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MANUAL

OF

CONCHOLOGY

VOL. XXV

PUPILLIDÆ

(GASTROCOPTINÆ, VERTIGININÆ)

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Collaborating on Hawaiian forms

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PREFACE

The present volume is chiefly concerned with the subfamily *Vertigininæ*, to be completed in the next and final volume on Pupillidæ.

In treating of these snails the author has had the advantage of assistance from Dr. V. Sterki with the American Vertigines. The portions relating to Hawaiian species are in large part due to the collaboration of Dr. C. Montague Cooke, though all of the species have been studied by both authors.

The work is based on material contained in the following collections, chiefly in the first two:

The Academy of Natural Sciences of Philadelphia.
The Bishop Museum, Honolulu.
The Museum of Comparative Zoology, Cambridge.
The United States National Museum.
The Carnegie Museum, Pittsburgh (Sterki collection).
The Indian Museum, Calcutta.
The Bryant Walker collection, Detroit.

In addition to the naturalists mentioned in Vol. XXIV, page vi, the author desires to express his thanks for material to

Dr. S. Stillman Berry of Redlands, California;
Mr. William H. Clapp, Cambridge, Massachusetts;
Major M. Connolly, London.

H. A. P.

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INTRODUCTION

For convenient reference a diagram showing the terminology of the teeth is repeated here.

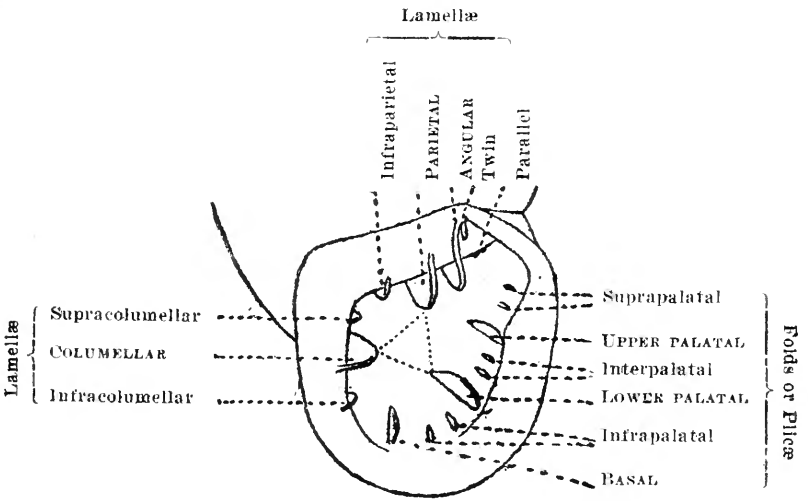

FIG. 1. TERMINOLOGY OF LAMELLAE AND FOLDS.

The names of primary teeth are in small capitals.

The bay formed by the upper arc of the outer lip, and usually limited by the upper palatal and angular teeth, is called the SINULUS. This term has also been used extensively in *Clausilia*, *Ennea*, etc., in the same sense.

In *Vertigo*, the point of the outer lip, running forward or bent inward, has been termed the AURICLE by Dr. Sterki.

The ridge encircling the whorl behind and parallel to the free margins of the peristome is known as the CREST (collar, *callus cervicalis*, *bourrelet extérieur*, *Nackenwulst*).

The use of formulas for expressing succinctly such structures as the teeth of bivalves or gastropods would be a great convenience if it were not that nearly every investigator invents a new system for himself. Without uniform currency, terminology loses its value as an intellectual tool. For this reason, and because such formulas appeal to some but not to all naturalists, little use has been made of them in this work.

In the Introduction to Vol. XXIV, p. viii, the tooth-formula used by Westerlund was noticed, and a more elaborate one was proposed. As the latter has never been used practically, it need not be considered further, being at best rather clumsy.

Westerlund's formula gives merely the number of teeth on each margin of the aperture, parietal, columellar, and palatal including basal, thus: 2–1–3. This is easily understood and often convenient for succinct statements in keys or tables.

More elaborate formulas for brief statement of the apertural denticulation of *Vertigo* (but applicable also to other Pupillidæ) have been published by Dr. V. Sterki (Proc. U. S. Nat. Mus., xi, 1889, pl. 42, fig. 5) and by Mr. C. M. Steenberg (Danmarks Fauna, Landsnegle, 1911, p. 156, fig. 127). Though these formulas have been used but little outside of the publications mentioned, the lists of symbols are given below as a matter of record.

Both the Sterki and the Steenberg formulas express the structures fully. The chief objection to them is that they are rather difficult for one not a specialist on Pupillidæ to interpret. Steenberg's symbols do not distinguish between primary and secondary teeth, and are based upon the Danish language; Sterki does not recognize the *lamella angularis* as a primary tooth. In writing his formulæ, Dr. Sterki uses dots in place of figures for the secondary teeth.

It appears to me that an "international" formula uniting the best features of both could be constructed by designating the six primary teeth by the initials of their Latin names, and the secondary denticles by dots; the parietal, columellar and baso-palatal parts of the formula to be separated by hyphens. In all formulæ the enumeration proceeds anticlockwise.

Terminology of this work.	*"International" formula.*	*Sterki formula.*	*Steenberg formula.*
Parallel and Twin lamellæ	.	1*a*	V_1
Angular lamella	A	1	V_2
Parietal lamella	P	A	V_3
Infraparietal lamella	.	2	V_4
Supracolumellar lamella	.		A_1
Columellar lamella	C	B	A_2
Subcolumellar lamella	.		A_3
Basal fold	B	C	B
Infrapalatal folds	.	3	G_{6-8}
Lower palatal fold	Pi	D	G_5
Interpalatal fold	.	4	G_4
Upper palatal fold	Ps	E	G_3
Suprapalatal fold	.	5	G_2
Sutural fold	.	6	G_1

In the second column the letters *i* and *s* are added to the initial P to indicate *inferior* and *superior* palatals.

As an example, the teeth of an 8-toothed *Vertigo antivertigo* (angular, parietal, infraparietal, columellar, basal, infrapalatal, lower and upper palatals) would be represented thus:

Westerlund formula: 3—1—4

Sterki formula: .A.BC.DE

Steenberg formula: $V_{2,3,4}$—A—B—$G_{3,5,6}$

"International" formula: AP.—C—B. Pi Ps

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Subfamily GASTROCOPTINÆ (continued).

Genus CHONDRINA Reichenbach.

Pupa, in part, DRAPARNAUD 1805, and of most subsequent authors; not of Bolten, 1798.—*Chondrus* CUVIER, 1817, in part. —*Cochlodonta* FÉRUSSAC, 1821, in part.

Torquilla STUDER, Kurzes Verzeich., etc., 1820, p. 89.—VON MARTENS, Die Heliceen, 1860, p. 287, type *Pupa avenacea* Brug. Not *Torquilla* Brisson, 1760 (*Aves*).

Chondrina REICHENBACH, Allgemeine Taschenbibliothek der Naturwissenschaften. 5ter Theil. Zoologie oder Naturgeschichte Thierreichs, i, 1828, p. 93, as substitute for *Chondrus* Cuv.; ii, 1836, p. 152, for *H. avenacea*.

Modicella H. and A. ADAMS, Genera Rec. Moll., ii, 1855, p. 169. — BOETTGER, Jahrb. Nassau. Ver. Naturk., xlii, 1889, p. 249.—WESTERLUND, Fauna Europaea Moll. Extramar. Prodr., ii, 1878, p. 178; Synopsis, 1897, p. 94.—*Cf.* also CAZIOT, Bull. Soc. Zool. France, vol. 33, 1908, p. 195.

Alloglossa LINDSTROEM, Om Gotlands Nutida Mollusker, 1868, p. 18; monotype *A. avenacea* (Brug.).

The shell is rimate, cylindric-conic or conic, brown (except the group of *C. similis*, which have the shell opaque-whitish), of 4½ to 10 whorls. Aperture with teeth arranged as in *Abida*, but often small, reduced in number or wanting; palatal plicæ not entering deeply and not enlarged to form an internal barrier. Peristome somewhat expanded.

Radula having the central and lateral teeth narrow, *unicuspid*, the cusp long and curved in profile; marginals with several cusps.

Type *C. avenacea* (Brug.). Distribution, southern Europe from Portugal to the Caucasus, north to Gotland; North Africa.

The radular teeth of *Chondrina* differ a good deal from those of other *Pupillidæ*, yet the peculiarity is probably not indicative of great systematic separation. Similar simplification of the teeth is seen in *Allognathus*, which in other characters differs but little from the rest of the Pentataeniate Helices; also in some tree snails.

C. avenacea is probably as near as any recent species to the ancestral forms of the genus, its aperture having the full tooth-formula of the *Abida* group of genera. The other sections of the genus (*Modicella* and *Solatopupa*) appear to be regional specializations from ancestors belonging to the *avenacea* group (*Chondrina s. str.*). The specialization usually was in the direction of tooth-reduction; but in the case of *Solatopupa* (*C. similis* and its allies) there has been adaptation to direct, brilliant sunlight, the shell becoming conspicuously calcareous.

Under *Abida* (Vol. XXIV, p. 263) the author has mentioned his diffidence in offering a compilation in place of the monograph by an expert which these genera stand in need of. It seems best not to leave the account of Pupillidæ incomplete, and it is not practicable at present to have the work done abroad.

Radula.—The dentition of this genus was first investigated by G. Lindström (Om Gotlands nutida mollusker, 1868, p. 18), who described and figured the teeth of *Pupa avenacea*. On account of the narrow, simple cusps he formed a new genus, *Alloglossa*, for this species. It is a pity that a prior name has to be used, as Lindström was the first to define the group scientifically.

Schako (in Westerlund, Fauna Europæa, etc., 1878, p. 167) stated that he had found dentition like that described by Lindström for *avenacea* in the species

avenacea Brug.	*goniostoma* Rm.
quinquedentata Born.	*ventilatoris* Parr.
megacheilos Jan.	*muhlfeldii* Küst.

Finally, the Rev. Prof. H. M. Gwatkin (Proc. Malac. Soc. London, iii, 1897, p. 227) gave the results of his examination

of Pupillid dentition with lists of the species described. The following are stated to have teeth of the *megacheilos–avenacea* type:

algesirae Kob.
amicta Parr.
avenacea Brug.
bergomensis Charp.
bigorrensis Charp.
calpica West.
megacheilos Jan.
quinquedentata Born.
scalaris Ben.
secale Drap.
similis Brug.

The inclusion of *secale* must be due to an error of some sort, as I have found that species to have broad lateral teeth, all of them bearing ectocones.

Distribution.

Chondrina, like *Abida*, is generally found upon rocks, walls and cliffs, preferably on limestone, and therefore is chiefly developed in broken country or mountains, where such stations abound, as are most of the Clausilias. Favorable stations are limited and discontinuous, leading to the segregation of colonies of snails having the habits mentioned.

In distribution, *Chondrina* is much like *Abida*, the Alps and the Pyrenees being evolution centers, with one plastic and adaptable species, *C. avenacea*, widely spread over central Europe.

About the Alpic center there is the typical or *avenacea* group of *Chondrina*, and the section *Solatopupa*, the *similis* group.

In the Pyrenean center and through Spain and Portugal there is the *bigorriensis* group of *Chondrina*, and the weakly differentiated section *Modicella;* both probably derivatives of avenaceous ancestors. Species and races are very numerous, though the structural differentiation has been less, perhaps, than in the Alpic center. The number of species diminishes rapidly westward from the Pyrenees, very few being found in Portugal and northern Morocco.

It appears reasonable to suppose that an *avenacea*-like stock, widely spread in southern Europe in late Tertiary time,

was subjected locally to a great variety of conditions consequent upon the elevation of the Alps and Pyrenees, with progressive interruption of limestone terranes by folding, faulting and erosion. To these isolating factors, probably, the prolific speciation is chiefly due.

C. tingitana in Morocco is very closely related to forms of the adjacent part of Spain. The group of *C. goniostoma, penchinatiana, letourneuxi* and *lallemantiana,* reported from Algeria by Bourguignat and Letourneux, have an aspect so Pyrenean that the possibility of importation occurs to one. They appear out of place in Algeria. *C. avenacea* reported by Letourneux also seems to be a stranger in Algeria, and Caziot directly denies its occurrence there (Ann. Soc. Linn. Lyon, Année 1908, p. 160, footnote 1).

Chondrina is not certainly known anterior to the Pleistocene. Several forms possibly referable to the genus are enumerated below, but by being toothless they resemble a few aberrant terminal products of evolution in the recent fauna rather than the more normal toothed forms which must have been ancestral. There is little reason for referring any of them to *Chondrina*, yet no other generic reference is obvious. The absence of definite traces of this genus in known Tertiary deposits leaves the question of its origin highly problematic.

CHONDRINA(??) TROCHULUS (Sandb.). *Pupa* (*Modicella*) *trochulus* SANDBERGER, Vorwelt, 1875, p. 601, pl. 29, f. 25.—CLESSIN, Malak. Bl. n. F., vii, p. 86.

Upper Miocene: Morsingen, Undorf. Similar to *Granopupa rupestris* Ph.; toothless; but in view of the frequency of tooth degeneration in *Pupillidæ* this character is almost worthless as a test of relationship.

PUPA MULTICOSTULATA Gutzwiller. Abhandl. Schweizerischen paläont. Ges., vol. 32, 1905 (1906), p. 28, pl. 4, f. 30. Eocene, Lausen near Basel. Aperture unknown, and position doubtful; externally resembles *Chondrina.*

CHONDRINA(?) TOURNOUERI (Ancey). *Pupa lusitanica* TOURNOUER, Journ. de Conchyl., vol. 27, 1879, p. 176, pl. 6, f. 3; not of Rossmaessler.—*Pupa tournoueri* ANCEY, Le Naturaliste, i, p. 414, n. n. for *lusitanica* Tour. — *Pupa tournoueri*

COTTER, Communicaçoes da Direcçao dos Serviços Geologicos de Portugal, iv, 1900-1901, p. 144, plate, f. A, 24, 25, n. n. for *lusitanica* Tour. Lower Miocene(?) near Lisbon, Portugal.

Nomenclature.

The species now referred to *Chondrina* have been known almost universally as *Pupa* or *Torquilla*. Both of these generic names were originally used for other groups of animals, and hence must be dropped in this connection. *Chondrina* was not discriminated from *Abida* until 1868, and in fact up to the present time few authors make the distinction, so that the notes on nomenclature given under *Abida* (Vol. XXIV, p. 267) are to be consulted in connection with the following:

The genus *Chondrus* Cuvier, 1817, comprised species of three modern genera, arranged in two divisions, as follows:

1. Bulimus zebra Oliv.
   Pupa tridens Drap.
   Pupa variabilis Drap.
2. Bulimus avenaceus Brug.
   Pupa secale Drap.

2. Pupa frumentum Drap.
   Bulimus similis Brug.
   Pupa polyodon Drap.
   Pupa quadridens Drap.

In 1821 Gray mentioned *Pupa cinerea* as an example of the genus, and Hartmann, in the same year, used *Chondrus* for species now referred to *Abida*, *Chondrina*, etc.; but no type was expressly named until Gray, in 1847, selected *Bulimus zebra*. *Chondrus*, however, was not valid, having been used previously by Lamouroux for another group.

Pfeiffer says of *Chondrus* Hartmann, 1821, "*genus restrictum ex typo P. frumenti*," but this is not the case. In his article, System der Erd- und Flussschnecken der Schweiz, mit vergleichen der Aufzählung aller auch in den benachbarten Ländern, Deutschland, Frankreich und Italien sich vorfindenden Arten (in Neue Alpina, Bd. i, pp. 218-220) Hartmann used *Chondrus* in somewhat wider than Cuvierian limits, including species of the modern genera *Chondrina, Abida, Chondrula, Vertigo, Pupilla, Truncatellina* and *Lauria*.

Recognizing the preoccupation of *Chondrus*, Reichenbach, 1828, proposed to substitute *Chondrina*, without mentioning any species. He considered it a subgenus or section of *Helix*

In 1836 he defined *Chondrina* briefly, mentioning one species, *H. avenacea*, as an example of his subgenus. This becomes, necessarily, the type of *Chondrina*.

Cochlodonta Férussac, Tableau Syst., 1821, pp. 28, 58, covered lengthened, toothed snails of many genera, including various Pupillidæ. As no type appears to have been selected, *Helix uva* Fér. (*Cerion uva* L.) has been named as the genotype (Man. Conch., XXIV, p. 268).

Modicella was also a composite group, proposed for toothless Pupæ, with the following species, the modern genera being added in parentheses:

conoidea Nc. (*Bothriopupa*)
fallax Say (*Ena, Pupoides*)
farinesii Desm. (*Chondrina*)
freyeri Schm. (*Zospeum*)
modica Gld. (*Pupoides*)
pacifica Pfr. (*Pupoides*)
pallida Ph. (*Chondrina*)
putilla Shuttl. (*Pupoides*)
rupestris Phil. (*Granopupa*)

No type has been selected, but Westerlund, Boettger and some other authors have used *Modicella* for the groups of *avenacea, rupestris* and their allies. Ct. Caziot has contended that the name should be dropped. *Pupa farinesii* is selected here as the type species.

Chondrina is here limited to species known or believed to have similar radulæ. It contains many of the species grouped in the genus *Modicella* by Westerlund (1897), but it differs by the exclusion of the Rupestrellæ (Westerlund's groups 5 to 8) and by the inclusion of the *similis* group, which Westerlund leaves with the Abidæ.

Westerlund has classified the species in eight groups designated by numbers. Commandant Caziot has offered a rearrangement into five groups (Ann. Soc. Linn. de Lyon, vol. 53, 1907, pp. 196-7), uniting Westerlund's 3d and 4th groups. and making two groups out of Westerlund's 5th to 8th, with also numerous transpositions of species. Most of these alterations appear to be improvements. In the following year Caziot and Margier outlined eleven groups to contain the Chondrinas and Rupestrellas, mentioning a few species under each group. Connecting links are so numerous that any linear

arrangement has its flaws, and the number of subordinate groups into which the three main series or sections may be split is here, as everywhere, purely a matter of convenience. The presence of several series of independent origin, in which the teeth have been reduced or lost, adds to the complexity of specific classification.

Sections of Chondrina.

a.[1] Shell brown, of different shades.

b.[1] Lamellæ and plicæ well developed, 6 or more. Section *Chondrina*, p. 7.

c[1]. Alpic; series of *C. avenacea*, no. 1 to 8.

c[2]. Pyrenean; series of *C. bigorriensis*, no. 9 to 28.

b.[2] Teeth small or wanting; not more than 2 plicæ in the outer-basal lip.

c[1]. Pyrenees and Spain. Section *Modicella*, p. 44.

c[2]. Alpes Maritimes and Liguria, species no. 3, 4.

a[2]. Shell opaque, whitish or very pale. Southern France and Italy. Section *Solatopupa*, p. 57.

It should be noted that some species of the *avenacea* group and of *Solatopupa* have degenerate teeth, as in the section *Modicella*. See species no. 3, 4, 42, 43.

Section CHONDRINA *s. str.*

Series of C. avenacea.

1. CHONDRINA MEGACHEILOS (Cr. et Jan). Pl. 1, figs. 1, 2, 3.

The shell is more or less openly umbilicate, nearly smooth or somewhat wrinkled, chestnut-brown to chocolate, paler above, shining. Spire slowly tapering, the penult whorl nearly as wide as the last; latter part of last whorl compressed into a narrow ridge below, flattened laterally, and often weakly impressed over the upper and lower palatal plicæ. Aperture oval, armed with 9 teeth: angular lamella long, continuous, or almost joining the short, higher, spiral lamella; parietal lamella short. Columellar lamella is strong and rather long, not quite reaching the peristome; subcolumellar smaller, shorter. Five palatals, the sutural and suprapalatal plicæ

very small, upper and lower palatals long, the former emerging to the peristome, basal plica small, rather deep. Peristome is expanded and *strongly thickened within*, white.

Length 7, diam. 3 mm.; 7½ whorls (Como).

Length 8, diam. 3.2 mm.; 8 whorls (Como).

Length 10.3, diam. 4 mm.; 9 whorls (Milan).

Italy: Lombardy and Piedmont; also in adjacent parts of the Tyrol and Switzerland, and rare west to Grasse (Alpes-Maritimes); valley of the Verdon, Basses-Alpes, abundant and of good size (Margier).

Chondrus megacheilos DE CRISTOFORIS et JAN, Catalogus rerum nat. in Museo extantium Josephi de Cristofori et Georgii Jan, sect. ii, pars 1, fasc. 1, p. 5, Mantissa, etc., 1832, p. 3.—*Pupa megacheilos* Jan, ROSSM., pt. 5, 1837, p. 13, pl. 23, f. 318; iii, pt. 17, p. 106, pl. 85, f. 938.—KUESTER, Conchyl. Cab., p. 46, pl. 6, f. 6-8.—DES MOULINS, Actes Soc. Linn. Bord., vii, 1835, p. 162, pl. 2, f. A1, A2.—MOQ.-TAND., in part, Moll. Fr., p. 354, pl. 25, f. 23-32; with var. *rufula*. — PFR., Monogr., ii, 346; iii, 547; iv, 673; vi, 315; viii, 384 (see for older references). — WESTERLUND, Malak. Bl., xxii, 1874, p. 62 (new diagnosis, and notes on transitions to *avenacea*).—SCHROEDER, Nachrbl. d. m. Ges., vol. 45, 1913, p. 171 (varieties, etc.).—E. MARGIER, Feuille Jeunes Naturalistes, 1904, no. 399, p. 65.—CAZIOT, Ann. Soc. Linn. Lyon, 1908, p. 158 (distribution, etc.).—*Torquilla tricolor* ANT. *et* J. B. VILLA, Dispositio Syst. Conch., etc., 1841, p. 57.—*P. albilabris* ZIEGLER MS., according to VILLA, Disp. Syst., 1841, p. 24.—*Pupa megacheila* CAZIOT, Étude Moll. terr. et fluv. Monaco, etc., 1910, p. 316, with var. *minor*, p. 317, pl. 9, f. 19, from north of Grasse, on the short-cut leading to Saint-Vallier.—*Pupa megacheylos* DUPUY, Hist. Nat. Moll. France, p. 394.

In its typical form this species differs conspicuously from *avenacea* by its strongly thickened white lip, the columellar border more straightened, and by the development of 9 teeth, the sutural fold never being found in *avenacea;* also by the strongly compressed base and the more open umbilicus; yet there are transitional forms in the Tyrol which appear to connect the two stocks. These have been left as "varieties" under *avenacea* in this work.

Doubtless all records from the Pyrenees, from those of Boubée and Des Moulins on, pertain to other species. It is not found in southern France beyond the dép. Alpes-Maritimes and Alpes-Basses, and even there the colonies are apparently few and small. According to Adami, the large, typical forms are at elevations above 2000 meters, smaller forms being found at lower levels.

Commandant Caziot regards the *bigorriensis* group of the Pyrenees as modifications of a *megacheilos* stock which radiated from the Alpic center, but I am disposed to look upon the *bigorriensis* group and *megacheilos* as parallel mountain modifications of an early *avenacea*-like stock, and not otherwise directly related.

Jan's original description is as follows: *Chondrus megacheilos.—Ch.* with the shell dextral, conic-cylindric, the summit a little obtuse (alt. 4½, width 1½ lines). Aperture 7-plicate (alt. 1½, width 1 line) peristome wide, white. Northern Italy.

Torquilla tricolor Villa was said to differ from *megacheilos* by the greater size, thicker shell, more reflected peristome and more numerous apertural folds (8); length 11-13, diam. 5 mm. In humid, limestone mountains of Valsassina, province of Como. This name may be used for the large form of *megacheilos* if one is needed.

Form *minor* West. Length 5½–6, diam. 2 mm. Different from *avenacea* by the compressed, keeled base of the last whorl, reflected lip, the mouth angular below, the straightened columellar lip, etc. (Fauna, iii, 1887, p. 96). No locality was given by Westerlund, but Schröder has reported it from near Gargnano, Salo, etc., on Lake Garda (Nbl., 1913, p. 174). Caziot also figured a "var. *minor*" from north of Grasse, length about 5.7 mm.

Var. *toscolana* Schröder. Shell similar to the type except that it is stronger; whorls 8–9; throat set with many folds and tooth-like tubercles (up to 16!). Length 11–14½, breadth 4–5 mm. On cliffs in Toskolano valley, in the mountains west of Lake Garda (*Modicella megacheilos* Jan, var. *toscolana* Schröder, Nachrbl. d. m. Ges., vol. 45, 1913, p. 174).

Var. *caziotana* n. n. A variety rather of *megacheila* than of *avenacea;* in the latter species the palatal folds are opposite the columellars, and do not reach the peristome, while in *megacheilos* the stronger palatal folds alternate with the columellars, and one at least, or several, reach the peristome, and this is the case with our variety, which is therefore closely related to the var. *maritima*. It forms a passage to *Pupa megacheila*, but has not an angular aperture. Alpes-Maritimes: Gorges of Cians, north of Beuil, at 1500–1600 meters elevation, and on the limestones of the plateau de Caussols, in the ravine near the road from Grasse to Thorenc, at the place called le Planesteli, at about 1000 meters (*Pupa megacheila* var. *labiosa* Caziot, Etude moll. terr. et fluv. Monaco, 1910, p. 317, pl. 8, fig. 9). It may perhaps be equivalent to *Pupa avenacea* var. *maritima* Loc., according to Caziot, *t. c.*, p. 316, footnote. The names *labiosa* and *maritima* are preoccupied in *Pupa*. Caziot's figures are too small to show any distinctive characters. His description is given above.

Var. *galloprovincialis* Margier. Hauteville (Ain). A form said to resemble that of the Tyrol. I have not found a description of it, and suspect that it is a MS. name. Mentioned by Caziot, Ann. Soc. Linn. Lyon for 1908, p. 159.

2. Chondrina avenacea (Brug.). Pl. 1, figs. 4, 5, 6.

The shell is perforate, rimate, cylindric-conic, thin, chestnut-brown or carob-brown; weakly, rather finely, irregularly striate. Whorls somewhat convex, the last well rounded at base, slowly ascending forward. Aperture with 7 teeth. Angular lamella low, rather long, either weakly joining the spiral lamella or shorter and discontinuous with the spiral; the spiral lamella is often rudimentary or absent. Parietal lamella short. Columellar lamella short, horizontal, a smaller, shorter subcolumellar below it. Upper and lower palatal and basal plicæ rather short, the upper reaching the peristome, the others a little immersed; frequently a minute suprapalatal plica is developed. Peristome thin, whitish, a little expanded; parietal callous very thin, transparent.

Length 6.8, diam. 2.8 mm.; 7½ whorls.

Length 5.8, diam. 2.2 mm.; 7 whorls.

Europe, from the French Pyrenees to Greece, north to Oeland and Gotland, but not in the British Isles. Western Caucasus. Type loc., near Paris.

Bulimus avenaceus BRUG., Encycl. Méth., i, 1783, p. 355 (environs de Paris). — *Pupa avenacea* Brug., PFR., Monogr., ii, 347; iii, 548; iv, 674; vi, 316; viii, 385 (see for older references).—CAZIOT, Ann. Soc. Linn. Lyon for 1908, pp. 160-169 (distribution, synonymy, etc.).—WESTERLUND, Fauna, iii, 1887, p. 97, with forms *eupora*, *paucidens*, and p. 98, var. *subhordeum*, *lepta*, *transiens* West., etc. — LOENS, Nachrbl., xxiv, 1892, p. 172 (varieties about Lake Lugano). — *Pupa* (*Modicella*) *avenacea* Brug., BOETTGER, Jahrb. d. m. Ges., viii, 1881, p. 226, and x, 1883, p. 179 (Caucasus and Transcaspian Territory). — *Alloglossa avenacea* Brug., LINDSTROM, Om Gotlands nutida Mollusker, 1868, p. 18, pl. 1, f. 11, 13 (jaw and radula). —STEENBERG, Danmarks Fauna: Landsnegle, 1911, p. 178, f. 147-149 (good).—*Torquilla avenacea* Brug., CLESSIN, Molluskenfauna Oesterreich-Ungarns u. der Schweiz, 1887, p. 227, f. 129. — *Modicella avenacea* WEST., Synopsis, 1897, p. 97.— STEENBERG, Nachrbl. d. Malak. Ges., vol. 45, 1913, p. 169 (occurrence in Denmark doubtful); Danmarks Fauna, Landsnegle, 1911, p. 178, f. 147-149 (teeth, genitalia and shell).— *Pupa avena* DRAPARNAUD, Hist. Moll. France, 1805, p. 64, pl. 3, f. 47, 48.—ROSSMAESSLER, Iconogr., i, p. 82, pl. 2, f. 36; pt. 5, p. 13, f. 319.—KUESTER, C. Cab., p. 48, pl. 6, f. 12-14.—*Pupa hassiaca* PFR., Symbolae ad Hist. Hel., i, 1841, p. 45; Monogr., ii, p. 334 (Habichtswald, Cassel, Hessen). — KUESTER, Conchyl. Cab., p. 85, pl. 12, f. 10, 11.—VON MARTENS, Nachrbl. d. m. Ges., x, 1878, p. 89 (type specimen is an *avenacea*, injured in the penult whorl).—CAZIOT, Bull. Soc. Zool. France, xxxiv, 1909, p. 221.—*Jaminea septemdentata* RISSO, Hist. Nat. Eur. Mérid., iv, 1826, p. 91.—*Pupa lucana* BRIGANTI, Su due nuove specie di testacei spettanti al genere Pupa, 1832, in Atti Ist. Incoraggiamente, Napoli, v, 1834, pp. 221-238 (not seen); placed as a synonym of *Pupa avena* by Scacchi, Catalogus Conchyliorum Reg. Neapolitani, 1836, p. 16.

This common snail is more widely distributed than any other

species of this or related genera except *Granopupa granum*. No satisfactory record for Spain has come to my notice, but Caziot states that, according to Margier, it has been found in the neighborhood of Gerona, Catalonia. Eastward the locality Caucasus is a long way from any other record, but the species probably extends through the southern provinces of Russia. Sicily and Greece are the southern extremes of its well-known range, but there is a single Algerian record, limestone rocks at the foot of the great massif of Thabbourt Bouzgueur, Kabylia (Letourneux, La Kabylie, i, 1872, p. 227).

The thin lip, dark color, rounded base and 7 or 8 teeth are the chief characters; but there are forms more or less connecting with *C. megacheilos*.

Westerlund has compiled a formidable list of varieties; to it considerable additions are here made. It is an undigested mass of forms of different grades which nobody has yet studied in a broad, comparative manner. Some of them probably pertain to *C. megacheilos*.

Form *eupora* West. Shell typical; aperture with 2 or 3 parietal and 2 columellar lamellæ, 4 palatal plicæ, the upper one punctiform, the fourth short (*West.*, 1887). Locality not given. Caziot states that most specimens of middle France are of this form.

Form *cerealis* Ziegler MS. Shell larger, length 8, diam. 2½–3 mm. (*Westerlund*).

Form *paucidens* West. Shell typical, but with 2 palatal plicæ (*West.*, 1887). Locality not given.

Var. *subcereana* West. Aperture with 2 parietal, 2 columellar, 4 palatal plicæ, the angular lamella very large, palatals subequal, remote; length 7½–8, diam. 2½ mm. Sweden: Gotland, Oeland; Denmark; also Tirol, Tauria (*Alloglossa avenacea* var. *subcereana* Westerlund, Fauna moll. terr. et fluv. Suecica, etc., 1873, p. 280; *Modicella a. s.*, West., Synopsis, 1897, p. 97).

Var. *ferruginea* West. Shell perforate, narrowly ovate-conic, rufous-ferruginous; very delicately, more distinctly striate at the suture, with few, distinct, whitish delicate riblets; whorls convex, the last a little convex at base; aperture with

3 parietal, 2 columellar, 4 palatal plicæ, the outer parietal fold very small, very deeply placed below the angular; the upper palatal minute, deeply placed, the median plicæ longest, higher within. Length 4–5, diam. 1½–2 mm. Agen, France. (*Pupa ferruginea* West., Fauna Europaea Moll. extramar. Prodr., ii, 1878, p. 180; Fauna, iii, 1887, p. 98; Synopsis, p. 97, as var. of *avenacea*). According to Margier, it was based upon decolored examples of *avenacea*.

Var. *subhordeum* West. (pl. 1, fig. below f. 8). Shell smaller, with the same number of whorls, nearly smooth; 2 folds on parietal wall, columella and palate; length 5, diam. 2 mm. ("*P. hordeum* of many authors, *P. avena* v. *minor* Küster, Mon., pl. 6, f. 15-16," *Westerlund*, Fauna, iii, 1887, p. 98). Küster's figure is copied. He gives the localities, Bavaria, Würtemberg, Switzerland, Carinthia and Carniola as far as Triest.

Var. *cocchi* Ben. Benoit states that in Sicily *Pupa avenacea* is common in woods and in the high mountains of Madonie, of Fiumedinisi; found also at Marineo and Busambra. The Sicilian specimens are usually a little smaller than those of the rest of Europe (Nuovo Catalogo, 1881, p. 93). This form is evidently that which Benoit tentatively named *Papa* [*sic*] *cocchi* in 1845, in this manner.

PAPA AVENA? *Drap.* Shell subconic, umbilicate, chestnut; whorls 7, obliquely striate; aperture subrotund; 7-toothed, lip emarginate; apex rather obtuse.

The shell which is found in Sicily is different, I believe, from that which lives in France; yet it is closely related, for the Sicilian form differs only by being less conic, by the number of whorls, by the shape of the aperture and by the arrangement of the folds in the same. According to Baron Mandralisca it is found abundantly at Madonie, on limestone rocks. Size 2½ lines. PAPA COCCHI? *Mihi.* (L. Benoit, Ricerche Malacologiche, 1845, p. 11, pl. 2, f. 7).

De Gregorio has named the same form *Pupa avenacea* Brug. var. *sicula*, Il Nat. Siciliano, xiv, 1895, p. 203; referring to Benoit's figures, Il. Sist., pl. 5, f. 33, and his Nuovo Cat., and stating that the examples differ from the typical form by the smaller size and by having the lip of the aperture simple.

Var. *minima* Loc. Shell a third smaller than the type, of a little more thick-set form, somewhat ventricose, the striæ more strongly marked. Not common; le Mont-d'Or lyonnais (Locard, Variations Malac., i, 1880, p. 253).

Var. *aureacensis* Loc. Shell much lengthened, slim, little tapering; 10 nearly flat whorls, the last a little larger; suture very large, as though channelled; aperture small, rather narrowly oval, retracted at base; 2 separated superior folds, the second immersed; 2 deeply placed columellars; 3 immersed palatals, the first barely reaching the peristome; peristome thin, sharp, straight; shell vinous-brown, with little gloss, ornamented with very strong and irregular ridges. Length 9-10, diam. 2 mm. Saint-Didier-au-Mont-d'Or (Rhone); Cauterets (Hautes-Pyrénées). (*Pupa aureacensis* Locard, Ann. Soc. d'Agric. Lyon (7), iii, 1906, p. 186.)

The two widely separated localities, in diverse faunas, raise a suspicion that it may have been based on abnormal shells.

Var. *avenieulum* 'Hartm.,' Clessin. Shell small (smaller than that of *hordeum*), of circular form. Length 5-6 mm. Switzerland, environs of Chur, Malans, right bank of the Landquart, Zizers, in the Schlundtobel on the Creta v. Schuders (Hartm. in sched. Am. Stein Graubünten, p. 61. *Torquilla avenacea* var. *avenieulum* Clessin, Moll.-fauna Oesterreich-Ungarn, 1887, p. 229).

Var. *duplicata* Küster (pl. 1, fig. below fig. 7) differs from *avenacea* by having four palatal folds, the upper one deeper and shorter, the other three not reaching to the peristome; the upper fold at the insertion of the right margin of the peristome is weak, not penetrating deeply; nearly behind it the second fold of the parietal wall is doubled, the right part hardly half as large as the left. Length 2, diam. 1 line. Toulon, southern France (*Pupa duplicata* Küster, Conchyl. Cab., *Pupa*, p. 109, pl. 14, f. 37-39). The separation of angular and spiral lamellæ is by no means rare among French specimens of *avenacea*, but the present form is also distinguished by having a suprapalatal plica and by small size.

Var. *lepta* West. Fusiform-turrited, slenderly elongated, acuminate, chestnut-brown or corneous-brown, nearly smooth;

whorls 8, convex. Aperture oblong, outer lip more strongly arcuate, thin; 7 lamellæ and folds: 2 parietal, 2 columellar, 3 palatal, these of nearly equal length. Length 5, diam. 2 mm. Adelsberg. (*Pupa avenacea* var. *lepta* Westerlund, Fauna, iii, 1887, p. 98.)

Var. *clienta* West. (pl. 1, figs. 7, 8). Slenderly fusiform, regularly, densely striatulate, aperture 8-toothed: 4 palatals, the two median pliciform, the upper produced to the margin, the one above it punctiform; peristome with the outer margin regularly arcuate (not angular above); length 7, diam. 2 mm. Choc, in the Tatra Mts., Galicia. (*Pupa avenacea* var. *clienta* Westerlund, Jahrb. d. m. Ges., x, 1883, p. 60.)

Two specimens figured were received from Bielz.

Var. *melanostoma* 'Paul.' West. Very dark chestnut-colored suffused with blue, mostly shortly ovate with very ventricose, rarely with conically elongated, spire; irregularly striate; whorls 6½–7, convex; peristome very narrowly expanded, thin; lamellæ and plicæ typical. Length 5–6, diam. 2–2½ mm. Opcina and Nabrecina near Triest; a var. is 4½ x 1½ mm. (*Pupa avenacea* var. *melanostoma* Paul. in sc., Westerlund, Fauna, iii, 1887, p. 98).

Var. *apuana* Issel. Pl. 1, fig. 12. This variety has some analogy with *P. hordeum*, but differs by the shape of the aperture. The shell is more slender than that of the type, of a brown color, and has the right margin of the aperture more regularly arcuate. Punta del Sagro in the Apuan Alps (*Pupa avenacea* var. *apuana* Issel, Dei Molluschi racc. nella Prov. di Pisa, in Mem. Soc. Ital. di Sci. Naturali, ii, no. 1, 1866, p. 21. Del Prete, Bull. Soc. Malac. Ital., v, p. 81, pl. 1, f. 10-12).

According to Del Prete, it is found in abundance at Carrara above Torano, at Tambura, and rare at Matanna. One of his figures is copied, pl. 1, fig. 12. His natural-size figure is 6.3 mm. long. The name appeared as *Alloglossa avenacea* var. *apuna* Issel, in Westerlund, Malak. Bl., vol. 22, p. 130.

Form *elatior* Paulucci. Larger, both in length and width, but differing chiefly by being much more slender. Avellana in Umbria and at Caramanico (*Pupa avenacea* form *elatior* Paul., Bull. Soc. Malac. Ital., vii, 1881, p. 119).

Var. *lessinica* Adami. Elongate, brown, the aperture irregularly subangulate, toothless; whorls 8-10; length 8-11, diam. 2½ mm. Breonio, Prov. of Verona (*Pupa avenacea* var. *lessinica* Adami, Bull. Soc. Malac. Ital., xi, 1885, p. 222).

"Found sporadically in many localities." From this remark it appears to be an occasional mutation rather than a race.

Var. *arcadica* Reinh. Two palatal plicæ, one parietal in the middle, the other vanishing, upper columellar fold strong, the lower deep, weak and vanishing. Otherwise strongly developed, resembling normal *avenacea* in color, striation and size, 6.5 to 7.5 mm. Mountain region of Kyllene, Arcadia, Greece. (*Torquilla avenacea* var. *arcadica* Reinhardt, Sitzungsber. Ges. naturforsch. Freunde Berlin, 1881, p. 137).

Form *tirolica* West. One parietal, 2 columellar, 4 palatal folds. Length 5½, diam. 2½ mm. Vallarsa, Tyrol (*Modicella avenacea* var. *arcadica* form *tirolica* Westerlund, Synopsis, 1897, p. 97). Why considered a form of *arcadica* is not apparent.

Var. *abundans* West. Shell subturrite-tapering, acuminate, rufescent, obsoletely, irregularly striate; whorls 8, convex, especially the upper ones; suture impressed; aperture oblong, rounded at base, the margins subparallel, outer one curved above, columellar margin long, straightened, vertical; with 8 teeth; upper palatal internal, very short. Length 8, width 3½ mm. (*Pupa* [*Modicella*] *avenacea* var. *abundans* Westerlund, Verh. k.-k. zool.-bot. Ges. Wien, 1902, p. 406. *Pupa* [*Torquilla*] *avenacea* Brug. var. *abundans* Westerlund, Nachrbl. d. m. Ges., xxvi, 1894, p. 172). Greece: Kylteni in the Morea (Th. Krüper).

(*Races having some characters of megacheilos, from the Tyrol, Venetia and Alpes-Maritimes.*) As I have seen only *riviana*, I can form no opinion upon the value or synonymy of these races.

Var. *avenoides* West. (*transiens* West.). Large, strong-shelled, cylindric-fusiform, very indistinctly striate, glossy, reddish-brown with bluish suffusion, the spire produced; whorls 8–8½, very convex; aperture oblong, with nearly equal,

weakly arcuate margins; lamellæ and plicæ 9: 3 parietal, 2 columellar, 4 palatal, none of them reaching the peristome, the upper one very small; margin whitish, somewhat expanded below and on the left. Length 7½–9½, diam. 2¾–3¼ mm. Lake Garda, Tirol. (*P. avenacea transiens ad megacheilos* Strobel. *P. megacheilos* var. *avenoides* and var. *bigorriensis* Westerlund, Fauna Europaea Moll. extramar. Prodr., ii, 1878, p. 168. *P. avenacea* var. *transiens* West., Fauna, iii, 1887, p. 98. Var. *transiens* W., Caziot, Ann. Soc. Linn. Lyon, 1908, p. 165.) Differs from *megacheilos* by having the last whorl rounded at the base, the base of the aperture regularly rounded, the lip not reflected and the more deeply placed palatal plicæ (*West.*). This appears to be a well-marked subspecies, which should evidently bear the earliest name, *C. avenacea avenoides* West. See also Gredler, Nachrbl., 1878, pp. 20, 21.

Var. *megacheiloides* Clessin. Shell moderately umbilicate, ovate-conic, usually of lighter color; peristome somewhat lipped; aperture with 3 nearly equal palatal plicæ standing directly opposite the columellar folds and the inner fold of the parietal wall, and one small upper palatal plica far within. Neck obtuse on the margins, usually without furrows. Southern Tirol, Doss Trento and S. Bernardino near Trient, Segno in the Nonsberge, etc. (*Pupa avena* Drap. Gredler, Conch. aus den Nordosten Tirols, 1860, p. 104. *Torquilla avenacea* var. *megacheiloides* Clessin, Molluskenfauna Oesterreich-Ungarns u. der Schweiz, 1887, p. 229). Probably a synonym of var. *avenoides* West.

Var. *transiens* Clessin. Shell as in the preceding variety, but more slender, regularly striate, darker colored; peristome less lipped. South Tirol, Bozen on porphyritic rocks, on the Schloss Rungelstein, near Dölsach in the Drauthal, on primitive rocks (the first fold rudimentary). (*Pupa avena* Gredler, Tirol, p. 104. *Torquilla avenacea* var. *transiens* Cless., Moll.-fauna Oesterreich-Ungarns, 1887, p. 229.) This is not *transiens* West., which probably has priority.

Var. *gredleriana* Clessin. Shell somewhat smaller; neck compressed, keel-like, the upper palatal fold wanting or rudi-

mentary and almost concrescent with the second fold. Aperture not rarely narrowed angularly at the base. South Tirol, Salurn on the Litschbach, on limestone (*Pupa avena* Gredler, Tirol, p. 104. *Torquilla avenacea* var. *gredleriana* Clessin, Moll.-fauna Oesterreich-Ungarn, p. 229).

Var. *riviana* Schröder. Pl. 1, figs. 9, 10. Shell narrowly umbilicate, fusiform-conic, finely striate or smooth, corneous-brown to dark brown, often with a bluish wash; 7-8 weakly convex whorls; neck somewhat flattened, compressed into a weak keel beneath; aperture large, ovate, obliquely truncate above; throat with 8 folds: 2 each on the parietal wall (the one next to the outer lip sometimes divided) and on the columella, 4 on the palate, the upper small, the next long and reaching the margin, the last somewhat shorter; peristome sharp, white, weakly lipped, somewhat reflected at the columellar margin. Alt. 7–10½, breadth 3–4 mm. (*Schroeder*).

Austrian Tyrol: cliffs on the banks of Lake Garda, at Torbole and Riva, especially on the nummulitic limestone of Monte Brione, usually in company with *Chondrula quadridens* and *Torquilla frumentum* (Schröder).

Modicella riviana Schroeder, Nachrbl. d. Malak. Ges., vol. 45, 1913, p. 173.

It differs from *Modicella avenacea* by its size, the wide mouth, the number and strength of the folds (*avenacea* 7, *riviana* 8); from *M. megacheilos* Jan by the more fusiform shape, the sharp peristome which lacks a flattened lip, and the number of teeth (*megacheilos* 9, *riviana* 8). The varieties introduced by Clessin, *megacheiloides*, *transiens* and *gredleriana*, from other districts of the southern Tyrol, have nothing to do with it (*Schroeder*).

Cf. also Westerlund's notes on the same form. Malak. Bl., xxii, p. 63, and Gredler, Nachrbl., 1885, p. 37, paragraph 3. Specimens collected at Riva by J. L. and A. L. Baily (pl. 1, figs. 9, 10) show considerable variation in shape and size. Whether it is to be ranked as a species, or as a subspecies of *avenacea* or *megacheilos* is a question to be decided when the intermediate forms abounding in the Tyrol shall be revised with adequate material.

Var. *plicatula* Adami. Shell subfusiform, brown, the aperture subangular below, brown within; 5 subequal palatal plicæ; columellar margin plicatulate. Whorls 8–9. Length 8–9, diam. 2½–3 mm. Heights of the limestone mountains in the Illasy valley (Mt. Malera, Zevola and Campobruno), Province of Verona. Near to *megacheilos* Jan. (*Pupa avenacea* var. *plicatula* Adami, Bull. Soc. Malac. Ital., xi, 1885, p. 221.)

Var. *maritima* Loc. Subcylindric-elongate, slowly tapering, 8-9 quite convex whorls, the last a little larger; suture deep; aperture quite large, oval-rounded, a little angular at the base; 2 superior folds, the second approaching and much immersed; 2 subequal and deeply placed columellar folds; 3 palatals, of which only one or two reach the peristome; peristome sharp, expanded, white-rose or red; shell vinous-brown, glossy, ornamented with striæ, occasionally obsolete. Length 10, diam. 3 mm. Saint-Martin-de-Lentosque (Alpes-Maritimes). (*Pupa maritima* Locard, Ann. Soc. d'Agric. Lyon (7), iii, 1906, p. 186. *Cf.* Caziot, Etude Moll. Monaco, 1910, p. 316.) Not *Pupa maritima* Pfr.

This form may perhaps be referable to *megacheilos*. The name was preoccupied.

3. Chondrina oligodonta (Del Prete). Pl. 1, figs. 13, 14.

Shell cylindric-conic, ashy-brown; aperture having a single columellar lamella, the parietal and palatal folds rudimentary, often wanting; right lip more arcuate.

This variety, which in external appearance differs little from the type [*avenacea*] and even less from var. *apuana* Issel, is well distinguished by the characters of the aperture, which has a single superior columellar tooth (and even this smaller than in the type), whilst the other superior and palatal teeth can scarcely be seen, or are wholly wanting. The exterior wall is characterized by wanting the three little white, parallel lines of the type [of *avenacea*], which correspond to the internal palatal teeth (*Del Prete*).

Italy: Apuan Alps, Liguria, only at considerable elevations.

Pupa avenacea Brug., var. *oligodonta* Del Prete, Bull. Soc. Malac. Ital., v, 1879, p. 80, pl. 1, f. 13-15.

My knowledge of this form is solely from the original account. Probably the shell which has been identified by Settepassi as *Pupa farinesii*, from the same region, is a form of *oligodonta* more advanced in tooth-reduction. I do not think it is at all likely to be the Pyrenean species. Part of Settepassi's note follows. *Cf. C. a. lessinica*, p. 16.

In the course of my researches in the Apuan Alps (a part of the Apennines penetrating Tuscany from the Magra river, Spezia, in Liguria, to the Serchio river, Lucca, in Tuscany) I found *Pupa farinesii* almost everywhere. It is the real *farinesii*, without teeth, mingled with *P. avenacea* Brug., but always at high elevations. Its presence has already been announced by Dr. Raymond del Prete, who has had it in his collection for several years. It is found together with another form which has one tooth, the variety described by Moquin-Tandon, 1855, p. 359, as var. *denticus* [*sic*], and with another having the same tooth and two columellar callosities above, var. *oligodonta* Del Prete (F. Settepassi, in Feuille Jeunes Naturalistes, no. 520, 1914, p. 75).

4. CHONDRINA CIANENSIS (Caziot). Pl. 1, fig. 15.

Shell dextral, subfusiform, a little swollen, tapering above; 8 convex whorls, slowly and regularly increasing, the last a little less convex, not ascending to the aperture, having a height of 3 mm. in a total height of 11. Suture oblique, well impressed throughout; summit obtuse. Umbilicus narrow, half encircled by a not very pronounced cervical gibbosity. Aperture ample, nearly vertical (the axis a little inclined to the right), oval, a little elongate, the upper border not angular, lower margin regularly oval, columellar margin straight, the margins converging and joined by a thin callous. In some specimens there is a very thin angular tooth, a reduced parietal, and a slightly more distinct columellar, but these teeth do not exist in all individuals. There are no traces of palatal teeth. Peristome thin, sharp, reflected chiefly in the lower part and the upper part of the columella. The shell is ochraceous, uniform, nearly of the same color as the rocks it lives upon; the first whorls are darker; ornamented with irregular, unequal, very oblique striæ, more or less crowded, the upper whorls not striate. Alt. 9, diam. 2¾ mm. (*Caziot*).

Alpes-Maritimes: gorges of the Cians, at about 1200 meters elevation, nearer to Beuil than Rigaut, living on Permian rocks in very numerous colonies, on the right bank of the torrent.

Pupa cianensis Caziot, Etude Moll. Monaco et Dép. Alpes-Maritimes, 1910, p. 318, pl. 9, f. 16.

P. cianensis differs from *pallida* by the coloration, the slower increase of the whorls, the deeper suture, stronger, coarser and more irregular striation; the more lengthened last whorl, which is less convex, and the longer aperture. *Pupa cianensis* does not belong to the group of *pallida*, but to that of *megacheilos* and *avenacea*. In the Alpic center it takes the role of *farinesii* in the Hispanic (*Caziot*).

It lives in a much colder zone than *pallida*, in gorges shaded from the rays of the sun except for short periods. Just what relation it holds to *C. oligodonta* of the Apuan Alps has not been touched upon by Ct. Caziot.

5. Chondrina cereana ('Muhlf.' Küster). Pl. 1, fig. 11.

Shell subperforate, cylindric-subfusiform, lightly wrinkle-striate, glossy, purplish-brown; spire turrited, rather acute; 8 slightly convex whorls, the last somewhat compressed at the base. Aperture oblong, brown, 8-plicate within: angular and parietal folds deeply placed, of moderate size; 2 columellars, the lower dentiform; 4 palatal plicæ, the upper one minute or obsolete, the rest subequal, nearly reaching the margin; peristome simple, narrowly expanded, the margins converging. Length 7, diam $2\frac{2}{3}$ mm.; aperture 2 mm. long, $1\frac{2}{3}$ wide (*Pfr.*).

Southern Germany and France (Kuester); Carinthia, southern France, northern Spain (Westerlund).

Pupa cereana Mühlfeldt in coll., Kuester, Conchyl. Cab., 1845, p. 47, pl. 6, f. 9-11.—Pfr., Monogr., ii, 348.—Westerlund, Fauna, iii, 1887, p. 99.—*Modicella cereana* Ch., Küst., Westerl., Synopsis, p. 98.

With the appearance of *P. avenacea*, it agrees more with *P. megacheilos* in structure of the plicæ (*Pfr.*). The distribution given by Westerlund does not appear plausible.

6. CHONDRINA CIRCUMPLICATA ('Mouss.' West.). Pl. 4, figs. 12, 13.

Shell shortly conic-turrited, dark purple to chocolate-brown, nearly smooth; whorls 8-9, convex, the last divided above the middle by a spiral furrow. Aperture with 7 or 8 lamellæ and plicæ: 2 parietal lamellæ, the angular lamella very long; 2 columellar lamellæ, the upper one prolonged to the margin; 3 or 4 palatal plicæ, the margin moreover closely set with small white folds. Length 6½, diam. 2½ mm. (*West.*).

Italy: Val Membrano above Bergamo, Lombardy.

Pupa circumplicata Mss., WESTERLUND, Malak. Bl., xxii, 1875, p. 131; Fauna Europaea, 1878, p. 168; Fauna, iii, 1887, p. 99. — PFR., Monogr., viii, p. 385. — *Modicella c.*, WEST., Synopsis, 1897, p. 98. — *Pupa multidentata* STROBEL, Essai d'une Distrib., 1857, not *J. multidentata* Risso, 1826.

The lamellæ and plicæ are all stronger and longer than in *avenacea*. The spiral lamella is either continuous with the angular or separated from it. There is a deeply immersed suprapalatal plica. The columellar lamella sometimes emerges weakly to the lip, sometimes not, but there is a slender lamella in the angle of columella and parietal wall. The specimens figured are from the Marchesa Paulucci.

7. CHONDRINA BERGOMENSIS ('Charp.' Küster). Pl. 4, fig. 10.

Shell short, deeply rimate, ovate-conic, lusterless, translucent, closely, obliquely rib-striate, pale corneous-yellow, the spire rather long, turrited, obtuse at apex; 7–7½ whorls are weakly convex, with simple, strongly impressed suture, the last somewhat ascending in front, slightly compressed below; the neck ribbed, impressed above the middle anteriorly. Aperture large, nearly ovate, 7-folded, 3 folds stand in the palate, 2 on the parietal wall, and 2 on the columella. The palatal folds are long and show outside as white lines; peristome expanded, scarcely thickened, whitish, the margins strongly converging, joined by a thin, glossy callous. Length 2½–2¾, diam. ¾ lines (*Kuester*).

Italy: around Bergamo, especially in the villages Valbona,

Rosciano and Ponteranica, on walls and limestone cliffs (Charpentier); Bergamasker Alps as far as Lake Garda (Kobelt).

Pupa bergomensis Charpentier MS., KUESTER, Conchyl. Cab., p. 114, pl. 15, f. 14-16.—PFR., Monogr., iii, 548.—WESTERLUND, Fauna, 1887, p. 99. — KOBELT, Iconogr. n. F., ix, 1902, p. 70, f. 1696.

It is distinguished from all its relatives (*megacheilos, avena* and *secale*) by its more slender shape, grayish horn-color, smaller size, and entire lack of gloss; but chiefly also by the rib-striæ, and by the very regularly and gradually increasing whorls (*Charp.* in Kuester).

The angular lamella is usually separated from the spiral, but sometimes they are weakly connected. There is no supra-palatal plica. The upper palatal reaches the peristome, the lower scarcely, and the basal is decidedly shorter. The base is rounded, though the last whorl is distinctly compressed laterally. Lip is thin and somewhat expanded throughout. Striation is *fine, close and regular.* Length 6, diam. to edge of lip 2.4 mm.

Var. *lepida* West. Shell longer, the last whorl wider and higher, the outer margin of aperture more strongly angular above, columellar margin strongly converging at the insertion; length 6½, diam. 2½ mm. Lago di Garda. (Westerlund, Fauna Europaea, etc., 1878, p. 173.)

8. CHONDRINA SPELTA (Beck). Vol. 24, pl. 48, figs. 6, 9.

Shell more conic than the typical form [of *avenacea*], umbilical crevice larger, whorls more convex, the suture therefore deeper, the last whorl almost globular; neck not compressed at base; lower columellar fold usually rather degenerate; always two folds in the palate; aperture somewhat more rounded; length 2, diam. 1 line, 7 whorls; in all other characters like the type. Dalmatia (*Rossm., P. avena* var. *minor*).

Shell with a narrow but penetrating umbilicus, ovate-conic, obtuse, from reddish-brown to brownish purple-red, frequently one of the whorls pale red, from the light-colored body showing through. The surface is closely rib-striate, almost luster-

less, the walls rather thick and scarcely translucent. The spire, which terminates in an obtuse apex, consists of 7 rather convex whorls separated by an impressed suture, and becoming rather high below. The last whorl is the broadest, narrowed below without a carina. Aperture almost round, reddish-yellow, rather large, with 6 rather strong teeth, of which 2 are in the palate, 2 on the parietal wall and 2 on the columella. The peristome is only slightly thickened, somewhat reflected towards the umbilicus only, the insertions approaching somewhat, the outer one joined with the upper fold of the parietal wall. Length 2½, diam. 1½ lines (*Kuester, P. mühlfeldtii*).

Dalmatia: Almissa, Ragusa, and on the islands Lesina, Brazza and Bua, on rocks and under stones (Küster). Servia (Möllendorff). Montenegro at Cettinje (Margier).

Pupa avena var. *minor* Menke, (syn.: *Torquilla hordeum*), Rossmaessler, Iconogr. 1, pt. v, vi, 1837, p. 13; *Pupa hordeum* on pl. 23, fig. 320.—*Torquilla spelta* Beck, Index Moll., 1837, p. 86 (based upon Rossmaessler's fig. 320). — *Pup[a] nana* Potiez et Michaud, Galerie des Moll., Mus. de Douai, i, 1838, p. 169, pl. 17, f. 3, 4 (La Dalmatie).—*Pupa mühlfeldtii* Kuester, Conchyl. Cab., p. 28, pl. 4, f. 1-3, with var. *major*, p. 29, f. 4, 5, and var. *minor* (*Pupa obscura* Mühlf. coll.), p. 29, f. 6, 7; Bericht nat. Ges. Bamberg, ix, 1870, p. 97.—Pfr., Monogr., ii, 332.—Westerlund, Fauna, iii, 1887, p. 104.—Caziot, Bull. Soc. Zool. France, vol. 35, 1910, p. 149. — Margier, Feuille Jeunes Nat., vol. 40, 1910, p. 95.—*Pupa quinqueplicata* Mühlfeldt MS., Anton, Verzeichniss Conch., 1839, p. 47, no. 1713 (nude name; not *P. quinqueplicata* P. & M., 1838). — *Alloglossa mühlfeldti* K., Moellendorff, Malak. Bl., xxi, 1873, p. 134 (Servia).

A markedly conic, chestnut-brown shell, of stouter figure than shells of the *philippii* group, and differing from *avenacea* and its immediate allies by the more conic shape and by having only two palatal folds, by the shorter angular lamella, etc. It is a rather isolated species.

Nomenclature.—This species, usually known as *Pupa mühlfeldti* or *mühlfeldi* K., has not been correctly designated dur-

ing the last 80 years. *Pupa avena* var. *maior* and var. *minor* Menke, Synops. Meth., 1828, p. 18, were not defined or localized, and in using var. *minor* for the present form, Rossmaessler admitted that he was in the wrong, as there is no evidence that Menke ever saw the Rossmaesslerian form, and apparently intended merely to designate small examples of *avenacea*. *T. hordeum* Studer, mentioned in this connection, is an undetermined Swiss species, certainly not the Dalmatian form. After Rossmaessler, Beck was the first to name the shell, his *Torquilla spelta* being based upon Rossmaessler's figures, one of which is copied in our pl. 48, fig. 6. This anticipated the subsequent names *nana*, *mühlfeldtii*, *obscura* and *quinqueplicata*.

The typical form of *spelta* is small, length 2 lines according to Rossmaessler's text, 5 mm. in the natural-size figure on his plate. There are but two palatal and no basal plicæ, and the angular lamella is distinct but not long, entering but little beyond the anterior end of the parietal lamella. This form is also represented by pl. 48, fig. 9, length 5, diam. 2.5 mm., 7⅓ whorls. Another of the same lot is 5.4 mm. long.

Küster (1870) notes that this species "is found almost everywhere in middle Dalmatia, from the interior (Verlika) to close to the coast, on cliffs, common in places, as on the fine cliffs near Almissa; also on the islands, where I obtained it on Lissa and Lesina. It appears to remain active also in summer.

"Two forms of this species occur, sometimes in the same places, sometimes segregated, the one double the size of the other, 6–6½ mm. high, 3 mm. wide; the smaller one only 4 mm. high, 2 broad. The larger form is usually darker—even deep cherry-brown, with 6 to 8 folds in the aperture, there being a little plica above the two normal palatal plicæ, and a fourth, rarely developed, in the base. The small form is brownish corneous-red, normal examples with 6 folds, 2 in the palate, 2 on the columella and 2 on the parietal wall are often present; but not rarely one disappears from each of the last two pairs, or only the lower columellar fold is lacking.

"At Ragusa I found both forms, but not together; on Lesina an intermediate form; the largest are at Spalato; fur-

ther inland there is only the small form at Makarska. On Lissa, rather large, yet not reaching the size of the Spalato shells."

These notes give the proper perspective for viewing the named varieties; Küster's large form being *ventilatoris*, his small one typical *spelta* and var. *obscura*.

Var. *ventilatoris* ('Parr.' West.). Vol. 24, pl. 48, fig. 11. Larger, more openly umbilicate, irregularly rib-striate, from dark chestnut-brown to deep cherry-brown; sometimes having a third palatal fold at the base, and a fourth little one above near the suture. Length 6⅔–7, diam. hardly 3 mm. (*West.*).

Dalmatia: Spalato.

Pupa ventilatoris Parreyss, Martens, Die Heliceen, 1860, p. 288 (name only).—Westerlund, Malak. Bl., xxii, 1875, p. 131 (description).—Pfr., Monogr., viii, p. 264.—Caziot, Bull. Soc. Zool. France, vol. 35, 1910, p. 151.—*Pupa mühlfeldi* [*sic*] var. *ventilatoris* Parr., Westerlund, Fauna, iii, 1887, p. 104.—*Pupa mühlfeldtii* var. *major* Kuester, Conchyl. Cab., p. 29, pl. 4, f. 5, *teste* West., Nachrbl., vii, 1875, p. 73.

Kuester recognized this race, but used a preoccupied name. His description follows:

Var. *major* Küster. Vol. 24, pl. 48, fig. 11. Shell in general like the typical form, but the color is generally darker, the whorls flattened in the middle, aperture with 6 or 7 folds, the seventh standing basally on the palate, where the peristome curves into the columella. Length 3, diam. 1¾ lines. Under stones near Spalato, Dalmatia, above Salona towards the fortress Clissa, in company with *Clausilia crenulata*, not uncommon (*K.*).

Var. *obscura* Mühlf., Küst. Vol. 24, pl. 48, fig. 4. Shell rather thin-walled, long-conic, the whorls flatly convex, with the suture but little impressed, aperture 6-plicate, the outer [angular] fold of the parietal wall sometimes almost imperceptible. Length scarcely 2 lines, diam. 1 line. Within the Spalatine district, on cliffs (*K.*). This is var. *minor* Küster.

The figures of this and the preceding variety are from Küster. A specimen having the angular lamella extremely low, but with convex whorls, is drawn in vol. 24, pl. 48, fig.

10; length 4.7, diam. 2.5 mm., 6½ whorls. Another of the same lot is 5.3 mm. long, with 7 whorls.

Series of C. bigorriensis.

The forms of this eminently Pyrenean and Spanish series have often been referred to *C. megacheilos* of northern Italy, on account of their strong teeth and lip; yet the relationship appears to be an indirect one, through a common ancestry in the *avenacea* stock. The series, while natural enough, is here segregated from the *avenacea* series rather as a matter of convenience in treating the numerous forms than because of any important structural features. However, the lip is usually thickened within.

The various varieties of *P. megacheilos* described by Des Moulins and Moquin-Tandon belong to the present group of species and races. *P. megacheilos* var. *rufula* Moq., Moll. Fr., p. 354, with the "shell reddish, more or less pale, Saint Sauveur," has not been recognized by subsequent authors, though doubtless known under some other name.

They may naturally be considered under these geographic groups:

a. Species of the Pyrenees, Catalonia and adjacent provinces of Spain, no. 9 to 20.
b. Species of central Spain, no. 21.
c. Species of northern Spain, no. 22, 23.
d. Species of Portugal, Cadiz and Morocco, no. 24 to 26.
e. Species of Algeria, no. 27, 28.

The group (*a*) of the Pyrenees and Catalonia is intricate, containing many forms which have not been figured or described in comparative terms, and which are scarcely known outside of the collections of their describers. A table giving some of the main characters is given as an aid to identification of species. The Algerian species also are known by the original account only. The few forms recorded up to this time from northern and western Spain, Portugal and Morocco are better understood.

Species	Teeth			Whorls	Length	Diam.	Sculpture	Locality
	Par.	Col.	Pal.					
bigorriensis. .	2	2	3 or 4	7½–8½	7–9	2.4–2.8	finely rib-striate. . .	Central Pyrenees.
moquiniana. .	2	2	5	7–8	7–8	2.5	finely rib-striate. . .	Basses-Pyrénées.
tenuimarginata	2	2	4	7–8	8–9	3	finely rib-striate. . .	Pyrénées-Orientales.
elongatissima .	2	2	4	9–10	12–13	3½–4		
goniostoma . .	2	2	4	7–8	8	3	very finely rib-striate.	Eastern Pyrenees.
aucta.	2	2	6					
juliensis . . .	3	2	4	. . .	. . .	. . . .	. . . . .	Andorra.
angulata . . .	2	2	5 or 6	12	11	2	densely striate. . . .	Spain.
arigonis. . . .	2	2	2	7–8	6½–8	3½	substriate.	Valencia.
baregiensis . .	2	1	4	8	9	3	coarse striae	Hautes-Pyrénées.
centralis . . .	2	2	2	7	7	3	spaced riblets	Hautes-Pyrénées.
dertosensis . .	2	2	2 or 3	7–8	6	2	striatulate	Catalonia.
crassata. . . .	2	2	4	9	10	2.5	nearly smooth. . . .	Spain.
schista	2	2	4	7–8	5–6½	2–2½	nearly smooth. . . .	Pyrenees.
hospitii. . . .	2	2	3 or 4	8	7–8	2	striate	Venasque, Spain.
gratiosa . . .	2	2	4	7	4	. . . .	delicately rib-striate .	Central Spain.
vasconica. . .	2	1	3	8	6	2	finely rib-striate . .	Orduna, N. Spain.
kobelti	2	1	4	7	5½	2	irregularly striate . .	Oviedo, N. Spain.
ordunensis . .	2	2	3 or 4	6½	5–5½	2.1	fine striae.	Orduna, N. Spain.

(*a. Species of the Pyrenees, Catalonia and Aragon, to Valencia.*)

9. CHONDRINA BIGORRIENSIS ('Charp.' Des M.). Pl. 2, figs. 1, 2, 3, 7.

The shell is fusiform-conic, perforate and rimate, hessian-brown, fading to cinnamon-brown at the summit; but slightly glossy; finely and regularly rib-striate (but varying in degree and distinctness). Whorls moderately convex, the last a little flattened over the palatal region, which is marked with three white lines; the base compressed into a rounded keel; whitish-rufous towards the lip. Aperture oblong, cinnamon within, having 8 teeth: angular lamella long, continuous with the spiral; parietal long and low; columellar larger and longer than the subcolumellar; 3 equal, rather long palatals, and a very minute or subobsolete and inconspicuous suprapalatal. Peristome white, but slightly expanded, a rather thick cinnamon callous within the throat, but not thickened at the edge.

Length 9.2, diam. incl. perist. 2.8 mm.; 8½ whorls.

Length 7, diam. incl. perist. 2.4 mm.; 7½ whorls.

Central Pyrenees: type loc. Bagnères de Bigorre (Hautes-Pyrénées).

[*Pupa megacheilos*] var. *d, pusilla* (*Pupa bigorriensis* Charp.), DES MOULINS, Actes Soc. Linn. de Bordeaux, vii, 1835, p. 163, pl. 2, f. D1, D2. — ? *P. farinesii* var. *bigoriensis* Charp. subvar. *ventricosa* DUPUY, Bull. Soc. d'Hist. Nat. Toulouse, xiii, 1879, p. 55 (La Preste; no description). — *Pupa bigorriensis* GOURDON, Moll. Mts. de Luchon et de la Barousse, Bull. Soc. d'Hist. Nat. Toulouse, xv, 1881, p. 92 (dist. in Hautes-Pyrénées and Haute-Garonne). — FAGOT, same Bull., xvi, 1882, p. 73 (Pic du Gar).—*Pupa megacheilos* var. *gracilis* ROSSM., Iconogr., ii, pt. 11, 1842, p. 10, pl. 53, f. 729 (Montpellier and Barrége).

Mr. Ancey has reported (as *Pupa bigorriensis* Charp. var. *sinistrorsa*) finding a single sinistral specimen among normal specimens from Cazaril, Bigorre (Le Naturaliste, i, 1881, p. 403).

Des Moulins' original description follows:

Var. *d.* (*pusilla*). It is this shell which received from M. de Charpentier the name of *Pupa bigorriensis*. It is smaller than the preceding variety [*tenuimarginata*]; its peristome is less widened; and the aperture, of which the basal angle is almost effaced, is less lengthened. The effacement of this inferior angle loses all really characteristic importance by its inosculation with the type [that is, the typical *megacheilos*, in which the aperture is somewhat angular at the base] equally in the four varieties. It only forms an individual variation which dominates the type at Bagnères de Bigorre, whilst it is the type which dominates at la Preste (Pyr.-Oriental.). Length 7-8, diam. 2¾ mm. Central Pyrenees.

Des Moulins' figure, copied in pl. 2, fig. 3, shows a fourth fold in the base. The specimens from Bigorre (received from Locard, and from other sources), do not show this fold.

Perhaps the name *pusilla* should be used for this species, since it was that adopted by Des Moulins; yet as *pusilla* and *bigorriensis* were published simultaneously (as above), it may not be necessary to reject the selection of the second by nearly all subsequent authors. Rossmaessler states that he received *pusilla* from the Pyrenees from Parreyss in 1845 under the name *P. consobrina* (Iconogr., iii, 1859, p. 108).

Pupa moquiniana is ranked as a variety of *bigorriensis* by Westerlund. There does not seem to be much difference.

Var. *moquiniana* Küster. Pl. 2, figs. 8, 9. The shell is elongate, rather obtuse, conic-cylindric, rimate, finely rib-striate, the striæ rather oblique, having a silky luster, dark reddish-brown, the apex rust-yellowish. The 7-8 whorls are flatly convex, contracted towards the base, joined by a simple, slightly impressed suture, and increasing in height very gradually. Neck flat, compressed at the base, rounded, sometimes quite keel-like, whitish; also the rest of the neck is light flesh-colored, with 4 unequal whitish streaks from the folds showing through. Aperture wide, rust-reddish, vertical, higher than wide, with 9 unequal folds in the contracted throat: two on the parietal wall, the inner one far within, small; 2 on the columella, the upper one much larger, sometimes emerging far; 5 in the palate, the upper one small, far within, like the rest in this place, elevated tooth-like; the 2d, 3d, and often

the 4th emerging to the peristome, the 5th small, obtuse, almost always in the obtuse angle formed by columella and lip, often even standing on the columella, frequently turned towards the right. Peristome sharp, broadly expanded, white-lipped; columella nearly straight; terminations approaching. Length 3½–4, diam. 1¼ lines (*Kuester*).

France: Mt. Beudar near Pau (Basses-Pyrénées).

Pupa moquiniana KUESTER, Conchyl. Cab., *Pupa*, p. 52, pl. 7, f. 4, 5.—PFR., Monogr., ii, 347.

10. CHONDRINA TENUIMARGINATA (Des Moulins). Pl. 2, figs. 4, 5.

"Very brown; less solid and less lengthened than the preceding [*elongatissima*], smaller and more striate than var. *a* [Italian *megacheilos*], with the same variations as to the inferior angle of the aperture, but having the margin of the peristome thinner, sharper, and reflected less flatly; 7-8 whorls. Length 8-9, diam. 3 mm. Pyrénées-Orientales. It was this which M. Michaud had intended to publish under the name *P. farinesi*, and M. Farines under that of *P. pyrenaica*. It offers a subvariety of a very light corneous color, transparent, fragile, very much striate, from Barcelona (*Des Moulins*).

Pyrénées-Orientales: la Preste (Farines, Fagot); also reported from Luchon (Haute-Garonne) by Moquin-Tandon.

Pupa frumentum BOUBÉE, Bull. Hist. Nat. France, 3e. sect., moll. et zooph., 1833, pp. 10, 11; edit. of 1834, p. 30; not of Drap.—*Pupa megacheilos* var. *c* (*tenuimarginata*) DES MOULINS, Actes Soc. Linn. Bord., vii, 1835, p. 163, pl. 2, f. c1-4.—*Pupa farinesi* Mich. MS., and *P. pyrenaica* Farines MS., acc. to Des Moulins, in synonymy of *tenuimarginata*, 1835.—*Pupa badia* MOQUIN-TANDON, as synonym of *tenuimarginata*, Hist. Moll. France, ii, 1855, p. 354.—*Pupa leptocheilos* FAGOT, Bull. Soc. d'Hist. Nat. Toulouse, 1879, p. 241. — *Pupa leptochila* Fagot, LOCARD, Ann. Soc. Agric. Lyon (7), iii, 1896, p. 188.

The arrangement of teeth is practically the same as in *bigorriensis*, but it is a less cylindric, lighter colored shell, with the aperture more angular below, at least typically. There is sometimes a small sutural fold. The angular lamella is con-

tinuous with the spiral. Des Moulins' figure is copied in pl. 2, fig. 5. The name was altered by Fagot on the ground that "*sesquipedalia verba excludenda sunt*" as specific names—a salutary but obsolete Linnean regulation.

Var. *elongatissima* (Des Moulins). Pl. 2, fig. 6. Remarkable for its elongation, the fusiform appearance, the narrowness of the umbilicus (consequent upon the elongation), and by the smallness of the whorls of the point, characters which make it resemble a Clausilia. The shell, more transparent than that of Italy [*megacheilos*], is more solid than in the following varieties [*tenuimarginata*, *bigorriensis*]. The peristome thickened and reflected almost as flatly as in that of Italy, presents the same variations as to the inferior angle of the aperture. The size of aperture is equal to that of var. *a* [*megacheilos*], which results in a different proportion which is very characteristic of the variety; 9-10 whorls. Length 12-13 mm., diam. 3½–4 mm. Pyrenees. The celebrated entomologist and lichenologist M. Léon Dufour gave four specimens to M. de Grateloup, but the precise locality is unknown to me (*Pupa megacheilos* var. *b* (*elongatissima*), Des Moulins, Actes Soc. Linn. Bord., vii, 1835, p. 162, pl. 2, f. B1, B2).

Moquin-Tandon has recorded this variety from back of Gavarnie on the Spanish side of the boundary; perhaps he intended the following form.

11. CHONDRINA GIGANTEA ('Moq.' Rossm.). Pl. 3, figs. 7, 8.

Its color is light corneous-brown; while very finely striate, it is much more decidedly so than *P. megacheilos* Jan. The umbilical orifice, narrow but very distinctly developed in *megacheilos*, is only weakly indicated; the back of the neck is less strongly compressed, and the aperture therefore less angular below. It is especially remarkable that the two middle palatal folds become weaker inwards, as usual, while in *megacheilos* they always begin there with a tubercle. The lip of the less expanded peristome is weaker and not so broad and flat as in the other species (*Rossm.*).

Cirque de Gavarnie, on the Spanish border, beyond the Pont de Neige (*Partiot*).

Pupa badia var. *gigantea* Moquin-Tandon MS., Rossmaesler, Iconogr., iii, 1859, p. 106, pl. 85, f. 937 (as var. ? of *megacheilos*).

