1 mm. Paratypes from 10 to 11.5 mm. diameter."

CALIFORNIA: Niles Canyon, Alameda Co. (F. L. Button), Type and paratypes 82879 A.N.S.P.

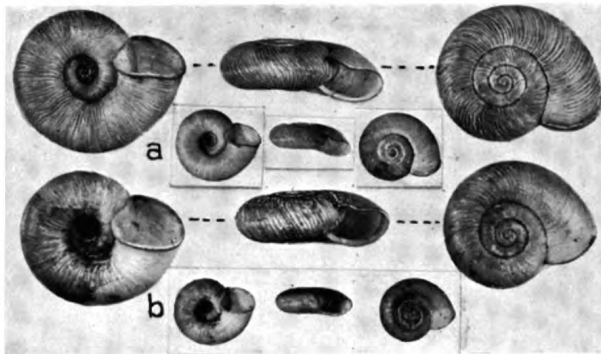


Fig. 106. *Haplotrema alameda*. a, type and paratypes, Alameda Co.; b, Giants' Forest, Sequoia National Park, Tulare Co. $\times 2$ and actual size.

It is closely related to the southern *H. transfuga* (Hemphill) but it is much smaller, with finer striation, on which some spiral lines can usually be traced. These seem to be absent in the larger, coarser *H. transfuga*. *H. alameda* has also been referred by some collectors to *H. voyana simplicilabris* Ancy, but Ancy's account of that shell shows it to be a thin-lipped *H. voyana*.

Mr. Allyn G. Smith (in litt.) gives the dimensions of *alameda* from his series of 27 from Niles Canyon: largest 4×12 mm., smallest 3.9×9.4 mm. "All specimens show somewhat regularly spaced, rather close axial ribbing. In some, however, the ribs are weak; in most, they are strong and well differentiated. On all specimens there is weak spiral sculpture that crosses the ribs, but in no instance does it extend into the spaces between them. I collected a single specimen from Mt. Diablo. It measures: diameter 9.6 mm., alt. 5.2 mm., and differs from the Niles lot in having much more deeply incised spiral sculpture, especially on the base, with the ribs almost entirely obsolete.

Localities for varying forms of *H. alameda* in the interior counties are now known from Calaveras to Tulare Counties. It appears that the Alameda Co. type locality is a limital western occurrence, rather out of the main range of the species. Until further study of the species throughout its range is made, no sound division into subspecies can be made. Some notes on lots in Californian collections are quoted here from a letter of Allyn G. Smith.

"Specimens collected by Dr. G. D. Hanna in the canyon of the Merced River, near El Portal, in Mariposa County just outside of the Yosemite Valley. They are larger and measure:

Greater diameter 14.1 mm., lesser 10.8 mm., alt. 4.9 mm.

Greater diameter 14.1 mm., lesser 10.7 mm., alt. 5.0 mm.

Greater diameter 13.2 mm., lesser 10.3 mm., alt. 4.3 mm.

"Spiral sculpture on these shells is almost obsolete and appears only on the base behind the aperture, and then only very faintly. Otherwise they are like the Niles Canyon haplotremas except for their larger size.

"Another lot of mine, containing one specimen only, comes from the Tuolumne County side of the Stanislaus River, at Melones, in the Mother Lode country. It measures: diameter 13.7 mm., alt. 5.2 mm. The ribs are fairly strong and there is almost no trace of spiral sculpture. It is nearly identical with Hanna's El Portal specimens.

"The last of my lots of *H. alameda* comes from the banks of the Calaveras River, near Jenny Lind, Calaveras County, Calif. One group contains ten specimens and the other, a single one. Five shells from the first lot, collected in 1921 measure from 9.7×3.8 mm., to 9.3×3.5 mm. This group differs from typical Niles Canyon *alameda* by having the axial ribs obsolete or nearly so, and by having very weak spiral sculpture as well. It averages smaller in size and in altitude." (A. G. Smith.)

In the form described as *H. alameda fieldi*, Fig. 106b, from the Giants Forest, Sequoia National Park (Stanley C. Field), the striation is decidedly weaker than *H. alameda*, and unevenly developed; umbilicus narrower within. Height 3.8 mm., diameter 10 mm.; others from 9.7 to 10.8 mm. diameter. This is far south of any other record.

"The dissections are based on preserved animals of paratypes, collected Mar. 24, 1902, by Fred Button (A.N.S.P. 82879). They are certainly not Ancey's *simplicilabris* (see *voyanum*).

"Foot spotted with black; almost pointed posteriad. Mantle collar deep; left neck lappet fairly prominent, twice as large as left accessory. Lung wall about 3 times as long as its base or length of kidney; with anastomosing streaks of dark pigment. Kidney about $1\frac{1}{2}$ times as long as its base or length of pericardium.

Ovotestis consisting of 4 clumps of alveoli; duct (Fig. 98: 11) swollen and coarsely convoluted; talon clavate. Free oviduct long, heavy walled with longitudinal plicae internally. Vagina with heavy sphincteric thickening, although without distinct muscular collar. Vas deferens slender, held in penioviducal angle by strands of penial sheath; opening through largest pilaster of apical penial chamber. Apical chamber of penis (Fig. 98: 10) conical, internally demarcated by a high, sphincteric fold and complicated by about 10 longitudinal plicae. Principal penial chamber with basal $\frac{2}{3}$ surrounded by a heavy sheath; internally with very numerous, closely packed thorn papillae (as in *concaum*). Cloaca large and obovoid, containing a tongue-shaped stimulator near base of vagina; lined by large papillae in upper and by coarse folds in lower halves; external opening low in foot but behind anterior edge of body stalk.

"Jaw very narrow. Radular formula (Fig. 98: 9) is $17 + 6 + 1 + 23$, with 46 transverse rows; central with abruptly pointed cusp; inner teeth as in *keepi*. Cerebral ganglia juxtaposed; abdominal and left parietal ones fused." (H. B. Baker.)

Haplotrema minimum (Ancey)

Fig. 107 a-d.

Selenites vellicata (California), and var. *minima* Ancey, 1888, Le Naturaliste, 2: 188, 2 ser. Not *Helix vellicata* Forbes.

Haplotrema minimum (Anc.) H. B. Baker, Proc. Acad. Nat. Sci. Phila., 82: 415, pl. 34, figs. 1-3.—W. M. Ingram, 1942, Nautilus, 55: 98. Habits.

Selenites vancouverensis Lea (*S. concavus* var. *occidentalis*) Hemphill, in Binney, 1892, Suppl. 4, Bull. Mus. Comp. Zool., 22: 165 (Sonoma Co. to Santa Cruz Co., Cal.).

Selenites vancouverensis var. *tenuis* Hemphill, 1892, in Binney, 4th Suppl., Bull. Mus. Comp. Zool., 22: 166 (Napa Co., Cal.).

Circinaria var. *kelseyi* Hemphill, 1911, Trans. San Diego Soc. Nat. Hist., 1: 103, fig. 3. (San Mateo Co. and San Luis Obispo Co., Cal.).

The shell is rather thin, smaller than *H. vancouverensis*, the spire convex but low. Umbilicus contained about $3\frac{1}{2}$ times in the diameter. Surface rather glossy, irregularly wrinkle-striate, covered with close, microscopic

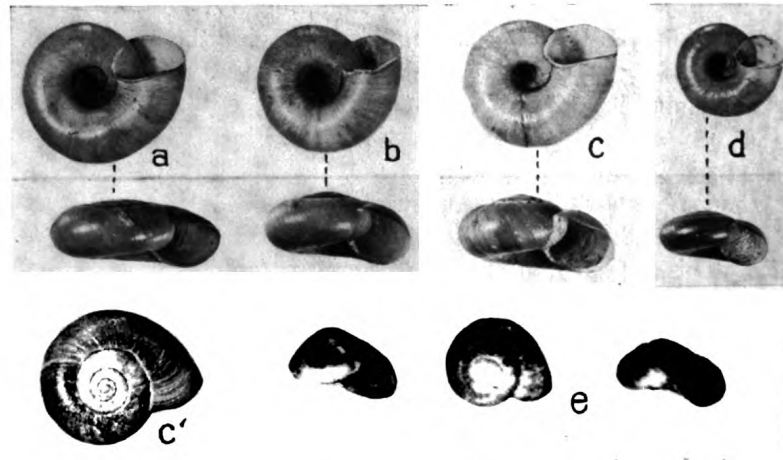


Fig. 107. *Haplotrema minimum*. a, Santa Cruz; b, San Francisco; c, c', near Inverness, Marin Co.; d, Salmon Creek, Monterey Co.; e, var. *kelseyi*, after Hemphill.

shallow spiral striae. The aperture is wider than high, the peristome slightly thickened, expanded on the basal margin, the upper margin somewhat straightened or a little bent downward.

Diameter 19.5 mm., height 9 mm.; 5 whorls. San Francisco.

Diameter 14 mm., height 7 mm.; Salmon Creek.

Diameter 18 mm., height 8.7 mm.; Oakland.

Diameter 21.8 mm., height 8.7 mm.; Santa Cruz.

CALIFORNIA: In the following counties: Sonoma, Napa, Marin, San Francisco, Alameda, San Mateo, Santa Cruz, Monterey and San Luis Obispo. Type loc., San Francisco.

The shell of this middle Californian race is often indistinguishable from small forms of *H. vancouverensis vellicata*, though the latter typically has more robust whorls and the lip is more sinuous. The chief differences are anatomical.

It has been observed by Dr. Ingram feeding on young and adults of *H. arrosa holderiana* and *H. diabloensis* in the field, and on the young of *H. aspersa* in the laboratory.

The large, normal form of *H. minimum* is what Hemphill called *occidentalis*, diameter 22 mm., height 9.5 mm.

"In his 1888 paper, Ancey gives a good description of the Californian species; suggests that the name *vellicata* be used and describes an exceptionally small, under-developed specimen from San Francisco as variety *minima*. Forbes' dimensions of *vellicata* do approach the usual size for *occidentale*, but his figure shows the sinuate peristome and stouter whorls of *vancouverense*. Hemphill's figures of *kelseyi* represent a much higher shell than *H. minimum*; Mr. Allyn Smith has very generously sent me photographs, made by Dr. Hanna and himself, of two of the original specimens. It is apparently a form of *minimum*; Mr. Smith writes me that, according to Hemphill's labels on these cotypes in the California Academy of Science, two other names had been considered (from Mateo and of Say). In addition, photographs of a cotype of *tenuis* (Allyn Smith writes Aetna Springs is the exact type locality) show that it is a synonym of *minimum*.

"The specimens of *H. minimum* (form *occidentale*) which have been dissected, come from Tomales Bay, Marin Co., Cal. (July 18, mainly collected by Mr. Nicholson); one of my five animals lacked both vas deferens and penis although the prostate was apparently normal and mature. Despite the marked differences between the animals of *H. minimum* and *H. vancouverense vellicatum*, I can give no shell characters that will separate all specimens.

"Foot whitish; sole narrowly rounded posteriad; tips of ommatophores black. Mantle collar very heavy, tinged with chrome externally; left neck-lappet twice as large as left accessory. Lung wall about $3\frac{1}{2}$ times as long as its base or length of kidney; with scattered brown spots, especially along hindgut and over kidney (much lighter than in *vancouverense*). Kidney about $1\frac{1}{2}$ times as long as its base or length of pericardium.

"Talon (Fig. 108: 1) large and irregularly clavate. Albumen gland especially short and broad. Free oviduct quite slender. Spermatheca with elongate sac (also swollen below aortic loop). Vagina stout, with heavy, almost complete muscular collar very near its base. Vas deferens long; descending limb looped and somewhat swollen; ascending limb slender and closely attached to penis; opening simple. Apical penial chamber (Fig. 108: 2) $\frac{1}{2}$ length of penis; thin walled and almost featureless internally; opening of vas deferens near middle of side. Principal penial chamber with heavier wall and very low, oblique, internal thickenings. Cloaca very short;

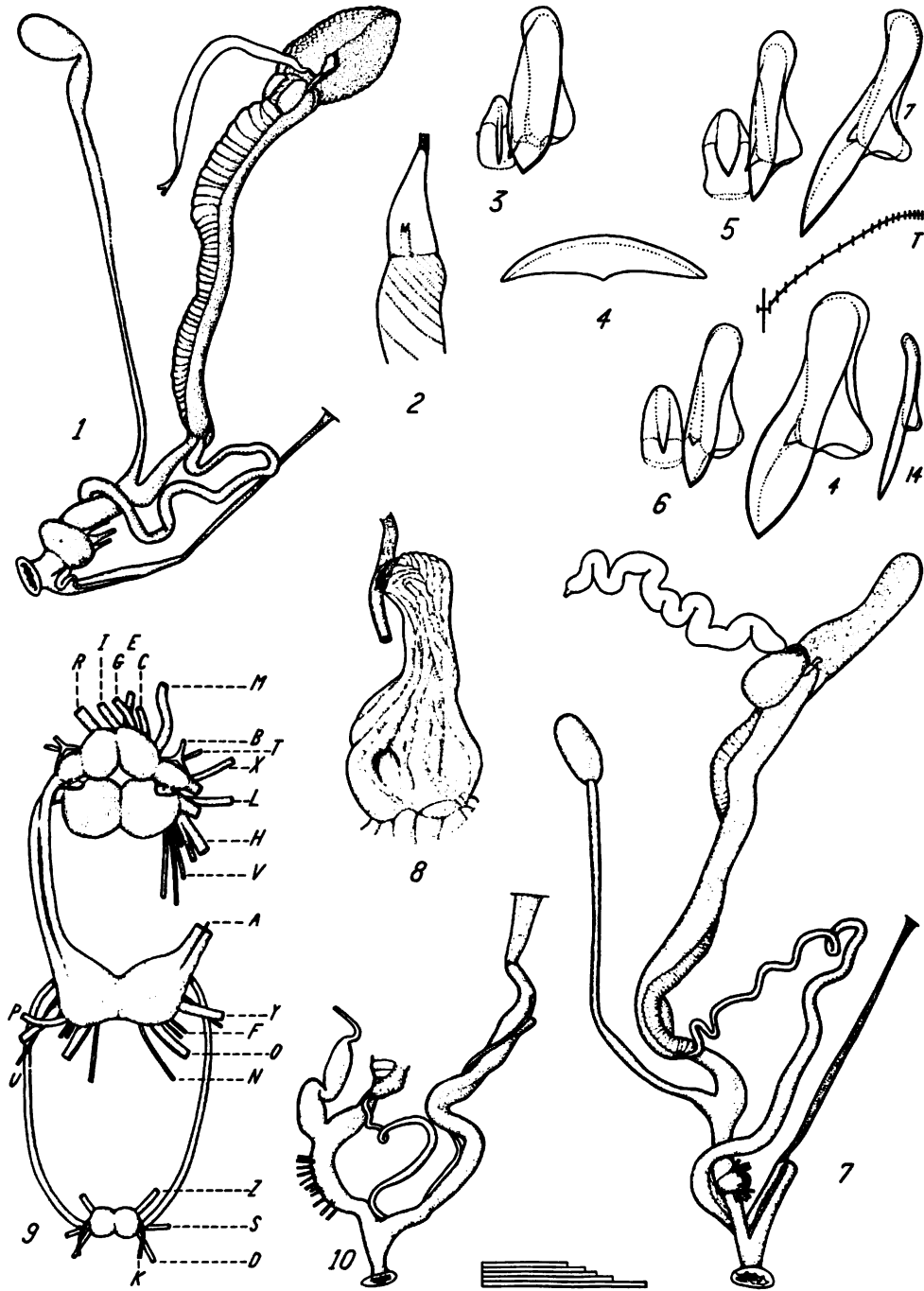


Fig. 108. See bottom of page 221 for legend.

external opening near upper edge of foot in middle of body stalk. Radular formula (Fig. 108: 3) is (17-18) + 6 + 1 + (23-24) with 32 rows; central with slender cusp; inner laterals with weak entocones. Nervous system with ganglia as in *H. vancouverense*." (H. B. Baker).