12. Chondrina goniostoma (Küster). Pl. 2, figs. 13, 14.

Shell somewhat cylindric-conic, rather thin, translucent, narrowly but deeply umbilicate, very finely rib-striate, glossy, especially on the penult whorl, reddish corneous-brown, the summit yellowish; the spire is rather drawn out, the 7-8 whorls flatly convex, appearing separated by a deep suture, slowly increasing; neck flat, yellowish behind the lip, with three whitish lines; base compressed, sharpened keel-like. Aperture rather broad, rounded-triangular, with a sharp angle below at the passage of the lip into the columella; at the base of the latter there is sometimes a tooth-like projection. Four plicæ in the palate, the first small, the second very large, emerging to the peristome and forming a blunt tubercle there; columellar lip ascending in a curve, much shorter than the peristome. Length 4, breadth 1½ lines (*Kuester*).

France: in the eastern Pyrenees (Küster).

Pupa goniostoma Kuester, Conchyl. Cab., p. 53, pl. 7, f. 1-3. —Pfr., Monogr., ii, 345; iii, 547; iv, 673; vi, 314.—Bourguignat, Moll. de San-Julia de Loria, 1863, p. 22; Malac. de l'Algerie, ii, 85, pl. 5, f. 35-38.

A species more closely related to *P. megacheilos* than the preceding [*P. moquiniana*], but readily distinguished by the peculiar shape of the aperture as well as by the lack of a white lip. The finer striation, stronger gloss, smaller number of folds and more purely conic form separate *goniostoma* from *moquiniana*, in which there is also a tendency towards the formation of an apertural angle. From *cereana* the present species is distinguished by the greater size and especially by the union of the second palatal fold with the peristome; from *avena* by the greater number of palatal folds (*Kuester*).

This appears to be a variety of *tenuimarginata* Des Moulins.

Form *aucta* West. With 6 palatal folds, the first very short, sutural, 2d short, 3d to 5th marginal, 6th below, near the columella (Fauna Pal. Reg. Binnenconch., iii, 1887, p. 96).

Var. *juliensis* Bgt. Pl. 2, figs. 15, 16. Shell resembling the type, but having two folds (instead of one) at the insertion of the right margin. San Julia de Loria, Andorra. The typical form is quite rare, but the var. *juliensis* is much more abundant (*Pupa goniostoma* var. *juliensis* Bourguignat, Moll. de San-Julia de Loria, 1863, p. 24).

13. Chondrina angulata (Fagot).

Shell perforate-rimate, conic-tapering, the spire fusiform, densely, subregularly striate, corneous-buff; whorls 12, the upper convex, lower flattened, the last with a strong white crest at base. Aperture oblique, oval-compressed, angular below; 2 parietal, 2 columellar and 5 or 6 palatal folds, the angular long, 3d palatal emerging, 4th and 5th punctiform; outer margin strongly thickened, the columella porcellanous. Length 11, diam. 2 mm. (*Westerlund*).

Spain.

Pupa angulata Fagot, in Crónica Cientifica, 1888, not seen. —*Modicella angulata* Fag., Westerlund, Synopsis, p. 95.

Appears to differ from others of the group by the large number of whorls.

14. Chondrina arigonis (Rossm.). Pl. 2, figs. 10, 11, 12, 17, 18.

Shell perforate-rimate, ovate-turrited, the spire acutely tapering; violaceous-brown, substriate; whorls 7-8, convex, the last finally ascending, the neck a little swollen, the base rotundly compressed a little, buff, having two short white lines; suture deeply impressed. Aperture rounded semi-ovate, 6-folded: two folds on the parietal wall, one oblique, at the insertion of the lip, the other elevated, immersed; two on the columella; two rather deeply placed plicæ of medium size in the somewhat calloused palate; peristome somewhat spreading, with a very fully developed white or brownish lip. Length 6½–8, diam. 3½ mm. (*Rossm.*).

Spain: Pego, Prov. Valencia (José Arigo).

Pupa arigonis Rossmaessler, Iconogr., iii, p. 105, pl. 85, f. 936.—Pfr., Monogr., vi, 316. — *Pupa arigoi* Rssm., Westerlund, Fauna, iii, p. 101.

By the form and the much developed lip it groups with the smaller forms of *megacheilos*, but differs by the base of the neck not compressed, and by having *only 2 palatal plicæ*, as well as by the upper anterior fold [angular lamella] which never penetrates inward to the inner end of the parietal lamella, but always terminates at its forward end (*Rossm.*).

The outer lip expands very little or not at all, but the whole peristome is widened by the conspicuous thickening of the inner edge. There is also a wide buff band behind the lip. Typically the teeth are strongly developed, but in one lot labeled Catalonia they are much reduced, low and weak, length 7.9, diam. 2.9 mm., 8 whorls. However, this lot is perhaps not really referable to *arigonis*.

In another set from the type locality, the shell is more conic, and there are very minute, deeply immersed suprapalatal and basal plicæ (figs. 17, 18, length 6, diam. 2.7 mm.). The surface, in all specimens seen, is nearly smooth or has very low, coarse wrinkles.

Other described forms of the series follow; none of them have been figured, and their relations with the better known species remain to be indicated.

15. CHONDRINA BAREGIENSIS ('Bgt.' Loc.). — Cylindric, a little ventricose, 8 slightly convex whorls, the suture well marked; aperture subtriangular, a little contracted, angular at the base; 2 small superior folds, the lower well immersed; 1 columellar at the superior angle; 4 narrow palatals, the upper obsolete, not reaching to the peristome; peristome thin, very little reflected, sharp; shell a little shining, dark red, ornamented with coarse striæ. Length 9, diam. 3 mm. Environs of Barèges (Hautes-Pyrénées). (*Pupa baregiensis* Bourguignat in coll., Locard, Ann. Soc. d'Agric. Lyon. (7), iii, 1896, p. 187.)

It appears to be distinguished by the single columellar lamella.

16. CHONDRINA CENTRALIS (Fagot). Quite small, conic, short and squat, rapidly tapering; 7 convex whorls with impressed suture. Aperture rounded basally, with parallel margins; 2 superior folds, one moderate, the other small; 2 columellars, the lower one more slender; 2 palatals, the lower obsolescent, not reaching the peristome. Peristome acute,

little reflected. Shell wine-brown, ornamented with quite spaced lamellar striæ. Length 7, diam. 3 mm. Plateau de Lourdes, vallée du Gave d'Osson (Hautes-Pyrénées). (*Pupa centralis*, Fagot, Hist. malacol. des Pyrénées Francaises et Espagnoles, Bull. Soc. Ramond, 1891, xxvi, not seen; desc. from Locard, Ann. Soc. d'Agric. Lyon, (7), iii, 1896, p. 188.)

17. CHONDRINA DERTOSENSIS (Bofill). Shell perforate-subrimate, ovate-subconoid, obtusely tapering at the apex, corneous-reddish, a little glossy, obliquely striatulate; 7-8 convex whorls, regularly increasing, separated by an impressed suture, smooth at the apex; the last whorl a little swollen, a little compressed at the rimation, slightly ascending to the aperture. Aperture subvertical, semiovate-rounded, plicate as follows: An angular fold at the insertion, another rather prominent, immersed parietal in the middle; 2 on the columellar lip, the lower one smaller; 2 or 3 palatals (in adults), the upper one stronger, reaching the lip, the others shorter, a little immersed; peristome unexpanded, acute, with a tawny lip within, the margins strongly approaching, the outer curved above, columellar slightly reflected. Length 6, diam. 2, aperture 2 x 1⅓ mm. (*Pupa dertosensis* Bofill, Bull. Soc. Malac. France, iii, 1886, p. 162).

Spain: rocks at the peak of the Serra de Cardo, Tortosa Catalonia).

This form has been placed by Westerlund in the *avenacea* group, by Caziot in the *farinesii* group near *pulchella*.

18. CHONDRINA CRASSATA ('Bofill', Fagot). Shell nearly covered rimate, almost cylindrical, rather rapidly tapering at the summit, corneous-violaceous or rufescent, nearly smooth. Whorls 9, rapidly regular, the last compressed basally, broadly crested, descending at the aperture. Aperture produced to the left, ovate, with 2 parietal, 2 columellar and 4 palatal folds. Columellar lamellæ nearly equal; first palatal punctiform, the rest subequal, not emerging; peristome expanded throughout, strongly thickened, porcellanous, the columellar margin oblique, straight, outer margin arcuate. Length 10, diam. 2½ mm. Spain. (*Pupa crassata* Bofill, in Fagot, Crónica Cientifica, 1888, not seen; desc. from Westerlund, Synopsis, 1897, p. 96.)

19. CHONDRINA SCHISTA (West.). Shell deeply perforate, cylindric-conic, cherry-brown, rarely reddish-corneous, smooth (sometimes, under strong magnification, very irregularly stri-

ate), with oblique apex. Whorls 7-8, somewhat convex, the upper very rapidly increasing, the two before the last nearly equal, the last anteriorly obtusely angular above; flattened in the middle, strongly blunt-keeled at the base. Aperture oval, with 2 parietal lamellæ (the angular lamella long, interrupted deep within); 2 columellar lamellæ, strong and horizontal; 4 palatal plicæ (the first very short, deep within, the rest very long, interrupted, the second nearly reaching the margin. Peristome narrowly expanded, brownish yellow; margins separated, the outer lip more arcuate above. Length 5–6½, diam. 2–2½ mm. Pyrenees. (*Pupa schista* Westerlund, Fauna Pal. Reg. Binnenconch., iii, 1887, p. 112.)

20. Chondrina hospitii (Fagot). Shell cylindric-conic, corneous-buff, a little rufous, not glossy, striate; whorls 8, convex, regular, the last a little larger, swollen in the middle, compressed below, much ascending. Aperture lunate-oval, large, with 2 parietal, 2 columellar and 3 or 4 palatal folds. Angular lamella thin, entering; parietal deep; columellar strong, immersed; 2 upper palatals subequal, the first somewhat immersed; sometimes with a punctiform fourth palatal fold. Peristome expanded throughout, white, thickened, the external margin much incurved, columella arcuate. Length 7-8, diam. 2 mm. Spain: Venasque. (*Pupa hospitii* Fagot, Crónica Cientifica, 1888, not seen; desc. from Westerlund, Synopsis, 1897, p. 95.)

Pupa ortigosana Fagot, of Ortigos (Logrona) is an unpublished species mentioned by Caziot, Ann. Soc. Linn. de Lyon, liii, 1907, p. 196, who placed it between *hospitii* Fag. and *lusitanica* Rm.

(*b. Species of Central Spain.*)

21. Chondrina gratiosa (West.).

Shell rimate, oblong-turrited, cylindric, brown, delicately rib-striate; whorls 7, convex. Aperture oblong-ovate, with 1 parietal, 2 columellar, 4 palatal folds (no angular; parietal deeply placed, high, compressed and short; columellars small, immersed, white; 1st to 3d palatals remote, outwardly thick, inwardly tapering, long and slender, the 4th basal, smallest, punctiform, more deeply immersed). Peristome unexpanded, thin, the margins distant, very lightly curved, the outer shortly arcuate above. Length 4 mm. (*West.*).

Central Spain, in drift of the Jarama river (S. Calderon).

P.[upa] (Modicella) gratiosa WESTERLUND, Ann. Mus. Zool. Acad. Imp. Sci. St. Pétersb., iii, 1898, p. 167.

It seems to be near *P. sardoa* Cantr. (*West.*).

(*c. Species of Northern Spain.*)

Besides the following forms, *C. gorbeana*, no. 40, belongs to this district.

22. CHONDRINA VASCONICA (Kobelt).

Shell fusiform-turrited, the spire slender, rather obtuse at the apex, rufescent-corneous, finely rib-striate; 8 convex whorls, separated by a deep suture, slowly increasing, the last a little longer than the penult, compressed at base, distinctly ascending in front, compressed behind the aperture, and lightly scarred over the lamellæ. Aperture small, truncate-ovate, with the peristome thickened, margins joined by a very thin callous, contracted by 6 lamellæ: two in the parietal wall, one larger, reaching the callous at the insertion of the outer margin, the other deep, entering, small; a third at the beginning of the basal margin; and three parallel folds in the outer margin, shining through to the outside, of which the lower is scarcely visible in the aperture. Length 6, diam. 2, alt. aperture scarcely 1.5 mm. (*Kobelt*).

Spain: Orduna, Biscaya (Kob.).

Pupa vasconica KOBELT, Jahrb. d. Malak. Ges., ix, 1882, p. 72.

23. CHONDRINA KOBELTI ('Hid.' Westerlund).

Shell oblong with rather conic spire, irregularly striate, chestnut-brown, whitish near the aperture. Whorls 7, very convex, the last rounded beneath, flattened anteriorly, slowly ascending above; suture impressed. Aperture triangular-oblong, with 6 or 7 teeth: 2 parietal lamellæ, the angular long, 1 columellar lamella, situated high, horizontal in front, not running forward, curving upward rapidly within; 4 palatal folds, the first very small, within, the other three nearly equal, separated, elevated within, very shortly entering. Peristome

simple, the margins separated; outer margin thin, arcuate above, then straightened; columellar margin nearly vertical, somewhat thickened, dilated; columella somewhat calloused. Length 5½, diam. 2 mm. (*West.*).

Spain: Oviedo, Asturias.

Pupa kobelti Hid., WESTERLUND, Fauna, Pal. Reg. Binnenconch., iii, 1887, p. 102. *Modicella kobelti* WEST., Synopsis, p. 95.

23*a*. *C. kobelti ordunensis* n. subsp. Pl. 3, figs. 2, 3, 4.

The shell is shortly rimate, cylindric-fusiform, rather solid, carob-brown, with an irregular cinnamon band behind the peristome and on the base; penult and last whorl flattened, tapering downwards, furrowed above the rounded, projecting base. Spire stout, convexly conic, not paler. Whorls convex. Sculpture of fine oblique striæ. The aperture is much longer than wide, subtriangular, being narrowed below, rounded basally, tawny within, armed with 7 (or 8) white lamellæ and plicæ: angular lamella low, rather long, extending a little beyond the outer end of the parietal, which is stronger; columellar lamella horizontal, strong, not emerging, curving upward deep within; the subcolumellar lamella obtuse, tuberculiform, tinted, not visible in a direct front view. Three subequal plicæ are evenly spaced, the upper palatal reaching to the peristome, the others shorter; they show as white or whitish streaks outside (and there is sometimes a minute, immersed, suprapalatal fold). The columellar lip is dilated, peristome otherwise unexpanded, with a thin, blunt edge; but it is rather strongly thickened a little distance within the palate.

Length 5.5, diam. 2.1 mm.; 6½ whorls (fig. 3).

Length 5, diam. 2.1 mm.

Spain: Peña de Orduña; type no. 22791 A. N. S. P.

This form differs from the unfigured *C. kobelti* West., from further west in northern Spain, by having a well-developed subcolumellar lamella, which, however, is immersed and scarcely visible in a front view. I have not seen *C. kobelti*.

(d. Species of Portugal, the Province of Cadiz, and Morocco.)

24. CHONDRINA LUSITANICA ('Rossm.' Pfr.). Pl. 3, figs. 5, 6.

The shell is subperforate-rimate, cylindric-conic, very obliquely, irregularly ribbed, brown; spire tapering, obtuse; whorls 8, convex, the last ascending at the end, the neck sharply costulate, buff; base somewhat compressed obliquely; with 4 white lines. Aperture suboval, liver-colored, 8-plicate: 2 rather long lamellæ, near together, on the parietal wall, one extending to the outer margin where it connects with the insertion, the other more immersed; 2 moderate folds on the columella; 4 in the palate, showing outside white through the tawny throat, the upper one remote and small, the second curved, reaching the margin, the third and fourth shorter and a little further in. Peristome spreading, somewhat thickened, the outer margin angularly curved above. Length 7, diam. 3 mm. (*Rossm.*).

Portugal: Serra d'Arzabida [Arrabida] (type loc.); many places in provinces Douro, Beira and Estremandura (Nobre).

Pupa lusitanica Rossm. *in litt.*, PFR., Monogr., ii, 1848, p. 347.—ROSSMAESSLER, Iconogr., iii, 1859, p. 105, pl. 85, f. 935.—LOCARD, Conchyl. Portugaise, Arch. Mus. d'Hist. Nat. Lyon, vii, 1899, p. 147. — *Pupa avenacea* var. *luzitanica* Rossm., NOBRE, Annaes Sci. da Acad. Polytech. do Porto, iii, 1908, p. 50, pl. 1, f. 3, 4.

This form is distinguished from *avenacea* chiefly by the strong rib-striation and the internally thickened lip, producing a light tawny area behind the lip. The teeth are strongly developed, the angular entering as far as the parietal, no division into angular and spiral lamellæ being evident. The minute denticle in the base is sometimes nearly obsolete, and the suprapalatal is minute.

Some authors have considered *lusitanica* a variety of *avenacea*, but it is surely quite distinct by the callous thickening in the throat and the strong sculpture. It belongs to a group of forms chiefly developed in the Pyrenees, and not to the immediate group of *avenacea*. Whether the true *avenacea* occurs in Portugal is highly doubtful; its western limit has

not been determined, and even reliable Spanish records are lacking. M. Morelet at one time cited *lusitanica* as *P. secale*, a species not found in Portugal. The best recent account of *lusitanica* is that of Nobre.

25. CHONDRINA CALPICA (West.). Pl. 3, figs. 10, 11.

Shell perforate, ovate-turrited, horn-yellow, often densely suffused with bluish, ribbed; 7½ whorls, the upper convex, the last depressed on the neck, somewhat compressed at the base, ascending above. Aperture oblong-semiovate, with 6 strong white, immersed lamellæ and plicæ: 1 parietal lamella, 2 columellar, the lower one very small; palatal folds 3, the upper very long; peristome thin, simple, acute; outer margin strongly arched above. Length 7, diam. 3 mm. (*West.*).

Gibraltar: along the way from the city to the fortress (J. Lindahl).

Pupa calpica WESTERLUND, Nachrbl. d. Mal. Ges., 1872, p. 27; Malak. Bl., xxii, 1874, p. 58, pl. 2, f. 6-8; Fauna, iii, 1887, p. 103.—PFR., Monogr., viii, 386.—KOBELT, Iconogr. n. F., ix, 1902, p. 70, f. 1694.

The angular lamella is rudimentary or obsolete. In fresh shells (Westerlund's had been preserved in spirits) the color is carob-brown or chocolate, fading more or less upward, but sometimes the whole tint is lighter, nearer walnut-brown. Sometimes there is a small suprapalatal plica, as in fig. 11. Length 6.5, diam. 2.8 mm. It is related to *tingitana*.

26. CHONDRINA TINGITANA (Kobelt). Pl. 3, fig. 9.

Shell rimate-perforate, fusiform-turrited, the spire slender; corneous; sculptured with oblique, rather widely spaced, arcuate ribs; 7 slowly increasing whorls, separated by a deep suture, the last nearly twice as long as the penult, the base compressed in an obtuse crest. Aperture ovate, somewhat oblique, with the margins of peristome converging, joined by a thin callous, subtuberculiferous near the insertion of the outer lip; contracted within by 6 lamellæ: one compressed parietal; two, the upper larger, in the basal [columellar] margin; 3 parallel in the outer margin. Alt. 7.5; a variety is smaller and more swollen (*Kobelt*).

Morocco: mountains of Beni Hosemar, opposite Tetuan, on limestone cliffs (*Kobelt*).

Pupa tingitana KOBELT, Jahrb. d. malak. Ges., ix, 1882, p. 71.

The specimen figured, labeled Tetuan, determined by Clessin, is not exactly typical of the species or the variety. The peristome is quite thin; angular lamella very low, irregular, composed of low tubercles weakly connected, and sometimes penetrating as far as the parietal lamella, but usually shorter or interrupted. Parietal lamella high. Upper and lower palatal plicæ are rather long, a minute suprapalatal above them. Length 7, diam. 2.9 mm.

Chondrina tingitana algesirae (Kob.). Differs from the preceding, which is close, by having the outer margin only armed with two lamellæ, and also the tubercle of the parietal callous far more distinct. Found by me in multitudes on a limestone ridge near Algeciras; seems constantly distinct from the preceding by the lack of the third lamella on the palate, yet is apparently only a local variety (*Kobelt*).

(*e. Species of Algeria.*)

27. CHONDRINA LETOURNEUXI (Bgt.). Pl. 3, figs. 14.

Shell rimate, obese-oblong, ventricose, rather solid, corneous, sharply and strongly costulate. Spire short, tapering, the apex obtuse, smooth. Whorls 8, slightly convex, slowly increasing, parted by a moderately impressed suture, the last whorl tapering, compressed-carinate at base, deeply furrowed in the middle, and strongly ascending at the insertion of the outer lip. Aperture semioval, 7-folded; a lamelliform fold at the outer lip, a stronger, more deeply placed parietal fold, two obliquely descending, emerging columellar folds, of which the lower is stronger, and three lamelliform, emerging palatal plicæ, of which the upper is very strong, converges towards the parietal fold, which it almost touches. Peristome thickened, white, expanded, the outer margin arcuately angular anteriorly; margins joined by a thick callous cut into seven little teeth, one in the upper angle between the outer lip and the large lamelliform fold, and six others between the large

fold and the columellar margin. Length 5½, diam. 2½ mm. (*Bgt.*).

Algeria: debris of the ravine of Chabet-Beinan, near Cape Caxine, 14 kilometers west of Algiers (Letourneux, Poupillier).

Pupa letourneuxi Bourguignat, Malacologie de l'Algérie, ii, 1864, p. 78, pl. 5, f. 19-22.

The exact relations of this species and the next are in doubt, as we do not know whether there is an internal palatal plica above the upper emerging one, and the presence of a spiral lamella is uncertain. Their presence in Algeria is rather anomalous, as they appear to be of Pyrenean type. I have elsewhere (p. 4) referred to the Algerian records for *C. goniostoma* and other Pyrenean species.

28. Chondrina lallemantiana (Bgt.). Pl. 3, fig. 13.

Shell rimate, acuminate-elongate, ventricose at base, solid, somewhat glossy, subpellucid, under the lens regularly and obsoletely subcostulate, pale corneous or whitish-ashen. Spire acuminate, the apex smooth, rather acute. Whorls 9, a little convex, slowly increasing, separated by an impressed suture, the last whorl tapering, compressed at the base (as though gibbous) and carinate (the keel acute, strong, nearly disappearing at the peristome), at the periphery thicker, whitish, and strongly ascending at the outer lip. Aperture semiovate, slightly contracted below, having 7 folds: a lamelliform fold at the outer lip; parietal fold minute, lamelliform; 2 strong columellar folds; and 3 emerging, lamelliform palatal plicæ, of which the upper is stronger. Peristome white-thickened, expanded, strongly reflected at base; outer margin arcuate anteriorly; the margins joined by a whitish callous ornamented with 7 or 8 very long little plications. Length 7, diam. 3 mm. (*Bgt.*).

Algeria: debris of the ravine Chabet-Beinan, near Cape Caxine, 14 kilometers west of Algiers (Letourneux, Poupillier).

Pupa lallemantiana Bourguignat, Malacologie de l'Algérie, ii, 1864, p. 80, pl. 5, f. 23-27.

Differs from *letourneuxi*, according to Bourguignat, by the conoid form, more glossy shell of a lighter tint, by the more separated, blunter, much less strong costulations, by the absense of a median furrow on the last whorl, as in *letourneuxi;* by the outer margin not angular and not projecting forward by the less projectng columellar folds, not obliquely entering; by the upper palatal plica not converging to the parietal fold, and by the plications of the parietal callous, which have a lamelliform, not a punctiform appearance as in *letourneuxi.*

Section Modicella Ads.

Series of C. farinesii.

These forms of the Pyrenees and southeastern Spain differ from *avenacea* by the weakness or loss of teeth; of palatal folds there are not more than two, often one or none. Parietal and columellar margins each bear two, one or no lamellæ. When present, the lamellæ and folds are small and short.

As is usual in series showing degeneration of the teeth, the individual lamellæ and plicæ become highly variable, and their value as specific characters is correspondingly diminished.

There has been no rational revision of the many local forms, races or species. The work can be done only by a naturalist able to get a practical knowledge of them in the field and by study of the types or topotypes.

As the data are not at hand for construction of a key, some of the more obvious characters have been tabulated below as an aid in determination. In the second column of the table, *a* indicates the presence of an angular lamella.

	Teeth			Whorls	Length	Diam.	Sculpture
	Par.	Col.	Pal.				
farinesii	0	0	0	7–7½	5–6.6	2–2.6	striate.
farinesii var.	a 0	0					
	a 1	0					
speluncae	0	0	0	9–10	8	3	fine crowded wrinkles.
tarraconensis	a 1	0					
	2 1	0		8	6	2	irregularly striatulate.
longini	2	1	0	7½	6	2	" undulately striatulate.
microdon	0	1	0	6½	4	1⅔	smooth.
boettgeriana	0	0	0	10–11	6.5	1.5	finely costulate.
jumillensis	a	2	0	8	8	3¾	wrinkle-striate.
ignota	a	2	0	8	7–8	3–3½	very finely striolate.
guiraonis	a	1	0	. .	. .	. .	wrinkle-striate.
saltus	a	1	1	9–10	7–8	2	hair-striate.
obliterata	2	1	2	8	7	2	distinctly, irregularly striate.
massotiana	2	1	1	8	6½	2¼	striate.
m. penchinatiana	2	1	2				
m. angustata	2	1	2	7	7	2¾	strongly striate.
m. confusa	2	2	0	. .	. .	. .	very finely, closely striate.
m. sexplicata	2	2	2				
aragonica	2	1	2	10	6–9	2–2½	irregularly hair striate.
domicella	2	2	3	8	7	2.5	ribbed.
pulchella	2	2	2	8	4.5	1.5	inconspicuous striae.
p. manotiana	2	2	2	7½	6	2	costulate-striate.
ilendensis	2	2	2	8	6	2	striatulate.
gorbeana	2	0	0	7½	7	2.8	fine, uneven striae.

29. CHONDRINA FARINESI (Des Moulins). Pl. 5, figs. 1, 2.

Shell cylindric-conic, more or less lengthened, striate, brown; whorls 6-7, a little convex, the suture deep. Aperture suboval, toothless; peristome whitish, simple, not reflected; umbilicus patulous virgulæform. Length 6–6½, diam. 2 mm. A variety is shortened, more conic, length 5, diam. 2 mm. (*Des M.*).

The shell is thin, chestnut-brown or carob-brown, finely and irregularly striate, the striation sometimes almost effaced, sometimes distinct. The whorls are strongly convex, the last somewhat compressed laterally, rounded basally. The peristome is thin, whitish, the columellar margin dilated, outer lip unexpanded, strongly arcuate above. Typically there is no trace of lamellæ or plicæ.

Length 6.6, diam. 2.6 mm.; 7½ whorls (La Preste).

Length 6, diam. 2.3 mm.; 7 whorls.

Length 5 mm.; 7 whorls (Perpignan).

Pyrenees of southern France and eastern Spain, generally distributed; type loc. La Preste (Pyrénées-Orientales), on limestone back of the thermal baths (J. N. Farines); northeastward to dép. Lozère.

Pupa farinesii Des Moulins, Actes Soc. Linn. Bordeaux, vii, 1835, p. 156, pl. 2, f. e1-3.—Pfr., Monogr., ii, p. 308.—Rossm., Iconogr., ii, pt. 10, p. 25, f. 639.—Kuester, Conchyl. Cab., p. 51, pl. 6, f. 21, 22.—Moquin-Tandon, Moll. Fr., ii, 1855, p. 359, pl. 26, f. 5-10, with var. *dentiens*, *l. c.*, f. 11.—Bourguignat, Mollusques de San-Julia de Loria, 1863, p. 15, pl. 2, f. 1-3, with var. *dentiens*, p. 17, pl. 2, f. 5, var. *obesa*, p. 17, pl. 2, f. 4, and var. *subcarinata*, p. 17, pl. 2, f. 6 (in Rev. et Mag. de Zool., xv, 1863, p. 58).—Caziot, Ann. Soc. Linn. Lyon, liii, 1907, p. 194 (distribution).—Margier, Feuille Jeunes Naturalistes, no. 516, 1913, p. 199 (distribution).—Probably not *P. farinesii* of Settepassi, Feuille J. Nat., no. 520, 1914, p. 75.

A well-differentiated species, by the lack or very small size of teeth, recalling the Sicilian *G. rupestris* and the Algerian *G. dupoteti*, yet not closely related to either.

The distribution of *farinesii* has been worked out by Margier and Caziot. It is generally distributed in the dép. Pyrénées-Orientales, and occurs also in the Spanish Provinces of Gerona and Barcelona. There is a record from Portugal, no doubt erroneous. In France it extends northward from the dép. Pyrénées-Orientales through Aude, Tarn, and Averyron to Lozère, that is, along the Cevennes uplift (using this term in a wide sense). There is even a single record from Langogne (dép. Allier), but I regard this as dubious, since the Abbe Dumas, who seems to have collected assiduously, did not find it (Rev. Sci. du Borbonnais, 1901). It is very local in these eastern departments, special localities being on limestone rocks of the gorge of Malefosse, of the Tarn, as far up as Blajoux. M. Locard found specimens in flood debris of the Rhone, doubtless washed in from a western affluent. There is

no satisfactory evidence that *farinesii* occurs anywhere east of the Rhone. It has been reported from the Apuan Alps of Tuscany, but while I have not seen specimens, I am disposed to think them terminal members of a parallel and independent evolution-series from the *avenacea* stock. See under *oligodonta*.

Of the several varieties described, the first three appear to occur with the typical form, and seem to be merely mutations.

Var. *obesa* Bgt. Shell shorter, more obese than the type. San-Julia de Loria, Andorra.

Var. *subcarinata* Bgt. Shell a little more lengthened than the type, with an obsolete carina at the base, which makes the aperture larger. San-Julia de Loria.

Var. *dentiens* Moq.-Tand. Pl. 5, fig. 4. The angular lamella present as a whitish deposit, diffuse or in form of a little tooth, and a low prominence may usually be seen on the columella. La Preste.

Var. *biplicata* Bgt. Shell of a little smaller size, having only one tooth on the columella instead of two as in the type [of *jumillensis*]. Rocks of San-Julia de Loria; also valleys of Ussat and Vic-Dessos (Ariége). (*Pupa jumillensis* var. *biplicata* Bourguignat, Moll. de San-Julia de Loria, 1863, p. 18, pl. 2, f. 10-12.) It differs from var. *dentiens* by having a low columellar lamella as well as an angular. See p. 50.

Var. *ascendens* West. Shell widely perforate; whorls 7½, the ascent of the last high and long, rounded at base. Aperture with the base narrower, two-folded; outer margin angularly curved above. Length 6, diam. 3 mm. St. Béat, Pyrenees. (*Pupa jumillensis* var. *ascendens* Westerlund, Fauna Europæa Moll. Extramar. Prodr., fasc. ii, 1878, p. 179.)

Pupa speluncae ('Bgt.,' Loc.). Cylindric-elongate, feebly tapering; 9-10 slightly convex whorls, the last a little larger, suture moderate; rimation quite strongly developed; aperture subrectangular, a little excentric; peristome thin, sharp, without external crest; shell quite solid, slightly glossy, deep brown, ornamented with fine, crowded wrinkles. Length 8, diam. 3 mm. Entrance of the grotto of Eaux-Chaudes (Basses-Pyrénées). (*Pupa speluncæ* Bourguignat in coll., Locard, Ann. Soc. d'Agric. Lyon, (7), iii, 1896, p. 185.)

Probably a large form of *farinesii*.

30. CHONDRINA TARRACONENSIS (Fagot). Shell rather openly perforate, regularly conic from the base, corneous-buff, irregularly striatulate; whorls 8, somewhat convex, slowly increasing, the last larger, ascending, rounded at the base. Aperture vertical, ovate-lunate, with 1 to 3 teeth: angular smaller, parietal more or less lengthened, or punctiform or wanting; columella thick, toothed; peristome unexpanded, margins nearly parallel. Length 6, diam. 2 mm. Spain. (*Pupa tarraconensis* Fagot, Catal. Moll. Essera (not seen); Westerlund, Synopsis, 1897, p. 100.) *Cfr. M. jumill.* v. *ascendens* W. (*Westerlund*).

31. CHONDRINA LONGINI (Fagot). Shell rimate-perforate, the perforation nearly covered by the columellar margin, cylindric-conic, opaque, glossy, corneous-violaceous, at the summit yellowish; irregularly and obliquely undulately striatulate; spire tapering from base to summit, especially so in the upper part, the apex corneous, smooth, mamillate, not prominent, as though truncate; whorls 7½, a little convex, separated by a well-impressed suture, regularly increasing, the last larger, not compressed below but rounded, ascending a little to the aperture. Aperture slightly oblique, ovate-rounded, 3-plicate as follows: 1 tooth-like, porcellanous angular; 1 immersed, lamelliform, compressed, tapering parietal, also porcellanous; 1 straight columellar, more or less incurved at the summit; peristome thickened at the aperture, the margins little approaching, the columellar margin lightly incurved, reflected at the umbilicus, outer margin simple, regularly curved. Alt. 6, diam. 2 mm.; alt. aperture 1¼, width 1 mm. (*Pupa longini* FAGOT, in Navas, Boletin Soc. Aragonesa de Cienc. Nat., v, 1906, p. 201).

Spain: peña Foradata above the Sallent, Aragon, at an elevation of over 2000 meters (R. P. Longin Navas).

It is perhaps approached only by our *Pupa saltus* of the Essera valley, and *ignota* of the valley of Panticosa; but it is distinguished from the first by the less numerous whorls (8 instead of 10), the last whorl rounded at the base and not compressed, the aperture more oval-rounded, by its columellar fold more immersed and curved at the top, etc.; from the second it differs by the greater size, more swollen whorls, the feebler teeth, etc. (*Fagot*).

This is apparently the *Pupa navasi* Fagot. ined., mentioned by Caziot, Ann. Soc. Linn. de Lyon, liii, for 1906 (1907), p. 197, from the same place.

32. CHONDRINA MICRODON (West.). Shell rimate-perforate, *ovate-conic*, with the spire 2½ times longer than the aperture, brown, *smooth*, the apex obtuse. 6½ strongly, *beautifully* convex whorls, regularly increasing, the last rounded below, ascending in front; suture deep, *narrow*. Aperture strongly receding below, obliquely oblong, *with one conic tooth deep within and high up on the columella;* peristome simple, nearly unexpanded, only the columellar margin being dilated above; margins very little and almost equally arcuate, except that the outer lip is strongly curved and protracted towards the columella above. Length 4, diam. 1⅔ mm. (*Pupa microdon* WESTERLUND, Fauna, Pal. Reg. Binnenconch., iii, 1887, p. 104.—*Modicella m.*, WEST., Synopsis, 1897, p. 100).

Spain: Montserrat, prov. Barcelona.

33. CHONDRINA BOETTGERIANA (Clessin). Pl. 5, fig. 3.

Shell rimate, subfusiform, thin, brown, pellucid, finely costulate, the ribs narrow, regular; 10-11 convex whorls, slowly and regularly increasing, separated by a moderately impressed suture, the last somewhat compressed at base, about equalling one-fifth the length. Aperture nearly quadrangular, toothless. Peristome acute, a little reflected, the margins connected by a scarcely perceptible parietal callous, the outer margin lightly impressed. Length 6.5, diam. 1.5 mm. (*Clessin*).

Spain: Jaen.

Pupa boettgeriana CLESSIN, Malak. Blätter (n. F.), v, 1882, p. 188, pl. 4, f. 4.

Described from one specimen. From farther southwest than other toothless species.

34. CHONDRINA JUMILLENSIS ('Guirao,' Pfr.). Pl. 5, figs. 6, 7.

Shell perforate, ovate-turrited, rather solid, obliquely wrinkle-striate, slightly glossy, purplish-brown. Spire convex, slowly tapering, the apex rather acute; suture deep, simple. Whorls 8, convex, the last scarcely forming one-third of the length, slightly compressed around the punctiform perforation. Columella longitudinally folded within and transversely two-toothed. Aperture slightly oblique, truncate-oblong; parietal wall having a little lamella at the right angle; peristome simple, slightly expanded, the right margin strongly curved above, toothless, columellar margin widely dilated. Length 8, diam. 3¾ mm., aperture 3 mm. long (*Pfr.*).

Southeastern Spain: Jumilla and Orihuela (Bourgeau).

Pupa jumillensis Guirao, Pfr., Monogr., iii, 1853, p. 540 (*Pupa bourgeaui* Shuttlew. Mss. cited as a synonym). Bourguignat, Moll. de San-Julia de Loria, 1863, p. 17, pl. 2, f. 7-9.

The original description of *jumillensis* is translated above. The figures are from Bourguignat, who did not give the source of the specimens, remarking that it is "found in a great number of Spanish localities."

Nomenclature.—Rossmaessler, in 1859, described as the true *Pupa jumillensis* of Guirao a form much smaller than Pfeiffer's and having but one columellar lamella instead of two. He was at a loss as to the source of Pfeiffer's specimens, which were supposed to have been furnished by himself. The matter is discussed at length in *Iconographie*, iii, p. 110. Bourguignat, in his Mollusques de San-Julia de Loria, cited above, redescribed *jumillensis* Pfr., and synonymized *jumillensis* Rm. with his own *P. jumillensis* var. *biplicata*, from the Pyrenees—a locality far from Rossmaessler's. Westerlund ignores Pfeiffer's *jumillensis* of 1853, accepting Rossmaessler's species of 1859, a proceeding clearly inadmissible. The untangling of this snarl must be left to European students who must elucidate the zoological relations of the forms as well as their nomenclature.

Various forms which have been described as varieties of *jumillensis* appear referable rather to *farinesii*. A variety with three folds, 1 angular, 1 immersed parietal and 1 columellar, is noted by Bofill in the Province of Barcelona (Bull. Soc. Malac. Fr., iii, 1886, p. 154). Possibly some form of *farinesii* is intended. *Cf. P. tarraconensis* Fagot.

Pupa ignota appears to have been proposed as a substitute for *P. jumillensis* Pfr. not Rossm., and if so it becomes an exact synonym of *jumillensis* as here understood. Since I have not seen the original publication, Locard's description of *ignota* is given here.

Pupa ignota Fagot. Cylindric-turriculate, a little elongate, spire high; 8 convex whorls, the suture well marked; aperture oblong-rounded, triplicate: 1 superior fold, lodged at the suture; 2 columellar folds; peristome a little everted; shell a

little glossy, violaceous-brown, very finely striolate. Length 7–8, diam. 3–3½ mm. Haute-Garonne, Hautes et Basses-Pyrénées, etc. (*Pupa ignota* Fagot, Cat. Moll. Essera, in Crónica Cientifica, 1888, p. 23; Locard, Ann. Soc. d'Agric. Lyon, (7), 1896, p. 185).

34*a*. *Chondrina jumillensis guiraonis* n. n. Vol. XXIV, pl. 47, fig. 9.

The color is between russet and chestnut-brown, somewhat glossy, wrinkle-striate. The aperture is shorter and more oblique than that of *farinesii*. Angular lamella small and slender; columellar lamella low, obtuse, so deeply immersed that it does not show in a direct face view. Length 4.7, diam. 2.2 mm.

Rossmaessler's description of *jumillensis* follows: "Shell most minutely perforate, ovate-turrited, brown, obliquely striate, the apex somewhat obtuse; whorls 6, convex, the last slightly compressed at base, a little ascending; aperture rounded semi-ovate, having 2 folds: one very slender fold at the insertion of the outer lip, one deep within on the straightened columella; peristome a little expanded, thin, simple, the outer margin strongly curved, columellar margin rather straightened. Alt. 5, diam. 2½ mm." (*Rossm.*).

Rocks of Monte San Miguel near Orihuela, prov. Alcante, and of Monte de Santa Ana near Jumilla, prov. Murcia, Spain (A. Guirao).

Pupa jumillensis Guirao, Rossm., Iconogr., iii, p. 110, pl. 85, f. 943.—*Cf. Pupa jumillensis* var. *biplicata* Bourg., Moll. de San-Julia de Loria, 1863, p. 18, pl. 2, f. 10-12.

This shell is shorter and rougher than *C. farinesii dentiens*, with a shorter aperture. The type specimen figured is from Jumilla, no. 22790 A. N. S. P.

Bourguignat's var. *biplicata* was said by him to equal *jumillensis* Rm., which I doubt. It is from Andorra in the Pyrenees, and is probably a form of *farinesii*.

35. Chondrina saltus (Fagot). Shell nearly covered rimate-perforate, corneous-buff, reddish, hair-striate; spire regularly tapering from the base, subulate; whorls 9-10, the last ascending; aperture oval, with single folds on parietal wall, columella and palate; angular tooth-like callous, colu-

mellar immersed, palatal small, immersed; outer margin thickened, arcuate, columella straightened, reflected above. Length 7-8, diam. 2 mm. Spain. (*Pupa saltus* Fagot, Catal. Moll. Essera, Crónica Cientifica, 1888, not seen; descript. from Westerlund, Synopsis, 1897, p. 101.)

36. Chondrina obliterata (Charp.). Pl. 5, figs. 9, 10.

The shell is long, cylindric-conic, thin, slightly glossy, purple-brown, distinctly but irregularly striate, composed of nearly 8 whorls, rather rapidly increasing in height, weakly convex, joined by a whitish, thread-like, somewhat impressed suture; the apex bluntly rounded, the last whorl contracted below, with flat neck. The aperture is semiovate; on the straight columella an indistinct fold stands; two of them in the palate, the upper one indistinct, punctiform, the lower somewhat longer; a fourth indistinct one on the parietal wall near the insertion of the peristome. The columellar reflection is wide and almost half covers the large, deep umbilical crevice. Length 3½ lines, width 1 line (*Kuester*).

Portugal (Holl).

Pupa obliterata Charpentier, in Kuester, Conchyl. Cab., p. 112, pl. 15, f. 7-9.—Pfr., Monogr., iii, 544.

This species is known only by the description of Charpentier, and the figure and description of his type by Küster. It has not been found by recent collectors in Portugal, and that locality must be considered dubious. It has some resemblance to forms of eastern Spain. *Cf.* also *M. avenacea apuana*.

37. Chondrina massotiana (Bgt.). Pl. 5, fig. 5.

Shell oval-turriculate, deeply rimate, corneous-chestnut, with a very fugacious blue-white bloom when fresh, obliquely striate. Spire lengthened, the summit smooth, glossy and quite obtuse; 8 whorls, regularly increasing; suture deep, making the whorls very convex and a little flattened towards the suture; last whorl slightly keeled around the umbilical fissure, and slightly ascending in front. Aperture slightly oblique, rounded-oblong, with four little teeth, as follows: one at the insertion of the outer lip, the second, deeply immersed, in the middle of the convexity of the penult whorl, the third in the

upper part of the columellar lip; finally a fourth, lamelliform, in the middle of the outer lip. These teeth exist only in quite adult individuals. Peristome a little everted. Columellar margin rectilinear, reflected and dilated, the outer lip strongly arched, the margins converging and strongly approaching. Length 6½, diam. 2¼ mm. (*Bgt.*).

Pyrenees: damp rocks along the pathway, San-Julia de Loria, Andorra.

Pupa massotiana Bourguignat, Moll. de San-Julia de Loria, 1863, p. 18, pl. 2, f. 13, 14 (in Rev. et Mag. de Zool., 1863).— *Pupa penchinatiana* Bgt., t. c., p. 20, pl. 2, f. 15, 16.

Closely related to *jumillensis* and *farinesii*, from which it differs by having a palatal fold and a small parietal lamella.

Var. *penchinatiana* Bgt. Pl. 5, fig. 11. Umbilical crevice more open, and there are two palatal folds, not reaching the peristome, while the single one of *massotiana* is on the peristome and extends a little way inward. Pathway at San-Julia de Loria.

Pupa penchinatiana has been recorded from the mountains of Kabylia in Algeria (Hanoteau et Letourneux, La Kabylie, 1872, p. 227). Such a distribution appears anomalous, yet, as in the case of *Abida brauni*, one is perhaps not justified in expressing more than surprise.

Var. *sexplicata* Bofill. With 2 columellar folds. Catalonia, at the Escalas de Sopeira; limestone rocks at Pont de Montanyana, and on the margins of the Noguera Ribagorzana (*Pupa penchinatiana* var. *sexplicata* Bofill, Bull. Soc. Malac. France, iii, 1886, p. 160).

Var. *angustata* West. Shell broadly perforate, conic, strongly striate, with 7 whorls; margins of the peristome obliquely produced downward, approaching one another; the aperture therefore narrowed below, outer lip strongly curved above. Two lamella on parietal wall, one on columella, two folds in palate. Length 7, diam. 2¾ mm. Alcazar, Spain. (*Pupa massotiana* var. *angustata* West., Fauna, iii, 1887, p. 102.)

Var. *confusa* West. Shell ovate-turrited, very finely, very obliquely and closely, regularly striate, dark cherry-brown;

the last whorl rounded below. Aperture with 4 white teeth: 1 small angular lamella, 1 sunken, short, strong, parietal, and 2 horizontal columellar teeth, deep within, high on the columella, the second one very small. No palatal folds. Catalonia. Coll. Ponsonby, sent by Bofill as *P. dertosensis* Bof. (*P. massotiana* var. *confusa* West., Fauna, iii, 1887, p. 102).

Var. *aragonica* Fagot. Shell rimate, cylindric-conic, elongate, buff-reddish, very delicately, irregularly hair-striate; whorls 10, somewhat convex, rapidly and regularly increasing, the last ascending, compressed at the base, but not carinate. Aperture oblique, oval, with 2 parietal, 1 columellar, 2 palatal folds. Angular lamella tooth-like; columellar small, oblique; palatals rather short, remote; peristome expanded throughout, white, the columellar margin nearly straight, outer margin longer, arcuate. Length 6–9, diam. 2–2½ mm. Spain. (*Pupa aragonica* Fagot, Catal. Moll. Essera, 1888, p. 17; descript. from Westerlund, Synopsis, p. 101.)

38. Chondrina domicella (Westerlund). Shell rimate, ovate-conic, obliquely ribbed, rufous-brown. Whorls 8, convex, regularly increasing, last slightly compressed at base; suture deep. Aperture oval, rounded beneath, with 6 lamellæ and plicæ: 1 long angular lamella, 1 much shorter, immersed parietal fold, 2 horizontal columellar lamellæ, situated high and immersed, the upper much the stronger, opposite the palatal laminæ; 3 palatal laminæ, not marginal, the 1st rather immersed, very short, 2d and 3d prolonged inward, especially the 2d. Peristome but slightly expanded, the outer margin obtusely, angularly curved above. Length 7, diam. 2.5 mm. (*West.*).

France: Lourdes (Fagot).

Pupa (*Torquilla*) *domicella* West. Verh. zool.-bot. Ges. Wien, xlii, 1892, p. 36. Lourdes, France.

"This species approaches nearest to *P. massotiana*" (*W.*).

39. Chondrina pulchella (Bofill).

Shell perforate-subrimate, conoidal, rather glossy, of a deep reddish color, obliquely ornamented with irregular, inconspicuous striæ; regularly tapering from the convexity of the last

whorl to the summit; 8 very convex whorls of slow, regular increase, separated by a deep suture, the first whorls smooth, summit quite obtuse; last whorl a little ascending above towards the aperture, ornamented with 2 transverse lines, not very long and not reaching the peristome, corresponding to palatal folds. Aperture nearly vertical, suboval-truncate, with 6 lamelliform denticles: one angular, white, approaching the outer lip at the beginning but diverging inwardly; one apertural [parietal], white, immersed, quite near the end of the angular lamella; two whitish columellars; two yellowish palatals, immersed, feebly prolonged inwardly. Peristome simple, narrow, curved towards the apertural angle, slightly everted at the base and the columella, the margins approaching, united by a weak callous. Length 4½, diam. 1½, aperture 1 x ⅓ mm. (*Bofill*).

Spain: arid places of Montsech, Catalonia, on rocks of the road of Pont de Montanyana, at "Ca'n Quinquilla."

Pupa pulchella Bofill, Bull. Soc. Malac. France, iii, 1886, p. 161.

By its teeth this Pupa has some resemblance to our var. *sexplicata* of *P. penchinatiana* (Bourg.), but it is readily distinguished by the conoidal form, by the regular taper of the spire from the convexity of the last whorl to the summit, by the very convex whorls, smaller size, slimmer form, and the reddish color (*Bofill*).

Possibly related to *granum* Drap.

Var. *manotiana* 'Bgt.,' West. Shell umbilicate, oblong-conic, costulate-striate, brown; whorls 7½, regularly increasing, convex, separated by a rather deep suture, the last somewhat ascending in front. Aperture oval, an angular fold at the insertion of the outer margin, and a parietal fold in the middle, a columellar fold, and two palatal folds, all deeply placed, white, short and high, a denticle on the columella below; peristome unexpanded, thin, the outer margin strongly arcuate above and approaching the columellar margin. Length 6, diam. 2 mm. Spain. (*Pupa* [*Torquilla*] *pulchella* Bof. var. *manotiana* Bgt. in sc., *Westerlund*, Nachrbl. d. m. Ges., 1894, p. 172.)

Var. *ilendensis* (Fagot). Shell rimate-perforate, conic, striatulate, corneous-buff; spire lengthened-turrited; whorls 8, regular, the last slightly larger, a little compressed at base. Aperture oblique, ovate, with 2 parietal, 2 columellar and 2 palatal folds. Angular lamelliform, the parietal regular, arcuate; upper columellar tooth-like, the lower remote; palatals equal, not emerging, exactly opposite the columellar. Peristome unexpanded, reflected at the umbilicus, the columellar margin almost straight. Length 6, diam. 2 mm. Spain. (*Pupa ilendensis* Fagot, Catal. Moll. Essera, 1888; descript. from Westerlund, Synopsis, p. 102.)

40. Chondrina gorbeana n. sp. Pl. 3, fig. 12.

The shell is deeply, rather shortly rimate, long-conic, slowly tapering from the last whorl to the obtuse summit, glossy, carob-brown, the apex paler, last whorl with a tawny or white band behind the lip. Sculpture of fine but irregularly developed oblique striæ. Whorls moderately convex, the last ascending in front, slightly compressed, the base quite narrowly rounded. The suture is impressed, bordered by a pale gray line. The aperture is truncate-oval, brown within. Angular lamella very low; parietal lamella represented by a barely perceptible callous; columellar lamella small, far within, high on the pillar. No palatal folds. The peristome is dilated above the umbilical fissure, the outer lip not in the least expanded; within its edge there is a rather strong, white callous throughout. Parietal callous thin and transparent. Length 7, diam. to lip-edge 2.8 mm.; 7½ whorls.

Spain: Peña de Gorbea (southern border of prov. Vizcaya).

This species differs from *avenacea* by the strong white callous within the peristome, as well as by the obsolescence of the lamellæ and absence of plicæ. In one specimen the angular lamella is short and tubercular but stronger than in the type. The species appears to be a degenerate member of the *bigoriensis* group. The locality is not far east of Orduna.

Section *Solatopupa* Pilsbry.

Solatopupa Pils., Man. Conch., XXIV, p. 234, type *Pupa similis* (Nov. 9, 1917).

The shell is *calcareous* though thin, opaque, *whitish* with more or less cinereous, violaceous or bluish tint, and often marbled with brown; having angular, parietal and columellar lamellæ, upper and lower palatal and basal folds, or lacking teeth. Type *C. similis* (Brug.).

Distribution: southern France, northern and western Italy south to Tuscany; a group of the olive zone, living on limestone rocks exposed to the sun.

a^1. Palatal folds well developed; 5 to 7 teeth.
C. similis, no. 41.

a^2. No palatal folds.
b^1. Shell conic, thin and fragile, toothless.
C. psarolena, no. 43.
b^2. Shell cylindric, opaque, teeth 3 to 0.
C. pallida, no. 42.

41. Chondrina similis (Brug.). Pl. 4, figs. 1 to 4.

The shell is shortly rimate, cylindric-fusiform, opaque, pale cinereous or nearly white, generally more or less clouded and obliquely flamed with cinereous or vinaceous gray, the upper whorls of a chamois tint. More or less distinctly striate. Upper whorls strongly, the later ones weakly convex, the base rounded. Aperture is shortly oval, brown within, having 5 whitish teeth: angular lamella short and low, joining the lip. Parietal lamella rather strong. Columellar lamella obliquely ascending within, not emerging, a very low prominence (or a small, blunt lamella) below it. Upper and lower palatal folds subequal, not approaching the peristome. Peristome white, somewhat expanded, scarcely thickened.

Length 10.5, diam. above aperture 3.2 mm.; 8½ whorls (Marseilles).

Length 14, diam. above aperture 3.6 mm.; 10 whorls (Grasse).

Length 13, diam. above aperture 4 mm.; 9½ whorls (Nice).

Length 8.6, diam. above aperture 2.9 mm.; 7½ whorls (Cette).

Southern France: northern and western Italy south to Tuscany; Corsica.

Bulimus similis BRUGUIERE, Encyclop. Méth., i, 1792, p. 355. —*Pupa similis* Brug., DUPUY, Hist. Moll. France, p. 401, pl. 20, f. 6.—WESTERLUND, Fauna, iii, 1887, p. 94; with (p. 95) forms *major, minor, variegella, pachygastra, laevigata, dissimilis;* var. *porcellata*, in Supplement, 1890, and Synopsis, 1897, p. 79.—MARGIER, Feuille Jeunes Nat., 1901, no. 365, p. 139 (distribution). — CAZIOT, Ann. Soc. Linn. de Lyon, vol. 50, 1904, pp. 147-154; var. *fasciata*, and var. *guidoni*, p. 151 (synonymy, varieties, distribution); Etude sur les Moll. terr. et fluv. de la Principauté de Monaco et du Dép. Alpes-Maritimes, 1910, p. 309. — MERLE, La Nature, 1912, no. 2055, p. 305, f. 2 (radiograph).—*Pupa cinerea* DRAP., Tableau, p. 61; Hist. Moll. Fr., p. 65, pl. 3, f. 53, 54.—ROSS., Iconogr., pt. 5, p. 19, f. 336.—KUESTER, Conchyl. Cab., p. 36, pl. 5, f. 4-8.—SCHMIDT, Abh. Nat. Ver. Sachsen u. Thüringen in Halle, i, p. 42, pl. 10, f. 82 (anat.).—PAGET, Ann. and Mag. N. H., (2), xiii, 1854, p. 455 (tooth variation and banding at Nice; includes several species).—*Pupa cinerea* Drap., var. *pachygaster* SHUTTLEWORTH, Mittheil. Naturforsch. Ges. in Bern, no. 3, June, 1843, p. 18, no description.—*Pupa quinquedentata* Born, Pfeiffer, Monogr., ii, 345, with var. *minor* = *Pupa variegella* Ziegl. in coll.; iii, 547; iv, 673; vi, 314; viii, 384.—ROSSM., Iconogr., iii, pt. 17, p. 111, pl. 85, f. 945.—MOQUIN-TANDON, Hist. Moll. Fr., ii, 1855, p. 352, pl. 25, f. 15-22; with varr. *major, variegella, minor, pachygaster*.—BOURGUIGNAT, Malac. Chateau d'If, p. 24, pl. 1, f. 14, 15, with var. *turriculata*, p. 25, pl. 1, f. 16.—G. NEVILL, P. Z. S., 1880, p. 125 (all along the Genoese Riviera, at Menton from the sea to 4000 ft.); also varr. *præhistorica* and *speluncarum*. Probably not *Turbo quinquedentatus* Born, Test. Mus. Caes. Vindob., 1780, p. 359, pl. 13, f. 9. — *Pupa quinquedentata* Born (*cinerea* Drap.) WIEGMANN, Nachrbl. d. Malac. Ges., 1901, p. 12 (anatomy).—*Jaminia quinquelamellata* RISSO, Hist. Nat. Eur. Mérid., iv, 1826, p. 91, teste Bourguignat.—*Pupa quinqueplicata* POTIEZ et MICHAUD, Galerie, etc., i, 1838, p. 163.

This very abundant species varies widely in size, degree of variegation and in sculpture, the greatest diversity being among lots from the Alpes-Maritimes. Bruguiere's type was about 10 mm. long, from the south of France.

In several lots from Italy there is a short basal fold which is often so far immersed that it is not visible in a direct face view (pl. 4, fig. 2, Florence). It is not constantly present in any lot examined. Paget appears to have noticed this fold in specimens from the Riviera, but no other author has mentioned it.

The subcolumellar lamella varies from distinct to so deeply immersed as to be nearly invisible, in different individuals of most lots examined.

In the Alpes-Maritimes it lives in populous colonies, according to Caziot, in well-exposed, sunny places, at Saint-Jeannet, Eze, Saint Vallier, etc., up to 1000 m., on calcareous rocks. It avoids alluvial plains and is very rarely found on igneous rocks. A length of 16 mm. is not common, but specimens that long have been found on the rocks of Eze, etc., the diam. 4 mm.

The distribution of *C. similis* has been worked out by Margier and Caziot. In northern Italy it is rare in Piedmont, but extends through Lombardy and as far as Verona in Venetia, according to specimens in this collection. Southward it appears to be confined west of the Apennines, being very common in Liguria, also in Tuscany (Leghorn, Florence, etc.) south to a point 17 kilom. southeast of Rome. In France it is found in Corsica, in the departments of Alpes-Maritimes, Alpes Basses, and westward, north to Drôme and Estaing (Aveyron), west to Amélie-les-Bains, in the Pyrenees. It has also been recorded from the province of Gerona, eastern Spain, from Fonteta and Figuera on the Ampurdan, its southern known limits. The details of distribution are given by Margier, Feuille Jeunes Nat., 1901, pp. 139-141.

A scalariform abnormal form resembling *Clausilia scalaris* Pfr. has been noted by Caziot (1904, p. 150).

Since 1848 this species has often been called *P. quinquedentata* (Born), but the identity of Born's species is very uncertain. The figure looks more like a *Clausilia*, and may possibly

be one of the long and slender varieties of *Abida variabilis;* the description is inconclusive, and the locality unknown.

The following described forms are synonyms:

Form *dissimilis* West. Quite cylindric, with the spire shortly, conically tapering only near the summit, all whorls equally and very slowly increasing, somewhat angular below; no angular lamella; parietal lamella very high, very oblique, long. Length 12-14, diam. scarcely 3 mm.; aperture 2¾ mm. See under *P. olivetorum.*

Pupa olivetorum Loc. Cylindric, very narrowly elongate, the spire feebly acuminate; 10-12 quite convex whorls, the last angular towards the rimation; suture well marked; aperture small, oboval; peristome not very thick; 2 superior folds, one very small at the suture, the other long and deeply placed; columella simply folded; two deep palatal folds; shell somewhat thin, ashy white, marbled, finely striolate. Length 15-16, diam. 3 mm. Le Midi, Alpes-Maritimes. Gard, Hérault, etc. (*Locard*, Ann. Soc. Agricult. Lyon, (7), iii, 1896, p. 183).

Identical with *dissimilis* West, and not a species or even a valid variety, according to Caziot (1904), but simply a slender mutation occurring individually in normal colonies in many places, never in pure colonies. The tendency to produce such cylindric individuals is common in many species of the genus.

Pupa plagionixa 'Bgt.,' Loc. Quite small, almost regularly conic, rather squat. 8-10 nearly flat whorls, the last well keeled at the base; suture not very deep; aperture subrectangular, with the same apertural teeth as *similis;* shell solid, ashy-white, marbled with blue, finely wrinkled. Length 9-11, diam. 3½ mm. Alpes-Maritimes, Var, Bouches du Rhone, Isère, etc. (*Locard*, Ann. Soc. d'Agric. Lyon, (7), iii, 1896, p. 184). According to Caziot (1904) this is certainly an abnormal shell.

Pupa variegella Ziegl. This form was mentioned as *Chondrus variegellus* Ziegl., but not defined by Cristofori and Jan (Catalogus, etc., sect. ii, 1832, p. 5, no. 18); they give the locality southern France. The next notice and first definition is by Beck, who has a var. c. varia, with the synonym *Pupa variegella* Zigl., under *Torquilla cinerea* (Index Moll., 1837, p. 87). He refers to Rossmaessler's fig. 336 as illustrating his variety. This figure appears to be a strongly variegated specimen of the typical form, about 13 mm. long. Pfeiffer, in

1848, recognized a var. *minor*, of which he cites *P. variegella* Ziegl. as a synonym, with the description, "Whorls 8, length 9½, diam. 3 mm." No locality is given. Moquin-Tandon, 1855, recognized var. *variegella* for a "shell larger [than typical *similis*], very distinctly marbled," with the locality Grasse. This interpretation has been accepted by Ct. Caziot (1904). If the name *variegella* is used at all, it should probably be restricted to the shell figured by Rossmaessler, but a better course would be to discard it as superfluous.

The following varieties are given for what they are worth—not much in most cases.

Var. *major* Moq. Shell larger, of the same color. Sainte-Lucie near Narbonne; Draguignan (Moq.-Tand., *l. c.*, pl. 25, f. 22). The figure measures 16.5 mm. long, 4.5 diam.

Var. *minor* Moq. Shell smaller. Caziot states that this form is common at the chateau of Nice and other places in the Alpes-Maritimes. Length 9-10, diam. 3 mm.; on the Var river, 8 x 2½ mm.

Var. *pachygaster* 'Shuttl.,' Moq. Shell of the same size as the typical form [9-13 x 3-4 mm.] or smaller, more ventricose. Corsica: Ajaccio, Saint-Florent (*Moq.-Tand.*). The name is preoccupied.

Form *laevigata* West. Irregularly, finely striate or almost smooth.

Var. *porcellata* West. Shell subfusiform, rather swollen in the middle, strongly tapering above, very acute, regularly and closely rib-striate; length 11, diam. in the middle 3½ mm. Spezzia, Italy.

Var. *fasciata* Caziot. Each whorl ornamented with a brown median band, as in *Cochlicella*. Aqueduct de Carpentras (Alpes-Maritimes); also in Provence.

Var. *guidoni* Caziot. Differs from the type by its coloration, the cask-like form of the whorls of the spire, the more pronounced suture and the nearly smooth shell. Pioggiola près le Mont Padro, Corsica, on granite.

Var. *juliana* Issel. Color reddish, more or less intense, probably due to the ferruginous material abundant in the same locality. Baths of S. Giuliano, Prov. Pisa. (*Pupa quinquedentata* var. *juliana* Issel, Memorie Soc. Ital. di Sci. Nat., ii, no. 1, 1866, p. 21.)

Var. *prehistorica* G. Nevill. The commonest subfossil shell in all the deposits except *F*; though varying in countless ways, it always preserves a distinct "facies" from that of the preceding living form [*similis*]; it can invariably be distinguished by the much stronger and more regular striation, not so oblique, so flexuous, or so inclined to be subobsolete; the aperture is also invariably smaller and more contracted, less everted as a rule, with both margins straight and parallel, instead of more or less rounded; the folds appear scarcely to differ at all. Long. 14, diam. 4 mm. Type of the var. from deposit *B*, Menton (*Nevill*).

Var. *speluncarum* G. Nevill. A more distinct and characteristic variety than the preceding, which I only found in deposit *F*, where it was abundant, and in the interior of the cave itself (as I have already mentioned). A very short, convexly swollen, tumid form, of only 9 instead of 10 whorls, the last being proportionally much broader; striation more like that of the typical form than of the preceding variety; the short, quadrangular, unusually everted aperture, with remarkably thickened and reflected peristome, seems to be its most characteristic feature, the margins being more convexly rounded and united by a distinct (instead of subobsolete) callosity. I can see no difference in the folds (or teeth). Long. 10½, diam. 3½ millim. From deposit *F* (*Nevill*). Menton.

Types, Indian Museum, Calcutta.

Var. *isabellæ* Caziot. A variety of lengthened shape, very slightly swollen, robust, 11 very slightly convex whorls. It differs from the type especially by the dimensions, length 17-18, diam. 4½ mm.

The typical *similis* varies between length 9-15, diam. 3-3½ mm. The var. *major* West. has, length 16 mm., with a diameter equal to my variety; it is thus more obese. The var. *isabellæ* approaches var. *variegella* Ziegler which has been found at Grasse, and which is more ventricose and more distinctly marbled. The variety of the Courmettes has, besides, the depth of the aperture of a dirty yellow color. Some specimens show a single band, such as is characteristic of my var. *unifasciata*. Southern slope of the Courmettes between the tor-

rent du Loup and the village Tourette (Alpes-Maritimes) (*Caziot*).

Pupa similis Brug. var. *isabellæ* Caziot, Feuille Jeunes Naturalistes, no. 513, 1913, p. 148, fig. on p. 147.

42. Chondrina pallida ('Phil.,' Rossm.). Pl. 4, figs. 5 to 8.

Shell with a shallow umbilical crevice, ovate-fusiform, pointed; lilac-ash-gray, with irregular brownish flecks and horn-colored apex; weakly striate, somewhat glossy. Eight somewhat convex whorls. Aperture semi-ovate, the throat yellowish-brown; peristome expanded, sharp, simple, the columellar margin shorter and straighter than the outer lip. Columella somewhat callous, advancing. Length 4, diam. 1⅓ lines, 7 whorls (*Rm.*).

Upper Italy (Philippi); Riviera from Toulon to Porto Venere near Spezia (v. Martens).

Pupa pallida Phil, *in lit.*, Rossmaessler, Iconogr., ii, pt. 11, 1842, p. 11, pl. 53, f. 732.—Kuester, C. Cab., p. 86, pl. 12, f. 12, 13.—Pfr., Monogr., ii, p. 308.—von Martens, Nachrbl. d. m. Ges., 1900, p. 70 (between Rapallo and Zoagli, very abundant on limestone cliffs). — *Pupa patula* Menke, teste Pfr., Monogr., viii, p. 363.

The type figure is copied, fig. 7. It is not known where the very small, toothless form which served as type of this species occurs; but it is doubtless merely a local race or colony of the prevalent larger form known as *amicta* Parr. It is unfortunate that the species was first described from a peripheral mutation.

Var. *amicta* Parreyss. — Shell deeply rimate, cylindric-turrited, solid, smooth, bluish-white; spire long, corneous above, gradually terminating in a rather obtuse cone; suture simple. Whorls 9, scarcely convex, the last about two-sevenths the total length, subtuberculate-compressed at base. Aperture nearly vertical, truncate-oblong, fleshy-brown within, with 3 teeth: the first angular, second standing apart deep on the belly of the penult whorl, the third fold-like, deep on the columella. Peristome white, a little expanded; the margins somewhat unequal, right margin toothless. Length 12, diam. 3 mm.; apert. 3⅔ mm. long, 3 wide (*Pfr.*).

Pupa amicta Parreyss MS., Pfr., Malak. Bl., i, 1854, p. 67; Monogr., iv, 668; vi, 307. — Bourguignat, Malac. terr. chat. d'If, p. 25, pl. 1, f. 11-13.—Issel, Bull. Soc. Malac. Ital., vii, 1881, pp. 208-212; with var. *excelsa*, p. 210. — *Pupa pallida* var. *tridentata* Rossmaessler, Iconogr., iii, pt. 17, 1858, p. 111, pl. 85, f. 944. — *P. pallida* var. *dentiens* Martens, Die Hel., 1860, p. 287.

Distinguished from typical *pallida* by the presence of small angular, parietal and columellar teeth; but these are variable in development in adult shells of the same lot. In some of the examples from Nervi, Liguria, the angular and parietal are reduced to slight traces (pl. 4, fig. 5), and there is no columellar. Such specimens approach the original *pallida* rather closely, but all I have seen are slightly larger, 9½ to 10 mm. long. Other shells of the same lot have two distinct teeth and a trace of the columellar, or none. Specimens from Spezia have the three teeth distinct (pl. 4, fig. 8). This may be taken as type locality of *amicta*, since Pfeiffer gave only *Sicily* (1854) and *northern Italy* (1859).

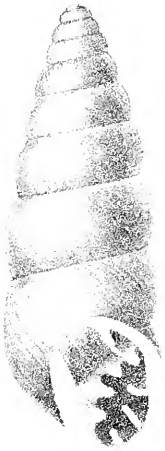
Specimens from Grasse (Terver) have the lip more expanded than Italian shells seen; two teeth, with rarely a small columellar also (pl. 4, fig. 6). The parietal is often not visible in a direct face view. They vary in size:

Length 12, diam. above aperture 3.3 mm.; 9 whorls.

Length 9.5, diam. above aperture 3 mm.; 7½ whorls.

Although *amicta* has been reported from the Chateau d'If (Dép. Bouches-du-Rhone) and the peninsula of Saint-Mandrié, near Toulon (Bourguignat, 1860), and I have specimens from Grasse (Var), yet it appears to be wanting in the Dép. Alpes Maritimes, where the snail fauna has been studied carefully by Ct. Caziot and many others. It occurs at suitable places along the whole coast of Liguria, but the colonies, while rather numerous, appear to be of limited extent.

According to Issel, *C. amicta* ordinarily lives on limestone rocks near sea level, but it has also been found inland and at some elevation, at Bavari and Traso in the Bisagno valley, five or six kilometers from the coast, at about 100 meters elevation, and above Cassagna and Statale, ten to twelve kilometers in-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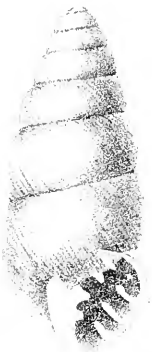
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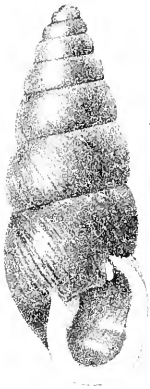

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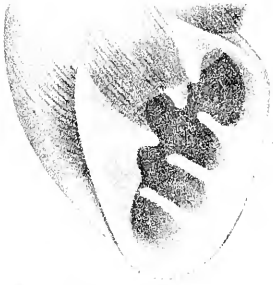

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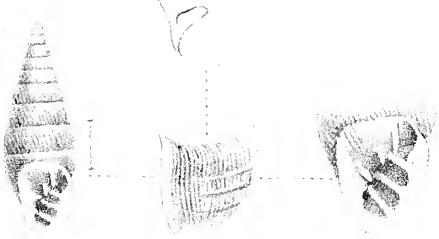

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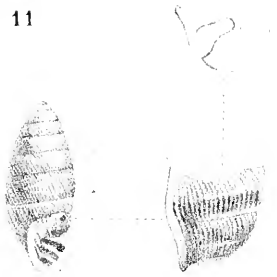

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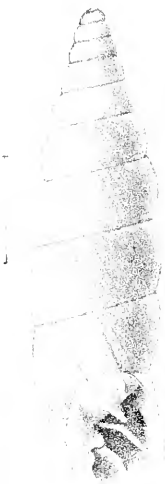

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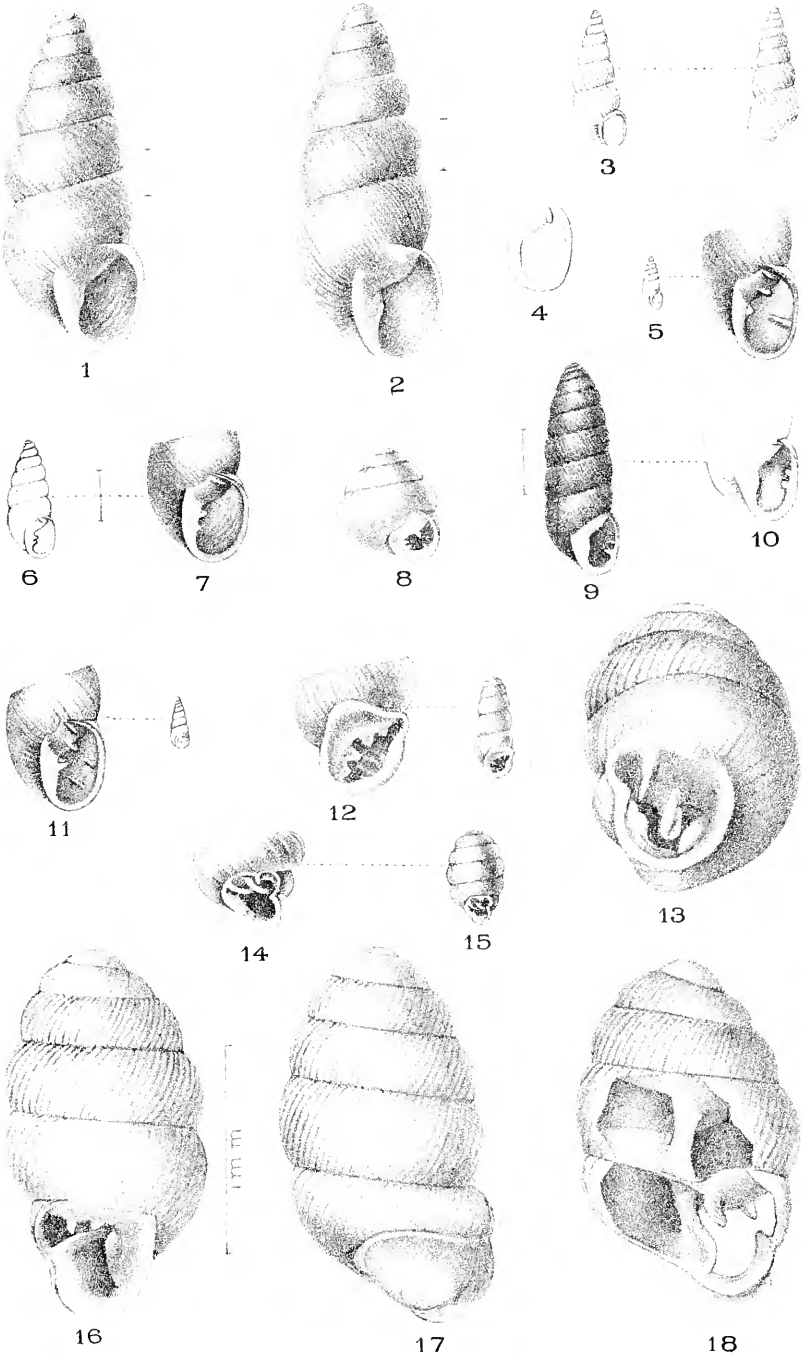
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land at about 450 meters above the sea. Upon these specimens he bases the following variety.

Var. *excelsa* Issel. The shell more slender, more acuminate, smaller, and having the aperture more regularly oval, and with the margins more approaching.

43. CHONDRINA PSAROLENA (Bgt.). Pl. 4, figs. 9, 11.

Shell rimate-perforate, conic-oblong, fragile, a little pellucid, obliquely striatulate; corneous, irregularly marked with longitudinal streaks of cinereous or whitish-blue. Spire conic, the apex acute, corneous, smooth; whorls 7, very convex, parted by a deeply impressed suture, the last whorl not one-third the whole length. Aperture rounded, the peristome simple, acute, not reflected; columella simple; columellar margin dilated, a little expanded; margins strongly converging, joined by a thin callous. Length 7-8, diam. 4 mm.; height of aperture 2.5, width 1.75 mm. (*Bgt.*).

Alpes-Maritimes, in the gorges of the Saorge (type loc., Bgt., Caziot); also cavern la Giachera in the Nervia valley, Liguria, and on the Costa di Drego above a little affluent on the left of the Argentina or Tazzia river, at 1000 meters elevation (Issel); fossil in the pleistocene deposits of Menton (Nevill).

Bulimus cinereus MORTILLET, Coq. fluv. et terr. de Nice, in Bull. Soc. Hist. Nat. Savoie, iii, 1851, p. 96.—*Bulimus cinereus* DUMONT et MORTILLET, Descript. somm. des esp. nouv., in Prospectus de l'Hist. Moll. terr., etc., Savoie et du Basin du Léman, 1852, p. 3. — ROSSMAESSLER, Iconogr., iii, pt. 17-18, 1858, p. 102, pl. 84, f. 929. Not *Bulimus cinereus* Reeve, 1848. —*Bulimus psarolenus* BOURGUIGNAT, Aménites Malac., ii, 1859, p. 116, pl. 15, f. 1, 2. — *Pupa psarolena* Bgt., STABILE, Bull. Malac. Ital., i, 1868, p. 33 (discussion of synonymy).—NEVILL, P. Z. S., 1880, p. 124.—CAZIOT, Étude Moll. Monaco, et Alpes-Marit., 1910, p. 313, pl. 9, f. 23, 24.—*Pupa mortilleti* v. MARTENS, Die Hel., 1860, p. 287 (n. n. for *B. cinereus* Mort.).