Form *tenuis* Hemphill, Fig. 109. "Shell broadly umbilicated, depressed, nearly planulate; of a dirty greenish brown color; whorls 5, flattened above,



Fig. 109. *Haplotrema minimum* form *tenuis*, type, Aetna Springs, California, diameter 16.6 mm. (Phot. Allyn G. Smith.)

more rounded beneath, the last expanding laterally as it approaches the aperture, and crowded with fine oblique striae; suture well impressed; aperture rounded, slightly flattened above; peristome simple, hardly reflected below. Height $\frac{1}{2}$ inch, breadth $\frac{7}{16}$ inch." (Hemphill.)

The lectotype in C.A.S. is from Aetna Springs, Napa Co., California. It measures: diameter 16.6 mm., height 7 mm., Hemphill's no. 7402.

The var. *kelseyi* Hemphill, Fig. 107e, is distinguished by the high spire, more elevated than in any other *Haplotrema*. Hemphill's type specimens were doubtless selected from more normal lots, and represent an extreme of variation rather than a true race.

Haplotrema vancouverense (Lea)

Fig. 110.

Helix vancouverensis Lea, 1839, Trans. Amer. Philos. Soc., 6: 87, pl. 23, fig. 72; Obs. 2: 87.—Binney, 1851, Terr. Moll., 2: 166, pl. 20.

Macrocyclus vancouverensis Lea W. G. Binney, 1878, Terr. Moll., 5: 90; 1886, 2d. Suppl., Bull. Mus. Comp. Zool., 13: 25.

Fig. 108. 1, *Haplotrema (Ancomena) minimum* (Marin Co., Cal.), dissected genitalia (ovotestis omitted). 2, *H. minimum*, penis cut open lengthwise and pinned out; opening of vas deferens is near center of upper part. 3, *H. minimum*, radula: central and first lateral. 4, *H. (Ancomena) keepi* (Mendocino Co., Cal.). Jaw. 5, *H. keepi*, radula: central and first lateral; also 7th tooth and diagram of transverse row. 6, *H. (Ancomena) vancouverense*, typical form (Pacific Co., Wash.). Radula: central and first lateral; also 4th and 14th teeth. 7, *H. vancouverense*, dissected genitalia (ovotestis omitted). 8, *H. vancouverense*, penis and cloaca cut open longitudinally and pinned out; vaginal orifice is on left near base. 9, *H. vancouverense*, typical form (topotype, Clatsop Co., Oregon). Central nervous system laid out in one plane (pedal nerves of right side and most of left pedal and pleural connectives omitted). 10, *H. keepi*. Terminations of genitalia, including penis (to right) and bases of spermoviduct (middle) and spermatheca (at left). After H. B. Baker.

Circinaria vancouverensis Lea, Pilsbry, 1908, Man. Conch., 19: xi, pl. 52, fig. 6. pallial organs.—Dall, 1905, Harriman Alaska Exped., Land and Fresh Water Moll., 13: 34, with var. *chocolata*.

Haplotrema vancouverense Lea, Henderson, 1929, Univ. Colo. Studies, 13: 141; 17: 95, fig. 56; 23: 108, 257.—H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 416, pl. 34, figs. 6-9.

Helix vellicata Forbes, 1850, Proc. Zool. Soc. Lond., p. 55, pl. 9, figs. 1a-1c.

The shell is rather solid, glossy, olive-ocher with darker and lighter streaks; depressed, with low, convex spire, the umbilicus contained about four times in the diameter; spire of $5\frac{1}{4}$ to $5\frac{1}{2}$ whorls, small, occupying less than half of the total diameter; suture deeply impressed. Sculpture of low, unequal wrinkles and close, microscopic spiral lines, which are usually fainter or not visible on the last whorl. The aperture is wider than high, the lip blunt, the basal margin expanded and thickened within, upper margin arched forward, straightened or depressed and sinuous.

Diameter 1.1 inches, height 0.5 inch (Lea).

Diameter 28.5 mm., height 12.5 mm. Point Ellis.

Diameter 25 mm., height 11.5 mm. Point Ellis.

Diameter 32 mm., height 13 mm. Oregon.

Diameter 24 mm., height 11.5 mm. Crescent City.

Diameter 20.5 mm., height 9.7 mm. Crescent City.

Diameter 22 mm., height 8 mm. (*Vellicata* Forbes.)

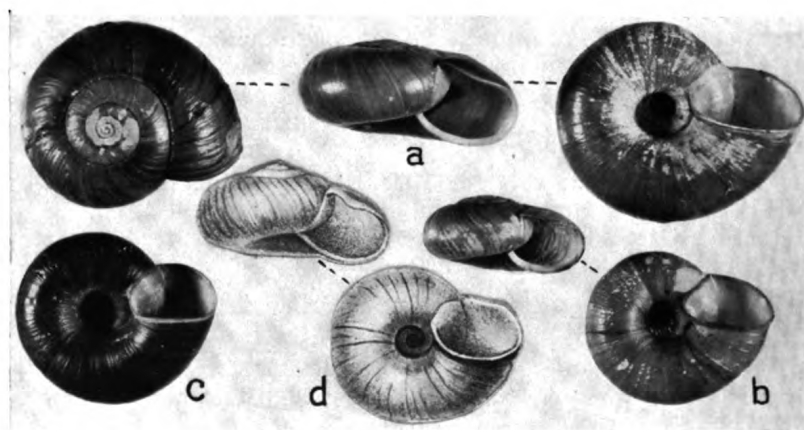


Fig. 110. *Haplotrema vancouverense*. a, typical form, Point Ellis, Washington, opposite Astoria; b, Crescent City, California. c, form *chocolatum*, near Kelso, Washington. d, copy of figures of *H. vellicata* Forbes.

Distribution.—In the moist and wooded region of northwestern California and northward to the Alexander Archipelago, Alaska, between the Cascade Range and the sea. Northeastern Oregon; northern Idaho.

ALASKA: Annette Island, Killisnoo, Sitka, Lynn Canal, throughout the Alexander Archipelago, and northward along the mainland shore to Lituya Bay (Dall). St. Paul

Island (Hanna); Forrester Island (Willett). BRITISH COLUMBIA: Vancouver Island at Comox, near Union, Cameron Lake; Quatsino Sound, Broughton Strait, Malcolm Island, Johnstone Strait, Harbledown and Pender Islands, Skidegate, Graham Island, and Cumshewa Inlet, Moresby Island, Queen Charlotte Islands (Dall); Langara Island; Vancouver (S. Brown). WASHINGTON: In the following counties: Jefferson, Whatcomb, Clallam*, King*, Pacific*, Cowlitz, Skamania, Clarke. Gray's Harbor, Thurston, and in the east, around Walla Walla. OREGON: In counties: Clatsop*, Tillamook, Marion, Multnomah, Clackamas*, Hood River, Lincoln, Douglas, Coos, Curry. Type loc. Vancouver, Washington Co., Type 425341 U.S.N.M. In the east, South Fork Walla Walla River above Milton; 9 mi. southeast of Weston, Umatilla Co., and valley of Pine Creek above Weston. IDAHO: 16 places in the following counties: Kootenai, Benewah, Shoshone, Clearwater, Bonner, Umatilla, collected by H. B. Baker. CALIFORNIA: Lighthouse Island and Endert's Beach near Crescent City, Del Norte Co.; Capetown, Humboldt Co. (E. P. Chace); 6 mi. above Charlotte, Humboldt Co. (Wharton Huber).

H. vancouverense is the largest species of the genus. It "usually attains its maximum development in fairly rich and humid situations although it sometimes approaches the brown form *chocolatum* in the wettest places." The large typical form occurs from Sitka to Oregon, but shows variation in the spiral sculpture, which is uniform and clearly cut in many places in Washington and northward, but very weak on the last whorl in the prevalent Columbia River shells. The specimens from Humboldt and Del Norte counties, California, are rather small, diameter 20 to 24 mm., and also are deficient in spiral lines, which are weaker or wanting on the last whorl. These specimens have not been compared anatomically with *H. minimum*. Dr. Newcomb stated that *H. vancouverense* of normal size occurs in the same neighborhood as *H. voyana* in Canyon Creek, Trinity Co., California. Some small Idaho *vancouverense*, such as those from between Sand Point and Coburn, Bonner Co. (H. B. Baker), have much the appearance of *H. sportella* form *semidecussata*, but the spiral lines are weaker. Diameter 18 to 21 mm.

In 1916 Dr. G. D. Hanna planted specimens of *H. vancouverense* behind the laboratories on St. Paul Island, Pribiloff group, Alaska, but none were seen there in 1918.

Helix vellicata Forbes, Fig. 110d, for which no definite locality was given, is merely a small form of the typical race of *vancouverensis* which Dr. Baker believes "probably came from the less humid shores of Puget Sound." It is sculptured with fine spiral striae, and differs from the Californian *H. minimum* by the more robust whorls of larger caliber.

Form *chocolatum* Dall, Fig. 110c. "A variety of a dark chocolate brown color, otherwise like the ordinary form, was found rather commonly at Sitka" (Dall). The color ranges to raw umber or between that and the usual color of the species. Dark colored specimens have been found also in Washington and Oregon; the figured specimen came from near Kelso, Cowlitz Co., Washington.

"Animals from the counties followed by asterisks in the preceding summary of range have been examined; all of the forms have the same anatomy

and show no approach to that of the Californian *H. minimum*. The exact limits of the two species must be determined by future studies. The following anatomical notes are mainly founded on animals of typical *vancouverense* from around Astoria (Clatsop Co., Ore., and Pacific Co., Wash.; Aug. 6-11).

“Foot large; lateral borders and head usually dark; sole obtusely rounded or shortly pointed posteriad. Mantle collar large and heavy, usually dark brownish externally; left neck lappet smaller than right but much larger than left accessory. Lung wall externally with considerable brown or black pigment (mainly darker than in *H. minimum*); more than 3 times as long as its base and less than 3 times length of kidney. Kidney about $1\frac{1}{2}$ times as long as its base or length of pericardium.

“Ovotestis consisting of numerous large groups of alveoli; duct (Fig. 108: 7) much swollen and coarsely convoluted; talon relatively minute, clavate. Free oviduct rather short. Vagina elongate with distinct muscular collar near middle of its length. Vas deferens with very long, complexly looped, descending limb, which is swollen like an epiphallus in basal half; ascending limb slender, straight and firmly attached along side of penis; terminally continuous with penial apex although latter has thicker wall. Penis relatively small, slender and not divided into apical and principal chambers; with heavy wall, which is thickened internally by a few coarse longitudinal folds (Fig. 108: 8). Penial retractor very long; inserting on penial end of vas deferens. Cloaca a short, swollen continuation of penis, with broader longitudinal thickenings; external opening near middle of body stalk slightly above upper edge of foot.

“The muscular collar around the vagina in this (and other) species does not quite form a complete circle. From a series of sections prepared by Dr. Eleanor Carothers, its circular strands of muscles are separated by lacunae as in erectile organs.

“Jaw narrowly crescentic, thick and heavy mesiad but very attenuate towards outer ends. Radular formula (Fig. 108: 6) is $18 + 6 + 1 + 24$, with 36 transverse rows; inner laterals with shorter entocones than in *H. minimum*.

“Nervous system (Fig. 108: 9). Right cerebral ganglion gives off from pedal gyrus: (N) nuchal (dorsal peritentacular) nerve to body wall between ommatophores, (O) large oculotentacular, (F) two frontals (lateral peritentaculars) to sides of head, (P) penial (right ganglion only), (Y) large palpolabial to inferior tentacles and lower lip, (U) upper labial to dorsal lip, pedal (cerebro-pedal) connective and (A) acoustic; and from pleural center pleural (cerebropleural) and buccal connectives. Either buccal ganglion gives off: (D) big anterior buccal along salivary duct to entrance into buccal mass, buccal connective, (S) lateral buccal that enters buccal mass a short distance laterad to ganglion, (K) small anterior oesophageal directly to oesophagus and (Z) posterior oesophageal back along salivary duct to supply salivary gland and most of oesophagus. Each pedal ganglion gives off to muscles of sole (V) 18 to 20 small ventral pedal nerves, of which the most anterior runs along side of pedal gland; and to lateral sides of foot and body wall (H) a big anterolateral pedal (anterior

external of Simroth), (L) a lateral pedal (median anterior), and (X) a posterolateral pedal (median posterior). Tentaculoretractor nerve (T) to tentacular muscle and buccoretractor (B) to pharyngeal muscle (on each side) arise apparently by one root from pleural connective and a second from right parietal ganglion or its sinistral homolog. Right parietal ganglion also gives off (R) right pallial nerve. Ganglion formed by fusion of left parietal and abdominal gives off (M) a left pallial, (C) a columellar (dorsocaudal) to lateral and columellar muscles and tail, (G) a carditogenital to uterus, etc., (E) an entero-aortic along aorta, and (I) an anal to hindgut." (H. B. Baker).

HAPLOTREMA SPORTELLA GROUP (Section *Ancotrema* H. B. Baker)

Ancotrema H. B. Baker, 1931, Proc. Acad. Nat. Sci. Phila., 82: 406, 408, 409. Type *Haplotrema sportella* (Gld.).

The following key is from H. B. Baker.

Key to Species of Ancotrema s.s.

- A. Shell with less gradually increasing whorls and less triangular aperture
H. sportella (Gould)
- B. Adult shell 9.5 to 18 mm. in diam.; growth wrinkles heavy and beaded by spiral striae; Puget Sound region, mainly east of Olympic Mts.
H. sportella sportella (Gld.)
- BB. Adult shell 18 to 27 mm. in diam., or with weak sculpture
H. sportella hybridum (Ancey)
- C. Shell with heavy sculpture approaching typical *sportella*, although often with smoother last whorl; olive green to brownish; mainly west of Coast Range, from Alaska to central California
 form *semidecussatum* (Gratacap)
- CC. Shell with weaker growth wrinkles and much weaker spirals; light green to straw color; peristome usually more undulate; mainly east of Coast Range, Oregon to southern Washington... typical form *hybridum* (Ancey)
- AA. Shell with more gradually increasing whorls and more triangular aperture; sculpture much as in typical *sportella*; mainly east of Coast Range, northern California and (?) southern Oregon.....*H. voyanum* (Newcomb)

***Haplotrema sportella* (Gould)**

Fig. III a-d.

Helix sportella Gould, 1846, Proc. Boston Soc. N. H., 2: 167. Puget Sound; 1851, Terr. Moll., 2: 211, pl. 22a, fig. 1; U. S. Expl. Exped., Moll., 12: 37, pl. 12, fig. 42.

Macrocyclis sportella Gld., W. G. Binney, 1878, Terr. Moll., 5: 91, pl. xv, fig. κ, teeth.

Haplotrema sportella sportella Gld., Henderson, 1929, Univ. of Col. Studies, 17: 96, fig. 57.—H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 418, pl. 35, figs. 1-4, anatomy.

"Shell much depressed, convex above, concave beneath, sloping into a broad, tunnel-shaped umbilicus. Surface delicate and shining, of a pale, yellowish-green color, regularly sculptured with sharp, coarse lines of growth, which are crossed by fine, crowded, revolving lines, which cut merely the summits of the radiating ridges, so that, to the naked eye, the surface appears minutely granulated; but under a magnifier the raised spaces are seen to be well defined squares. Whorls five, separated by a deep suture, the outer one proportionally large. Aperture nearly circular, a little angular at base, modified by the preceding whorl; lip acute, simple. Diameter half an inch; axis a little over one-fourth of an inch." (Gould.)

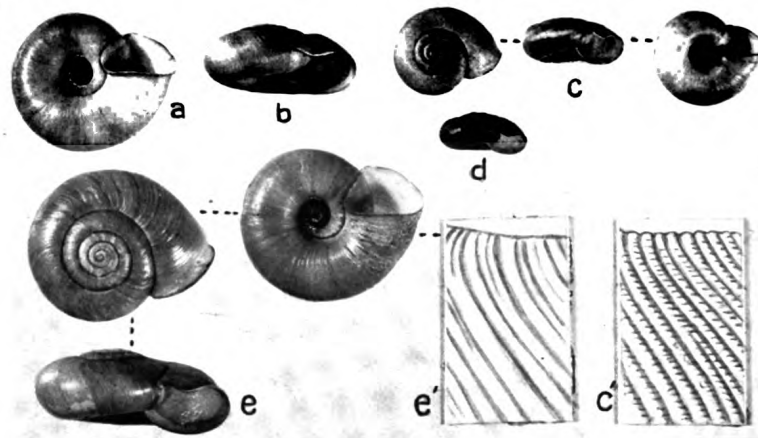


Fig. 111. a-d, *Haplotrema sportella*; a, Elkton, Oregon; b, c, c', d, Seattle, Washington. e, e', *Haplotrema sportella hybridum*, Riverdale, Oregon.

Height 6.2 mm., diameter 11.2 mm.; $5\frac{1}{4}$ whorls. Seattle.

Height 7 mm., diameter 14 mm. Seattle.

Height 7.4 mm., diameter 15 mm. Seattle.

Height 9.2 mm., diameter 20 mm.; 6 whorls. Seattle.

Height 9.7 mm., diameter 21.4 mm.; $6\frac{1}{4}$ whorls. Elkton, Ore.

BRITISH COLUMBIA: Vancouver Island in various places (C. M. Cooke Jr., H. A. Pilsbry). WASHINGTON: Whatcom, Whatcom Co. (Hemphill). Near Mora and Port Angeles, Clallam Co. (H. B. Baker). San Juan I. (Hemphill). McAleer Creek, King Co. (Baker). Nisqually, Pierce Co. (S. N. Rhoads). Olympia, Thurston Co. (Hemphill). OREGON: Newport, Lincoln Co. (J. G. Malone). East of Astoria, Clatsop Co. (H. B. Baker). Elkton, Douglas Co. CALIFORNIA: Endert's Beach, 5 miles south of Crescent City (E. P. Chace). Humboldt Co. and "Klamath Co." (Newcomb).

The sculpture of sharp, somewhat coarse striae cut by impressed spiral lines is characteristic, this sculpture typically extending over the last whorl; but in many lots there are transitions to *hybridum*, in which the striae become weaker, coarse wrinkles rather than striae, and the spirals are decedent, or only fine ones present on the last whorl.

H. sportella varies widely in size, even in the same neighborhood, as in the several lots from around Seattle, measured above.

"This small, heavily sculptured subspecies is mainly developed around Puget Sound in the drier valleys east of the Olympic Mts. It intergrades perfectly with the *semidecussatum* form of *hybridum*." (H. B. B.)

The Californian specimens are large, up to 8.3×17.3 mm., and finely, clearly sculptured, with spiral lines usually well developed. However, at Endert's Beach the Chaces found also some with sculpture weak on the last whorl, as in the *hybridum* form.

The following anatomical notes are mainly founded on specimens of *sportella* from King Co., Washington (Aug. 15-19).

"Foot mainly whitish but gray towards head; tentacles black tipped; sole pointed posteriad. Living animal much more active than *H. vancouverense*. Mantle collar (Fig. 112: 4) light brownish externally, heavy and deep; left neck lappet long and attenuate; left accessory about half as large. Lung wall white but with some brown externally over hindgut and kidney; almost 3 times as long as its base and about $2\frac{1}{2}$ times length of kidney. Kidney over twice as long as its base and about $1\frac{1}{2}$ times length of pericardium.

"Ovotestis (Fig. 112: 2) consisting of 5 large groups of alveoli; duct swollen; talon long with a spherical knob on its recurved tip. Free oviduct quite slender. Spermatheca strongly swollen at base, which is much larger than free oviduct. Vagina very short, almost covered by heavy muscular collar. Vas deferens quite slender and simple; opening in summit of lateral penial pilaster. Apical penial chamber (Fig. 112: 1) small and sub-spherical, internally with longitudinal plications and demarcated basally by a high sphincteric ridge. Principal penial chamber differentiated into apical and basal halves; apical region thin walled except for large, internal pilaster under vas deferens; basal region internally with 6 to 7 very heavy, longitudinal ridges with high crests towards their upper ends. Penial retractor arising from left side of columellar tail fan, curving dorsad of oesophagus and salivary glands. [In specimen figured, the retractor is contracted and the principal penial chamber is elongated.] Cloaca short, with lower folds than penial base; external opening behind middle of body stalk and above upper margin of foot.

"Radular formula (Fig. 112: 3) is (14-15) + (6-7) + 1 + (21-22); 39 transverse rows counted. Central usually with bifid mesocone and lateral angles. Inner laterals with weak entocones. Salivary glands larger and longer than buccal mass. Stomach slender, $\frac{2}{3}$ whorls in length. Cerebral commissure slightly longer than in *H. vancouverense*." (H. B. Baker.)

(*Sportella*, a little basket.)

Haplotrema sportella hybridum (Ancey)

Fig. III e, e'.

Selenites vancouverensis forma *hybrida* Ancey, 1888, Le Naturaliste, 10^e année (2 Ser.), 2: 188, fig. 1; with variety *depressa* Ancey.

Selenites vancouverensis var. *hybrida* Hemphill, 1890, Nautilus, 4: 42 (Astoria).

Macrocyclis vancouverensis var. *semi-decussata* Gratacap, 1901, Bull. Amer. Mus. N. H., 14: 340 (Astoria).

Haplotrema (Ancotrema) sportella hybridum ("Thomson" Ancey), and form *semidecussatum* (Gratacap), H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 420.—Henderson, 1936, Univ. Colo. Studies, 23: 256.

The shell is larger than typical *H. sportella*, the intermediate and later whorls of the spire with sharp, close striae more or less deeply cut by impressed spirals; on most or all of the last whorl the sculpture is reduced to low, unequal wrinkles, and the spirals become microscopic or subobsolete. Aperture as in *H. sportella*.

Diameter 23 mm., height 11.5 mm.; $6\frac{1}{2}$ whorls (Ancey).

Diameter 24.5 mm., height 11 mm.; 6 whorls (Spec. from Ancey).

Diameter 15.7 mm., height 7 mm.; 12 miles from Mt. Hood.

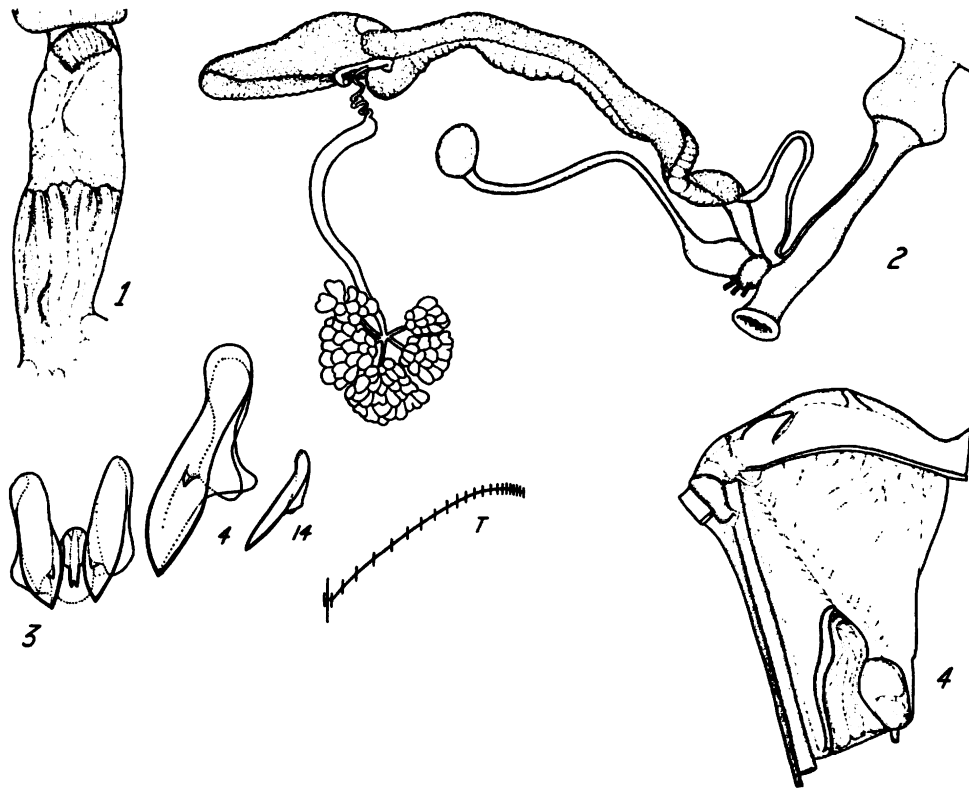


Fig. 112. 1. *Haplotrema sportella sportella* (Univ. of Wash. campus, King Co.). Penis and cloaca split open longitudinally and pinned out; opening of vas deferens is in fork of Y-shaped pilaster. 2, dissected genitalia (penial muscle retracted and penis elongated). 3, radula: central and both of first laterals; also 4th and 14th teeth and diagram of transverse row. 4, internal view of pallial complex.

WASHINGTON: Thurston Co. OREGON: Riverdale near Portland, type loc.; Multnomah, Clackamas, Douglas and Wasco counties.

"Ancey's description and figure are mainly founded on the form with almost obsolete sculpture and very sinuate peristome; it is the commonest *Haplotrema* around Portland. Hemphill, who was apparently unaware of Ancey's paper, founded his *hybrida* on a specimen of the coastal form *semidecussatum* (Gratacap), which sometimes approximates *H. vancouverense chocolatum* (Dall) in the darkness of its coloration. One lot of A.N.S.P. specimens, from Tawney's Hotel on the Salmon River, 12 miles from Mt. Hood (Clackamas Co., Ore.), approaches typical *sportella* in size but has the same smoothish surface as the very large shells from near Portland.

"The anatomy of both Riverdale (Aug. 1-5) and Astoria (Aug. 6-11) animals is essentially the same as that of typical *sportella*. The radular formula of a Riverdale specimen is (15-16) + (7-8) + 1 + 23, with 34 transverse rows. None of my specimens show signs of ovoviviparity. One specimen of *semidecussatum* from near the mouth of the Quillyute River, Clallam Co., Washington, lacks both the vas deferens and the penis." (H. B. Baker.)

Var. *semidecussatum* (Gratacap). Umbilicus slightly more open within, color buffy olive or somewhat more smoky or brownish; glossy. Diameter about 23 to 25 mm., 6 whorls.

OREGON: Astoria, type locality of this form. Also found in Vernon, Osoyoos, Clatsop, Lincoln and Douglas counties. CALIFORNIA: Bolinas Bay, Marin Co. (W. M. Gabb). Napa and San Mateo counties. ALASKA: Duncan Island, Unalaska, Sitka. BRITISH COLUMBIA: Queen Charlotte and Vancouver Islands.

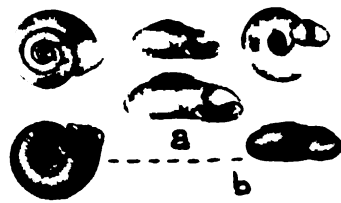


Fig. 113. *Haplotrema voyanum*. Central figure a paratype; lower figures after Newcomb.

***Haplotrema voyanum* (Newcomb)**

Fig. 113.

Helix (Macrocyclis) voyana Newcomb, 1865, Amer. Jour. Conch., 1: 235, pl. 25, fig. 3.

Macrocyclis voyana Newc., W. G. Binney, 1873, Terr. Moll., 5: 93, fig. 12 (dimensions and locality "San Diego" incorrect).

Selenites voyana Newc. Ancey, 1882, Le Naturaliste, 2: 111 (dimensions erroneous).

Haplotrema (Ancotrema) voyanum (Newc.) H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 420; 1941, Nautilus, 54: 132, pl. 9, figs. 3, 4 (anatomy).

Selenites voyana var. *simplicilabris* Ancey, 1882, Le Naturaliste, 2: 111.

Shell broadly umbilicate, depressed, pale horn-color, minutely obliquely striate, slightly shining, translucent; spire obtuse, nearly on a plane; whorls 5, convex, the last large and shelving down, in front slightly descending; aperture sinuate, truncately ovate; lip a little reflexed, angulated at its juncture with the body whorl above, farther forward strongly bent down; a strong plait or elevated ridge on the body whorl connecting the outer and inner lips. Diameter .5, altitude .2 inches (Newcomb).

Height 5 mm., diameter 11.3 mm. Paratype.

CALIFORNIA: Canyon Creek, Trinity Co. (Voy), type in Newcomb collection. Cornell Univ., paratypes 11816 A.N.S.P.; Shasta Co. (Newcomb). Trinity River half a mile north of Trinity Alps Camp, Trinity Co. (G. D. Hanna).

The sculpture is of fine but well-developed close striae, their summits cut by impressed spiral lines which may be weak or obsolete on the latter part of the last whorl. The subtriangular aperture is rather strongly oblique, its somewhat straightened basal margin expanded and thickened within, the upper margin arched forward in form of a strongly developed lobe.

"The figured animal (Fig. 103: 3, 4) was collected in June, 1931, by Dr. G. D. Hanna, along a small creek entering Stuarts Fork, Trinity River, $\frac{1}{2}$ mile north of Trinity Alps Camp, Trinity County, California. No embryos have been observed by me. Animal similar to *H. sportella* (Gould), H.B.B., 1930, Proc. A.N.S.P. 82: 418. Lung with brown spots, sometimes grouped into a vague network. Vagina (V, f. 4) much longer, with muscular collar near middle. Penial retractor (PR; $\frac{2}{3}$ omitted) arising partly from diaphragm but connecting with nearby tail fan by muscle strands. Penis (P) internally shows, in apical half, high, papillate folds below entrance of vas deferens; small apical pocket much less sharply demarcated; basal chamber very thick-walled, but with longitudinal folds much weaker towards apex (basally also smooth when everted). Radular formula (Fig. 103: 3): 12-13 + 8 + 1 + 20-21; 29 rows counted; central with two minute points, visible only on more posterior teeth; under-cusps longer, on inner 8 teeth.