I have not seen this species, which appears to take the place of *pallida* in the Alpes-Maritimes, but apparently at much greater elevations than *pallida*. It lives on dusty limestone

rocks according to Caziot. Bourguignat found it on rocks of the gorges above the village of Saorgio, near Nice, in great abundance. Mortillet's locality was back of Menton. G. Nevill found an elongated form of the species in the pleistocene of Menton. Caziot's figures also represent more lengthened examples.

Unidentified and Undescribed Species of Abida, Granopupa or Chondrina.

Pupa affinis Aradas et Maggiore, Catalogo regionato della Conchiglie viventi e fossili di Sicilia, p. 116 (Atti Accad. Gioenia, xv, 1839; xx, 1843). Shell conic-cylindric, ashy, smooth, solid; aperture 5-toothed; margin white, slightly reflected. Alt. 3¾, diam. 1⅓ lines. Coast of Catania. Differs from *P. variabilis* by the form, cylindric to the upper third, and the situation of the teeth, of which one is in the insertion of the lip, second in the labrum, two minute and contiguous on the columella, and the fifth, laminar, in the labium. I have not seen this publication, and take the diagnosis from Philippi, Enum. Moll. Sicil., ii, 220, who quotes from A. & M. Rossmässler's use of the name *P. affinis* was probably prior.

Pupa contorta Calcara. T. cylindraceo-conica, striata, corneo-cinerascens; anfr. 8 plano-convexi, ultimus ante finem notabiliter contortus; apertura alba, 8-dentata, margine crassiusculo, subreflexo. Long. 3 lin. Palermo, Sicily. (Calcara, Effem. scient. per la Sicil., N. 75, p. 101.)

Torquilla gastrodes Zigl. Beck, Index Moll., 1837, p. 58. Dalmatia.

Jaminia heptodonta Risso. T. glabra, nitida; anfr. 11, lineolis obliquis impressis sculpti; apertura septemdentata; epidermis fuscescens. Cirea Nizza. Long. 0.009 (Risso, Hist. Nat. Eur. Merid., iv, 1826, p. 92).

Torquilla hornbeckii Villa. See vol. xvi, p. 24.

Pupa libanotica Tristram. Shell cylindric-oblong, corneous or whitish, under the lens irregularly striate, the apex very obtuse; whorls 10, a little convex, the suture impressed; first 5 whorls very obtuse and rapidly increasing; 6th whorl about equal to the 7th; the last and penult strongly contracting, the

last carinate at the base and contracted at the aperture. Aperture semi-oval, one-toothed, the tooth standing on the callous; peristome whitish, reflected, continuous in a callous. Length 11, diam. 4½ mm. (*Tristram*).

Palestine: Ainat, Lebanon (Tristram).

Pupa libanotica TRISTRAM, Proc. Zool. Soc. Lond., 1865, p. 538.

This species has not been figured. It may belong to the *Enidæ*, but has been considered a *Torquilla*.

Pupa plusiodonta Holmberg. Shell subperforate, fusiform-ovate, thick, scarcely shining, unequally subplicate and striate, brownish fulvous, paler towards the apex; spire subovate-conic, the apex obtuse, suture deep; whorls 7⅓, gradually increasing, convex, the first brownish-tawny, smooth, the rest darker, the last very little ascending, one-third the length. Aperture oval, contracted by 8 pliciform teeth: two parietal, of which one is produced to the suture, the other more deeply placed, parallel, further from the right margin; two on the columella, of which one further from the base is higher than the other; one basal, is smaller than the rest; and three marginal, parallel and equidistant, the first nearly basal, the second going further in, the third deep; these being visible externally as whitish lines. Peristome acute, expanded, pale, whitish externally and within; columellar margin straight, the basal regularly curved, right margin moderately curved, becoming strongly so near the suture; margins separated, joined by a thin callous. Length 9½, diam. 3½, aperture 3½ mm. long, 2⅔ wide (*Holmberg*).

Argentina: on the left bank of the Rio Negro near where it enters the sea, a single specimen found among fluviatile, land and sea shells (*Pupa plusiodonta* HOLMBERG, Apuntes de Historia Natural, i, no. 2, Feb. 1909, p. 27).

It has not been figured. The description suggests a form of *Abida* or *Chondrina*. As the unique type was found among shells which had been collected some twenty-five years before, it appears likely that a stray European shell, perhaps from Italy, had got among them in the meantime.

The following names, without further information, except

that they belong to the subgenus *Torquilla*, are from Schaufuss, Molluscorum Systema et Catalogus, Samml. Fr. Paetel, 1869:

Pupa dalmatina Prtsch. Dalm. P. 85.
Pupa parrajena d'Orb. Cuba. P. 85.

Second edition of the same: Catalog der Conchylien-Sammlung von Fr. Paetel, 1873.

Pupa baldensis Parr. M. Bald. P. 107.
Pupa depressilabris Parr. Görz. P. 107.
Pupa formosa Parr. Balkan. P. 108.
Pupa inconspecta Parr. Serb. P. 108.
Pupa labiosa Parr. Grasse. P. 108. [= *P. braunii* var. *labiosa* Moq.?]
Pupa oblonga Parr. Italia. P. 108.
Pupa prolongata Parr. Banat. P. 108.
Pupa proxima Rm. Illyr. P. 108.
Pupa striatula Parr. Hispan. P. 108.
Pupa turgida. Zglr. Illyr. P. 109.

The same, edition of 1883:
Pupa anceps Fagot. Europ. P. 158.

The same, 4th edition, 2d part, 1889:
Pupa scalariformis Rm. Sicil. P. 304.

Pupa tricolor Sowerby, Conch. Icon., xx, pl. 20, f. 190. ? = *tricolor* Villa.

Subfamily VERTIGININAE.

Pupillid snails without inferior tentacles.

This group comprises Pupillidae having compact, oval, ovate or cylindric shells of quite small or minute size, usually 1½ to 3 mm. long, from brown to amber or olivaceous color, having the typical 6 teeth of the family, or varying to none or to a greater number. The axis is perforate, but usually closed in the adult stage. *Vertigininae* are abundant in Holarctic, Polynesian and Hawaiian faunas, almost wholly wanting in South American and African.

The subfamily, in its present limits, is a new group. The family *Vertiginidae* of Stimpson (Shells of New England, 1851, p. 53) comprised only the genus *Vertigo* including *V. simplex* Gld., but Stimpson also characterized his family by the want of inferior tentacles.

From the literature it may be gathered that some Pupillidae certainly belonging to other subfamilies are deficient in tentacles, and according to Gredler, a reliable observer, *V. genesii* has inferior tentacles. Further careful observations on many species are needed. The inferior tentacles are usually very short in Pupillidae, and may therefore be overlooked easily.

A general likeness may be traced between the shells of the genera now referred to Vertigininae; it appears to be a natural group; though the variation is so great throughout the family that definitions sufficiently elastic to cover any of the groups larger than genera become too comprehensive to be diagnostic.

The genera fall into two main geographic divisions: 1. northern or mainly Holarctic, including *Vertigo, Truncatellina, Sterkia* and their satellite groups, and 2. Polynesian and Tropical, with *Nesopupa* and the associated groups. Places where these divisions overlap are extremely few.

A list of fossil genera and species of Vertigininae follows the account of the genus Vertigo.

Genus VERTIGO Müller.

Vertigo O. F. Müller, Vermium terrestrium et fluviatilium Hist., ii, 1774, p. 124, monotype *V. pusilla* Müll.

Isthmia Gray, London Medical Repository, xv, 1821, p. 239, for "*Helix Isthmia cylindrica* Drap, t. 3, f. 30, 31," = *V. pygmæa* Drap. *Cf.* Dall. Tr. Wagner Inst. iii, pt. 2, p. 248; Nautilus xvii, 1904, p. 114, and Newton and Harris, Proc. Malac. Soc. London i, p. 72, footnote 1.—Gray, P. Z. S. 1847, p. 176, type *Vert. nitida* = *edentula* Drap.

Alæa Jeffreys, Trans. Linn. Soc. London xvi, 1830, p. 357. —Gray, P. Z. S. 1847, p. 176, type *A. palustris* Jeffr. = *V. antivertigo.*—Pilsbry, Nautilus xviii, 1905, p. 119.

Staurodon Lowe. Proc. Zool. Soc. 1854, p. 214, type *P. pygmæa* Drap. Not *Staurodon* Lowe, 1852.

Dexiogyra Stabile, Moll. terr. Viv. du Piémont, 1864, p. 104 (in Atti della Soc. di Scienze Nat., Milano, vi), for *V. moulinsiana*, *V. pygmæa*, *V. antivertigo*. *V. antivertigo* here designated as type.

Dexiogira De Betta, Moll. Prov. Veron., 1870, p. 83.

Nearctula Sterki, Nautilus vi, 1892, p. 5, type by orig. des., *V. californica* Rowell.

Haplopupa Pilsbry, Nautilus xi, Feb. 1908, p. 119, monotype *V. dalliana*.

Pupa Draparnaud, 1801, and of many subsequent authors. Not *Pupa* Bolten, see Vol. XXIV, p. 267.

Small, oval, oblong or ovate, compact Pupillids, the summit very blunt; usually glossy and some shade of brown. Aperture having the typical six teeth of Pupillidae, none of them concrescent, part or all of them sometimes wanting; angular lamella not marginal when present. Outer lip straightened or bent inward in the middle. Animal without inferior tentacles.

Type, *V. pusilla* Müll.

The apertural teeth of *Vertigo* show great modifications in number and size. There are often small teeth accessory to the six typical ones, and in other forms there has been reduction of teeth, the basal, angular and upper palatal being lost in many species. Other forms have gone further, toothless species resulting from degeneration of teeth in several phyletic lines within the genus in both Europe and America. These modifications make a diagnosis of the genus almost impossible.

These teeth, though among the best specific characters, are subject to wider variation than usual. The secondary denticles are especially likely to vary; but also the basal fold, the angular lamella and often the upper palatal fold are variable, being either present or absent in many species.

In many Vertigos the *basal fold* is subcolumellar in position, rather than on the basal margin at the foot of the columella. It has therefore often been counted as a second columellar tooth in descriptions.

In Europe, several diverse forms have given rise to *sinistral* species, but up to this time no sinistral species or specimens have been reported from America or Japan.

The shells of *Vertigo* are usually clean, but *V. dalliana* at least occurs daubed with slime and dirt, like many Gastrocoptinae.

Key to the subgenera of Vertigo.

a^1. Angular lamella curving towards and connected with the outer lip; lamella and plicae well developed.
Subgenus *Ptychalœa*, species no. 41.

a^2. Angular lamella, when present, standing free of the peristome, not emerging to the edge.

b^1. Columellar lamella short, lamellar or toothlike, subhorizontal or inwardly ascending a little, sometimes absent. Subgenus *Vertigo*.

b^2. Columellar lamella subvertical, spirally ascending (pl. 5, fig. 18); upper palatal fold entering very deeply, the lower shorter or wanting.
Subgenus *Vertilla*, species nos. 81, 82.

b^3. Columellar lamella subvertical, the upper palatal fold shorter than the lower or wanting; no angular lamella or basal fold in known species.
Subgenus *Vertillaria*, species no. 31.

b^4. Columellar lamella curving down at its inner end (pl. 13, figs. 2, 4); lower palatal fold entering very deeply, much longer than the upper.
Subgenus *Angustula*, species nos. 32, 33.

Nomenclature.

In his original publication of *Isthmia*, 1821, Gray refers to only one species, identical with *Vertigo pygmœa*. On account of his somewhat irregular system of indicating the groups of "Helix," Harris & Newton have ruled this paper out as not binomial, stating that the name must date from Gray, 1840. It may be observed that their ruling has not been followed by any other author. All the names of a work stand or fall together; one cannot accept part as binomial and

reject the remainder as polynomial. In the present case, Gray was in effect using subgenera, and not what is commonly understood as polynomial terms; I have not found Gray's publication of *Isthmia* in 1840, though he quotes that date in his paper of 1847, where *V. nitida* (presumably = *Pupa edentula* Drap.) is mentioned as the type. *Isthmia* has been extensively used in Europe for the genus *Truncatellina* Lowe.

Alæa was proposed by Jeffreys for dextral Vertigines, but later, in the British Conchology, he considered "this generic addition to be quite useless and untenable." Dall has expressed a similar view; and I fully agree with these authorities, although Boettger, Westerlund and most German authors have used *Alæa*. *Dexiogyra* was proposed for the same group, and is even less defensible.

The value of *Nearctula* and *Haplopupa* remains to be ascertained when the affinities of their type species are better understood. They do not seem separable from the subgenus *Vertigo* by sufficient characters, as at present known.

Distribution of Vertigo.

Vertigo is essentially a northern genus of humid stations or regions. The group of *Vertigo modesta* is circumpolar, numerous in races and individuals above the parallel of 60°, and extending south at increasing elevations, in the Canadian and Transition zones, to about lat. 33° in Arizona, there only in mountain-top colonies. In Europe it does not go so far south, only to the Austrian Tyrol.

Only 5 species of *Vertigo* have been reported from the American tropical fauna (Mexico and the West Indies), 3 of them being identical with northern species, the other 2 doubtfully distinct from the widely spread *V. ovata*. This identity, together with the fact that they appear to be among the rarest snails in those regions, surely indicates that *Vertigo* is a late comer in the American tropics, if not, as I suspect, imported by man. Species have been found as far south as about 18 N. Lat.

In the Palæarctic fauna, Scandinavia and the eastern Alps (Tyrol) have the greatest development of the genus. No

species is known from as far south as the 35th parallel, and only a few species (in Algeria and Tunis) approach it.

Where *Vertigo* occurs in arid regions it inhabits humid places, usually at high levels. Thus, in the arid zone of southern New Mexico and Arizona, *Vertigo* is often abundant in the forests mainly above 8000 ft., where there is abundant shade and moisture. It may usually be found where there are aspens.

Part of the species of temperate latitudes of Europe and America are identical or very similar. Their distribution probably dates from the Pliocene. Doubtless much if not all of the evidence of the route has been destroyed by glacial action. While the present distribution of these closely allied forms suggests emigration around the north Atlantic, a Pliocene distribution through northern Asia seems far more likely, though northern Pliocene fresh-water deposits which might contain traces of this fauna are still unknown.

This interpretation is in harmony with the facts of present distribution relative to the circumpolar *modesta* group, where the data indicate continuity of distribution within post-Pliocene time from Alaska west to Lapland, and a southern movement during Glacial time. The other Vertigines, less tolerant of cold and for the greater part more differentiated, no doubt were pressed south earlier, and were exterminated in Siberia and the mountain states of western America. The survivors are chiefly at the extremes of their former range, in Europe and in the eastern half of North America.

Vertigo pygmæa is to be regarded as a member of that Pliocene fauna, still unchanged in the two hemispheres, though in both giving rise to various divergent races. *V. ovata* and *antivertigo* are but slightly differentiated. *V. moulinsiana* and *V. ventricosa* differ slightly more, and a few other species could be similarly paired. In both hemispheres there are also far more differentiated forms of *Vertigo*, mainly southern in distribution, indicating a long period of evolution in America as well as in Europe.

Where *Vertigo* arose may perhaps never be known. The presence of typical species in the Oligocene of Central Europe,

and of highly peculiar species in the Bermudas and Bonins—outlying, degraded old volcanic masses which have been base-levelled and further reduced by subsidence—indicate a long period of evolution in the northern continents. Its absence in the Atlantic archipelagos—Azores, Madeira, etc., is perhaps due to belated arrival of *Vertigo* proper in extreme western Europe. There are a few Eocene species probably belonging to the Vertigininae, which indicate the presence of the subfamily in western Europe prior to the Oligocene. The single genus *Staurodon* in Madeira points in the same direction.

The species of *Vertigo* are considered in four groups:

I. American species.

II. Species of Japan and the eastern border of Asia.

III. Palæarctic species of Europe, Asia and northern Africa.

IV. Tertiary species.

I. American species of Vertigo.

After the early work of Say and A. Binney, the American Vertigines were studied by Dr. Gould, and twenty years later by Professor E. S. Morse, who was a pioneer in the critical study of our minute land shells. His results, published in various papers between 1864 and 1868, were incorporated by W. G. Binney in his Terrestrial Mollusks vol. V, becoming a permanent addition to science. In 1889 Dr. V. Sterki published the first of a long series of papers on Pupillidæ which have made him the first American authority on the subject. We owe to him the discovery of many of the most remarkable of our Vertigos, and also valuable critical work on the older species, their mutations and races. Many collectors were induced by him to search for the small Pupillidæ, with gratifying results.

In the preparation of the following monograph the author has had frequent occasion to consult Dr. Sterki. It will be seen that his published work, letters and MS. notes have been quoted freely; and the monograph is much the better for his generous assistance. In every case Dr. Sterki's contributions have been acknowledged in the text.

Specimens of all of the American species except *V. arthuri* have been examined in the course of this work, including types, paratypes or specimens from the describer of all except a few of the older species.

SPECIES OF BERMUDA.—The species, while strongly differentiated, are evidently related to forms of the eastern United States.

V. marki Gul., no. 18 (related to *V. tridentata*).

V. numellata Gul., no. 7 (remotely related to the *ovata* group).

V. bermudensis Pils., no. 33 (related to *V. milium*).

SPECIES OF THE WEST INDIES.—These tropical forms may be presumed to be of northern origin, since all of them are either identical with species of the United States or at least not satisfactorily shown to be different. Possibly all may be importations within the period of commerce; I cannot otherwise understand the absence of differentiation in those I have been able to examine. The following have been recorded.

V. ovata Say, no. 4. Cuba, Haiti, Porto Rico.

V. neglecta Poey. Cuba (? = *ovata*, no. 4).

V. hexodon C. B. Ad. Jamaica (? = *ovata*, no. 4).

V. gouldii Binn., no. 11. Jamaica, Cuba, St. Croix, Tortola.

V. milium Gld., no. 32. Jamaica.

V. cubana Dall. "Cuba" (= Hawaiian *Lyropupa*).

Key to American groups of Vertigo.

a^1. Columellar lamella crescentic, its inner end turning downward; lower palatal fold entering to the dorsal side and turning down at the end. Teeth all well developed.
Subgenus ANGUSTULA, species nos. 32, 33.

a^2. Columellar lamella subvertical; lower palatal fold short, a conspicuous external constriction over it (pl. 8, fig. 10); 3 or rarely 4 small teeth. Southern states.
Subgenus VERTILLARIA, species no. 31.

a^3. Columellar lamella short, entering horizontally or ascending inwardly, or wanting. Subgenus *Vertigo*.

b^1. Lower palatal fold entering to the dorsal side; 6 well developed teeth; a very high crest. Bermuda.
Group of *V. numellata*, species no. 7.

b^2. Without the above combination.

c^1. 6-9 teeth; crest or auricle generally well developed; rather strong, dark colored forms (pl. 6). Group of *V. ovata*, species nos. 1-6.

c^2. 2-6 teeth (pl. 7).
Group of *V. pygmæa*, species nos. 8-20.

c^3. 4-6 teeth; shell cylindric or oblong, *striate*.
Group of *V. coloradensis*, species nos. 21-24.

c^4. 0-5 teeth, never a basal fold; cylindric or ovate (pl. 10).
Group of *V. modesta*, species nos. 25-28.

c^5. 0-4 teeth, no basal fold; no trace of a crest; cylindric, ribbed or with traces of ribs (pl. 9).
Group of *V. californica*, nos. 29-30.

The keys to species are often insufficient for the identification of critical or variable forms, but they are offered as better than no guide. I have not been able to make differential definitions of the groups of *V. ovata*, *V. ventricosa*, *V. modesta* and *V. californica*.

Group of Vertigo ovata.

Rather dark-colored, glossy shells usually having 7 to 9 teeth, never less than 5, the basal fold always present, but often subcolumellar in position; angular lamella present, often an infraparietal also. Crest and auricle generally distinctly developed.

Key to species.

1. Shell distinctly striate, the palatal callus, crest and impressions behind the lip weak or wanting. Austro-riparian. *V. rugosula*, no. 1.
   Shell weakly or scarcely striate. 2.
2. Last half whorl deeply impressed or constricted over the palatal folds (pl. 8, fig. 14). Lamellae and lower palatal fold long. Southern states. 3.
   Last whorl only moderately or slightly impressed over the lower palatal fold (pl. 6, fig. 2). 4.

3. 1.8 x 1 mm.; seven teeth. *V. alabamensis*, no. 2.
   1.5 x 1 mm.; six teeth. *V. a. conecuhensis*, no. 2*a*.
4. More than 2.6 mm. long, of 6 whorls; spire long, the aperture relatively small. *V. morsei*, no. 3.
   Shell smaller. 5.
5. Ovate, the spire very convexly conic; length about 2.2, diam. 1.3 to 1.4 mm.; 5 whorls; usually with 7 to 9 teeth. 6.
   Oblong-conic, the spire more slender than in *V. ovata*; 2.5 x 1.35 mm., 5½ whorls. California. *V. berryi*, no. 5.
   Oblong-cylindric, 2 x 1.1 mm., 5 whorls. Rocky Mountains. *V. binneyana*, no. 6.
6. Crest and auricle well developed. 7.
   Crest and auricle very weakly developed. California. *V. o. mariposa*, no. 4*b*.
7. Teeth moderately large. *V. ovata*, no. 4.
   Teeth longer and stronger. Texas. *V. o. diaboli*, no. 4*a*.

1. Vertigo rugosula Sterki. Pl. 8, figs. 1, 2, 3.

"Related to *V. ovata* and *gouldii*, in shape more elongated than the latter, more cylindrical and somewhat larger. Apertural parts and lamellae much like those of ovata, but the columella is decidedly longer and straighter, and the inferior columellar lamella is distinctly placed on it. Of a peculiar formation is the surface: of the 5 well rounded whorls, about one and a half of the upper are nearly smooth; the following with exception of the last are distinctively and regularly striated, the last very finely but distinctly rugose in the sense of the lines of growth; near the aperture again striated. Color, dark chestnut. Length 1.8 to 2, diam. 1.1 mm." (*Sterki*).

South Carolina: Sullivan's Island, type loc., W. G. Mazyck. Tennessee: near Cowan and near Sherwood, H. H. Smith. Mississippi: Pass Christian, B. Walker. Louisiana: De Soto Parish, L. S. Frierson; Lovett Landing, Morehouse Parish, C. B. Moore. Oklahoma: Limestone Gap, Ferriss & Pilsbry. Texas: Lee Co., J. A. Singley; Navidad River bottom, Jackson Co., J. D. Mitchell.

Vertigo rugosula STERKI, Proc. A. N. S. Phila. 1890, p. 34; Nautilus iv, p. 39, pl. 1, f. 3; reprinted by Binney, Fourth Supplement T. M. vol. v, in Bull. Mus. Comp. Zool. vol. 22, no. 4, 1892, p. 201, figure.—WHEELER, Nautilus xxv, p. 124 (Monte Sano, Madison Co., Ala.).

Besides the smaller size, darker color, and characteristic striation, which is much more regular and stronger than in *V. ovata*, this species differs by the shape of the angular lamella, which is rather long, low in front, rising inwardly. It emerges about as far as the parietal lamella, which is strong and quite long. The infraparietal lamella is a very small tubercle, as a rule, sometimes scarcely or not perceptible. The inner end of the upper palatal fold turns downward. Further differences are given by Dr. Sterki: "The last whorl is relatively smaller, the aperture is somewhat less broad; the crest and impressions over the palatal folds are less marked or wanting; the palatal callus is thin or wanting; the basal fold is situated higher on the columellar margin, in the position of a subcolumellar lamella, while in *V. ovata* it is basal."

In profile view there is a slight prominence of the outer lip, at the termination of a shallow depression, but it is far less developed than the "auricle" of *V. ovata*.

A topotype received from Dr. Sterki (fig. 3) measures, length 2, diam. 1.2 mm.; barely 5 whorls.

Dr. Sterki gave also the locality Fish Camp, Fresno Co., California, H. Hemphill; I have not seen the specimens but possibly they are what I am calling *V. ovata mariposa*, a shell which does not have the distinct striation of *V. rugosula*.

1*a*. *Vertigo rugosula oralis* Sterki. Pl. 8, figs. 5, 6, 7.

"It is somewhat smaller [than *rugosula*], ovate, the striation and rugosity of the surface are less marked, and the inferior apertural [infraparietal] lamella is wanting; in turn it has in most examples a lamella at the base (between inferior columellar and inferior palatal) and the callus in the palatal wall is rather strong. The coloration of part of them is somewhat lighter. It cannot be confounded with *V. ovata* Say, its relations to the type of *rugosula* being evident, and in addition,

ovata has been found with it. Nor can it be referred to *ventricosa*—it is larger and stronger, of much darker color, its surface is not so smooth and polished, it has 3 or even 4 lamellæ more, and the columella is longer'' (*Sterki*, for var. *ovulum*).

Florida: Volusia Co., type loc., G. W. Webster, Pilsbry and others. Alabama: Stevenson; Tallapoosa R., about 7 miles S. E. of Wetumpka.

[*Vertigo rugosula* var.] *ovulum* STERKI, Proc. A. N. S. Phila. 1890, p. 35. Not *Pupa ovulum* Pfr., 1841, also a *Vertigo*.—*Vertigo rugosula ovalis* Sterki, PILSBRY & VANATTA, Proc. A. N. S. Phila. 1900, p. 608 (substitute for *ovulum* Sterki).—*V. r. oralis* Sterki, PILSBRY, Nautilus xix, 40 (Cape Sable, Fla.)—WHEELER, Naut. xxvi, p. 15 (region of Huntsville, Ala.)—VANATTA, Naut. xxvi, 20, 33 (near Marco; Lee Co.; Seminole Pt., Monroe Co., Fla.).

It is generally stouter in figure than *V. rugosula*, but the contour varies widely. Some shells are very globose.

Length 1.7, diam. 1.1 mm., 4½ whorls } Tallapoosa R. 7 miles
Length 2, diam. 1.2 mm., 5 whorls } s. E. of Wetumpka, Ala.
Length 1.6, diam. 1.1 mm. } Volusia Co., Fla.
Length 1.9, diam. 1.15 mm. }

The angular lamella is shorter than in *V. rugosula*, and it is not lower in front. The lip-point is more strongly developed in some specimens from Alabama (fig. 5) than in most of those from Florida (figs. 6, 7). There is often a noticeable light-colored crest behind the lip. In a specimen from ''Mt. Taylor,'' Volusia Co., the suprapalatal and infrapalatal folds are strongly developed.

Though this form was at first described as a variety of *V. rugosula*, Dr. Sterki regards it as nearer to *V. ovata*, and very close to the European *V. antivertigo*. The name was published in 1900 as *V. r. ovalis*, but this appears to have been an error for *oralis*, under which name it has appeared in several subsequent lists.

2. VERTIGO ALABAMENSIS Clapp. Pl. 8, figs. 9, 13, 14.

The shell is cylindric-oval, perforate, convex, sutures well

impressed, the last whorl somewhat tapering below, bulging above, and deeply constricted over the palatal folds; crest well marked. Lip well reflected, pale brown, and deeply constricted opposite the upper palatal, simple above the constriction, and with a strong callus or internal collar running down and connecting with the columella. Denticles 7, the parietal high, sinuous and deeply entering; angular strong, flat; upper palatal deep, very high in front and tapering to the rear, lower palatal very deeply seated, inner end back of the subcolumellar lamella, both palatals distinctly showing from the outside as white lines. Columellar lamella strong flat; subcolumellar bifid, strong; basal fold distinct, set on the callous collar just below the subcolumellar lamella. Length 1.8, diam. 1.10 mm.; length of aperture 0.69, width 0.63 mm. (Clapp). 5½ whorls.

Alabama: among rotting leaves in a ravine near junction of North River with Black Warrior, Tuscaloosa Co., H. H. Smith.

Vertigo alabamensis Clapp, Nautilus xxviii, April, 1915, p. 137, pl. 6, f. 6, 6*a*, 6*b*.

This is a peculiar species. The parietal lamella is very strongly developed, high and long. The angular lamella is far longer than usual in Vertigo, and converges inwardly towards the parietal. The columellar lamella descends near its outer end, and penetrates deeply. The "subcolumellar" descends obliquely inward, its crest either emarginate or level (pl. 8, fig. 9). It is apparently to be considered a basal fold, since the palatal callus extends to it. If this interpretation is correct, the tooth described as the basal must be an infrapalatal fold. It is usually a very low tubercle, and very rarely "distinct," as described and figured by Dr. Clapp. The palatal folds are very strongly developed, the upper a high lamina, the lower rising to a peak deep within.

The types of this and the following form are in coll. G. H. Clapp; figured from paratypes in coll. A. N. S. P.

2*a*. *Vertigo alabamensis conecuhensis* n. subsp. Pl. 8, fig. 12.

At Evergreen, Conecuh Co., Ala., Mr. Smith found a variety which differs from the type in being shorter and more globose

with the teeth less strongly developed and the basal fold absent in all shells examined. Length 1.53, diam. 1 mm. Length of aperture 0.58, width .63 mm. (*Clapp*).

Vertigo alabamensis conecuhensis CLAPP, Nautilus xxviii, April, 1915, p. 137, pl. 6, f. 7, 7*a*.

The size varies from 1.6 x 1.05 mm. to 1.5 x 1 mm.

3. VERTIGO MORSEI Sterki. Pl. 6, figs. 8, 9.

"Shell large (for the group), cylindrical-turriculate, with a rather acute apex, imperforate rimate, with few obsolete striae of growth, shining, translucent. Whorls six, rather slowly and regularly increasing, the last scarcely higher than the penultimate and rather narrower, somewhat sloping towards the base, slightly ascending at the aperture; suture deep. Aperture lateral, scarcely oblique, comparatively small, inferior and palatal part well-rounded, the latter with an angular impression and slightly protracted in about its middle, the upper half more strongly curved, peristome everted; on the palatal wall, at some distance from and parallel with the margin [externally] a moderate crest, behind it a deep and large impression over the palatal folds, and in front of it a groove corresponding with the impression at the auricle; inside the crest there is a distinct callus of the same color as the shell; apertural lamellae and folds typically nine: three on the parietal wall (the same as in *V. ovata*), the largest whitish; two on the columella, the superior strong, vertical above, then in an angle turning horizontally, the inferior horizontal, lamelliform, thin, high and directed obliquely upward; basal small, sometimes double, rarely 0; palatals high, and rather long, curved and directed upward; suprapalatal small, nodule-like.

"Alt. 2.7, diam. 1.3; apert. alt. 0.9, lat. 0.8 mm." (*Sterki*).

New Jersey: White Pond, Warren Co., Pilsbry. Michigan: Kent Co., type loc., Dr. De Camp. Ohio: Sandusky; fossil in marl, Castalia, Erie Co. Indiana: margins of Lakes James, Tippecanoe and Maxinkuckee under dead weeds, wood etc. L. E. Daniels. Illinois: Joliet, J. H. Ferriss.

Vertigo morsei STERKI, Nautilus viii, Dec., 1894, p. 89.—

Blatchley and Daniels, 27th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, 1902, p. 587, 632 (Kosciusko, Marshall and Steuben counties, Ind.—Walker, Moll. of Michigan, 1906, p. 516, f. 149 (Dewey's Mill, near Grand Rapids, type loc.; Eaton, Bay and Washtenaw counties, Mich.).

"In one example the inferior parietal tooth is wanting, in another the basal only trace-like, and in a third the same is double, as frequently found in *V. ovata*. With the latter species, *V. morsei* has much resemblance, especially in the aperture: the configuration and the 'teeth' are the same, but the inferior columellar, and the two principal parietals, are rather larger, and markedly directed upward. The main difference is in the number and relative size of the whorls: while in *V. ovata* they are five, and rapidly increasing, the last predominating, in our species there are six, slowly increasing, the last, and consequently the aperture, comparatively small. This is a radical difference, and gives the shell quite another aspect, so that there can be no question about its being distinct. But *V. morsei* is also decidedly larger, *V. ovata* not, or little, exceeding 2 mm. in altitude" (*Sterki*).

The species is named in honor of Prof. E. S. Morse.

Specimens determined by Dr. Sterki measure:

Length 3, diam. 1.5 mm., 6½ whorls.

Length 2.6, diam. 1.3 mm., 6 whorls.

The color is from auburn to chestnut-brown. There is a distinct crease behind the lip, from the crest to the lip-point, and over both palatal plicae there is a wide depression externally. Dr. Sterki writes that out of 100 specimens examined from the marl of Erie Co., Ohio, 10 have an infra-parietal, quite small or vestigial.

While it stands very close to *V. ovata*, this species does not appear to intergrade, so far as seen. It is the largest *Vertigo* known.

4. Vertigo ovata Say. Pl. 6, figs. 1 to 4, 7.

"Shell dextral, subovate, brown; apex obtuse; whorls five, glabrous; suture not very deeply impressed, body whorl indented near and upon the labrum; aperture semioval; labrum

five-toothed, of which three are situate on the transverse portion of the lip, parallel to each other, equidistant, the superior and inferior ones being small, the latter sometimes obsolete, the intermediate one lamelliform, prominent, and the two others situate on the columella, approximate, extending at right angles to the three preceding ones, the superior one oblique and smaller; labrum reflected but not flattened, bidentate, teeth lamelliform, prominent; umbilicus distinct. Length less than one-tenth of an inch. Breadth nearly 1/20 inch'' (*Say*).

Length 2.2, diam. 1.4 mm.; 5 whorls (Dutchess Co., N. Y.).

Length 2.3, diam. 1.4 mm. (Ottawa, Canada).

Length 2.15-2.35, diam. 1.35 mm. (Oswego, Ore.).

Labrador and Alaska, south to Alabama, Texas and Arizona; State of Vera Cruz, Mexico and West Indies. Type loc. Philadelphia.

Vertigo ovata Say, Journ. A. N. S. Phila. ii, 1822, p. 375. Binney, Man. Amer. Land Shells, 1885, p. 334, f. 362, 363.—Morse, Amer. Nat. i, 1868, p. 668, f. 67, 68.—Taylor, Nautilus v, 91 (Vancouver I.).—Webster, Naut. v, 119 (Florida).—Stupakoff, Naut. vii, 135 (Allegheny Co., Pa.).—Pleas, Naut. vii, 68 (Henry Co., Ind.).—Squyer, Naut. viii, 63 (Mingusville, Mont.).—Prime, Naut. viii, 70 (Long Island, N. Y.).—Sterki Proc. U. S. N. M. xi, 1888, p. 375, pl. 42, f. 5-7; Naut. viii, 89 (Kent Co., Mich.); ix, 116 (San Marcial, N. M.); xxix, 123 (Geneva, O.).—Schick, Naut. viii, 137 (Philadelphia).—Sargent, Naut. ix, 89 (Clearwater, Minn.).—Hanham, Naut. x, 101 (Quebec); xiii, 3 (Winnepeg).—Pils. & Ckll., Naut. xiv, 86 (Las Vegas, N. M.).—Cockerell, Naut. x, 41-43 (Mesilla, near Silver City and Rincon, N. M.)—Chadwick, Naut. xix, 58 (near Milwaukee, Wis.).—Pilsbry, Naut. xix, 130 (Grant, N. M.); xxv, 75 (Monroe Co., Pa.).—Walker, Naut. xx, 81 (Monroe canyon, Neb.); Moll. of Michigan, 1906, p. 516, fig. 148 (entire state).—Smith, Naut. xx, 90 (Otsego Co., N. Y.).—Wheat, Naut. xx, 101 (Cayuga Lake, N. Y.).—Hanna, Naut. xxiii, 95 (Douglas Co., Kansas).—Nylander, Naut. xxii, 143 (Aroostook Co., Me.).—Henderson, Naut. xxii, 9 (Amarillo, Texas).—Pilsbry & Ferriss,

Naut. xxii, 104 (Albuquerque, N. M.).—Berry, Naut. xxiv, 63 (Unity, Me.); xxix, 125 (Winnecook, Mont.).—Wheeler, Naut. xxv, 124 (Monte Sano, Madison Co., Ala.).—Greeger, Naut. xxix, 89 (Payne Co., Okla.).—Over, Naut. xxix, 91 (Deuel and Clay Co., S. Dak.).—Daniels, 27th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, 1902, p. 632 (Kosciusko and Steuben counties, Dunreith, Arlington, Lawrenceburg and Indianapolis, Ind.).—J. Henderson, Univ. of Colo. Studies iv, p. 171, fig. 9 (Twin Lakes and Saguache, West Cliff, Trinidad, and *V. o. antiquorum* Ckll., Grape Creek, Colo.).—Johnson, Fauna of New England 13, 1915, p. 215 (all New England states).—Dall, Land and Fresh Water Mollusks, Harriman Alaska Exped. xiii, 1905, p. 32 ("Ungava Bay, Labrador! Victoria, British Columbia! St. Paul, Kadiak I.! Alaska; Tigalda Island, Aleutian chain! Laggan, Alberta, Manitoba").

Pupa ovata Say, Gould, Boston Journ. Nat. Hist. iv, 1843, p. 350, pl. 16, f. 7, 8.—Pfr., Monogra. ii, p. 360.—v. Martens, Biol. Centrali Amer., Mollusca, p. 327.—*Isthmia ovata* Say, Morse, Journ. Portland Soc. N. H., i, 1864, p. 38, f. 93; pl. 10, f. 94.

Zonites upsoni Calkins, Valley Naturalist ii, Dec., 1880, p. 53, fig. —. *Cf.* W. G. Binney, Suppl. to Terr. Moll. V, Bull. M. C. Z. xi, no. 8, Dec., 1883, p. 149, pl. 1, f. L (immature stage).

Pupa ovata forma nov. *antiquorum* Cockerell, Zoe ii, April, 1891, p. 18.

In the collection of the Academy *V. ovata* is present from Prince Edwards Island, Quebec and Ontario, through all the eastern states south to the Potomac, and west of the Alleghanies south to Alabama and Galveston, Texas; through all of the northern states west to Montana and Colorado; also in the Rio Grande Valley, south to Mesilla, New Mexico; in southern Arizona near the Mexican boundary in the Huachuca Mts., and westward to Tempe and Jerome. It is, however, decidedly local in Arizona and New Mexico, and except in the Huachucas, the specimens are from stream debris, perhaps always washed from greater elevations than the places

mentioned. In the Pacific states, there are specimens from Seattle, Washington (P. B. Randolph) and Oswego, Clackamas Co., northern Oregon (J. A. Allen). I have not seen it from Idaho, Utah, Nevada or California, but allied or subspecific forms occur in California. Specimens are also wanting in this collection from the southern Atlantic states, from Virginia to Florida. Antillean specimens are noted below.

The Alaskan records are all from Dall. It appears to extend north to about 58°, south to about 18°. If the specimens from these extremes are reliably determined, *V. ovata* has the greatest range in latitude and climate of any *Vertigo* or other Pupillid snail in the world, so far as I know.

"*V. antivertigo* Drap. and *V. ovata* Say have almost exactly the same dentition as to number, size, and shape, and places of the single lamellae, and also as to other features of the shells they are very similar. *V. ovata*, in general, is a little larger, of lighter coloration, the margin is somewhat more expanded; the aperture appears larger because the columellar margin is relatively a trifle shorter; the whorls increase in size somewhat more rapidly, and the suture is a trifle deeper. Specimens from Massachusetts are not only of the same or even a darker shade [than *V. antivertigo*], but also of the same and sometimes of a smaller size, and other distinguishing features are slightly marked. They resemble each other so much that it is difficult to separate them, and if collected at the same place no one would regard them as even distinct varieties. I hesitate, however, to declare them identical because I have not yet made a comparison of the soft parts. Doubtless they are parallel forms, and if found on the same continent would be regarded as varieties of one species. *V. antivertigo* is remarkably constant throughout Europe so far as I know it, while *V. ovata* is on the contrary quite variable, owing, possibly, to the greater differences in climate. Also a few decided varieties exist and maybe more will be found; the future study of these forms is likely to be of great interest" (*Sterki*).

I have not seen var. *antiquorum* Ckll., but no differential characters of importance appear in the description, which follows.

"*Pupa ovata* forma nov. *antiquorum*. 2 mm. long; lamellæ 7; three on parietal wall, the central one large and slender, the others very small: two on columella, these approximately of equal size, and both rather slender; two on external wall, continued backwards, the upper one large and curved downwards about its middle. Whorls 4½, body-whorl inflated, the others diminishing regularly and rather rapidly towards the apex, outer lip conspicuously curved inwards opposite the upper tooth on external wall. Posttertiary deposit at West Cliff, Colorado. This form also occurs living, as Dr. Sterki, to whom I sent a specimen says it 'is of a form of which I have seen examples from many parts of the country, of the same size, shape and formation of lamellae.'" (*Ckll.*).

Translation of the original description of *Pupa ovulum* follows:

"*Pupa ovulum* Pfr.—Shell minute, dextral, slightly rimate at base, apex obtuse, shining, brown; whorls 5, a little convex, narrow, the last one inflated and impressed in the middle; aperture 6-toothed: two equal teeth on the columella, two in the right margin and two in the left. Length 1, diam. ½ lin. Vera Cruz (Hegewisch). Very like *Vertigo pusilla* Müll., but dextral, brown, the whorls less convex" (*Pupa ovulum* PFEIFFER, Symbolae ad Hist. Hel. i, 1841, p. 46).

P. ovulum was placed in the synonymy of *Pupa ovata* Say in the *Monographia* ii, 1848, p. 361; Pfeiffer there referring the figures in Küster (pl. 14, figs. 1, 2) to *ovulum*, so it may be inferred that they were drawn from Vera Cruz specimens; though in the text of Küster they are called *Pupa ovata* Say, and a different description is given. The figure is so poorly drawn that it might represent any form of the *ovata* group.

Subsequent collectors do not appear to have found the Vera Cruz form. Its identity with *V. ovata* remains to be verified. There are no recent records of *V. ovata* from Mexico.

Antillean forms provisionally referred to V. ovata.

Forms which appear referable to this species are before me from Porto Rico, Santo Domingo and Cuba; and the species described as *Vertigo neglecta* and *Pupa hexodon*, from Cuba

and Jamaica, have not been satisfactorily differentiated. Until sufficient material is brought together for definite conclusions the whole may be referred provisionally to *V. ovata*.

A bleached *Vertigo* from Santo Domingo, collected by W. M. Gabb, measures 1.9 x 1.2 mm. There is a suprapalatal tubercle but no other accessory teeth. The surface is distinctly, finely but not sharply striate, but otherwise agrees with *ovata* (pl. 13, fig. 13).

Three specimens from Humacao, Porto Rico (pl. 13, fig. 16), similar to *V. ovata* in color and surface, are small, length 1.7, diam. 1.15 mm., with 4⅔ whorls. There are weak infrapalatal nodules in two of them, all having a suprapalatal. None has an infraparietal lamella. Possibly this and the preceding forms are separable as subspecies, but the material seen is insufficient for a decision.

The J. B. Henderson collection contains a Cuban specimen of *V. ovata*, received from Poey through Gill, 2.1 x 1.36 mm., having a minute suprapalatal but no other accessory teeth. It does not differ from many northern examples.

Pupa hexodon is not known to me by Jamaican specimens. In the description, repeated below, there is nothing to differentiate it from six-toothed individuals of *V. ovata*.

Pupa hexodon (C. B. Adams). "Shell ovate; brown; smooth and shining; spire with convex outlines; whorls 5, rather convex, with a well impressed suture; aperture semi-oval, with the transverse lip rather oblique, constantly with six teeth, of which two are on the transverse lip, the inner one being a little larger; two teeth are on the columella, the upper one being a little larger, and on the outer lip are two, of which the lower one is a little larger; umbilicus very small. This species resembles *P. ovata* Say. Length .085 inch, breadth .055 inch" [about 2.12 x 1.4 mm.] (*Adams*).

Jamaica, C. B. Adams.

Pupa hexodon C. B. Adams, Contributions to Conchology, no. 3, p. 37.—Shuttleworth, Diagn. n. Moll., no. 6, p. 145.

Vertigo neglecta Poey (pl. 13, fig. 11). Shell dextral, rimate-perforate, ovate, very delicately striate, thin, pale brown; spire conic, obtuse; whorls 4½, convex, the last ex-

ceeding half the total height of the shell. Aperture subrotund, coarctate, 4-toothed: two very minute marginal teeth on the columella; one palatal, short; one strong, marginal in the process of the right margin. Peristome simple, expanded, the margins seperated by the lack of a callus; no apertural tooth. Length 1⅔, diam. 1 mm. Aperture small (*Poey*).

Cuba: Cardenas, on the sandy shore (R. Arango).

Vertigo neglecta Ar. mss., Poey, Memorias sobre la Historia Natural de la isla de Cuba, ii, 1856, p. 30, pl. 2, f. 17, 18.—Pfr., Monographia v, p. 328.

This has been surmised to be a *V. ovata* without the parietal teeth; and as the type was taken on the shore, it may very likely have been a dead shell in which the parietal callus bearing the teeth had scaled off,—not an unusual condition in drifted shells.

4*a*. *Vertigo ovata diaboli* n. subsp. Pl. 6, figs. 11, 12.

All of the lamellae and plicae are larger than in *V. ovata*, entering further; infraparietal lamella developed. Palatal plicae, especially the upper, which converges towards the lower, very strong and long. The entering point of the outer lip is well developed, and the crest behind the lip moderately strong, but lower than in typical *ovata*.

Length 2.2, diam. 1.25 mm.; 5 whorls (type).

Length 2.3, diam. 1.3 mm.

Texas: drift debris of Devil's River, about 4 miles from the Rio Grande, Val Verde Co.; collected by Ferriss and Pilsbry, 1903. No. 90437 A. N. S. P.

The specimens are all "dead" shells, but appear to have been lighter-colored than typical *V. ovata*. The point of the outer lip is seen to project well forward, in a profile view. The impressions behind the lip are about as in *V. ovata*. Perhaps a distinct species, but as it is known by a single gathering, it is left under *V. ovata* for the present.

4*b*. *Vertigo ovata mariposa* n. subsp. Pl. 6, figs. 5, 6.

The shell has the usual broadly ovate shape and auburn or darker color. The teeth are about as in typical *V. ovata*.

Lower palatal is longer and enters more deeply than the upper. The basal is subcolumellar in position. *The outer lip bends inward only very slightly*; the crest and the external impression over the palatal plicae are but weakly developed. Length 2.2, diam. 1.35 mm.; length of aperture 0.85 mm.; 4¾ whorls.

California: Mariposa Co., type no. 11644 A. N. S. P.; meadow near Wawona, Sequoia Park, in the same county, H. N. Lowe, 1916.

Easily recognized by the shape of the outer lip. So far as known, typical *V. ovata* does not occur in California.

Mr. Lowe's specimens are a trifle smaller, 2.1 mm. long, and the color is very dark.

5. VERTIGO BERRYI n. sp. Pl. 6, figs. 10, 13.

The shell is oblong-conic, auburn, glossy, slightly irregularly striate. The spire tapers from the last whorl, the lateral outlines being slightly convex; summit is very obtuse, of a paler tint. The whorls are rather strongly convex; the last having an inconspicuous narrow, low ridge close behind the lip expansion, preceded by a broad and deep impression over the palatal region, above which it remains strongly convex. Except for its smaller size, the aperture is about as in *V. ovata*. There is a small angular lamella near the large parietal; columellar lamella rather massive, ascending inward. Palatal plicae subequal, rather long, the basal fold smaller; suprapalatal quite small. The teeth and palatal callus are much lighter than the lip. The peristome is expanded; outer border is slightly curved in, but far less than in *V. ovata*.

Length 2.5, diam. to lip edge 1.35 mm.; length of aperture 0.9 mm.; 5½ whorls.

California: Mill Creek Canyon, at 4600 ft., in the San Bernardino Mountains; collected by Dr. S. S. Berry, July, 1910. Type 105166 A. N. S. P. Also Valle Trinidad, Lower California, C. R. Orcutt, 1901; no. 308964 U. S. N. M.

This species differs from *V. ovata* by the relatively narrow, almost straightly tapering spire, the much weaker inbending of the outer lip, the minute crest outside the peristome, and

the capacious external excavation over both palatal plicae. *Vertigo morsei* is similar to *V. berryi* in having a long spire relative to the aperture, but the Eastern species is much larger, has more convex lateral outlines, a much more developed point on the outer lip and a stronger crest behind the lip.

It was reported as *Vertigo ovata* (Say) var., in Nautilus xxx, p. 38.

6. VERTIGO BINNEYANA Sterki. Pl. 11, fig. 12.

The shell is cylindric-oblong, auburn, somewhat transparent, glossy, weakly, irregularly striate. The whorls are moderately convex, the last having a low but distinct crest behind the lip, a small impression between the crest and the point of the lip, and a rather large impression behind the crest, over the palatal folds. The aperture is rather small. The teeth are whitish; parietal lamella strong but rather short; a quite short angular lamella stands even with its outer end. Columellar lamella strong, but not long, ascending a little inwardly. The palatal folds are both quite strong, the lower entering much further. Basal fold short. The peristome is somewhat expanded, the outer lip a little bent inward above the middle. There is a moderate palatal callus. Length 2.1, diam. 1.1, length of aperture 0.75 mm.; 5 whorls.

Montana: Helena, type loc., H. Hemphill; Glendive, Dr. Sterki; drift debris of Musselshell River, Winnecook, S. S. Berry. Manitoba: Winnipeg, Sterki. Nanaimo, Vancouver Island, G. W. Taylor. (?New Mexico: Albuquerque, Dr. Sterki.)

Vertigo binneyana STERKI, Proc. A. N. S. Phila. 1890, p. 33; Nautilus iii, 1890, p. 125 (Helena and Glendive, Mont.; Winnipeg, Man., Albuquerque, N. M.); iv, p. 39, pl. 1, f. 1. —BINNEY, Fourth Suppl., Bull. M. C. Zool. xxii, 1892, p. 198, fig.—PILSBRY, Proc. A. N. S. Phila. 1899, p. 315, fig. 2 (specimen from Winnepeg). — RANDOLPH, Naut. ix, 102 (Seattle, Wash.).—SQUYER, Naut. viii, 63 (Mingusville, Mont.).—BERRY, Naut. xxix, 125 (Winnecook, Mont.).

It is smaller and more cylindric than any form of *V. ovata*, has a longer lower palatal fold, and a less impressed point in

the outer lip. *V. pygmæa* is wider, has a much stronger crest, and the angular lamella is small or wanting.

Dr. Sterki informs me that it has been found in drift débris of the Missouri River, Iowa.

Group of Vertigo numellata.

The aperture has the typical six teeth well developed, the *lower palatal fold long*, entering to the dorsal side, columellar lamella receding, ascending somewhat inwardly. There is a *very high, rounded crest.*

The single species inhabits Bermuda.

7. VERTIGO NUMELLATA Gulick. Pl. 13, figs. 14, 15.

The shell is shortly rimate, oval, auburn, the surface distinctly but weakly striate, glossy. Whorls weakly convex, the last having a *very high*, rounded crest, then deeply contracted behind the peristome; behind the crest it is flattened, and narrowly furrowed over the palatal folds, one or both of the furrows usually extending upon the crest. Aperture is obstructed by 6 teeth: the angular lamella is rather long and stands remote from the parietal. Parietal lamella strong and entering deeply. The columellar lamella is deeply placed, rather massive, and ascends somewhat inwardly. The upper palatal fold is strong and rather long. Lower palatal is somewhat more immersed and longer, entering to a dorsal position. The basal fold is low and small, sometimes subobsolete. The palatal callus is not conspicuous. The peristome is thin, well expanded, prominently projecting forward and bent inward above the middle of the outer lip, thinner and retracted above the prominence.

Length 1.8, diam. 1.05 mm.; 5 whorls (type).

Length 1.8, diam. 1 mm.; 5½ whorls.

Length 1.6 mm.; 4½ whorls.

Bermuda: Paynter's Vale, between Tucker's Town and Walsingham Bay, pleistocene and recent; also Knapton Hill, fossil; near Bailey Bay in the red clay breccia near Castle Harbor. Type no. 85583 A. N. S. P.

Vertigo numellata GULICK, Proc. A. N. S. Phila. 1904, p.

413, pl. 36, f. 6.—VERRILL, Trans. Conn. Acad. xii, 1907, p. 170, f. 54*c*.

While highly specialized and peculiar, this species appears to be somewhat related to *V. oralis* and especially *V. alabamensis*. It has also some resemblance but probably no direct relationship to *V. ovata*. It differs from all American species by the far more massive crest. There is a long lower palatal fold, but it is not turned down at the end as in *V. milium*, and the shape of the columellar lamella shows that *V. numellata* is not an *Angustula*.

This species was described from fossil examples in the lime rock, but it is abundant as a recent shell in Paynter's Vale, about Church Cave, near Tucker's Town. Except in color, there is no difference between recent and fossil examples.

Group of Vertigo pygmaea.

It is scarcely possible to define this group, some species approaching the group of *V. ovata* closely, while others are hardly distinguishable from the *modesta* group. As a whole the group is equivalent to the European group of *V. moulinsiana* and *pygmaea*.

Key to species.

(Eastern and central species).

1. Aperture having 3 teeth, parietal, columellar and lower palatal; sometimes a minute upper palatal. 2.
   Aperture having at least 4 well developed teeth. 5.
2. 1.8 to 2.2 mm. long; upper palatal fold generally present but minute. 3.
   1.5 to 1.6 mm. long; upper palatal fold rarely developed. 4.
3. Palatal callus slight or wanting; Maine to Colorado. *V. tridentata*, no. 16.
   Palatal callus strong; Bermuda. *V. marki*, no. 17.
4. Subcylindric, yellowish, the lower palatal fold penetrating to the dorsal side; Ohio, N. C. *V. parvula*, no. 15.
   Ovate, dark olive buff, fragile, the lamella and folds small and short. New England. *V. perryi*, no. 14.
5. Lower palatal fold long, very deeply immersed, an im-

pression on the back over it; 6 teeth; 1.7 x 0.95 mm. Maine. *V. nylanderi*, no. 11.

Lower palatal fold not notably immersed. 6.

6. Shell sharply but very finely striate, especially the penult whorl; no palatal callus; 1.85 to 1.95 x 1 mm.; 5 to 6 teeth. *V. gouldii*, no. 10.

Shell nearly smooth, or but weakly striate. 7.

7. Crest and palatal callus moderately or strongly developed. 8.

Crest very low when present; palatal callus very weak or wanting. 11.

8. Shell cylindric-oval, 1.8 to 2 mm. long; no angular lamella and the basal fold small or wanting. Maine to Va., west to Lake Superior. *V. pygmæa*, no. 9.

Ovate, 1.8 to 2.2 mm. long. 9.

9. No angular lamella or basal fold; upper palatal fold small or minute. 10.

A basal fold, and often an angular also; ovate-conic; upper palatal fold well developed. Northern states. *V. v. elatior*, no. 8*a*

10. Palatal callus moderate or thin; Maine to Colo. *V. tridentata*, no. 16.

Palatal callus heavy; Bermuda. *V. marki*, no. 17.

11. Angular, parietal and columellar lamellae, upper and lower palatal folds; no crest; 1.25 x 0.84 mm. Florida Keys. *V. hebardi*, no. 13.

No angular lamella, 4-5 teeth, a basal fold present or wanting; Northern States and Canada. 12.

12. 1.75 x 1.1 mm. *V. ventricosa*, no. 8.

1.5 x 0.9 mm. *V. bollesiana*, no. 12.

(*West Coast species*).

1. With 4 or more well developed teeth. 2.

With 2 or 3 weak teeth; no trace of crest or palatal callus; 2 x 1.23 mm.; California. *V. sterkii*, no. 20.

2. 4 teeth; cylindric-oval; Oregon to Alaska. *V. columbiana*, no. 18.

5 to 6 teeth. 3.

3. Ovate-conic, with a strong palatal callus; British Columbia. *V. v. elatior*, no. 8*a*.
Cylindric-oblong; palatal callus very weak or wanting; Washington to California. *V. andrusiana*, no. 19.

(*Eastern species, Atlantic to Rocky Mountains*).

8. VERTIGO VENTRICOSA (Morse). Pl. 7, figs. 1, 2, 3.

"Shell umbilicate, ovate, conic, smooth, polished; apex obtuse; suture deep; whorls four, convex. Aperture, semicircular, with five teeth, one prominent on the parietal margin, two smaller on the columellar margin, and two prominent within, contracting the aperture at the base; peristome widely reflected, the right margin flexuose, within thickened and colored. Length .07 inch; breadth .45 inch" [1.75 x 1.1 mm.] (*Morse*).

Magdalen and Prince Edward Is., Quebec, New England and New York, west to Ohio, Michigan and Illinois.

Isthmia ventricosa MORSE, Ann. Lyc. Nat. Hist. N. Y. viii, Nov., 1865, p. 207, fig. 1.—*Vertigo ventricosa* Morse, BINNEY, Terr. Moll. v, 1878, p. 218.—STERKI, 8th Ann. Rep. Ohio State Acad. Sci., 1900, p. 32 (Tuscarawas Co., O.).—WHITEAVES, Ottawa Naturalist 1905, 171 (Riviere du Loup, Quebec).—NYLANDER, Nautilus xiii, 103 (Aroostook Co., Me.).—HANHAM, Naut. x, 101; xi, 111 (Isle d'Orleans, Quebec).—WHEAT, Naut. xx, 161 (Cayuga L., N. Y.).—BLANEY, Naut. xviii, 46 (Ironbound I., Me.).—WALKER, Moll. of Michigan, 1906, p. 517, f. 150 (Grand Rapids and Beulah, Benzie Co.).—JOHNSON, Fauna of New England no. 13, 1915, p. 214 (Me., N. H., Conn.).—*V.*[*ertigo*] *approximans* STERKI, Nautilus iii, 1890, p. 136.

The author has seen typical *ventricosa* only from Canada, New England and New York, but it has been reported by Walker and Sterki from states bordering the Great Lakes as far west as Illinois.

V. ventricosa differs from *V. ovata* by the constantly smaller size, absence of an angular lamella, and smaller number of teeth. It is of an auburn color, somewhat transparent, glossy, with only a trace of striation. Under a high power

it shows microscopic punctation or granulation. The basal fold is usually quite small, though sometimes, as in the specimen from Prince Edward Island figured (fig. 1), it is well developed. In many Maine examples it is absent (fig. 3, Buckfield, Oxford Co., Me.). The degree of prominence of the inwardly bent point of the lip-edge varies a good deal. The crest is quite low. Specimens measure:

Length 1.7, diam. 1 mm.; 4½ whorls (Hebron, Me., fig. 2).

Length 1.95, diam. 1.2 mm.; 4½ whorls (Buckfield, Me., fig. 3).

A form which Dr. Sterki listed as *V. approximans* was originally stated to be "characterized by the two palatal lamellae being close together." It was from Rockford, Ill. The original specimens are lost, but what appears to be the same form has been found in Ohio. "It is rather small, length 1.3, diam. 0.9 mm., more or less; short, slight, with no callus in the palate or a slight one. There are parietal and columellar lamellae and two palatal folds, all small, the palatals close" (*Sterki*).

Dr. O. Boettger considered *ventricosa* a synonym of *V. moulinsiana* of Europe (Jahrb. Nassauischen Vereins, 1889, p. 307); but the resemblance does not appear sufficiently close for specific identity.

8*a*. *Vertigo ventricosa elatior* Sterki. Pl. 7, fig. 6.

"Larger and more elevated than *ventricosa*, with a rather acute apex; a strong callus in the palate, into which the palatal plicae merge, a strong tooth-like lamella in the base" (*Sterki*).

Length 2.15, diam. 1.2 mm.; 5 whorls.

New York, Ohio, Michigan and west to Montana (Sterki); Aroostook and Hancock counties, Maine; Darby and White's Springs, west of Ward, Mont.; Field, B. C. and Laggan, Alberta; Oscuro Mts., Socorro Co., N. M.

Vertigo ventricosa var. *elatior* STERKI, The Land and Fresh Water Mollusca in the vicinity of New Philadelphia; a contribution to the Natural History of Tuscarawas Co., Ohio, p. 5, 1894. Eighth Ann. Rep. Ohio State Acad. Sci., 1900, p.

33; Nautilus viii, 107; xxix, 123 (Geneva, Ohio).—SARGENT, Naut. ix, 89 (Clearwater, Minn.).—NYLANDER, Naut. xiii, 103 (Aroostook Co., Me.).—HENDERSON, Naut. xx, 97 (Cazenovia, N. Y.).—WALKER, Moll. Michigan, 1906, p. 517 (throughout the Lower Peninsula).—J. HENDERSON, Univ. of Colo. Studies iv, 172 (Lake George, Colo.).—*Vertigo gouldi lagganensis* PILSBRY, Proc. A. N. S. Phila, 1899, p. 314, fig. 1 (Laggan, Alberta).

Dr. Sterki reports it from the loess at New Harmony, Indiana, and from marl deposits, Castalia, Erie Co., Ohio.

The shape, more conic than *V. ventricosa*, the strong palatal callus and teeth, the well developed basal fold and the larger size give this race individuality. It has an extensive range west of that of *V. ventricosa*, though also occurring in territory of the latter in the northeast, as far as northern Maine.

Compared with *V. pygmæa*, *V. g. elatior* is *more conic*, the outer lip has a more distinct point or "auricle," the crest is less massive, usually weak, and there is a deeper external impression over the lower palatal fold.

Dr. Sterki notes that there is often a supra-palatal fold developed, and occasionally an angular lamella.

It would not be amiss to rank *elatior* as a species.

9. VERTIGO PYGMAEA (Drap.). Pl. 7, figs. 11, 12.

The shell is cylindric-oval, auburn or chestnut-brown, glossy, having only weak traces of striation, but the surface appears densely weakly pitted microscopically. The whorls are moderately convex, the last having a *strong rounded crest* a short distance behind the peristome, separated from it by a concavity, and somewhat paler colored than the rest of the shell. The parietal lamella is strong but rather short, median. Columellar lamella deeply placed, short, ascending inwardly. Both palatal folds are strong, the lower one longer, as usual. They stand on a strong callus. The basal fold is very small, rarely absent. There is often a low suprapalatal fold. The peristome is well expanded, somewhat reflected, colored like the shell. The outer lip is only slightly incurved.

Length 2, diam. 1.1 mm.; 5 whorls.

Length 1.8, diam. 1 mm.

Maine: Rockland, Thomaston and Warren, Knox Co., N. W. Lermond. Massachusetts, E. W. Roper. New York: Staten Island, E. W. Hubbard; Westchester Co., E. G. Vanatta; Dutchess Co., W. S. Teator; Madison Co., Henderson, Pilsbry; Herkimer Co., A. Bailey. New Jersey: Burlington Co., B. Long. Pennsylvania, Philadelphia Co., Montgomery Co., Pilsbry; Chester Co., W. D. Hartman. D. C., Sterki. Virginia: Alexandria, Sterki. Ohio: Columbus, H. Moores; Lake Superior, J. T. Crans.

Vertigo callosa Sterki, Proc. A. N. S. Phila. 1890, p. 31 (Columbus, O., Mass., N. Y.) not of Reuss, 1849.—*Pupa (Nearctula) superioris* Pilsbry, Nautilus xii, 1899, p. 103 (Lake Superior).—*Vertigo pygmæa* Drap., Sterki, Nautilus vi, May, 1892, p. 5; Nachrbl. d. m. Ges. 1889, p. 114.—Pilsbry, Proc. A. N. S. Phila. 1900, p. 608.—Hanham, Nautilus xi, 111 (Quebec).—Henderson, Naut. xx, p. 97 (Cazenovia, N. Y.). —Johnson, Fauna of New England no. 13, 1915, p. 216 (Me. and Mass.).

This species was first recognized in America by Dr. Sterki; it had long been in collections, confused with other species. It proves to be somewhat widely spread, having been found in many places between Quebec, Maine, Virginia and Ohio. The strong, continuous crest behind the well expanded lip and the absence of a distinctly defined upper arc or sinulus of the outer lip are its more prominent features. *V. gouldii* is a paler, much more sharply striate shell with weaker crest and distinct sinulus. *V. ventricosa* has a weaker and interrupted crest.

In some lots, as that from Cazenovia, Madison Co., N. Y., the basal fold is small or rarely absent, only five teeth present. In others of the same lot there are both basal and suprapalatal folds, the latter weak; these having seven teeth. Dr. Sterki notes that sometimes the basal fold is bifid, as an individual variation, and occasionally a small angular lamella is present. The crest and the palatal callus vary in strength.

For other references to *V. pygmæa* see under Palaearctic species, no. 52.

10. VERTIGO GOULDII (Binney). Pl. 7, figs. 4, 5, 8.

Shell light chestnut, cylindrical-ovate; whorls between 4 and 5, ventricose, the last occupying nearly half the length of the axis; apex obtuse. Aperture lateral, composed of two unequal curves meeting in the center of the outer lip; with 5 prominent white teeth: one upon the transverse margin, two upon the umbilical margin and two upon the labial margin; lip thickened, not reflected, umbilicus a little open (*A. Binney*).

Length 1.85 to 1.95, diam. 1 mm.; Brookline, Mass.

Prince Edward and Magdalen Islands west to Alberta, Field, B. C. and Montana, south to the Potomac River, North Carolina (Sterki), Tennessee at Cade's Cove, Blount Co.; near Valley Head, Alabama (H. H. Smith), and Pleistocene of Kansas (?); also reported from the West Indies.

Pupa gouldii BINNEY, Proc. Boston Soc. N. H. i, 1843, p. 105; Terrestrial Moll. ii, p. 332, pl. 51, f. 2.—*Vertigo gouldi* W. G. BINNEY, Terr. Moll. v, p. 214.—STERKI, Proc. A. N. S. Phila. 1890, p. 31; 8th Ann. Rep. Ohio State Acad. Sci., 1900, p. 32 (Tuscarawas Co., O.); Nautilus xxix, 123 (Geneva, O.); iii, p. 125 (Helena, Mont.; Ottawa, Ont.).—NYLANDER, Nautilus viii, 126 (Aroostook Co., Me.).—HANHAM, Naut. x, 191; xi, 111 (Quebec).—CLAPP, Naut. xiv, 64 (Kennebunkport, Me.).—HENDERSON, Naut. xx, 97 (Cazenovia, N. Y.).—JACKSON, Naut. xxi, 144 (North Haven, Me.).—BERRY, Naut. xxiv, p. 63 (Unity, Me.).—PILSBRY, Naut. xxv, 75 (Monroe Co., Pa.).—VANATTA, Naut. xxviii, 11 (Sussex Co., N. J.).—DANIELS, 27th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, 1902, p. 632 (Henry Co., Connersville, Dunreith, Ind.).—COCKERELL, Nautilus x, p. 143 (post-Tertiary deposit at West Cliff, Colo.).—WALKER, Moll. of Michigan, 1906, p. 517, f. 151 (generally distributed).—JOHNSON, Fauna of New England, no. 13, 1915, p. 214 (Westbrook, Bethel and Woodland, Me.; Cambridge, Roxbury and Westport, Mass.; Tiverton, R. I.; Northfield, Conn.).—? HANNA and JOHNSTON, Kansas Univ. Sci. Bull. vii, no. 3, Jan. 1913, p. 120, pl. 18, f. 4 (Pleistocene, Phillips Co., Ks.).

Vertigo gouldii paradoxa Sterki, in NYLANDER, Nautilus xiii, Jan., 1900, p. 103.

It is related to *V. pygmæa*, but the crest behind the lip is not so strong, the whorl is more flattened or impressed at and behind the point or "auricle" of the lip, giving the latter the appearance of being biarcuate, though it is not as conspicuously so as Binney's description would lead one to suppose. *The surface is very distinctly striate*, especially the penult whorl. The basal plica is subcolumellar in position. The parietal lamella is strong and rather long. There is never any trace of a palatal callus.

"The angular lamella may be present or absent. The inferior columellar (basal) is by no means constant, and in some forms is generally wanting. In a few specimens from Summit Co., Ohio, there is a very small but distinct infraparietal nodule; one of these has an angular also, and is thus 7-toothed. The palatal folds are rather variable in position and shape, and there may be a well marked external impression over them, or none" (*Sterki*).

V. gouldii is rather commonly distributed in New England and New York, but more local southward, where it appears to follow the mountains to Tennessee and northern Alabama. The Pleistocene form from Kansas, as figured by Hanna and Johnston, differs so much in the position of the basal fold that its reference to *gouldii* appears doubtful. So far as I know, there is no Austroriparian record, so that the West Indian occurrence appears anomalous, and requires confirmation. Dr. Sterki states that it is found in Cuba and Jamaica, and single specimens of this species are in coll. A. N. S. P. labelled St. Croix (Griffith), and Tortola (R. Swift). While these localities appear improbable, the high degree of accuracy of the Swift collection labels causes me to mention them. The possibility of importation or mixture of specimens must be considered.

10*a*. *Vertigo gouldii paradoxa* Sterki, n. subsp. Pl. 12, figs. 6, 8.

"Rather small, generally cylindrical, with the surface striae well developed, the palatals, usually somewhat long and thin, are close together, and the lower palatal is placed markedly

inward. Inferior columellar (basal) is usually wanting or quite small'' (*Sterki*).

Length 1.75, diam. 1 mm. (fig. 6).

Maine: Woodland, Aroostook Co., type loc., Nylander. Quebec, Sterki.

Figured from cotypes, no. 119007 A. N. S. P. It had been mentioned before (Nautilus xiii, 103), with the note ''Fine examples with the two palatal folds continuous and one angular''—terms not diagnostic of the race. It stands midway between *gouldii* and *nylanderi*.

10*b*. *Vertigo gouldii cristata* Sterki, n. subsp. Pl. 12, figs. 4, 5.

''The shell is rather large, about 2 mm. long (1.8 to 2.1); form cylindrical to somewhat oblong, barrel-shaped. Surface striae rather fine. Some distance behind the outer and basal lips there is a rather large, conspicuous crest, which does not extend above the middle; behind it there is a broad flattening or impression over the palatals, the base being narrow there, then becoming rather broadly rounded towards the aperture. A small angular lamella may be either present or wanting. There is no basal ('lower columellar') fold.'' (*Sterki.*)

Length 2.1, diam. 1,2 mm. (fig. 4).

Canada: Quebec, rather abundant, A. W. Hanham.

A strongly marked race, having the crest as well developed as in many examples of *V. pygmæa*, but without a callus in the palate, and with the sculpture of *gouldii*. Figured from cotype no. 119008 A. N. S. P.

11. Vertigo nylanderi Sterki. Pl. 7, figs. 13, 14, 15.

Shell rimate, oblong, with a rather acute apex, cinnamon colored, pellucid; whorls 4½-5, quite convex, with a deep suture; sculptured with somewhat irregular, crowded striæ (except the embryonic whorl); the last occupying about one-half of the altitude, gradually narrowed towards the aperture, which is small. Peristome slightly everted, margin not thickened. The outer margin has an indentation barely above its middle, forming a well-marked sinulus; behind it a trace of a

crest, and behind that a *long, deep, furrow-like impression* over the palatal folds, ascending obliquely from near the base; no callus within; lamellæ and plicæ 6; parietal lamella long and curved; parallel with it is a thin, lamelliform angular; columellar lamella ascending inwardly. Palatal folds long, the *lower palatal deep-seated, emerging only about to the inner end of the upper.* Basal fold small, subcolumellar in position.

Length 1.7, diam. 0.95 mm.

Length 1.6, diam. 0.9 mm.

Maine: Woodland, Aroostook county, O. O. Nylander.

Vertigo nylanderi STERKI, Nautilus xxii, Feb., 1909, p. 107.

By the fine striation it has some resemblance to *V. gouldii* and might be regarded as an extreme form of *V. g. paradoxa*, as Dr. Sterki has suggested to me. The color is more that of *V. bollesiana.* It differs from those, and from all other American species, by the deeper immersion of the long lower palatal fold, and the deep impression in the back, over the palatals.

It is remarkable that this strongly characterized species has been found in only a single locality. Type no. 1075 Sterki coll. Description and figures from a cotype, 98331 A. N. S.

12. VERTIGO BOLLESIANA (Morse). Pl. 7, figs. 9, 10.

Shell minutely perforate, cylindrical ovate, delicately striated, subtranslucent; apex obtuse; suture well defined; whorls four, sub-convex; aperture suborbicular, somewhat flattened on its outer edge; with five teeth, one prominent and rather curved on the parietal margin, two similar in form, the lower one the smaller, on the columellar margin, and two slightly elevated lamelliform teeth within and at the base, peristome subreflected and thickened.

Length .065 inch; breadth .035 inch (*Morse*).

Maine: throughout the State, type loc. Orono. Massachusetts, New Hampshire, New York. Also reported from Indiana and Michigan, south to Norfolk, Virginia (Morse) and mountains of East Tennessee.

Isthmia bollesiana MORSE, Ann. Lyc. of Nat. Hist. of N. Y., viii, 1865, p. 209, figs. 4-6.—W. G. BINNEY, Terr. Moll. vol. v,

1878, p. 215, f. 120; Man. Amer. Land Sh., 1885, p. 191.—STERKI, Nautilus iv, p. 9, footnote; iii, 125 (Sewanee, Tenn.; St. Croix, W. I.).—PILSBRY, Proc. A. N. S. Phila. 1900, 133 (Cades Cove and Tuskeegee Mt., E. Tenn.).—TEATOR, Nautilus iii, 69 (Dover Plains, Dutchess Co., N. Y.).—PLEAS, Naut. vii, 68 (Henry Co., Indiana).—GARDNER, Naut. viii, 76 (Long Island, N. Y.).—CLAPP, Naut. xiv, 64 (Mt. Agamenticus, Me.).—BLANEY, Naut. xviii, 46 (Ironbound I., Me.).—WALKER, Moll. of Michigan 1906, p. 518, f. 152 (Petoskey, Charlevoix, Crystal Lake, Benzie Co. and Huron Mts., Marquette Co., Mich.).—JOHNSON, Fauna of New England, no. 13. 1915, p. 214 (Bethel, Me., Francestown, N. H.).

There is an extremely small crest close behind the lip, and a rather large oblique depression over the palatal folds. The basal fold is subcolumellar in position, and rarely it is absent. As Morse says, it is smaller, lighter-colored and more transparent and delicate than *V. gouldii*, and it is *less distinctly striated*. The teeth are smaller, especially the palatals. Length 1.5, diam. 0.9 mm.; 4½ to 4⅔ whorls.

According to Morse, it occurs under dead leaves and on bark, in hardwood groves. It appears to be rare except in Maine.

The specimens at hand are from New England and New York. The western records, Michigan, Ohio, Indiana, and those from East Tennessee I have not been able to verify personally. Dr. Sterki writes that he has "no specimens from Michigan and Ohio; some records may have been founded on misidentification. It appears to be northeastern."

Dr. Sterki contributes the following notes: "After again looking over a good deal of material, including a number collected by E. S. Morse, I come to the conclusion that *V. bollesiana* is specifically distinct from *gouldii*, though some specimens of the latter resemble it closely. *V. bollesiana* is rather uniform in size, length 1.3 to 1.6 mm. (1) The striæ are slighter, finer, than in *gouldii*, often subobsolete, sometimes subregular, very fine and crowded. (2) the form is oval or ovoid, never cylindric. (3) it is generally of lighter color, corneous, not reddish or brownish. (4) the configuration of

the palate externally is different, though *gouldii* varies in that respect. In *bollesiana* there is generally a small, narrow crest close behind the lip-margin, and a slight impression at the auricle, suggesting a double curve of the outer lip. This is less marked in *gouldii*.

"The inferior columellar (basal) is often wanting or vestigial. In some specimens it is bifid. Some specimens have a very small angular. The peristome was described as subreflected and thickened, but it is narrowly everted, and thus only apparently thickened in a front view."

13. VERTIGO HEBARDI Vanatta. Pl. 8, fig. 4.

The shell is minute, distinctly perforate, very shortly rimate, shortly oval, fragile, corneous; first whorl smooth, the penult irregularly, finely striate, last whorl with few striæ; glossy. The whorls are rather strongly convex, the last not noticeably flattened or grooved, and without a crest behind the lip. The aperture is indistinctly triangular and has 5 teeth: angular lamella very low, half as long as the rather short, high parietal. The columellar lamella enters deeply and horizontally, its crest slanting downward. The palatal folds are rather short, subequal, the lower being slightly stouter and a trifle further in. The outer lip is scarcely expanded, somewhat straightened, without a projecting point. Length 1.25, diam. 0.84 mm.; 4 whorls.

Florida: Long Key, Morgan Hebard.

Vertigo hebardi VANATTA, Proc. A. N. S. Phila. 1912, p. 445, fig.

It is most like *V. bollesiana*, but the shell is shorter, has a distinct angular lamella and no external crest or impression behind the lip. Figure and description from the type.

14. VERTIGO PERRYI Sterki. Pl. 7, fig. 7.

"Shell minute, dextrorse, ovate with the apex rather acute, rimate; thin, transparent, of rather dark brown color with a slight greenish tinge [dark olive buff]. Whorls 4½, rather rapidly increasing, separated by a moderately deep suture, the last comparatively large, occupying over one-half of altitude,

rounded; with a slight impression over the palatal fold; aperture well rounded, truncate, the margins slightly everted, the outer margin barely impressed at the auricle which is marked by a slight angle projecting over the level of the peristome; no callus in the palate; lamellæ and folds three or four, small, very short, of brownish color; the parietal, columellar and inferior palatal, and sometimes there is also a superior palatal. Surface with very fine, irregular striæ, somewhat shining. Alt. 1.5 to 1.6, diam. 1.1 mm.; aperture, alt. 0.6 mm." (*Sterki*).

Rhode Island: Warwick, J. F. Perry. Massachusetts: Duxbury, W. F. Clapp.

Vertigo perryi STERKI, Nautilus xix, Sept., 1905, p. 53.

"The present species resembles the low form of *Vertigo ventricosa* Mse. in the shape and size of the shell, but the formation of the aperture and its lamellæ and folds is quite different, the color is deeper and the surface less shining. From the other three described, typically three-toothed, eastern Vertigos: *tridentata* Wolf, *oscariana* Sterki and *parvula* Sterki, *V. perryi* is also very different; in all of the three, the parietal lamellæ and palatal folds are much larger, longer, and of whitish color; the aperture is higher than wide; the shells are more elevated and of lighter color" (*Sterki*).

The two localities now known for this strongly distinct species are only about 45 miles apart, and both are close to the sea. It is remarkable that a species so well characterized could exist undetected for so long, close to centers of conchological work. Specimens are contained in the collections of Dr. Sterki, Mr. Perry, Mr. H. F. Carpenter, the Academy of Natural Sciences, The Museum of Comparative Zoology and perhaps some others. The example figured measures: length 1.6, diam. 1.05 mm. In some others the teeth are weaker, and rarely there is the trace of an upper palatal fold. Often the columellar lamella is hardly visible in a front view. The lower palatal fold is often developed when the other teeth are scarcely noticeable. The shell is very fragile. At Duxbury, where it was collected by Mr. and Mrs. W. F. Clapp, it lives on grass in a swamp, in wet weather as much as a foot above the ground.

15. VERTIGO PARVULA Sterki. Pl. 12, figs. 7, 9.

"It is of about the size, shape and appearance of *V.* (*Angustula*) *milium* Gld., but ranges in quite another group, having a quite simple palatal wall and margin, and only 3 lamellae" (*Sterki*).

The shell is minute, subcylindric, tapering very little upwards, the summit obtuse; thin, subtransparent, slightly yellowish, smooth and glossy, becoming finely striate behind the outer lip. The whorls are moderately convex, the last whorl well rounded, slightly impressed behind the projection of the outer lip. The aperture is somewhat triangular, with three teeth: parietal lamella rather short and high; columellar lamella short, steeply ascending inwardly; lower palatal fold rather high in front, rapidly becoming lower as it recedes, penetrating to the dorsal side. Peristome very little everted, slightly thickened, and having a distinct callus ridge within. The outer lip projects forward and is slightly bent inward above the middle.

Length 1.55, diam. 0.85 mm.; barely 5 whorls.

Ohio: Summit Co., A. Pettingell. Also found by A. G. Wetherby in the mountains of North Carolina, according to Dr. Sterki.

V. [*ertigo*] *parvula* STERKI, Nautilus iii, April, 1890, p. 136.

Figures and description are from the type specimen, no. 270 Sterki coll. It is one of the rarest species, known by the small size, cylindric shape and three well-developed teeth, the lower palatal being quite long and not marked externally by an impression. The auricle or point of the outer lip projects well forward but is not much bent inward.

It is much smaller than *V. tridentata*, and more cylindric and lighter colored than *V. perryi*, with relatively larger teeth. It is quite distinct from all of our species.

The name *parvula* has been used in *Pupa* by Deshayes, 1864, but as there is some doubt as to whether his species is a *Vertigo*, I do not think it necessary to change the name of the form under consideration.

16. VERTIGO TRIDENTATA Wolf. Pl. 12, figs. 1, 2, 3.

"Shell narrowly ovate, amber-colored, highly polished; whorls 5, smooth, with three teeth in the mouth, one on the middle of the lower lip, and one on each side, forming a regular triangle" (*Wolf*).

The shape varies from ovate to tapering oblong. It is honey-yellow, shading to somewhat browner below, paler above; surface smooth, with only faint indications of striæ, glossy. The last whorl is somewhat flattened externally over the lower palatal fold, and has a rather narrow but generally distinct crest behind the lip. The outer lip projects forward and slightly inward near the middle. Parietal lamella high, rather short. Columellar lamella blunt, directed downward. Lower palatal fold strongly developed. Upper palatal fold quite small or sometimes wanting. These folds stand on a more or less distinct palatal callus. Angular lamella and basal fold are never developed.

Length 2.2, diam. 1.1 mm.; 5½ whorls.

Length 2, diam. 1.1 mm.

Length 1.85, diam. 1.1 mm.; 4¾ whorls.

New York: Troy, Aldrich; Mohawk, G. H. Clapp; Syracuse, pleistocene, Burnett Smith. New Jersey: Princeton, A. D. Brown; near Clementon, Bayard Long. Pennsylvania: Philadelphia; York Furnace, A. P. Brown; Northampton Co., B. Long. Ohio: New Philadelphia, Sterki. Indiana: Lafayette, Tippecanoe Co., Satterthwait. Illinois: Canton, J. Wolf, type loc. Also reported from Ontario, Minnesota, Michigan, Kansas, Colorado, New Braunfels, Texas, etc.

Vertigo tridentata WOLF, Amer. Journ. of Conch. v, May 5, 1870, p. 198, pl. 17, f. 1.—STERKI, Proc. U. S. Nat. Mus. xi, 1888, p. 375, no. 15, pl. 42, f. 4; Nautilus iii, April, 1890, p. 135; xxix, 123 (Geneva, O.).—PLEAS, Naut. vii, 68 (Henry Co., Ind.).—HANHAM, Naut. xi, 111 (Quebec).—DANIELS, 27th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, 1902, 632 (Danville and Dunreith, Ind.).—HANNA, Naut. xxiii, 95 (Douglas Co., Kansas).—WALKER, Moll. of Michigan, 1906, p. 518, f. 153 (Ann Arbor and Grand Rapids).—J.

HENDERSON, Univ. of Colo. Studies iv, p. 172 (South Park, Colo.).—SARGENT, Naut. ix, 89 (Clearwater, Minn.).—JOHNSON, Fauna of New England 13, 1915, p. 214 (Maine).

The light color, tapering form, absence of basal and angular teeth and the small size or sometimes absence of an upper palatal, distinguish this from other American species. Most specimens have the upper palatal fold developed, either distinct though small, or as a trace; yet in some it is wholly absent. The type is no. 58008 A. N. S. P, figured in A. J. C. Figs. 1-3 represent specimens of the type lot.

The species was placed in the synonymy of *V. ovata* by Mr. Binney, but Dr. Sterki, in 1888, called attention to its distinctive characters, which are now generally admitted. The two species are not closely related.

Mr. Wolf found it "abundant in shady copses on green weeds, climbing as high as three feet from the ground. I collected 12,000 from standing weeds and not one from the ground, although it was searched well to find them."

V. perryi differs from *V. tridentata* by the smaller size, more fragile, distinctly greenish shell, with broader, more rounded aperture, smaller teeth and dark-edged peristome.

17. VERTIGO MARKI Gulick. Pl. 13, fig. 17.

The shell is shortly rimate, ovate, the spire convexly conic, the summit obtuse. Surface nearly smooth; color yellowish (bleached). The whorls are moderately convex, the last somewhat flattened over the lower palatal region, having a low, white crest close to the lip. Aperture with 4 teeth: a strong, moderately long parietal lamella, a low, massive columellar lamella, a small upper and larger lower palatal fold, both tuberculiform. The palatal callus is strongly developed. Peristome is slightly expanded, a little prominent and bent in above the middle of the outer margin.

Length 2.05, diam. 1.1 mm.; 5 whorls (type).

Bermuda: Paynter's Vale (Gulick, S. Brown) and Bailey Bay road cut (Verrill).

Vertigo marki GULICK, Proc. A. N. S. Phila. 1904, p. 414, pl. 36, f. 7.—VERRILL, Trans. Conn. Acad. xii, 1907, p. 170.

It appears rather closely related to *V. tridentata* from which it differs chiefly by the narrower aperture, further contracted by a much stronger palatal callus. Description and figure from the type, no. 85574 A. N. S. P. Other specimens were taken by S. Brown in leaf mould, Paynter's Vale, near the type locality; but while doubtless recent they are bleached. It is far less abundant than *V. numellata* in the same places.

(West Coast species of the V. pygmæa group).

18. VERTIGO COLUMBIANA Sterki. Pl. 9, figs. 12, 13.

Shell minute, cylindric-oval, perforate, thin, pale corneous-brown (grayish cream-buff), somewhat transparent, glossy and weakly striatulate. Whorls nearly 5, convex, the last expanded in a very low crest very close to the lip, not noticeably constricted in front of the crest. Aperture truncate-oval, 4-toothed, the peristome thin, hardly expanded; parietal lamella short and high, columellar a little smaller, lower palatal a rather short fold, about twice as long as the upper palatal which is smaller, shorter, almost tuberculiform; all the teeth are white, and the palatals show through the outside wall.

Length 1.9, diam. 1.1 mm. (type).

Length 2.05, diam. 1.2 mm.

Vancouver Island, George W. Taylor, type loc. (no. 68881 A. N. S.). Washington: Olympia and Tacoma, H. Hemphill; Seattle, Hemphill, P. B. Randolph; L. Quiniault, Chehalis Co., S. S. Berry. Oregon: Douglas county, F. H. Andrus. St. Paul Island, Bering Sea, Dall.

Vertigo columbiana STERKI, Nautilus, vi, 1892, p. 5 (name only).—PILSBRY & VANATTA, Proc. A. N. S. Phila., 1900, p. 602, pl. 23, fig. 11.—DALL, Alaska Land and Fresh Water Mollusks, 1905, p. 30.—*Pupa columbiana* STERKI, PILSBRY, Nautilus xi, 1898, p. 119; Class. Cat., p. 21, no. 212.

The surface is decidedly less striate than in *V. coloradensis*, *V. concinnula* or *V. gouldii*. It is like that of *V. ventricosa*. There is no angular lamella and no basal fold in any of the specimens; but only a few have been seen from each locality. The single specimen from Olympia is very short, 1.4 x 1 mm.

(fig. 13). The species was mentioned in lists by Dr. Sterki as early as 1892, but it was described from no. 68881 A. N. S. P., in 1900.

I have hesitated whether to rank *V. columbiana* as a western race of *V. ventricosa*, but as I have seen only one or two from each of the localities, it is left distinct temporarily. There is no "auricle" or incurved point of the outer lip, such as most specimens of *ventricosa* show, and none of the examples seen shows a basal tooth; yet in *ventricosa* this is sometimes lacking. If *columbiana* is not a race of *V. ventricosa*, it is certainly very near akin. Pl. 9, fig. 12 represents the type specimen, no. 68881 A. N. S. P. I have not seen the St. Paul Island specimens.

V. columbiana utahensis Sterki (Nautilus vi, p. 5, name only; Pils. & Van., P. A. N. S. 1900, 603, pl. 23, fig. 10; Pils. & Ferr. 1910, p. 144) is identical, I believe, with *V. coloradensis*, and has no direct relationship with *V. columbiana*. The type, no. 109009 A. N. S. P., is figured, pl. 12, fig. 12.

19. VERTIGO ANDRUSIANA Pils. Pl. 11, figs. 9, 10, 11.

The shell is rimate, imperforate, cylindric-oblong, with convexly conic, obtuse summit; cinnamon-brown, becoming paler upwards, the initial whorl gray; somewhat glossy, without noticeable striation, most minutely granulose. The whorls are moderately convex, the last having a rather low but distinct crest followed by a wide, shallow contraction behind the lip; an impressed line over the upper palatal fold terminates at the lip, which is slightly bent in at this point. The aperture has (four to) six teeth: a short, high parietal lamella, a small, tubercular angular lamella (sometimes very inconspicuous), a stout, short, columellar lamella which ascends a little inwardly, a small, tubercular basal fold (sometimes wanting) and two well developed palatal folds, the lower being longer. The palatal folds stand upon a thin, light-colored callus. The outer lip is scarcely expanded, the basal slightly so, the columellar margin dilated.

Length 2.46, diam. 1.3 mm.; 5½ whorls (type, fig. 10).

Length 2.35, diam. 1.3 mm.; 5⅓ whorls.

Length 2.3, diam. 1.3 mm.

Oregon: Douglas Co., F. H. Andrus, type loc. Also northward to Chehalis Co., Washington.

Vertigo andrusiana PILSBRY, Proc. A. N. S. Phila. 1899, p. 315, fig. 3; Nautilus xvii, p. 131.

It stands very near *V. pygmæa*, but is slightly longer, *the crest and palatal callus are less developed*, and there is an angular lamella in the most fully developed examples, which however have the other teeth smaller than in *pygmæa*.

The type specimen is redescribed above and drawn in pl. 11, fig. 10. In the original description and figure the angular lamella was overlooked; the shell was rolled too far towards the right under the monocular microscope used, and this small tooth was not seen.

There are ten shells in the original lot, but perhaps only the type and another are absolutely mature. Both have the angular and the basal teeth distinct. Two other shells are very nearly adult. In both the angular lamella is represented by a slight thickening, of the color of the shell, and only noticeable in a basal view, and neither of them has a basal fold (fig. 11). It is likely that the basal is either wanting or present in adult examples of the species.

Similar specimens were taken by Mr. S. S. Berry at Lake Quinault, Chehalis Co., Washington; one before me has a very low angular lamella but no basal fold. The spire has whitish streaks.

A series of some thousands of specimens was taken by Mr. John A. Allen "about clumps of bushes in a meadow," Oswego, Clackamas Co., Oregon. The shells (pl. 11, fig. 9) are all smaller than the type lot, variable in size and shape, and with the crest weak, or in the shorter individuals wanting. Among many examined, none has an angular lamella. The basal fold is occasionally developed, but more frequently absent. There is a distinct if thin palatal callus except in the quite small individuals. The color is usually darker than cinnamon brown or russet, often with light streaks on the spire.

Length 2.15, diam. 1.2 mm.; 5¼ whorls.

Length 1.85, diam. 1.2 mm.; 4½ whorls.

While this form has characters of *V. columbiana, V. pygmæa*

and *V. a. sanbernardinensis*, it appears most closely related to *V. andrusiana*.

19*a*. *Vertigo andrusiana sanbernardinensis* n. subsp. Pl. 11, figs. 6, 7, 8.

The shell is shortly rimate, imperforate, oblong, tapering very little upwards, terminating in a rounded, obtuse summit; cinnamon-brown, moderately glossy, weakly, irregularly striate. The whorls are rather convex, the last slightly flattened over the lower palatal fold, a trifle swollen in front of the flattening, but not crested, often having an impressed line parallel to the suture over the upper palatal fold. Teeth four to six: parietal lamella short, compressed, a small, tubercular angular lamella, even with or in advance of its outer end (sometimes wanting). Columellar lamella short but rather massive. Lower palatal fold strong and rather long, the upper palatal very much smaller and shorter. (Basal fold small and tubercular, at the junction of basal and columellar margins, and not present in the form selected as typical). There is no noticeable callus between the palatal folds. The outer lip expands very little; it is straightened and slightly thickened internally above the middle. Columellar lip is narrowly reflected.

Length 2.25, diam. 1.3 mm.; 5 whorls.

Length 2.2, diam. 1.2 mm.

Length 2.15, diam. 1.2 mm.; 5 whorls (type).

Length 1.9, diam. 1.1 mm.; 4½ whorls.

California: San Bernardino Mts., 7550 to 7750 ft., in the *cienaga* below Bluff Lake (type loc.), that north of the lake, and Bluff Lake meadow, everywhere associated with the local races of *V. modesta*, all collected by S. S. Berry.

This form stands close to *V. andrusiana*, but there is no crest or contraction behind the lip, and no trace of a palatal callus. It appears to represent one extreme of a series leading through *andrusiana* to *pygmæa*. Whether the California form requires subspecific separation from *andrusiana* is open to doubt, but there is certainly some difference typically. It differs from *V. columbiana* by the much darker color, by being less

thin, and typically by having more teeth. *V. binneyana* is a paler, slightly more slender species, having a more distinct crest, and a deeper external impression over the palatal folds. All of these forms appear to be closely related, and are discriminated with some difficulty.

The type is no. 118419 A. N. S. P. A paratype has been placed in the collection of S. S. Berry.

In the topotypic lot the following tooth-mutations were found in adult specimens:

1. Angular, parietal, columellar, basal, upper and lower palatals.

2. Angular, parietal, columellar, upper and lower palatals (type).

3. . . . parietal, columellar basal, upper and lower palatals.

4. . . . parietal, columellar, . . . upper and lower palatals.

The second arrangement is much the more abundant, the first, or complete tooth formula, and the third being rare, one of each out of 27 specimens.

The presence of a basal fold is therefore exceptional in shells from around Bluff Lake.

20. VERTIGO STERKII n. sp. Pl. 11, figs. 2 to 5.

The shell is imperforate, with a curved umbilical crevice, ovate, chestnut-brown, glossy, slightly striate, but becoming distinctly striate behind the lip. The whorls are moderately convex, the last without any trace of a crest or contraction behind the lip, having a short, inconspicuous impression behind the auricle. The aperture has three teeth (or sometimes two). The parietal lamella is low and short. Columellar lamella small, obtuse and deeply placed. The lower palatal fold is small, tuberculiform (and wanting in some examples). There is no palatal callus. The peristome is thin, brown, and well expanded, having a slight prominence inwardly above the middle of the outer margin, above which it is narrower.

Length 2.1, diam. 1.25 mm.; 4½ whorls. Type, fig. 3.

Length 2, diam. 1.23 mm.

Length 1.8, diam. 12 mm.

California: Funston Meadow, Kern River, Tulare Co., type

loc.; Onion Valley, Kearsarge Pass, Inyo Co., J. H. Ferriss and E. Hand, 1916.

V. dalliana is a more conic, thinner shell, of different color, having more rapidly increasing, more convex whorls, and a larger aperture. Moreover, adult specimens of *V. sterkii* are always toothed. *V. andrusiana* is generally larger, and so far as seen, it always has much larger teeth. *V. tridentata* is a far paler, more slender shell, with smaller aperture, stronger teeth and a distinct auricle.

In both of the localities *V. sterkii* occurred associated with *V. modesta castanea*—a form also characterized by degeneration of the teeth.

Group of V. coloradensis.

Subcylindric, distinctly striate forms, the striation strongest on the penult whorl, related to the *modesta* and to the *ventricosa* and *gouldii* groups. Typically they are mountain snails—6000 ft. up; but *V. hannai* and *V. arthuri* are from the lower plains eastward.

Key to species.

1. 2 to 2.3 mm. long; a low crest; parietal and columellar lamellae, sometimes an angular; 2 *long* palatal folds. Alpine in Colo., N. M., Ariz. *V. concinnula*, no. 23.
   1.5 to 1.8 mm. long. 2.
2. No angular lamella. 3.
   An angular lamella present; crest wanting or very weak. 5.
3. No noticeable palatal callus; a low crest. 1.7-1.9 mm. long. Mountain forms. 4.
   A strong palatal callus; 1-1-3 teeth; 1.5 x 0.8 mm. Western Dakota. *V. arthuri*, no. 24.
4. Teeth 1-1-2, no basal fold. *V. coloradensis*, no. 22.
   Teeth 1-1-3, a basal present. *V. c. basidens*, no. 22*a*.
5. Teeth 2-1-2, no basal fold. *V. c. arizonensis*, no. 22*b*.
   Teeth 2-1-3, a basal present. 6.
6. Diameter 1 mm. or more; striation irregular. Western Kansas. *V. hannai*, no. 21.
   Diam. under 1 mm. Santa Catalina Mts., Arizona. *V. c. inserta*, no. 22*c*.

21. VERTIGO HANNAI Pilsbry, n. n. Pl. 12, fig. 12.

"Shell light brown; ovate in outline. Lines of growth faint and oblique. Whorls, four and a half, well rounded, and the sutures well impressed. Apex smooth and white and obtusely pointed. Peristome thin and sharp, slightly expanded and the ends connected across the body whorl by a thin deposit of callus, almost no indentation in the upper palatal wall. Aperture semicircular and with six teeth. Two on the parietal wall, both of which are lamellar in shape, and the angle tooth is the smaller of the two, one columellar in the center of that wall of the aperture. This tooth is bifid, that portion toward the apex of the shell being the larger. One basal tooth, small and nodule-like. Two palatals, both of which are lamellar in shape, the lower one of which is the larger. Variation in the large series of this species is slight" (*H. & J.*).

Length 1.77, diam. 1.04 mm.

Length 1.74, diam. 1.04 mm.

Length 1.63, diam. 1.04 mm.

Length 1.55, diam. 1.04 mm.

Kansas: Phillips County, along Prairie Dog creek between Norton and the Republican river, Pleistocene, Hanna and Johnston; type in U. S. N. M. no. 226396.

Vertigo martini HANNA and JOHNSTON, Kansas University Science Bulletin vii, no. 3, Jan., 1913, p. 120, pl. 18, f. 3. Not *V. martini* Sayn, 1911.

"This and *Vertigo ovata* are the only species found in this part of the country with two teeth on the parietal wall. The latter species, however, is much the larger and more ovate in outline. The size of *martini* is about the same as that of *gouldi* from the same deposits, but that species is more cylindrical and the angle tooth is never developed. The size is somewhat less than that of *Vertigo tridentata*, a recent shell of Eastern Kansas in which the basal tooth is absent" (*H. & J.*).

The entire absence or merely indistinct trace of a crest behind the lip, the slighter "auricle" of the latter, and the

shorter palatal folds, as well as the somewhat shorter, wider shape, separate this species from *V. binneyana*, which is otherwise similar. It does not agree in detail with any of the forms of *V. coloradensis*, though closely related to them. The striation is of irregularly, rather widely spaced wrinkles, as strong as in *V. coloradensis* but decidedly less regular and less crowded than on the penult whorl of that species. The outer lip is not at all expanded, rather blunt. The parietal lamella is rather long, as in *V. coloradensis*.

The figure is from the type, one of no. 226396 U. S. N. M. As the name had been used by Sayn for a Pleistocene species of France, that of Mr. Hanna has been substituted.

22. VERTIGO COLORADENSIS (Cockerell). Pl. 12, fig. 13.

"Shell brown, shiny, thinnish, translucent enough to show teeth through (body whorl) from outside, striate, especially on penultimate whorl. Outline oblong-oval, barrel-shaped, apex blunt. Whorls four. Aperture pyriform. Peristome brown, thick, continuous by a well-marked callus on parietal wall. Outer lip not constricted; a crest is indicated behind peristome, but not well developed. The teeth within the aperture are brown, one long one on parietal wall, one on columellar, and two, the lower one largest, on outer wall. Length 1½, diam. 1 mm. (*Ckll.*).

Length 1.75, diam. 1 mm.

Colorado: near Swift Creek, Custer Co., Cockerell, type loc.

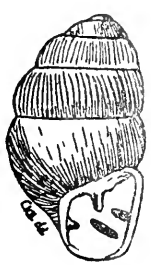


FIG. 1.—VERTIGO COLORADENSIS CKLL.

Utah: Box Elder canyon at 4500 ft., H. Hemphill. Arizona: Pine Canyon, at 7500 ft., and head of Cave Creek canyon,

8000 ft., Chiricahua Mts., Ferriss.

Pupa coloradensis COCKERELL, Journ. of Conch., Leeds, vi, 1889, p. 63 (name only); British Naturalist, 1891, p. 100 (description); and in Binney, Fourth Supplement to Terr. Moll., v, Bull. M. C. Z., xxii, no. 4, p. 191.—*Vertigo coloradensis* Ckll., STERKI, Nautilus, vi, 1892, p. 5.—COCKERELL, Nautilus, x, 1897, p. 134.—PILSBRY & VANATTA, Proc. A. N. S. Phila. 1900, p. 603, fig. 2.—PILSBRY, Nautilus xvi, p. 58 (copy of orig. desc.).—*Vertigo columbiana utahensis* Sterki, in PILSBRY & VANATTA, Proc. A. N. S. Phila. 1900, p. 603, pl. 23, fig. 10.

Professor Cockerell's description and figure are given above. The type specimen is said to be in the British Museum. It differs from *V. concinnula* by the smaller size, from *V. gouldii* by the absence of a basal fold and the coarser striation; typically it is also a trifle smaller than usual in *gouldii*, measuring 1.75 mm. long, 1 wide, while *gouldii* is generally 1.85 to 2mm. long. Prof. Cockerell's measurement, 1½ mm., was certainly only approximate. The columellar lamella is a little oblique, ascending somewhat as it enters. Perhaps it could be ranked as a subspecies of *gouldii*, but I think it sufficiently distinct.

V. columbiana utahensis from Box Elder canyon, northern Utah, is the same thing. The type is drawn in pl. 12, fig. 13.

A few specimens from the Chiricahua Mountains are slightly larger, 1.9 x 1.1 mm.

Dr. Sterki has given me the following notes on a specimen received from Cockerell through Binney. "Subcylindrical to somewhat barrel-shaped, perforate, whorls over 5, the last narrowed; aperture very small, 0.5 mm. high; a slight, rounded crest behind the margin and a slight flattening or even impression over the palatals; at the auricle a slight, small, impressed groove just behind the margin and barely above the upper palatal plica. Peristome not or very little thickened; inside there is a distinct, rather thin callus into which the two palatal plicae merge, the lower rather long, the upper much shorter; no suprapalatal. Parietal moderately large; a very small angular; columellar not large but well formed, apparently not lamellar. 1.7 x 1 mm."

22*a*. *Vertigo coloradensis basidens* Pils. & Van. Pl. 12, fig. 15.

Cylindric-oblong, with strongly striate middle whorls, and with a parietal lamella only on the parietal wall, as in *V. coloradensis*; but having a small, short basal fold within the junction of columellar with basal margins; the lower palatal fold is especially long; there is a more or less distinct callus running upward from the outer end of the upper palatal fold; finally, there is a wide and more or less prominent crest behind the lip. Length 1.8, diam. 0.95 mm.

New Mexico: Bland, Bernalillo Co., Ashmun, type loc. Colorado: Rio Blanco, Cockerell. Montana: Ward, L. E. Daniels. British Columbia: Field, S. Brown.

V. coloradensis basidens Pilsbry & Vanatta, Proc. A. N. S. Phila. 1900, p. 604.

The palatal folds, especially the lower, are decidedly longer than in *V. gouldi*. The crest is rather broad and sometimes decidedly prominent, more so than in any closely related form.

Two specimens from Field measure: 1.75 x 1.05 and 1.95 x 1 mm. Those from Ward, Mont., have the crest especially strong and light-colored, and the callus above the upper palatal fold is quite heavy.

22*b*. *Vertigo coloradensis arizonensis* Pils. & Van. Pl. 12, figs. 14, 16.

Shell cylindric-oval, rimate, very small; very densely and sharply but most minutely striate; light brown. Whorls convex, the last tapering below, the last half whorl narrow as though pinched at base, flattened over the position of the palatal folds, then rising in a low, hardly noticeable crest, obsolete except near the base. Aperture irregularly truncate-oval, the peristome well expanded, brown. Denticles 5, the parietal lamella high and strong, a minute angular lamella standing near its outer end. Columellar lamella entering obliquely, ascending a little. Upper and lower *palatal folds very long, rising conically in the middle*, distinctly showing through from the outside, the lower fold being a little stronger and more immersed, its position marked by a depression outside. There is no palatal callus.

Length 1.8, diam. 0.9 mm.; 5½ whorls.

Length 1.7, diam. 0.9 mm.; fully 5 whorls.

Arizona: Mt. Mingus, near Jerome, at about 8500 ft., type loc., and on Oak Creek, 40 miles from Jerome, Yavapai Co., Ashmun; Bill Williams Mt., Coconino Co., Ferriss; Graham Mts., and Black River, Graham Co., Ferriss; Dragoon and Chiricahua Mts., Cochise Co., Ferriss & Pilsbry. New Mexico: Grants, Valencia Co., A. & J. Bailey, and Bland, Bernalillo Co., E. H. Ashmun; on Willow, Whitewater and Silver creeks, Mogollon Mts., Ferriss & Daniels; everywhere along the crest of the Black Mts., Ferriss & Pilsbry.

Vertigo coloradensis arizonensis Pilsbry & Vanatta, Proc. A. N. S. Phila. 1900, p. 604, pl. 23, f. 9.—Pilsbry, Nautilus xix, 130 (Grants, N. M.).

This race, of which large numbers have been studied from many localities, is somewhat narrower than *V. coloradensis*, and invariably has an angular lamella when adult. The palatal folds are long, and there is no basal or subcolumellar denticle. The penult whorl is usually more coarsely and distinctly striate than the others.

22c. *Vertigo coloradensis inserta* n. subsp. Pl. 12, figs. 10, 11.

The shell is similar to *V. c. arizonensis* in size, shape and sculpture, and in possessing a small angular lamella; but the parietal and columellar lamellae are larger and thicker, and there is a basal fold.

Length 1.85, diam. 0.9 mm.; 5 whorls.

Length 1.7, diam. 0.9 mm.

Arizona: many places in the Santa Catalina Mts., the type locality being Bear Wallow; J. H. Ferriss.

It appears to be of general occurrence in the Santa Catalinas, the localities being between 8500 and 9500 ft. *V. c. arizonensis*, which inhabits the same zone in ranges north, west and east, was not found in the Santa Catalinas. One quite short specimen from Rustler Park, high in the Chiricahuas, measuring 1.6 x 0.95 mm. appears to be the same race.

It differs from *V. c. basidens* by having an angular lamella.

23. VERTIGO CONCINNULA Ckll. Pl. 10, figs. 9, 10.

Shell ovoid-cylindrical in outline, slightly tapering toward the blunt apex; solid and somewhat opaque, so that the palatal folds are usually only dimly seen through from the outside. Surface shining, irregularly, obliquely *striate*, more strongly so on the penult whorl. Whorls 5, apical 2 whitish, the rest cinnamon (often with numerous irregularly scattered spots and flecks of very light buff). Whorls quite convex, the last slightly ascending toward the aperture, its latter half very decidedly flattened on the outer-inferior portion, this part bearing a moderate or low wavelike crest or ridge behind the lip, and then slightly constricted. Umbilical rimation short, imperforate. Aperture rounded, truncate above; peristome a little expanded; parietal wall bearing a rather strong entering parietal lamella in the middle, and usually a smaller angular lamella to the right of its outer end; columella with a strong, deep-seated entering lamella; outer wall with two rather low, long palatal folds, the lower one longer. Length 2.1, diam. 1.2 mm.

Colorado: Custer and Summit counties, 6,000-10,000 ft. (Cockerell), and other places noted below. New Mexico: Beulah, Sapello canyon, T. D. A. Cockerell; Bland, Jemez Mts. and Capitan Mts., Ashmun; Cloudcroft, Sacramento Mts., H. L. Viereck; Mogollon Mts., on Turkey, Willow and Silver Creeks, Ferriss and Daniels. Arizona: Mt. Mingus, near Jerome, Ashmun.

Vertigo californica Rowell, INGERSOLL, Bull. U. S. Geol. Surv. Terr., i, p. 128 (1875); Ann. Rep. U. S. Geol. and Geogr. Survey Terr. for 1874, Hayden, p. 392, 1876. No description. Not of Rowell.—*Vertigo ingersolli* Ancey MSS. in COCKERELL, J. of Conch., Leeds, vi, 1889, p. 64 (name only, substituted for *P. californica* Ing. non Row.).—STERKI, Nautilus, vi, 1892, p. 5, with varieties *haydeni* Anc. and *accedens* Anc. (names only).—COCKERELL, Nautilus, x, 1897, p. 135 (identity with *concinnula* affirmed from part of original lot).—*Pupa ingersolli* Ancey MS., COCKERELL, British Naturalist, 1891, p. 101; reprinted in Nautilus xvi, p. 59.—*Vertigo concinnula* COCKER-

ELL, Nautilus, x, 1897, p. 135.—PILSBRY and VANATTA, Proc. A. N. S. Phila. 1900, p. 599, pl. 23, f. 8.—J. HENDERSON, Univ. of Colo. Studies iv, p. 172 (Animas Valley, Rio La Plata and Cunningham Gulch, Cockerell, Naut. x, 135. Summit and Custer Counties and Black Lake Creek, Cockerell. "*Vertigo californica*" Ing., Blue River Valley, Los Pinos Agency, S. W. of Los Pinos; Howardsville, Animas Valley and Rio La Plata, Ingersoll, 1874, 392. Eldora, Henderson).—WHEELER, Nautilus xxv, 124 (Monte Sano, Madison Co., Ala.).—*Pupa concinnula* Ckll., PILSBRY, Nautilus, xi, 1898, p. 119; Class. Cat. L. Sh. Amer., p. 21; Nautilus, xii, 1899, p. 103.

The dull, rather opaque shell, cylindrical and small, with long palatal folds and parietal lamella, separate this from *V. modesta* and its varieties. It approaches *V. modesta parietalis*, which, however, is larger and smoother, with shorter parietal lamellae and palatal folds. The form of *modesta* from Labrador agrees with *concinnula* in having the penult whorl distinctly striate. The larger size, more cylindrical shape and presence of an angular lamella distinguish *concinnula* from *V. coloradensis*. *V. c. inserta* is distinctly smaller than *concinnula*. In Colorado, according to Professor Cockerell, it occurs at higher elevations than *V. coloradensis*, between 6,000 and 10,000 feet; but in the Mogollon Mountains, N. M., *concinnula* is found in the same zone with *V. coloradensis arizonensis*.

This species was first collected by Ernest Ingersoll, who identified it with the West Coast *V. californica*. Ancey detected the error, and named it *Vertigo ingersolli* in MS. In 1891 Professor Cockerell published a brief descriptive note on *V. ingersolli*:—"It is allied to *coloradensis*, but 2 mm. long, cylindrical, dull brown, with a half whorl more, and a double lamella on the parietal wall." As the number of whorls of *V. coloradensis* had not been stated, and there are two lamellae, not a "double lamella," on the parietal wall, I have held this note to be insufficient to establish a species (Nautilus xvi, 59). The first recognizable description is that of *concinnula* Cockerell, 1897. Since *ingersolli* is known solely by Cockerell's several notes, no description of Mr. Ancey's type having

been published, it seems undesirable to revive that name. The type of *V. concinnula*, from near Brush Creek, Custer Co., 10,000 ft., is drawn in fig. 9. The two varieties, *haydeni* and *accedens*, have never been defined.

There are some forms approaching *corpulenta*, but *concinnula* is more distinctly striate and has longer palatal folds.

The specimens from Arizona and New Mexico are of a clearer, more translucent cinnamon color than those seen from Colorado; the crest is generally somewhat better developed. Length 2 to 2.3 mm. These southern examples form a transi-

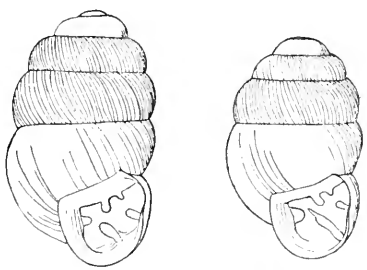


FIG. 1.—VERTIGO CONCINNULA CKLL.

tion to *V. modesta insculpta*, the only difference being the smaller size and generally longer palatal folds of *concinnula*.

According to Mr. Wheeler, the record from Alabama was based upon an identification by the writer; but the place is so remote from the known range of *concinnula*, and the environment so diverse, that possibly the identification might be revised if the specimen was at hand.

24. VERTIGO ARTHURI (Martens).

"Shell ovate, striatulate, perforate, of 5 rather swollen whorls; the aperture triangular, outer margin *thickened within*; 2 palatal folds, 2 columellars, the upper one larger, and 1 strong parietal. Length 1.5, diam. 0.8, apert. 0.5 mm." (*Marts.*)

Vertigo bollesiana Morse var. *arthuri* von MARTENS, SB. Ges. Nat. Freunde, Berlin, nr. 9, Nov., 1882, p. 140.

"Little Missouri, Dakota, coll. by Arthur Krause. It differs from the type form of the species [*V. bollesiana*] by the

strongly thickened outer margin and the somewhat stronger dentition'' (*Marts.*).

The locality is at or near Medora or Little Missouri station of the Northern Pacific R. R., in Billings county, North Dakota. It occurred with *Euconulus fulvus, Vallonia pulchella* and *gracilicosta, Pupilla muscorum* and *blandi, Gastrocopta armifera*, ''*P. pentodon* var.'' (?=*G. holzingeri*), and *Succinea lineata* W. G. B. *V. b. arthuri* is not known to American conchologists, but the description suggests *V. coloradensis basidens.*

Dr. V. Sterki has sent a note on a *Vertigo* collected by Mr. A. W. Hanham at Winnipeg, Manitoba, which I suspect to be identical with *arthuri.* ''Like *coloradensis*, though one specimen has somewhat of a rounded crest over the palate. There is a strong, white callus in the palate, thickest where the short upper palatal plica merges into it, and thinner at the lower palatal. It does not extend up to the suture or to the base.

''Length 1.6, diam. 0.9 mm.

''Length 1.5, diam. 0.8 mm.''

Group of Vertigo modesta.

Moderately large species, 2 to 3 mm. long, without sharp striation (except in *V. m. insculpta*), and *never having a basal tooth*, the tooth formula varying from 0-0-0 to 2-1-2.

It is a circumpolar Arctic and alpine group, comprising many races with few teeth or none. The collections at hand are deficient in Siberian and Greenland Vertigines, and I am therefore leaving as species various forms which may prove to be merely local races of *V. modesta*, such as *V. hoppii, V. krausseana* and *V. arctica.* The arctic and subarctic forms have teeth as follows:

	Angular.	Parietal.	Columellar.	Palatal.
V. krausseana	0	1	0 or trace.	0
V. arctica	0	1	1	0 or 1
V. a. extima	0	0	0	0
V. m. ultima	0	0	0	0
V. hoppii	0	1 or 0	1 or 0	1 or 0
V. modesta .....1 or 0		1	1	2

It may turn out that the slight differences in size and teeth are insufficient for separating these forms specifically, and the subordination of all under *V. modesta* would not surprise me, when series of specimens from Lapland, Siberia, and Greenland can be brought together for comparison with the better known boreal American forms of *V. modesta*.

Key to American species.

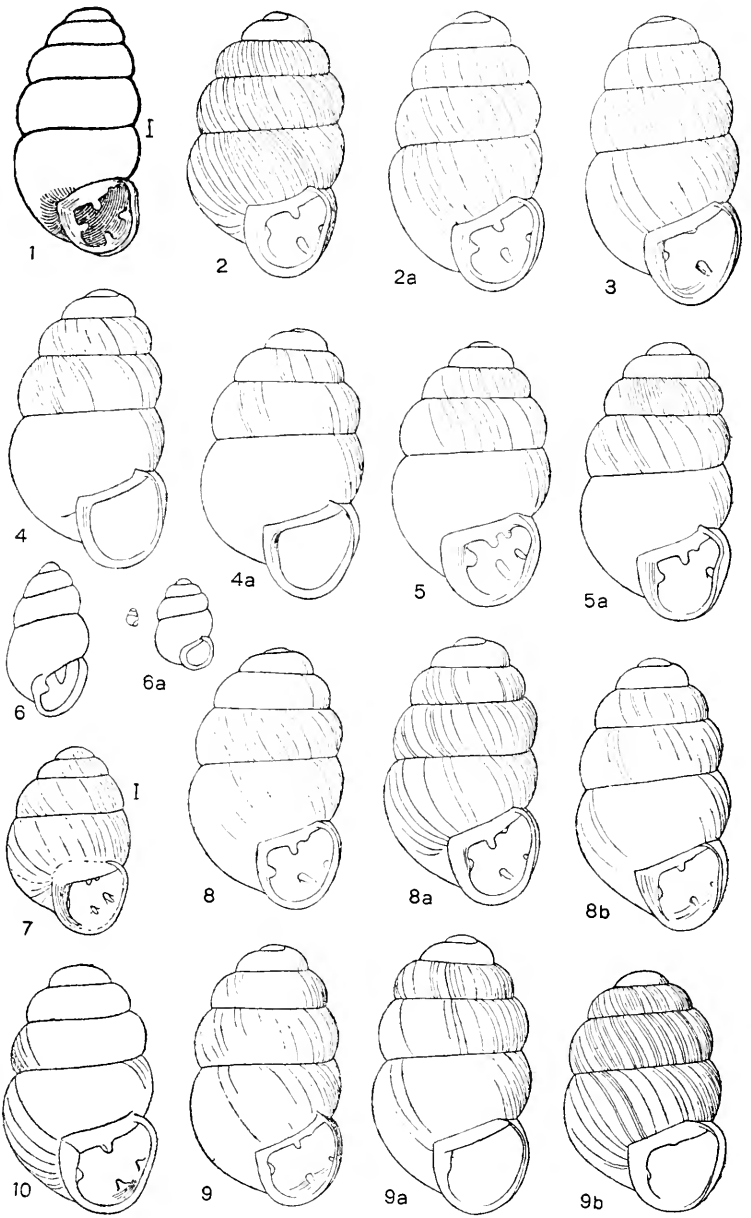
Shell cylindric-oblong or cylindric-ovate; 0 to 5 teeth.
V. modesta and allies, nos. 25-29.
V. rowelli, no. 32.
Shell ovate, the spire strongly tapering; California.
5 small teeth. *V. occidentalis*, no. 25*f*.
Without teeth. *V. dalliana*, no. 30.

25. VERTIGO MODESTA Say. Pl. 10, figs. 1, 2; page 124, figs. 1, 2, 2*a*.

"Shell dextral, suboval, minutely wrinkled; *apex* obtuse; *whorls* six; *umbilicus* distinct; *aperture* obliquely subovate; *labium* with a prominent compressed semioval tooth equidistant from the extremities of the labrum, and a somewhat conic one rather below the middle of the columella; *labrum* not reflected, joining the preceding whorl at its upper extremity with a curve; bidentate, lower tooth placed opposite to that of the middle of the labium, the other smaller and placed a little above. Length less than one-tenth of an inch. Inhabits the Northwest Territory" (*Say*).

The cylindric-oblong shell is from tawny to cinnamon colored, glossy, rather weakly striate, the striation more distinct on the middle whorls. The last whorl has a weak crest behind the obtuse, brown outer lip, which expands very little, and is not noticeably caught in to form a sinulus. Teeth four, white: the parietal and columellar lamellae and lower palatal fold subequal, short; the upper palatal fold smaller. Length 2.6, diam. 1.3 mm.; 5½ whorls.

Labrador, westward, over the crest of the Rocky Mts. (Field, B. C.) to Victoria and Nanaimo. Reported locally in Maine, Vermont and Connecticut. Loess of Iowa (Iowa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8a
8b
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9a
9b
10

City, Des Moines) and Kansas (Phillips Co.). Alaska, abundant. The typical *modesta* replaced in the Rocky Mountain system and California by various weakly differentiated races.

EXPLANATION OF FIGURES, p. 124.

Fig. 1. *Vertigo modesta* (Say). Photographic copy of Gould's original figure of *Pupa decora*.
Figs. 2, 2*a*. *Vertigo modesta* (Say). Loess, Iowa City, Iowa, no. 11657.
Fig. 3. *Vertigo modesta* (Say), form resembling *V. arctica* Wallenb. Length 2.6 mm., Norton Bay, Alaska, no. 79561.
Figs. 4, 4*a*. *Vertigo modesta ultima* Pils. Norton Bay, Alaska, no. 79562.
Figs. 5, 5*a*. *Vertigo modesta parietalis* Anc. Wickersham's, Miller Peak, Huachuca Mts., Arizona, no. 97509.
Figs. 6, 6*a*. *Vertigo hoppii* Moller. Photographic copies of Moerch's figures.
Fig. 7. *Vertigo occidentalis* St. Type specimen.
Figs. 8, 8*b*. *Vertigo modesta parietalis* Anc. Bluff Lake, San Bernardino Mts., Cal., no. 104659.
Fig. 8*a*. *V. m. parietalis* Anc. Cienaga below Bluff Lake, no. 105167.
Fig. 9. *Vertigo modesta castanea* St. Mouth of Big Arroyo, Kern R., Tulare Co., Cal., no. 115204.
Fig. 9*a*. *V. m. castanea*. Wood's Creek, Tulare Co., no. 115203.
Fig. 9*b*. *V. m. castanea*. Onion Valley, Kearsarge Pass, Inyo Co., Cal., no. 115199.
Fig. 10. *Vertigo modesta corpulenta* (Morse). Photographic copy of Morse's figure.

Pupa modesta SAY, Long's Second Expedition, appendix, 1824, p. 259, pl. 15, fig. 5.—*Vertigo modesta* (Say), PILSBRY & VANATTA, Proc. A. N. S. Phila., 1900, f. 600, pl. 23, f. 2, 3, 6.—WHITEAVES, Ottawa Naturalist 1905, 171 (Kananaskis, Alberta).—JOHNSON, Fauna of New England, 13, Mollusca, 1915, p. 213 (Cape Elizabeth, Maine; Stonington, Conn.).—HANNA & JOHNSTON, Univ. of Kansas Science Bull. vii, 1913, p. 120 (Pleistocene of Phillips Co., Kansas).—Dall, Alaska, Land and Freshwater Mollusks, p. 29, Harriman Alaska Exped. xiii, 1905 (in Alaska at Killisnoo, Chilkat and Chilkoot valleys, Pyramid Island, Portage Bay, Dyea, Klukwan, Point Romanof at the Yukon delta; St. George Island! St. Paul

Island! Unalaska! Rooluk Island, Unalga Pass! Akutan Island! Popof Island, Shumagins, St. Paul, Kadiak Island! Orca, Prince William Sound! Yakutat Bay! Berg Inlet, Glacier Bay! Muir Inlet!).—*Pupa decora* GOULD, Proc. Boston Soc. N. H. ii, 1848, p. 263, fig. in text (region of Lake Superior).—BINNEY, Terr. Moll. v, 1878, p. 201, pl. 71, f. 3 (Fort Resolution, Great Slave Lake).—*Vertigo decora* Gld., MORSE, Amer. Naturalist i, 1868, p. 670 (Ascutney, Vt., *L. L. Thaxter*).—REINHARDT, S. B. Ges. Nat. Freunde, Berlin, 1883, p. 39 (Portage Bay, Killisnoo, Kätlrachiä, Kluguan, lower Dejä valley and on Pyramid Island, *Krause*).

An imperforate cylindric-oblong or somewhat ovate shell, with short, rather small teeth arranged in form of a cross, or not infrequently the upper palatal fold is wanting, especially in examples from the loess of Iowa. It is widely distributed in the Dominion of Canada and Alaska, and in the loess formation of Iowa and Kansas.

V. modesta differs from typical *V. m. corpulenta* by the more cylindric shell, with one whorl more, but intermediate individuals or lots occur in the West. No specimens having a distinct angular lamella are known from east of the Rocky Mountains.

There are numerous forms and mutations, some of them apparently subspecies characteristic of definite areas; others, such as *parietalis,* often occur associated with various races in the same colonies. The subspecific taxonomy is more or less arbitrary, and the number of forms worth recognition by name will vary with the material studied and the observer until collections fairly covering the range of the species are available.

"This is the most abundant and widely distributed species in the north country." The type locality of *modesta* was somewhere near or west of the western end of Lake Superior. *P. decora* also came from the region of Lake Superior. The two names were evidently applied to exactly the same race. A photographic copy of Gould's figure of *P. decora* is given on p. 124, fig. 1.

It is a variable snail. A specimen from Labrador meas-

ures, length 1.9, diam. 1.2 mm., and is closely striate on the penult whorl.

Specimens from the loess of Iowa are quite variable in form and size. Those figured measure:

Length 2.65, diam. 1.45 mm. (page 124, fig. 2*a*, Iowa City).

Length 2.4, diam. 1.35 mm. (page 124, fig. 2, Iowa City).

Length 2.3, diam. 1.2 mm. (plate 10, fig. 2, Des Moines).

The smallest of these, pl. 10, fig. 2, is rather strongly striate, much as in *V. concinnula*.

It has also been found by Mr. A. A. Hinkley in loess at New Harmony, Indiana, according to Dr. Sterki.

In a series from Dyea valley, Alaska, the size varies from 2.4 x 1.4 to 2.65 x 1.4 mm. The crest is rather strong. The teeth vary from typical to slightly larger, and in some of them a small angular lamella is added. The lot is intermediate between *modesta* and mut. *parietalis*, or rather, it includes both forms. A specimen was figured in Proc. A. N. S. Phila. 1900, pl. 23, fig. 2.

Specimens taken on Norton Bay, Alaska (R. C. McGregor) are deficient in teeth, an upper palatal fold being absent (page 124, fig. 3), the parietal and columellar lamellae small. Length 2.4 to 2.6, diam. 1.4 mm. It agrees rather closely with the description and figures of *V. arctica* Wallenb., described from Lapland, and I have no doubt is identical with the form listed as *arctica* from Port Clarence by Westerlund (Vega-Exped. Vet. Arbeten, iv, 163); yet I can but regard it as a form of *modesta*, in view of the fact that it is in the *V. modesta* area, and that a similar deficiency in teeth occurs in forms of *modesta* found in the loess of Iowa and in California. I do not here consider the question whether *V. arctica* is distinct from *modesta* for the reason that I have no Lapland examples of *arctica*.

Pupa borealis Morelet is generally admitted to be identical with *decora* (*modesta*). A translation of the description follows: Shell rimate, ovate-oblong, glossy, diaphanous, fulvous-corneous, regularly striate under the lens; whorls 6, a little convex, the last compressed at base, forming a moderate excavation. Aperture somewhat rounded oval, moderate,

four-toothed: 1 pliciform tooth deep on the parietal wall, 1 columellar, the rest smaller, in the palate. Peristome simple, straight, the columellar margin shortly dilated above. Length 3, diam. 1.5 mm. Kamchatka (*Morelet*).

Pupa borealis Morelet, Journ. de Conchyl. vii, 1858, p. 9. —Pfr., Monogr. vi, p. 311.—W. G. Binney, Terr. Moll. v, 1878, p. 211; Third Supplement, Bull. M. C. Z. xix, 1890, p. 185, fig. in text; Man. Amer. Land Sh. p. 483.

Binney's figure of a specimen from Petropaulovski shows no upper palatal fold, and might be considered identical with *V. arctica*; yet the teeth are so variable in these derivatives of *modesta* that a single specimen is inconclusive.

Wallenberg's figures of the form he calls *V. shuttleworthiana* from Lapland look a good deal like *modesta*, the shells being much larger than the true *shuttleworthiana*. See Malak. Bl. v, pl. 1.

25*a*. *Vertigo modesta ultima* n. subsp. Page 124, figs. 4, 4*a*.

On the north shore of Norton Sound Mr. R. C. McGregor obtained an entirely toothless form, having the shape and striation of *V. modesta*, and probably merely a terminal member of the mutation-series represented by the three-toothed form found elsewhere on Norton Sound. Like the latter, it is not distinguishable from the terminal forms of *V. m. castanea* except by the remote locality. It is smaller than *V. arctica extima* of central Siberia and differs from *V. krausseana* by having no teeth and by the somewhat greater size.

Length 2.6, diam. 1.4 mm.

Length 2.5, diam. 1.5 mm.

25*b*. *Vertigo modesta mut. parietalis* Ancey. Pl. 10, fig. 4.

"Shell having two teeth on the parietal wall" (*Ancey*). The shape varies from that of *corpulenta* to about that of *modesta*; whorls about 5. Teeth 5, there being an angular lamella; and the others are larger than in typical *corpulenta*. The surface is somewhat striate, as in *modesta* and *corpulenta*. Length 2.45, diam. 1.3 mm.; 5⅓ whorls.

Rocky Mountain region etc., the type locality Ogden canyon, Utah.

Pupa corpulenta Morse var. *parietalis* ANCEY, Conchologists Exchange ii, Dec. 1887, p. 80 (Ogden canyon, Utah).—*Vertigo modesta parietalis* Anc., PILSBRY & VANATTA, Proc. A. N. S. Phila. 1900, p. 601, pl. 23, f. 1.—HENDERSON, Univ. of Colo. Studies iv, p. 172 (Delta and Custer counties, Black Lake Creek, *Cockerell*; North Park, *Barber*).—COCKERELL, Nautilus xxv, 59 (Tolland, Colo.).—BERRY, Nautilus xxix, p. 127 (Big Snowy Mts., Mont.).

In the Sierra Nevada counties of California *V. modesta* and *parietalis* appear to be rather abundant. They were collected in the valleys of the San Joaquin and King's rivers, Bear and Fish Creeks, Fresno county, in many places by Mr. Ferriss in 1917. In some lots four-toothed forms occurred with *parietalis*, the latter in the majority.

Lots from Pumice Flats, San Joaquin river, Bear Creek and Grouse Meadow, Kings river, are quite distinctly striate, much as in the Arizonian *insculpta*. In one lot from Simpson's meadow, Kings river, there are apparently adult shells having 5, 4 and 2 teeth (columellar and lower palatal). By individuals these specimens could be referred to *parietalis*, *modesta* and *castanea*.

Other Californian forms of the species are noticed under *occidentalis* and *castanea*.

The size and shape are variable in the same lots. The shorter shells having 5 whorls or even less, the larger fully 5½ whorls.

Length 2.4, diam. 1.4 mm., Miller Pk., Huachucas (p. 124, fig. 5).

Length 2.55, diam. 1.3 mm., Miller Pk., Huachucas (p. 124, fig. 5*a*).

Length 2.4, diam. 1.3 mm., Boise Co., Idaho.

Length 2.7, diam. 1.35 mm., Boise Co., Idaho.

This form is far more generally distributed than the typical *corpulenta*. In some places, as in in Ogden Canyon, the type locality, the two occur together; but in most localities all of the adult shells are *parietalis*. As forms with the *parietalis*

teeth occur in some places associated with both *corpulenta* and with shells having the contour of typical *modesta*, the subspecific status can hardly be allowed this form. I conclude that *parietalis* is the more primitive stock, and *corpulenta* a mutation thereof, which has not obtained so wide a distribution. Typical *V. modesta* is a more cylindric form which has mutated from long *parietalis* in the same way by loss of the angular tooth; but as the five-toothed stock is not found east of the Rocky Mountains, where *modesta* has a wide range, the racial distinction may perhaps be retained.

Fig. 4 is from an Ogden Canyon specimen.

Professor Cockerell has reported a form from Tolland, Gilpin Co., Colorado, under the name *V. m. parietalis*, with the following note "Rather small for parietalis, but over 2 mm. long; palatal plicae long, as is *concinnula*; shell clear chestnut; aperture strongly elbowed above. This is apparently a distinct race, between *parietalis* and *concinnula*, but hardly recognizable by a separate name. Ancey's name *ingersolli* certainly included such forms as this, and could be so restricted without much risk of error" (Nautilus vol. 25, Sept., 1911, p. 59).

See also under *V. m. castanea*, p. 134, for notes on *parietalis* forms of the San Bernardino Mts., Cal., figured on p. 124, figs. 8, 8*a*, 8*b*.

25*c*. *Vertigo modesta corpulenta* (Morse). Pl. 10, fig. 3.

Shell rimate perforate, elongate ovate, finely striated, polished, translucent, dark olive brown, apex round, obtuse; whorls four, convex, tumid, wider at the base, aperture large, sub-circular, with four obtuse teeth, one on the parietal margin, one on the columellar margin, and two on the labrum; peristome slightly thickened and reflected. Length, .10 inch; breadth .06 inch (*Morse*).

Nevada: Little Valley, Washoe Co., type loc., on the east slope of the Sierra Nevada, 6500 ft. above the sea, R. E. Stretch.

Isthmia corpulenta Morse, Am. Lyc. Nat. Hist. N. Y., viii, 1865, p. 210, f. 7.—*Pupa corpulenta* Morse, Binney, Land and

F.-W. shells of N. A. i, 1869, p. 238; Terr. Moll. v, p. 201; Man. Amer. L. Sh., 1885, p. 172, f. 163.—*Vertigo modesta corpulenta* (Morse), PILSBRY & VANATTA, Proc. A. N. S. Phila. 1900, p. 601, pl. 23, f. 7.—HENDERSON, Univ. of Colorado Studies iv, p. 172 (Colorado: Los Pinos Agency, *Ingersoll*; Center and Delta counties, *Ckll.*).

Decidedly more obese than *V. modesta*, of only about 4½ whorls. The crest behind the lip is distinct, and the four teeth are short, the lower palatal being tubercular or very short. Usual length 2.2, diam. 1.35 mm., to 2.45 x 1.4 mm. A photographic copy of Morse's figure is given on page 124, fig. 10.

It is not known whether *corpulenta* occurs as a pure race. In a few small lots examined there are no *parietalis*, but all of the large lots available containing *corpulenta*, have *parietalis* also.

25*d*. *Vertigo modesta insculpta* n. subsp. Pl. 10, figs. 12, 13.

The shell is similar to *V. m. parietalis* in teeth, but differs by the distinct, rather sharp striation of the penult and antepenult whorls, sometimes also the last. Length 2.6, diam. 1.35 mm.

Arizona: Bill Williams Mt., Coconino Co., Ferriss; Santa Catalina Mts. in many localities, 9000-9500 ft., the types from Mt. Lemon, 9500 ft.; White Mts., Apache Co.; Blue River and Rim of Blue Mts., Graham Co.; Chiricahua Mts., at head of Cave Creek and Long Park, about 8000 ft., Ferriss. New Mexico: Black Range, in the forest zone, Ferriss & Pilsbry.

It differs from the southern form of *V. concinnula* by the larger size and typically shorter palatal folds, yet there is a certain amount of intergradation in both characters. In the Black Range, especially, there are often short specimens, down to 2.25 mm. long. Each of the ranges which ascends into the zone of coniferous forest appears to have either a smaller (*concinnula*) or a larger (*insculpta*) stock, in the average distinguishable, though individuals are often perplexing. The distinction is rather finely drawn, yet such as it is, has been reached after examining some thousands of fresh shells.

Specimens from Bill Williams Mt., in northern Arizona are particularly sharply striate. They were recorded as *V. concinula* in Proc. A. N. S. Phila. 1911, 197, but on account of their size, 2.4 to 2.5 mm. long, 1.4 wide, they appear more properly placed here. The locality is far north of others known, yet the whole intervening region is still unexplored for shells.

The specimens from the Chiricahua range, which were formerly recorded as *V. modesta parietalis* and *V. concinnula* appear to be better placed here. They measure 2.4 to 2.5 mm. long.

At several places in the Santa Catalinas Mr. Ferriss found beautiful albino specimens. They have the translucent waxlike texture of *Gastrocopta pentodon* or *corticaria*. In every case they occurred in colonies of cinnamon-brown shells.

25*c*. *Vertigo modesta castanea* Sterki. Pl. 10, figs. 5, 6.

"Shell oblong or cylindric-oval, glossy, somewhat translucent; chestnut, sometimes with some whitish stripes. Whorls 4¾-5, the last with a moderate crest behind the lip. Teeth very small, placed as in *corpulenta*, the lower palatal largest, columellar usually developed, parietal very small or obsolete, upper palatal wanting or minute. Alt. 2.3, diam. 1.4 mm." (*P. & V.*).

California: Lake Co., *Hemphill*; Fish Camp, Fresno Co., *H. Hemphill*, type loc.; Ranger, Panther creek, Wood's creek, Funston meadow on Kern River, Babb Creek falls, Rae Lake, Tulare Co., *Ferriss*; Wawona meadow, *H. Lowe*; Onion valley, Kearsarge Pass, Inyo Co., *Ferriss*; Holcomb meadows, east of Sugar Loaf Peak, at 8300 ft., San Bernardino Mts., S. B. Co., *S. S. Berry*.

Vertigo castanea Sterki, Nautilus vi, 1892, p. 5 (Lake Co.; name only).—*Pupa castanea* Sterki, Pilsbry, Nautilus xi, 1898, p. 119 (name only).—*Vertigo modesta castanea* Sterki, Pilsbry and Vanatta, Proc. A. N. S. Phila. 1900, p. 602, pl. 23, f. 4, 5 (Fish Camp).—Lowe, Nautilus xxx, p. 95 (Wawona Meadow, Cal.).

This form was recorded from Lake Co. by Dr. Sterki, but

without description. It was first described and figured from Fresno Co. specimens, the type being no. 11655 A. N. S. P. (pl. 10, fig. 6).

The typical form has three teeth, parietal, columellar and lower palatal; but there are also specimens in the same lot which lack the palatal, and one without any teeth.

In a lot from Wood's creek, Tulare Co., there are specimens having 3 teeth, 4 teeth (a minute angular lamella being added), and no teeth (page 124, fig. 9*a*), though the shells seem otherwise to be equally mature. As the teeth appear before the lip is fully formed, this variation is clearly not a matter of age.

A very minute but distinct upper palatal fold is seen in some specimens, as no. 115204, from mouth of big arroyo, Kern River, Tulare Co. (page 124, fig. 9). Others of the same lot have three teeth, and in others a minute angular lamella is developed also. The teeth are best developed in specimens from Rae Lake (pl. 10, fig. 5), some of which would be referred to *parietalis* were they not associated with others more or less deficient in teeth, or without teeth, but otherwise similar. In this lot the shell is largely whitish, or is streaked with white.

Some lots contain among normally proportioned shells, a few short examples such as page 124, fig. 9*b*, but having the crest and lip of adult character. Two from Onion valley, Kearsarge Pass measure:

Length 2.5, diam. 1.4 mm. (normal).

Length 2.3, diam. 1.5 mm. (page 124, fig. 9*b*).

The more cylindric shape and the distinct crest behind the lip distinguish this race from *V. occidentalis*. I have not seen specimens from Lake Co., but the other localities are well represented in the collection of the Academy.

V. m. castanea, in some of its forms, does not seem distinguishable from *V. arctica* and *V. m. ultima* so far as I can see; yet as it has some different mutations, the localities are remote, and none have been found in the intervening territory, it may belong to an independent, parallel line of differentiation of the *modesta-parietalis* stock. On the other hand, there may

possibly be unknown intermediate links in the distribution between Alaska and California.

Perplexing forms are found in the *occidentalis* territory of the upper San Bernardinos, where Mr. S. S. Berry has collected many specimens, such as those listed by him as *V. m. parietalis* (Nautilus xxx, 38). Figs. 8, 8*a*, 8*b*, on page 124 represent specimens having the subcylindric shape of *parietalis*; there is a very small crest close behind the lip (smaller than in *parietalis*, but larger than in typical *occidentalis*). The teeth vary from quite as small as in the type of *occidentalis*, or as in the most fully toothed forms of *V. m. castanea*, to as large as in some *parietalis*; and in some examples which seem to be adult, there is no angular lamella. The columellar lamella is usually deeply immersed. The base is minutely perforate, or in some specimens scarcely so. Length 2.5, diam. 1.35 mm., or slightly smaller. It seems to be an intermediate stage between *parietalis*, *castanea* and *occidentalis*, some individuals resembling one, others another of these races.

25*f*. VERTIGO OCCIDENTALIS Sterki. Pl. 10, fig. 11; page 124, fig. 7.

The shell is perforate, and shortly rimate, globosely *ovate*, the spire being convexly *conic*, summit obtuse; decidedly wider at the last whorl than at the penult; of a dull hazel color, somewhat glossy, subopaque when adult, of 4½ rather convex whorls, the last having a small external dent over the lower palatal fold, but no ridge or crest behind the peristome. The aperture is rather large, obstructed by five teeth: parietal lamella short, a very small angular lamella near it; columellar lamella about equal to the parietal, rather deeply placed; both palatal folds short, the lower slightly larger. No palatal callus. The outer lip is thin, narrowly expanded, projecting forward above the middle; columellar margin broadly dilated and reflected.

Length 2, diam. 1.25 mm.; 4⅓ whorls (type, p. 124, fig. 7).

Length 2.2, diam. 1.4 mm., aperture 0.95 mm.; 4½ whorls (topotype).

California: San Bernardino Mts., at Bluff Lake, 7,550 ft., type loc.; also Bluff Lake cienaga, in the cienaga just north, and along the "New England Trail," 7500 ft.; cienaga west of Green Valley, 6900 ft., S. S. Berry.

Vertigo occidentalis Sterki, Nautilus xxi, Dec., 1907, p. 90. —Pilsbry, Nautilus xxi, Apr., 1908, p. 133, pl. 11, f. 5.—Berry, Nautilus xxiii, Nov., 1909, p. 75.

The original description was from a single specimen, which seems not quite mature, drawn in page 124, fig. 7 (no. 1860 coll. Berry). An older shell from the type locality, pl. 10, fig. 11, has the teeth somewhat stronger, particularly the columellar lamella, which is a very low nodule in the type specimen.

The more conic shape and more distinctly perforate base, as well as the smaller teeth, distinguish *occidentalis* from *V. m. parietalis*; the columellar lamella, too, appears to be a little more immersed than in *parietalis*, and there is no crest behind the peristome.

I have not been able to satisfy myself about the status of this snail. On account of the ovate, tapering shape, I am disposed to give it specific rank, as Dr. Sterki has done; yet there appear to be some equivocal forms connecting with *V. m. parietalis*, which influenced me to use the subspecific form. No doubt the examination of large series from the original locality will clear up this uncertainty—either demonstrating intergradation or a constant difference.

26. Vertigo hoppii (Möller). Page 124, figs. 6, 6*a*.

"Shell dextral, cylindric, obtuse, smooth; columella two-toothed. Length 1.2 lines" (*Möller*).

"Shell subperforate, cylindric-ovate, thin, very delicately striatulate, with a rather glossy, pellucid brown (often white) epidermis; spire convexly-conic. Whorls 5 or 7½, convex, suture deep, ascending in front; columella with an obtuse fold; parietal wall having a compressed, almost median fold; aperture subtriangular, the peristome a little reflected, the outer lip moderately arched, with a very obsolete denticle in front of the middle. Length 2¾, diam. 1 mm." (*Moerch*).

Greenland: Nisik, in the Kusukfjord; Igaliko; different

places in Amaraglik, in the small willow thickets by the ruins; Ekalluit at about 400-500 ft. above the sea (Möller).

P. [*upa*] *hoppii* Moller, Index Molluscorum Groenlandiae, 1842, p. 4.—Pfeiffer in Küster, Conchyl. Cab. p. 163, pl. 19, f. 29, 30; Monogr. ii, 328; iii, 536; viii, 366.—Binney, Bost. Journ. vii, p. 147, pl. 7, f. 2.—Westerlund, Malak. Blätter xxii, 1870, p. 57.—W. G. Binney, Terr. Moll. vol. v, 1878, p. 198, f. 102? (Greenland; Anticosti I.).—*Pupa* (*Vertigo*) *hoppii* Möll., Moerch, Amer. Journ. Conch. iv, 1868, p. 30, pl. 3, f. 6-9.—*Vertigo hoppii* Möller, Dall. Alaska, Land and Fresh Water Moll., p. 29.—*Pupa steenbuchii* Beck, Verz. Kiel., 1847, p. 76 (*nomen nudum*).

I have not seen this species, which evidently stands close to *V. modesta*, differing by the more reduced palatal folds. Mörch notes that "it looks most allied to *Pupa arctica* Wallenb." He states that "the figure of Küster is very bad." Those he gives, from pen drawings by Möller, do not look much better. Some show parietal and columellar lamellae, others none. Two of these figures are copied in my figs. 6, 6*a*.

A var. with "the shell hyaline, glossy, white, destitute of epidermis," based upon "several live specimens with and without teeth, at Amaraglik," is noted by Mörch.

The localities Ungava, Labrador, and Anticosti Island are doubtful, and may perhaps refer to some form of *V. modesta* Say.

Westerlund states that an example of this species from Greenland, in the Berlin Museum, is much larger than *P. arctica* Wallenb., almost larger than *P. laevigata* Kok., has a far more rounded aperture, and there is no trace of a tooth in the palate.

27. Vertigo krauseana (Reinhardt).

Shell dextral, long-ovate, rimate, reddish brown, but little shining, the surface closely and finely striate under the lens. Whorls 5, convex, parted by a deep suture, the last three of about equal width, but gradually and regularly increasing in height, the last whorl forming about two-fifths the total height of the shell, not ascending to the aperture. The aperture is as

high as wide, the columellar border nearly vertical, reflected above, dilated inwardly; outer margin somewhat angular towards the insertion, the basal margin semicircular. On the parietal wall a weak, short tooth stands deep within, behind the callus connecting the lip-margins, while the columella is toothless. Behind the aperture there is sometimes a very weak indication of a callus [crest] parallel to the outer margin. Length 2.2, diam. 1.2 mm. (*Reinh.*).

Siberia: Chukchi Peninsula, at Pooten (Poot); branches of St. Lawrence Bay; Ratmanof Harbor (Krause). Alaska, at Chilkat Inlet.

P. [*upa*] *krauseana* REINHARDT, S. B. Ges. Nat. Freunde, Berlin, 1883, p. 38.—*Vertigo krauseana* Reinh., DALL, Alaska, Land and Fresh Water Moll., p. 32 (Chilkat Inlet?).

"Only a few examples show a weak, tubercular elevation on the columella. The species stands near the Greenlandic *P. hoppei* Möller, in dentition, but the latter is distinguished by the more plump, ventricose shape, paler color, smoother and glossy surface and greater transparency" (*Reinh.*).

This appears likely to prove merely a race of *V. modesta,* but as it is not known to me autoptically and is smaller than any Alaskan specimens I have seen, it is here allowed specific rank. I have seen *modesta* and *modesta castanea* as short as 2.3 mm., but they were associated with larger specimens.

28. VERTIGO DALLIANA (Sterki). Pl. 11, fig. 1.

Shell conic or ovate-conic, of greenish-horn color, transparent, finely irregularly striate in the lines of growth, polished; whorls 4½, well rounded, with deep suture, rather rapidly increasing, the last occupying about ⅗ of altit., towards the aperture somewhat ascending on the penultimate. Aperture lateral, somewhat oblique, subovate with just perceptibly flattened palatal margin; margins approximate, the ends protracted; peristome shortly but decidedly expanded, with a very fine thread-like lip near the margin, the same continuing as a very fine callus on the apertural wall inside of the line connecting the ends of the margins; palatal wall quite simple; no lamellæ (*Sterki*).

Length 2.1, diam. 1.35 mm.

California: near Clear Lake, Lake Co., *Hemphill.*

Pupa dalliana STERKI, Nautilus iv, June, 1890, p. 19; August, 1890, p. 39, pl. 1, f. 2.—W. G. BINNEY, Fourth Suppl. Terr. Moll. v, in Bull. Mus. Comp. Zool. xxii, 1892, p. 195, fig. in text.—*Vertigo* (*Haplopupa*) *dalliana* Sterki, PILSBRY, Nautilus xi, 1908, p. 119.

"The specimens before me were fifteen, fresh, remarkably uniform in their whole appearance; all were more or less covered with a dark brown, hard crust of slime and dirt, generally thickest around the aperture. Doubtless this coating is done 'purposely' by the animals, as in many other species also. When cleaned, it shows about the size and shape of a well-grown *Vertigo ovata*, Say, but by a good eye or under a glass is at once recognized as something else, by the rounded aperture and the absence of lamellae" (*Sterki*).

The color is grayish-olive. There is a deep and rather long crevice but no umbilical perforation. It resembles *V. m. occidentalis* closely in shape, but is slightly smaller, greener in hue, and toothless. *V. m. castanea* has a more oval, less conic shape. *V. dalliana* is perhaps a toothless member of the *V. modesta* group, the end product of a tooth-degeneration series. In the *modesta* and *californica* groups there are many forms showing various stages of this process. *V. m. occidentalis* appears to be the most nearly related species.

By a typographical or other error the length was given as 1.2 mm. instead of 2.1, in the original description. The type specimen is here figured, no. 416 Sterki collection.

Group of Vertigo californica.

Nearctula STERKI, Nautilus vi, 1892, p. 5, type *V. californica.*

Vertigines of cylindric shape, *without crest* or grooves over the palatal folds, and with no palatal callus; typically having parietal and columellar lamellae, upper and lower palatal folds, but in some forms the teeth have been partly lost, only the parietal remaining, or sometimes the aperture is wholly toothless.

These forms are approached so closely by some of the

V. modesta group that a distinction may be impracticable; yet the want of any trace of a crest behind the lip may serve to distinguish the present series from most of the *modesta* group. Moreover, the two groups differ so widely in zonal distribution that a different ancestry is suggested: the *californica* group inhabits low levels, while the *modesta* group is restricted to the colder Canadian and Transition zones, at higher elevations in California, descending to low levels only in the north.

Key to species and subspecies.

1. Sculpture of rather strong oblique riblets. 2.
   Surface striate but not distinctly ribbed; about 2.5 mm. long. Four well developed teeth. *V. rowelli*, no. 30.
2. Aperture having 4 teeth, at least the columellar, parietal and lower palatal well developed. 3.
   Aperture having 3 small teeth. Monterey. *V. c. trinotata*, no. 29*a*.
   Aperture having 1 tooth, the parietal, or none. 6.
3. About 2.5 x 1.3 mm.; parietal lamella not entering deeply. San Francisco. *V. californica*, no. 29.
   Shell smaller or narrower; parietal lamella long, entering rather deeply. Monterey southward, and the islands. 4.
4. Shell 2 to 2.5 mm. long. *V. c. elongata*, no. 29*d*.
   Shell 1.75 to 2 mm. long; whorls short. 5.
5. Sculpture strongly developed. S. Catalina and S. Clemente. *V. c. catalinaria*, no. 29*e*.
   Sculpture weaker and irregular, Cypress Point. *V. c. cupressicola*, no. 29*f*.
6. San Diego southward. *V. c. diegoensis*, no. 29*b*.
   Placer county. *V. c. cyclops*, no. 29*c*.

29. VERTIGO CALIFORNICA (Rowell). Pl. 9, figs. 1, 2.

"Shell rimate subperforate, elongate ovate, thin, dark horn colored, with oblique rib-like striæ; apex obtuse; deep suture; with 5-6 convex whorls, the last a little compressed at the aperture; aperture oblique, suborbicular, armed with four white denticles: one lamelliform, strongly developed, slightly

twisted, on the parietal wall, one on the columella, and two deeply seated within or near the base of the aperture; peristome slightly expanded, columella margin somewhat reflected. Long. 2½, diam. 1 mm." (*Rowell*).

California: San Francisco, Rowell and others.

Pupa californica ROWELL, Ann. Lyc. Nat. Hist. of N. Y., vii, Jan., 1861, p. 287.—BLAND, Ann. Lyc. viii, 1865, p. 166, fig. 12.—BINNEY, Terr. Moll. vol. v, 1878, p. 202, f. 107.—STERKI, Nautilus iv, May, 1890, p. 8.

The figures are from paratypes received from Mr. Rowell.

V. californica differs from all other American Vertigos by its sculpture. The initial 1½ whorls are smooth (showing the usual minute granulation under the microscope); the next whorl is finely but sharply rib-striate, after which the riblets become coarse, more oblique, and on the last whorl about one-tenth of a mm. apart. There is no trace of a crest or contraction behind the narrowly expanded outer lip; columellar border is well dilated. Both ends of the lip are somewhat calloused in fully adult specimens.