"The longer vagina, the shifted origin of the penial retractor and the stronger radular entocones of *H. voyanum* approach the conditions in the section *Ancomena*." (H. B. Baker.)

Selenites voyana var. *simplicilabris* Ancy was based upon "A quite typical example of *H. voyanum* (Newc.) with a slightly weaker periostomatic callus. Ancy was misled by W. G. Binney's obscure figure and impossible dimensions." (H. B. Baker.)

Haplotrema voyanum humboldtense new subspecies

A large form from Humboldt and "Klamath"⁶¹ counties has a somewhat narrower spire than typical *voyanum*, and the striation is strong and coarser.

Diameter 17 mm., height 8 mm.

Diameter 15.5 mm., height 7 mm.

Note on Testacella

Testacellidae.—The agnathous genus *Testacella* has been found several times in greenhouses but as it has not, to my knowledge, been found living in the open, it can hardly claim place in this book. The species is the west

⁶¹ Klamath is an extinct county (Nautilus, 50: 105); the locality of the *Haplotrema* probably is in what is now Humboldt County.

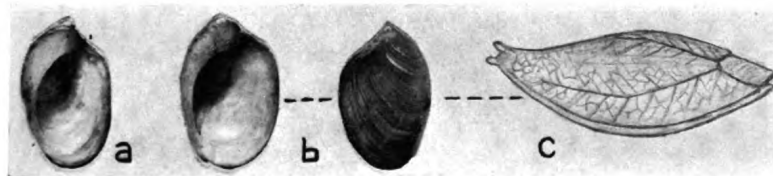


Fig. 114. *Testacella haliotideae*. a, shell from Lincoln Park, Chicago. b, Roxborough, Philadelphia. c, contracted animal. Shells $\times 2\frac{1}{2}$.

European *T. haliotideae* Draparnaud,^{61a} in which the two impressed lines on the back terminate separately but near together in the groove around the mantle. Figs. 114 a-c will serve to identify this carnivorous, worm-eating snail.

It has been found in a greenhouse in Lower Roxborough, Philadelphia (Nautilus, 5: 83, 1891); greenhouse on School Lane, Germantown, Philadelphia (Nautilus, 8: 134, 1895); greenhouse in Lincoln Park, Chicago (Nautilus, 15: 59, 1901; Fieldbook Illinois L. Snails, p. 142); Berkeley, California (T. Maslin, Feb. and Mar., 1940, recorded in an unpublished thesis by R. J. Waste). Some of these records were under the name *T. maugeri* Fér., an erroneous identification.

AULACOPODA

Sigmurethrous snails in which the pedal groove is conspicuously impressed and situated well above the lateral angle of the foot, which is bordered by a band of the sole.

In the Stylommatophora a groove, the pedal groove, marks the boundary where the smooth ciliated integument of the sole joins the tuberculate side wall of the foot. This pedal groove is usually rather inconspicuous and in or close to the angle of the foot (the "holopod" condition, Fig. 115b), but in aulacopod snails it is situated higher, leaving a distinct band of the sole above the lateral angle, as in Fig. 115a. Above the pedal groove there is a second parallel groove in the lateral integument of the foot, which Wächtler has termed the suprapedal groove. This is often close to the pedal groove and inconspicuous or irregular, but rarely it is rather widely separated from the pedal groove and deeper than that. When this is the case, holopod snails sometimes have the superficial appearance of Aulacopoda, as in *Ferussacia* (cf. Hugh Watson, 1928, Jour. of Conch., 18: 237-8), *Glyptostoma* (our Fig. 278), and some other genera.⁶²

^{61a} Kennard and Woodward, 1920 (Proc. Malac. Soc. London, 14: 77), have given the history of the genus and of the three British species in malacological literature. They conclude that the name *T. haliotideae* Drap. is homonymous with the prior *T. haliotoides* Lam., and therefore prefer to use the name *T. europaea* Roissy for *haliotideae*. While the names are unfortunately similar, most zoologists dealing with nomenclature would certainly consider them different. Hugh Watson, 1943 (Jour. of Conch., 22: 42) has fully discussed the questions of nomenclature involved.

⁶² The surface morphology of the land snail foot has been ably discussed by Walter Wächtler, 1935, Jahrb. Akad. gemeinn. Wissensch. Erfurt, n. F., Heft 52: 107.

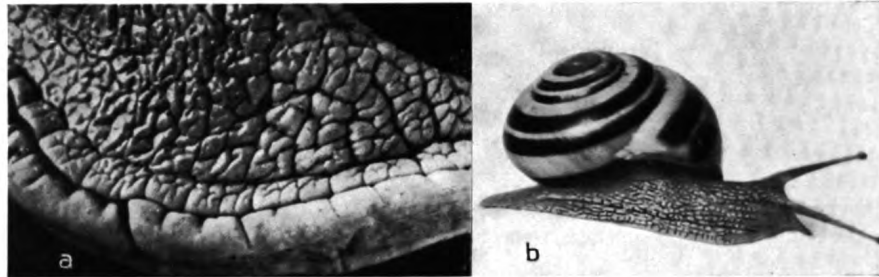


Fig. 115. a, Part of foot of *Oxzychilus cellarius*, showing suprapedal and pedal grooves (after W. Wächtler). b, *Cepaea nemoralis*, only the suprapedal groove showing.

On the other hand, some aulacopod snails appear to have assumed the holopod foot structure, the only such case known to me being the Bermudan *Poecilozonites*. In this genus the pedal groove is visible as a thin impressed line where it begins at the end of the sinus between head and foot; this line soon descends to the lateral angle of the foot, where it becomes only very faintly or not visible (in alcoholic preparations). A suprapedal groove is irregularly and quite weakly developed. Thus it will be seen that there are a few exceptional cases where the distinction between the aulacopod and holopod patterns is obscured.⁶³

In many aulacopod snails there is a caudal pit extending backward from the posterior union of the pedal grooves. This varies in form from a simple slit, as in Fig. 172, to a triangular fossa, or a fissure of quite irregular figure, Fig. 165. It varies greatly in degree of development, and sometimes may be either present or absent among genera otherwise closely related.

The sole is often tripartite in aulacopod genera, the areas separated by impressed lines, but this condition grades insensibly through various species into that where the difference is only one of color, and that again passes into a uniform sole. However, in preserved specimens side areas may often be indistinctly traced by different degrees of contraction.

The superfamily Aulacopoda⁶⁴ was instituted about fifty years ago for five families arranged in two divisions: I, Zonitidae and Limacidae, and II, Endodontidae, Arionidae and Philomyceidae. In Thiele's arrangement, 1931, all of these families are included in his stirps Zonitacea and Ariophantacea, but mingled with a number of wholly unrelated holopod families. Dr. H. B. Baker (1941, p. 206) gave the name Limacacea to the group containing Limacidae, Zonitidae and Helicarionidae, equivalent to the division I of my arrangement of 1896.

⁶³ It may be said that in genera where the foot structure appears ambiguous, other structures, such as radula and genitalia, leave no doubt about the actual relationships.

⁶⁴ Pilsbry, *Nautilus* 9: 110, February, 1896

Family XIII. ZONITIDAE

Shell spiral, partly or wholly external, usually helicoid but varying from discoidal to conic, umbilicate or rarely imperforate, the aperture with thin, unexpanded lip. Foot with conspicuous pedal furrows, often with a mucous pit at their caudal meeting. Sole either tripartite or uniform. Kidney triangular, less than twice the length of pericardium. Central and lateral teeth of radula with squarish basal plates, one to three cusps; marginal teeth with basal plates longer than wide, the cusps long, oblique, simply thorn-shaped or with one or more ectocones also, elevated on the main cusp. Jaw smooth and solid or showing edges of flat plaits.

The family is accepted here in rather wide limits. Some authorities consider the Vitrininae a group of family rank, Vitrinidae, intermediate between Zonitidae and Limacidae. Others place the Euconulinae in the family Helicarionidae (or "Ariophantidae"). These two groups are only sparsely represented in temperate North America. Our genera may be grouped in the following subfamilies: ⁶⁵

EUCONULINAE.—Small or minute, narrowly perforate, conic or biconvex shells of slowly widening whorls. Radula with tricuspid central and lateral teeth, the marginals with two or three points. Penis bearing a digitiform appendix.

ZONITINAE.—Shell depressed, heliciform, sometimes toothed. Caudal pit when present not overhung by a prominence or "horn." Mantle without lobes reflexed over the shell. Marginal teeth unicuspid. No dart apparatus, and spermathecal duct not forked anteriorly.

GASTRODONTINAE.—Shell as in Zonitinae, frequently toothed. A dart apparatus developed on the male side (absent in some minute forms); a duct from penial sheath to oviduct, or to the spermathecal duct. Outer marginal teeth unicuspid.

VITRININAE.—Shell very thin, imperforate, of few rapidly enlarging whorls. Sole tripartite; no caudal pit. Mantle with two shell lobes and two body lobes. Marginal teeth with two or more points.

Subfamily EUCONULINAE

Conulinae Strebel & Pfeffer, 1880, Beitr. Mex. Conchyl., 4: 23.

Euconulinae H. B. Baker, 1928, Proc. Acad. Nat. Sci. Phila., 80: 9; 1941, B. P. Bishop Mus. Bull., 166: 208, 212 (as a subfamily of Helicarionidae).

Small or minute snails with conic or biconvex, narrowly perforate shells of slowly increasing whorls. Radula with tricuspid central and lateral teeth, the marginals with two or three cusps. Penis bearing a digitiform appendix, and with terminal retractor and short epiphallus, without lime sac or flagellum. Spermatheca small and short. Locomotion arhythmic so far as known.

⁶⁵ Cf. H. B. Baker 1941, B. P. Bishop Mus. Bull., 166: 205, and Hugh Watson, 1943, Jour. of Conch., 22: 43-45.

Two genera occur within our area:

Euconulus, with no horn on the tail, the marginal teeth bicuspid, shell with close microscopic axial striation.

Guppya, with a horn on the tail over the meeting of the pedal furrows, marginal teeth tricuspid, and shell without thread-like axial striation.

EUCONULUS Reinhardt

Conulus Fitzinger, 1833, Systematisches Verzeichniss, etc., in Beiträge zur Landeskunde Oesterreichs, 3: 94. — Gray, P. Z. S., 1847, p. 173, type *Helix fulva*. — Pilsbry, 1899, Nautilus, 12: 113, review of American species. Not *Conulus Rafinesque*, 1814.

Euconulus Reinhardt, 1883, Sitzungs-Ber. Ges. Nat. Freunde zu Berlin, p. 86, for *E. fulvus* and *E. praticola*. — Pilsbry, 1900, Nautilus, 14: 81; 1910, Proc. Acad. Nat. Sci. Phila., p. 131, type *E. fulvus*. — H. B. Baker, 1922, Occas. Pap. Mus. Zool. Univ. Mich., No. 106, p. 49 (teeth; related tropical genera). — H. B. Baker, 1928, Proc. Acad. Nat. Sci. Phila., 80: 9, anatomy; 1941, B. P. Bishop Mus. Bull., 160: 213, Pacific species.

Arnouldia Bourguignat, 1890, Bull. Soc. Malac. France, 7: 328. (Substitute for *Conulus*, same type.)

Petasia Beck, in part, Index Moll., 1837, p. 21. — Herrmannsen, 1847, Indicis Gen. Malac., 2: 240, type *Helix fulva* Müll. — Gray, P. Z. S., 1847, p. 173, type *Helix trochiformis*. Not *Petasia* Stephens, 1828 (Lepidoptera).

Trochulus Westerlund, 1886, Fauna, 1: 26, *Conulus fulvus* here selected as type. Not "*Trochulus* Christ," Gray, P. Z. S., 1847, p. 173, type *Hel. hispida*.

Petasina Gude and Woodward, 1921, Proc. Malac. Soc. London, 14: 177. Not of Beck, 1847, cf. Hugh Watson, 1943, Jour. of Conch., 22: 56 (nomenclature and systematic place of *Euconulus*).

Euconulops H. B. Baker, 1928, Proc. Acad. Nat. Sci. Phila., 80: 11, type *Euconulus chersinus polygyratus* Pilsbry.

Shell very small, minutely or scarcely perforate, conic, or convexly conic, thin, fragile, composed of $5\frac{1}{2}$ to 7 convex, closely coiled whorls, the last angular in the neanic stage, subangular or rounded in the adult; apparently smooth, but having a microscopic sculpture of close, regular vertical striae. Aperture crescentic or lunate; lip thin, its insertions widely separated.

The foot is long and very slender, the sole not distinctly tripartite except somewhat so in color; no caudal horn or distinct pore. The mantle forming the wall of the long and narrow lung is variegated with black bars or angular spots.

The genital orifice is near the right eye stalk. The penis bears a large digitiform appendix; penial retractor and epiphallus are terminal, the latter represented only by a slight expansion of the end of the vas deferens. The small spermatheca is on a very short duct.

The teeth of *E. fulvus* (Fig. 116a) have long mesocones and small side cusps. The centrals are tricuspid; laterals numerous, tricuspid but asymmetric, with weak inner cusp. The 10th and 11th teeth are transitional. The marginals are bicuspid, having an ectocone nearly as long as the main cusp.

Locomotion appears to be arhythmic. Sterki saw no waves in *E. chersinus*, and none could be seen by me in *E. fulvus*.

Distribution.—Holarctic Realm generally; common in high latitudes.

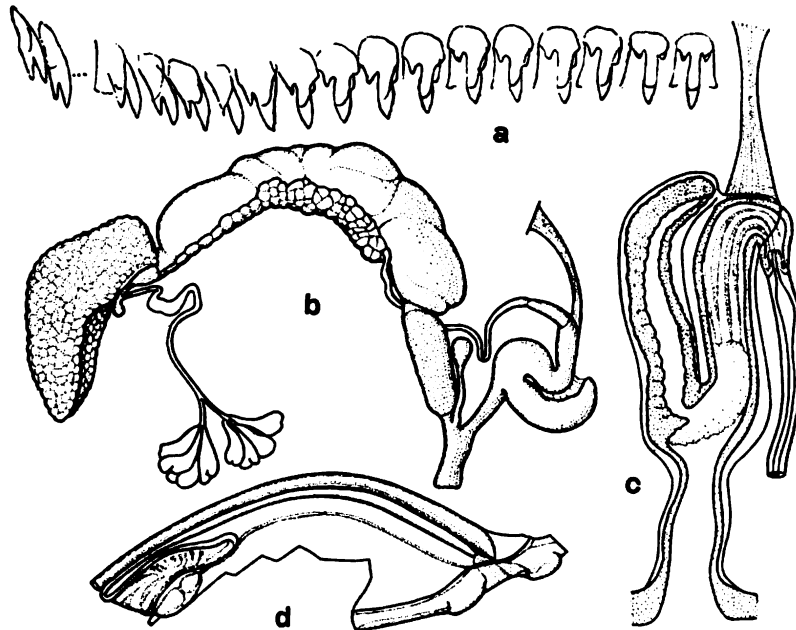


Fig. 116. *Euconulus fulvus*. a. teeth. b. genitalia. c. penis and accessories. d. inside view of pallial complex. (Figs. b, c, d after H. B. Baker.)