In the typical subspecies the four teeth are well developed as a rule, but in some individuals the upper palatal fold is quite small, or even wanting in rare individuals. Dr. Sterki mentions seeing traces of an angular lamella in some specimens.

Length 2.65, diam. 1.35 mm.; 5⅓ whorls.

Length 2.5, diam. 1.3 mm.

The size and shape are rather variable in a lot from San Francisco received from Dr. R. E. C. Stearns: length 2.6, diam. 1.4 mm., to length 2.25, diam. 1.25 mm.; the shorter ones ovate, the longer cylindric.

Besides the typical form, which is known to me from San Francisco only, the following local races have been defined:

29*a*. *Vertigo californica trinotata* (Sterki). Pl. 9, fig. 9.

"In size not much different from the type, yet a little smaller, and more generally obovate; the striæ are less coarse; the peristome is slightly but distinctly expanded. There is no superior palatal lamella, and the three present are small, the columellar even a trace, or wanting entirely" (*Sterki*).

Length 2.25, diam. 1.15 mm.; nearly 5 whorls.

California: Monterey, Hemphill.

[*Pupa californica*] var. *trinotata* STERKI, Nautilus iv, June, 1890, p. 18.

The figure is from a paratype.

29*b*. *Vertigo californica diegoensis* (Sterki). Pl. 9, figs. 8, 11.

"The diminution of the lamellae is going on; none but the apertural is left in this variety, and even that is quite small or a mere trace. In size and shape the specimens are not much different from the Monterey form, which is an intermediate one" (*Sterki*).

California: San Diego, H. Hemphill, type loc. Lower California: San Ramon, C. R. Orcutt.

[*Pupa californica*] var. *diegoensis* STERKI, Nautilus iv, June, 1890, p. 18.—*Vertigo diegensis* St., BERRY, Nautilus xxx, p. 83 (False Bay near Asher Station).

In the specimens from San Ramon the parietal lamella is sometimes well developed, and there is very rarely a tubercular palatal fold, as in pl. 9, fig. 8. A few examples have no teeth whatever. The least decadent individuals of this race have reached about the same stage of tooth-reduction as *V. c. cyclops*, and some specimens are not distinguishable from that; yet as the localities are remote and in regions physically diverse, the resemblance is evidently not due to direct relationship, but to parallel evolution.

Length 2.65, diam. 1.35 mm.; 5¼ whorls.

Length 2.35, diam. 1.25 mm.; 5 whorls.

29*c*. *Vertigo californica cyclops* (Sterki). Pl. 9, fig. 3.

"Large, conic or ovate conic, or turriculate, umbilicated, rib-like striæ rather strong; whorls 5, well rounded, with deep suture, the last occupying more than ½ alt.; aperture subovate or nearly circular, margins much approximate and the ends protracted, peristome shortly but decidedly expanded; lamella one, apertural [parietal], small. Alt. 2.5; diam. 1.5 mill. For its size, rounded aperture and single lamella I would name this form var. *cyclops*" (*Sterki*).

Length 2.7, diam. 1.45 mm.; 5 whorls.

California: Rocklin, Placer Co. (25 miles northeast of Sacramento), Hemphill.

[*Pupa californica*] var. *cyclops* Sterki, Nautilus iv, June, 1890, p. 18.

A paratype is figured. It is slightly larger than Dr. Sterki's type. "Some specimens have no columellar lamella, and some have a small palatal fold" (*Sterki*, in letter).

29*d*. *Vertigo californica elongata* (Sterki). Pl. 9, fig. 4.

"A little smaller and generally more cylindrical than the type; a part are even long cylindrical having the appearance of an *Isthmia* [*Truncatellina*]. The coloration is somewhat paler and the lamellae are well formed" (*Sterki*).

Length 2.5, diam. 1.2 mm.; 6 whorls.

Length 2.25, diam. 1.1 mm.; 5½ whorls.

Length 2.1, diam. 1.2 mm.; 5 whorls.

California: San Clemente Island, Hemphill, type loc. Santa Barbara I., Hemphill.

[*Pupa californica*] *elongata* Sterki, Nautilus iv, May, 1890, p. 8.

Fig. 4 is from a paratype. The parietal lamella is *decidedly longer* than in *V. californica*, entering deeply. From the elongate form figured it varies, in the same lots, to much shorter forms. Specimens from Santa Barbara are 2.3 to 2.4 mm. long, or even smaller, 2 to 2.25 x 1.15 mm.

This race is intermediate between *V. californica* and *V. c. catalinaria*.

29*e*. *Vertigo californica catalinaria* (Sterki). Pl. 9, figs. 5, 6.

"Small, rather short, pale horn colored; shell thin, delicate; rib-like striæ less numerous and relatively larger; the whorls are less high, which gives the shell a different appearance. All lamellae are present and well formed, especially the apertural [parietal]" (*Sterki*).

Length 1.75, diam. 1.05 mm.; 5¼ whorls.

California: Santa Catalina I., Hemphill, type loc.; also San Clemente I. and Santa Barbara I., Hemphill.

[*Pupa californica*] var. *catalinaria* Sterki, Nautilus iv, May, 1890, p. 9.

"One peculiarity is that in about one-third of the examples a part of the shell is wanting, always on the side of the aperture, so that 3 or even 4 whorls are opened. This can hardly be accidental, and probably that part of the thin shell is worn off by friction in moving" (Sterki).

This race has four well-developed teeth, the parietal lamella being long, as in *V. c. elongata*, from which it differs by the smaller size and shorter whorls; it is also more fragile. A paratype is figured (fig. 6), and a longer shell from Santa Barbara Island (fig. 5).

The Santa Barbara Island specimens are somewhat perplexing. Some are typical *catalinaria*, 1.75 x 1 mm., but also up to 2.15 mm. long, while there are also stouter shells with them, 2 to 2.25 mm. long, 1.15 wide, which seem referable to *elongata*. If it were not for these examples, I would consider *catalinaria* specifically distinct.

29*f*. *Vertigo californica cupressicola* Sterki, n. subsp. Pl. 9, fig. 10.

Small, cylindric, with the riblets distant, irregular and partly obsolete; apertural lamellae and folds relatively larger than in *californica*, the parietal lamella long. Length 1.83, diam. 1.1 mm.; barely 5 whorls.

California: Cypress Point, Monterey, S. S. Berry, J. C. Paine. Type 118835 A. N. S. P.

Closely related to *V. c. catalinaria*, but differing by the weaker, irregular sculpture. In some examples the spire tapers a little more than in the figured type.

30. Vertigo rowellii (Newc.). Pl. 9, fig. 7.

Shell perforate, oblong-ovate, dark horn-colored, shining, translucent, finely striated; apex obtuse; whorls 5, convex; aperture truncately ovate, armed with 4 teeth: one prominent and plicate on the columella, 3 deeply seated within the aperture; peristome slightly reflected. Long. 2, lat. 1 mm. (*Newc.*).

California: near Oakland, Newcomb, type loc.; *cienaga* north of Bluff Lake, San Bernardino Mts., S. S. Berry. Oregon: Douglas county, F. H. Andrus.

Pupa rowellii NEWCOMB, Ann. Lyceum of Nat. Hist. N. Y., vii, April, 1860, p. 146.—BLAND, Ann. Lyc. viii, p. 166, fig. 11. —W. G. BINNEY, Terr. Moll. v, 1878, p. 202, fig. 106 (near Oakland, Monterey, San Bernardino, El Dorado Co.); Man. Amer. L. Shells, p. 483 (Alameda Co.).—*Vertigo* (*Nearctula*) *rowelli* Newc., STERKI, Nautilus vi, 1892, p. 5.

With the teeth like *V. californica*, this species differs by its smoother surface. Under a lens there are delicate, irregularly spaced thread-like striæ corresponding to the far stronger riblets of *V. californica*. The color is somewhat brownish olive. Specimens from Douglas county, Oregon measure:

Length 2.7, diam. 1.5 mm.

Length 2.65, diam. 1.35 mm.

A single example was found in a lot of *V. a. sanbernardinensis* from the San Bernardino Mts. It measures 2.48 x 1.35 mm.

Subgenus VERTILLARIA n. subg.

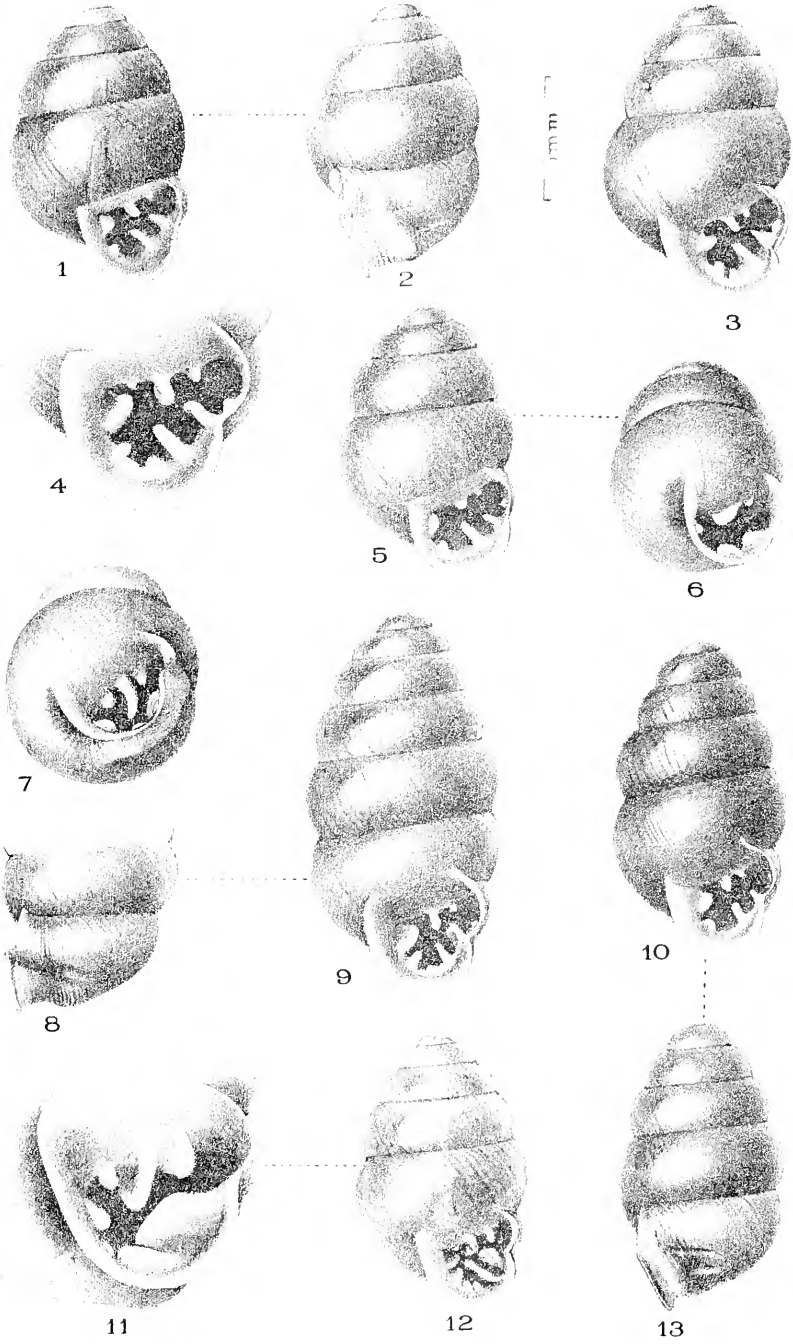
Shell oblong, with the columellar lamella in form of a blunt *vertical* plate, other teeth short; outer lip biarcuate. In the type species there is no angular lamella or basal fold, and the upper palatal fold is minute or wanting.

Type *V. oscariana*. Austroriparian, from Florida to Texas.

The blunt, vertical columellar lamella, parallel to the axis, is entirely unlike other American species of *Vertigo*, being comparable to that of *Vertilla angustior*. I suspect *Vertilla* may be the most nearly related form, though the American species has the lower palatal fold much larger than the upper, and there is no angular lamella. The deep external furrow of the last whorl suggests that an ancestral form had a long lower palatal fold, though the present species is rather degenerate in teeth. There is no external crest and no palatal callus.

31. VERTIGO OSCARIANA Sterki. Pl. 8, figs. 8, 10, 11.

"This is the most peculiar of our species. It is the size of *milium*, but oblong with either end nearly equally pointed, the last whorl being considerably narrowed and flattened to-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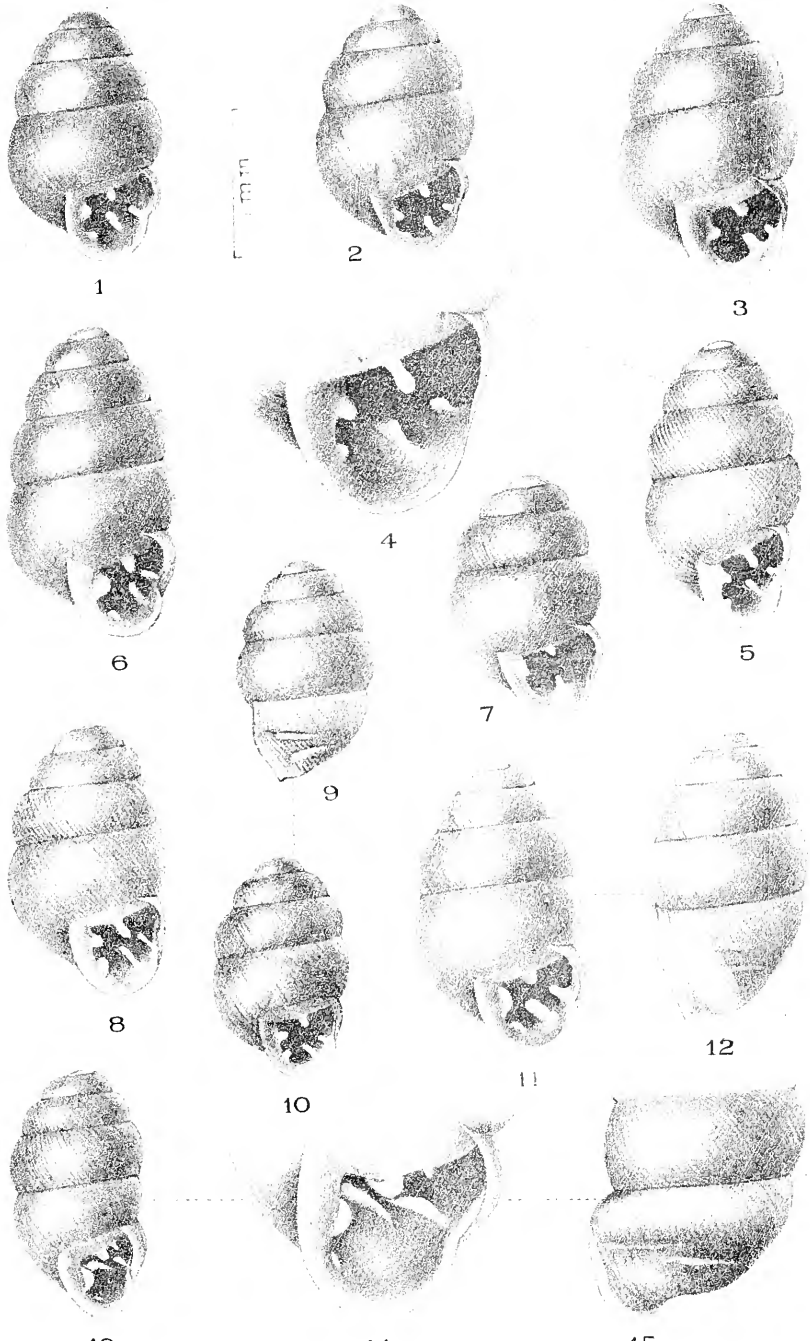
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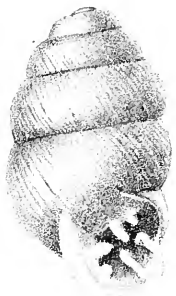

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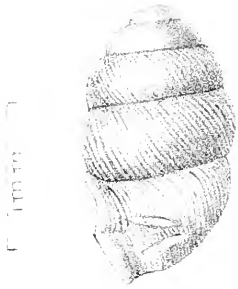

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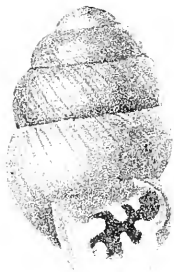

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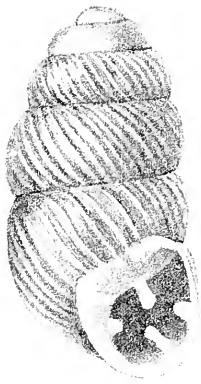

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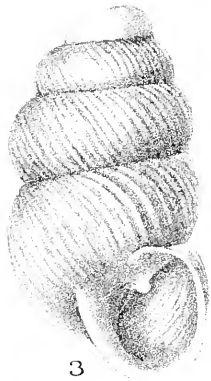

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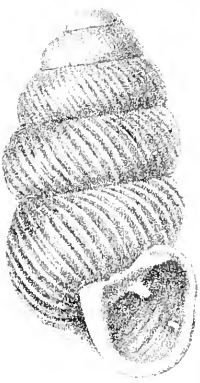

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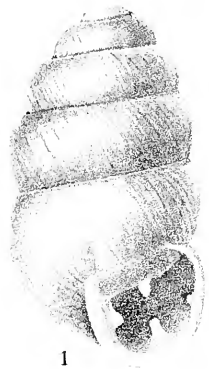
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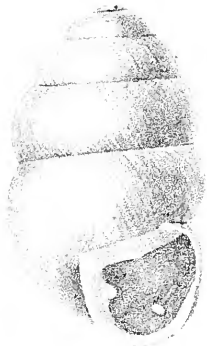
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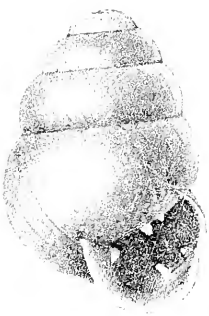
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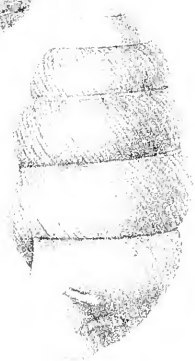
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wards the subtriangular small aperture. Shell thin, delicate, of pale horn color, as is the palatal wall and margin; the latter simple and straight, with a very slight, thin callus inside, lamellæ 3, whitish, rather small: one apertural [parietal], one columellar, longitudinal, and the inferior palatal; sometimes there is also a very small superior palatal. Length 1.5, diam. 0.8 mm." (*Sterki*).

Length 1.45, diam. 0.8 mm.; nearly 5 whorls.

Length 1.53, diam. 0.85 mm.

Florida: Mosquito Island, Volusia Co., type loc., Oscar B. and G. W. Webster; Grassy Key, Raybon. Alabama: Evergreen, Conecuh Co., H. H. Smith. Louisiana: S.-W. cor. Madison Parish, Bayou Macon, C. B. Moore. Arkansas: Keller Place Landing, Ouachita R., Calhoun Co., C. B. Moore. Texas: Guadalupe R. near New Braunfels, Ferriss and Pilsbry.

Vertigo oscariana Sterki, Proc. A. N. S. Phila. 1890, p. 33; reprinted in Binney, 4th Suppl. Terr. Moll. v, Bull. M. C. Zool. xxii, 1892, p. 197, fig. —, Nautilus iii, 1890, p. 136; iv, 1890, p. 39, pl. 1, f. 5.—Pilsbry, Proc. A. N. S. Phila. 1906, p. 147.—Clapp, Nautilus xxviii, 1915, p. 137, pl. 6, f. 8.

The surface is delicately but rather sharply and regularly striate, most conspicuously so on the penult whorl. The columellar lamella is rather blunt and thick, the lower end vertical, the upper slanting slightly inward. The parietal lamella is short and rather high. Figured from the type, no. 60463 A. N. S.

It varies in degree of inflation, as the figures show. Dr. Clapp has noted that the specimens from Evergreen, Alabama, are nearly smooth, showing only obsolete striation. One measures 1.45 x 0.8 mm. The Texan form is also nearly smooth, 1.7 x 9 mm., and some have a thin palatal callus. All of the localities given are for specimens in coll. A. N. S.

It is an isolated species, without near relatives in our fauna.

Subgenus Angustula Sterki.

Angustula Sterki, Proc. U. S. Nat. Mus. xi, 1888, p. 378, for *V. milium* and *V. venetzii*; Nachrbl. d. m. Ges. 1889, p. 117.—*Vertilla* P. & V., Proc. A. N. S. Phila. 1900, p. 597.

Angular, parietal and columellar lamellae are strongly developed, the parietal long, columellar crescentic, its inner end curving downward. Palatal folds strong, the lower entering to the dorsal side, its inner end curving downward. Type *V. milium*.

The peculiarities of *Vertigo milium* were first fully worked out by Doctor Sterki, who considered it related to the European *V. angustior* (*venetzii*); but the relation seems to be one of partial parallelism rather than of direct affinity. I may mention that Dr. Sterki now considers the relationship doubtful.

The two species differ as follows:

V. milium.	*V. angustior.*
Dextral.	Sinistral.
Columellar lamella running downward inwardly.	Columellar fold spirally ascending inwardly.
Lower palatal fold entering deeply.	Upper palatal fold entering deeply.

Angustula has some features in common with the Californian species of *Sterkia*, particularly the well-separated angular and parietal lamellae and the descending inner end of the columellar lamella; but there is probably no direct relationship.

Dr. O. Boettger has considered *V. ovatula*, of the German upper Oligocene and lower Miocene, to be closely related to *V. milium*. I have not seen that species, but as the form of the columellar lamella as figured is entirely different in *V. ovatula* and *V. milium*, the former evidently does not belong to *Angustula*.

Two species are known: *V. milium*, no. 32, in which there is a moderate swelling behind the outer lip, and *V. bermudensis*, no. 33, having a very high, massive crest.

32. Vertigo milium (Gld.). Pl. 13, figs. 1 to 7.

"Shell minute, of a globosely-oval form, color a light chestnut; whorls four or somewhat more, obviously wrinkled obliquely, rather convex; apex bluntly rounded; suture deep;

aperture half the width of the last whorl, heart-shaped, the apex being at the right posterior angle; the transverse margin is nearly direct; the outer lip is scalloped by an indentation of the lip; the remainder of the margin is regularly arcuated; lip white, slightly everted; throat with six teeth, two of which are on the transverse lip, equidistant; one, with a tubercle at its base, is on the middle of the columella, and nearly at right angles with the preceding, and is the largest; a fourth is on the indenture of the outer lip, directed between the two on the transverse lip; and two smaller ones, more retired within the shell, are equidistant between the two last mentioned; umbilicus large and deep. Length less than 1/30 of an inch: breadth 1/40 of an inch'' (*Gould*).

Maine to Florida, west to South Dakota, Grand County, Colorado and southeastern Arizona; Tampico, Mexico; Jamaica. Type locality Oak Island, Chelsea, near Boston.

Pupa milium GOULD, Boston Journal of Natural History iii, pt. 3, 1840, p. 402, pl. 3, f. 23; iv, p. 359, 1843; in Binney, Terr. Moll. ii, p. 337, pl. 71, f. 1; Invert. Mass. p. 187, f. 118. —ADAMS, Vermont Moll., p. 157.—*Vertigo milium* Gld., W. G. BINNEY, Terr. Moll. v, 1878, p. 215, pl. 71, f. 1; Man. Amer. Land Shells, 1885, p. 332, f. 361.—MORSE, Amer. Nat. i, 1868, p. 669, f. 65, 66.—STERKI, Proc. U. S. Nat. Mus. xi, 1888, p. 377, pl. 42, f. 10, 13; Nautilus xxix, 123 (Geneva, O.).—WALKER, Moll. of Michigan, 1906, p. 515, f. 146, 147 (Newaygo, Kent, Bay, Oakland, Washtenaw and Lenawee counties); Nautilus xxxi, 54, 56 (Chester Shoals and Palm Beach, Fla.).—JOHNSON, Fauna of New England 13, 1915, p. 215 (Me., Vt., Mass.).—DANIELS, 27th Ann. Rep. Dep. Geol. and Nat. Res. Indiana, 1902, p. 632 (Steuben Co., Brookville, Lawrenceburg, Dunreith, Ind.).—OVER, Nautilus xxix, 91 (Chamberlain, Brule Co., S. Dak.).—VANATTA, Naut. xxviii, 11 (Sussex Co., N. J.).—PILSBRY, Nautilus xiv, 74 (Cape May, N. J.); xxv, 35 (Atlantic City, N. J.).—HANNA, Nautilus xxiii, 95 (Douglas Co., Ks.).—HINKLEY, Nautilus xxi, 77 (Tampico).—HANHAM, Nautilus x, 101 (Quebec).—CHADWICK, Nautilus xix, 58 (near Milwaukee).—CKLL., Nautilus iii, 21 (Kremmling, Colo.).—SMITH, Nautilus xx, 90 (Otsego Co., N. Y.).—

STUPAKOFF, Nautilus vii, 135 (Allegheny Co., Pa.).—PRIME, Nautilus viii, 70 (Long Island, N. Y.).—GARDNER, Naut. viii, 76 (Long Island).—SARGENT, Naut. ix, 89 (Clearwater, Minn.).—PLEAS, Naut. vii, 68 (Henry Co., Ind.).—*Pupa millium* SOWERBY, Conch. Icon. xx, pl. 18, f. 164.

Gould's description and figure are not quite correct in some points; evidently the columellar lamella and lower palatal fold were not fully seen. The color of the shell is cinnamon or paler. The last whorl has an external impression over the lower palatal fold; there is a swelling in front of the impression and below a deeper impression which runs to the lip, over the upper palatal fold. The angular lamella is high, short, and situated inward from the insertion of the outer lip. The parietal is high and long, entering deeply. The high columellar lamella enters horizontally at first, then turns downward, being crescent-shaped. (Its downward continuation was mistaken by Gould for "a tubercle at its base"). The upper palatal fold is long and high, slightly curved. Lower palatal is a little immersed, high, thin and enters to the dorsal side, where it curves downward (fig. 5). Both palatal folds are rather thick and tapering at their outer ends. The basal fold is somewhat immersed, short and high. There is sometimes a small, tubercular suprapalatal fold. The outer lip is somewhat expanded and strongly biarcuate. The parietal callus is generally rather thick.

Length 1.75, diam. 1 mm.; 5 whorls. Cleveland, Ohio, fig. 1.

Length 1.38, diam. 0.8 mm.; 5 whorls. Cleveland, O., fig. 3.

Length 1.65, diam. 0.85 mm. Vermont, fig. 7.

Length 1.4, diam. 0.9 mm.; 4½ whorls. Volusia Co., Fla., fig. 6.

V. milium shows but little variation in the teeth, though in some examples the lower palatal fold emerges further than in others, and the degree of curvature of its inner end varies somewhat. The size and contour of the shell, however, are quite variable, as will be seen by reference to the measurements and figures. In one lot I found the length from 1.38 to 1.75 mm.

The shortest specimens seen (but generally associated with

others of normal shape) are from the Gulf States. In a specimen from "Mt. Taylor," an artificial mound on the St. Johns River, south of Volusia, Florida, the diameter is two-thirds of the length (pl. 13, fig. 6). Examples from Arizona and Tampico, Mexico, appear to be normal in shape and teeth.

Specimens from Brownstown, St. Ann's, Jamaica, have strongly developed teeth, the inner end of the lower palatal fold scarcely bent downward, the shape normal. Length 1.2 to 1.25 mm.

33. VERTIGO BERMUDENSIS n. sp. Pl. 13, figs. 8, 9, 10, 12.

The shell is minute, oblong, gray, irregularly rather weakly striate but not polished on account of a microscopic granulation. Whorls rather strongly convex, the suture appearing margined by translucence of the shell; last whorl convex in front but becoming flattened and tapering downwards dorsally. Some distance behind the aperture there is a *very high, massive, rounded crest,* followed by a deep contraction, in which there is a pit behind the prominence of the outer lip. The aperture is piriform, having teeth arranged as in *V. milium.* The angular lamella is rather long and emerges further than the parietal, which is very long and curved, entering spirally. The columellar lamella is somewhat immersed (sometimes inconspicuous in a front view); it enters horizontally, then turns downward along the axis, much as figured for *V. milium.* The stout upper palatal fold emerges to the palatal callus. The lower palatal arises farther inward, is high and lamellar, penetrating to the dorsal side where it turns downward slightly. The basal fold is absent, or represented by an indistinct callus. The peristome is well expanded and projects forward in a rounded "auricle" above the middle of the outer margin.

Length 1.45, diam. 0.8 mm.; 5 whorls.

Bermuda: around Church Cave, Paynter's Vale, near Tucker's Town (S. Brown, Arthur Haycock).

This species has about the size and shape of *V. milium,* from which it differs chiefly by the enormous development of the oblique crest behind the lip. The much larger *V. numel-*

lata has a similar crest, the lower palatal fold is long, also, and the angular and parietal lamellae similar in position; yet it has not the peculiarly shaped columellar lamella of *Angustula*.

Pupa eyriesii Drouet, of Guyana, which I have placed in the genus *Sterkia*, has about the size of this species, but as nothing was said of the extraordinary crest, it appears to be quite different. I have not seen it.

II. Japan and Eastern Asia.

Vertigo appears to be generally distributed in Japan, the maritime province of Siberia and northward to Bering Strait, though there are as yet but few records, widely scattered over a vast area. The insular species are known by shells brought together by Mr. Y. Hirase of Kyoto. For those of the mainland we depend upon records which leave much to be desired in point of illustration, and in some cases, possibly, of precision.

The Japanese species (except *V. dedecora*) are quite similar to forms of North America and Europe, and belong to the same groups. Like *Cochlicopa* and a few other Holarctic genera, they mingle in a snail fauna which is otherwise chiefly Oriental in its affinities. *V. dedecora* of the Bonins is related to Tertiary species of Europe.

The mainland species of eastern Siberia are not known to me by specimens, and all but one are boreal forms also found in Europe or America. The following have been reported.

V. denudata (Mouss.) Vladivostok. No. 40.

V. alpestris (Alder). Vladivostok, Amur Valley. See no. 73.

V. borealis (Morel.), Kamchatka (= *V. modesta*, no. 25).

V. krausseana (Reinh.). Chukchi Peninsula (and Alaska?). No. 27.

V. arctica (Wallenb.) Chukchi Peninsula? No. 66.

The last three species, as represented in the Chukchi Peninsula and Alaska are in need of rigid comparison, as it does not seem likely that three very similar forms in the same region are specifically distinct.

They belong properly to the circumpolar fauna.

Key to Japanese species of Vertigo.

1. Angular lamella curving into and connected by a ridge with the upper termination of the peristome (subgenus *Ptychalaea*). *V. dedecora*, no. 41.
   Angular lamella, if present, not connected with the upper termination of the peristome (*Vertigo s. str.*). 2.
2. Having a strong palatal callus and an external crest. 3.
   Without a palatal callus; no external crest. 6.
3. Shell finely but sharply striate, 1.8 x 1.15 mm.; no angular lamella present. *V. hachijoensis*, no. 36.
   Shell smoothish, striation very weak if present. 4.
4. An angular lamella present; basal tooth present, in a subcolumellar position; outer lip noticeably bent in near the middle. 5.
   No angular lamella; crest very close to the lip. *V. kushiroensis*, no. 37.
5. 2.15 x 1.4 mm.; a suprapalatal nodule present; crest strong. *V. eogea*, no. 34.
   1.75 x 1 mm.; no suprapalatal tooth. *V. hydrophila*, no. 35.
6. Outer lip straightened in the middle; smoothish, aperture with 4 small teeth; 1.65 to 1.8 mm. long. *V. hirasei*, no. 38.
   Outer lip biarcuate. 7.
7. Smoothish, with 1-1-2 teeth. *V. japonica*, no. 39.
   Striate, with 2-1-2 teeth. *V. j. tosana*, no. 39*b*.

Subgenus VERTIGO s. str.

34. VERTIGO EOGEA n. sp. Pl. 14, figs. 1, 2, 3.

The shell is rimate, broadly ovate, auburn, fading somewhat above, glossy, nearly smooth, but under the microscope some very weak striae are seen. The whorls are moderately convex, the last having a distinct, oblique impression over the palatal folds, followed by a rather strong, somewhat sinuous crest, which is light-colored and striate; in the concavity between crest and lip there is a linear impression running to the projection of the lip. The aperture has a well

marked sinulus. The parietal lamella is strong and rather long; angular lamella small and short. The columellar lamella is situated high, ascends inwardly, and is rather large and massive. The two strong palatal folds are rather short and near together. The basal fold is smaller, at the junction of basal and columellar margins. There is a low suprapalatal nodule. The palatal and basal folds are united by a strong buff callus. The outer lip is strongly biarcuate, a little expanded, the columellar margin being rather widely reflected.

Length 2.15, diam. 1.4 mm.; nearly 5 whorls.

Japan: Akkeshi, Kushiro, Yesso (Y. Hirase). Type and paratypes no. 87899 A. N. S. P., from no. 1307 Hirase coll. Also Kashima, Harima (Hirase).

I formerly identified these specimens with *V. hydrophila*, but they differ by the larger size, paler color, by the development of a suprapalatal fold, and by the shape, if Reinhardt's figures are correct. Possibly a comparison of specimens may show that it is a subspecies of *V. hydrophila*. It has some resemblance to *V. pygmaea*.

A race from Kashima, Harima, in central Japan, differs by the less swollen spire and the very small size of the basal fold. Length 2.05, diam. 1.3 mm. (Fig. 3).

35. VERTIGO HYDROPHILA (Reinh.). Pl. 14, figs. 4, 5.

Shell dextral, ovate, rimate, glossy, glabrous, striatulate under the lens, corneous, pellucid; spire conic, obtuse; 4½ slightly convex whorls, rapidly increasing, the penult large, the last rounded, not compressed at the base. Aperture transversely cordate, 5 to 6 dentate: a strong parietal lamella and another [angular] obsolete; 2 columellars, the upper one stronger; 2 palatals. The palatal and columellar teeth are united by a glossy, ivory-like callus, which appears rufous externally. Peristome acute, a little expanded, the margins remote, joined by a thin callus, the right margin a little produced and bent inward, the columellar margin a little reflected. Length 1.75, diam. 1 mm. (*Reinhardt*).

Japan: Hakodate, Yesso (Dr. Hilgendorf).

Pupa (*Vertigo*) *hydrophila* O. REINHARDT, Jahrb. d. Malak. Ges. iv, 1877, p. 323, pl. 11, f. 6.—*Pupa hydrophila* Reinhardt, KOBELT, Fauna Moll. Extramar. Jap., 1879, p. 61, pl. 1, f. 16.

"Belongs in the kinship of *P. antivertigo* and stands especially near *P. ovata* Say, which differs, however, by the somewhat slimmer shape, the last whorl somewhat compressed at base, and by the somewhat stronger teeth" (*Reinhardt*).

I have not seen this species. The second columellar tooth described is what would now be considered a basal fold, subcolumellar in position.

36. VERTIGO HACHIJOENSIS n. sp. Pl. 14, figs. 6, 7.

The shell is rimate, rather shortly oval, sayal brown, opaque. The surface is very *finely, sharply striate* on the penult and next earlier whorls, more coarsely and less sharply so on the last whorl. The whorls are moderately convex, the last not compressed below or impressed over the palatal region; it expands into a *rounded crest close to the lip.* The aperture is ovate, with four well developed teeth: parietal lamella rather long; columellar lamella somewhat smaller; two rather small palatal folds, the lower one larger, as usual. In old specimens, such as the figured type, there is also a very low, almost inmersed basal fold (but in others this is wanting). There is a rather *thick palatal callus.* The outer lip is straightened and very slightly incurved in the middle, its edge a trifle expanded. Length 1.8, diam. 1.15 mm.; 4¾ whorls.

Japan: Hachijojima, Izu, Y. Hirase. Type and paratypes no. 83394 A. N. S. P.

It is distinguished from other Japanese species having a crest and a palatal callus by the distinctly striate shell. It was mentioned without description in Proc. A. N. S. Phila., 1905, p. 718.

37. VERTIGO KUSHIROENSIS Pils. & Hir. Pl. 14, figs. 8, 9, 10.

The shell is rimate, ovate, auburn. Surface glossy, nearly smooth, with only weak traces of striation. The whorls are convex, the last not impressed over the palatal region, having a strong, opaque buff crest behind the lip. The aperture is

ovate, with 4 or 5 white teeth: parietal lamella moderately developed; columellar lamella directed downward, ascending a little within; two well developed palatal folds, the lower longer; a small basal fold (but wanting in some examples). There is a distinct whitish palatal callus. The outer lip is straightened in the middle but not inflexed; lower part of the peristome is expanded.

Length 1.8, diam. 1.1 mm.; barely 5 whorls (type, figs. 8, 10).

Length 1.75, diam. 1 mm. (fig. 9).

Japan: Akkeshi, Kushiro, in northeastern Yesso, Y. Hirase. Type and paratype no. 90223 A. N. S. P.

Vertigo hirasei kushiroensis PILSBRY & HIRASE, Proc. A. N. S. Phila., 1905, p. 718.

This species differs from *V. hydrophila* by having no angular lamella; from *V. hirasei* by the development of a strong crest, as well as by the stronger, darker shell.

38. VERTIGO HIRASEI Pils. Pl. 14, figs. 13, 14.

The shell is rimate, cylindric-ovate, ochraceous-buff, imperfectly transparent, thin. Surface glossy, with faint traces of striae, becoming finely more distinctly striate a short distance behind the lip. The summit is very obtuse. Whorls are rather weakly convex, the last not compressed below, without external impressions or crest. The aperture is ovate, having 4 small teeth: the parietal lamella is oblique, about 0.2 mm. long; columellar lamella short, ascending a little inwardly. Lower palatal fold short, but longer and more immersed than the very small upper palatal. There is no trace of a palatal callus. The peristome is thin, strongly arched above, straightened in the middle; it is very slightly expanded in the lower part. In profile view (fig. 14) it is seen to bend well forward in a rounded lobe above the middle of the outer margin. Length 1.65, diam. 1 mm.; fully 4½ whorls.

Japan: Yanagawa, Chikugo, in Kiushiu, Y. Hirase. Type and paratypes no. 79738 A. N. S. P.

Vertigo hirasei PILSBRY, Nautilus xiv, March, 1901, p. 128; Proc. A. N. S. Phila., 1901, p. 484, pl. 28, f. 53.—*Vertigo*

hirasei glans PILSBRY & HIRASE, Proc. A. N. S. Phila., 1904, p. 631 (Okinoerabushima).

The absence of angular and basal teeth and small size of the others, the thin lip, without palatal callus and not inflexed, and the absence of a crest, are characteristic of this species.

V. h. glans.—The characters I relied upon in characterizing *V. h. glans* have little value, and I doubt whether it is really separable. The shell is more egg-shaped and a trifle smaller than the type specimen of *V. hirasei*, and there is no upper palatal fold.

Length 1.5, diam. 0.85 mm. (pl. 14, fig. 15, type specimen).

Specimens of a race of *V. hirasei* were sent by Mr. Hirase from Miyakejima, an island of Izu. The teeth are larger than in the Kyushu form. It probably is another subspecies, but the specimens are not in sufficiently good condition for decision (pl. 14, figs. 11, 12).

28*a*. *Vertigo hirasei okinoerabuensis* Pils. & Hir. Pl. 14, fig. 16.

The shell is longer than *V. hirasei*, of paler tint, with the lower palatal fold longer; upper palatal present. Length 1.8, diam. 0.95 mm.; nearly 5 whorls.

Okinoerabushima, an island of Osumi, Hirase. Type and paratypes no. 87690 A. N. S. P.

Vertigo hirasei okinoerabuensis PILS. & HIR., Proc. A. N. S. Phila., 1904, p. 631.

The type is figured. A rather weakly differentiated form.

39. VERTIGO JAPONICA Pils. & Hir. Pl. 15, figs. 1, 2.

The shell is perforate and rimate, oblong, the summit obtuse, auburn, thin; surface smoothish, showing some weak striae under the microscope, the last whorl distinctly striate behind the lip. The whorls are convex, parted by a well impressed suture, the last half of the last whorl tapering towards the base, having a rather deep furrow running to the auricle, but no crest. Aperture ovate, with four well-developed teeth: parietal lamella large and rather long; columellar lamella smaller, ascending a little inwardly; two

palatal plicae well developed, the lower one somewhat more immersed. No palatal callus. The outer lip is biarcuate, a conspicuous entering angle at the junction of the arcs; edge blunt and expanded. Length 1.65 diam. 0.95 mm.; 5 whorls.

Japan: Ikusagawa, Ojima, Y. Hirase. Type and paratypes no. 85746 A. N. S. P.

Vertigo japonica PILSBRY & HIRASE, Nautilus xvii, Feb., 1904, p. 118.

It differs from *V. hirasei* by the entering point of the outer lip; from *V. hydrophila* by the same character and by having fewer teeth.

39*a*. *Vertigo japonica coreana* n. subsp. Pl. 15, fig. 4.

Differs from *V. japonica* by the decidedly longer lower palatal fold. Length 1.53, diam. 0.9 mm.

Korea: Island of Ko-je, Y. Hirase. Type and paratypes no. 95772 A. N. S. P.

Some "dead" specimens from Fusan, Korea, partly young and all more or less broken, look like *V. japonica*, but their identity is not certain.

39*b*. *Vertigo japonica tosana* n. subsp. Pl. 15, fig. 3.

The shell is *distinctly striate*; there is a low angular lamella; other teeth as in *V. japonica*. Length 1.65, diam. 0.95 mm.

Japan: Irazuyama, Tosa, Y. Hirase. Type no. 86486 A. N. S. P.

40. VERTIGO DENUDATA (Mousson). Pl. 15, fig. 8.

Shell very minute, perforate, long-ovate, denuded of epidermis, smoothish, slightly striatulate, subopaque, whitish. Spire convex, rather obtuse at summit; suture impressed. Whorl 5½ to 6, convex, the penult a little larger, the last whorl somewhat tapering, not compressed below. Aperture nearly vertical, semicircular; peristome acute, a little reflected, bordered by a wrinkle outside; margins connected; outer margin curved at the insertion, almost forming a right angle. Within there are two distant parietal teeth, one columellar and one palatal, sometimes a second small one being

added. Length 1.2, diam. 1 mm. Ratio of aperture [to spire] 1:1 (*Mouss.*).

Siberia: Vladivostok, Louis Graeser.

Pupa (*Vertigo*) *denudata* MOUSSON, Journ. de Conch. xxxv, 1887, p. 19, pl. 1, f. 6.

"Taken at the same point as *P. alpestris*, but it is not to be confused with that. It is always denuded, with little translucence, whitish, while the other species is corneous and distinctly translucent. *P. denudata* has ½ to 1 whorl more than *alpestris*, its whorls are less close, giving it a longer, slimmer shape; the aperture is more regularly rounded, the outer margin not concave" (*Mousson*).

The presence of two teeth on the parietal wall, and of a crest ("*perist. . . . extus ruga circumdatum*") seem to show affinity with the *V. hydrophila* group, but the figure is not sufficiently exact for a critical comparison with the Japanese species. Moreover, the dimensions given are clearly erroneous

Subgenus PTYCHALAEA Boettger.

Ptychalaea BOETTGER, Jahrb. Nassau. Ver. Naturkunde, Jahrg. 42, 1889, p. 293. Type by orig. des. *V. flexidens* (Rss.).

Similar to *Vertigo* except that the angular lamella connects by a curved callous ridge with the termination of the outer lip; there is a rounded crest behind the peristome. Type *V. flexidens* Reuss.

Distribution, Lower Miocene to Pliocene of Europe; recent in the Bonin Islands.

The type of this subgenus, *V. flexidens* (pl. 15, fig. 15), has an infraparietal lamella and a suprapalatal denticle. The angular lamella and the rest of the structure agree exactly with the recent species, and I believe that there can be no doubt that the latter belong to *Ptychalaea*. The Bonin Islands have a highly peculiar snail fauna, doubtless evolved on a far larger land-mass which included all of the present islands. This fauna appears to have been derived from the continent not later than the middle Tertiary, and probably earlier. In Europe the species of *Ptychalaea* had about the

distribution and nearly the duration of the Gastrocopts, which are also related to those of the Bonin Islands.

The Tertiary species are enumerated on page 220.

41. VERTIGO DEDECORA (Pilsbry). Pl. 15, figs. 5, 6, 7, 9.

The shell is minute, with a distinct circular perforation, and a rather long umbilical chink, obesely oval, tawny, the surface having very weak but somewhat coarse striae and very little gloss. The whorls are moderately convex, the last one flattened over the palatal folds, rising in a rounded, lighter-colored crest behind the peristome, this crest being very prominent at the base. The parietal lamella is very long, entering deeply, not emerging to the edge of parietal callus. Angular lamella is much shorter, connected by a callus with the termination of the outer lip. The columellar lamella is horizontal and deeply immersed. Upper palatal fold is larger and longer than the lower, and it emerges nearly to the peristome. Basal fold is short and somewhat immersed. There is a distinct palatal callus. The peristome expands and is of a tawny color, the margins united by a distinct parietal callus. The outer margin is slightly impressed in the middle, a slight groove preceding the impression.

Length 1.5, diam. 1 mm.; 5 whorls.

Length 1.6, diam. 1.05 mm.; 5 whorls.

Bonin Islands (Ogasawara-jima): Hahajima, Y. Hirase. Type no. 82583 A. N. S. P.

Nesopupa dedecora PILSBRY, Proc. A. N. S. Phila., Apr. 23, 1902, p. 31.

The compact, broadly oval figure, strong crest, long parietal lamella and the union of angular lamella with the peristome are the more prominent features of this species.

41*a*. *V. d. tamagonari* Pils. & Hir. Pl. 15, figs. 10, 11. The shell is somewhat more globose and often smaller than typical *dedecora*; the crest is not quite so prominent. Chichijima, Ogasawara.

Length 1.4, diam. 0.95 mm. (type).

Length 1.5, diam. 1 mm.

Nesopupa tamagonari PILSBRY & HIRASE, Nautilus xvii, Feb., 1904, p. 118.

Comparison of the whole series now at hand shows that this is merely a slight variant from another island, doubtfully separable from the original *dedecora*.

III. Palæarctic Species, Europe, Asia and Northern Africa.

The European Vertigos have never been monographically studied. Westerlund's several works are synoptical compilations not really aiming to be critical monographs, I presume; and the extensive and valuable papers of Gredler and Boettger, as well as the several faunal manuals, such as those of Clessin and others, cover only part of the ground. Westerlund has carefully described many new forms from Sweden, where the genus appears to have an extraordinary development; but they have not been figured, and most of them are to be found in very few collections, or in but one, many being practically unknown outside of Sweden.

Most of the species of Central Europe have been figured by Kobelt, Geyer and others, in lithographs, and by Steenberg in admirable pen drawings, among the best figures of *Vertigo* ever published. Having no special knowledge of European species, and possessing few of them, the author has compiled most of the following account from the original publications.

North African Species are all supposed to be distinct from those of Europe. They are still known only by Bourguignat's work of over 50 years ago.

V. discheilia Bgt., no. 49.
V. maresi Bgt., no. 50.
V. aprica Bgt., no. 57.
V. codia Bgt., no. 58.
V. briobia Bgt., no. 59.
V. microlena Bgt., no. 60.
V. latasteana Bgt. & Let., no. 45.

Westerlund has constructed a partial key to Palæarctic species, which is recast below with some small alterations.

1. Shell dextral. 2.
   Shell sinistral. 9.
2. Aperture toothless; neck scarcely impressed in front, without an encircling crest; no internal palatal callus:

V. genesii, 78; *dicæa*, 63; *celata*, 64; *inermis*, 62; *eggeri*, 66; *regularis*, 65.

Aperture toothed. 3.

3. No crest behind the peristome. 4.
Having a crest. 6.

4. No palatal callus, the palatal folds standing free. 5.
Palatal folds united in front by a palatal callus. *V. eremia*, 61.

5. One parietal lamella or none: *V. daliaca*, 69; *pineticola*, 70; *krauseana*, 26; *hebraica*; *gemma*, 71; *ovoidea*, 72; *arctica*, 67; *tatrica*, 67*b*; *alpestris*, 74; *acheila*, 76; *heldi*, 74*a*; *haeusleri*, 52*a*; *schultzii*, 75; *helvetica*, 74*d*; *leontina*, 74*b*; *büttneri*, 77.
Having two lamellae on the parietal wall: *thibetica*, vol. xxiv, p. 138.

6. No palatal callus between the palatal folds. 7.
Palatal folds united by a palatal callus. 8.

7. No impression behind the outer lip, crest weak: *V. decora*, 25; *ronnebynesis*, 68; *graellsiana*, 56.
An impression between the strong crest and the edge of outer lip: *V. antivertigo*, 45; *lilljeborgi*, 46; *küsteriana*, 53*b*; *latasteana*, 45.

8. One parietal lamella: *V. moulinsiana*, 53; *pachygaster*, 54; *pygmæa*, 52; *loroisiana*, 55; *aprica*, 57; *codia*, 58; *briobia*, 59; *microlena*, 60.
Two lamellae on parietal wall: *V. sieversi*, 73; *substriata*, 51; *reneana*, 45*c*; *baudoni*, 47; *discheilia*, 49; *maresi*, 50.

9. Upper palatal fold not longer than the lower when present. 10.
Upper palatal fold very long, entering to the dorsal side; columellar lamella spirally ascending, blunt: *V. angustior*, 81; *callista*, 82.

10. 5 to 10 teeth: *V. pusilla*, 42; *erlandi*, 44; *collina*, 43.
2 or 3 teeth: *V. otostoma*, 79; *clevei*, 80.

Group of V. pusilla.

These are merely sinistral species, otherwise like the *antivertigo* group.

42. VERTIGO PUSILLA Müller. Pl. 16, figs. 1, 2, 3.

Shell subfusiform, with somewhat of a quadrangular outline, thin and semitransparent, very glossy, horn-color, with a faint tinge of yellow, very slightly and remotely striate in the line of growth; periphery rounded, with a tendency to angularity; epidermis thin; whorls 4½ or 5, very convex and cylindrical, gradually increasing in size, the penultimate whorl as broad as the last, which occupies about two-fifths of the shell; spire shortish, but rather tapering, and blunt at the point; suture very deep; mouth semioval, contracted or sinuous in the middle of the outer edge; teeth six or seven, viz. two on the pillar [parietal wall], two on the pillar lip (the inner one of which is always larger, and the outside one tubercular and placed in the angle where the outer lip joins), and two or three within the outer lip (the third, when it is present, placed near the pillar lip and being a mere tubercle:) outer lip rather thick and slightly reflected, strengthened by a strong rib both outside and inside, which is situate near the opening of the mouth and is yellowish-white; outer edge rather abruptly inflected; inner lip slightly thickened in full grown specimens; umbilicus small and narrow, contracted by a rather sharp and gibbous crest or ridge at the base of the shell. L. 0.07. B. 0.045 inch (*Jeffreys*).

Europe; Caucasus; Asia Minor.

Vertigo pusilla MÜLLER, Vermium terr. et fluv. Hist., ii, 1774, p. 124.—A. MÜLLER, Wiegm. Archiv f. Naturg. 1838, i, p. 211, pl. 4, f. 5.—ROSSMAESSLER, Iconogr. ii, pt. 10, p. 29, pl. 49, f. 649.—JEFFREYS, Brit. Conch. i, p. 263.—MOQUIN-TANDON, Moll. France ii, p. 409, pl. 29, f. 12-14.—*Pupa pusilla* (Müll.) PFEIFFER, Monographia ii, p. 364; iii, 560; iv, 686; vi, 336; viii, 404.—KUSTER, Conchyl. Cab. p. 129, pl. 16, f. 38-40. —WESTERLUND, Fauna iii, 1887, p. 141; Acta Soc. pro fauna et flora Fennica xiii, no. 7, p. 70 (dist. in Norway, Sweden, Finland).—*Helix vertigo* GMELIN, Syst. Nat. (13), p. 3664.—*Pupa vertigo* DRAP., Hist. Moll. France, p. 61, pl. 3, f. 34, 35.—*Vertigo heterostropha* Leach, TURTON, Manual, 1831, p. 105. —LEACH, Synopsis Moll. G. B. 1852, p. 94.

With teeth somewhat as in *V. antivertigo,* this species differs by the more oblong shape and sinistral coil. Westerlund gives the length as 1⅞ to 2½ mm.; those I have measured are mainly between 1.9 and 2.1 mm. long; the shortest adult 1.6 x 1 mm.

It is locally distributed in England and Ireland but not in Scotland, according to Jeffreys.

42*a*. *Vertigo pusilla tumida* Westerlund. Shell ventricose-ovate, obtuse, the base swollen on the right; brown, striatulate; whorls 4½ to 5, convex, the last pale anteriorly, with a very thin callous, the base a little compressed. Aperture broadly, unequally cordate, 4 to 6 toothed: parietal 2 or 1, columellar 2 or 1, palatal 3. Length 1⅞, diam. 1½ mm. Sweden, at Pehrsborg near Ronneby among rotten, damp leaves in a beech wood (type loc.) and Borgholm; Norway, Malmöen; Denmark, Linaa Vesterskov. (*Westerlund*).

Vertigo tumida WESTERL., Malak. Blätter xiv, 1867, p. 203. —*Pupa tumida* WESTERL., Fauna iii, 1887, p. 141; Acta Soc. fauna et flora Fennica xiii, no. 7, p. 71.

Said to differ from *V. pusilla* by the smaller, blunt and ventricose shell, with different shaped aperture, darker color and smaller umbilical crevice.

"I am not sure that it is more than a dwarf variety or form of *V. pusilla.* The two specimens sent by Dr. Westerlund differ from each other in the number of teeth, one specimen having 5 and the other 7 teeth. He describes *tumida* as 6-dentate, and *V. pusilla* as 6-8 dentate." (Jeffreys, Ann. Mag. N. H. 5th ser., ii, 1878, p. 381). Mr. J. W. Taylor states that Westerlund sent him a specimen labelled *Vertigo pusilla* Müll. var. *tumida* West. (Journ. of Conch. v, 357).

43. VERTIGO COLLINA Westerlund.

Shell [sinistral] rimate, ovate, striatulate, corneous. Spire subconic, short, rather obtuse. Whorls 5½, somewhat flat, united by a lightly impressed suture, not descending at the aperture, the last whorl a little impressed in the middle in front, strongly sloping below, as viewed from the side. Aperture oblique, subcordate, with 2 lamelliform, parallel palatal

teeth, not reaching the margin; peristome simple, unexpanded, the outer margin forming two well curved circles; connected with the columellar margin by a rather strong callus. Length 2, diam. 1⅛ mm. (*Westerl.*).

Sweden: Pehrsborg near Ronneby, among rotten leaves in a beech wood.

Pupa collina WESTERLUND, Nova Acta R. Soc. Sci. Upsal. (3), viii, 1871, p. 100; Acta Soc. pro fauna et flora Fennica xiii, no. 7, p. 71.

44. VERTIGO ERLANDI (Westerlund).

Shell [sinistral], circularly perforate, oblong-conoid, corneous-brown, delicately striatulate. Whorls 6, regularly increasing, convex, the suture oblique as far as to the aperture, the last whorl with no transverse callus, smooth. Aperture sinuate-oval, the parietal margin very oblique, with 1 entering parietal lamella; 2 conic columellar teeth; 3 rather thick, long, palatal folds, impressed in the middle, or abrupt, the 1st emerging, corresponding to an external furrow, the 3d basal. Outer margin much longer, formed of two arcs, the upper one stronger, produced. Length 2, diam. 1 mm. (*Westerl.*).

Sweden: Dalbyö, prov. Södermanland.

Pupa (*Vertilla*) *erlandi* WESTERL., Acta Soc. pro fauna et flora Fennica, xiii, no. 7, 1897, p. 194.

Group of V. antivertigo.

Ovate, glossy, usually rather dark colored species with 6 to 10 teeth, 2 or 3 on the parietal wall (or in *V. moulinsiana* 4-6 teeth, 1 or 2 on parietal wall).

This group of fully toothed forms of Europe and north Africa is equivalent to what is called the group of *V. ovata* in America. *V. callosa* of the central European Oligocene belongs to the same group, and is probably ancestral to the recent European species.

45. VERTIGO ANTIVERTIGO (Drap.). Pl. 16, figs. 4, 5, 6.

The shell is rimate, oval, ventricose, nearly smooth, glossy,

amber-brown or nearly chestnut, slightly transparent, outlines very convex. Whorls rather convex, the last somewhat compressed below, with an impression over the lower palatal fold, a moderately developed, opaque crest behind the peristome; and a very deep impression between the crest and the point of the outer lip. Aperture having 6 principal and usually several smaller teeth: parietal lamella rather long; angular and infraparietal short and smaller. Columellar lamella large, ascending inwardly. Upper and lower palatal folds strong, the lower longer. Basal fold stout, in a subcolumellar position. Usually there are small suprapalatal and infrapalatal denticles. Peristome thin, a little expanded, the outer margin biarcuate, with a median entering angle. Palatal callus well developed.

Length 1.95, diam. 1.2 mm.; 5 whorls (Lyons).

Length 2.25, diam. 1.4 mm. (Lausanne).

Nearly all Europe; Transcaucasus; Armenia, Talysch Turkestan (Westerlund).

Pupa antivertigo Draparnaud, Tabl. Syst. Moll. France, 1801, p. 57; Hist. Nat. Moll. Fr., p. 60, pl. 3, f. 32, 33 (dans la Bresse; en Languedoc).—Pfr., Monogr. Hel. Viv. ii, 361; ii, 558; iv, 685; vi, 332; viii, 404.—Küster, Syst. Conchyl. Cab. p. 125, pl. 16, f. 27-30.—Westerlund, Fauna iii, 1887, p. 140; Nova Acta R. Soc. Sci. Upsal. (3), viii, 1871, p. 89, with varr. *ferox, seminulum.—Vertigo antivertigo* Drap., Nobre, Moll. Portugal, p. 241.—Moquin-Tandon, Moll. France, 1855, p. 407, with var. *octodentata* Stud.—Boettger, Jahrb. Nassau. Ver. Nat. 42, 1889, p. 299 (recent and Pleistocene distribution).—Weiss, Nachrbl, D. M. Ges. 1894, p. 156, pleistocene of Taubach, with ver. *ferox*.

Alaea palustris Leach MS., Jeffreys, Trans. Linn. Soc. Lond., xvi, pt. 2, 1830, p. 360.

Turbo sexdentatus Montagu, Test. Brit. 1803, p. 337, pl. 12, f. 8.—*Vertigo sexdentata* Wagner in Chemnitz, Conchyl. Cab. xii, p. 175, pl. 235, f. 4124.

Vertigo 8 dentata Studer, Kurzes Verzeich., in Naturwiss. Anzeiger allg. Schweiz. Ges. Naturwiss. iii, May 1, 1820, p. 89, based upon Drap. pl. 3, f. 32, 33 (near Bern and Ringgen-

berg).—*Pupa vertigo* var. *P. 7 dentata* HARTMANN, Neue Alpina i, 1821, p. 219, based upon Drap. pl. 3, f. 32, 33, *Pupa antivergio* [sic].—*Vertigo septemdenta* FÉRUSSAC, Tabl. Syst. p. 64, based upon *P. antivertigo* Drap., *V. 8 dentata* Studer, *T. sex dentatus* Mont.—ROSSMAESSLER, Iconogr. ii, pt. 10, p. 28, pl. 49, f. 647.

Distinct from other species of its region by the three teeth on the parietal wall, the obesely oval shape and the deep angle between the two arcs of the outer lip. It is very closely related to the American *V. ovata*, but is smaller with less impressed suture. Boettger, however, considered *ovata* a variety of *antivertigo* (Jahrb. Nassau. Ver. Nat. 1889, p. 300); and probably, if the areas of the two were not so widely separated, this view might be generally entertained.

Westerlund gives the size as length 2-2½, diam. 1½-1⅔. This indicates a somewhat larger size than any I have seen.

According to Jeffreys it is found "under stones and logs of wood as well as at the roots of grass, and on moss, flags and water plants, in marshy places and at the sides of streams and canals."

Many of the minor modifications have been named, but probably few if any of them have racial value, so far as one may judge by the literature. It has not been stated that any occur in pure colonies. Moreover, some forms appear to have been named more than once.

Westerlund recognizes the following forms: *sexdentata* Mont., 2 columellar teeth, the upper wanting; *octodentata* Hartm., with 3 palatal teeth; *ferox* West., aperture 9 to 10 toothed, 2 or 3 parietal, 3 columellar, 4 palatals, two lamelliform, two minute; or with 3-2-4 or 3-2-5 teeth (= var. *novemdentata* Sandberger, Vorwelt, 1875, p. 795). Sterki noted *antivertigo* mit 10 Zähnen, Schleitheim, Switzerland, Nachrbl. 1881, p. 37. This form occurs also in Germany.

Var. *seminulum* West. Shell small, oval; whorls 4; aperture 5 to 6 toothed: 2-2-2. Length 1½, diam. 1 mm. Oestergötland, Sweden.

Pollonera defines the following forms: *typica*, teeth 2-3-2; *irregularis*, 2-2-3; *aequidentata*, 2-2-2; *padana*, 2-1-3; *cisalpina*,

3-2-2. All from Piedmont (Atti R. Accad. Sci. Torino, xx, 1885, p. 686).

Var. *major* Locard. Alt. 2-2¼, diam. 1¼ mm.; 5 folds. Uriage (Isère). (*Locard*, Ann. Soc. Agricult. Lyon (5), ii, 1880, p. 855).

Var. *novemplicata* Loc. Shell conforming to the type but with a third fold on the penult whorl; this fold is very low and situated near the columellar margin, ordinarily quite immersed. Alluvium of the Rhone at Lyons (*Locard*, t. c., p. 856).

Var. *cornea* Loc. Pale corneous, subtransparent. Environs of Lyons (*Locard*, l. c.).

Pfeiffer (Monographia ii, 361) mentioned, as a doubtful small variety of *V. antivertigo*, a *Pupa pusilla* Bivona *fils*, Monogr. p. 14; Arad. et Magg., Catal., p. 131. "T. valde parva, ovato-conica, apice obtuse, corneo-rufescente; anfr. 4—5 convexis, suturis impressis; aperture 6- vel 7 dentata, latere dextro sinuosa; margine reflexo.—Long. ½ lin." (*Ar. et Magg.*). It is from the river Oreto, Sicily. The name is preoccupied. Benoit (Nuovo Catal. Conch. terr. e fluv. Sicilia 1881, p. 99) remarks that two varieties of *Pupa antivertigo* have been observed in Sicily, the larger one living at Madonie, the smaller on the banks of the Oreto river. If really as small as stated, this is evidently a distinct species.

Vertigo sinuata Mousson (pl. 16, fig. 7). Shell small, dextral, rimate, globose-ovate, slightly striatulate, pellucid, glossy, pale corneous. Spire convexly conic, the apex obtuse, suture somewhat impressed. Whorls 5, rapidly increasing, the penult largest, inflated, the last ascending a little, tapering below, more distinctly striate, in the middle of its alt. acutely impressed and having a transverse wrinkle. Aperture small, vertical, irregularly semioval, conspicuously sinuate above on the right, internally 7-toothed: 2 distinct and a third rudimentary parietals. 1 long in the post-sinual angle, 1 deep, elongate and another shorter in the lower margin, finally a seventh, immersed, on the columella. Peristome rather obtuse, a little reflected, labiate within; margins somewhat approximate and converging, joined by a somewhat callous lamella, the right bisinuate, the angle projecting strongly into

the aperture, a little produced forward. Length 0.9, diam. 0.6 mm. (*Mouss.*). Banks of the Araxis river, Transcaucasus.

Vertigo sinuata Mousson, Journ. de Conchyl. 1873, p. 213, pl. 8, f. 10.—*Pupa sinuata* Mouss., J. de C. 1876, p. 40.—Pfr., Monogr. viii, p. 405.

If the dimensions are correctly given by Mousson, this must be distinct from *V. antivertigo*, of which it has been considered a synonym.

45*a*. *Vertigo reneana* Servain. Shell rimate-perforate, ovate-globose, ventricose, corneous, glossy, nearly smooth. Spire convexly oblong, the apex large. Whorls 5, convex, slowly increasing, parted by a deep suture; the last whorl minute, rounded, straight above, crested-tuberculose below, the protuberance joined to the gibbosity preceding the peristome; gibbous behind the margin, the swelling paler, strong, transverse, stronger below, and concave in front of the swelling below. Aperture ventrical, subtrigonal, narrowed and indistinctly angular below, externally sinuate, 7 plicate, as follows: 3 parietals, of which the median is stronger; 2 columellars, the upper one thicker, and 2 nearly equal palatals, the upper one attaining the margin. Peristome lipped within, somewhat expanded and slightly reflected, the outer margin sinuated within, columellar margins obliquely straightened, margins remote. Length 2½, diam. 1½, aperture ¾ x ½ mm. (*Servain*).

Spain: drift of the Ebre at Saragossa. *Vertigo reneana* Servain, Etude Moll. Esp. Port. 1880, p. 126.

Resembles *V. maresi* of Algeria in form and size, but it differs by the aperture having 7 teeth and by the characters of the last whorl (*Servain*). It has not been differentiated satisfactorily from *antivertigo*.

46. Vertigo lilljeborgi (Westerlund).

Shell ventricose, ovate, strongly glossy, very finely striate, chestnut horn-color. Whorls 5, rather rapidly increasing, convex, the last but little higher than the penult, double as high as the next earlier whorl, a little ascending in front. Suture but slightly oblique. Aperture quite piriform, or obliquely cordate, with 1 parietal tooth (sometimes with an-

other punctiform one), 2 columellar teeth, the lower very small, often wanting; 2 short, high, equal, immersed teeth in the palate, bounded by a reddish brown streak in front. Peristome weak, expanded, the margins delicately united; outer margin not impressed, scarcely produced angularly forward. Length 2 to 2¼, diam. 1¼ to 1½ mm. (*Westerl.*).

Sweden and Norway, type loc. on the southern shore of Tresjön lake, near Ronneby. Western Ireland: Ballynahinch, Co. Galway; Connemara.

Vertigo moulinsiana JEFFREYS, Brit. Conch. i, 1862, p. 255 (not of Dupuy), with var. *bidentata*, p. 256.—*Vertigo modesta* WESTERLUND, Œfvers af K. Vet. Akad. Förh, 1865, p. 556; Malak. Bl. xiii, 1866, p. 45 (not of Say, 1824).—*Pupa modesta* A. West., PFR., Monogr. vi, 332.—*Vertigo lilljeborgi* WESTERLUND, Coll. Typ. Moll. Suecia, 1868, No. 60; Synopsis, 1897, p. 119, with var. *merita*, p. 119, and var. *globula*, p. 120. —R. A. PHILLIPS, The Irish Naturalist, May, xvii, 1908, p. 89, pl. 3, f. 13, 14; p. 92, figs. G, H. (history of the species in Ireland).—*Pupa lilljeborgi* WESTERLUND, Exposé crit., Nova Acta Reg. Soc. Sci. Upsal. (3), viii, 1871, p. 90 (dist. in Sweden); Fauna iii, 1887, p. 136.

V. lilljeborgi, compared with *V. moulinsiana*, "is much smaller, more glossy, its whorls are more tumid, and its thinner lip lacks the broad, almost colorless margin of the latter. The habits of the two animals also appear to be quite different, for, as has been shown, *V. moulinsiana*, although inhabiting marshes, avoids during both summer and winter anything in the nature of damp or decaying matter; while the favorite, if not only, habitat, in this country at least, of *V. lilljeborgi*, is among the decaying roots and stems of aquatic plants cast up on lake shores" (*R. A. Phillips*).

Westerlund's localities in Sweden are also lake shores. Among other notes he states that the present species has so much resemblance to *P. antivertigo* Drap. in form, color, size, that he at first glance took it to be the young of this species, which also occurs on nearly all of our lake shores. It differs from *antivertigo* by the yellowish, not reddish brown color, the more convex whorls, brighter gloss, the shape of the neck

and the aperture. In *antivertigo* the neck has a swollen callus, cut above by a scratch-like impression, the furrow between the callus and the somewhat reflected peristome deep and narrow; it has also a differently shaped aperture and more numerous teeth, 6 to 10.

Var. *merita* Westerlund. Callus of the last whorl extremely thin, rufous or nearly obsolete; no groove behind the aperture; teeth 1-1-3 (2), very small, nodiform. Sweden at Oestersund, Finland at Rissalanranta (Westerl.).

Var. *globula* Westerlund. Shell subglobose, extremely ventricose, brownish-chestnut, striatulate; 4 very convex whorls, the penult largest, 3 times as large as the antepenult, larger and especially wider than the last; last whorl dilated anteriorly, having a callus [crest] of the same color, and a small groove on the back. Aperture with 1-1-2 teeth, the parietal small, deeply placed, columellar basal, palatals punctiform, distant, submarginal. Length 2, diam. 2 mm. Sweden, in the province Södermanland (*Westerlund*).

Var. *bidentata* Jeffreys. Labial or palatal teeth wanting. If this named variety is really a form of *lilljeborgi*, it should be noted that the name is anterior.

47. VERTIGO BAUDONI Massot.

Ovoid-globose; 5 quite convex whorls, the suture much impressed; aperture half-round, very obtuse at base; 2 immersed superior folds of which that in the middle is largest; 2 deeply placed columellars; 3 palatals, the upper one short, the two others reaching the peristome; peristome continuous, expanded, rather thick, with an external crest; shell yellowish rufous-brown, ornamented with spaced, regular epidermal expansions. Length 2, diam. 1 mm. (*Locard*).

France: Tautavel (Pyrénées-Orientales).

Vertigo baudoni MASSOT, Enum. Moll. Pyr.-Or., 1872, p. 72 (not seen).—LOCARD, Ann. Soc. Agricult., Sci., Ind., de Lyon, (7), iii, 1896, p. 221.

This little-known form should be recognized by the 7 teeth and the sculpture; it may be related to *V. substriata.*

48. VERTIGO LATASTEANA Let. et Bgt.

Shell very minute, slightly rimate, swollen ventricose, subovate-spherical, fragile, diaphanous, corneous, smooth; spire short, very obtuse; whorls 5, convex (the embryonic small, median relatively ample and turgid, the last smallest, diminishing and tapering), rapidly increasing, separated by a rather deep suture; last whorl small, less wide than the penult, externally compressed, scrobiculate, elegantly marked with a lip [crest] behind the peristome, compressed at base and angular around the umbilical crevice; above ascending to the insertion of the lip. Aperture suboblique, very small, contracted, subtriangular and 5-toothed as follows: 2 long and rather strong parietal teeth; 1 robust columellar; 2 lamelliform palatals, reaching the outer margin, the upper one stronger and forming a deep external pit. Peristome paler, rather thick, spreading throughout; columella very short; outer margin sinuated in the position of the external pit, and produced forward in a sort of little beak; columellar margin dilated; the margins remote. Length 2, diam. 1 mm. (*L. & B.*).

Tunis: debris of the Oued Sidi-Aich.

V.[ertigo] latasteana LETOURNEUX et BOURGUIGNAT, Prodr. Malac. Tunisie, 1887, pp. 109, 166.

This very small species, remarkable for the contraction of its aperture and the spherical shape, cannot be assimilated with any of the living Vertigos. We see only *V. milne-edwardsi* of the hill of Sansan which resembles it not only in respect to the denticulation but in shape and contours (*L. & B.*).

49. VERTIGO DISCHEILIA Bourguignat. Pl. 16, figs. 8, 9.

Shell very minute, rimate, globose-oblong, glossy, subpellucid, corneous, obliquely substriatulate under the lens. Spire tapering, obtuse, the apex smooth, paler, obtuse. Whorls 5, convex, rather rapidly increasing, separated by an impressed suture; the last small, tapering, a little compressed basally, straightened in front. Aperture a little oblique, lunate, half-round, ringent, with many folds: 2 parietals, the lower deeper

within, lamelliform; 2 columellar, or often 3, the upper one stronger; 2 lamelliform palatals, forming external furrows; finally, in adult shells, very often a dentiform fold at the insertion of the outer lip. Peristome a little expanded, acute, with a whitish thickening deep within, and encircled externally at the periphery with a thick and strong whitish lip [crest]. Outer margin sinuous above, arcuate anteriorly, the margins joined by a rather strong callus. Length 2½, diam. 1¼ mm. (*Bgt.*).

Algeria: debris of the Harrach at Algiers, of the Oued Tademit near Oran, and the Safsaf near Philippeville; type loc., fossil in Pleistocene deposits of the Oued Tademit, 15 leagues S.-W. of Djelfa. Tunis: debris of the Oued Sidi-Aich (Bgt.).

Vertigo discheilia Bourguignat, Paléont. Algerie, 1862, p. 78, pl. 4, f. 3, 4; Malac. Alger. ii, 1864, p. 105, 313, pl. 6, f. 45-47.—Letourneux et Bourguignat, Prodr. Malac. Tunisie, 1887, p. 109.

Var. *unilabiata* Bourguignat. Like the type but without external peristomial callus. Drift of the Harrach.

50. Vertigo maresi Bourguignat. Pl. 16, figs. 10, 11.

Shell pygmy, rimate, globuloid, glossy, pellucid, fulvous, smooth. Spire very obtuse, the apex very obtuse, paler. Whorls 5, convex, rapidly increasing, separated by a deep suture, the penult largest, inflated-globuloid; the last small, contracted, tapering, a little compressed basally, straightened in front, often in some specimens a little swollen and angulate-flattened at the suture. Aperture lunate, somewhat half-rotund, ringent, many-folded: 2 lamelliform parietal folds, the inferior deeper and stronger; 2 or often 3 columellars, the upper one stronger and the lower remote and very minute; 2 palatals, lamelliform, forming furrows externally. Peristome simple, acute, slightly expanded, slightly thickened within, and externally encircled by a more or less strong, vinaceous-fulvous, very rarely paler lip [crest]; outer margin sinuous above, slightly arching forward, the margins joined by a thin callus. Length 2, diam. 1¼ mm. (*Bgt.*).

Algeria: Oued Tademit, 15 leagues S.-W. of Djelfa, originally found fossil, but later also living in the same valley, in humid places under stones (Marès). Alluvium of the Isser (Letourneux).

Vertigo maresi Bourguignat, Paléontologie de l'Algerie, 1862, p. 79, pl. 4, f. 6-8; Malac. Alg., ii, 1864, p. 106, 313, pl. 6, f. 48-50.—Hanoteau & Letourneux, La Kabylie, i, 1872, p. 228.

Group of V. substriata.

Strongly striate or rib-striate, with teeth as in the *antivertigo* group, 1-1-2 to 3-1-2 or 3-1-3. According to Jeffreys the half grown shell has a spiral columellar lamella.

51. Vertigo substriata Jeffreys. Pl. 17, fig. 10.

"Shell oval or subfusiform, rather thin, and semitransparent, glossy, pale yellowish-horn-color, very strongly and obliquely striate and almost ribbed in the line of growth, but less so on the body whorl, which is faintly striate spirally, periphery rounded: epidermis rather thick: whorls 4½, very convex or cylindrical, and suddenly increasing in bulk, the penultimate whorl slightly exceeding in breadth the last, which occupies about one-half of the shell: spire short, very abrupt and bluntly pointed: suture remarkably deep: mouth semioval, contracted or sinuous in the middle of the outer edge; teeth from four to six, viz. from one to three (usually two) on the pillar [parietal wall], one on the pillar lip, and two or three on the inside of the outer lip, the last springing from a white rib; in half grown specimens the pillar lip has a spiral or longitudinal fold. Outer lip thin and slightly reflected, strengthened [externally] by a strong rib, which is placed very near the opening the mouth; outer edge abruptly inflected, inner lip thickened in the adult; umbilicus small and narrow, contracted by a keel or ridge at the base of the shell. L. 0.065. B. 0.04 inch." (*Jeffreys*).

Great Britain, "from Skye to Devon as well as throughout Ireland" (Jeffreys). Scandinavia, Denmark and Germany, south to Switzerland and the Austrian Tyrol; Caucasus.

Type loc., Barnstaple, Devonshire. "Under stones, among dead and decaying leaves and at the roots of grass in woods and moist places."