Mr. E. G. Vanatta studied the sculpture of American species of *Euconulus*. It appears that all the forms examined have a minute sculpture of excessively close, regular vertical striae on the upper surface, though in some examples it is less distinct than in others. This sculpture, when strongly developed, lends a silk-like luster to the surface in quite fresh examples.

(*Ev* + *conulus*, a real little cone.)

***Euconulus fulvus* (Müller)**

Fig. 117.

Helix fulva Müller, 1774, in part, Hist. Vermium, 2: 56.

Helix fulva Müll., Draparnaud, 1801, Tabl. Moll. terr. et fluv. de la France, p. 72; 1805: Hist. Nat. Moll. de la France, p. 81, pl. 7, figs. 12, 13.

Zonites (Conulus) fulvus Müll. Binney, 1885, Man. Amer. Land Shells, p. 67.

Euconulus trochiformis Montagu, Dall, 1905, Harriman Alaska Exped. Mollusca, 13: 40 (q. v. for other references).

Helix egena Say, 1825, Jour. Acad. Nat. Sci. Phila., 5: 120 (Delaware River 10 miles above Philadelphia)

Helix mortoni Jeffreys, 1830, Trans. Linn. Soc., 16: 332.

Conulus chersina Say, Morse, 1864, Jour. Portland Soc. N. H., 1: 19, fig. 46. Not *Helix chersina* Say.

Euconulus fulvus (Müll.) Pilsbry, 1908, Nautilus, 22: 25; 1926, Nautilus, 40: 68 (nomenclature)

Conulus fabricii "Beck," Mörch, 1868, Amer. Jour. Conch., 4: 29, pl. 3, fig. 5, not *Petasia fabricii* of Beck, 1837.

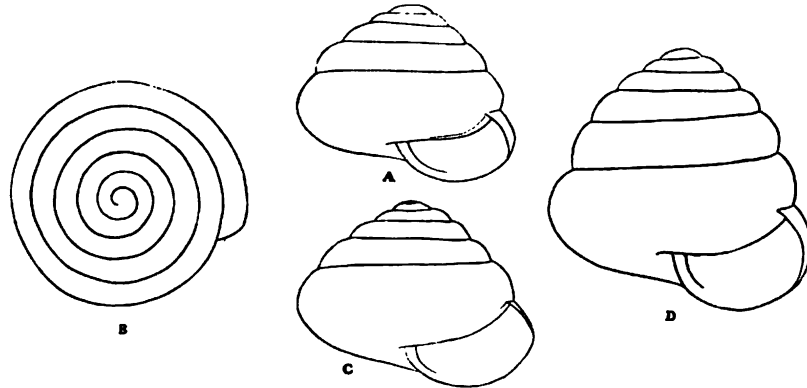


Fig. 117. *Euconulus fulvus*. A, Burnley, England; B, c, Herkimer County, N. Y.; D, Buckfield, Maine. ($\times 10$)

The shell is thin, minutely perforate or closed, conic, cinnamon or dilute tawny, the summit paler. Spire conic with slightly convex outlines and obtuse apex, the periphery rounded or weakly angular, base convex. Surface glossy, with close microscopic striae along lines of growth, and faint spirals. The aperture is lunate; peristome thin, dilated near the columellar insertion.

Height 2.4 mm., diameter 3.1 mm.; $5\frac{1}{2}$ whorls.

Distribution. — Almost throughout the Holarctic realm, but wanting in the Gulf and South Atlantic States from Texas to North Carolina. Middle Pliocene, Montpellier, France. Type locality, Fridrichsdal, Denmark.

E. fulvus lives among damp leaves in well-shaded places, and may usually be obtained by leaf sifting where its presence would otherwise be unsuspected. It is often common in the drift debris of creeks and rivers. Some of the published locality records of *fulvus* may have been based upon *E. chersinus*, since the two species were not generally discriminated until about 1908.

In *E. fulvus* from the northeastern United States the first whorl has fine spiral striae and very indistinct traces of vertical (radial) striae, not seen in some but legible, though weak, in other examples. The upper surface of the last whorl has about 126 vertical striae in 1 mm., crossed by spiral striae. There are about 6 whorls (fig. 117 B, c, Herkimer Co., N. Y., 59,521 A.N.S.P., height 2.4, diam. 3.1 mm. Fig. D, Buckfield, Oxford Co., Maine, 87,302 A.N.S.P., height 3.5, diam. 3.4 mm.). The largest examples seen are from Buckfield, Me., collected by Mr. J. A. Allen.

An English example (fig. 117A, Burnley, England (R. Walton, 75,912 A.N.S.P.) has distinct vertical striae on the first whorl as well as spirals, and on the last whorl there are 140 vertical striae in 1 mm., with no noticeable spirals. Height 2.4, diam. 2.8 mm.

It seems that there is considerable variation in the minute sculpture of *E. fulvus*, though it appears to be always somewhat coarser than in *E. chersinus* and, in the average at least, finer than in *E. fulvus alaskensis*.

Specimens collected in Greenland were incorrectly called *Helix* or *Conulus fabricii* "Beck," by Pfeiffer and various subsequent authors,⁶⁶ but no characters separating them from *E. fulvus* have been mentioned, and a specimen from Karssingnak, Godthaab, collected by John Möller, 1923, appears indistinguishable from *E. fulvus*. Mörch (1868) stated that about 20 specimens in all may have been collected, at the following Greenland localities: Skakortok (Holböll); Nisik in Kuksukfjord, District of Godthaab; Tiksaluk, District of Julianchaab; above the ruins of the Amarglikfjord (Möller).

Mr. Bayard Long and Dr. Stanley T. Brooks found *E. fulvus* abundant along the west and south coasts of Newfoundland.

(*Fulvus*, tawny.)

Dr. Baker dissected specimens from Cheboygan Co., Michigan (Fig. 116). His account follows.

"Animal: grayish with still darker tentacles; mantle with large black blotches; liver orange, overlain by dark pigment at sutural edge. Sole: very long and slender; tripartite, with median zone about $\frac{2}{3}$ as wide as either lateral one; no pedal waves observed in locomotion but coarse right and left undulations of entire foot give animal a snake-like progression. Tail: weakly keeled above; truncate, projection quite low and rounded. Mantle collar: narrow, with prominent right and left neck lappets and double free edge. Lung (Fig. 116d): about $5\frac{1}{2}$ times as long as its base or 3 times length of kidney; principal pulmonary vein large; narrow zone between last and hindgut with indistinct transverse venation. Kidney: $2\frac{1}{2}$ times as long as its base or $1\frac{1}{3}$ length of pericardium. Secondary ureter: completely closed, much as in *Guppya*.

"Ovotestis (Fig. 116b): with 2 groups of a few, irregularly clavate lobules; duct quite short, greatly swollen beyond the middle of length; talon clavate; carrefour elongate. Albumen gland: with S-loops of intestine imbedded in its outer surface. Uterus: apical $\frac{1}{3}$ a grayish, thick-walled sac with a large pilaster down exterior side of otherwise simple lumen; basal $\frac{2}{3}$ sacculate with very complexly folded walls. Free oviduct: quite long, mainly consisting of a long-ellipsoid sac with yellowish, glandular walls (cells with coarse granules). Spermatheca: sac ovoid; stalk very short, columellar in position. Vagina: practically absent. Prostate: well developed, almost as long as uterus. Vas deferens: stout; carried into penioviducal angle. Epiphallus (Fig. 116b) apparently represented only by a

⁶⁶ The *Petasia fabricii* of Beck, 1837 (as well as *Helix fabricii* Möller, 1842), was based solely upon "*Helix nitida*," of Fabricius, 1780 (Fauna Groenlandica p. 389), an "umbilicate, subdepressed" shell thought by Fabricius to be Müller's *H. nitida* and Ström's *H. hammonis*, and which apparently has not been correctly identified later. Pfeiffer, 1848 (Zeitsch. für Malak., 5: 90), seems to have been the first to describe the Greenland *Euconulus* as *Helix fabricii* Beck, followed by Mörch and others. The Greenland *Euconulus* has thus no nomenclatorially valid special name, but apparently none is needed.

slight expansion of end of vas deferens; penial papilla narrow, about $1\frac{1}{2}$ times as long as broad. Penis: large, with a big, digitiform appendix attached below middle; apical region with heavy walls and 4 or 5 longitudinal pilasters; middle part with some glandular thickenings similar to those of appendix; basal region slender with thinner, more elastic walls and weak plicae; appendix with high, columnar cells in wall opposite penis proper. Penial retractor: shorter than penis and stout; origin from diaphragm; insertion a little below penis (at end of loop) on intimate sheath which surrounds most of penis and, in a separate compartment, all of appendix. Cloaca: quite short; opening just above dorsal pedal groove almost directly under base of right tentacle. Fig. 116c, optical section.

"Columellar muscle gives off: (1) left free retractor almost immediately; (2) right tentacular slightly below; (3) right lateral muscle near root of tail; (4) left lateral slightly anterior; and spreads out into (5) large, heavy, tail fan. Left free and tentacular retractors: much as in *Guppya*.

"Salivary glands: combined mass lanceolate, about as long as buccal mass and above oesophagus; left gland slightly smaller; ducts contiguous, left one about as long as buccal mass. Stomach: about one whorl in length. Intestine: S-loops accompanied by only a little liver tissue and well imbedded in albumen gland."

***Euconulus fulvus alaskensis* (Pilsbry)**

Fig. 118.

Conulus fulvus alaskensis Pilsbry, 1899, *Nautilus*, 12: 116 (Dyea Valley and Point Romanof).

Euconulus fulvus alaskensis (Pils). Pilsbry & Ferriss, 1910, *Proc. Acad. Nat. Sci. Phila.*, p. 131, fig. 26.—Henderson, 1924, *Univ. Colo. Studies*, 13: 146 (full localities and references); 1929, *ibid.*, 17: 101, fig. 63; 1936, *ibid.*, 23: 111, 258.—Chamberlin & Jones, 1930, *Bull. Univ. Utah*, 21: 5.—Berry, 1919, *Proc. Acad. Nat. Sci. Phila.*, p. 202, 203; 1937, *Nautilus*, 50: 87 (constancy of characters questioned).

"Similar to *C. fulvus* but with only $4\frac{1}{2}$ whorls, the last one wider; periphery a little angular in front, becoming well rounded; columellar insertion of the lip reflexed over the perforation, nearly or quite closing it. Height 2.6, diameter 3.25 mm."



Fig. 118.—*Euconulus fulvus alaskensis*. A, B, type, Dyea Valley, Alaska; C, Head of Cave Creek, Chiricahua Mountains; \times about 10.

E. fulvus alaskensis differs from *fulvus* chiefly by having about one whorl less in shells of similar size. On the first whorl the radial striae begin at the first fourth, and are about as close as on the rest of the shell. The

last whorl has 90 to 105 striae in 1 mm. There are no spiral striae on the first or later whorls.

ALASKA: Dyea Valley (P. B. Randolph), Type 59522 A.N.S.P. Point Romanof (Randolph). Yukon drainage, Lake Lindeman to Point Romanof and St. Michael (Dall). Mountain and Pacific states south to the Chiricahua and Huachuca Ranges, Arizona.

For details of distribution in the mountain states see Junius Henderson's copious records. In Arizona it extends to the Mexican boundary, but southward occurs at elevations mainly above 7000 ft. In California it is found in places along the western slope of the Sierra Nevada, and as far south as the San Bernadinos. It was taken by Dall at Petropavlovsk, Kamchatka.

EUCONULUS CHERSINUS GROUP (Section *Euconulops* H. B. Baker)

Euconulus chersinus (Say)

Fig. 119 a, b.

Helix chersina Say, 1821, Jour. Acad. Nat. Sci. Phila., 2: 156.
Conulus chersinus Say, Pilsbry, 1899, Nautilus, 12: 116.

"Shell subglobose-conic, pale yellowish-white, pellucid, convex beneath; volutions about six, wrinkles not distinct; spire convex-elevated; suture moderate; body whorl slightly carinated on the middle; mouth nearly transverse, unarmed, the two extremities nearly equal; labrum simple; umbilicus none. Breadth one-tenth of an inch." (Say.)

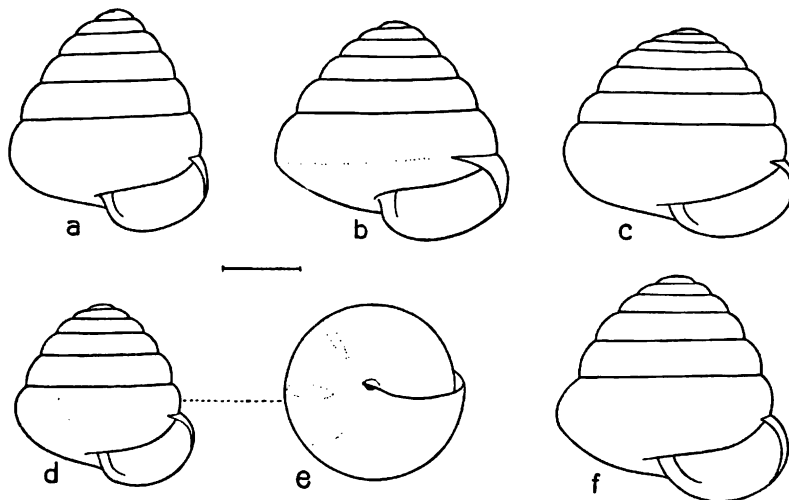


Fig. 119. a, *Euconulus chersinus*, Gainesville, Fla.; b, University, Ala. c, *E. c. polygyratus*, Buckfield, Me. d, e, *E. c. dentatus*, Dove, Tenn. f, *E. c. trochulus*, Bastrop Co., Texas. Scale line = 1 mm.

The outlines of the spire are less convex than is usual in *E. c. polygyratus*, and the individual whorls are noticeably less convex. In fully grown shells the periphery becomes rounded.

Height 2.9 mm., diameter 2.6 mm.; $6\frac{3}{4}$ whorls.

Height 2.25 mm., diameter 2.4 mm.; 6 whorls.

Height 3.45 mm., diameter 2.95 mm.; 8 whorls. Port Republic, N. J.

Distribution.—Florida to littoral New Jersey, west to Illinois and Louisiana. Type locality: Sea Islands of Georgia.

This species differs from *E. fulvus* by the more elevated spire, more numerous, narrower whorls, the narrower aperture, and in fresh specimens by the silky luster, *E. fulvus* being more glossy. The microscopic sculpture is finer than in *fulvus*, there being 165 to 170 vertical striae in one mm. on the last whorl. The apex has both spiral and radial striae.

Immature shells, which are more abundant than adults, are much more angular at the periphery, with less convex base and narrower aperture.