Alæa substriata JEFFREYS, Trans. Linnean Soc. London, xvi, 1830, p. 515; *Vertigo substriata* JEFFREYS, British Conchology i, p. 261.—KOBELT, Iconogr. (2), viii, p. 89, f. 1524, 1525.—STANDEN, Journ. of Conch. xi, 1905, p. 200, monstr. *sinistrorsum.*—*Vertigo* (*Alæa*) *substriata* Jeffr., BOETTGER, Jahrb. Nassau. Ver. Nat. 1889, p. 303 (Pleistocene and recent distribution).—STEENBERG, Danmarks Fauna, Landsnegle, 1911, p. 162, f. 133.

Pupa substriata Jeffr., KÜSTER, Syst. Conch. Cab. p. 180, pl. 21, f. 22, 23.—PFR., Monogr. ii, 363; iii, 559; iv, 685; vi, 334; viii, 407.—GREDLER, Nachrbl. D. M. Ges. 1872, p. 70, with var. *sextana.*—WESTERLUND, Exposé crit., in Nova Acta. Reg. Soc. Sci. Upsal. (3), viii, 1871, p. 92 (many localities in Sweden and Norway), with var. *monas.*—*Pupa* (*Vertigo*) *substriata* Jeffr., GEYER, Jabresh. Ver. vaterl. Naturk. Württemberg, 36, 1907, p. 424; occurrence in Germany.

Pupa curta HELD, Isis, 1837, p. 304 (Bavaria).

Vertigo 5-dentata and *V. 6-dentata* STUDER, in Coxe, Travels in Switzerland, 1789, iii, p. 388, *names only*; = *substriata* according to Jeffreys, Linn. Trans. xvi, 516.

The short, keg-like shape, the 6 or 7 teeth and especially the very strong striation, amply distinguish this species. Length 1.75, diam. 1.1 mm., or slightly smaller. Steenberg, who has published the best figure of the species, gives the length of Danish examples as 1.5 to 1.8 mm.

Var. *mitis* Boettger. Pl. 17, fig. 4. Form, sculpture and position of teeth as in *substriata, V. sieversi* being less strongly sculptured, more glossy and turrited. There is a similar weak transverse keel preceding the aperture as in typical specimens from Yorkshire. The outer parietal tooth is always very small, a feature observed here and there also in specimens from Dalarne, Sweden, and in other localities of the species. The Caucasian form is indistinguishable from specimens of the last-named locality. Alt. 1¾, diam. 1 mm. Caucasia:

Abastuman and Kasbek. *Pupa* (*Vertigo*) *substriata* var. *mitis* Bttg., Jahrb. d. m. Ges. vii, 1880, p. 140, pl. 4, f. 7.

Var. *monas* Westerlund. Very small, oval, very finely striate, dark colored, whorls 4½, cervical callus yellowish-red. Length 1⅓-1½, diam. 1-1¼ mm. Sweden: Ronneby and Mt. Mösseberg in prov. Westergötland. Würtemberg at Hohin Wittlingen (*Westerlund*).

Var. *sextana* Gredler. The lower tooth on the columella is wanting, the palatal teeth weaker, the crest and projection around the umbilicus are scarcely indicated, the shell is thicker and more opaque, browner, somewhat larger, also the striation is less close (*Gredler*). Tyrol: Sexten valley (Pusterthal), under stones.

Form *viridana* Lindholm. Shell pale greenish, the neck encircled anteriorly with a whitish callus. Bobylsk, near Lachta, northwest of Petrograd, at the extreme eastern end of the gulf of Finland (*Alaea substriata* f. *viridana* Lindh., Nachrbl. d. m. Ges. vol. 42, 1910, p. 35).

Group of V. pygmaea.

Similar to the *V. antivertigo* group, but with fewer teeth, a single lamella on the parietal wall; the shell smoothish or weakly striate. Europe and northern Africa, North America.

Only *V. pygmæa* and *V. moulinsiana* can be considered well known species, most of the others being known by the original descriptions only.

52. Vertigo pygmæa (Drap.). Pl. 17, figs. 15, 16, 17.

Shell extremely small, oval-cylindric and obtuse at the summit, of a more or less deep brown, smooth and little shining. Spire of 5 progressively increasing whorls. Aperture scarcely longer than wide, and nearly round, furnished with 4 teeth, of which the superior is acute, two deeply placed inferior, and finally one on the columellar margin. Often a fifth is found in the base of the aperture. The lateral margin is slightly angular in the middle. Peristome reflected below. Umbilical crevice quite pronounced. Lives under the hedges (*Drap.*).

Europe; Caucasus and Transcaucasia; Talysch region; Asia Minor. Ponto Delgado, S. Miguel, Azores, probably imported.

Pupa pygmaea DRAPARNAUD, Tableau Moll. terr. et fluv. de la France, 1801, p. 57; Hist. Nat. Moll. terr. et fluv. France, p. 60, pl. 3, f. 30, 31.—PFEIFFER, Monogr. Hel. Viv. ii, 362; iii, 559; iv, 685; vi, 334; viii, 405 (see for older references).—KÜSTER, Syst. Conch. Cab. p. 127, pl. 16, f. 31-34.—GREDLER, Tyrol's Land- und Süsswasser-Conchylien, Verh. Zool.-bot. Vereins in Wien. vi, 1856, p. 126, with var. *athesina* and *sarena*.—WESTERLUND, Fauna, 1887, p. 137.—WOLLASTON, Testacea Atlantica, p. 47.—*Pupa pygmea* and var. 5 *dentata* HARTMANN, Neue Alpina i, 1821, p. 219.

Vertigo (*Alaea*) *pygmaea* (Drap.) BOETTGER, Jahrb. Nassau. Ver. Nat., 1889, p. 305 (Pleistocene and recent distribution).—ROSSMAESSLER, Iconogr., pt. x, 1839, p. 29, fig. 648.—MOQUIN-TANDON, Moll. France, ii, p. 405, pl. 28, f. 37-42 with var. *quadridentata*.—STEENBERG, Danmarks fauna, Landsnegle, 1911, p. 161, f. 132, with forms *quadridentata* and *quinquedentata* Studer, *sexdentata* and *septemdentata*, new *forms*.—GEYER, Unsere Land- und Süsswasser-Mollusken, 1909, p. 55, pl. 5, f. 26, 27; 6, f. 1.

Vertigo similis FÉR., Tabl. Syst. p. 64.

Vertigo 4 et 5 dentata STUDER, Kurzes Verzeichniss der bis jetzt in unserm Vaterlande entdeckten Conchylien, Naturwissensch. Anzeiger der allg. Schweizerischen Gesell. f. d. gesammten Naturwiss., May 1, 1820, p. 89 (based upon *Pupa pygmæa* Drap., 3:30, 31).

Helix Isthmia cylindrica GRAY, Lond. Medical Repository, xv, 1821, p. 239, based upon Drap. pl. 3, f. 30, 31.—*Vertigo vulgaris* LEACH, in TURTON, Manual of land and fresh-water shells of the Brit. Is., 1831, p. 103 (as synonym of *V. pygmaea*).

A fuller description and American references may be found on p. 96. I can see no difference between European and American specimens. It is perhaps the most generally distributed Vertigo in Europe, from Portugal and the British Isles eastward.

Form *similis* Férussac (Tabl. Syst. p. 64) had no definition

further than "4 dentata" and the citation of "Vertigo 4 à 5 dentata, Studer, Catal."; this last being repeated also under *V. pygmaea*. It was taken up by Fitzinger as "*Vertigo pygmaea* var. *similis* mihi" without definition (Beiträge zur Landeskunde Oesterreich's, iii, 1833, p. 109). Férussac's intention was to segregate the form lacking the basal fold, which was subsequently named *quadridens* West., as follows.

Form *quadridens* Westerlund. Aperture with 4 teeth, lacking the lower columellar (*Pupa pygmæa* v. *quadridens*, West., Exposé critique, Nova Acta Reg. Soc. Sci. Upsaliensis (3) viii, 1871, p. 93). No special locality is given for this, which appears to be not subspecifically separable from *pygmaea*. Many Scandinavian localities are mentioned for the latter. Var. *quadridens* has been reported from numerous places, as far south as the Balkans.

Var. *sexplicata* Locard. Similar to the type but there are 6 apertural folds; the upper fold of the penult whorl is split, giving rise to a second obsolete superior fold. Debris of the Rhone north of Lyons. (*V. p.* var. *sexplicata* Loc., Fauna Mal. Bassin Rhone, in Ann. Soc. d'Agricult. Lyon, (5), ii, 1880, p. 853).

Var. *rubella* Loc. shell similar to the type, with 5 folds, but of deep, reddish color. Environs of Grenoble (*Locard, l. c.*).

Var. *cornea* Loc. shell similar to the type, with 5 folds, but of pale, subtransparent corneous color. Environs of Lyons and Grenoble (*Locard, l. c.*). This appears not to differ from *pallida*, which is earlier.

Form *pallida* Jeffreys. Shell thinner and of a lighter color (*V. pygmaea* Jeffr., Brit. Conch. ii, 1862, p. 257, with var. *pallida* on p. 258).

Form *ausonia* de Stefani. Upper palatal fold elongated. Italy. (Bull. Soc. Malac. Ital. ix, 1883, not seen. Westerl., Fauna iii, p. 137).

Form *minor* Westerlund. 1⅔ to 1¾ x 1 mm. Caucasus (Fauna iii, 1887, p. 137).

Var. *callicarens* (Bttg. Hesse). A form without a transverse callus preceding the mouth. Near Greussen, Germany

(*Hesse*). Neighborhood of Piazza, in the Val Brembana, Italy (Andreae).

Pupa pygmaea var. *callicarens* Bttg., HESSE, Nachrbl. d M. Ges. 1881, p. 7.—*P. p.* var. *callocarens* ANDREAE, Nachrbl. 1883, p. 135.

Var. *athesina* Gredler. The impression behind the cervical callus [crest] inconspicuous; in the palate a small third tooth near the insertion of the outer lip, which is often more elevated than the lower one of the columella, and relative to size appearing to stand in an inverse proportion to the latter. I first found [this variety] in several examples at Bad Bergfall, near Olang in the Pusterthal, under stones. Further I have noticed it, more or less characteristically developed, in the whole Etsch river region, especially at Klausen, Botzen, Salurna, Naturna, etc. [Tyrol] (*Gredler*).

Var. *sarena* Gredler. Shell larger; aperture 8-toothed: the lower tooth on the columella split into two smaller ones; in the palate 4 instead of 2 teeth, of which the 1st and 3d are noticeably larger, the 2d and 4th bluntly conic. [Tyrol] In the Sarnthal, in the village of the same name, under stones associated with var. *athesina* (*Gredler*).

Dr. D. Geyer (Nachrichtsblatt d. deutschen Malak. Ges., 44, 1912, p. 117-124), in an article on what might be called over-grown snails, discusses the individuals sometimes met with (*a*) having the last whorl abnormally inflated, (*b*) the shell relatively elongated by a whorl or two, with weakening of apertural structures, or (*c*) with these peculiarities combined; noting various instances. Elongation of the shell is said to be commonest in *V. pygmaea*; frequently a sixth whorl is added, the peristome being left sharp, without the characteristic armature. Others have the aperture finished, but without teeth or folds. He believes that *Pupa haeusleri* and *Vertigo heldi* are such forms of *Vertigo pygmaea*. In the river valleys of the south German Jura, where these rare snails appear to be restricted, they always occur associated in the river debris with *V. pygmaea*, never without it, though *pygmaea* occurs also without either *haeusleri* or *heldi*.

Similar cases of gigantism are known in *Cochlicopa* (Proc. Malac. Soc. Lond., xii, p. 312), *Azeca* and other genera.

The description of *P. haeusleri* follows. It is a little-known form, placed by Westerlund near *alpestris* and *heldi*.

52*a*. *Pupa haeusleri* Sterki. Pl. 17, fig. 9. Shell perforate, cylindric, rather obtuse at the apex; rufous-brown, the early whorls paler; irregularly striatulate, glossy, pellucid. Whorls 6, slowly increasing, convex, the suture rather deep, a little ascending before the aperture. Aperture nearly ⅓ the length, ¾ oval or subtriangular, three plicate: one conic tooth on the columella, two lamelliform in the palate. Peristome simple, straight, acute, the palatal margin having no callus or impression either outside or within. Length 2.5, diam. scarcely 1.2 mm. (*Sterki*).

Switzerland: drift debris of the lower Aar in the vicinity of Brugg, Dr. Häusler.

Pupa haeusleri Sterki, Nachrbl. d. Malak. Ges. 1883, p. 72, fig.

At first glance, especially on account of the similar color, the specimens have a resemblance to *P. striata* Gredler, not considering the strong fold on the parietal wall of that species. The lack of this fold, in combination with the shape is conspicuous and characteristic for our species as belonging to Vertigo (*Sterki*).

53. Vertigo moulinsiana Dupuy. Pl. 17, figs. 1, 2, 3.

Shell dextral, minute, ovate, ventricose, obtuse at apex, smoothish, subperforate. Aperture semiovate, 4-toothed: 1 tooth on the parietal wall, another on the columella, and two palatals, the lower one longer. Whorls 4, parted by a distinct suture, the last doubly larger than all the others together. Rather solid, glossy, subpellucid and of a uniform fulvous color. Length 2½ to 3, diam. 2 mm. (*Dupuy*).

Marshy places near Lyons, type loc. Spain, France, Sicily, east to the Caucasus at Poti; north to Germany, Denmark, the south of England and Ireland; Pleistocene of Oestergötland, southern Sweden. Living upon plants growing around swamps.

Pupa moulinsiana Dupuy, Cat. extramar. Gall. Test. 1849, no. 284; Hist. Nat. Moll. France, p. 415, pl. 20, f. 11.—Westerlund, Fauna, iii, 1885, p. 136; Malak. Blätter, 1875, p. 132.—*Alaea moulinsiana* Dupuy, Clessin, Die Molluskenfauna

fauna Oesterreich-Ungarns u. der Schweiz, 1887, p. 274, f. 173.

Vertigo moulinsiana JEFFREYS, Ann. Mag. Nat. Hist. (5), ii, 1878, p. 380 (description of living animal, etc.); (4), xix, p. 432.—PHILLIPS, The Irish Naturalist, 1908, p. 89-93, pl. 3, f. 1-12 (distribution, variation, etc.).—ODHNER, Arkiv for Kemi, Mineral. och Geol. iii, no. 33, 1910, p. 4-8, fig. 1 (occurrence in Pleistocene of Sweden, and general distribution). STELFOX, Proc. Malac. Soc. London x, 1912, p. 43.—GROVES, Trans. Herts Nat. Hist. Soc. i, 1880, plate; Journ. of Conch. iv, p. 85.—PINI, Atti Soc. Ital. Sci. Nat. xix, 1876, p. 493.—MOQUIN-TANDON, Hist. Nat. Moll. France ii, 1855, p. 403, with var. *personata*.—BOETTGER, Jahrb. Nassau. Ver. Nat., 42, 1889, p. 306 (Pleistocene and recent distribution).—KOBELT, Iconogr. (2), viii, p. 94, f. 1537.—TOMLIN & BOWELL, Journ. of Conch. xii, 1908, p. 212, f. A-F, pl. 3, f. 1-12.—*Vertigo moulinsii* MOQ.-TAND., Moll. Fr., Atlas, 1855, p. 51, ref. to pl. 28, f. 31-33.

Pupa desmoulinsiana Dupuy, JEFFREYS, Ann. Mag. N. H. (2), xv, 1855, p. 29 (Clarens; Payerne; Visp; marsh west of Lausanne, Switzerland).—*Vertigo desmoulinsi* GERMAIN, Encycl. Sci., Moll. de la France et des reg. voisins, 1913, p. 188.

Pupa laevigata Kokeil, in GALLENSTEIN, Conch. v. Kärnthen 1852, p. 80.—PFR., Monogr. iv, 681 (marshy meadows near Klagenfurt, Carinthia).

Pupa charpentieri Shuttleworth MS., KÜSTER, Conch. Cab. p. 129, pl. 16, f. 41-43 (Heidelberg, Bern u. Toulouse).—PFR., Monogr. iii, p. 555; iv, 681.

Vertigo limbata Partiot MS., acc. to MOQUIN-TANDON, Moll. France ii, 1855, p. 403.

The ovate shell is of a slightly transparent cinnamon color, glossy, with only weak traces of striae. Behind the lip there is an opaque, rounded crest, in front of this is a pit behind the "auricle," or projection of the outer lip. The parietal lamella is high but not long; columellar lamella stouter; 2 palatals are short, well-developed. The small basal fold, when present, approaches a subcolumellar position. There is a strong palatal callus, which sometimes is weakly denti-

culate or uneven. The expanded peristome is distinctly caught in at the middle of the outer margin.

Length 2.6, diam. 1.6 mm. (Lyons, fig. 1).

Length 2.3, diam. 1.45 mm. (Wicken Fen, Cambridge, figs. 2, 3).

Having examined many specimens from England, France and Hungary, I am unable to agree with Dr. Boettger that this species is identical with *V. ventricosa* (Morse). The European species is constantly much larger, has a stronger palatal callus and more expanded peristome with a deeper indentation behind the outer lip.

Variations in the teeth have served for the definition of several varieties, which have little basis in nature. Among specimens from Lyons (received from Terver, one of the original collectors according to Dupuy), the form with a basal fold, var. *personata*, is common; also specimens having the distinct trace of an angular lamella, and some weak infrapalatal nodules as in "var. *octodentata*."

An account of the habits of *V. moulinsiana* has been given by Mr. R. A. Phillips, who on October, 1907, discovered a colony in a marsh by the river Barrow, near Tinnahinch, Co. Carlow, Ireland. "I first perceived it resting on the stems and leaves of the tall grass, Glyceria aquatica and other plants, and a further search revealed some dozens of specimens on the leaves and twigs of a hawthorn bush at the edges of the marsh. During the second week in January I was again at Tinnahinch and revisited the marsh. Expecting to find the animals wintering, like some other Vertigoes, in the shelter of hollow stems and other plant-remains, I spent some time examining the marsh débris without finding a trace of them; at last quite unexpectedly, I caught sight of a specimen on the trunk of a small Alder; this gave me a clue to their true winter habitat and I was not long in discovering numbers of the hardy little creatures hibernating, during the coldest spell of weather we had last winter on the most exposed parts of the lower branches at from two to three feet above the ground. They are gregarious and apparently viviparous, as there were several small communities of from four to

about twenty individuals huddled together, many of them bearing young ones of two or three whorls on the backs of their shells. Later on I took some handfuls of loose, dry leaves that had got caught by the forking of the branches, and found that each curled-up leaf contained several specimens both adult and juvenile. In no case did I find one among leaves that were wet or in a position to retain moisture. Its constant companion in both these situations was *Succinea putris.*''

Var. *personata* Moquin-Tandon is described as having the shell a little longer; aperture with 2 columellar folds, the peristome interrupted. Toulouse (Partiot).

Var. *ventrosa* Heynemann. Pl. 17, figs. 5, 6. Shell subperforate, very shortly ovate, smooth, glossy, chestnut-fulvous; spire conic, rather obtuse. Whorls 4, somewhat convex, the last slightly compressed at the base. Aperture obliquely cordate, 6 or 5 toothed: 2 or 1 parietal teeth, 2 columellar, 2 palatal. Peristome a little expanded, the margins joined by a thin callus, right margin sinuous, impressed outside above the middle. Length 2¼, diam. 1½ mm., ap. ¾ mm. long. (*Heynemann*).

On reeds of a pond near Frankfort a. M.

Vertigo ventrosa HEYNEMANN, Malak. Blätter ix, 1862, p. 11, pl. 1, f. 6-8 (shell and teeth).—*Pupa ventrosa* PFEIFFER, Monogr. viii, p. 406.

Distinguished by the presence of an angular lamella and a basal fold; the former and often the latter being absent in typical *moulinsiana.*

Westerlund's var. *octodentata* (Fauna Europæa 1878, p. 195; Fauna Pal. Reg. iii, 1887, p. 137) has 2-2-2 teeth, and two little denticles in the angle between columella and basal margin. Apparently an individual variation of *ventrosa.* Correctly the formula would be 2-1-3, as the second columellar tooth is really the basal fold.

53*a*. *V. moulinsiana küsteriana* (Westerlund). The shell is most like *P. moulinsiana* in form and size, but is very different by the more ventricose shape, far blunter apex, the peristome much more broadly reflected, more strongly bulg-

ing out above the middle, also in the middle angularly produced forward and externally deeply impressed; by the free palatal teeth, the upper one large, thickened anteriorly, emerging to the margin, the lower one broadly distant from the margin; 1 parietal and 1 columellar tooth (*Westerl.*)

Germany: Mergentheim, Würtemberg (coll. Küster).

Pupa küsteriana WESTERLUND, Malak. Blätter, 1875, p. 133; Fauna iii, p. 136.—PFR., Monogr. viii, 407.

54. VERTIGO PACHYGASTER Jensen.

Shell rimate, ventricose, irregularly, finely striate, under a strong lens showing very fine spiral lines, glossy, greenish-brown. Spire broadly conic. Whorls 4½, convex, rapidly increasing, the penult double the height and wider than the preceding; in front much lower than, and behind equal to the last whorl. Last whorl has a strong brown-reddish callus behind the peristome. Aperture half-oval, 4-toothed: teeth 1-1-2, fold-like, short, white. Peristome simple, thin, of the same color, the margins separated, outer margin neither produced forward or impressed, regularly curved. Length 1¾, diam. 1⅕ to 1¼ mm. (*Westerl.*).

Norway: Skien.

V.[ertigo] pachygaster JENSEN, Indberetning om en i Sommeren 1870 foretagen Reise i Kristiania og Kr.-sands Stift, etc., 1872 (p. 69 of separate copy), in Nyt Magazin for Naturvidenskaberne, xix, 1873, p. 171.—*Pupa gravida* WESTERLUND, Fauna Moll. terr. et fluv. Sveciæ, Norwegiæ et Daniæ, 1873, p. 610; Malak. Bl. xxii, 1875, p. 128.—PFEIFFER, Monogr. viii, 399.—*Vertigo pachygastra* Jensen, WESTERL., Synopsis Moll. extramar. Pal., 1897, p. 120.

The name of this species was changed by Westerlund on account of the earlier *Pupa pachygaster*, which is an *Abida*; it does not appear to be preoccupied in *Vertigo*, and has been restored in his later *Synopsis*.

55. VERTIGO LOROISIANA (Bourguignat). Pl. 16, fig. 15.

Shell dextral, minute, ovate-cylindric, rimate, rather fragile, smooth, but under the microscope some fine striae are visible;

of a corneous-fulvous tint. Summit obtuse, smooth, and of a paler tint. 6 convex whorls, regularly increasing, separated by a deep suture. Aperture slightly oblique, rounded-lunate, having 4 strong, elevated denticles: one in the middle of the convexity of the penult whorl, a second on the columellar, 2 other palatals on the internal callus of the peristome. Peristome double, the first, interior, is indicated within by a whitish callus, and externally by a swelling; the second peristome is simple, acute and a little reflected. Between the two peristomes the last whorl is a little constricted, this being very marked at the base. The margins are united by a nearly invisible callus of the same color as the rest of the shell. Length 2½, diam. 1 mm. (*Bgt.*).

France: around Vannes (Morbihan), under stones in shady places.

Pupa loroisiana Bourguignat, Malac. terr. et fluv de la Bretagne, 1860, p. 65, pl. 2, f. 7-9.—*Pupa laroisiana* Bgt., Westerlund, Fauna iii, 1887, p. 138.—*Vertigo laroisiana* Bgt., Westerlund, Synopsis, 1897, p. 121.

The strong palatal callus and external crest, the rather elongate shape and four teeth appear to be the salient characters of this form, which is more slender than the related *V. moulinsiana* according to Bourguignat's account, by which it is solely known.

56. Vertigo graëllsiana Servain.

Shell minute, rimate-perforate, oblong, very glossy, smooth, subdiaphanous, reddish-corneous. Spire rather long, obtuse at summit, the apex large. Whorls 5, convex, regularly and slowly increasing, separated by a rather deep suture; the last whorl small, rounded, straight above, angular below, around the perforation, the angle confluent with a swelling behind the peristome; contracted and then gibbous behind the lip, the gibbosity paler, strongly convex, transverse, joining the basal angle. Aperture vertical, semiovate or subtrigonal, wide above, narrowed and angular below, 4-plicate, as follows: one median, lamelliform parietal; one strong columellar; and two equal palatals, in the middle of the convexity

of the outer margin, and visible outside. Peristome lipped within, patulous and reflected throughout, the outer margin sinuated; columellar margin oblique, somewhat straightened; margins approaching. Length 2¼, diam. 1¼ mm., apert. ½ mm. high, ¼ wide (*Servain*).

Spain: drift debris of the Ebre at Saragossa and of the Xenil at Grenada.

Vertigo graëllsiana Servain, Etude sur les Moll. rec. en Espagne et en Portugal, 1880, p. 124.

How this differs from *V. moulinsiana* has not been made clear.

57. Vertigo aprica Bourguignat. Pl. 16, fig. 14.

Shell rimate, small, globose-oblong, obtuse, shining, subpellucid, fulvous-corneous, under the lens very sharply substriatulate. Spire tapering, obtuse, apex smooth, minute, obtuse; whorls 6, convex, regularly increasing, separated by an impressed suture, the last slightly larger, tapering, the base compressed, anteriorly ascending very little. Aperture slightly oblique, semioblong, 4-plicate: 1 parietal, 1 columellar and 2 palatal, of which the lower is more immersed. Peristome acute, with a whitish thickening within, expanded, especially at the base, externally encircled by a whitish lip [crest]; outer margin sinuous, arcuate in front and forming a sulcus externally at the periphery; the margins joined by a scarcely visible callous. Length 3¼, diam. 2 mm. (*Bgt.*).

Algeria: Alluvium of the Oued Isser, near Algiers, Letourneux.

Vertigo aprica Bgt., Malac. de l'Algerie ii, 1864, p. 101, pl. 6, f. 36-38.

58. Vertigo codia Bourguignat. Pl. 16, fig. 12.

Shell minute, perforate, globuloid, ventricose, glossy, subpellucid, smooth, corneous. Spire obtusely tapering, the apex paler, obtuse. Whorls 5½ to 6, rapidly increasing, separated by a deep suture, the penult longest, inflated, rotund; the last tapering, compressed at the base, very little ascending in front. Aperture slightly oblique, lunate, trigonal, nar-

rowed at base, 4-plicate: 1 lamelliform parietal, 1 dentiform, deeply placed columellar and 2 palatals, the upper one emerging, dentiform, the lower immersed, lamelliform. Peristome white lipped within, expanded especially on the basal and columellar margins. Outer lip sinuous and anteriorly arcuate, having a little sulcus at the periphery; the lip margins united by a rather strong callus. Length 2½, diam. 2 mm. (*Bgt.*).

Algeria: alluvium of the Oued Mazafran and the Harrach, near Algiers.

Vertigo codia Bgt., Malac. Algerie ii, 1864, p. 103, pl. 6, f. 39-41.

Vertigo codia differs from *V. aprica* by the globulose form, ventricose, not oblong, by the much more rapid increase, the far more swollen penult whorl, smaller, more tapering last whorl, the triangular aperture, etc. (*Bgt.*).

59. Vertigo briobia Bourguignat.

Shell very minute, rimate, oblong, glossy, subpellucid, smooth, corneous; spire obtusely tapering, apex obtuse. Whorls 5, a little convex, regularly increasing, separated by an impressed suture, the last somewhat compressed basally, straightened at the aperture. Aperture slightly oblique, a little lunate, oblong-subtrigonal, 4-plicate; 1 lamelliform parietal, 1 dentiform columellar and 2 palatals, the lower stronger. Peristome straight, acute, white-lipped within, lightly expanded at the columellar margin, and outside encircled with a paler lip [crest], swollen below; margins joined by a callus. Length 2, diam. 1 mm. (*Bgt.*).

Algeria: debris of the Harrach near Algiers.

Vertigo briobia Bgt., Malac. de l'Algerie ii, 1864, p. 313.

60. Vertigo microlena Bourguignat. Pl. 16, fig. 13.

Shell rimate, very minute, oblong-globose, glossy, subpellucid, corneous, smooth; spire obtusely tapering, the apex minute, paler. Whorls 5, convex, rather rapidly increasing, separated by an impressed suture, the last slightly larger, tapering, somewhat flattened at the periphery behind the

outer lip, constricted, especially in the lower part (as well as having a hanging swelling, as though a blister had been raised); at the base lightly compressed and straightened in front. Aperture vertical, lunate, semirotund, ringent, 5-plicate: 1 strong parietal, 2 columellar (the upper lamelliform, strong, the lower small, dentiform), and 2 strong palatals. Peristome expanded, white-lipped deep within, externally at the periphery encircled with a whitish lip [crest] which is swollen below. Outer margin straight; margins joined by a callus. Length 2, diam. 1¼ mm. (*Bgt.*).

Algeria: debris of the ravine of Chabet-Beinan, near Cape Caxine, west of Algiers; debris of the Harrach at Algiers.

Vertigo microlena Bourguignat, Malac. Algerie ii, 1864, p. 104, pl. 6, f. 42-44.—? *Pupa pygmæa* Morelet, Journ. de Conchyl. iv, 1853, p. 292.

61. Vertigo eremia (Westerlund).

Shell tumid-ovate, ventricose, brown; smooth, the last whorl rugose-striate anteriorly. Whorls 5, convex, the penult twice as large as the antepenult, the last swollen outwardly, a little shorter. Aperture somewhat semirotund, 3-toothed, the teeth rather strong, 1-1-1; parietal tooth compressed, columellar tooth conic, palatal tooth thick, tuberculiform, united with a strong white palatal callus. Margins of the peristome united by a callus joined to the apertural callus, the outer margin arched above, somewhat straightened below. Length 2, diam. 1½ mm. (*Westerl.*).

Sweden: Medelpad at Ange.

Pupa eremia Westerl., Acta Soc. pro fauna et flora Fennica, xiii, no. 7, 1897, p. 67.

Described from one specimen. Appears to resemble the American *V. tridentata*, but there is no crest behind the peristome.

Group of V. modesta.

The "auricle" or lip-point is but little developed; teeth 1-1-2 to 0-0-0, small when present, and with a tendency to be reduced or lost in many of the species. Chiefly boreal or mountain forms.

62. VERTIGO INERMIS (Westerlund).

Shell *umbilicate-perforate*, ovate, very finely striate, glossy, reddish horn-color, obtuse at apex. Whorls 5, convex, the penult (viewed from the right side) half as high in front as behind, the last double as high in front as behind on account of the deep suture strongly ascending, to the aperture; last whorl nearly horizontal at the base, almost equally as wide as the penult. Aperture *distinctly lateral*, oval, *narrowed towards the base*, toothless; margin very weakly lipped within, a broad, thin deposit of callus between the margins. Length 2, diam. 1⅓ mm. (*West.*).

Siberia: north of Seliwarinskoje, about 70° N. Lat.

Pupa inermis WESTERLUND, Siberiens Land- och Sötvatten-Mollusker, in Kongl. Sv. Vet. Akad. Handlingar, xiv, no. 12, 1877, p. 103; Fauna iii, 1887, p. 130.—*Vertigo inermis* WEST., Synopsis, 1897, p. 115.

63. VERTIGO DICÆA (Westerlund).

Shell cylindric-ovate, seen to be densely striatulate under a strong lens, yellowish corneous. Whorls regularly increasing, a little convex, separated by a rather deep, oblique suture, ascending below, back of the last whorl obliquely flattened a little, strongly constricted, dilated on both sides in front. Aperture semiovate, toothless, parietal wall oblique, outer margin regularly arcuate, columella dilated, spreading. Length, 1⅔, diam. 1⅓ mm. (*Westerl.*).

Sweden: Dalbyö, Södermanland.

Pupa dicæa WEST., Acta Soc. pro Fauna et Flora Fennica, xiii, 1897, no. 7, p. 64.

64. VERTIGO CELATA (Westerlund).

Shell perforate, cylindric-conic, apex obtusely conic; densely striatulate rufous-corneous. Whorls 6½, slowly increasing, very convex, or swollen-convex, separated by a deep suture which is subhorizontal throughout, penult and antepenult whorls equal, the last scarcely or slightly larger, rotund at base. Aperture small, semioval, wholly toothless. Peristome

simple, thin, the outer margin arcuate, unexpanded, columellar margin a little straightened, strongly reflected. Length 2½, diam. 1 mm. (*Westerlund,* 1894).

Sweden, the special locality unknown.

Pupa (*Alaea*) *celata* WESTERL., Nachrblatt D. M. Ges. 1894, p. 173.

Belongs to the little group of *P. genesi* Gr., *eggeri* Gr. and *inermis* W., differing from all by its shape, the number and the different growth of the whorls (*Westerl.*).

Westerlund subsequently (1897) stated that this description, being inaccurate, was to be deleted and the following substituted. It appears likely that the two descriptions apply to two species; but as neither has been figured, and no specimens are at hand, this surmise cannot be controlled.

Vertigo celata W. Shell subperspectively perforate, obese, cylindric-ovate, obtuse, brown-reddish, whitish at apex, densely striate under a lens. Whorls 5½, convex, separated by an impressed suture which is oblique above, horizontal below; the three last very slowly increasing, the antepenult nearly double the height of the preceding, the last two almost equal; last whorl almost equal in height in front and behind, the back regularly convex. Aperture semiovate, toothless, parietal margin subhorizontal; margins unexpanded, the outer regularly arcuate. Length 2, diam. 1½ mm. (*Westerlund,* Acta Soc. pro fauna et flora Fennica, xiii, no. 7, 1897, p. 64).

Sweden: Dalbyö, Södermanland.

65. VERTIGO REGULARIS (Westerlund).

Shell openly perforate, cylindric, very obtuse, smooth, rufous-corneous. Whorls 6, somewhat tumidly convex, the upper ones very narrow, the antepenult one-third higher than the preceding, equal to the penult, the last a third shorter than the penult, at the back scarcely, in front distinctly higher, rotund at base; suture immersed [? impressed], nearly horizontal throughout. Aperture toothless, truncate-ovate, the parietal wall a little oblique, the margins distant and separated, equally curved, the outer margin straight, columellar margin shortly reflected. Length 2, diam. 1⅓ mm. (*West.*).

Turkestan: confluence of the Radonak with the Bartang river (A. Kasnakow).

P.[upa] (Vertigo) regularis WEST., Annuaire Mus. Zool. Ac. Imp. Sci. St.-Pétersb., iii, 1898, p. 166.

"Related to *P. celata* of middle Sweden." One specimen.

66. VERTIGO EGGERI (Gredler).

Shell umbilicate, ovate-conic, the spire much narrowed, unevenly substriatulate, glossy, brown-rufous. Whorls 5, convex, rapidly increasing, the last somewhat widened, shortly ascending at the insertion. Aperture ample, semioval, *toothless*. Peristome a little reflected, whitish bordered, the outer margin subangularly impressed and more produced in the middle, arcuate above at the insertion, the margins joined by an indistinct parietal callus. Length 2½, width 1½ mm. (*Gredler*).

Tyrol: in the so-called Bärental bei Steinegg, near Bozen, under damp moss.

Pupa (Vertigo) eggeri GREDLER, Nachrbl. D. M. Ges. xxii, 1890, p. 41.

V. eggeri has much greater dimensions than *V. genesii*, and differs moreover by the totally different habitus, by its conic spire and more distinct striation, but it approaches *genesii* in the strong convexity of the whorls, in the coloring (also that of the peristome), and in lacking denticulation (*Gredler*).

67. VERTIGO ARCTICA (Wallenb.). Pl. 10, figs. 7, 8.

Shell dextral, rimate, ovate, thin, smoothish, somewhat glossy, pellucid, brownish-tawny. Whorls 5 to 5½, convex, the last nearly two-fifths the altitude, rounded at base, anteriorly having a somewhat swollen crest. Aperture slightly oblique, semiovate or piriform, obstructed by 3 teeth: in the middle of the parietal wall, on the columella, and a smaller one in the palate (frequently wanting); peristome spreading, slightly labiate, the margins joined by a callus, the right margin very strongly curved above, columellar margin somewhat dilated, spreading. Length 2.5, diam. 1.5 mm. (*Wallenb.*).

Lapland: Walli-corso, a narrow ravine between Walli-faltet and Gaskaiwo, at the upper limit of trees; also one of the islands near Quickjock (Wallenberg). Bohemia; at high elevations in the Tatra and Austrian Tyrol (as *P. tirolensis*). It has also been reported from the Chukchi Peninsula and Alaska, but these specimens may be referable to *V. modesta*.

Pupa arctica Wallenberg, Malak. Bl., v, 1858, pp. 32, 99, pl. 1, f. 3*a-c*, 4.—Pfeiffer, Monogr. vi, 325.—Reinhardt, SB. Ges. Nat. Fr., Berlin, 1883, pp. 32, 38 (Chukchi Penins.; Emma Harbor).—Westerlund, Vega-Exped. Vet. Iakttag. iv, 1887, pp. 152, 155, 157, 163 (Lapland, Siberia, Port Clarence, Alaska).—*Vertigo arctica* Wallenb., Westerlund, Mal. Bl. xiv, 1867, pp. 201, 202.—Babor & Novak, Nachrbl. 1909, p. 147.—Kobelt, Iconogr. (2), viii, p. 93, f. 1535.—*Pupa tirolensis* Gredler, Verh. Zool-bot. Ges. in Wien, xix, 1869, p. 912.

Wallenberg states that out of 20 specimens apparently adult, only 2 had the palatal fold developed.

It has never been made clear how *V. arctica* differs from weak-toothed races of *V. modesta*; especially since Westerlund, who should certainly know *V. arctica*, identified it from Port Clarence, Alaska. Specimens possibly referable to *V. arctica*, collected at Norton Sound, Alaska by Mr. R. C. McGregor, have three teeth as in *V. arctica*, differing from typical *V. modesta* by lacking an upper palatal fold, and compared with typical *modesta*, by the smaller size of the teeth. The example figured measures, length 2.65, diam. 1.35 mm. (page 124, fig. 3). I have not seen specimens of *arctica* from Lapland or any part of Europe, and cannot therefore indicate how it differs from *V. modesta*, if at all.

Westerlund placed *Pupa tirolensis* in the synonymy of *arctica* after comparison of a specimen received from Gredler, and Kobelt has referred *Pupa tatrica* to the same species. The descriptions of these forms follow.

67*a*. *Vertigo arctica extima* (West.).

Shell broadly perforate, ovate-oblong, brown-corneous, slightly shining, smooth; whorls 5½, convex, rather slowly and regularly increasing, rounded at base, encircled with a

thin callus of the same color behind the aperture; suture strongly ascending anteriorly. Aperture little oblique, semiovate, rounded at the base, entirely toothless; peristome slightly spreading, the right margin strongly curved above; columellar margin a little straightened, reflected-spreading above; the right margin thinly labiate within. Length 2¾ to 3, diam. 1½ to 1¾ mm. (*Westerlund*).

Siberia: Baklanowskij, Jenesei, lat. 64° 25′ N.

Pupa (*Vertigo*) *arctica* Wallenb., var. *extima* WESTERLUND, Nachr. d. Malak. Ges., viii, 1876, p. 99; Sibiriens Land- och Sötvatten-mollusker, p. 42, in Kongl. Svenska Vet. Akad. Handl. xiv, no. 12, 1877.

The shell appears to be larger than other toothless forms of the *V. modesta* stock, about the size assigned for *V. hoppii*.

67*b*. *Vertigo arctica tatrica* (Hazay).

Shell small, dextral, cylindric, obtuse, corneous-buff, glossy. Aperture semiovate, 2 or 3 toothed. Whorls 5½. Alt. 2, diam. 1 mm.

The small shell has a long-cylindric shape, is glossy, translucent, of yellowish horn-color; spire blunted. The 5½ convex whorls increase very slowly, the last being scarcely noticeably wider than the penult, occupying scarcely ⅓ the length of the shell. Aperture semiovate, having 2 or 3 denticles: one sharp, lamelliform, stands on the parietal wall, a smaller on the columella and a small punctiform tooth on the inner wall [of the outer lip]; the last is often lacking. The outer margin is evenly curved, not impressed (*Hazay*).

Carpathians: Hohen Tatra, in Kotlina valley, on old tree trunks.

Pupa tatrica HAZAY, Jahrb. d. Malak. Ges. xii, 1885, p. 32; Eszaki Karpat. p. 356.

This species stands nearest to *Pupa leontina* Gredl., which is said to have 2 denticles, but differs by its conic shell with only 4½ whorls and the impressed peristome. It is distinguished from *Pupa arctica* Wallenberg, which also has 3 denticles, by the shape, increase of the whorls, the peristome not bent in (*Hazay*).

67*c*. *V. arctica tirolensis* (Gredler).

Shell umbilicate ovate, obtuse at the apex, obsoletely striate, glossy, pellucid, rufous-corneous. 5 convex whorls. Aperture oblique, cordate, bidentate, the columellar tooth short, acute, the parietal pliciform. Peristome a little expanded, furcate, margins joined by a very thin callus, the right margin slightly inflected in the middle and somewhat projecting forward. Length 1⅕, diam. ⅔ lines (*Gredler*).

Tyrol: Rodlerberg near the Peitler Kofel, at the upper limit of trees, under stones.

Pupa tirolensis Gredler, Verh. k. k. zool.-bot. Ges. Wien, xix, 1869, p. 912.

68. Vertigo ronnebyensis (Westerlund). Pl. 17, fig. 14.

Shell deeply perforate, long-ovate, regularly finely striate, very glossy, reddish-brown. Whorls 5½, convex, the last about equal to the penult, which is a third higher than the preceding whorl, which is double the height of the next earlier; last whorl has a transverse callus of the same color near the aperture. Suture very oblique, ascending to the aperture. Aperture quite obliquely piriform, excised by the *very oblique* parietal wall, 4-toothed: 1 parietal lamella, 1 conic tooth at the lower end of the sharply emerging, dark-colored columella; 2 short, widely separated, deeply immersed palatal folds. Margins delicately united, the outer margin weakly arcuate, nearly straight, the columellar margin broadly reflected. Length 2⅓ to 2½, diam. 1⅓ to 1½ mm. (*Westerl.*).

Sweden: Pehrsborg, near Ronneby, under rotten beech leaves. Northern Germany, Bohemia.

Pupa ronnebyensis Westerlund, Exposé Crit., in Nova Acta Reg. Soc. Sci. Upsal. (3) viii, 1871, p. 94; Fauna iii, p. 135.—D. Goldfuss, Nachrbl. d. m. Ges. xxvi, 1894, p. 216; xxvii, 1895, p. 100 (Tegel near Berlin; Cladow, Neumark; near Landsberg a. Warthe, Spechthausen bei Eberswalde, Oderberg in der Mark and from the Oscher Walde (Kreis Schwetz) in West Prussia). — *Vertigo ronnebyensis* West.,

MERKEL, Nachrbl. d. m. Ges. 1887, p. 13-16 (Tegel bei Berlin). —BABOR & NOVAK, Nachrbl. 1909, p. 147 (Bohemia).— GEYER, Unsere Land- und Süsswasser-Mollusken, 1909, p. 55, pl. 5, f. 18, 19 (dist. in Germany).

This species approaches *P. alpestris* by the aperture provided with 4 teeth, but it differs considerably by the shell being of dark color, oblong-ovoid, and noticeably larger, nearly as large as a *P. edentula* of 6 whorls, the palatal teeth short and higher, etc. (*Westerlund*).

The figure is from Geyer.

69. VERTIGO DALIACA (Westerlund).

Shell oblong-cylindric, with rounded summit, smooth, reddish horn-colored, somewhat glossy. Whorls 5, somewhat convex, the first two small, the second half as long as the third, the three last regularly increasing, the last slightly and very slowly ascending, rounded, not as wide as the penult. Suture oblique. Aperture rounded, *with one strong, conic, acute tooth high on the columella*; parietal margin but slightly oblique; the margins equally arcuate, outer margin somewhat angular above. Length 1⅞, diam. 1⅓ mm. (*Westerl.*).

Sweden: Dalsland.

Pupa daliaca WESTERLUND, Fauna Pal. Reg. Binnenconchylien, iii, 1887, p. 131.

Var. *dalecarlica* Westerlund. Shell cylindric, brown, slightly striatulate; whorls 5 to 6, slowly and regularly increasing, the last 2 subequal, a little convex, the last rotund at the base, the suture oblique in the middle, subhorizontal at the aperture. Aperture semiovate: 1 very short, white, deeply placed parietal tooth, one in the palate nearly at the base, nodiform, immersed, rarely with 1 or 2 punctiform, brown, very obsolete teeth in the middle of the palate outwardly. Columellar margin of the peristome subvertical, reflected, the outer margin strongly curved above, then obliquely straightened, unexpanded. Length 1½ to 2, diam. 1 mm. Sweden in the province Dalarne, at Leksand and at Fu par. Mora. (*Pupa daliaca* var. *dalecarlica* Westerlund, Acta Soc. pro fauna et flora Fennica, xiii, no. 7, p. 64, 1897).

70. VERTIGO PINETICOLA (Westerlund).

Shell rimate, ovate-cylindric, finely striate, reddish-brown, glossy. Spire produced, *gradually tapering*. 5 whorls, slowly increasing, convex, the last scarcely ascending in front. Suture deep, *nearly horizontal*. Aperture oblique, piriform, *with one tooth below on the columella*; parietal margin *very oblique*; peristome somewhat expanded. Length 2⅓-2½, diam. 1½ mm. (*Westerl.*).

Sweden: Tenhult, prov. Smaland (E. Hemberg).

Pupa pinecticola WESTERLUND, Exposé Critique, in Nova Acta Reg. Soc. Sci. Upsaliensis, (3), viii, 1871, p. 97; Fauna iii, 1887, p. 131.

71. VERTIGO GEMMA Westerlund.

Shell cylindric-oblong, slowly tapering above the middle, obtuse, chestnut, glossy, smoothish. Whorls 6, convex, the last two wide, slightly unequal, the upper ones narrow (the penult more than double the alt. of the preceding), last whorl in front dilated below, the base gibbous-crested; suture oblique above, horizontal below. Aperture (margins not as yet wholly complete) subtriangular, narrowed below, 1 or 2 toothed: palatal tooth nodiform, below the middle of the margin, a very minute denticle above the middle. Peristome simple, the outer margin angularly produced above the middle, very strongly arcuate above, a little straightened below the middle. Columella straight, vertical, thickened at base, the columellar margin dilated and reflected above, in front of the columella, below the columella strongly arched backward. Palatal and cervical callus wanting, between the penult and last whorls there is a transverse white line, from a thin internal lip. Length 2½, diam. 1⅓ mm. (*Westerlund*).

Sweden: Dalbyö, Södermanland.

Pupa gemma WESTERLUND, Acta Soc. pro fauna et flora Fennica, xiii, no. 7, p. 65, 1897.

Described from one specimen.

72. VERTIGO OVOIDEA (Westerlund).

Shell ovate, ventricose, widest in the middle, reddish-yellow, finely striate, rather glossy. Whorls 5, convex, the upper ones rapidly increasing in width, the last equal in height to the penult in front, behind strongly sloping, far lower and less wide than the penult. Suture very oblique above, nearly horizontal below. Aperture semiovate, with three small tubercular teeth, one each on the parietal wall, columella and deep in the palate. Parietal wall scarcely oblique; peristome simple, acute, the columellar margin somewhat reflected above, margins delicately joined. Length 2, diam. 1¼ mm. (*Westerl.*).

Sweden: Tenhult, Prov. Smaland (E. Hemberg).

Pupa ovoidea WESTERLUND, Exposé Critique, in Nova Acta Reg. Soc. Sci. Upsal. (3) viii, 1871, p. 96; Fauna iii, p. 131.—PFR., Monogr. viii, 393.

73. VERTIGO SIEVERSI (Bttg.). Pl. 17, figs. 11, 12.

Nearest related to *V. substriata* Jeffr., but ovate-turrited, not shortly ovate, the sculpture slighter. Shell small, ovate-turrite, somewhat glossy, rather silky, corneous-olivaceous, the apex obtuse. Whorls 5, convex, very delicately but distinctly striate, the last scarcely one-third the total length, encircled anteriorly with an annular broad but not strong callus, either fulvous or whitish, externally not or slightly impressed. Aperture truncate-ovate, 6-toothed: two pliciform palatals, two subequal columellars, and *two* parietals, the inner one larger. Peristome a little expanded, pale, somewhat thickened, sublabiate, the margins connected by a thin callus. Outer margin a little projecting and slightly impressed in the middle. Length 1⅞ to 2⅛, diam. 1 mm. (*Bttg.*).

Caucasia: Tabizhuri (Dr. Sievers); debris of the Psekup (Rosen).

Pupa (*Vertigo*) *pygmæa* Drap. var. *nitidula* MOUSSON, Journ. de Conch. 1876, p. 143.—*Pupa* (*Vertigo*) *sieversi* BOETTGER, Jahrb. d. m. Ges. vi, 1879, p. 407, pl. 10, f. 6; with var. *punctulum*, pl. 10, f. 7; Jahrb. vii, 1880, p. 141, with var. *punctum* [*sic*] and var. *subalpestris*.—*Vertigo*

sieversi Bttgr. var. *subalpestris* BOETTGER, Bericht Senckenb. Nat. Ges. 1889, p. 25.—*Pupa sieversi* Bttg., ROSEN, Nachr. d. m. Ges. vol. 39, 1907, p. 205.

Constantly of a more elongate turrited form [than *V. pygmæa*], by the striation and position of the parietal tooth most nearly related to *V. substriata* (*Bttg.*).

Var. *punctulum* Bttg. Pl. 17, fig. 13. Smaller, more ovate. Mauglis; debris of the Kura at Borshom (*Sievers*); also Martkopi and Abastuman (Leder).

In all the specimens from Abastuman the lower columellar tooth of typical *P. sieversi* is wanting (*Bttg.*).

Var. *subalpestris* (Bttg.). Differs from *V. alpestris* chiefly by the very small size, alt. 1⅝, diam. ¾ mm., the more ovate shape, the somewhat stronger sculpture and the stronger development of the upper parietal denticle.

Caucasia: on the Kasbek (type loc.); forest region of the southeastern and northern spurs of the Oschten-Fischt mountain-group (Leder).

Dr. Boettger states that specimens from the last locality are somewhat larger, length 1⅞, diam. 1 mm.; the second parietal tooth is altogether lacking, and in these characters and the size this form is so similar to the true *V. alpestris* that without the most careful attention it would be mistaken for that. Besides the differential features noted above, *subalpestris* has the weak indication of a narrow transverse callus in the base of the mouth, near the peristome. Were it not for the transitions to *sieversi* from the Kasbek, *subalpestris* would be united with the real *alpestris*.

Vertigo sieversi was first described as *P. pygmaea* var. *nitidula*, by Mousson; and I am not sure that his name should be rejected. Boettger gives no reason for doing so. There is, however, a *Tornatella nitidula* of Lamarck, which in modern nomenclature will become *Pupa nitidula*. Mousson's description follows.

Pupa (*Vertigo*) *pygmaea* Drap. var. *nitidula* Mousson. Smaller, 1.5 mm. long, 0.9 diam., brown, glossy, the base not compressed; 2 minute palatal teeth, not produced, visible externally, columellar tooth single small. This appears to me

to be only a variety of *V. pygmaeus,* which in Europe also varies considerably. Its smaller size, slightly less cylindric shape, the more rounded base, the weakness of the teeth, of which the 2 palatals are more immersed but visible from the outside, and the single, rudimentary columellar distinguish it from the type (*Mouss.*).

Transcaucasia: Tabizhuri, Dr. Sievers.

74. VERTIGO ALPESTRIS Alder. Pl. 18, figs. 1, 2.

"Shell subcylindrical, thin and semitransparent, very glossy, pale yellowish-horn-color, closely and rather strongly striate in the line of growth; periphery rounded: epidermis thin. Whorls 4½, convex, but slightly compressed. Spire short, abrupt and bluntly pointed. Suture excessively deep. Mouth semioval and subangular, owing to the outward compression of the periphery: teeth four, viz.: one sharp and prominent tooth on the middle of the pillar [parietal wall], one strong and also prominent and thick tooth on the pillar lip, and two lamellæ or plate-like teeth which are placed at some little distance within the outer lip, but not on any rib or callous fold as in *V. pygmæa*; the labial teeth are visible on the outside, owing to the thinness and transparency of the shell. Outer lip rather thick very slightly reflected, not strengthened by any rib either outside or inside, outer edge abruptly reflected; inner lip somewhat thickened in adult specimen. Umbilicus small and narrow, but rather deep. L. 0.07. B. 0.04 inch (*Jeffreys*).

Length 2, diam. 1.1 mm.

Length 1.9, diam. 1 mm.

England: Lipwood, near Haydon Bridge, Northumberland, on an old wall, type loc.; Clithero, Lancashire, etc. The Alps, Switzerland, the Lower Harz, etc. Norway, Sweden and Lapland; in Siberia east to the Amur valley and Vladivostok.

Vertigo alpestris Fér., ALDER, Trans. Nat. Hist. Soc. of Northumberland, etc., ii, 1838, p. 340.—GRAY, Turton's Manual, p. 202, pl. 12, f. 141.—JEFFREYS, British Conch., i, p. 259.—BOETTGER, Jahrb. Nassau. Ver. Nat. 42, 1889, p. 307 (Pleistocene and recent dist.)—KOBELT, Iconogr. (2), viii, p.

91, fig. 1531.—Dean and Kendall, Journ. of Conch. xii, 1908, p. 209 (distribution in England, and frequent association with *V. pusilla*).

Pupa alpestris Fér., Pfr., Monogr. viii, 1877, p. 396.—Mousson, Journ. de Conch. 1887, p. 19 (Wladiwostock).—Westerlund, Fauna, iii, 1887, p. 132; Kongl. Sv. Vet. Akad. Handlinger, xiv, no. 12, 1877, p. 44 (Jenissei, Siberia, 6 m. s. of Podk. Tunguska, 61° N. lat. Lapland N. to Quickjock, 67-68° N. lat.). *Pupa alpestris* Alder, Sterki, Nachrbl. d. Malak. Ges. 1883, p. 73 (many localities in Switzerland), with var. *elongata*.

Pupa shuttleworthiana Charpentier MS., Pfeiffer, Zeitschr. f. Malak. 1847, p. 148 (Bex, Switzerland); Monogr. Hel. Viv. ii, 355; iii, 555; iv, 680; vi, 327.—Kuester, Conchyl. Cab., Pupa, p. 128, pl. 16, f. 35-37.—Wallenberg, Malak. Blätter v, 1858, p. 101, pl. 1, f. 5 (Quickjock, Lulea-Lapland). Schrenck, Amurl. Moll., 1867, p. 657.—Gredler, Verh. Zool.-bot. Vereins Wien, 1856, p. 128; Nachrbl. d. m. Ges. 1879, p. 112, with var. *mitis* (occurrence in the Tyrol).—Schrenk, Reisen u. Forsch. im Amurlande ii, p. 657 (Krasnojarsk, around Irkutsk, Kultuk on L. Baikal, lower Amur above Kidsi).—*Vertigo shuttleworthiana* Charpentier, Kobelt, Iconogr. (2), viii, p. 94, f. 1536.

Pupa pygmaea var. *alpestris* Maack, Bull. Acad. St. Pét. xi, 1853, no. 263, 264.

Pupa (*Vertigo*) *parcedentata* (in part) Sandberger, Verh. Phys.-Med. Ges. Würzburg, n. F., xx, 1887, with varieties *quadridens*, pl. 8, f. 1*a-c*; *tridens*, f. 2; and *adversidens*, f. 3.

The total absence of a crest or palatal callus and the somewhat straightened but not in-bent outer lip are characteristic. Wallenberg found the Lapland specimens a little larger than those of England, 2.2 x 1.2 mm.

Var. *mitis* Westerlund. Aperture bidentate, one parietal and one columellar tooth; or tridentate, one parietal, one columellar and one lower palatal. Sweden. (*Pupa alpestris* var. *mitis Westerl.*, Fauna Europaea, fasc. 1, 1876, p. 197; *Pupa alpestris* forma *mitis*, bidentata and tridentata, Westerlund, Fauna iii, 1887, p. 132).

It has been reported from Transylvania by Clessin, and has been described as *P. parcedentata* var. *tridens* (see pl. 18, fig. 13) and perhaps var. *adversidens* (pl. 18, fig. 16) by Sandberger, who records these, together with var. *quadridens* (pl. 18, fig. 14, = typical *alpestris*) from the Rhine valley loess.

It may be presumed that Westerlund did not intend the terms *bidentata* and *tridentata* as names, but merely descriptive of the forms he included under var. *mitis*.

Var. *elongata* Sterki. A few examples of a beautiful, large, cylindric form, of brownish color, rather smooth, from Trous (Canton Graubünden) [Switzerland] are in the Mousson collection, collected by Blauner, and labelled *pygmaea* (*Sterki*, Nachrbl. d. Malak. Ges. 1883, p. 73).

The identity of *Pupa shuttleworthiana* (pl. 18, fig. 3, copied from Steenberg) with *V. alpestris* has been affirmed by Jeffreys (British Conchology, p. 261) and by Boettger (Nachrbl. d. Malak. Ges. 1882, p. 19), who declared them absolutely identical. Kobelt, in the *Iconographie*, remarks that "in the local faunas this species has frequently been misunderstood; it is hardly anything other than a four-toothed race of *V. alpestris*." He states that the original locality is Bex, Switzerland, and it has also been reported from Belteberga, Sweden, by Westerlund.

74*a*. *Vertigo alpestris heldi* (Clessin). Pl. 18, fig. 4.

Shell rimate, turrited, irregularly and very finely striate, of reddish-brown color, glossy. Whorls 6, slowly increasing, rather convex; the first 3 form a blunt summit which is about ⅓ the length of the shell; the last 3 are of nearly equal height and form the remaining cylindric part of the shell. The last whorl is neither calloused nor contracted preceding the aperture Aperture about ¼ the length of shell, arcuately convex, somewhat impressed on the outer side, the impression running as a groove-like depression for a short distance on the last whorl. Toothed, the teeth reddish, very weak and placed deep in the throat; 1 tooth on the middle of the parietal wall, 1 on the columella, 2 very weakly developed, frequently wanting, on the palatal wall. Peristome continuous, somewhat

expanded, little thickened. Length 4-4.5, diam. 1 mm. (*Clessin*, 1877).

Germany: drift debris of the Danube, Regensburg, Bavaria type loc. Günzburg on the Danube, Schönthal on the Jagst and Neckarthailfingen on the Neckar (Goldfuss). Ireland?

Pupa (*Vertigo*) *heldi* CLESSIN, Nachrbl. d. Malak. Ges. 1877, p. 49; Deutsche Exk.-Moll.-Fauna, edit. 2, p. 266, fig. 156. — OBERNDORFER, Nachrbl. 1898, p. 69. — *Pupa* (*Alaea*) *heldi* CLESSIN, Berichte naturwiss. Vereines zu Regensburg xiii, Heft für 1910-1911, p. 83.—*Pupa pygmaea* var. *elongata* GEYER, Jahresh. Ver. Vaterl. Naturk. Württemberg 1894, p. 107; identical with *P. heldi*, same Jahresh. vol. 36, 1907, p. 424. Debris of the Danube, Neckar, etc.

? *Vertigo heldi* TOMLIN, Irish Naturalist xii, 1903, p. 110; Journ. of Conch. x, 1903, p. 307; Proc. Malac. Soc. London xii, 313 (an abnormal *V. pygmaea*).—B. B. WOODWARD, t. c., p. 361 (doubts the identification).

Clessin found only dead specimens in the Danube debris, but thought it must live not far away. It was found living in the Württemberg Jura. Dr. Geyer believes *heldi* to be an overgrown *V. pygmaea*. He notes that "full-grown specimens with completed peristome and teeth are rare. Contrary to the other Vertigos, the palatal teeth appear first, and the parietal tooth may even continue absent, this condition leading to *P. haeussleri* Sterki."

V. heldi was first reported from Ireland (Ballintoy, Co. Antrim) by Mr. B. Tomlin, whose specimen was examined by Dr. Boettger, who believed *heldi* to be a variety of *alpestris*. In his second note, attention is called to the smooth and glossy surface of the Irish shell while *heldi* is described as striate. "Placed side by side with a typical *V. alpestris* it differs in possessing an extra whorl and larger dimensions in every way, in its reddish-brown color, in its feebler dentition, and in the shape of the mouth, the outer margin of which slopes very obliquely from right to left, thus producing the sort of channel at the top to which Clessin refers." Subsequently Mr. Tomlin thought the Irish shell an abnormal *V. pygmaea*. This harmonizes with the ideas of Geyer, noticed under *V. pygmaea*.

74*b*. *Vertigo alpestris leontina* (Gredler). Pl. 18, figs. 5, 6.

The shell is very small, subperforate, ovate-cylindric, obtuse, very delicately striate, very glossy, pellucid, whitish-corneous. Whorls 4½, convex. Aperture semioval, 5-plicate, plicae unequal; 1 parietal, 1 columellar, 3 very small palatals, the lower one punctiform, the median and upper lamelliform. Peristome a little reflected, thickened, white, margins joined by a thin callus, the right margin sinuous. Length ⅔, diam. ⅖ of a line (*Gredler*).

Tyrol: Lienz, scarce, at the foot of the Tristacherwand.

Pupa leontina Gredler, Verh. zool-bot. Ver. Wien 1856, p. 127, pl. 2, f. 4.—Westerlund, Malak. Bl. xxii, p. 128 (identical with *Pupa schultzii* Phil.).—Pfr., Monographia iv, 680.

Among the Tyrol Pupas this new species stands next to *P. shuttleworthiana* [*alpestris*], but it is smaller, lighter colored, more transparent, and has half a whorl less. The palatal folds (though the specimen is full grown) are far more weakly developed and differ in number (*Gredler*).

Pupa isarica Westerlund. Pl. 18, figs. 7, 8.

2-toothed, without any trace of palatal folds, though full grown, 1.7 x 1.1 mm. Bavaria: drift debris of the Isar, one specimen.

Pupa leontina Gredler, Clessin, Deutsche Excursions-Mollusken-Fauna, 1876, p. 216, f. 122, not of Gredler.—*Pupa isarica* Westerlund, Fauna Pal. Reg. Binnenconch. iii, 1887, p. 134 (based upon Clessin's note and figure); Synops. Moll. extramar. Reg. Pal., 1897, index p. 11.—*Vertigo isarica* West., Kobelt, Iconogr. (2) viii, p. 95, f. 1539.

Except by lacking palatal folds, this form agrees with *V. leontina*. It is known by a single example, possibly abnormal.

74*c*. *Vertigo alpestris helvetica* (Westerlund).

Shell rimate-perforate, long-cylindric, with conically tapering apex, light reddish horn-color, very finely striate, whorls 6½, somewhat convex, regularly increasing, rather high, the last whorl small, but little more than ¼ the total length, anteriorly impressed at the base, then tubercularly blunt keeled

below, behind strongly sloping. Aperture oblique, narrow, triangular, with 1 parietal lamella, 1 columellar lamella, in the middle, receding below. Peristome simple, thin; outer margin arcuate above, then obliquely produced to the left; the columellar margin short, somewhat oblique towards the right. Length 2¾, diam. 1¼ mm. (*Westerlund*).

Switzerland: based on a single specimen without definite locality.

Pupa alpestris var. *helvetica* WESTERLUND, Fauna Europaea 1876, p. 198.—*Pupa helvetica* WESTERL., Fauna Pal. Reg. etc., iii, 1887, p. 134.

75. VERTIGO SCHULTZII (Philippi). Pl. 18, fig. 9.

Shell minute, rimate, subcylindric, obtuse, very smooth, glossy, fulvous; whorls cylindric, aperture rounded, the throat 5-toothed, single teeth on parietal wall and columella, 3 in the palate, the lower one smallest. Alt. 1, diam. $^{7}/_{12}$ lines; whorls 5 to 6 (*Philippi*).

Sicily: Palermo, Dr. Schultz.

Pupa (*Vertigo?*) *schultzii* PHILIPPI, Zeitschr. f. Malak. 1844, p. 106.—*Pupa schultzii* KÜSTER, Conchyl. Cab. p. 93, pl. 13, f. 3, 4.—PFR., Monogr. ii, 359.—*Vertigo schultzii* Phil., KOBELT, Iconogr. (2), viii, p. 95, f. 1538 (copied from Küster).

A very remarkable species of the form of *P. dilucida* Ziegl., but with the whorls more strongly convex, and without trace of striae. By this it compares best with *Vertigo pygmaea*, though far more slender, with more strongly convex whorls. The parietal fold emerges very far, while the second palatal fold is only weakly developed (*Philippi*).

A lost species, possibly a form of *alpestris* as surmised by Kobelt, though the locality and very smooth surface are against that view.

76. VERTIGO ACHEILA Servain.

Shell very minute, perforate, ovate, more convex on the left than on the right side, very glossy, smooth, diaphanous, corneous. Spire obtuse. Whorls 5, a little convex, slowly increasing, separated by a rather deep suture, the last whorl

moderate, convex, angular below around the perforation, above straight and slightly descending to the insertion of the lip, nearly ⅓ the total alt., thicker but not swollen behind the aperture. Aperture slightly oblique, trigonal, below angularly narrowed and transversely straightly thickened, 4-plicate, as follows: 1 strong parietal, 1 columellar at the upper part of the columella, and two approximate palatals, visible externally, the upper one stronger and reaching the margin. Peristome lipped within, spreading and a little reflected, the outer margin a little straightened, thicker in the middle; the columellar margin somewhat straightened, in an oblique direction from left to right; margins rather remote. Length 1¾, diam. 1¼, alt. ap. ¾, width ½ mm. (*Servain*).

Spain: drift debris of the Ebre at Saragossa.

Vertigo acheila SERVAIN, Etude Moll. rec. en Espagne et en Portugal, 1880, p. 125.

"The columellar margin has an obliquely rectilinear direction from right to left, rendering the aperture triangular and quite angular at the base. The aperture is, moreover, characterized by a horizontal thickening interiorly in the lower part, altogether identical with that which has been remarked in the *pupa microtragus* of Turkey" (*Servain*).

It appears to be known only by Servain's description.

77. VERTIGO BÜTTNERI Siemaschko.

Shell very minute, ovate, somewhat obtuse, very elegantly striate, subrimate. Aperture semiovate, peristome white-lipped; parietal wall and palate 1-toothed. Length 2, diam. 1.5 mm.; whorls 4½ (*Siem.*).

Courland: Parvecia (H. Büttner).

Vertigo buttneri SIEMASCHKO, Bull. de la Classe Physico-Math. de l'Acad. Imp. Sci. St. Pétersb., vii, no. 159, 1849, p. 234.

This small reddish-brown snail has great resemblance to *Pupa bigranata*, but it is a true *Vertigo*; lightly striate, above obtuse, the aperture half-round, with thickened white margins, outwardly a little angular, and two-toothed. Of the teeth, one stands above, the other below, obliquely opposite; on the

right from the latter one sees sometimes another quite small denticle which stands nearer the outer lip. The greatest diameter is equal to the height of the last whorl (*Siem.*).

So far as I know, this species has not been recognized by any subsequent author; yet it may be known under another name.

78. VERTIGO GENESII (Gredler). Pl. 18, figs. 10-12, 17, 18.

The shell is very small, ovate, obtuse, indistinctly, spaced striate, glossy purplish brown. Whorls 4½, rather convex, high, rapidly increasing, joined by a somewhat impressed suture, the penult large, almost ventricose. Umbilical opening moderate. Aperture semirotund, nearly quadratic, without any folds. Peristome scarcely expanded, thickened lip-like, bordered with bluish black, the margins connected by a very weak callus, the right margin arched at the insertion. Length ¾, diam. ½ line [about 1.5 x 1 mm.].

Animal raven-black, the tentacles short, contracted in the middle, the anterior pair not indistinct (*Pupa ?*). Bears itself quite timidly, but promptly takes courage again (*Gredler*).

Tyrol: above St. Jenesien, near Botzen, at 5000 ft. (Gredler). Also in Germany, near Kisslegg, southern Würtemberg (Geyer). Sweden: Westergötland (Linnarsson).

Pupa genesii GREDLER, Tirol's Land- und Süsswasser-Conch., Verh. z.-b. Ver. Wien vii, 1856, p. 122, pl. 2, f. 3.—PFR., Monogr. iv, 662.—*Alaea genesii* CLESSIN, Corresp.-Bl. Zool. Min. Vereins Regensburg, 1877; Moll. fauna Oesterreich-Ungarns, 1887, p. 279.—*Pupa genesii* WESTERLUND, Nova Acta Reg. Soc. Sci. Upsaliensis, (3), viii, 1871, p. 97; Fauna, iii, p. 130 (Oestergötland).—*Pupa* (*Vertigo*) *parcedentata* var. *genesii* SANDBERGER, 1887.—*Vertigo genesii* GEYER, Nachrbl. d. m. Ges. 1912, p. 125.—STEUSLOFF, Archiv Ver. Fr. Naturg. in Mecklenburg, 61 Jahr. 1907, p. 68, 71 (dist. in quaternary). —*Pupilla genesii* Gredl., KOBELT, Iconogr. (2), viii, p. 82, f. 1512.

Originally described as toothless, this species varies to forms with 4 teeth. It has been considered a toothless variety of *V. parcedentata* by Sandberger and Boettger, and if this view

is supported, the latter will stand as *V. genesii parcedentata*, as *genesii* was the first to be described.

Kobelt placed the species in *Pupilla* on account of Gredler's note on the tentacles.

D. Geyer, who collected *V. genesii* at the original locality, under the guidance of Gredler, writes as follows:

"*Vertigo genesii* Gredler is not invariably toothless ('*ohne alle Falten*' Gredler), but 4-toothed examples occur with the toothless ones; 1 tooth on the parietal wall, 1 on the columella and 2 in the palate, showing through outside. These last two develop last, and examples about to become complete therefore appear to be transitional, with only 2 or 3 teeth. *V. genesii* is therefore similar in dentition to *Pupilla muscorum, steini, triplicata* and others. The station of the snail is at the Salten near Jenesien (so the name of the village is pronounced, and so it appears on the charts—not 'St. Genesien'), in the neighborhood of Bozen. The snail is not restricted to rocks, as Gredler stated, but also lives on wood, in humid forest openings.

"*V. genesii* is not confined to the Salten and Tyrol, but also lives in Germany. Years ago I found 4 specimens in a meadow near Kisslegg in the Würtemberian Allgau, and a single 4-toothed Pupa in the debris of the Aach near Wolfegg, 9 kilom. northwest of Kisslegg. * * * I see now that these German specimens, also from a humid but far lower station (at Salten about 1200, at Kisslegg 647 m.), agree completely with those of the Tyrol, being only a little lighter in color."

Geyer further states that *genesii* and *parcedentata* "show the same variability in dentition, both having 0 to 4 teeth, but in size, contour, growth and number of whorls they differ from one another decidedly." Yet it must be noted that Geyer compares with Sandberger's fig. 1, which Boettger considered to be really *V. alpestris*. Geyer considers that *parcedentata* is a synonym of *alpestris*; but the small form without columellar or upper palatal folds, which is really the typical *parcedentata*, appears to support the view of Sandberger and Boettger, that *parcedentata* is specifically not separable from *genesii*.

An allied but larger form has been found in the Kartitsch Valley, Tyrol, by Wiedemayr (Zeits. Ferdinandeums für Tirol u. Vorarlberg, Innsbruck, 44, 1900, p. 167).

Vertigo pygmaea var. *concinna* Scott = *V. levenensis* Scott has been placed by Kennard and Woodward (1917) in the synonymy of *V. parcedentata*. Dr. Boettger considered specimens submitted to him to be identical with *genesii*. The original description follows.

Rather smoother and more glossy than the typical *Vertigo pygmæa*. It differs chiefly, however, in the mouth being unfurnished with teeth. In this respect it agrees with *V. edentula*, but the form of the shell is certainly that of *V. pygmæa* (*Scott*).

Scotland: Kirkland marl, Leven; Pleistocene.

V. pygmæa var. *concinna* T. Scott, Proc. Roy. Phys. Soc. Edinburgh, x, p. 335, footnote, 1890; Scottish Naturalist, April, 1891, p. 53 (not seen).—*Vertigo levenensis* Scott, Scottish Naturalist 1891, p. 141, *n. n.* for *V. p. concinna* (not seen). Cf. Kennard & Woodward Proc. Malac. Soc. Lond. vii, 119.

The name *concinna* was quite unnecessarily changed to *levenensis* on account of *Pupa concinna* Lowe, a Madeiran snail belonging to a different subfamily.

78*a*. *Vertigo martini* Sayn. A very small species of the size and nearly the shape of the short varieties of *V. pygmaea*, but having the aperture absolutely without folds or teeth. I do not see that there is anything in the French fauna which is comparable, and the Pliocene fossil forms having the aperture toothless, such as *V. crossei* of Hauterive, are all much larger and of a different shape (*Sayn*).

France: Pleistocene; marnes inférieures de Pont-Neuf, Ain river near its confluence with the Rhone.

V. [*ertigo*] *martini* Sayn, Ann. Soc. Linn. de Lyon Année 1911, lviii, p. 246.

A. S. Kennard and B. B. Woodward have suggested that this is probably identical with *Vertigo parcedentata* (Al. Braun) (Proc. Geologists' Asso., xxviii, 1917, p. 170). It

will be noted that the description of *V. martini*, such as it is, agrees with that of *V. concinna* = *levenensis*. Its distinctness from *V. genesii* remains to be established, if it is not identical.

78*b*. *Vertigo genesii parcedentata* (Al. Br., Sbgr.). Pl. 18, figs. 15, 19.

The small, narrowly ovate shell has a narrow umbilical crevice and blunt summit; consists of 4½ to 5 convex whorls separated by a deeply impressed suture, the last whorl forming half of the total length. First whorl entirely smooth, the rest having rather oblique striae, of which there are several finer between two stronger striae. The aperture is semi-ovate, obliquely truncate above, with weakly reflected margins which are connected by a very thin callus; the right margin being weakly arched forward. It has either one to four teeth [one or two; see below] or is wholly toothless. Length 1.8 to 2.2, diam. 1 mm. (*Sandberger*).

Germany: Pleistocene and Alluvium of the Rhine valley, etc.

Pupa or Vertigo parcedentata A. Braun, Amtl. Bericht über die XX Versammlung deutscher Naturforscher u. Aerzte zu Main, 1842, p. 143 (Wiesbaden; *no description*).—*Pupa* (*Pupilla*) *parcedentata* A. Braun, Sandberger, Vorwelt, p. 876, pl. 36, f. 25, 1875; Verh. Phys.-Med. Ges. Würzburg xx, 1887, pp. 229-235, pl. 8; with, on p. 232, varieties *quadridens*, fig. 1; *tridens*, fig. 2; *adversidens*, fig. 3; *bidens*, fig. 4; *glandicula*, fig. 5; *genesii*, figs. 6-8.—*Vertigo* (*Alaea*) *parcedentata* (Al. Br.) Boettger, Jahrb. Nassau. Ver. Nat. xxxxii, 1889, p. 308.—*Vertigo parcedentata* Al. Br., Kennard and Woodward, Proc. Geol. Asso. xxviii, 1917, p. 170. (Pleistocene and Holocene, Northampton, Middlesex, Fifeshire); Proc. Malac. Soc. London vii, 1906, p. 119 (identity of *V. levenensis* with *parcedentata* var. *genesii*).—*Pupa adversidens* and *Pupa glandicula* Sandberger, Verh. Phys.-Med. Ges. Würzburg, n. F., xix, 1886, p. 319, names only.—*Pupa* (*Vertigo*) *parcedentata* Al. Br., Wüst., Zeitschr. deutschen Geol. Gesell, vol. 59, 1907, p. 121; Zeitschr. f. Naturwiss, vol. 75, 1902, pp. 316, 320, pl. 6, f. 26-32.