In most southern states there are two forms which we have been referring to *E. chersinus*: the high typical form, Fig. 119a, and a wider form in which the last whorl remains more or less angular at the periphery. One of these from Tuscaloosa Co., Alabama, measures: height 2.8 mm., diameter 2.9 mm., $6\frac{1}{2}$ whorls. Fig. 119b.

There appears to be a form somewhat similar to *chersinus* in Europe, described as *Arnouldia vesperalis* Bourguignat.

(*Xépsivos*, of wild land.)

***Euconulus chersinus polygyratus* (Pilsbry)**

Fig. 119 c.

Conulus chersinus polygyratus Pilsbry, 1899, *Nautilus*, 12: 116.

Euconulus chersinus polygyratus (Pilsbry), Walker, 1906, Ill. Cat. Moll. Mich., Terr. Pulm., p. 482, fig. 54.—Mozley, 1928, *Nautilus*, 42: 15.—H. B. Baker, 1928, Proc. Acad. Nat. Sci. Phila., 80: 11, pl. 2, fig. 3, anatomy.

The shell is thin, imperforate, globosely conic, cinnamon buff, the surface somewhat dull and silky except in the middle of the base which is glossy and somewhat transparent. The spire is rather dome-shaped, its outlines being strongly convex. The whorls increase slowly and are strongly convex, the last with sharply angular periphery in immature shells, but becoming rounded in those of full growth. The aperture is narrowly lunate, the basal margin well curved.

Height 2.8 mm., diameter 3.25 mm.; $7\frac{1}{2}$ whorls. Buckfield, Me.

Height 2.4 mm., diameter 2.9 mm.; 7 whorls. Cheboygan Co., Mich.

Height 2.8 mm., diameter 3.35 mm.; $6\frac{1}{4}$ whorls. Grand Rapids, Mich.

Height 2.3 mm., diameter 2.75 mm.; $6\frac{1}{2}$ whorls. Hamilton, Ont.

Distribution.—Ontario and Maine west in the northern tier of states to Wisconsin and to Malachi, Ontario, and Yonker, Saskatchewan. Type and paratypes 90 A.N.S.P., from Grand Rapids, Michigan.

While full-grown shells of this race appear distinct enough from *chersinus* by the more strongly convex whorls and usually more dome-shaped spire, one is often quite uncertain about the identity of half-grown examples, which are far more numerous in collections than adult shells. For this reason, and because a close study has not yet been made of all materials

available, the limits of distribution of *chersinus* and *polygyratus* still remain nebulous. I have elsewhere expressed doubts of the validity of *polygyratus*, but am now disposed to admit this northern race.

"My specimens," Dr. Baker writes, "come from Cheboygan County, Michigan; one was dissected. The anatomy is fundamentally similar to that of *E. fulvus* and only important differences will be noted.

"Animal: usually lighter in color throughout. Hermaphroditic duct: strongly swollen for middle half of length; talon clavate, slightly curved; carrefour ovoid. Spermatheca: very short, clavate; sac not clearly differentiated. Epiphallus (Fig. 119bis): sausage-shaped; walls heavy with longitudinal plicae; penial papilla large, cylindrical, slightly longer than broad, on one side of apical chamber of penis. Penis: apex demarcated as an ovoid chamber with large papillae; remainder with longitudinal plicae; appendix relatively short, with heaviest walls on side towards penis. Penial retractor; bifid terminally so as to invest epiphallus and insert either side of apex of penis.

"The development of the epiphallus and the differentiation of the apical region of the penis seem to be more important than specific differences. For this reason, I am proposing the new section *Euconulops* for this species." (H. B. Baker.)

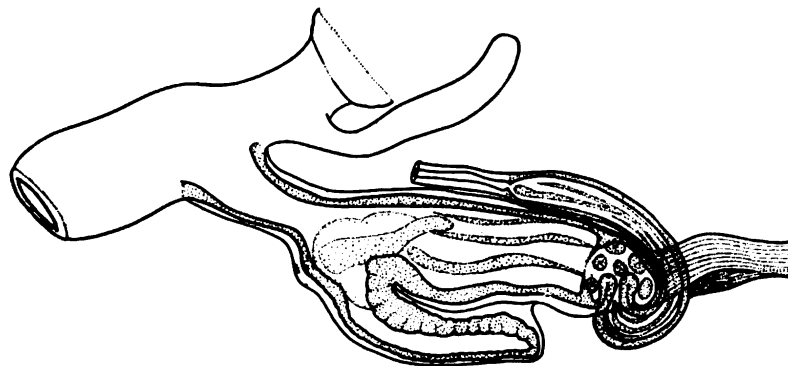


Fig. 119 bis. *Euconulus chersinus polygyratus*. Michigan. Penis and accessories, with outlines of vagina and spermatheca. After H. B. Baker.

***Euconulus chersinus trochulus* (Reinhardt)**

Fig. 119 f.

C.[onulus] trochulus Reinhardt, 1883, Sitzungs-Ber. Ges. Nat. Freunde zu Berlin, Jahrg., 1883, p. 41 (Texas).

Conulus chersinus trochulus Reinh., Pilsbry, 1899, Nautilus, 12: 116.

Euconulus chersinus trochulus (Reinh.). Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 153.

“Shell sharply conic, the lower surface flat, pale horn colored, closely coiled; whorls 7, sharply keeled, with silky luster by the very fine and close radial striation, the under surface with glassy shine and very fine spiral striation. On the upper side the whorls appear terraced, each following exactly along the sharp keel of the preceding. The suture is deep and narrowly margined. The narrow umbilicus is completely covered by the reflected columellar margin. Aperture narrowly trapezoidal, columella vertically descending, outer margin meeting the lower margin below the angle at the keel; the basal margin evenly and weakly curved, parallel to the parietal wall. Greater diameter 3, least 2.6 mm., height 2.5 mm.” (Reinhardt.)

Height 2.53 mm., diameter 2.90 mm.; 7 whorls. Bastrop Co.

TEXAS: Bastrop, Calhoun, Comal, Dallas, Hays, Hidalgo, Jackson, Lee, Live Oak, Medina, Travis, Val Verde and Victoria counties. LOUISIANA: Caddo Parish. OKLAHOMA: Ft. Gibson. ARKANSAS: Sulphur City.

The shell is very much like *chersinus*, but it has about one whorl more in shells of similar size, and the aperture is narrower. In full-grown specimens the periphery is angular or sometimes almost rounded rather than keeled as Reinhardt stated, probably having immature shells.

The type, collected by Jacob Boll, was from Texas, without more definite locality; but the form is rather widely distributed and is usually present in the drift debris of streams.

***Euconulus chersinus dentatus* (Sterki)**

Fig. 119 d, e.

Conulus fulvus Müll., var. *dentatus* Sterki, 1893, Nautilus, 7: 4 (Jackson Co., Ala.).

Euconulus chersinus dentatus (Sterki), Pilsbry, 1899, Nautilus, 12: 116, 131.—Pilsbry & Ferriss, 1906, Proc. Acad. Nat. Sci. Phila., p. 563.—Walker, 1928, Terr. Moll. Alabama, p. 92.

“From Jackson Co., Alabama . . . a few specimens with distinct ‘teeth’ in the base of the last whorl.” Specimens “were mostly small, young and half grown, and most of them showed 1, 2 or 3 small, white, testaceous deposits in the base of the last whorl, at somewhat irregular intervals, roundish or elongate in a radial direction. They are not high, tooth-like, but quite distinct, whether seen through the shell, or if near enough, from the aperture inside, and recall the same feature in the smaller *Gastrodonts*, although I have never seen more than one tooth on the same radius. But, as said, in some they in the form of radial bars, and when two or three are present they are always of the same character, either round or transverse. Two examples, mature or nearly so, but weathered and opaque, have at least one distinct round deposit each, about one-half volution above the aperture.” (Sterki.)

All specimens seen are rather small, with the narrow whorls of *chersinus*, the last whorl containing one to three low teeth, which appear, when the shell is viewed from the base, as radial white streaks, spaced at intervals of about 120 degrees (a third of a whorl), when more than one is present, or sometimes much closer.

Height 2.37 mm., diameter 2.4 mm.; 6½ whorls; 2 teeth. Dove, Tenn.

PENNSYLVANIA: Ardsley, Montgomery Co. DISTRICT OF COLUMBIA: Washington. VIRGINIA: Page, Amherst and Rockbridge counties. NORTH CAROLINA: near Asheville. ALABAMA: Chilton, Choctaw, Clarke, Conecuh, DeKalb, Elmore, Jackson, Madison, Mobile, Shelby and Tuscaloosa counties. LOUISIANA: Catahoula and Rapides Parishes. TENNESSEE: Knox and Marion counties. ARKANSAS: near Blue Mountain Station, and Magazine Mt. at about 2800 ft., Logan Co.; Sulphur City, Washington Co.

In some specimens the internal barrier is in form of one or sometimes two low "teeth," usually with the long axis across the cavity; but in most of the older individuals there is only one low radial callus. Specimens with teeth or callus are usually small; it is a feature of young stages, only occasionally developed, and rarely found present in all of the specimens of any lot. The shell measured above and drawn in fig. 119 d, e is quite well rounded at periphery, but possibly might have added another half whorl. The fully adult stage is, I suppose, usually toothless, and not distinguishable from typical *chersinus*. At all events, part of the toothed examples seen were segregated from lots in which the larger examples are toothless. In some examples, like that figured, the base shows fine, close spiral striation.

GUPPYA Mörch

Guppya Mörch, 1867, Jour. de Conchyl., 15: 256, for *Conulus "vaccus"* (error for *C. vacans* Guppy, in part = *G. gundlachi*).—H. B. Baker, 1925, Occas. Pap. Mus. Zool. Univ. Mich., 156: 7; 1928, Proc. Acad. Nat. Sci. Phila., 80: 7. Nomenclature and anatomy.

Spiroconulus Von Martens, 1892, Biol. Centrali-Amer., p. 122. Type *G. gundlachi* (Pfr.).

The shell is similar to *Euconulus* with a somewhat lower spire; the initial whorl or all the whorls are either spirally striate or smooth, but without the crowded microscopic thread-like axial striae of *Euconulus*.

Mantle collar with right and left shell lobes. Foot with pedal grooves, the tail having a projection above the caudal pit. Sole tripartite. The lung is about $4\frac{1}{2}$ times the length of the kidney. The genital opening is just behind and below the right eye stalk. Penis with a digitiform appendix and terminal epiphallus and retractor, the epiphallus cecoid at the end. The spermatheca with short duct. *G. gundlachi* is ovoviviparous.

Jaw smooth, highly arched. Radula with tricuspid central and similar, almost symmetrical, tricuspid lateral teeth; the elongate, oblique marginals tricuspid.

Distribution.—Tropical and subtropical America, a single species (*G. sterkii*) north to New York and Ohio.

Key to species

- A. Diameter 2 to 3 mm., of 4 whorls or more
 - B. Surface spirally striate.....*gundlachi*
 - BB. Surface smooth.....*miamiensis*
 - AA. Diameter 1 to 1.25 mm., of $3\frac{1}{2}$ whorls.....*sterkii*
- (*Guppya*, in honor of R. J. L. Guppy, a resident of Trinidad, author of many papers on the geology and conchology of the West Indies.)

Guppya gundlachi (Pfeiffer)

Fig. 120 a.

Helix pusilla Pfeiffer, 1839, Archiv f. Naturg., 1: 351. Not of Lowe, 1833.*Helix gundlachi* Pfeiffer, 1840, Archiv. f. Naturg., 1: 250; substitute for *H. pusilla*; 1848, Mon. Hel. Viv., 1: 50.*Zonites gundlachi* Pfr., W. G. Binney, 1878, Terr. Moll., 5: 127, pl. 22a, fig. 3; pl. 2, fig. v, teeth.*Helix egena* Gould in Binney, 1851, Terr. Moll., 2: 245, pl. 22a, fig. 3. Not of Say.*Guppya gundlachi* Pfr., Von Martens, 1892, Biol. Centr.-Amer., Moll., p. 122.—H. B. Baker, 1922, Occas. Pap. Mus. Zool. Univ. Mich., 106: 45, pl. 17, figs. 1, 3, jaw and teeth.*Helix simulans* C. B. Adams, 1849, Contrib. to Conch., No. 3, p. 35 (Jamaica).

The pale brown, minutely perforate shell is depressed, low-conic above, convex beneath, obtusely subangular at the periphery. Surface glossy, with

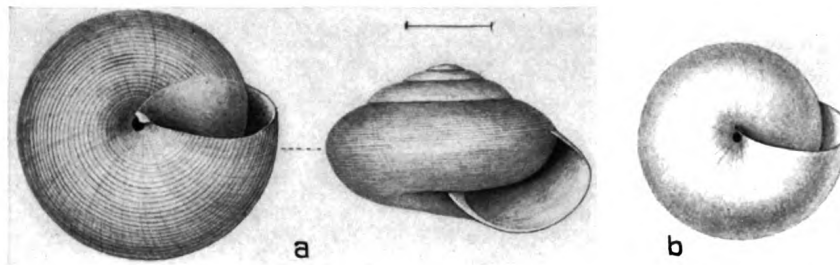


Fig. 120. a, *Guppya gundlachi*, Lec Co., Florida. b, *Guppya miamiensis*, Miami. Scale line = 1 mm.

scarcely perceptible lines of growth and, after the smooth apical half whorl, sculptured with minute, moderately spaced spiral lines. Aperture lunate the peristome thin and sharp, becoming slightly dilated near the columellar insertion. Height 1.75 mm., diameter 3 mm.; $4\frac{2}{3}$ whorls.

Distribution.—Florida and Texas south to the Republic of Panama; West Indies; Trinidad and Venezuela. Type locality, "in provincia Canimarensi," province of Matanzas, Cuba.

FLORIDA: The Keys generally; and on the peninsula north to Volusia, Marion and Alachua counties and Cedar Keys. TEXAS: Hidalgo (J. A. Singley); Brownsville (Hebard & Rehn).

A common and generally spread snail in southern Florida, easily recognized by the low conic form of the light brown shell, and its minute spiral lines.

Guppya miamiensis Pilsbry

Fig. 120 b.

Guppya miamiensis Pilsbry, 1903, Nautilus 17: 77.

The pale brown shell is perforate, biconvex, being low conoidal with obtuse summit, obtusely subangular periphery and convex base, closely similar to *G. gundlachi* in shape, size and color. Surface smooth and

glossy, without any trace of spiral lines. Aperture as in *G. gundlachi*. Height 1.45 mm., diameter 2.35 mm.; 4 whorls.

FLORIDA: Brickell's Hammock and elsewhere around Miami, Type and paratypes 77083 A.N.S.P. Coral Gables. Big Grassy Key and West Crawl Key.

Though similar to *G. gundlachi* superficially, it is readily separated from that under the lens by the absence of spiral lines.

***Guppya sterkii* (Dall)**

Fig. 121.

Hyalina sterkii Dall, 1888, Proc. U. S. Nat. Mus., 11: 214, figs. 1-3.

Conulus sterkii Dall, Sterki, 1893, Nautilus, 6: 106.

Zonites sterkii Dall, W. G. Binney, 1890, 3d Suppl., Mus. Comp. Zool. Bull., 19: 187, fig. — Vaughan, 1893, Nautilus, 6: 118 (Mt. Lebanon, La.).