The first description of this snail, so far as I can learn, was that of Sandberger in 1875; from this it appears that the form with a weak parietal tooth as well as one opposite it in the palate [lower palatal], is to be regarded as typical. It is that which he figures. Boettger states that according to his understanding typical *parcedentata* forms have 1 or 2 blunt denticles, and occur in his environs in the younger Middle-Pleistocene loess of the "Erbenheimer Tälchens bei Wiesbaden und von Schierstein und im alten alluvium des Grossen Bruchs bei Traisa in der Prov. Starkenburg." Outside of this region it is known from the loesses of Heidingsfeld, Würzburg and Regensburg, and the toothless form has also been recognized in England and Scotland, perhaps also in France.

According to Boettger, the earliest Pleistocene forms known appear to have been toothless; afterward variable, partly toothed forms in the later Pleistocene and Alluvium, finally extinction of the toothed *parcedentata* stock, which Boettger considered to belong to lower elevations, the toothless *genesii* alone surviving, and only in Alpine and high northern regions.

In his paper of 1887 Sandberger described the following varieties, the first three probably referable to *V. alpestris*.

Var. *quadridens* (pl. 18, fig. 14). Aperture armed with one mammilliform parietal tooth, one columellar and two on the throat [palate], of which the anterior is smaller.

Var. *tridens* (pl. 18, fig. 13). Anterior tooth of the throat obsolete or wanting, the rest present.

Var. *adversidens* (pl. 18, fig. 16). No columellar tooth, the rest are apparent.

Var. *bidens* (pl. 18, fig. 15). Columellar and anterior tooth of the throat wanting. This form is the typical *parcedentata*.

Var. *glandicula* (pl. 18, fig. 19). Only the parietal tooth visible.

Var. *genesii* (pl. 18, figs. 10-12). Toothless; bright brown in life, subpellucid, the margins of aperture violacous-brown [= *genesii* Gredler].

Dr. Boettger considers the relatively large, 4-toothed loess form which Sandberger described as var. *quadridens* to be

V. alpestris (Alder). He states farther that he knows of no form of *parcedentata-genesii* having more than two teeth, none having a columellar or an upper palatal. Sandberger's varieties *quadridens, tridens* and *adversidens* would therefore be forms of *alpestris.* Boettger further remarks that recent forms of *V. alpestris* (Ald.) with only one palatal fold, or without them, are not rare, and have been described by Westerlund as var. *tridentata* and *bidentata. Cf.* notes under *alpestris* var. *mitis* West.

See also Geyer's notes under *V. genesii,* from which it appears that the living form may be either toothed or toothless. At present the distinctions, if any, between *genesii* and *parcedentata* remain to be formulated. The present usage appears to be this: the recent specimens are called *genesii* and the fossil (Pleistocene or Holocene) are called *parcedentata.*

Group of V. otostoma.

Sinistral species with few, small teeth, arranged 1-1-1 or 1-1-0.

79. VERTIGO OTOSTOMA Westerlund.

Shell [sinistral], cylindric, finely striate, yellowish-brown, glossy. Whorls 6½ to 7, slowly increasing, convex, the two penult nearly equal, the last *much higher,* having two pale longitudinal furrows anteriorly. Aperture small, *ear-shaped, with only 2 low white folds and 1 very small tooth in the lower part of the palate.* Peristome very *oblique,* margins connected, the outer margin long, angularly drawn forward above the middle, not impressed, strongly arcuate above, passing into the weakly sigmoid columella in a short arc. Length 2⅔, diam. 1⅓ mm. (*West.*).

Sweden: Tenhult, prov. Småland.

Pupa otostoma WEST., Nova Acta R. Soc. Sci. Upsal. (3) viii, 1871, p. 100; Fauna iii, 1887, p. 142.—PFR., Monogr. viii, 410.

The special locality of this "ganz eigenthümlich und höchst merkwürdig" shell is Augustenborg, a high hill opposite the road to the estate of Tenhult, 1½ Swedish miles from the town

of Jönköping, southward, where it occurs with *V. pineticola, ovoidea, arctica* and others of the genus, upon twigs and fallen leaves.

80. VERTIGO CLEVEI Westerlund.

Shell [sinistral] obesely ovate; whorls 5½, convex, the penult inflated below, the last scarcely higher, much narrower, impressed at the aperture. Aperture truncate-ovate, the outer margin arcuate above, straight in the middle, oblique; basal margin rounded. Teeth only 2, one each on the parietal wall and the columella. Length 1⅓, diam. 1 mm. (West.).

Sweden: Sala, in a place called Gröna gängen (Prof. P. T. Cleve).

Pupa clevei WEST., Fauna Pal. Reg. Binnen-conch. iii, 1887, p. 142.

Subgenus VERTILLA Moquin-Tandon.

Vertilla M.-T., Hist. Nat. Moll. terr. et fluv. France ii, 1855, p. 408, for *V. plicata* and *V. pusilla*.

Angular and parietal lamellae well developed, the angular not connected with the peristome, parietal long; columellar lamella subvertical, spirally entering above. Upper palatal fold very long, its inner end curving down; the lower palatal short or wanting. Type *V. angustior* Jeffr. (*V. plicata* Moq.).

This group differs from *Augustula* by having the columellar lamella of entirely different form, and the upper palatal fold penetrating deeply, its inner end decurved and somewhat hook-like (as in pl. 5, fig. 17). In *Augustula* and most species of *Vertigo* the upper palatal fold is shorter than the lower. While *Augustula* and *Vertilla* show a certain parallelism or convergence, there appears to be no direct or close relationship. *Vertigo angulifera* Boettger, a dextral species of the German Miocene, is said to be closely related to *V. angustior*, and probably is ancestral to the recent species.

Vertilla was proposed for *sinistral* species of *Vertigo*.—including the type of the genus; and the name has been extensively used by European authors in this sense. The sinistral forms have obviously been derived from several dextral stocks

independently, so that *Vertilla*, as used by Boettger, Westerlund and others is heterogeneous. The name may properly be restricted to *V. angustior* and its immediate relatives.

81. VERTIGO ANGUSTIOR Jeffreys. Pl. 5, figs. 13, 16-18.

Shell subfusiform or barrel-shaped, narrower in proportion than V. pusilla, rather solid, but semitransparent, glossy, light horn-colour, strongly, obliquely and rather closely striate in the line of growth; periphery compressed and somewhat angular: epidermis thin: whorls 4½, rather convex, but compressed, gradually increasing in size, the penultimate one a trifle broader than the last, which occupies about two-fifths of the shell, the first or upper whorl smooth and shining: spire rather short, abrupt, and blunt at the point: suture rather deep, mouth subtriangular, and very narrow in consequence of the great contraction or sinuosity of the outer edge in the middle as well as towards the base; teeth four or five, viz. two on the pillar [parietal wall], the outer one of which is a little in advance of the other; one on the pillar lip [columella], which is sunk deep within the mouth and resembles a strong curved plate more than a tooth; and one thick and prominent tooth inside the outer lip, with rarely a small tubercle by the side of it. Outer lip exceedingly thick and scarcely inflected, strengthened outside and inside by a strong rib which is situate near the rim and is yellowish-white; the inside rib remarkably thick and increasing the contraction of the mouth; inner lip consisting of a slight deposit on the columella. Umbilicus very small, narrow and indistinct, being much contracted by a sharp and gibbous keel or crest at the base of the shell. L. 0.06. B. 0.035 inch (*Jeffreys*).

Vertigo angustior JEFFREYS, Trans. Linn. Soc. London xvi, pt. 2, 1830, p. 361 (rejectamenta of a small stream at Marino, near Swansea); British Conchology i, p. 265.—STEENBERG, Danmarks Fauna, Landsnegle, 1911, p. 166, f. 137.—*Pupa angustior* Jeffr., PFEIFFER, Monogr. iii, 560; iv, 686; vi, 336.—WESTERLUND, Fauna Europaea Moll. Extramar. Prodr. ii, 1878, p. 200, with var. *producta* and *gothorum*, p. 201; Fauna iii, p. 142, with var. *nana* Mich., *producta* W., *gothorum* W.—

Acta Soc. pro founa et flora Fennica, xiii, no. 7, p. 71 (distribution, etc.).

Turbo vertigo MONTAGU, Testacea Brit. 1803, p. 363, pl. 12, f. 6. Not *Helix vertigo* Gmelin.—*Vertigo vertigo* ISSEL, Moll. Pisa, 1866, p. 23.

Pupa öcsensis HALEVATS, Res. Wiss. Erforsch, Balatonsees, iv, pt. 2, p. 60, pl. 3, f. 10. Upper Pontic beds, Oecs, Lake Balaton (considered by O. Boettger a var. of *V. angustula*).

Vertigo venetzii Charpentier MS., FÉR., Prodr. p. 65 (nude name).—CHARPENTIER, Cat. Moll. Suisse, p. 18, pl. 2, f. 11.—ROSSMAESSLER, Iconogr. pt. 10, p. 30, f. 650.—STERKI, Proc. U. S. Nat. Mus. 1888, p. 380, pl. 42, f. 11, 12.—*Pupa venetzii* Charp., PFR. Monogr. ii, 364.

Vertigo hamata HELD, Isis, 1837, p. 304.

Vertigo plicata A. MÜLLER, Wiegmann's Archiv für naturg. 1838, i, p. 210, pl. 4, f. 6 (Neuhaldensleben).

Vertigo nana MICHAUD, Complément de l'hist, nat. des moll., etc., 1831, p. 71, pl. 15, f. 24, 25 (Lyons).

V. angustior is readily known by the strongly striate shell tapering towards both ends, the vertical columellar lamella and the very long and strong upper palatal fold, decurved at its inner end; the lower palatal being either quite weak or wanting. The palatal callus is very strong.

Var. *nana* Mich. 2 parietal teeth; columellar margin less thickened, with scarcely noticeable teeth. Upper palatal tooth short, the lower rudimentary. Southern France at Lyons; northern Italy (*Westerlund*).

Michaud's description and figure are not complete for details of structure, and as far as I can see pertain to practically typical *V. angustior*. Numerous specimens from Lyons appear to be practically typical. Westerlund, however, defines *nana* as a variety. Dupuy says of specimens received from Michaud that the upper palatal fold is less strong, and the lower less distinct than in what he had figured as *Pupa venetzii* (Hist. Nat. Moll. France, p. 121).

Var. *producta* Westerlund. Elongate ovate, chestnut-colored, 5½ to 6 convex whorls, the last with straight back, very oblique, with a strong white tubercle at the base, pro-

duced forward, almost equally bipartite by the deep longitudinal furrow. Length 2, diam. 1¼ mm. (*Westerlund*). Sweden: Borgholm.

Var. *gothorum* Westerlund. Shortly oval, rather ventricose, the 4½ to 5 whorls but little convex, the last longitudinally impressed in front, a little tubercular below. (Margins of the peristome united by a callus. Length 1½, diam. 1 mm. (Westerlund). Sweden: "Bellevue," Carlshamn.

82. VERTIGO CALLISTA Westerlund.

Shell cylindric, chestnut-brown or rufous brown, densely striatulate; whorls 6, convex, the antepenult and preceding entirely cylindric, separated by a deep suture, the penult whorl largest, the back of the last whorl strongly and straightly sloping, divided into two parts by a deep transverse furrow, the upper, larger part narrow, cylindric, the other very short basal part with a strong white protuberance near the aperture, from which it is separated by a wide furrow. Suture very oblique, not ascending to the aperture. Aperture placed to the left, suboval, with about 2 [parietal] teeth or folds: one shorter, more exterior, marginal, the other deeply entering, nearly continuous with the former; palatal fold long, strongly curved within; columella calloused, and the lip with a rufous callus deep within the outer margin. Peristome unexpanded, the outer margin strongly arcuate above, and angularly produced above the middle. Length 1½, diam. ⅔ mm. (*Westerl.*).

Sweden: Dalbyö, prov. Södermanland.

Pupa callista WESTERLUND, Acta Soc. pro fauna et flora Fennica, xiii, no. 7, 1897, p. 72.

Undescribed or uncertain species.

Vertigo lucida Jan. T. dextrosa, conico-cylindrica, obtusa, diaphana, lucidissima; apertura ovalis; labium columellae coarctatum; perist. edentulum. (*Jan* Mantissa p. 3), northern Italy.

Vertigo dinii Stefani, = *Truncatellina.*

Pupa (*Vertigo*) *danica* Westerl., Cat. der Conchyl.-Sammlung Fr. Paetel, 1873, p. 107. Dania, nude name.

Vertigo guadalupensis Fér., Tabl. Syst. p. 64, no. 6 "(4 dentata). *Habit.* La Guadeloupe."

Vertigo cylindrica J. Colbeau, Ann. Soc. Malac. Belgique iii, 1868, p. 97, pl. 2, fig. 7. Shell cylindro-conic, yellowish brown, glossy, the growth-striae quite noticeable, 5-6 whorls, the first very small, the later ones nearly equal; aperture small, oval, longer than wide, without teeth. Length 1¾, diam. about 1 mm.

Colbeau remarks that the unique example of this shell he formerly regarded as a variety or anomaly of *V. pygmæa*, not adult. The aperture is relatively smaller than in *V. muscorum* [Drap., *non* L.] and *edentula*; it is larger and more glossy than *muscorum*, smaller and darker colored than *edentula*. From Belgium. The figure is copied, pl. 17, fig. 8. May be a *Truncatellina* or an abnormal *V. pygmaea*.

Vertigo subtrochiformis de Gregorio (pl. 17, fig. 7). Shell very minute, pupoid, subtrochiform, the last whorl a little angular, aperture small, subrotund. Length 2 mm. Perhaps this is a variety of the preceding ["*Pupa muscorum*," a *Truncatellina*] having the last whorl broken and the spire a little wider. I have only one specimen (*Vertigo subtrochiformis* de Greg., Annales de Geol. et de Paleont., 32 livr., Feb., 1907, p. 8, pl. 1, f. 17).

Italy: Abano, found in mud from a hot spring. The figure is obviously inexact, and looks like anything but a *Vertigo*. Generic position dubious; though not so absolutely hopeless as some other generic references in the same paper, such as the "*Glandina*" and "*Melanopsis*."

IV. Fossil species of Vertigo and other Vertigininae.

Vertigininae are common as Pleistocene fossils, which in this work are included with the recent species.

A few Eocene species described as *Pupa* are probably *Vertigininae*, but the only one of which the apertural character is known has no teeth. As this is undoubtedly a secondary condition, such a form could not be ancestral to the modern genera, and it was probably an end-product of evolution from some toothed genus of the Palaeocene or Mesozoic.

Undoubted species of *Vertigo*, having teeth like *V. moulinsiana* or *alpestris*, and of quite modern aspect, appeared in the Lower Oligocene (amber of the Baltic coast); and in the Middle and Upper Oligocene and Miocene of central Europe the species became somewhat numerous. Most of these forms differ only in specific characters from living species, and the ancestors of the latter are probably among them. In Italy and southern France, Pliocene species occur, some closest to Miocene, others to recent forms. There has thus been a succession of similar species in Europe from Oligocene to recent times.

The subgenus *Vertilla* appeared in one or two species in the German Lower Miocene.

Ptychalaea, in the recent fauna known only from the Bonin Islands, is known by several European species from the Lower Miocene to Pliocene.

Glandicula occurs in the Upper Oligocene and Lower Miocene, Germany and France, then becoming extinct, so far as known. *Pseudelix* and *Enneopupa* are other genera of the German Upper Oligocene which left no descendants.

In America *Vertigo* is possibly represented by two Middle Eocene species, which from their shape and size appear referable to this genus rather than to *Pupilla*; yet as the apertural characters are unknown, and they are from a far lower horizon than any indubitable *Vertigo*, little stress is to be placed upon the generic reference. The general appearance is that of the two French Eocene species following. Perhaps we have to do with an unrecognized Eocene genus, and for this reason the species are here listed as *Pupae*, as originally described.

List of Tertiary species of Vertigo.

PUPA ARENULA White. 12th Ann. Rep. U. S. Geol. and Geogr. Surv. Terr. for 1878, pt. 1, p. 46, pl. 19, f. 8*a*, *b*. Upper Green River Group [= Bridger] Valley of Henry's Fork southward from Green River City, Wyoming.

PUPA ATAVUNCULA White. *Loc. cit.*, pl. 19, f. 9*a*. Same locality and horizon.

PUPA BONNETI Cossm. Ann. Soc. Roy. Zool. et Mal. Belg. xli, 1906, p. 283. Eocene: Sparnacien inférieur, Grauves.

PUPA HEBERTI Fougeroux et Denainvilliers. Journ. de Conchyl. 1875, p. 75, pl. 3, f. 7. Upper Eocene: Calcaire de Provins, Saint-Parres near Nogent-sur-Seine.

VERTIGO HAUCHECORNEI Klebs. Jahrb. Preuss. geol. Landesanst. u. Bergakademie zu Berlin, 1885, (1886), p. 382, pl. 17, f. 5.—Koken, Die Vorwelt, p. 463, f. 112. Lower Oligocene, in amber, Prussian coast.

VERTIGO KÜNOWII Klebs. Jahrb. Preuss. geol. Landesanst, 1885 (1886), p. 386, pl. 17, f. 6. Lower Oligocene, in amber of the Prussian coast. Resembles *genesii*.

VERTIGO MINOR Boettger. *Vertigo callosa* var. *minor* BTTG., Jahrb. d. geol. Reichsanst. xx, 1870, p. 296, pl. 13, f. 7. —*V.* (*Alaea*) *minor* BTTG., Jahrb. Nassau. 1889, p. 305. Tuchoric, Bohemia, Upper Oligocene.

VERTIGO DEFRANCII (Brong.). *Pupa defrancii* BRONGNIART, Mém. du Muséum, xv, 1810, p. 378, pl. 22, f. 19.—DESHAYES, An. s. Vert. ii, 1864, p. 857, pl. 56, f. 37-39.

Aquitanian: Meulières supérieures, Milon, Palaiseau, Montmorency.

VERTIGO MOENANA Zinndorf. 37-42 Bericht ueber die Thätigkeit des Offenbacher Ver. Naturk. 1901, p. 136, pl. 5, f. 9. Upper Middle Oligocene, Offenbach a. M.

VERTIGO ELSHEIMENSIS Bttg. Jahrb. Nassau. Ver. Nat. 42, 1889, p. 295, pl. 7, f. 2. Middle Oligocene, Elsheim in Rheinhessen.

VERTIGO CALLOSA (Reuss). *Pupa callosa* REUSS, Paleontographica ii, 1849, p. 30, pl. 3, f. 7.—SANDBERGER, Vorwelt, p. 400, pl. 24, f. 19.—*Vertigo* (*Alaea*) *callosa* BOETTGER, Jahrb. Nassau. Ver. Nat. 42, 1889, p. 296. Upper Oligocene, Tuchoric, Bohemia.

V. c. mut. *maxima* Bttg., t. c., 1889, p. 296, pl. 7, f. 3. Upper Oligocene, Hochheim.

V. c. mut. *convergens* Bttg., t. c., p. 297, pl. 7, f. 4. Old Lower Miocene, Affenstein, near Frankfort a. M.

V. c. mut. *alleodus* (Sandberger). *Pupa alleodus* SDBGR., Mainzer Becken p. 58, pl. 35, f. 10.—*V. c.* mut. *alleodus* BTTG., t. c., p. 298. Lower Miocene, Appenheim, Rheinhessen, etc.

V. c. mut. *quinquedentata* Joos, Jahrb. Nassau. Ver. Nat. 64, 1911, p. 66. Miocene, Budenheim.

Vertigo callosa cyrenarum Zinnd. *Vertigo* (*Alaea*) *callosa* (Rss.) var. *cyrenarum* Zinndorf. 37-42 Bericht Offenbacher Ver. Naturk. 1901, p. 136. Cyrena marl, Upper Middle Oligocene, Offenbach a. M.

Vertigo callosa divergens Flach. Verh. Phys.-Med. Ges. zu Würzburg, n. F., xxiv, 1890, p. 8, pl. 3, f. 4.—Joos, Nachrbl. d. m. Ges. 1912, 39.—*Pupa* (*Vertigo*) *cardiostoma* var. *divergens* Clessin, Ber. naturw. Ver. Regensburg 1893, iv, p. 9, no. 38, pl. 1, f. 6.

Vertigo cardiostoma (Sandberger). *Pupa* (*Vertigo*) *cardiostoma* Sdbgr., Vorwelt, 1875, p. 600, no description.—Clessin, Regensburger Correspondenzblatt 1877, p. 37; Malak. Blätter viii, p. 86.—*Vertigo* (*Ptychalaea*) *cardiostoma* Boettger, Jahrb. Nassau. Ver. Nat., 42, 1889, p. 294.—Flach Verh. Phys-med. Ges. Würzburg, 1890, p. 8, pl. 3, f. 5.—*Vertigo* (*Alaea*) *cardiostoma* Joos, Nachrbl. d. m. Ges. 1912, p. 39. Upper Miocene, Undorf, near Regensburg, Bavaria; Steinheim.

Placed by Boettger in *Ptychalaea*, by Joos in *Alaea*.

Vertigo protracta (Sandberger). *Pupa protracta* Sdbgr., Vorwelt, 1875, p. 400.—*Vertigo* (*Alaea*) *protracta* Boettger, Jahrb. Nassau. Ver. Nat. 1889, p. 300, pl. 7, f. 5. Upper Oligocene, Hochheim.

Vertigo ovatula (Sandberger). *Pupa ovatula* Sdbgr., Vorwelt, 1875, p. 400.—*V.* (*Alaea*) *ovatula* Boettger, Jahrb. Nassau., 1889, p. 301, pl. 7, f. 6. Upper Oligocene, Hochheim.

V. o. mut. *miliiformis* Boettger. Bericht Senck. Ges. 1884, p. 270, pl. 4, f. 9; Jahrb. Nassau, 1889, p. 302. Older Lower Miocene, near Niederrad.

V. o. mut. *hydrobiarum* Boettger, Jahrb. Nassau, 1889, p. 302, pl. 7, f. 7. Newer Lower Miocene, Mosbach-Biebrich. Var. *mosbachiensis* Bttg., t. c., p. 303, pl. 7, f. 8; with the preceding.

Dr. Boettger considers this species to be closely related to *V. milium*; but there is nothing in the description or figures to show that it has a columellar lamella of the *Angustula* type,

so that the relationship claimed is quite uncertain, and appears to me improbable.

VERTIGO KOCHI Boettger. Jahrb. Nassau. Ver. Nat. 42, 1889, p. 304, pl. 7, f. 9. Upper Oligocene, Hochheim.

VERTIGO DIVERSIDENS (Sandberger). *Pupa diversidens* SDBGR., Vorwelt, 1875, p. 549, pl. 29, f. 23.—*Vertigo diversidens* BOURGUIGNAT, Malac. Sansan p. 84, f. 124-127; *Vertigo presbytera* Bgt. mentioned as a synonym. Middle Miocene: Sansan.

VERTIGO TUCHORICENSIS (new name). *Pupa microstoma* REUSS, Sitzungsber. Math.-Nat. Cl. k. Akad. Wiss. Wien, xlii, 1861, p. 73, pl. 2, f. 8.—SANDBERGER, Vorwelt, p. 438, pl. 24, f. 17.—*Vertigo microstoma* Reuss, KLIKA, Tert. Land- und Süsswasser-Conch. des nordwesten Böhmen, p. 98, f. 93, in Archiv naturwiss. Landesdurchforschung von Böhmen, vii, no. 4, 1891. Lower Miocene: Lipen, Bohemia. This is not *Pupa microstoma* Milldff., 1881, or *Pupa microstoma* Pfr., 1852.

VERTIGO (?) GLOBULUS Desh. *Pupa globulus* Dh., An. s. Vert. ii, 1864, p. 860, pl. 56, f. 16-18. Lower Miocene: Calcaire de Beauce. Perhaps a *Gastrocopta*. It has been referred by Oppenheim to his genus *Paracraticula*.

VERTIGO (?) ANODON (Desh.). *Pupa anodon* DESHAYES, An. s. Vert. Bassin Paris, ii, 1864, p. 849, pl. 56, f. 22-24. Lower Miocene: Calcaire de Beauce.

VERTIGO (?) PARVULA (Desh.). *Pupa parvula* Dh., An. s. Vert. ii, 1864, p. 852, pl. 56, f. 31-33. Lower Miocene: Calcaire de Beauce.

VERTIGO COARCTATA (Desh.). *Pupa coarctata* Dh., An. s. Vert. ii, 1864, p. 856, pl. 56, f. 13-15. Lower Miocene: Calcaire de Beauce.

VERTIGO DIEZI (Clessin). *Pupa (Alaea) diezi* CLESSIN, Berichte Naturwiss. Ver. Regensburg, xiii, 1912, p. 107. Middle Miocene, Undorf, near Regensburg, Bavaria.

VERTIGO UNDORFENSIS (Clessin). *Pupa (Alaea) undorfensis* CL., t. c., p. 108. Middle Miocene, Undorf.

VERTIGO GLOBUS, new name. *Pupa (Alaea) globula* Cl., t. c., p. 108 (Not *Pupa globulus* Deshayes). Middle Miocene, Undorf.

VERTIGO MUSCICOLA Clessin. *Pupa* (*Alaea*) *muscicola* CLESSIN, t. c., p. 108. Middle Miocene, Undorf.

VERTIGO INFLATULA (new name). *Pupa* (*Alaea*) *inflata* CLESSIN, t. c., p. 109 (not *Pupa inflata* Wagner, 1827). Middle Miocene, Undorf.

VERTIGO MINIMA Clessin. *Pupa* (*Alaea*) *minima* CLESSIN, t. c., p. 109. Middle Miocene, Undorf. The name *minima* has been used in *Pupa* in a varietal sense.

VERTIGO CYCLOPHORA Bgt. Malacol. de Colline de Sansan 1881, p. 83, pl. 5, f. 120-123. Middle Miocene: Sansan. The following 12 species are from the same formation.

VERTIGO CAMPANEA Bgt., t. c., p. 85, pl. 5, f. 140-143.

VERTIGO SANSANICA Bgt., t. c., p. 87, pl. 5, f. 128-131.

VERTIGO LŒMODONTA Bgt., t. c., p. 88, pl. 5, f. 132-135.

VERTIGO CALLOSTOMA Bgt., t. c., p. 89, pl. 5, f. 136, 137.

VERTIGO CODIOLENA Bgt., t. c., p. 91, pl. 5, f. 144-147.

VERTIGO MILNE-EDWARDSI Bgt., t. c., p. 92, pl. 5, f. 148-151.

VERTIGO BOTHRIOCHEILA Bgt., t. c., p. 93, pl. 5, f. 152-155.

VERTIGO RAGIA Bgt., t. c., p. 95, pl. 5, f. 156-159.

VERTIGO TRIODONTA Bgt., t. c., p. 96, pl. 5, f. 160-163.

VERTIGO RHYNCHOSTOMA Bgt., t. c., p. 97, pl. 5, f. 164-167.

VERTIGO ONIXIODON Bgt., t. c., p. 98, pl. 5, f. 168-171.

VERTIGO MICRONIXIA Bgt., t. c., p. 100, pl. 5, f. 172-175.

VERTIGO PERAPERTA (new name). *Pupa* (*Alaea*) *aperta* Sandb. Ms., K. MILLER, Jahresh. Ver. Vaterl. Naturk. Württemberg, vol. 56, 1900, p. 397, pl. 7, f. 13.—Joos, Nachrbl. 1912, p. 40, pl. 2, f. 7. (Not *Pupa aperta* Marts., Mal. Bl. x, 1863, p. 180). Upper Miocene, Steinheim.

It is said by Joos to be closely related to *V. angulifera* Bttg., which appears to be a *Vertilla*. The palatal fold is described by Joos as about 5 mm. long,—an obvious mistake, in a shell 1.4 mm. long; probably 0.5 mm. was intended.

VERTIGO PSEUDANTIVERTIGO Paladilhe. Revue des Sciences Naturelles, ii, 1873, p. 207, pl. 2, f. 25-27. Pliocene, near Montpellier.

VERTIGO (?) BLEICHERI Paladilhe. Rev. Sci. Nat. ii, 1873, p. 51, pl. 2, f. 19-21. Pliocene, Montpellier.

VERTIGO MYRMIDO Michaud. Ann. Soc. Linn. de Lyon, Rev.

Ser., ii, 1855, p. 47, pl. 5, f. 14, 15.—*Pupa* (*V.*) *myrmido* SANDBERGER, Vorwelt, p. 723, pl. 27, f. 22. Pliocene, Hauterive.

VERTIGO CROSSEI Michaud. Journ. de Conchyl. x, 1862, p. 77, pl. 4, fig. 3. Pliocene, Hauterive (Drôme). A toothless form of which the position is dubious; perhaps a *Columella*. See Locard, Ann. Mus. d'Hist. Nat. Lyon, ii, 1878, p. 230.

VERTIGO SCHLOSSERI (Cossmann). *Pupa* (*Vertigo*) *oviformis* SCHLOSSER, Jahrb. k.-k. Geol. Reichsanstalt 1907, lvii, p. 757, pl. 17, f. 5. Not *Pupa oviformis* Michaud. *P.*[*upa*] *schlosseri* COSSMANN, Revue Crit. Paleozool. 1908, p. 257. Pliocene, Eichkogel near Mödling.

VERTIGO GLOBOSA Sacco. Fauna Malac. All. il. Piemonte, 1885, p. 31, pl. 2, f. 3.—*Alaea globosa* SACCO, I Moll. Terr. Terz. Piemonte xxii, p. 71, pl. 6, f. 8. Pliocene, Tassarolo.

V. g. tassaroliana Sacco. Riv. Fauna malac. foss. terr. lac., 1887, p. 174.—*Alaea g.* var. *tassaroliana* SACCO, I moll. terr. Terz. Piem. xxii, p. 71, pl. 6, f. 9. Tassarolo, Fossano.

Subgenus PTYCHALAEA Boettger.

VERTIGO (PTYCHALAEA) FLEXIDENS (Rss.). *Pupa flexidens* REUSS, Sitzungs-Ber. K. Akad. Wiss. Wien, Math.-Nat. Cl., xxxii, p. 74, pl. 2, f. 9.—SANDBERGER, Vorwelt p. 439, pl. 24, f. 18.—*V.* (*P.*) *flexidens* BOETTGER, Jahrb. Nassau. Ver. Nat. xxxxii, 1889, p. 293, pl. 7, f. 1. Lower Miocene, Appenheim in Rheinhessen; Tuchoric and Lipen, Bohemia; Saucats, Bordeaux (var. *girondica* Boettger, t. c., p. 294).—WENZ, Nachrbl. d. m. Ges. 44, 1912, p. 190, f. 2.—KLIKA, Arch. Naturwiss. Landesdurchforschung von Böhmen, vii, no. 4, 1891, p. 95, f. 90.

VERTIGO (PTYCHALAEA?) TRIGONOSTOMA (Al. Braun). *Pupa trigonostoma* Al. Br., in Walchner's Geognosie, p. 1185.—SANDBERGER, Mainzer Becken p. 59, pl. 5, f. 17.—*V.* (*Ptychochilus*) *trigonostoma* BTTG., Jahrb. Nassau. Ver. Nat. 1889, 292. Upper Oligocene, Hochheim.

VERTIGO (PTYCHALAEA) BLUMI Boettger. *V.* (*Ptychochilus*) *blumi* BTTG., Bericht Senck. Ges. 1884, p. 268, pl. 4, f. 8. Lower Miocene, Schleusenkammer bei Niederrad.

VERTIGO (PTYCHALAEA) PRISCILLA Paladilhe. *Vertigo pris-*

cilla PALAD., Revue Sci. Nat. (Montpellier), ii, 1873, p. 53, pl. 2, f. 22-24. Pliocene, Montpellier.

VERTIGO (PTYCHALAEA) CAPELLINII Sacco. *Vertigo* (*Scarabella*) *capellinii* SACCO, 1885. *Scarabella capellinii* SACCO, I Moll. Terr. Terz. Piemonte, xxii, p. 71, pl. 6, f. 7.

Piedmont Upper Pliocene, Villafranchian stage, Fossano and Tassarolo.

V. c. ligustica Sacco. *V.* (*S.*) *capellinii* var. *ligustica* SACCO, 1887. *Scarabella c. l.*, SACCO, l. c. Tassarolo.

Subgenus VERTILLA Moquin-Tandon.

VERTIGO ANGULIFERA Boettger. Bericht Senck. Nat. Ges. 1884, p. 271, pl. 4, f. 10; Jahrb. Nassau. Ver. Nat. 42, 1889, p. 310. Lower Miocene of the Schleusenkammer near Niederrad. Placed in *Alaea* by Boettger, but probably a dextral species of *Vertilla*.

Genus GLANDICULA Sandberger.

Glandicula SANDBERGER, Land- und Süsswasser-Conchyl. der Vorwelt, p. 401, 1875; monotype *Pupa* (*Glandicula*) *tiarula* A. Brn.—*Paracraticula* OPPENHEIM Denkschr. k. Akad. Wiss., Wien, vol. 57, 1890, p. 126.

Acorn-shaped, with deeply impressed suture, the post-embryonic whorls having sculpture of distant, oblique ribs; aperture triangular, the outer lip inflexed; typically with 3-1-2 teeth, the *angular and parietal lamellae emerging to the margin.*

Type *G. tiarula* (A. Brn.), pl. 5, figs. 14, 15. Upper Oligocene: Hochheim, Landschneckenkalk.

GLANDICULA TIARULA (A. Brn.). *Vertigo tiarula* A. Braun, Walchner's Geogn. 2 edit., p. 1135.—*Pupa tiarula Sandberger,* Mainzer Becken p. 60, pl. 5, f. 18; Vorwelt, p. 401, pl. 23, f. 17.—*Vertigo* (*Glandicula*) *tiarula* Boettger, Jahrb. Nassau. Ver. Nat. Jahrg. 42, 1889, p. 290.

Boettger has given a good account of this rare snail, which has not been figured in sufficient detail. He believes its affinity to be with *Ptychochilus* (*Lyropupa*), mentioning such forms as *perlonga* Pse. and *lyrata* Gld., evidently influenced

by the sculpture, a character of no great importance. I have not seen specimens.

GLANDICULA TURCICA (Desh.). *Pupa turcica* Deshayes, An. s. Vert. Bassin Paris ii, 1864, p. 861, pl. 57, f. 1-3. Lower Miocene: Calcaire de Beauce.

GLANDICULA (PARACRATICULA) UMBRA (Oppenh.), *Pupa* (*Paracraticula*) *umbra* OPPENHEIM, Denkschr. k. Akad. Wiss., Wien, vol. 57, 1890, p. 126, pl. 3, f. 10. Eocene, Pugniello, Italy. This species is the type of *Paracraticula* Oppenh. Referred to *Glandicula* with some doubt.

Genus ENNEOPUPA Boettger.

Enneopupa BTTG., Jahrb. Nassau. Ver. Nat. xxxii, 1889, p. 288. Monotype *Pupa cylindrella* Al. Br.

Shell cylindric, of few (5-6) costulate whorls, the neck having a groove parallel to the suture; aperture oblique; peristome continuous, subobsolete; angular lamella distinct but low, (1 or)2 deeply placed, not marginal parietal lamellae separated from the angular; 2 columellar lamellae; (3 or)4 long palatal folds.

ENNEOPUPA CYLINDRELLA (Al. Braun). Pl. 5, fig. 12. *Pupa cylindrella* Al. Br., Walchner's Geogn. p. 1136.—Sandberger, Mainzer Becken, p. 50, pl. 5, f. 9; Vorwelt p. 393, pl. 23, f. 7.—*Vertigo* (*Enneopupa*) *cylindrella* BTTG., t. c., p. 288. Upper Oligocene of Hochheim.

Sandberger's figures are copied in pl. 5, fig. 12.

Genus PSEUDELIX Boettger.

Pseudelix BTTG., Jahrb. Nassauischen Vereins f. Naturkunde, Jahrg. 42, 1889, p. 316, type *Pupa microhelix* Sbgr.

Shell with a small perforation, globose-conic, heliciform, the apex rather obtuse. Whorls 4-5, nearly smooth. Aperture oblique, semilunar, with 1 to 3 compressed teeth, not deeply placed, the parietal lamella always distinct; margins expanded, somewhat labiate.

Type: *Pupa microhelix* Sbgr., from the Upper Oligocene landshell chalk of Hochheim (pl. 5, fig. 8).

This group is compared by Boettger with the American *Pupa*

conoidea Nc., which has some resemblance in figure and teeth. The entirely different and peculiar sculpture of *conoidea*, which belongs to the genus *Bothriopupa* (Vol. XXIV, p. 231), together with other differential features, shows that the supposed affinity is improbable. Prof. Boettger had not seen a specimen of *conoidea*. *Pseudelix* has a somewhat specialized shape, and appears to have left no survivors or no closely related genera.

The nomenclature of the two species is not clear to me, Boettger's synopsis is followed.

PSEUDELIX MICROHELIX (Sbgr.). *Pupa microhelix* SANDBERGER, Mainzer Becken, p. 61, pl. 35, f. 26; Vorwelt, p. 402, pl. 23, f. 18.

PSEUDELIX COMES Boettger. Jahrb. Nassau. Ver. Naturk. 1889, p. 317. — *Helix pupula* Al. Braun, in Walchner's Geognosie, 2d ed., p. 1139.—*Pupa microhelix* in part, SANDBERGER, Mainzer Becken p. 61, pl. 3, f. 8. Upper Oligocene landshell chalk of Hochheim.

Genus *Carychiopsis* Sandberger.

Fusulina SANDBERGER, *olim.*—*Carychiopsis* SANDBERGER, Land und Süsswasser-Conch. der Vorwelt, pp. 169, 170 (1872), type *Pupa dohrni* [*dhorni*] Deshayes.

A group of minute, slender Pupoid snails, chiefly Lower Eocene, contains the species *Pupa remiensis*, *alternans*, *bigeminata*, *dhorni* (= *dohrni* Dh., Sandberger) and *coarctata*, all of Deshayes (Anim. s. Vert. Bassin Paris, ii, 1864, pp. 853-856). Some of these have been referred to *Vertigo* by subsequent authors, but in the opinion of Sandberger, which appears well founded, they have no special affinity with that genus, but belong near *Carychium*.

Pupa interferens Desh. may possibly also belong to this group, though somewhat different. It has the general appearance of *Gastrocopta*.

Carychiopsis costulata Sandberger, t. c., p. 371, of the Lower Miocene of Germany and Bohemia, is the latest known member of the group. *Pupa schwageri* Reuss, Sitzungsber. d. k. Akad. Wiss. Wien lvii, p. 82 is synonymous.

Genus STAURODON Lowe.

Staurodon Lowe, Ann. and Mag. of Nat. Hist. (2), ix, 1852, p. 278, for *Pupa saxicola* and *P. seminulum*.

The shell is minute, oblong, the last whorl without crest. Peristome continuous by a strong parietal callus. Teeth arranged as in *Vertigo* except that the *angular lamella is tuberculiform, marginal upon the parietal callus* close to the termination of the outer lip, with or without a short continuation inward.

Type *Staurodon saxicola* (Lowe). Distribution, Madeira. See pl. 15, figs. 12-14.

The emergence of the angular lamella and its union with the outer lip is probably an ancestral character, found also in *Ptychalaea* and some other Vertiginine groups, as well as in other subfamilies, such as *Gastrocoptinae*. In *Staurodon* this lamella has been much shortened, often running inward less than shown in pl. 15, fig. 14.

The genus has probably existed on Madeira since the early Tertiary, as it appears to have no near relatives in the European series from the Oligocene on. The strong parietal callus is doubtless a later development. Many snails of arid regions show more or less similar strucures.

In his publication of 1852, Lowe places only the species *Pupa saxicola* and *P. seminulum* under *Staurodon*, but in his differential diagnosis of *saxicola* he mentions *P.* (*Vertigo*) *alpestris* and *P. pygmaea* in order to point out how *saxicola* differs from them, but without stating or implying that they belong to *Staurodon*. It appears from this that either *saxicola* or *seminulum* must be the type of *Staurodon*. In 1854 Lowe designated *P. pygmaea* Drap. the type of *Staurodon*, a course clearly barred by the fact that he had not included this species in his group in 1852.

1. Staurodon saxicola (Lowe). Pl. 15, figs. 13, 14.

The shell is shortly rimate, cinnamon-brown, oblong, tapering slightly upwards, very finely but distinctly striate, the striation strongest on the penult and antepenult whorls. The

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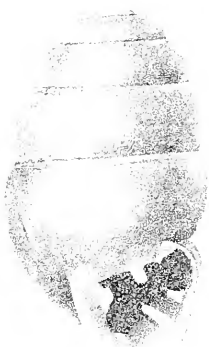

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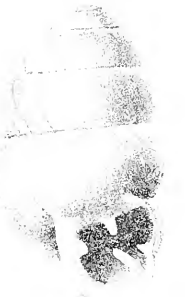

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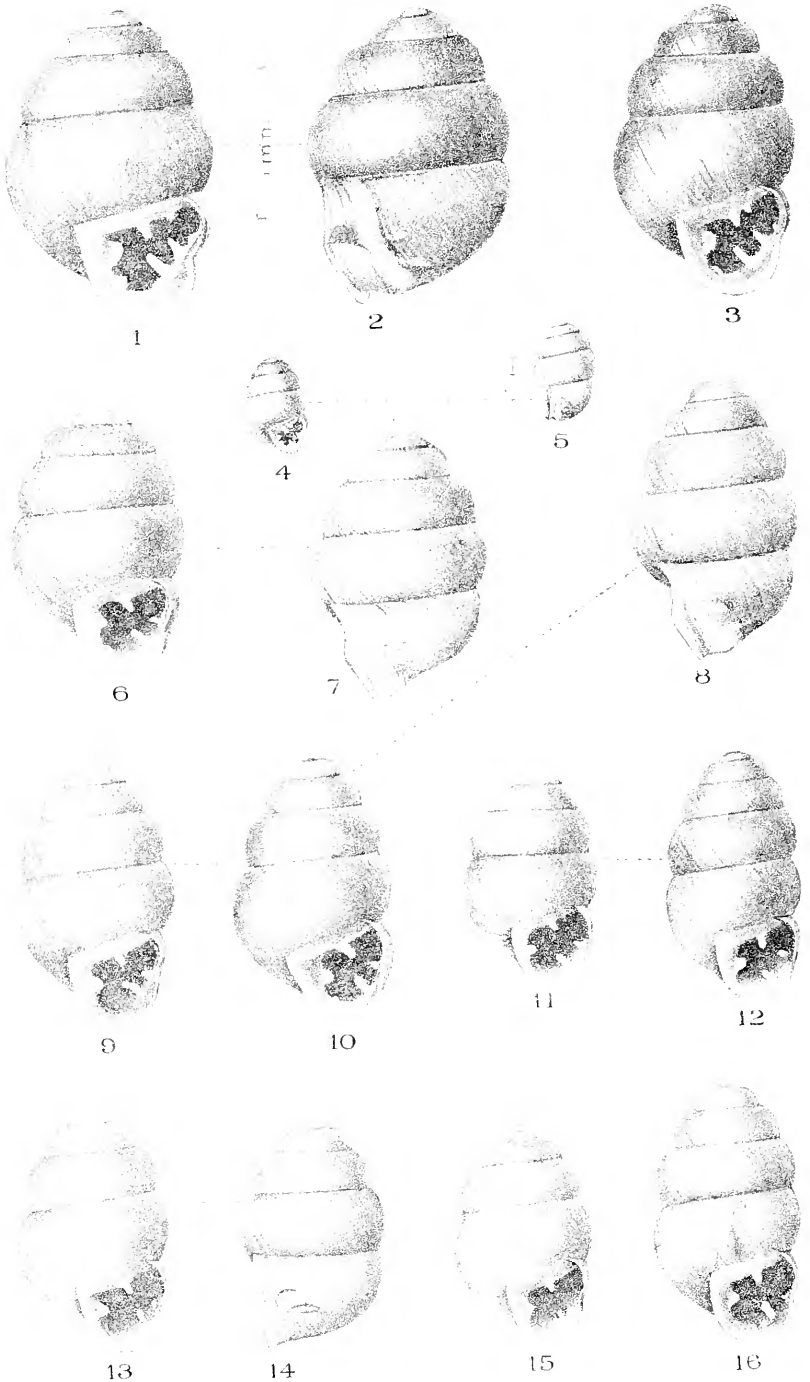
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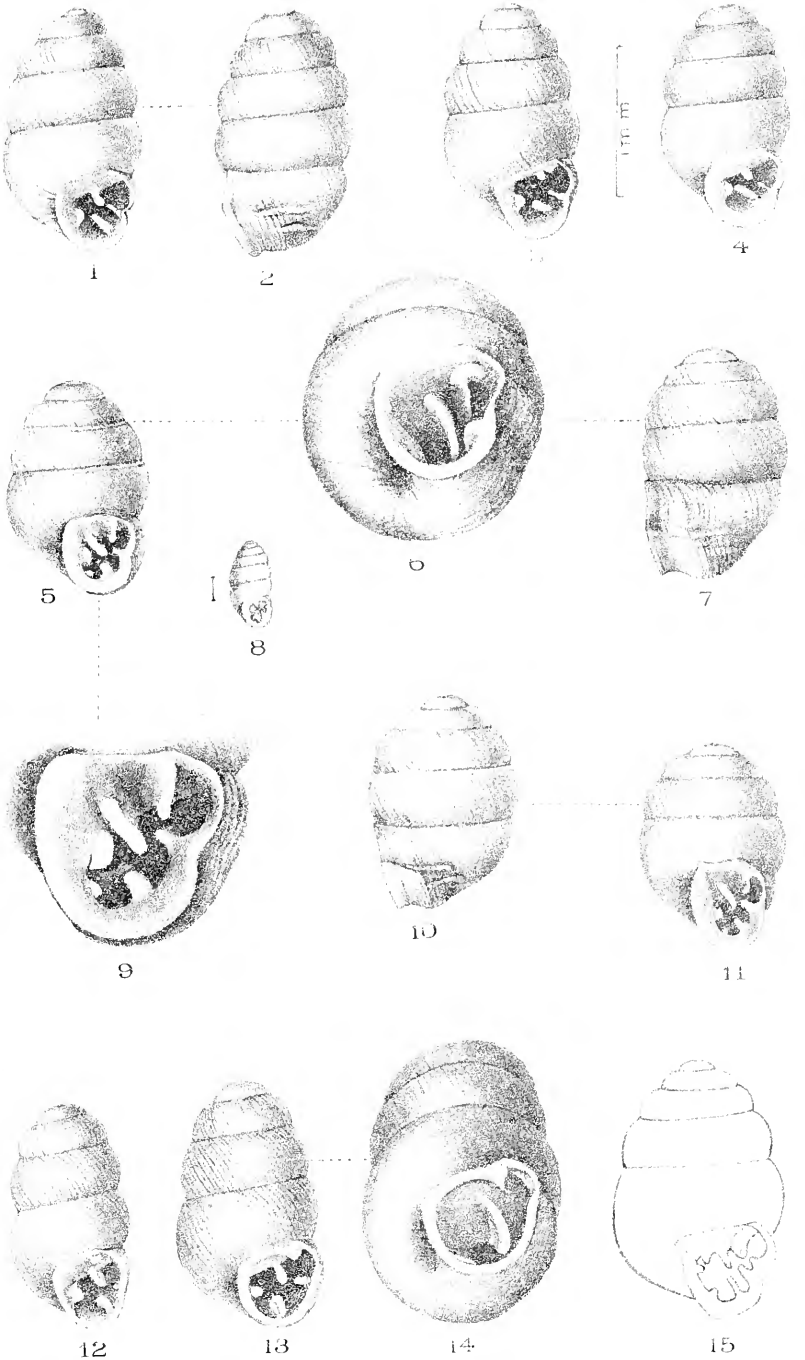
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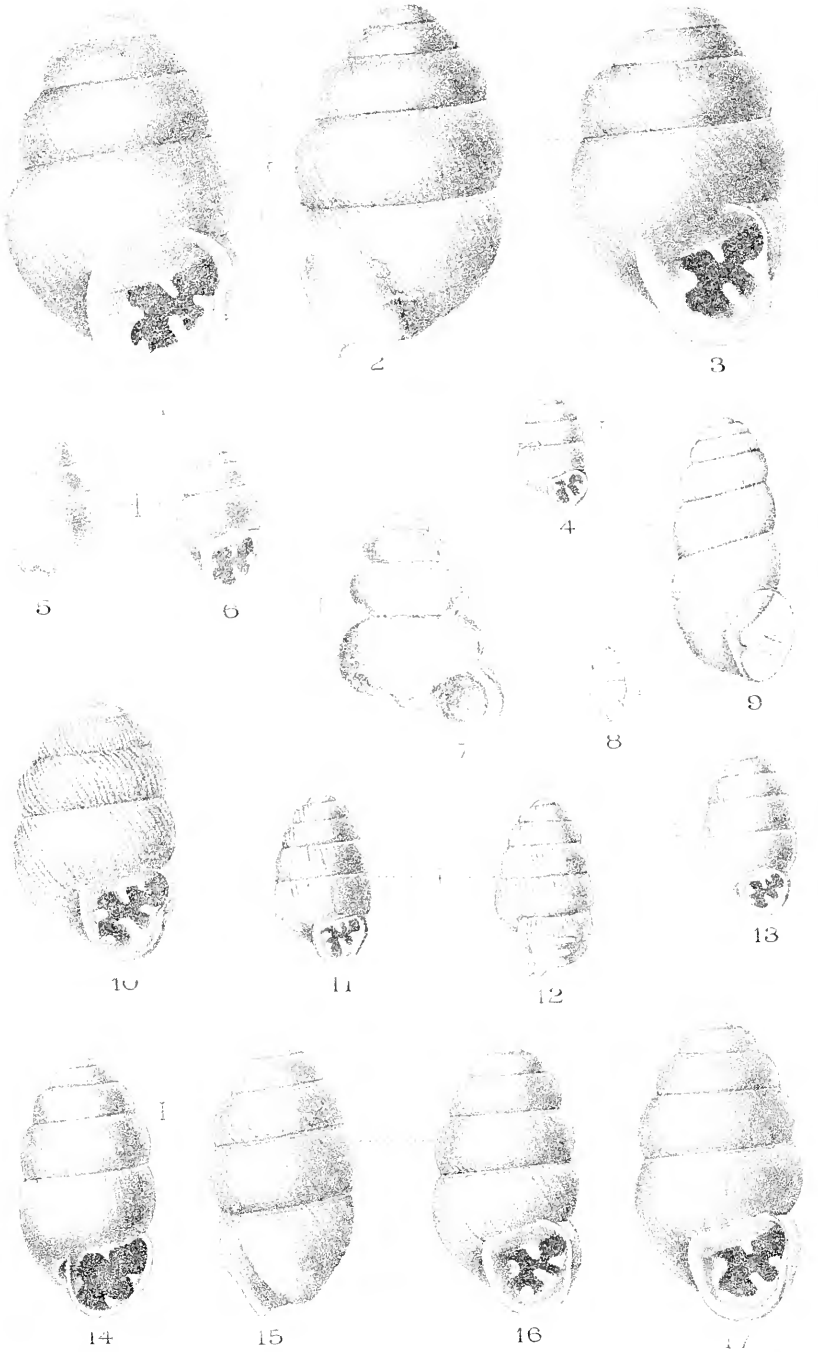
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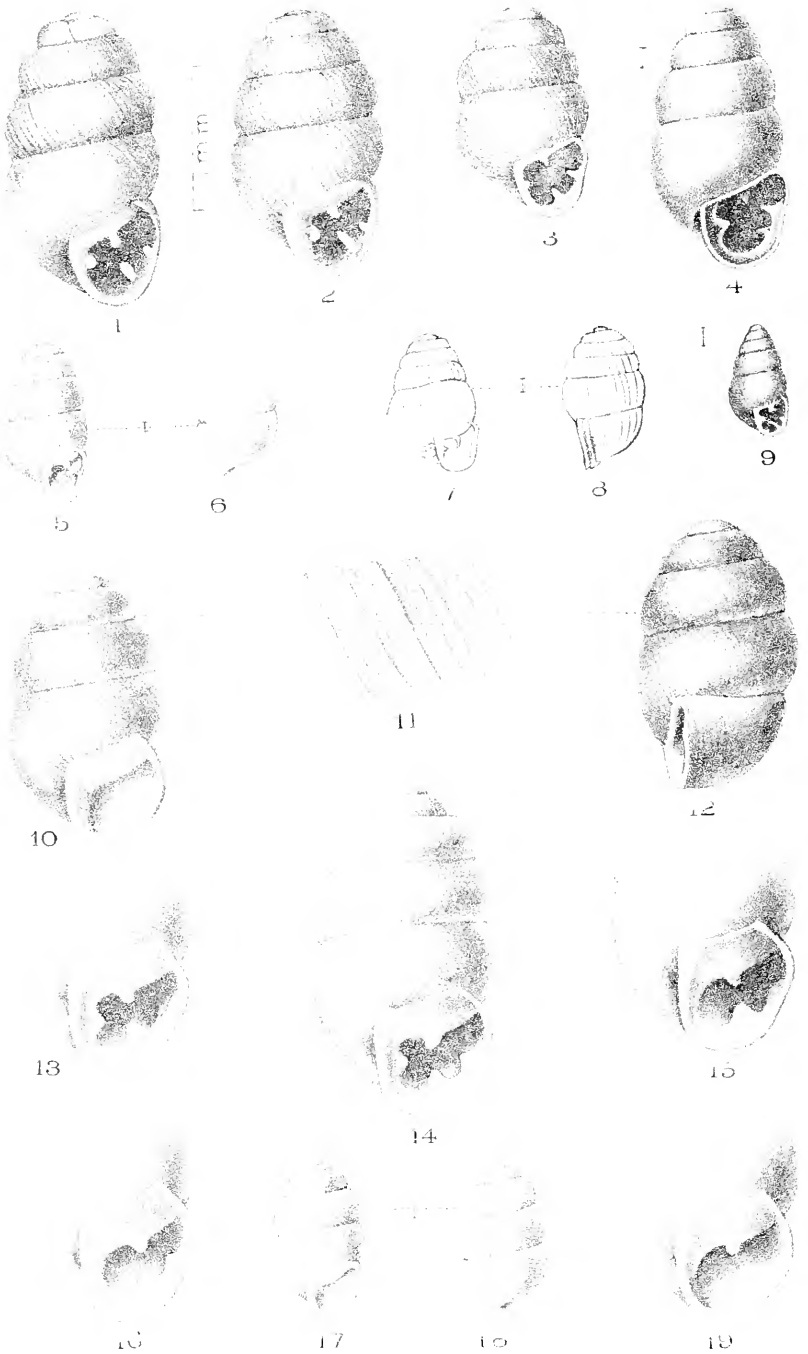
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first whorl smooth. The whorls are moderately convex, the last without grooves or crest behind the lip. The aperture is rounded-piriform, containing 5 teeth. The angular lamella is a blunt, callous tubercle close to and in adults connected with the outer termination of the lip. The parietal lamella is long, high, and stands remote from the edge of the parietal callus. Columellar lamella short, entering horizontally. There are two rather short but high palatal folds, the lower one longer. No palatal callus. The peristome is slightly expanded, thick, of lighter tint than the shell; outer margin a little straightened in the middle, connected with the columellar margin by a thick, straight, cord-like callus across the parietal wall, bearing the angular lamella.

Length 1.7 to 1.8, diam. 1 mm.; 4⅛-4½ whorls.

Madeira: beneath stones and scoriae in dry, rocky spots of low elevation, in the south of Madeira: Praia Bay, west of Funchal, under loose pieces of basalt at the top of the cliff at the eastern end (Wollaston, Leacock); Feijaa dos Asnos and Cabo Girao (Baron Paiva). Subfossil in calcareous deposits near Canical (Wollaston).

Pupa saxicola Lowe, Ann. Mag. N. H. ix, 1852, p. 278; P. Z. S. 1854, p. 214.—Pfeiffer, Monogr. Hel. Viv. iii, 1853, p. 559.—Küster, Conchyl. Cabinet, *Pupa*, p. 182, pl. 21, f. 26, 27.—Albers, Malacol. Maderensis p. 62, pl. 16, f. 13, 14.—Paiva, Monogr. Moll. Ins. Mader. 1867, p. 139.—Wollaston, Testacea Atlantica, 1878, p. 237.

Pupa seminulum Lowe, Ann. Mag. N. H. ix, 1852, p. 278; Syn. p. 14.—Pfr., Monogr. iii, 559.

The cord-like parietal callus and the structure of the angular tubercle are characteristic.

1*a*. *S. saxicola seminulum* Lowe (Pl. 15, fig. 12). Differs from *P. saxicola* by the smaller, even very minute size, the whorls more swollen, suture deeper, shape more obese, the aperture triplicate, the folds unequal, arranged in a triangle, the ventral largest, the columellar and palatal smaller and subequal; the subangularly somewhat straightened lip bent inward; the upper denticle somewhat distinct inward (*Lowe*).

The figure represents a shell from the Lowe collection. It is smaller than *saxicola*, length 1.55, diam. 0.8 mm. In his second description Lowe gives the length as 1¼ to 1⅓, diam. ⅔ mm. His description, translated above, was from a shell without the upper palatal fold, perhaps not fully mature. Wollaston remarks that "the *P. seminulum* Lowe, which was detected by Mr. Leacock at the Cabo Garajao or Brazen Head, does not appear to me to differ specifically, in any single particular, from the present species [i. e., *saxicola*]."

Genus LYROPUPA Pilsbry.

By H. A. Pilsbry and C. Montague Cooke.

Lyropupa Pils., Proc. A. N. S. Phila. 1900, p. 432 (as a subgenus of *Nesopupa*), type *Pupa lyrata* Gould.—Ancey, Proc. Malac. Soc. London vi, 1904, p. 124 (as a genus).

The shell is openly rimate, often perforate, the shape from broadly ovate to cylindric; embryonic 1½ whorls microscopically granulose, sometimes spirally striate, the following whorls abruptly becoming strongly sculptured with axial or oblique ribs narrower than their intervals. Aperture truncate above, rounded below, the peristome continuous, free and expanded. Angular lamella emerging to the margin; parietal strong, somewhat immersed. Columellar deeply placed, strongly developed, axial or oblique. Two palatals *the upper very long, emerging* to the lip, defining a sinulus. A deeply placed basal fold often developed. Axis hollow and rather large. Immature stages toothless.

Type *Pupa lyrata* Gould. Distribution, Hawaiian Islands.

There are no inferior tentacles. The head has rounded lateral processes and a somewhat prominent median convexity above. The sole is almost white in species examined, the back and face pigmented.

Important specific characters are found in the form and arrangement of the palatal folds, but they are so deeply immersed that the shell must be broken to see them. Holding it

in the fingers under a dissecting microscope, the front of the last whorl and the whole columellar side of the aperture can be broken away with a needle, leaving the entire inside of the outer wall of the last half whorl exposed. In fossil shells it breaks off (as figured in pl. 25, figs. 2, 14, 15). The piece may then be stuck upon a slip of card for convenient examination under the microscope. Care must be taken to break away enough of the basal wall to show the basal fold, which is often hard to see. A bull's eye or other condenser is useful.

In comparing specimens with the drawings it must be remembered that the apparent shape of the tubercle under the inner end of the upper palatal fold changes somewhat with the angle of vision.

The large, hollow axis is broadly open in the young, as in pl. 26, fig. 8, *L. spaldingi*.

Lyropupa lives on or near the ground. The sinistral species inhabit the humid forest zone where they may be found on mossy stones, fallen twigs and dead leaves. The dextral species live in dryer open country, under stones and logs. Only dextral forms are known from Niihau and Kahoolawe.

Lyropupae are abundant in Pleistocene and later deposits on all the islands. They formerly occupied a far greater area than at present. The forest species occurred at lower levels than now, as the Achatinellas did. A good part of the low country species are now extinct, and others which are abundant as fossils are rare and local as living snails.

Twenty-two species are now recognized, nine of them defined by former authors, Gould, Pease, Dall and Ancey. One species, *Vertigo striatula* Pease, has not been recognized with certainty. The type specimens of all the others have been examined in the preparation of this work.

Distribution.—16 of the 22 species are confined to single islands, so far as known. 6 are common to two or more islands, but in most cases represented by special races on each. A narrower view of species than we have taken would increase the apparent insular endemicity but would not show inter-island relationships so well.

L. perlonga, Oahu, a subspecies in Niihau and Kauai.

L. lyrata, Oahu, a variety in Kauai.

L. micra, Oahu, a subspecies in Molokai.

L. ovatula, Oahu, a subspecies in Molokai and Hawaii.

L. rhabdota, Molokai, a subspecies in Lanai and Maui.

L. kahoolavensis, Molokai, Lanai, Kahoolawe and Hawaii.

L. kahoolavensis shows very little variation throughout its range. It inhabits more islands than any other species, and is one of the most primitive. It occurs on 4 islands as a fossil only.

Except in the case of *L. ovatula*, the islands inhabited by one species are always contiguous. Probably some race of *ovatula* (also of *kahoolavensis*) will be found on Maui, where the Pupillidae are much less known than on other islands. If so the single exceptional case will be eliminated.

Niihau and Kahoolawe each have but one species also found on the contiguous islands.

Species of the islands from Molokai east are closely related, but Molokai also connects with Oahu, having three fossil subspecies of specific stocks which are widely spread on Oahu. Otherwise the species of the eastern group of islands all differ from those of Oahu and the western islands.

In general, the distribution of *Lyropupa* agrees with *Leptachatina*. The orderly sequence of species and subspecies from island to island, as well as upon the single islands, suggests migration over continuous land, and gives no ground for the hypothesis of carriage by wind, birds or other accidental or unusual means, which would surely have produced a less harmonic distribution.

In the following table *r* signifies recent, *f* fossil forms; *fr* denotes forms chiefly known as fossils, but also rarely found living.

	Niihau.	Kauai.	Oahu.	Molokai.	Lanai.	Kahoolawe.	Maui.	Hawaii.
L. lyrata			r					
uncifera			fr					
" var.		r						
fossilis			f					
L. microthauma			r					
L. rhabdota				r				
pluris				r				
lanaiensis					r			
baldwiniama							r	
L. thaanumi							r	
L. prisca								f
L. clathratula								r
L. truncata								r
L. spaldingi			r					
L. mirabilis			r					
L. antiqua			f					
L. hawaiiensis								f
L. sparna				r				
sinulifera				r				
L. anceyana								r
L. scabra							r	
L. kahoolavensis				f	f	f	?	f
puukolekolensis				r				
L. perlonga			fr					
interrupta			f					
filicostata	f	f						
L. micra			fr					
percostata			f					
maunaloae				f				
L. ovatula			f					
kona				f				f
L. plagioptyx			f					
L. cyrta								f
L. cubana		?						
L. thaumasia		r						

Key to species of Lyropupa.

I. Shell sinistral.

a^1. Angular lamella long and high; surface minutely striate spirally (in fresh shells).

b^1. Species of Oahu.

c^1. Small, length about 2 mm. or less.

L. microthauma, no. 2.

c^2. Larger, length over 2.2 mm.

d^1. Inner end of lower palatal fold straight. *L. lyrata*, no. 1.

d^2. Inner end of lower palatal fold hooked downward. *L. lyrata uncifera*, no. 1*a*.

b^2. Species of Molokai, Lanai, Maui and Hawaii.

c^1. Summit abruptly truncate; Hawaii. *L. truncata*, no. 7.

c^2. Summit strongly convex, obtuse.

d^1. Ribs rather close, 18 to 19 on the last whorl; Maui. *L. thaanumi*, no. 4.

d^2. Ribs rather distant, about 15 on the last whorl; Molokai. *L. rhabdota pluris*, no. 3*a*.

c^3. Summit conic with obtuse apex.

d^1. Spiral threads distant; about 12 ribs on the last whorl. *L. clathratula*, no. 6.

d^2. Spiral threads close or obsolete.

e^1. Molokai, Lanai and Maui. *L. rhabdota*, no. 3.

e^2. Hawaii. *L. prisca*, no. 5.

a^2. Angular lamella short and low, scarcely penetrating beyond the outer end of the parietal lamella; later whorls with no spiral striation.

b^1. Lower palatal fold interrupted, a short outer and a high, tubercular inner portion. Oahu. *L. mirabilis*, no. 9.

b^2. Lower palatal fold continuous, penetrating more deeply than the upper, and usually stronger.

c^1. Back with 3 sulci; shell pale, fusiform; Oahu. *L. spaldingi*, no. 8.

c^2. Back with one broad sulcus; color brown (in recent shells).

d^1. Basal fold strong; Hawaii.

e^1. Whorls *very convex*, the last with 12 to 14 ribs; length 2.25 mm. *L. anceyana*, no. 13.

c^2. Whorls less convex, with more ribs; length 2.4 to 2.9 mm.
L. hawaiiensis, no. 11.

d^2. Basal fold rather weak or wanting; Oahu, Molokai, Lanai and Maui.

e^1. 15 to 17 ribs on the last whorl.

f^1. Palatal folds rather long; Oahu. *L. antiqua*, no. 10.

f^2. Palatal folds short; Maui.
L. scabra, no. 14.

e^2. 19 to 25 ribs on the last whorl; length 2 to 2.3 mm.; Molokai, Lanai.
L. sparna, no. 12.

II. Shell dextral (Section *Mirapupa*).

a^1. Lower palatal fold continuous, rather long, entering as far as the upper palatal, its inner end slightly enlarged and turned downward (pl. 22, figs. 2, 4); shells having the external appearance of *L. perlonga*. Molokai, Lanai, Kahoolawe and Hawaii. *L. kahoolavensis*, no. 15.

a^2. Lower palatal fold very short or reduced to a low, callous pad or tubercle; one, or usually two strong tubercles or short folds below the inner end of the upper palatal fold, forming a vertical barrier (pl. 25, figs. 14, 15).

b^1. Form cylindric, the last three whorls flattened in the middle; three impressions on the back; ribs narrow, generally flexuous.

c^1. Back having a hump below the middle of the last whorl; shell generally under 2 mm. long.
L. micra, no. 17.

c^2. No dorsal or basi-dorsal hump.

d^1. Narrow, flexuous ribs, mostly continuous and rather widely spaced; Oahu.
L. perlonga, no. 15.

d^2. Very irregular, closer ribs; Oahu.
L. p. interrupta, no. 16*a*.

d^3. crowded, slender riblets; Kauai and Niihau. *L. p. filicostata*, no. 16*b*.

b^2. Form ovate or cylindric-tapering, or cylindric with conic summit; *whorls convex*; ribs strong, arcuate, about 15-16 on the last whorl; diam. equal to or exceeding half the length.

c^1. Last half whorl having deep impressions: length 2 to 2.3 mm.

d^1. Species of Oahu.

e^1. A prominent, straight basal crest (pl. 24, fig. 2); lower palatal fold a diffuse tubercle.

L. ovatula, no. 18.

e^2. No distinctly differentiated basal crest; lower palatal a short, high, oblique fold.

L. plagioptyx, no. 19.

d^2. Species of Hawaii. Lower palatal and basal folds developed as oblong tubercles: back humped at base.

L. o. kona, no. 18*a*.

c^2. Last half whorl having two slight impressions, sometimes obsolete; lower palatal a very low, callous tubercle; length 2.75 mm. Hawaii.

L. cyrta, no. 20.

b^3. Form broadly oval, compact, the whorls short, convex, the last whorl with 25-30 ribs, and one or two impressions on the back; length 1.9-2.2 mm.

c^1. Diameter about 70 per cent of the length; 5 whorls; aperture contained 2½ times in length of the shell. *L. cubana*, no. 21.

c^2. Diameter about 58 to 65 per cent of the length; 5½ whorls; aperture scarcely one-third length of shell. *L. thaumasia*, no. 22.

Group of L. lyrata.

Sinistral Lyropupae characterized by a strong, long, angular lamella, and by minute spiral striæ between and on the strong ribs. There are two series belonging to this group.

Species from Kauai and Oahu have the surface of the embryonic whorls wrinkled-granulose (except *L. microthauma*). Those from Molokai, Lanai, Maui and Hawaii have the embryonic whorls minutely, closely, spirally striate.

The two Oahuan species are quite distinct, but *L. lyrata* has numerous local races or forms not yet fully worked out. *L. truncata* of Hawaii is one of the most characteristic of the genus, but the other known species of Molokai, Lanai, Maui and Hawaii are closely related and by no means conspicuously differentiated. The following key is given as an alternative to that on p. 229; it is based upon more natural characters, but partly not to be observed in worn or fossil specimens.

a^1. Embryonic whorls minutely granulose-wrinkled; Oahu.
L. lyrata, no. 1.

a^2. Embryonic whorls minutely striate spirally.
b^1. Later whorls very *closely* striate spirally.
c^1. Summit bluntly rounded.
d^1. Ribs numerous; Maui.
L. thaanumi, no. 4.
d^2. Ribs rather widely spaced; Molokai.
L. rhabdota pluris, no. 3*a*.
c^2. Summit subconic.
d^1. Length 1.8 to 2.1 mm.; Oahu.
L. microthauma, no. 2.
d^2. Length 2.5 to 2.7 mm.; Molokai, Lanai and Maui. *L. rhabdota*, no. 3.
d^3. Length 2.7 to 3.1 mm.; Hawaii.
L. prisca, no. 5.
b^2. Later whorls *distantly* striate spirally; Hawaii.
c^1. Summit subconic. *L. clathratula*, no. 6.
c^2. Summit abruptly truncate. *L. truncata*, no. 7.

1. LYROPUPA LYRATA (Gld.). Pl. 19, figs. 1 to 6.

"The shell is small, most generally sinistral, chestnut colored, widely umbilicate; 5 convex whorls, with about 20 neatly clathrate flexuous riblets; aperture somewhat orbicular, bell-shaped, posteriorly armed with two lamella-like teeth and

two others in the throat. Length 22/200, diam. 13/200 inch'' [2.75 x 1.62 mm.] (*Gould*).

Hawaiian Islands (Gould). Oahu: very abundant over nearly the whole length of the Koolau Mountains (Thaanum, Spalding, Gouveia, Emerson, Cooke, Pilsbry). Type and paratypes no. 219, G. 2687, Museum of the University of New York.

Pupa lyrata GOULD, Proc. Bost. Soc., i, 1843, p. 139; Boston Journ. of Nat. Hist., iv, 1844, pl. 16, f. 16; Otia Conch., 1862, p. 189 (Habitat, Maui; ''length 1/10, diam. 1/20 + inch'') [2.54 x 1.27 mm.].—PFR., Monographia Hel. Viv., iii, p. 561—nec *Pupa lyrata* PFR., Monographia Hel. Viv. iv, p. 686—nec BOETTGER, in von Martens' Conchologische Mittheilungen, i, 1881, p. 61, pl. 12, f. 17.—*Vertigo lyrata* H. and A. ADAMS, Gen. Rec. Moll., ii, p. 172.—PEASE, Proc. Zool. Soc., London, 1871, p. 474 (Oahu).—*Nesopupa* (*Lyropupa*) *lyrata*, PILSBRY, Proc. A. N. S. Phila., 1900, p. 432.—non *Lyropupa lyrata* ANCEY, Proc. Malac. Soc. London, vi, 1904, p. 124.—*Pupa magdalenae* ANCEY, Mem. Soc. Zool. France, v, 1892, p. 716 (Palama, Baldwin).—*Pupa lyrata* SYKES, Fauna Hawaiensis, ii, 1900, p. 294.—*Lyropupa carbonaria* ANCEY, Proc. Malac. Soc. London, vi, 1904, p. 125, pl. 7, f. 21 (Nuuanu).

The specimens in the Albany Museum, the original material on which Gould based his species, bear the habitat *Kauai*. Gould later, in *Otia Conchologica*, gave *Maui* as the habitat, and the measurements in this description are smaller than originally given. Both of these localities are incorrect. The Lyropupae from Maui and from Kauai have been compared with Gould's specimens and found to belong to different species or subspecies. *P. lyrata* was doubtless from Oahu, where typical examples have been taken in Nuuanu valley.

Gould's type lot is heterogeneous. This accounts for his expression ''*plerumque sinistrorsa*'' and for the discordant measurements of his two descriptions. There is one specimen of the widely spread *Nesopupa newcombi* in the lot, and two of the dextral *Lyropupa perlonga*, a common Oahuan shell. The larger one of these was probably the original of Gould's left hand figure, which represents a dextral shell. His other

three figures show a sinistral shell, which may be taken as the type. This shell is drawn in pl. 19, fig. 4; or at least so we assume, as only this one specimen had the aperture well cleaned when the lot was examined.

The spire is convexly conic. The ribs are strong throughout, 17 on the last whorl (Gould probably doubled the number seen on the face to reach the number "ad 20"). There is a rather deep external impression about a half whorl long over the upper palatal, and a shorter one, diverging forward, over the lower palatal. The lower palatal fold is rather long, as seen in the mouth. It becomes stronger towards the inner end, which penetrates slightly beyond the upper palatal fold. It is not hooked downward at the inner end, and not interrupted, though in some specimens of the lot there is a submedian depression of the crest of the fold. Fig. 5 represents the palatal region of an example of the Gould series. Some others have the lower palatal fold somewhat shorter and lower anteriorly (fig. 6).

Length 2.7, diam. 1.6 mm.; 5⅛ whorls (type).

Length 2.4, diam. 1.6 mm. (another of type lot).

The contour varies, as the measurements indicate, the shorter examples being shaped like pl. 19, fig. 1, which represents a paratype of *magdalenae*.

With this typical, strongly ribbed form of *lyrata* there are other specimens, probably collected from a different colony or locality, in which the ribs are weak and irregularly developed or partly wanting on the last whorl or two (pl. 19, figs. 8, 9). These may be called *L. lyrata* form *gouldi*.

Pease's locality for this species, "Oahu," was based doubtless on correctly named specimens. Boettger's description of *lyrata* was founded on specimens of another species from Hawaii. These are undoubtedly the same specimens used by Pfeiffer for his description. Ancey's description of *lyrata* was based on specimens of an unnamed species for which the name *L. anceyana* is proposed.

Pupa magdalenae Ancey (type no. 18744 Bishop Mus., paratypes 18745 B. Mus. and 119455 A. N. S. P.) is not separable

from *lyrata*, in our opinion. It agrees in shape with the shorter examples of the Gould series. The only difference is that the lower palatal fold has a rather deep depression between the inner tubercle and the rather high outer portion; but this is a variable feature in the type lot of *lyrata*. Two paratypes of *magdalenae* are drawn in pl. 19, figs. 1, 2. The paratypes have 17 to 19 costæ on the last whorl, with the interstices minutely, spirally, deciduously striate; just back of the aperture are two shallow sulci which further back unite, forming a rather broad sulcus extending for nearly half the length of the whorl; the embryonic whorls, in immature specimens, are minutely granulose, the granules arranged in transverse wrinkles; at about the middle of the second whorl the costæ suddenly appear. The angular lamella is strong, high, thin and long and terminates at the margin of the aperture; the parietal lamella is more deeply seated, strong, slightly bent outwards and is nearly half a whorl in length; the columellar lamella is strong, lunate, axially seated on the columella and extending to the base; the lower palatal is rather short, very deeply seated, corresponding to the lower outer sulcus; upper palatal long, elevated in back, low in front, terminating almost on the margin of the peristome; with the angular it forms a well-defined sinulus; there is no indication of a basal fold. There are from 5 to 5½ whorls in adult specimens. Ancey's paratypes measure: Length 2.56 to 2.7, diam. 1.56 to 1.65, aperture 0.95 to 1.0 mm.

L. carbonaria Ancey appears, from the entire type lot (now no. 18752 Bishop Museum), to be synonymous with *lyrata*. A paratype is drawn in pl. 19, fig. 3. It is somewhat more elongate than the Palama *magdalenae*, representing the longer phase of variation, as that does the shorter. It is similar to Gould's type specimen of *lirata*, which probably came from the same valley, Nuuanu. The palatal folds (pl. 19, fig. 6) are exactly as in some specimens of *lyrata* though the lower palatal is shorter than in the *lyrata* selected for the figure.