Euconulus sterkii Dall, Wheeler, 1912, Nautilus, 25: 125.—Walker, 1928, Terr. Moll. Alabama, p. 94, fig. 129.

Guppya sterkii (Dall), Vanatta, 1920, Nautilus, 34: 28.—H. B. Baker, 1922, Occas. Pap. Mus. Zool. Univ. Mich., 206: 46, pl. 17, fig. 2 (teeth).

"Shell minute, thin, yellowish translucent, brilliant, lines of growth hardly noticeable, spire depressed, four-whorled,⁶⁷ whorls rounded, base flattened, somewhat excavated about the center, which is imperforate; aper-

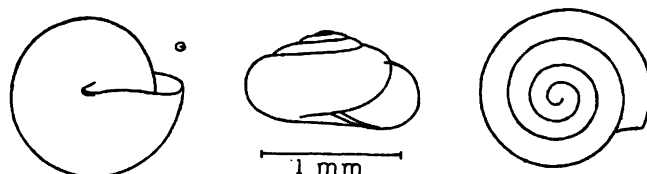


Fig. 121. *Guppya sterkii*, actual size and enlarged.

ture wide, hardly oblique, not very high, semilunate, sharp-edged, the upper part of the columella slightly reflected; upper surface of the whorls roundish, though the spire as a whole is depressed. Alt. 0.52 mm., diameter maj. 1.1 mm. (Dall.).

Height 0.75 mm., diameter 1.22 mm.; 3½ whorls.

NEW YORK: near Camillus, Onondaga Co. NEW JERSEY: Springdale, Sussex Co.; Foul Rift, Warren Co. PENNSYLVANIA: Beaver, Bucks, Chester, Delaware, Montgomery and Northampton counties. VIRGINIA: Natural Bridge, Rockbridge Co. WEST VIRGINIA: Braxton, Pendleton and Pocahontas counties. NORTH CAROLINA: Spruce Pine, Mitchell Co.; Cranberry, Watauga Co. FLORIDA: Alachua, Citrus, Dade, Marion, Osceola and Pinellas counties. ALABAMA: Baldwin, Choctaw, Chambers, Conecuh, DeKalb, Jackson, Jefferson, Lauderdale, Marion, Mobile and Randolph counties. LOUISIANA: Mt. Lebanon (Vaughan). TENNESSEE: Bledsoe, Carter, Knox, Marion and Unicoi counties. KENTUCKY: Pine Mt., Harlan Co. OHIO: Hudson, Summit Co.; New Philadelphia (Sterki, type locality).

This is one of the smallest American land shells. The spire is lower than in the species of *Euconulus*, and it is more like *Guppya gundlachi* in sculpture. To the original description, copied above, it should be added

⁶⁷ The original figure shows but 3½ whorls, and this is the number found in specimens from the type locality and other places.

that the first whorl has microscopic engraved spiral lines, the rest have even closer spirals, and very weak, relatively coarse wrinkles of growth.

The New York and Pennsylvanian specimens were obtained by leaf sifting. The type lot "was collected on a grassy slope inclining to the northward and covered with grass, moss and small bushes." Shells have been examined from all localities mentioned above except Louisiana and part of the counties of Alabama, the latter quoted from Walker.

Vanatta first noticed that it has the caudal horn and trifid marginal teeth of *Guppya*. The radula, according to H. Burrington Baker (1922) "is so minute as not to fill the field of an oil-immersion objective. The central tooth, for instance, is only about 4 microns (.004 mm.) in width. The formula is approximately C 1/3; L 5/3; M $\frac{13-15}{3}$ (the number of teeth is given above, of cusps on each tooth below). The number of cusps out to the 9th marginal was determined, but their shape on this tooth could not be made out very accurately, as the ends of the cusps are smaller than the limit of possible microscopic vision, and could be detected only as points of light. For the same reason, the number of cusps on the outermost marginals, and the exact number of the teeth themselves, is indeterminable without resort to ultra-microscopic methods. All of the inner teeth are quite of the same shape as those of *Guppya gundlachi*. The jaw is also very similar in the two species, but that of *G. sterkii* is even more nearly semicircular in outline." (H. B. Baker.)

A subspecies, or perhaps distinct allied species, has been described as *G. sterkii punctum* H. B. Baker, from Necaxa, State of Puebla, Mexico.

(Named for its discoverer, Dr. Victor Sterki, 1846-1933. *Nautilus*, 46: 134.)

Subfamily ZONITINAE

Key to genera by shell characters

- A. Shell *Vitrina*-shaped, imperforate, of about 3 rapidly enlarging whorls *Vitrinizonites*
- AA. Shell spiral, helicoid.
 - B. Whorls normally increasing to the last, which is very much wider.
 - C. Smooth, strongly depressed, 6 to 17 mm. diameter; introduced species *Oxychilus*
 - CC. Striate, or with spaced grooves also; depressed; umbilicus narrow or closed; diam. 3.5 to 13 mm..... *Retinella*
 - CCC. Smooth or striate, of medium or large size, 15 to 35 mm.; discoidal to subglobose *Mesomphix*
 - BB. Whorls 4 to 5, tubular, regularly increasing to the end; diameter about 2.5 mm. *Hawaiiia*
 - BBB. Whorls narrow, closely coiled; small or minute species, with narrow aperture, sometimes toothed.
 - C. Parietal and columellar lamellae present, at least in immature stages *Pilsbryna*

- CC. No parietal or columellar lamellae; having radial barriers or rows of teeth within basal lip, or often toothless.
 D. East of 100th meridian.....*Paravitrea*
 DD. Western; Pacific slope and Great Basin.....*Pristiloma*

OXYCHILUS Fitzinger

- Oxychilus* Fitzinger, 1833, Beitr. Landesk. Oester., 3: 100.—Herrmannsen, 1847, Ind. Gen. Malac., 2: 183, type *Helix cellaria* Müll.—H. B. Baker, 1928, Proc. Acad. Nat. Sci. Phila., 80: 18.—Bowell, 1933, Jour. of Conch., 19: 287-293.—H. Watson, 1943, Jour. of Conch., 22: 45.
Polita Held, 1837, Isis 30: 916.—Herrmannsen, 1847, op. cit., 2: 313, type *H. cellaria*.
Hyalina "Ag." Charpentier, 1837, Neue Denkschr. Allg. Schweiz Ges., 1, no. 2, p. 13.—Bourguignat, 1890, Bull. Soc. Malac. France, 7: 328, type *H. lucida* Drap.
Hyalina "Féruss.", Gray, 1847, Proc. Zool. Soc., p. 174. Not *Hyalina* Schumacher, 1817.
Aplostoma (Férussac) Moquin-Tandon, 1855, Hist. Moll. France, 2: 72.—Lindholm, 1927, Arch. Molluskenk., 59: 322, Type *H. cellaria* Müll.
Lucilla Lowe, 1855, Proc. Zool. Soc., p. 177, type *Helix cellaria* Müll.
Euhyalina Albers, 1857, Malak. Bl., 4: 91, type *H. cellaria* Müll.
Omalota Megerle MS., in Scudder, 1882, Nomencl. Zool., p. 233 (= *Oxychilus*).
Helicella Gray, 1847, Proc. Zool. Soc. London, p. 173, type *Helix cellaria*.—Gude & Woodward, 1921, Proc. Malac. Soc. Lond., 14: 177. Not of Férussac.

The shell is of medium or small size (diameter 5 to 16 mm. in our species), depressed, biconvex, umbilicate, the umbilicus contained 5 or 6 times in the diameter (in our species); thin, translucent, glossy, of 4 to 6 whorls increasing moderately to the last which is much wider.

Foot long and narrow, the sole tripartite, the areas bounded by impressed lines; in progression showing distinct waves over the central area. There is a small, slit-like caudal pit. The left neck-lappet is single, long and narrow. The kidney is triangular, not much longer than the pericardium, the gut ureter closed.

The jaw is smooth, with a pronounced median projection. The radula has relatively few teeth, the formula in two examples of *O. cellarius* being

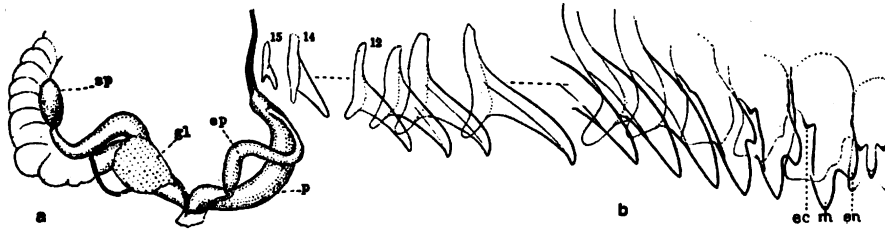


Fig. 122. *Oxychilus cellarius*, Philadelphia a, anterior part of genitalia; b, teeth; ec, ectocone; en, entocone; ep, epiphallus; gl, glandular area; m, mesocone; p, penis; sp, spermatheca.

12.3.13.12. The central tooth is typically rather weakly developed, narrower than the laterals, tricuspid, with mesocone shorter than the basal plate. The three laterals are very large, conspicuously tricuspid, the entocones strongly developed. Marginal teeth simple, thorn-shaped (Fig. 122b, *O. cellarius*).

The atrium is short; vagina rather long (in typical species encircled by a thin dark gland covering base of spermathecal duct. The duct of the spermatheca is short relative to the oviduct. Penis with terminal retractor, the epiphallus inserted well below the apex (Fig. 122a, *O. cellarius*). Orifice of genitalia "well behind and somewhat below right ommatophore, but near anterior margin of visceral stalk." The right ocular retractor lies between ♂ and ♀ branches of genitalia.

A palaeartic genus of closely related species, often hard to discriminate, several of which have been accidentally imported. *O. cellarius* and *O. draparnaldi* are now widely spread suburban snails and often abundant.

Some introduced Zonitidae have been reported additional to the Oxychili described below. *Retinella (Aegopinella) nitidula* (Drap.)⁶⁸ has been identified from gardens in Oakland, Cal. (Hemphill), and from Ft. Resolution, Great Slave Lake, Northwest Territory, collected by Robert Kennicott in 1860 (Dall, Harriman Alaska Exped., 13: 39). The identification of this snail, and its status as a resident, seem dubious. The Oakland specimens are possibly *alliaris* or *helveticus*. The shell of *R. nitidula* is described as smaller than *O. cellarius* with one whorl less, a wider umbilicus; surface with a dull, waxy appearance; and the last whorl expands as it approaches the aperture. Height 4 mm., diameter 8 mm.; 4½ to 5 whorls. *Oxychilus glaber* (Studer) has been reported from a greenhouse in Seattle, Washington (Nautilus, 10: 70), but it is not known to have become resident, and the identification should be reviewed. No American specimens of these species have been seen by the author.

Helix cultellata Thomson, MS., W. G. Binney, Terr. Moll., 4: 22, pl. 76, fig. 6.—*Zonites cultellata* Thomson, W. G. Binney, 1869, L. and Fr.-W. Sh. N. A., 1: 283, fig. 505.—J. G. Cooper, 1887, Bull. Cal. Acad. Sci. (2), 1: 11. This shell was sent to W. G. Binney by J. H. Thomson as from Contra Costa Co., California. It was subsequently found by Mr. Binney to be a stray example of *Zonites acies* (Partsch) of Dalmatia.

Professor T. D. A. Cockerell has made the following key for the determination of living specimens of the common introduced Oxychili.⁶⁹

- Shell small, about 6 mm diameter; shell and animal both quite dark; in life nearly always with a strong garlic odor.....*O. alliaris* (Miller)
 - Shell much larger when mature, and not smelling of garlic
 - Shell about 10 mm. diameter, compact, nearly circular in outline, pale brownish or (var. *margaritacea*) white; animal pale, darker dorsally
O. cellarius (Müller)
 - Shell larger when mature, broader, diam. 12 to 16 mm., with last whorl broader and flatter, dark-colored; animal very dark bluish or bluish slate, the bases of the upper tentacles swollen....*O. lucidus* (Drap.) = *draparnaldi* (Beck)
- (ὄξυς, χεῖλος, sharp lipped.)

⁶⁸ *Helix nitidula* Draparnaud, 1805, Hist. Moll. France, p. 117, pl. 12, fig. 136.

⁶⁹ Nautilus, 21: 132.

Oxychilus cellarius (Müller)

Fig. 123 c.

Helix cellaria Müller, 1774, Hist. Verm., 2: 28 (wine cellars of Copenhagen).

Helix glaphyra Say, 1816 [Nicholson's] Amer. Edit. British Encycl., art. Conchology, No. 5, pl. 1, fig. 3 (garden in Philadelphia).

Zonites cellarius Müll., Leidy, 1851, Terr. Moll., 1: 233, pl. 7, fig. 1.—W. G. Binney, 1878, Terr. Moll., 5: 112, pl. 2, fig. c (teeth); 1885, Man. Amer. Land Sh., p. 448, figs. 493, 494.

Oxychilus cellarius Müll., Ellis, 1926, British Snails, p. 245, pl. 12, figs. 10-12.

Oxychilus pulchro-striatum MacMillan, 1940, Amer. Midland Nat., 23: 731, figs. 2-4 (Duquesne Bluff, Pittsburgh, Pa.).

The shell is strongly depressed, narrowly umbilicate (umbilicus contained about 6 times in the diameter); imperfectly transparent, clear corneous with a faint amber or yellowish tint above, more or less distinctly whitish around the umbilicus; smooth, very glossy, with some weak striation, and under the microscope showing faintly to distinctly traced close spiral lines. Spire slightly convex; the suture conspicuous, with a narrow transparent margin. Aperture rather deeply lunate.

Height 4.2, diameter 9 mm.; 5 whorls.

"The animal is light grey, darker above, with a pale sole, and the edge of the mantle is spotted with brown. The penis-sheath is not abruptly narrowed at its junction with the atrium, as it is in *O. lucidus*, and the epiphallus is short and not twisted." (Ellis.)

The ectocone is weakly indicated on the third lateral, without a cutting point (Fig. 122b).

Distribution.—Europe, Asia Minor and north Africa. In America, known from seaports and also inland places in Nova Scotia, Quebec, Ontario; Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, District of Columbia, Virginia, South Carolina, Michigan, Indiana, Illinois, Missouri, California (San Francisco, 1888, Cooper), and Oregon. Doubtless occurs in other states also.

O. cellarius is chiefly found in cellars, in and around greenhouses and under rubbish in neglected city and suburban gardens. It seems to have obtained a permanent foothold in many places, and is often found in abundance. On the Pacific coast it is "found in gardens and greenhouses wherever gardening operations are conducted," according to Hanna (Bull. Dept. Agric. Cal., 28: 310), who reports *O. draparnaldi* and *alliaris* also.

O. cellarius belongs to an European group in which the radula is rather specialized. The teeth are relatively large. The central tooth is degenerate, having very weak cusps. The three laterals are very large, with large entocones and mesocones, the first two with small ectocones, the third with it represented by a mere situation. The inner marginals are very large, but the size diminishes rapidly outwards. Two radulae from Philadelphia specimens have the tooth formula 12.3.1.3.12.

Oxychilus pulchro-striatum MacMillan is specifically identical, in my opinion, with *O. cellarius*. Numerous specimens of *cellarius* have been compared, including lots from Conshohocken near Philadelphia and from England, determined for me by Mr. B. B. Woodward. The spiral striation described by MacMillan appears to be as strong in many other *cellarius* as in the paratype of *pulchro-striatum* lent me by the author. Spiral striation is mentioned in Taylor's description of *cellarius*. It is always minute, and visible only in places.⁷⁰

***Oxychilus draparnaldi* (Beck)**

Fig. 123 a.

Helix lucida Draparnaud, 1801, Tabl. des Moll. France, p. 96 (?) Not of Pulteney, 1799.^{70a}

Helix nitida Draparnaud, 1805, Hist. Nat. Moll France, p. 117. Not of Müller, 1774.

Helicella draparnaldi Beck, 1837, Index Moll., p. 6, substitute for *H. nitida* Drap.

Hyalinia lucida Drap., Taylor, Mon. Brit. Land and Freshwater Moll., Zonitidae, p. 18, 456.

Vitrea draparnaldi Beck, Soelner, 1902, Nautilus, 16: 94.

Oxychilus draparnaldi (Beck), H. B. Baker, 1928, Proc. Acad. Nat. Sci. Phila., 80: 18. Anatomy.

Polita draparnaldi (Beck), F. C. Baker, Nautilus 42: 59 (Chautauqua Lake, N. Y.).

Oxychilus lucidum (Drap.), F. C. Baker, 1939, Fieldbook Ill. Land Snails, p. 140, text fig.

The somewhat transparent, strongly depressed shell is convex above, umbilicate, the umbilicus contained about 6 times in diameter; glossy, pale

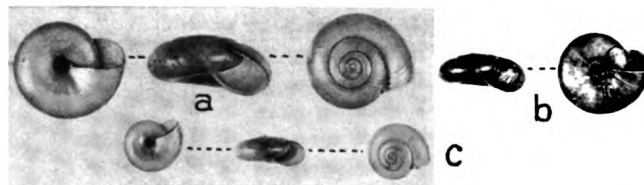


Fig. 123. a. *Oxychilus draparnaldi*, Germantown, Pennsylvania. b. *O. draparnaldi*, small variety, San Diego, California. c. *O. cellarius*, Philadelphia.

brown above, much paler beneath; of $5\frac{1}{2}$ moderately convex whorls, slowly increasing to the last which is very much wider. The strongly oblique aperture is deeply lunate, the lip thin.

⁷⁰ Cf. also the Japanese form described as *Oxychilus hokkaidensis* Pils. (Proc. Acad. Nat. Sci. Phila., 80: 207), which does not appear to differ materially from the widely spread *O. cellarius*.

^{70a} This species has commonly been known as *Helix lucida* Drap., 1801, but there was an earlier *Helix lucida* of Pulteney which may or may not be the same as that of Draparnaud. It was described as exactly resembling *H. ericetorum* in figure but quite smooth and glossy, and wholly without striae, marks or bands, three-eighths of an inch long. Found on plants in the river Stour. Pulteney referred to Pennant's no. 134 and to a figure in Gualtieri, both surely different; and of course his reference to *H. ericetorum* is not quite right for *lucida* Drap., which has a smaller umbilicus. Kennard & Woodward (1926) considered *H. lucida* Pult. as in part referable to *H. nitidula* Drap. However, as British conchologists have not accepted Pulteney's *H. lucida*, it is obviously a *nomen dubium*, but still it bars the use of *H. lucida* Drap.

Height 8 mm., diameter 16.5 mm. Germantown, Pa.

Height 6.5 mm., diameter 14.5 mm. Germantown, Pa.

Distribution.— Throughout Europe, nearer Asia and north Africa. In the United States: Boston, Massachusetts; Gloucester, New Jersey; Germantown, Pennsylvania; Washington, D. C.; Staunton and Norfolk, Virginia; Charleston, S. C.; Chicago, Illinois; Boulder, Colorado; San Francisco and Oakland, California; Portland, Oregon; Seattle, Washington.

The largest of the introduced *Oxychili*, and a little more openly umbilicate than the others. It is said to be carnivorous by preference. The date of first introduction in the United States is unknown, but a lot from Charleston, S. C. (J. S. Phillips) probably dates from before 1850.^{70b}

Many small, dark specimens, up to 12 mm. diameter, which appear referable to *draparnaldi*, have been taken by Dr. Joshua L. Baily in Balboa Park, San Diego (Fig. 123b).

***Oxychilus alliaris* (Miller)**

Fig. 124 b.

Helix alliaris Miller, 1822, Ann. Philos. (N. S.), 3: 379.

Hyalinia alliaris Miller, Taylor, 1907, Mon. Land and Freshw. Moll. Brit. Is., Zonitidae, p. 57.

Zonitoides alliaris Henderson, 1907, Nautilus, 20: 144; cf. Cockerell, Nautilus. 21: 132.

“Shell depressly convex above, but more compressed below than in *Hyalinia helvetica*; whorls 4-4½, semi-transparent, glossy and smooth, with faint but regular striation in the line of growth, most pronounced at the sutures; of an amber or horn color above, passing imperceptibly into a whitish basal opacity; umbilicus about a millimeter in diameter, distinctly

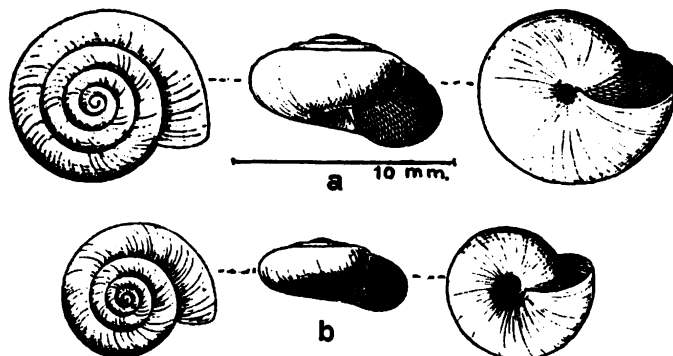


Fig. 124. a, *Oxychilus helveticus* (rogersi); b, *Oxychilus alliaris* (both after B. B. Woodward).

showing the penultimate whorl, and comparatively much wider than in *H. helvetica*; whorls regularly increasing in size; spire somewhat elevated;

^{70b} The *Helix lucida* reported from New York by A. Binney (Terr. Moll., 2: 233) is *Zonitoides nitidus*.

suture distinct but not deep; aperture crescentic and somewhat oblique with a thin and sharp peristome. Diameter maj. 6 mm., min. 5 mm., alt. $2\frac{1}{2}$ mm. (Taylor).

Distribution.—Central and western Europe. Type locality, environs of Bristol, England. Fredericksdal, Greenland. In the United States: Poughkeepsie and Brooklyn, New York; Newark, New Jersey; Ft. Collins and Boulder, Colorado, in greenhouses; San Francisco, 1891 (W. J. Raymond), Oakland and Redlands (S. S. Berry, 1916), California.

It is smaller than *O. cellarius*, 6 to nearly 7 mm. in diameter in those seen, with 4 to $4\frac{1}{2}$ whorls, and with a relatively wider umbilicus, contained about 6 times in the diameter of the shell. The animal is deeply pigmented, and gives off a strong scent of garlic (*Allium*) when handled, a peculiarity which suggested its name.

***Oxychilus helveticus* (Blum)**

Fig. 124 a.

Hyalina (Polita) helvetica Blum, 1881, Nachr. d. malak. Ges., 13: 141.

Vitrea rogersi B. B. Woodward, 1903, Jour. of Conch., 10: 310, pl. 6, figs. 2, 5, 11-13.

Helicella rogersi A. S. Kennard and B. B. Woodward, 1926, Syn. Brit. non-mar. Moll., p. 76.

Hyalina helvetica Blum, Taylor, 1907, Mon. Land and Freshw. Moll., Brit. Is., Zonitidae, p. 45, 463.

Oxychilus rogersi Woodward, Baily, West Coast Shells, p. 299.

Oxychilus helveticus (Blum). Hugh Watson, 1943, Jour. of Conch., 22: 46.

“Shell depressed, slightly convex above, a little flattened below (especially in the region of the umbilicus, which is narrow, small and deep), shining, very transparent, smooth and polished with obscure almost obliterated lines of growth, visible under the lens, becoming more marked at the suture. Color pale horn or waxy brown, with an opalescent or milky white tinge around the umbilicus. Spire but little elevated, whorls five, slightly convex, increasing regularly, the last having about twice the diameter of the preceding. Suture well marked and in some lights having a false appearance of being channelled; aperture rounded-lunate, the columellar lip, which is not reflexed, being in its first part not much inclined to the axis of the shell, while the axis of the aperture as a whole is; peristome thin and sharp, the ends slightly approximate. Dimensions: altitude 4.5 mm., diameter maj. 8.5, min. 7.5 mm.” (Woodward, *O. rogersi*.)

Distribution.—Central Europe, in Switzerland, Germany and France; British Islands. In the United States: Oakland, California. (Hemphill.)

“The shell of *H. helvetica* may be separated from that of its close ally, *H. alliaris*, by its larger size, its more convex and swollen outline above, and its greater flatness beneath; the umbilicus also is comparatively and actually narrower, and the surrounding opaque whitish area more pronounced. From *H. cellaria* it may be distinguished by its smaller size and greater proportionate height, its rounder mouth, its less perceptible basal opacity, and by the umbilicus not disclosing the penultimate whorl so fully as in *H. cellaria*.”

"The animal is distinguished from that of *H. alliaria* by its paler coloring, the much more distinct zebra-like markings of the body, and the deep-black edging to the mantle, which shows as a broad and sharply-defined black line near to and parallel with the mouth of the shell whether the animal be in motion or retracted and at rest within. In crawling, the tail extends considerably beyond the shell. From *H. cellaria* it differs strikingly by the distinct zebra-like transverse striping along the sides of the body, and by the peculiar broad and black mantle margin." (J. W. Taylor.)

Whether the British form described as *V. rogersi* is specifically identical with *O. helveticus* (Blum) has been the subject of some controversy among British malacologists; but Hugh Watson, who collected at the type locality of *O. helveticus*—Weissenstein, Solothurn, on the Swiss side of the Jura Mountains—considers the English snail to be the same species. As the shells from Oakland which I sent were identified by Mr. Woodward with his *O. rogersi*, I have given his description above with photographic copies of his figures. I have seen American specimens from this locality only.

(*Helveticus*, Swiss.)

RETINELLA "Shuttleworth" Fischer

Retinella Shuttleworth, Fischer, 1877, Notitiae Malac., 2: 5.—Kobelt, 1880, Illustr. Conchylienb., p. 223, *Hyalina olivetorum* (Gmel.) designated type.—H. B. Baker, 1930, Proc. Acad. Nat. Sci. Phila., 82: 193.

Aegopina Kobelt, 1878, Rossmässler's Iconogr., 6: 15; 1880, Illustr. Conchylienb., p. 223, *H. olivetorum* designated type.

Glyphyalinia Von Martens, 1892, Biol. Centr.-Amer., p. 117.—H. B. Baker, 1928, Proc. Acad. Nat. Sci. Phila., 80: 19, *Helix indentata* Say designated type.

Nesovitrea C. M. Cooke, 1921, Occas. Pap. B. P. Bishop Mus., 7: 271, "type *Vitrea paucillus* Gld., from Maui."—H. B. Baker, same Papers for 1941, 166: 328.

Perpolita "Pilsbry," H. B. Baker, 1928, *ibid.*, pp. 14, 15, "type *Helix hammonis* Ström, from Cheboygan Co., Mich." = *H. electrina* Gld.

Glyphyalops H. B. Baker, 1928, *ibid.*, pp. 15, 19, type *Vitrea rhoadsi* Pils.

Glyphyalus H. B. Baker, 1928, *ibid.*, pp. 15, 19, type *Glyphyalinia burringtoni* Pils.

Glyphyaloides H. B. Baker, 1930, Proc. Acad. Nat. Sci., 82: 194, 196, type *R. roemeri* (Pils. and Ferr.).

Glyphognomon H. B. Baker, 1930, *ibid.*, 82: 194, 196, type *Helix sculptilis* Bland.

Hyalina, *Hyalinia*, *Vitrea*, *Polita* and *Zonites* of some former authors.

Shell (in our species) small (diameter about 3.5 to 13 mm.), depressed, thin, subtransparent, clear to amber tinted, umbilicate or imperforate; with very low spire and smooth apical whorl. Aperture lunate, the lip thin.

The foot is long and narrow, the sole tripartite (at least in some species, few have been observed); waves over the central area in movement (*electrina*, *indentata*); pedal grooves as usual. There is often a slight prominence above the tail pore.

Penis with terminal retractor (except in *Glyphognomon*), and bearing an epiphallus, which is well developed except in *Perpolita*. Spermathecal duct either long or short.

Jaw semilunar, smooth, with small median projection. Radula with tricuspid centrals. Laterals few, 3 to 5, with or without entocones. Marginals simply thorn-shaped, or in *Glyphyalinia* the outer ones are serrate.

Distribution.—About twenty American species, from the Arctic to southern Mexico, but chiefly in and around the Appalachian region. Also numerous palearctic species.

The nomenclature of this genus is not satisfactory for the reason that there has been no adequate study of the anatomy of the genotype, *R. olivetorum* (Gmelin), a large, *Omphalina*-like South European species. Most work which has been published on the anatomy of smaller palearctic species referred to the genus is insufficient in detail for comparison with those of our fauna. There is, moreover, notable diversity among the American Retinellae. Most of them have tricuspid lateral teeth wholly like those of *Orychilus*, *Vitrea* and *Paravitrea*, but *R. rhoadsi* and the *indentata* group, *Glyphyalinia*, have bicuspid laterals, without entocones. *Glyphyalinia* and its companion section *Glyphognomon* (the *sculptilis* group), have the unique structure of fine serration in the place of an ectocone on the outer marginals. In these forms there are many more teeth in a transverse row than in Retinellae with tricuspid laterals.

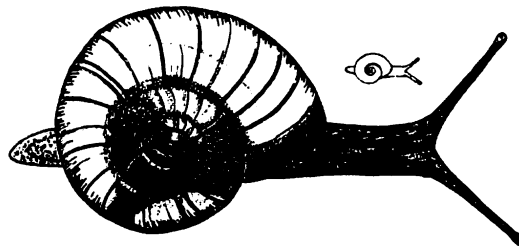


Fig. 125. *Retinella indentata* $\times 7$. Philadelphia, Pennsylvania.

In the genitalia, the circumpolar group *Perpolita* or *Nesovitrea* (*R. electrina* and others) has no distinctly differentiated epiphallus, but that organ is present in all the other divisions. In *Glyphyalinia* (*R. indentata* and others), together with the *R. sculptilis* group, the spermathecal duct is short, as represented in the European *R. nitidula* and *R. pura*, but it is rather long in all of our other groups. In the *R. sculptilis* group the penis projects as a slender appendage beyond the retractor muscle insertion, as in *Mesomphix s.s.*

In his study of the entire series, Dr. H. B. Baker concluded that "the North American species present such a continuous series of minor groups, that, rather than recognize four or five genera, I am recombining all of these

small Zonitinae under the oldest name, *Retinella*." With some misgivings, Baker's decision as to nomenclature has been accepted in the following account.