1*a*. *Lyropupa lyrata uncifera* C. & P., n. subsp. Pl. 19, figs. 12, 13. The shell is slightly smaller than that of the typical form, and more cylindrical in outline, with 17 to 18 strong, hardly flexuous costæ. In its fossil state, the fine deciduous spiral striæ are absent. There is a light-colored peripheral zone on the last whorl between tawny sutural and basal zones. Whorls 5, convex and separated by a deep suture; the last tapering towards the base. Parietal lamella more deeply

seated and closer to the angular than in the typical form. Lower palatal fold converging towards the upper inwardly, *its inner end enlarged and curving towards the base.*

Length 2.4, diam. 1.4 mm.; 5⅓ whorls.

Length 2.55, diam. 1.5 mm.; 5½ whorls (type).

Length 2.2, diam. 1.35 mm.; 5 whorls.

Oahu: Coral bluff 1½ miles west of Kahuku (Cooke and Pilsbry, type loc.); Malaekahana, Kaipapau, Laie and Punaluu (Cooke). Fossil in Pleistocene and later deposits.

The essential character of this northwestern race is the hook-like shape of the lower palatal fold. In *L. lyrata* it is nearly straight.

In its typical form the race appears to be extinct, yet there are some living forms which approach it and are referred here provisionally.

Recent specimens from Kamanaiki, Kalihi, show some approach to the fossil form. The lower palatal has an enlarged, slightly decurved inner end, which is almost separated from the low outer portion. Those collected living in Glen Ada, Nuuanu, have the lower palatal fold *strongly hooked downward* (pl. 19, fig. 10). The external shape varies from somewhat conic to that of *uncifera*. The variations and races of *lyrata* will not be understood until specimens from a large number of places are opened for study of the palatal folds. It will probably be found necessary to recognize a number of local races.

Kauaian race.—A slightly larger race which appears closely related to this subspecies though not identical, is found in a fossil state on Kauai at Limahuli (Dole, Cooke) and Haena (Cooke). The shells agree with *uncifera* in having the parietal lamella very deeply seated and close to the angular lamella, but the lower palatal fold is low and rather wide, and its inner end descends very little. One of the specimens measures: Length 2.62, diam. 1.45, alt. apert. 0.95 mm.; whorls 5⅓. A specimen from Limahuli is drawn in pl. 20, fig. 1.

1*b*. *Lyropupa lyrata fossilis* C. & P., n. subsp. Pl. 19, figs. 7, 11. The shell is longer and narrower in proportion to its

length than *L. lyrata* and more cylindrical in outline; the apical whorls are granulose-wrinkled, the rest of the whorls strongly sculptured, the last with about 15 hardly flexuous costæ. Lower palatal fold very short.

Length 2.8, diam. 1.47, apert. 1.0 mm.; whorls 5½ (type).

Length 2.6, diam. 1.55 mm.

Oahu: Very abundant in pleistocene deposits, Manoa. (Thaanum, Cooke); Waimanalu (single specimen, Cooke). Type 11039 Bishop Museum; paratypes 45279 Bishop Museum and 119462 A. N. S. P.

The external features are about as in *uncifera*, but the lower palatal fold is somewhat more reduced than in any other form.

2. LYROPUPA MICROTHAUMA Ancey. Pl. 21, figs. 2, 3.

"Shell smaller than the preceding [*mirabilis*] and less cylindrical, hence more conoidal-oblong; whorls 5, with the upper margin extended less outwardly, angular lamella more elongate and distinct, the upper palatal elongate, almost abruptly truncate near the external margin, the lower more elongate, scarcely drop-shaped, not at all parallel to the preceding, but diverging gradually forward. Length 1.8, diam. 1, apert. 0.66 mm." (*Ancey*).

Oahu: Nuuanu, type loc. (Thaanum); numerous localities in the Koolau range from Keawaawa to Kaipapau (Spalding, Gouveia, Bridwell, Cooke); Waianae range, Pukaloa (Spalding, Cooke). Holotype 18750 Bishop Museum and paratypes 18751 Bishop Museum and Thaanum Coll.

Lyropupa microthauma ANCEY, Proc. Malac. Soc., London, vi, 1904, p. 126, pl. vii, f. 20.

L. microthauma is somewhat intermediate between the group of *L. lyrata* and that of *L. mirabilis*. The embryonic whorls are minutely *spirally* striate, a character found in most of the species of the first named group. The angular lamella is shorter than in the other species of this group but higher and more developed than in any species of the second group. The columellar lamella is very deeply, almost axially seated. It is rather strong and viewed from above slightly semilunate

in outline. The abrupt termination of the upper palatal fold at the lip, and its slight enlargement there, are special features of the species. The lower palatal fold is shorter and stouter than the upper, and penetrates more deeply. In a few specimens the last whorl is distinctly closely and minutely striate spirally, but in most specimens the minute spiral striæ are visible only on the ribs and have entirely disappeared from the interstices.

Specimens from the type locality have from 19 to 21 rather strong slightly oblique ribs on the last whorl. Those from Kaipapau have 23 to 24.

In a Kaipapau shell opened the lower palatal fold is somewhat longer than in the Nuuanu preparation figured, and is curved, the concavity towards the base, the inner end being a little stronger.

Length 1.96, diam. 1.04, apert. 0.65 mm.; 6 whorls (type loc., head of Nuuanu Valley).

Length 1.9, diam. 1.04, apert. 0.64 mm.; 5⅔ whorls (Kaipapau).

Length 1.92, diam. 1.1, apert. 0.65 mm.; 5½ whorls (Pukaloa, Waianae Range).

This species has never been found abundantly in any locality. It is usually taken in loose, damp talus more or less covered with dead leaves. It is probably distributed over the whole length of the Koolau Mts., as it has been found by a number of collectors in rather widely separated colonies. In the Waianae Mts. it has only been taken, on two occasions, from one of the little valleys.

3. Lyropupa rhabdota C. & P., n. sp. Pl. 20, fig. 2.

The shell is sinistral, rimate-perforate, subcylindrical, with slightly convex and tapering outlines, brussels brown, except for a rather broad lighter zone at the middle of the last whorl, hardly translucent, dull. Sculpture of strong, slightly oblique ribs, 12 to 14 on the last whorl, the interstices and ribs spirally striate with minute, close, raised threads. Spire tapering above to a slightly conical, obtuse summit. The individual whorls very convex and separated by a deep suture.

Whorls 5½, 1½ embryonic, nearly smooth, marked by minute, close, raised, spiral lines, the transverse ribs beginning abruptly at this point. The last whorl tapers downward, and the latter part ascends slowly towards the aperture; there is a broad, shallow furrow extending for nearly ⅔ its length and ending just back of the lip. The aperture is perpendicular, truncate above, rounded below, peristome continuous. The inner half of the parietal margin is appressed to the penultimate whorl, the outer half free. Angular lamella strong, erect, long, slightly curved outwards in cross section, extending to the outer margin; parietal lamella strong, somewhat curved spirally. Columellar lamella very deeply seated, obliquely placed on the columella, short. Upper palatal fold long, extending nearly to the margin of the aperture, slightly modified in front by the angular, with which it forms an almost complete simulus. Lower palatal long, low, much more deeply seated than the upper and almost parallel with it. Peristome more or less expanded on all sides, thin at the margin.

Length 2.7, diam. 1.53, apert. 1.0 mm.

Molokai: Pelekunu, type loc. (Forbes), Wailau Pali and Kamalo (Cooke), Kalamaula (Thaanum, Pilsbry and Cooke), fossil at the base of the Kalaupapa cliffs (Cooke) and top of Mauna Loa (Pilsbry and Cooke). Type 11040, Bishop Museum; Paratypes 24871 B. M. and 119456 A. N. S. P.

There can be no doubt that this species is distributed over the whole of the wooded portion of Molokai. Unfortunately it has never been found in any number in any one locality and in none of the lots are there more than half a dozen specimens—in most of them only 1 to 3.

This species is, at first glance, very similar to some of the forms of *lyrata* from Oahu. It is easily separated by the different sculpture of the embryonic whorls and the longer lower palatal fold.

3a. *L. rhabdota pluris* P. & C., n. subsp. Pl. 20, figs. 3, 4, 5.

This short form of *L. rhabdota* is found along the pipe-line trail, upper Kaunakakai. The summit is obtuse and rounded, about as in *L. thaanumi*. The spiral striae are weaker, less regular than in typical *L. rhabdota*.

Length 2.25, diam. 1.3, aperture 0.8 mm.; 5¼ whorls.

Length 2.15, diam. 1.4, aperture 0.9 mm.

The form from the western ravine of upper Kamalo (figs. 3, 5) is similar but slightly larger.

Length 2.45, diam. 1.5, apert. 0.95 mm.; 5⅓ whorls.

Length 2.4, diam. 1.4 mm.; 5⅓ whorls.

These forms were collected by the authors in some abundance among dead leaves in humid, shady places, with *L. h. sparna*. They differ from *L. thaanumi* by the smaller size and fewer ribs.

A still smaller race of *L. rhabdota* was found in Mapulehu Valley (Cooke). Except for their smaller size the shells agree perfectly with the larger and more widely distributed typical form. Length 2.1, diam. 1.28, apert. 0.75 mm.; 5 whorls.

3*b*. *L. rhabdota lanaiensis* Cooke, n. subsp. Pl. 20, fig. 6.

Specimens from Lanai differ slightly from the Molokai form. The shells are slightly smaller, more conical in outline, tapering more gradually towards a somewhat acute summit; they are darker colored and with the pale zone only indicated near the aperture. There are 16 to 18 ribs on the last whorl; the embryonic whorls, under a strong lens, are distinctly, spirally striate; the columellar fold enters obliquely, is short, almost nodule-like when viewed from above, and there is usually a minute basal fold, situated deep within. Length 2.5, diam. 1.5, apert. 0.92 mm.; 5½ whorls.

Lanai: (Thaanum, Spalding, Forbes). Type 11041, Bishop Museum; Paratypes 34182, Bishop Museum, and 119451 A. N. S. P.

3*c*. *L. rhabdota baldwiniana* Cooke, n. subsp. Pl. 20, figs. 7, 8.

Specimens from West Maui agree very closely with the type form in shape, color, etc., but are slightly smaller. They differ mainly in that the embryonic whorls are much more finely striate spirally, and in the presence of a minute basal fold and the more axially seated columellar fold. There are usually about two more ribs on the last whorl, which is furnished with from 15 to 17. Length 2.5, diam. 1.5, apert. 1.0 mm.; 5¼ whorls.

West Maui: Iao (type loc.), and Waikapu (Cooke); Honokawai (Thaanum); Maunahoama (Forbes and Cooke); Honakahua (Fleming). Type 11042 Bishop Museum; paratypes 38949 Bishop Museum and 119457 A. N. S. P.

From *L. r. lanaiensis* it is separated by its more convex and swollen whorls, lighter color and much more finely spirally striate embryonic whorls.

4. LYROPUPA THAANUMI C. & P., n. sp. Pl. 20, figs. 12, 13.

The shell is sinistral, rimate-perforate, cylindrical, mars brown, with a very indistinct, broad, pale zone just above the periphery of the last whorl, chiefly visible on the ribs which are there dirty white; rather solid, opaque, dull. Sculpture of strong ribs, 18 or 19 on the last whorl, the interstices with minute, close, deciduous spiral striæ, only visible with a strong lens. Spire nearly cylindrical, with a rounded, *blunt almost truncate summit*, the first two whorls nearly immersed in the third; last three whorls rather strongly convex, separated by a deep narrow suture. Whorls 5½, the embryonic 1½ when viewed under a strong lens (in adult specimens) are nearly smooth though indistinctly spirally striate. The last whorl ascends slightly near the aperture, tapering towards and contracted at the base, furnished with a broad, shallow furrow for a little more than half its length; the furrow bifurcates indistinctly near its termination, the upper branch extending to the margin of the lip. Aperture perpendicular, nearly quadrangular in outline, with rounded corners, and base, the peristome continuous, the inner half of the upper margin appressed to the penult whorl, the outer free. The angular lamella is long, strong, its free edge slightly curved outwards, extending to the outer margin of the aperture. Parietal lamella strong, very deeply seated, bent outwards; columellar lamella very deeply and almost axially seated. Upper palatal fold is long, high within, becoming low in front, emerging nearly to the margin of the aperture. Lower palatal fold very deeply seated and parallel to the upper, a little curved, extending deeper than the upper palatal, and enlarged, nodule-like, below the inner end of the latter.

Length 2.75, diam. 1.67, aperture 1 mm. (type).

Length 2.5 mm.

East Maui: Auwahi, type loc. (Thaanum); Ukulele (Forbes). Type 11043 Bishop Museum; paratypes 36896 Bishop Museum, 119452 A. N. S. P. and 7597 Thaanum collection.

This species is related to *L. rhabdota* and its subspecies. It differs, however, in its larger size, more cylindric outline and the depressed, rounded summit. The same character separates it from *L. prisca*, which appears to be the most closely allied species. *L. thaanumi* is also related to *L. truncata*, but is easily separated by its less flattened apex, thicker shell and especially by the finer and closer spiral striæ on the last whorl.

5. LYROPUPA PRISCA (Ancey). Pl. 20, figs. 9, 10, 11.

The shell is sinistral, rimate-perforate, subcylindrical, in its fossil state pinkish cinnamon with a narrow nearly white band above the periphery on the last two whorls, thick, opaque, strongly costate, with 15 to 17 slightly oblique ribs on the last whorl; the interstices very minutely, closely, spirally striate (but in its fossil state these striæ are usually absent). Spire subcylindrical, tapering gradually above to a rather obtuse apex; individual whorls convex, separated by a deep suture. Whorls 5¼ to 5½, the embryonic 1½ whorls (under a strong lens) nearly smooth, only traces of minute close, spiral striæ remaining. The last whorl ascends slightly towards the aperture, and, tapers very gradually to the base; it has two distinct nearly parallel shallow sulci which unite further in back into a broad shallow furrow. Aperture perpendicular, roughly triangular with broadly rounded base, its margins continuous. Angular lamella long and strong, emerging to the margin. Parietal lamella thinner than in most of the species and decidedly slanting outwards. Columellar lamella strong, deeply seated, obliquely entering, high in front, low in back, running into the columella above. Upper palatal fold long, extending nearly to the margin, high within, very low where opposite the angular. Lower palatal fold shorter and broader, deeply seated, nearly parallel to the upper, and penetrating inward beyond it, either simple or divided by a median depression

(figs. 9, 10). There is a very small and very deeply placed basal fold, at least in some specimens. Peristome very slightly expanded.

Length 3, diam. 1.62, apert. 1.1 mm.

Length 2.7, diam. 1.6 mm.

Hawaii: In pleistocene deposits at Mana and Palihoukapapa (Henshaw, Thaanum). Type 18746 Bishop Museum; paratypes 18756 Bishop Museum, 119453 A. N. S. P., also in Henshaw and Thaanum colls.

Lyropupa magdalenae var. *prisca* ANCEY, Journal of Malacology, London, xi, 1904, p. 68, pl. 5, f. 19.—? *Pupa lyrata* Gould, BOETTGER in v. Marts., Conchol. Mittheil., i, 1881, p. 61, pl. 12, f. 17 (Auf der Insel Hawaii).

The above description is not drawn from Ancey's type specimen but from another from Mana, as the former is not in perfect condition. Ancey gave Palihoukapapa as the type locality but as this species is extremely rare in the deposits and common in those from Mana, I am of the opinion that the former locality is an error. Two nearly equal lots of earth from each locality were picked over and the Mana lot contained nearly 200 specimens of *prisca* to 1 from Palihoukapapa. From the number of specimens of *prisca* in the Ancey collection I have no doubt but that his came from the Mana deposit.

L. prisca is in no way closely related to *L. magdalenæ*, the surface sculpture of the embryonic whorls is enough to separate the two as species. It differs from the other species from Hawaii in having *close*, fine, spiral striæ in the interstices between the costæ in the most perfectly preserved examples; these striæ are almost or entirely absent in most the specimens examined, due to the fossil condition of the shells. Ancey's measurements in the Journal of Malacology are somewhat confusing; his type measures, length 2.8, diam. 1.5 mm.

Dr. Boettger's description and figure of what he identified as *Pupa lyrata* appears to have been based upon recent specimens of this or some very closely related Lyropupa. He placed *V. striatula* Pease in the synonymy of *lyrata*, but without having any knowledge of it other than the original description.

L. thaanumi of Maui is very near akin to *prisca*; but the

blunter summit together with the distribution on a different island incline us to separate it specifically.

6. LYROPUPA CLATHRATULA Ancey. Pl. 21, figs. 1.

"Shell sinistral, oblong, rimate-perforate, opaque, with a somewhat silky sheen, deep purplish-black, unicolorous, somewhat thin; sculptured, except on the apex, with acute, oblique, equidistant lamella-like liræ (12 on the last whorl); in addition encircled and slightly clathratulate in the interstices with very slightly prominent elevated membranous lines, especially on the last two whorls. Spire ovate, obtuse. Whorls 5, convex, separated by an impressed suture, under a strong lens marked with lines of growth, the last furnished near the aperture with a not very distinct impression parallel to the suture, scarcely angulate about the umbilicus, ovate, a little tapering. Aperture suboblique, appressed, irregularly ovate, externally angulate above, obstructed by 5 lamellæ or plicæ, namely: 2 parietal lamellæ, one of which [parietal] is submedian, free, and the second shorter, more externally seated, united with the margin: a deeply seated semilunate columellar, visible when viewed obliquely; 2 long palatal, the upper almost reaching the margin, the lower more deeply seated, corresponding to the shallow, external sulcus. Peristome slightly expanded, purplish-brown, with the margins approaching above, but hardly continuous. Length 2.25, diam. 1.5 mm." (*Ancey*).

Hawaii: Olaa (Thaanum). Type 18742, paratypes 18768 Bishop Museum, 119436 A. N. S. P. and Thaanum coll.

Lyropupa clathratula ANCEY: Proc. Malac. Soc. London, vi, 1904, p. 125, pl. vii, f. 19; note bottom of p. 68, Journal of Malacology, xi, 1904.

L. clathratula may ultimately prove to be a synonym of *L. striatula*. It is somewhat closely related to *L. truncata*; both have few and widely separated spiral striæ; in the latter species, however, the apex is much blunter and there are more apertural teeth. From the other species of *Lyropupa* it is most easily distinguished by the stronger and more distant spiral threads. The embryonic whorls are minutely, closely and regularly spirally striate. The columellar lamella is

rather obliquely seated. In most of Ancey's specimens the peristome is continuous, the portion which is appressed to the penultimate whorl being very thin. The lower palatal fold is shorter than the upper and penetrates inward beyond it. Length 2.45, diam. 1.5 mm. The original account follows of

LYROPUPA STRIATULA (Pease).—"Shell cylindrical, oblong, somewhat solid, sinistral, umbilicate, longitudinally obliquely and flexuously strongly costate, with the interstices delicately transversely striate; whorls 5, rotundly convex, frequently rotund-angulate in the middle, the last scarcely extended, concentrically broadly sulcate at its middle, rotund-angulate about the umbilicus, compressed at the base; apex obtuse; suture well impressed; aperture subquadrangular, rotund at base, contracted by 3 lamellæ, 2 on the parietal wall, the first [angular] large, united with the lip, the second median internal; one on the superior portion of the columellar margin, attached to the labium; peristome continuous, somewhat thickened, slightly expanded and reflexed, the outer lip posteriorly sinuous; reddish chestnut, with whitish ribs.

"Length 2.5, diam. 1.5 mm." (*Pease*).

Hawaii (Pease).

Vertigo striatula PEASE, Proc. Zool. Soc., London, 1871, p. 461.

The type of this species is not to be found in Pease's collection in the Museum of Comparative Zoology. Pease mentioned 3 lamellae, 2 on the parietal wall and 1 columellar lamella joined to the labium, that is, the inner lip; implying that none were seen within the outer lip. As no known Hawaiian Pupillid has this structure, we assume that for the moment he forgot that the shell was sinistral, and the phrase "in margine columellari superne [lamella] 1 ad labium juncta" really applies to the *outer* lip and its upper palatal fold. It is quite natural that Pease, a careless observer, overlooked the real columellar lamella and the lower palatal fold, as these are deeply immersed. This hypothesis makes the description intelligible, and increases the probability that *striatula* is identical with *L. clathratula*. Since the point cannot be demonstrated beyond doubt, we think it best to ignore *V. striatula* as a lost species unless new evidence is found.

7. LYROPUPA TRUNCATA Cooke. Pl. 21, fig. 4.

The shell is rimate; sinistral, cylindrical, dark brown, clathratulate, with about 14 well developed lamelliform costæ on the last whorl (between the costæ 5-8 minute striæ) and with 3-4 raised spiral striæ on each whorl. Spire cylindrical; apex almost flat, giving the shell a truncate appearance. Suture simple depressed. Whorls 5, the embryonic without transverse costæ but with numerous minute close spiral striæ, increasing rather rapidly; the rest convex, clathratulate, increasing slowly; the last slightly narrower than the penultimate, with two indistinct shallow, longitudinal depressions corresponding to the palatal plicæ. Aperture perpendicular quadrate-ovate, with 7 folds, viz.: the angular lamella slightly arcuate, extending nearly to the margin of the peristome; the parietal a little deeper-seated, strongly developed; and, a minute dentiform infraparietal lamella; a deeply seated obliquely entering, but well developed columellar lamella; three nearly parallel palatal plicae, the upper extending nearly to the margin of the peristome, the lower more deeply seated and in addition to these a very short, deeply seated basal plica. Peristome continuous, slightly expanded.

Length 2.6, diam. 1.66, aperture 1.1 mm.

Hawaii: Kohala Mts. (Thaanum). Type 15411 Bishop Museum; paratype in Thaanum coll.

Lyropupa truncata COOKE, Occasional Papers of the B. P. Bishop Museum, iii, 1908, p. 211, text figure.

An extremely rare species of which only a very few specimens have been taken. The only close relative known at present is *L. clathratula*, from which it is easily distinguished by its much blunter summit and more numerous apertural teeth. Unlike all of the other *Lyropupas* except *clathratula*, the ribs are thin with membranous edges. The spiral striæ are further apart than in any other species.

Section *Lyropupilla*, n. sect.

Sinistral Lyropupas with a low, short angular lamella, and without spiral striation on the lower whorls. Type *Lyropupa spaldingi*.

8. LYROPUPA SPALDINGI n. sp. Pl. 21, figs. 10, 12, 13.

The shell is sinistral, rimate-perforate, somewhat ovately fusiform, *cartridge buff*, somewhat thick, translucent with a silky sheen, marked with strong slightly flexuous costæ, about 17 on the last whorl, the interstices are nearly smooth, indistinctly flexuously striate. Spire convexly conic, tapering gradually to a slightly blunt apex, the upper whorls convex, the last two very convex, slightly angulate above the periphery, separated by a deep suture. Whorls 6½, the embryonic minutely granulose-wrinkled, the costæ appearing abruptly at about the middle of the second whorl; last whorl tapering strongly towards the base, somewhat inverted-conic in outline, with a rather acute base, deeply concentrically *tri-sulcate* back of the aperture, the upper sulcus long and broad, extending for nearly ¾ the length of the whorl, and reaching almost to the lip. Aperture perpendicular, somewhat quadrangular in outline with much rounded corners, the margin continuous, free. Angular lamella short, blunt, extending to the margin; parietal lamella deeply seated, its outer end extending just beyond the inner end of the angular, strong, long, its free margin bent outwards, flexuous; infraparietal usually present, very deeply seated and nearly nodule-like or short lamella-like; columellar lamella very deeply and axially seated, nodular, viewed from above lunate with the horns pointing outwards; upper palatal fold long, high in back, low in front, extending to the inner margin of the peristome; lower palatal deeply seated, long, parallel to the upper; there is present a short, low, deeply and concentrically seated basal fold which terminates almost at the base of the columellar lamella. Peristome free, continuous, its outer margin expanded.

Length 2.82, diam. 1.53, apert. 0.85 mm.

Oahu: Waianae Mts. from Palehua to Mokuleia; type locality Puu Kaua (Cooke). Type 11048, Bishop Museum, paratypes 37192, and 119470 A. N. S. P.

This is by far the most abundant species of *Lyropupa* found on the Waianae Mts., and its habitat extends over the whole length of the range. It is especially abundant in talus, but is

also found on dead leaves and twigs. It is usually taken in rather open country but has also been found in damp forest patches as well as in talus in open situations. A basal view of a young specimen is drawn in pl. 26, fig. 8.

It is easily separated from *L. mirabilis* by its lighter color, fewer and more widely spaced costæ, its broader outline, the continuous lower palatal fold and the additional lamellæ in the aperture.

9. LYROPUPA MIRABILIS Ancey. Pl. 21, figs. 5, 6, 7.

"Shell sinistral, dark brown, cylindrically oblong, except for the apex regularly and obliquely sculptured with distant acute liræ, scarcely shining, rimate-perforate. Spire obtuse. Whorls 6, regularly increasing, convex, with an impressed suture; the last inflated in front of the aperture, afterwards broadly slightly constricted, hardly attenuate, impressed at its middle, somewhat compressed at the umbilicus. Aperture scarcely oblique slightly projecting towards the right at the base and externally towards the outer and upper margin, extended, armed on the parietal wall with a marginal and short dentiform lamella near the upper angle; a second, the parietal, much larger, deeply seated and nearly median; a deeply seated strong columellar fold (only seen when viewed obliquely), and 2 palatal lamellæ, the lower of which is guttiform, short, deeply seated, the upper long and extending to the margin.

Length 2.5, diam. 1.33, apert. (alt.) 0.75 mm." (*Ancey*).

Oahu (Ancey); Popouwela, Waianae Mts. (Spalding, Cooke, Pilsbry). Type 18747 Bishop Museum.

Pupa mirabilis ANCEY, Bull. Soc. Mal. France, vii, 1890, p. 339; Mem. Soc. Zool. France, v, 1892, pp. 716.—*Lyropupa mirabilis* ANCEY, Proc. Malac. Soc., London, vi, 1904, p. 126, pl. vii, f. 18.

Ancey described this species from a single specimen and without exact locality. As his specimen came from the aperture of a specimen of *Ach. mustelina*, the Waianae Range is undoubtedly the original locality. *L. mirabilis* is distributed over nearly the whole range. It is very abundant among dead

leaves and débris in the woods on the western ridge of Popouwela, with *Endodonta* and other small shells.

In the type specimen there are 6⅓ whorls, the embryonic whorls are wrinkled-granulose. The last whorl has 22 slightly oblique, slightly flexuous ribs. The angular lamella is short, low, blunt; the parietal is deeply seated, curved, its edge bent outwards, hardly emerging further than the inner termination of the angular; the columellar is strong, deeply and axially seated on the columella, nodule-like viewed from the back. The lower palatal fold is short and rather high. Some distance beyond it there is a strong, oblique, white tubercle below the inner end of the upper palatal plica. A very weak basal appears below it (fig. 6). The type specimen, according to my method of measuring, has the following dimensions: length 2.38, diam. 1.22, apert. (vert.) 0.75 mm. The specimens figured are from Popouwela. Figure 5 measures: length 2.3, diam. 1.28, apert. (vert.) 0.75 mm. 6 whorls.

10. LYROPUPA ANTIQUA C. & P., n. sp. Pl. 21, figs. 8, 9, 11.

The shell is oblong, somewhat cylindric, slowly tapering to the apex, the whorls rather narrow and convex; sculpture of strong, somewhat oblique ribs, 15 to 17 on the last whorl. The last whorl has a broad and deep spiral concavity somewhat below the middle. Armature of the aperture is outwardly as in *L. mirabilis*, the angular lamella low and short, the parietal deeply placed, becoming strong deep within, flaring towards the upper palatal. The columellar lamella is rather massive. The upper palatal fold is relatively rather short. Lower palatal very deeply placed, low in front, where it is parallel with the upper, then stronger and turning downward, penetrating well beyond the upper palatal (pl. 21, fig. 8).

Length 2.8, diam. 1.4, aperture 0.8 mm.; 6½ whorls.

Oahu: Manoa, in pleistocene deposits along the Upper Manoa Road (Thaanum, Cooke). Type 11047, Bishop Museum; paratypes 45280, Bishop Museum and 119472 A. N. S. P.

This species is easily separated from *L. mirabilis* by its larger size, more numerous whorls and fewer ribs on the last whorl. Internally it differs by the continuous, strongly bent lower palatal fold.

It is the only species of the *mirabilis* group so far reported from the Koolau Mountains. It is abundant in the deposits from the upper portion of the road, but entirely absent from the lower deposits—less than half a mile distant. It appears to be rather local, but it may have had a wider extension before the destruction of the lower forest zone.

11. LYROPUPA HAWAIIENSIS (Ancey). Pl. 22, figs. 12, 14.

The shell is sinistral, rimate-perforate, oblong, thick, opaque, in its fossil state brownish, marked with strong transverse, slightly flexuous ribs, 19 to 22 on the last whorl, the interstices minutely flexuously striate, parallel to the ribs. Spire with convex outlines, rapidly tapering above; apex rather obtuse. The individual whorls are rather strongly convex, separated by a rather narrowly impressed suture. Whorls $5\frac{3}{4}$ to 6, the embryonic $1\frac{1}{2}$ nearly smooth, under a strong lens very minutely granulose, the transverse costæ appearing abruptly at about the middle of the second whorl. The last whorl has a somewhat flattened base; furnished with a rather broad shallow sulcus on about the last $\frac{3}{4}$ of its length, the sulcus ending just behind the expanded peristome. Aperture perpendicular, indistinctly triangular in outline, with very rounded corners; peristome continuous, with free margins. Angular lamella short, blunt and low, extending to the margin; parietal strong, very deeply seated, a little curved concentrically, not very long, oblique, its free margin flaring outward. Sometimes there is an indistinct nodular, deeply seated infraparietal present. Columellar lamella short, nodular, high, deeply seated and very obliquely entering; upper palatal fold rather short, low and not emerging to the lip. Lower palatal is somewhat higher and more deeply seated, nearly parallel to the upper, which reaches about to the middle of its length. Basal fold transverse, deeply seated, blunt, Peristome continuous, expanded. Length 2.58, diam. 1.45, apert. 0.95 mm. (fig. 14).

Hawaii: Palihoukapapa and Mana (Henshaw, Thaanum); fossil. Type 18748 Bishop Museum, paratypes 36656 Bishop Museum and 119468 A. N. S. P. Also in Thaanum and Henshaw collections.

Lyropupa mirabilis var. hawaiiensis ANCEY, Journal of Malacology, xi, 1904, p. 68, pl. 5, f. 19.

The above description is based on a specimen from the original material from which Ancey's type came, and may be considered a paratype. It agrees with Ancey's type which is slightly broken.

This species is superficially close to *L. mirabilis*. It is here considered distinct on account of the fewer costæ on the last whorl, the relative proportions of the lower palatal fold, *which is not interrupted*, to the upper, and the presence of a basal fold. The possession of this fold shows some relationship to *L. anceyana* from which it is easily separated by its oblong, less ovate form, the less convex whorls and more numerous ribs on the last whorl.

Ancey's description follows: "Separated from the type (from the Waianae Mts., Oahu) as the shell is usually a little larger, more robust, with pale costulæ; with a stronger and more elongate lower palatal lamelliform tooth; whorls 6. Length 2.5, diam. 1.25, apert. (long.) 0.75 mm. There are twenty to twenty-two costulæ on the last whorl, while in the type specimen there are about twenty-two to twenty-four."

According to our methods, Ancey's type specimens has the following measurements: Length 2.45, diam. 1.35, apert. 0.85 mm.

12. LYROPUPA SPARNA C. & P., n. sp. Pl. 22, figs. 6, 7, 10, 11.

The shell is subcylindric, with rather long terminal cone, walnut brown or darker, with sculpture of rather short narrow ribs, about 20 on the last whorl, intervals microscopically granulose. There is a deep median sulcus on the last half whorl. Aperture is somewhat triangular, with well-expanded, pale, continuous peristome. The angular lamella is a low ridge or reduced to a mere swelling. Parietal high but short. The columellar lamella is short, thick, rounded, somewhat transverse to the columella. The upper palatal fold is low and not very long; lower palatal deeply placed, somewhat stronger than the upper, and penetrates much further in; it is usually a little curved. The basal fold is a low rounded or oblong tubercle.

Length 2.05, diam. 1.15, aperture 0.75 mm. (type).

Length 2.1, diam. 1.33, aperture 0.75 mm.

Length 2.2, diam. 1.2, aperture 0.8 mm.

Molokai: Kalihi, type loc. (Pilsbry & Cooke), Kalamaula (Thaanum), Kawela (Cooke), also fossil at Kaluaaha, Kalaupapa and Kaiehu (Cooke); Lanai: Mahana and Kaiholena (Forbes). Type 33627 Bishop Museum (fig. 6); paratype 108919 A. N. S. P. (figs. 7, 10, 11).

L. sparna differs from *L. mirabilis* by the palatal armature. It resembles *L. antiqua* in this respect, but the shell is smaller and the ribs thinner and more numerous. *L. hawaiiensis* is a larger, more robust shell, with less triangular aperture and a stronger basal fold, but closely related. It occurred along the pipe-line trail in some abundance among dead leaves.

As far as known, only two specimens have been collected on Lanai, one from each of the localities mentioned above. These two specimens agree very closely with those from Molokai. One of them measures, length 2.1, diam. 1.25 mm., 5½ whorls.

12*a*. *L. sparna simulifera* P. & C. Pl. 22, fig. 13.

The angular lamella is developed as a distinct though small plate, and the upper palatal fold is somewhat stronger than in *sparna*, the sinulus being therefore better defined. The lower palatal fold is strong and deeply placed, more than half of its length beyond the inner end of the upper palatal.

Length 2.2, diam. 1.1 mm.

Molokai: Western ravine of Kamalo; also in small numbers along the pipe-line trail with *L. sparna* (Cooke & Pilsbry).

13. Lyropupa anceyana C. & P., n. sp. Pl. 26, figs. 3, 6.

The shell is sinistral, ovate, chestnut-brown, scarcely shining. Sculpture of strong, rather narrow, equidistant, oblique ribs, slightly flexuous on the last whorl, where they are often more prominent above the middle, and number 12 to 14; minute striae of growth may be seen between the ribs, but no spiral striæ. The first 1½ whorls are microscopically granulose. The spire is oblong-tapering, the summit obtuse. The whorls are very convex, the suture deep and undulating.

The last whorl is impressed by a moderately deep and wide sulcus parallel with the suture, the base being narrowly rounded and prominent. The aperture is rounded below, truncate above, the sinulus not very well defined. The angular lamella is short and very low. The parietal lamella is median, oblique, deeply placed, its deeply penetrating inner part stronger. The columellar lamella, rather deep within, appears as a plate with arcuate outline; the upper end recedes, the plate standing obliquely. The upper palatal fold is low, slender, and does not penetrate far. Lower palatal is more deeply placed, *very strong*, somewhat curved, and penetrates to the back. *There is a strong but short, obliquely axial basal fold.* The peristome is whitish, somewhat thickened and well expanded, continuous.

Length 2.25, diam. 1.4, aperture 0.72 mm.; 5½ whorls.

Hawaii: Olaa (Thaanum). Type 11050 Bishop Museum; paratypes 18769 Bishop Museum, 119469 A. N. S. P. and 838 Thaanum Coll.

Lyropupa lyrata (Gld.) ANCEY, Proc. Malac. Soc. London, vi, 1904, p. 124; not *Pupa lyrata* Gould.

This species is based on specimens believed by Mr. Ancey to be Gould's *Pupa lyrata*. It is well distinguished from allied forms by the very convex whorls, the unusually strong lower palatal fold and the short, high, deeply placed basal fold, stronger than in any related form. It is not nearly related to *L. lyrata*, which differs by the well-developed angular lamella and the spiral striation.

L. anceyana stands close to *L. hawaiensis*, but it is smaller with the ribs more widely spaced, the spire more tapering, and the whorls are conspicuously more convex.

14. LYROPUPA SCABRA P. & C., n. sp. Pl. 26, figs. 1, 2.

The shell is perforate and rimate, tapers above, last two whorls forming a short, cylindric portion; russet with sculpture of well-spaced ribs, about 16 on the last whorl. Last two-thirds of the last whorl has a *deep and wide sulcus.* The aperture is dark within with pale brown peristome and teeth. Angular lamella short, rather low. Parietal strong. Colu-

mellar lamella strong, almost transversely placed upon the columella. Upper palatal fold small, shorter than the lower, and not quite reaching the inner margin of the peristome; the entire length of both seen in a front view.

Length 2.8, diam. 1.6, apert. 1.1 mm.; 5¾ whorls.

East Maui: Ukulele, type loc. (Forbes). W. Maui: Maunahooma (Cooke). Type 11049 Bishop Museum; paratypes 12639, Bishop Museum and 119465 A. N. S. P.

Only five adult specimens of this race have been seen, four from the type locality, one from West Maui.

The shell is less fusiform than *L. spaldingi*, darker colored, the base less produced, and the palatal folds shorter; but it differs conspicuously by the single broad and deep furrow on the back of the last whorl.

Section *Mirapupa* C. & P., n. sect.

The shell is *dextral*; the angular lamella is high and rather long; the surface is ribbed and minutely striate spirally (when unworn). Other characters as in *Lyropupa*. Type *Lyropupa perlonga* (Pse.).

Typically the lower palatal fold is short, and there are two tubercles forming a vertical barrier under the inner end of the upper palatal fold; but some species have the palatals as in typical Lyropupae.

Except in being dextral, these shells resemble the typical Lyropupae.

On all of the Hawaiian islands, these are Lyropupae chiefly of the arid lower zone, probably nowhere found in the zone of humid forest. They live under stones. Owing evidently to increasing aridity since the Pleistocene, many forms have become extinct, and the others are local and infrequently found as living snails. They are among the most abundant Pleistocene and Holocene fossils, in many places to be collected by hundreds or by thousands.

The peculiar feature of most Mirapupae is the inner barrier formed of two short folds or tubercles below the inner end of the upper palatal fold, as in pl. 25, fig. 15 and other figures. These internal tubercles are the enlarged and isolated inner

ends of the lower palatal and basal folds, which are otherwise reduced or sometimes absent. The structure is strictly comparable to that of some Abidas, such as are illustrated in vol. 24, pl. 44, fig. 6. *L. kahoolavensis* is a relatively primitive species not showing this specialization. Among the sinistral *Lyropupæ* there is similar interruption of the lower palatal fold in *L. mirabilis*.

15. LYROPUPA KAHOOLAVENSIS P. & C., n. sp. Pl. 22, figs. 1 to 4, 8, 9.

The shell is cylindric, obtuse at the ends, cinnamon-brown, very thin. Earlier whorls are strongly convex, the last two flattened in the middle, bulging below the deep suture. Embryonic 1½ whorls are granose-vermiculate, the next whorl closely obliquely ribbed. The last 3 whorls, forming the cylindric portion, have widely spaced ribs, at first continuous and oblique (retractive), but on the last two whorls they are subvertical and widely spaced on the upper half of the whorl, interrupted in the middle, and on the lower half more oblique and irregular, and more numerous; minute spiral striae may be traced in the intervals. The last whorl has three impressions parallel to the suture, the upper long, reaching the lip, the others short, the third one being basal. The aperture has the usual squarish form. Peristome continuous, expanded, whitish. Lamellae of parietal wall as in *L. perlonga* except that the parietal does not penetrate so deeply. The columellar lamella is very deeply placed, vertical, but the lower end bends a little outward, the upper end bending inward. The upper palatal fold enters about one-third of a whorl. The lower palatal is immersed, continuous, bent downward and enlarging at the inner end, which is even with that of the upper palatal. Below it there is a tubercular basal.

Length 2.15, diam. 1.05 mm.; 5⅓ whorls. Type, Hakioawa Bay.

Length 2.3 mm.; 5½ whorls.

Length 2.4, diam. 1.2 mm. Hanakanaea or Smuggler's Bay.

Length 2.6, diam. 1.2 mm. Kanapou.

Length 2.55, diam. 1.15 mm. Kanapou.

Length 2.75, diam. 1.15 mm.; 6 whorls. Kanapou.

Length 2.15, diam. 1.15 mm.; 5 whorls. Lanai.

Length 2.5, diam. 1.2 mm.; 6 whorls. Maunalei, Lanai.

Length 2.2, diam. 1.1 mm.; 5⅓ whorls (Kona crater, Hawaii).

Kahoolawe: Hakioawa (type loc., figs. 1-3, 9), Kanapou and Hanakanaea Bays (Cooke, Stokes and Pilsbry); probably wherever fossils occur, as these places are near the north, southeast and western angles of the island.

Lanai: Maunalei (Forbes).

Molokai: Summit of Mauna Loa and at Moomomi (Cooke and Pilsbry); Mauna Loa near the shifting sands and Kaiehu, near Moomomi (Cooke).

Hawaii: Kona crater (Thwing; pl. 22, f. 4, 8).

This species, which seems to be widely distributed on Kahoolawe, and the only *Lyropupa* known from that island, differs from other Mirapupas by the better developed, longer and continuous lower palatal fold. The enlarged inner end of this fold represents the upper of the two tubercles of the inner barrier of the other species. The Kahoolawe species is also characterized by the sculpture and thin shell. No specimens were collected alive, though some appear fresh. The island is now a mere desert, many square miles without humus or herbage of any kind. At the third locality it was found but a few feet above sea level; at the others in aeolian material at higher levels, up to several hundred feet above the sea.

Specimens from Hawaii (no. 119466 A. N. S., 12438 Bishop Mus.) are somewhat more solid than those of Kahoolawe. In the specimen figured there are about 20 ribs on the last whorl (pl. 22, figs. 4, 8).

In Molokai this species is somewhat widely distributed on the treeless western part, as a fossil of Pleistocene and more recent age, sometimes in aeolian deposits of calcareous sand, but on Mauna Loa under stones where they lived. Usually the lower palatal fold is shorter, its inner half higher than typical, and the tubercle below it is generally strongly developed (pl. 26, fig. 13, Mauna Loa, near the shifting sands).

On Lanai, as on Kahoolawe, this is the only Lyropupa known to exist.

While some slight insular differentiation has been noted above, it is too variable to allow us to speak of races on the different islands. Cases of similar distribution have been recorded in *Leptachatina* and the Tornatellinidae.

L. kahoolavensis punkolekolensis P. & C., n. subsp. Pl. 26, figs. 9, 12.

Recent specimens from Punkolekole, Molokai, collected by Thaanum, are tawny or a little darker, irregularly sculptured, numerous riblets being intercalated on the lower half of the last whorl or two. The sinulus is more distinct than in Oahuan *perlonga* as the upper palatal fold emerges nearly to the edge. The lower palatal fold is a rather large callous pad, as seen in the mouth. It has a lower connection backward with the high tubercle below the inner end of the upper palatal. There is a quite weakly indicated basal callus, and the usual tubercle deep within.

Length 2.1, diam. 1.2 mm.; 5 whorls (fig. 9).

Length 2.25, diam. 1.25 mm.; 5 whorls.

This form has a lower palatal fold intermediate in development between *kahoolavensis* and *perlonga*, but the sculpture is practically as in the latter. It is more specialized than the fossil *kahoolavensis*, as the connection between the anterior and posterior portions of the lower palatal is low, and except in certain lights the fold appears interrupted.

16. LYROPUPA PERLONGA (Pease). Pl. 23, figs. 1-6, 13, 14; pl. 24, figs. 6, 7.

"Shell elongate, cylindrical, rimate-perforate, dextral, pale-straw color, longitudinally thread-like costate, the costae oblique, remote, flexuous; spire obtuse; suture impressed; whorls 5, somewhat flat, the last concentrically sulcate at the middle, indented near the base; the base compressed, rotundate-angulate about the umbilicus; aperture somewhat quadrangular, slightly extended, contracted at the base, rotund, posteriorly bilamellate, the upper lip sinuous above, unilamellate;

peristome continuous, scarcely everted. Length 2.5, diam. 1 mm." (*Pease*).

Oahu: (Pease). Very abundant in pleistocene and holocene deposits on the costal plain of Oahu, Diamond Head eastward; Kailua; living examples from Koko Head.

Vertigo perlonga PEASE, Proc. Zool. Soc. London, 1871, p. 462.—*Pupa perlonga* PFEIFFER, Mon. Hel. Viv., viii, p. 377.—BOETTGER, in von Martens, Conchologische Mittheilungen, i, 1880, p. 60, pl. 12, f. 16.—*Nesopupa* (*Lyropupa*) *perlonga* PILSBRY, Proc. A. N. S. Phila., 1900, p. 432.—*Lyropupa perlonga* ANCEY, Proc. Malac. Soc. London, vi, 1904, p. 126.

This is the most widely distributed and commonest Oahuan species of *Lyropupa*. Numerous specimens of the typical form or of one of its races are found in most of the fossil deposits adjacent to the Koolau range. Living examples are only occasionally found and are hardly ever abundant; as far as known, less than a dozen lots have been reported. In every case where the junior author found living examples they were taken in open country under dead sticks and stones. Only once were they found in any number, and that was near the top of Koko Head, at an elevation of about 1,000 ft.

Pease's unique type specimen, No. 48063 Mus. Comp. Zool., is drawn in pl. 23, fig. 1, with the aperture enlarged, fig. 2. It is a fossil shell, a good deal worn, the ribs worn from the upper part, giving it a more tapering outline than it originally had. There are about 17 narrow ribs on the last whorl, 0.17 mm. apart on the face of the whorl, closer behind the lip, part of them extending over the strong basal ridge, which has an obtuse hump in the middle, preceded and followed by dimples, visible in basal view. The outer edge of the lip is broken away. The angular lamella is long, parietal lamella higher, entering deeply, emerging to the middle of the angular. The columellar lamella is seen as a broad, vertical plate, in front view. Upper palatal fold emerging to the lip. Lower palatal fold a low, callous nodule. Internal barrier, so far as it is visible in the mouth, as in pl. 24, fig. 7. Length 2.1, diam. 1.05 mm.

The dimensions do not agree fully with Pease's description,

but his measurement was doubtless only approximate. He gave the locality Oahu, and the label (in Anthony's hand) gives Nuuanu. It was probably from some Holocene deposit at a low level.

Specimens from the bench of calcareous sandstone east of Diamond Head agree closely with the type specimen (pl. 23, figs. 3, 4, 5; also pl. 24, figs. 6, 7, showing the lamellae and an inside view of the palatal region).

The summit is blunt; the embryonic whorls are coarsely wrinkled-granulose; the first three whorls increasing rapidly, the third whorl swollen, as broad as the last two; the later two or three whorls are slightly swollen below the suture, the last whorl tapering and narrowing below; there are about 18 costæ on the last whorl, the back of which is trisulcate, the uppermost sulcus long, shallow and broad, lightly indicated on the penult whorl, the two lower being short, dimple-like; the margin of the peristome is free; the angular lamella is long and low, extending to the margin; the parietal more deeply seated, emerging to the middle of the angular; the columellar lamella is deeply seated, its upper part vertical, the lower end sloping towards the aperture somewhat. In shape it is a semi-circular plate, slightly concave on the side next the aperture. The upper palatal fold is long, slender, its crest only slightly sinuated where approached by the angular and parietal lamellæ. The lower palatal fold is nodule-like, low and short; beyond it, further in, there is a strong, triangular or comma-shaped barrier, a lower callus below it (pl. 24, fig. 7, interior view of palatal wall). Specimens from the raised bench of consolidated coral sand east of Diamond Head measure:

Length 2.45, diam. 1.05, aperture 0.8 mm.; 5½ whorls.

Length 2.25, diam. 1.1 mm.

Length 2, diam. 1 mm.; 5 whorls.

The same typical form is found on Diamond Head near the lighthouse, and on the floor of the crater. All of these are fossil.

Living specimens collected on Koko Head (pl. 23, fig. 6; pl. 26, figs. 4, 7) are brussels brown in color, they are slightly

smaller than the typical *perlonga*, with closer costæ, and have distinct though minute close spiral striae in the intercostal spaces. There are about 20 riblets on the last whorl.

The lower palatal fold is comma-shaped (pl. 26, fig. 4) in some examples, but in others there is a very low anterior callous pad, connected with the higher posterior portion (pl. 26, fig. 7). This may be a more mature phase. Length 2.15, diam. 1.2 mm. The shell of nearly 3 whorls is drawn in pl. 23, figs. 13, 14; diam. 1 mm.

At Kaelepulu, Kailua, on a low lime-rock bluff about a quarter mile from the shore, this species is abundant and variable, extreme specimens measuring:

Length 2.4, diam. 0.96 mm.; 6 whorls (pl. 24, fig. 10).

Length 1.9, diam. 1 mm.; nearly 5 whorls (pl. 24, fig. 9).

It occurs with *L. ovatula*, *L. micra* and *L. m. percostata*, also with other land shells, all now extinct in that place. The lower palatal fold is reduced to a very low, small rounded callus, difficult to see. The same form is found on the neck of Mokapu peninsula, likewise extinct.

Form *cylindrata*, pl. 23, fig. 8. Specimens from a few localities differ somewhat from the typical form. The shells are longer, more cylindrical in outline and the third whorl is usually slightly more swollen and wider than the lower whorls. The lower palatal fold is shorter than in the forms described above.

Length 2.6, diam. 1.05, apert. 0.73 mm.; 5½ whorls. Oahu: Makua; type loc.

Length 2.7, diam. 1.1, apert. 0.8 mm.; 6¼ whorls. Oahu: Diamond Head, sea-cliffs.

16*a*. *Lyropupa perlonga interrupta* P. & C., n. subsp. Pl. 22, figs. 5; pl. 25, figs. 1 to 4, 10.

The shell is cylindric, cinnamon or somewhat darker, the whorls flattened, swollen along the suture, with sculpture of irregular ribs, on the last whorl or two interrupted in the middle. Impressions on the last half whorl are strongly developed. The parietal lamella is very long, curving at its inner end. Columellar lamella is crescentic, both ends curving

towards the aperture. The internal palatal tubercles are strongly developed, the lower palatal fold otherwise very low, in form of a rounded callus pad (fig. 2).

Length 2.25, diam. 1.1 mm.; 5½ whorls; type.

Length 2, diam. 1.2 mm.; 5 whorls.

Length 1.8, diam. 1.1 mm.; 4½ whorls.

Oahu: abundant in debris of the "coral bluff" 1½ miles west of Kahuku (Cooke & Pilsbry); Maleakahana (Cooke).

It is readily distinguishable by the irregular sculpture. The internal structure is much as in *ovatula*, but it has not the strongly differentiated basal crest of that. The parietal lamella penetrates much further than in Diamond Head *perlonga*, and the columellar plate is larger and more curved.

Occasional individuals are very short but of about the diameter of the longer ones, as in the third measurement given above. Sometimes there is an indistinct dorsal hump near the base of the last whorl.

A small form, resembling the smallest found at Kahuku, has been taken at Maleakahana (pl. 25, fig. 10); dune deposit west of the Laie stream, between the highway and the sea (Cooke & Pilsbry), on the north shore, near the northwestern point of Oahu.

There is an inconspicuous, rounded basi-dorsal prominence; the lower palatal is rather strongly developed. It is wider than *L. micra* of the same length, but approaches it somewhat by the incipient hump. Length 2, diam. 1.1 mm.

16*b*. *L. perlonga filocostata* C. & P., n. subsp. Pl. 23, fig. 12.

Specimens from Kauai and Niihau differ from those from the other islands in that the surface is crowded with slender, oblique, flexuous costæ (sometimes quite irregular), about 28 to 30 on the last whorl. All the specimens examined are fossil. In some of these the delicate spiral striæ are still present. The lower palatal fold is low but comparatively *strongly developed*, and appears to be weakly united with the strong, oblique tubercle further in. There is a weak basal fold, followed within by another callus tubercle.

Length 2.15, diam. 1.15, apert. 0.8 mm.; 5½ whorls; Kauai: Limahuli, type (Cooke).

Length 2.5, diam. 1.18, apert. 0.75 mm.; Niihau: Kiekie (Stokes).

17. LYROPUPA MICRA C. & P., n. sp. Pl. 23, fig. 7; pl. 25, figs. 5, 6, 7.

The shell is smaller than *L. perlonga*, the whorls nearly flat; ochraceous-tawny, with sculpture of many low riblets, which are somewhat irregular and unevenly spaced. The last half-whorl has the usual three impressions well developed, and below the middle there is a *vertical ridge or hump*, running to the base, about a third of a whorl behind the outer lip. The sinulus is small and rounded. The parietal lamella is not very long, but penetrates beyond the strong columellar lamella, which is straight and vertical. The upper palatal lamella penetrates to the dorsal side. Lower palatal is deeply immersed, short but large. The basal fold is narrow and longer, but also deeply placed. There is a vertical barrier below the end of the upper palatal, composed of two strong tubercles separated by a rather narrow sinus.

Length 1.9, diam. 1.1 mm.; 5 whorls (Kaelepulu, type).

Length 1.9, diam. 1.05, aperture 0.65 mm.; 5 whorls (Lualualei).

Length 1.8, diam. 0.95, aperture 0.65 mm.; 5 whorls (Rocky Hill).

Oahu: Kaelepulu, Kailua, on a lime-rock bench about ¼ mile from the north shore (Pilsbry, type loc.). Rocky Hill, Manoa valley (Cooke; fig. 7); and in the Waianae region at Lualualei (Cooke) and Kawaihapai (Cooke and Pilsbry). Living at Lualualei, elsewhere fossil. A subspecies in Molokai.

L. micra is more slender than *L. thaumasia*. The dorsal hump, while variable in prominence, appears to be constant in the great number seen. Both on Oahu and on the dry western part of Molokai it occurs with larger species of the *perlonga* group. The living specimens from Lualualei are cinnamon-colored.

The specimens from Kaelepulu, Kailua (pl. 25, figs. 5, 6, 7), have the sculpture weaker than most of those from Rocky Hill though there are often prominent, thin laminae near the

base. The Rocky Hill example figured, pl. 23, fig. 7, is one of the most strongly sculptured.

17*a*. *L. micra percostata* P. & C., n. subsp. Pl. 25, figs. 11, 12.

The ribs are more prominent than in *L. micra*, more separated, often in pairs. There is a prominent dorsal hump, below the middle of the last whorl. The parietal lamella is deeply placed, high within, its free edge flaring towards the suture. Columellar lamella immersed, vertical, nearly straight, the ends very weakly bent forward. Upper palatal fold about one-third of a whorl long. Lower palatal a small, low and indistinct rounded callus, deeply immersed. Basal fold deep within, blunt and elongate. There are well-developed tubercles below the inner end of the upper palatal fold, beyond the lower palatal and basal.

Length 1.8, diam. 0.9 mm.; 5 whorls (type).

Length 2 mm.; 5⅓ whorls.

Oahu: Kaelepulu, Kailua, on a lime-rock bluff about a quarter mile from the shore (Pilsbry).

Chiefly distinguished by its sculpture. This and the less strongly ribbed *L. micra* are abundant in the same Holocene deposit, without intergrading forms.

17*b*. *L. micra maunaloae* P. & C., n. subsp. Pl. 25, figs. 8, 9.

The Molokai form is somewhat more sharply sculptured than that of Oahu, and there are low protractive waves below the suture on the last whorl or two, or the riblets are grouped by fascicles there.

Length 1.95, diam. 9 mm. (type, fig. 9).

Length 1.75 mm.

Length 1.9, diam. 0.97 mm.; 5 whorls.

Molokai: summit of Mauna Loa, and at Moomomi on the north shore, near sea level (Cooke & Pilsbry); near the shifting sands, Mauna Loa (Cooke). Pleistocene ?, and on the summit of Mauna Loa later, within the human period, though now extinct.

Some of the examples from Moomomi are a little larger 2 to 2.1 mm. long.

18. LYROPUPA OVATULA C. & P., n. sp. Pl. 23, fig. 11; pl. 24, figs. 1 to 5.

The shell is of shorter, wider shape than *L. perlonga*, tapering more upwards. Whorls convex, the first 1½ smoothish, the rest sculptured with curved ribs stronger than in *L. perlonga*, subequally spaced, retractive on the spire, more nearly vertical on the last whorl, where there are about 16, standing nearly 0.2 mm. apart on the face of the whorl. The last whorl has three impressions on the last half: a long, deep and wide impression below the middle, the others shorter and sharper. *The base has a prominent, straight crest* (pl. 24, fig. 2), divided by the inferior impression, the ribs passing over it being small or obsolete. Its posterior end forms a rounded hump. The angular and parietal lamellae are longer than in *L. perlonga*. The vertical columellar lamella is crescentic, the concavity towards the aperture, and much more curved than in *L. perlonga*. The upper palatal fold emerges, and penetrates to the dorsal side. Below its inner end there are two callous nodules, as usual (pl. 24, fig. 4). There is a low but rather strong lower palatal fold, and a small basal fold. The peristome is rather well expanded.

Length 2.25, diam. 1.3 mm.; 5½ whorls. Kailua.

Length 2.1, diam. 1.25 mm. Kailua.

Length 2.2, diam. 1.28, ap. .85 mm.; 5 whorls. Manoa, pl. 23, fig. 11.

Oahu: Kaelepulu, Kailua, in crevices and along the base of a low lime-rock bluff about ¼ mile from the shore (Pilsbry); Rocky Hill, Waimanalo and Koko Head (Cooke). It has only been found fossil.

The peculiar basal crest is the most conspicuous external feature of this species. Internally, the longer parietal lamella and the markedly crescentic columellar lamella distinguish it. At Kaelepulu the type locality (pl. 24, figs. 1-3, 5) it occurs with *L. perlonga*, *L. micra* etc., all being abundant.

The specimens are all dead, apparently being Holocene fossils. They vary in color from vinaceous-cinnamon to cartridge-buff, or of the former tint with a cartridge-buff median

zone. The shape varies from cylindric to more tapering. Spiral striation is not perceptible in most specimens, but it is faintly visible on some.

18*a*. *Lyropupa ovatula kona* P. & C., n. sp. Pl. 26, figs. 10, 11, 14, 5.

The shell is shortly cylindric, the upper third conic, apex obtuse; whorls convex, the last contracted below the periphery. Cinnamon-colored. The first 1½ whorls are smooth (microscopically pitted), the rest with coarse sculpture of well-spaced ribs, quite oblique, retractive on the spire, nearly vertical on the last whorl, where they are usually interrupted or partly so in the middle, and about 16 in number. The intercostal intervals are nearly smooth, without spiral striae. The last whorl has a conspicuous constriction in the middle, stronger on its last half; there is an inconspicuous furrow (sometimes obsolete) over the position of the lower palatal fold, and a short basal furrow. Behind the basal and lower palatal furrows, and below the main constriction, there is a small inflation or hump. The aperture is wide, with continuous, expanded peristome. Angular lamella long; parietal lamella high, not emerging. The columellar lamella is very deeply placed. The upper palatal fold defines a nearly closed sinulus. Lower palatal is very deeply placed, a rather strong, oblong tubercle. Basal fold, below the preceding, similar but narrower (or sometimes shorter). Below the inner end of the upper palatal there is a barrier formed of two erect tubercles, representing the inner ends of the lower palatal and basal folds (pl. 26, fig. 10).

Length 2.3, diam. 1.25 mm.; 5½ whorls (type, Huehue).

Length 2.1, diam. 1.25 mm. (Huehue).

Length 2.25, diam. 1.3 mm. (Kapulehu).

Hawaii: North Kona at Huehue (type loc.) and Kapulehu (Gouveia). Molokai: Moomomi (Cooke & Pilsbry). Only found fossil.

The Hawaiian *L. cyrta* differs by the more regular shape of the last whorl. *L. kahoolavensis* has a continuous lower palatal fold, among other differences. *L. o. kona* is nearly related to

L. micra and especially *L. ovatula*. It is larger than the former, with far stronger sculpture. *L. ovatula* of Oahu is very closely related, but the prominent basal crest and hump distinguish it. The lower palatal and basal folds are stronger in *L. o. kona*.

The chief variations noticed among the numerous specimens are in shape (see measurements) and strength of the ribs, as shown in the figures.

A single specimen (pl. 26, fig. 5) was among Lyropupae taken by the authors on Molokai at Moomomi on the north coast, at the end of the escarpment running north from Mauna Loa. It measures, length 2.25, diam. 1.4 mm., and appears to differ in no respect from those of the Kona slope of Hawaii.

Probably the species will be found in Maui when fossil material from that island comes to hand.

19. LYROPUPA PLAGIOPTYX P. & C., n. sp. Pl. 24, figs. 8, 11, 12.

The shell is ovate, rather solid, the whorls strongly convex, the greatest convexity below the suture, with sculpture of *regular, strong, arcuate ribs*, about 15 on the last whorl. The last whorl tapers downwards. Its last half is swollen and strongly ribbed below the suture, encircled in the middle with a rather deep sulcus, crossed by the ribs. Below this is a short, sharp lateral sulcus (over the lower palatal fold), and on the basal convexity are two very short impressions. The ribs diminish in size and are increased in number on the basal half of the last half whorl. Aperture as usual in the group externally. The columellar lamella is strongly crescentic, as in *L. ovatula*. The crest of the upper palatal fold is uneven. Below its inner end there is a small but high and short vertical tubercle. The lower palatal fold is immersed but visible in a front view, *short, high and oblique, its outer end sloping steeply downward.*

Length 2.15, diam. 1.3 mm.

Oahu: Kawaihapai, on a steep, wooded hillside about 500 ft. above the plain and perhaps ¾ mile from the sea (Cooke & Pilsbry, 1913).

This species, found only dead in the surface débris, is re-

lated to *L. ovatula*, but it differs by not having a distinctly differentiated basal crest and especially by the internal structure of the palatal region. The tubercle below the inner end of the upper palatal fold is of different shape, and the lower palatal fold is a high and oblique lamina in *L. plagioptyx*, a lower, diffuse tubercle in *L. ovatula*.

The locality is at the western end of the Waianae range.

20. LYROPUPA CYRTA C. & P., n. sp. Pl. 23, figs. 9, 10.

The shell is stouter than *L. perlonga*, the outlines more convex, the spire tapering more upwards. The whorls are regularly and strongly *convex*, the last having only two sulci, and these *very shallow* or even scarcely discernible. The ribs are stronger than in *perlonga*, not flexuous, and number about 15 on the last whorl. They pass over the narrowly rounded base.

The lower palatal and basal folds are deeply placed, the former a short, rather spreading callous tubercle, the latter narrower and longer. Two strong tubercles stand beyond their inner ends (pl. 25, fig. 15).

Length 2.75, diam. 1.45, aperture 1 mm.; 5½ whorls.

Hawaii: fossil at Mana, type loc., and Palihoukapapa (Henshaw, Thaanum).

This species resembles *L. ovatula*, but it is larger with far less distinct sulci on the last whorl and no differentiated basal crest.

21. LYROPUPA CUBANA (Dall). Pl. 25, figs. 13, 16, 17.

"Shell pinkish brown, paler toward the apex, small, short, stout, dextral, five-whorled, apex rather bluntly rounded, sides subparallel, base full and rounded; spiral sculpture of fine striae, most prominent between the ribs on the last whorl and obsolete on the early whorls; they do not overrun the ribs: transverse sculpture of (on the last whorl about twenty-five) strong, sigmoid, squarish, narrow, elevated ribs, running from suture to suture, and separated by much wider interspaces; these ribs are closer and finer toward the apex of the spire, they resemble when best developed those of *Pupa lyrata* Gould; last whorl subconstricted before the aperture is

formed; aperture obscurely trilobate, margin well reflected, whitish; primary lamellae, except A and E, set rather more deeply in the throat than usual.

Formula A C E according to Dr. Sterki's arrangement. The primary A [angular lamella] is stronger and more triangular at the aperture than the others, but becomes a thin, narrow, sharp lamella internally; the secondary 2 [parietal lamella] does not come so near the aperture as A [angular lamella], but further back is a little higher than the latter, and the two run parallel like rails on a track, but somewhat irregularly. From the aperture no lamella can be observed on the pillar, but the primary C, [lower palatal fold] which falls short of reaching the margin and is comparatively weak toward the aperture, in the depths of the throat, is higher and stronger, forming a prominent, high, thin lamella. The primary E [upper palatal fold] is prominent at the angle of the outer lip, and projects toward A [angular lamella]; deeper in it becomes lower and weaker, and still further in it projects in a high triangular plate stronger than any of the others at that depth. There are no indications of any other lamellae or callosities. The margin of the aperture is set somewhat obliquely to the axis (see fig. 16). Max. lon. of shell 1.75; max. diam. 1.37 mm. Habitat, Cuba" (*Dall.*).

Vertigo cubana Dall, Proc. U. S. Nat. Mus. xiii, 1890, pl. 1, figs. 1, 2.

"A single specimen of this remarkable little species is in the U. S. National Museum, mollusk register 87645. It was received from the collection of the late Dr. Shurtleff, now belonging to Wesleyan University, Middletown, Conn., and was obtained by him from the late Prof. C. B. Adams, or at least still occupies the tiny glass tube, stopped with sealing-wax, in which Professor Adams secured his minutiae, and a tiny label on which is written "*Pupa* . . . . Cuba" in Professor Adams' well-known chirography" (*Dall.*).

There can be little doubt that the locality *Cuba* was an error. Professor Adams received and described land shells from the Hawaiian Islands, and as *V. cubana* differs very little from *L. thaumasia*, a Hawaiian origin appears probably, al-

though up to this time no other Hawaiian specimens have been turned up. The species was referred to *costata* Pse. as a synonym by the senior author (Proc. A. N. S. Phila. 1900, p. 432, footnote 4), upon comparison of the figures with examples of *L. thaumasia* which Pease sent out as *costata*; but there are some small differences in shape which cause us now to leave them apart.

The type specimen of *cubana* has lamellae and folds like those of *thaumasia*. In both species the broad, milk-white columellar lamella may be seen in an oblique view in the aperture. The lower palatal fold is short and rather high. The internal barrier is not visible in the mouth, but externally the impressions and the light markings due to the plicae are exactly as in *thaumasia*. The specimen measures: length 1.9, diam. 1.3 mm., alt. of aperture 0.8 mm. Figs. 16, 17 are copies of the original illustrations; fig. 13 a direct face view of the same specimen.

22. LYROPUPA THAUMASIA C. & P., n. sp. Pl. 24, figs. 13 to 15; pl. 25, fig. 14.

The shell is small, broadly oval, perforate and rimate, tawny, solid. Outlines of the spire are strongly convex. The whorls are short, convex, the embryonic 1½ very minutely granulate, the rest with sculpture of moderately strong, oblique, somewhat arcuate ribs about half as wide as their intervals, about 27-30 on the last whorl, which ascends slightly near the aperture. There are minute spiral striae between the ribs. The last half whorl has a rather shallow sulcus (sometimes scarcely noticeable) parallel with the suture, and nearer the base a shorter broader excavation preceded by an inflation. The base is narrow, rounded and straight (as viewed from below), passing posteriorly into the baso-dorsal inflation mentioned. The aperture is but slightly oblique, squarish, the peristome well expanded, continuous, though adhering to the preceding whorl for a short distance above the columella. The angular lamella is rather long and straight; its edge curves slightly outward, to form a nearly entire circular sinulus with the upper palatal plica. The parietal lamella is very long, curved

at the inner end, its free edge being reflected towards the suture. The very deeply placed columellar lamella is not visible in a frontal view; it is stout and semicircular. The upper palatal fold is long, its free edge having two concavities where the angular and the parietal lamellae approach it; its inner end curves downward a little, terminated on a very low semicircular callous rim which bounds the cavity formed by the posterior inflation of the basal crest. Upon this rim stand two short, high oblique folds, upper and lower, converging towards each other inwardly. The lower palatal fold is short and rather high. Externally the palatal folds are visible as buff markings, the upper palatal and upper oblique fold showing as a decurved band, the lower oblique fold and lower palatal as indistinct spots (pl. 25, fig. 14).

Length 1.95, diam. 1.18, aperture 0.73 mm.; 5½ whorls (type).

Length 1.95, diam. 1.13, aperture 0.66 mm. Limahuli, fossil.

Length 2.02, diam. 1.3 mm. Ekaula.

Length 2, diam. 1.25 mm.; 5½ whorls.

Length 1.9, diam. 1.25, aperture 0.6 mm.; 5⅓ whorls.

Kauai: Hanakapiai (type loc.); Ekaula and Olokele (Cooke); also fossil at Limahuli (Dole and Cooke). Type 11061 Bishop Museum; paratypes 15575 Bishop Museum and 119449 A. N. S. P.

This species is well distinguished by its short, compact contour, numerous strong ribs, the absence of any trace of a third or subbasal impression on the back, and by the strongly developed apertural processes.

L. thaumasia is closely related to *L. cubana*, and may prove to be connected by intermediate forms. On comparison of the type specimens there is no difference in color, sculpture or convexity of the whorls, but *cubana* is clearly wider than the shortest *thaumasia* at hand. In *thaumasia* of the same length as *cubana*, 1.9 mm., there is nearly a half whorl more, and the aperture is distinctly smaller. Its length, measured vertically is slightly less than one-third that of the shell, while in *cubana* it is decidedly more than that, contained 2½ times in length of shell. There is no difference in the apertural parts so far as visible in the mouth.

In *L. thaumasia* the diameter of the shell is about 58 to 65 per cent of the length; in *L. cubana* it is about 70 per cent.

The specimens from Ekaula (4) and Olokele (1) are slightly larger than the typical form, more globose in outline, with considerably weaker palatal plicæ and with shallower and less distinct sulci on the last whorl. Fossil specimens from Limahuli agree very closely with the typical form.

Pease distributed this species as his *Vertigo costata*; but the description of that shell does not apply well to this.

Undetermined species.

"VERTIGO COSTATA Pse.—Shell cylindrical, oblong, somewhat solid, dextral, rimate-perforate, longitudinally flexuously strongly costate, reddish; whorls 4, rotundate-convex, the last strongly concentrically bisulcate, compressed at the base, apex obtuse; suture strongly impressed; aperture bell-shaped, rotund at the base, furnished with 4 lamellæ, 2 on the parietal wall, the first united with the lip, the second median, entering, 1 on the basal margin, 1 on the lip posteriorly; inner lip flexuous; peristome thin, with the margins not joined. Length 2.0, diam. 1.0 mm. Hawaii." (*Pease.*)

Vertigo costata PEASE, Proc. Zool. Soc. London, 1871, p. 461. —*Pupa costata* PFR., Monographia Hel. Viv., viii, p. 399.—BOETTGER, in von Martens, Conchologische Mittheilungen, i, 1880, p. 59.—ANCEY, Mem. Soc. Zool. France, 1892, v, p. 710.

This species could not be found in the Pease collection at Cambridge, and the junior author, in the course of many years' collecting has never seen a specimen meeting all the requirements of the description, which gives characters both of *Nesopupa* and *Lyropupa:* the 4 whorls and disjoined margins of the aperture would place it in *Nesopupa*, but the deep suture, strong, flexuous costæ and the position of the upper palatal fold on the outer lip show that *costata* has certain claims to be ranked as a *Lyropupa*.

Specimens sent by Pease as *costata* to the Academy of Natural Sciences and others sent to A. D. Brown (now in the museum of the Academy) are *Lyropupa thaumasia*; but this species is far broader than Pease's measurements indicate, the

peristome is continuous, the dorsal impressions are not deep, and it could hardly have been described as *flexuose forte costata*.

It was these specimens from Pease which the senior author referred to as *Nesopupa* (*Lyropupa*) *costata*, in Proc. A. N. S. Phila., 1900, p. 432. Other authors who have mentioned the species knew it only by Pease's description.

At present therefore *V. costata* appears to be a lost species of uncertain genus; unless the type comes to light it must be dropped as unrecognizable.

Genus PTYCHALÆA Boettger.

This volume, pp. 157, 220.

This group was proposed for a Lower Miocene species of Europe; a recent species of the Bonin Islands appears to agree, but the writer has not seen the fossil genotype.

They differ from *Nesopupa* chiefly by having a strong crest behind the lip, as in many Vertigos. This is not usually a character of much importance, but it is absent in the long series of species referred to *Nesopupa*. Boettger himself made a distinction between *Ptychalæa* and *Ptychochilus* (= *Nesopupa*), both of which he recognized in the European Tertiary.

We now consider *Ptychalaea* incorrectly placed in Vertigo. We are strongly disposed to subordinate *Nesopupa*, *Costigo* and *Pronesopupa* to *Ptychalaea* as subgenera; yet specimens of the fossil type of the latter are not at hand, and species intermediate between *Ptychalaea* and *Nesopupa* have not been found. At present we admit several genera, *Nesopupa*, *Pronesopupa* and *Costigo*, among the Polynesian and Oriental Vertigininae as a temporary expedient rather than as an expression of definite conviction. It is quite probable that a study of the dentition would yield characters of value in this inquiry.

1. PTYCHALAEA DEDECORA (Pils.). P. 158.

The fossil species *P. flexidens* Reuss, and possibly *capellinii* Sacco belong here. The other species enumerated under *Ptychalæa* on p. 220 belong to *Nesopupa*.

Genus NESOPUPA Pilsbry.

Ptychochilus Boettger, Conchol. Mittheil., i, 1881, p. 47; type *P. tantilla* Gld. Not *Ptychocheilus* Agassiz, Amer. Journ. Sci. and Arts xix, 1855, p. 227. Not *Ptychochilus*, Jordan, Bull. U. S. Nat. Mus. no. 10, 1877, p. 58.

Nesopupa Pils., Proc. Acad. Nat. Sci. Phila. 1900, p. 432.

The shell is minute, rimate, oval or ovate, the surface usually opaque and dull, pitted, striate or ribbed. Aperture with angular, parietal and columellar lamellae and usually palatal folds; lip expanded. Type *N. tantilla* (Gld.).

Animal similar to *Vertigo* in lacking inferior tentacles. Eye tentacles cylindric, rather stout, not swollen distally, the eyes central in the ends as seen from above.

Distribution: islands of the Pacific, Oriental and Ethiopian regions, St. Helena.

Nesopupa is closely related to *Ptychalaea* (see above) and to *Lyropupa*, also to *Costigo*, *Pronesopupa* and *Campolæmus*, which we believe to be groups derived from various Nesopupæ. The Madeiran *Staurodon* is also closer to *Nesopupa* than to *Vertigo*.

As tertiary fossils Nesopupae are known from the Upper Oligocene to Pliocene of Europe. *N. trigonostoma* (A. Brn.), *N. blumi* (Bttg.), *N. priscilla* (Palad.) (see p. 220) apparently belong here, appearing to be most related to the section *Indopupa*. Central Europe at that time had numerous Oriental genera of land snails.

Inhabiting widely separated island groups, there have been several nearly independent centers of evolution, making the construction of a phylogenetic classification exceptionally difficult. Thus, the Hawaiian *Vertigininae* though greatly varied, show few points of contact with those of other regions. The forms of Polynesia and Micronesia are a homogeneous group, but a few closely related species occur in the Moluccas and Mauritius. The Oriental region series is closely related to the Ethiopian group.

While the interrelations of Nesopupid groups of restricted areas are fairly clear, it is not so when those of different faunal

units are to be combined in one classification. Different combinations of characters, and parallel but not identical stages in their evolution are to be considered. Under these conditions it has been thought most convenient for those concerned to treat the species by faunal rather than by taxonomic groups. The following synopsis of classification is therefore an arrangement for convenience, in which groups of different faunas in a similar stage of evolution but not directly related are sometimes juxtaposed.

Synopsis of Sections of Nesopupa.

a^1. Angular lamella long, entering rather deeply, anteriorly curved, joining the peristome.
  Inner end of the columellar lamella turning downward I.
  Inner end of columellar lamella straight or upturned II.
a^2. Angular lamella not entering deeply, straight, joining the peristome III.
a^3. Angular lamella very short, nodular or shortly lamellar, sometimes not emerging to the peristome IV.

I.

Nesopupa, typical section. The angular lamella is long, strong, curving to join the outer lip near its insertion; the inner end of the columellar lamella turns downward; there are at least 5 well developed teeth. The surface is more or less pitted-granulose, with spaced cuticular riblets, often deciduous.

This Section includes all of the Nesopupæ of Polynesia and Micronesia which we have seen, *N. moluccana*, *N. gonioplax* of Mauritius, and probably the Melanesian species.

N. tantilla (Gld.). Tahiti.
N. pleurophora (Shutt.). Tahiti.
N. armata (Pse.). Borabora.
N. paivae (Crosse). Gambier Is.
N. dentifera (Pse.). Cook Is.
N. godeffroyi (Bttg.). Samoa Is.
N. tongana (Bttg.). Tonga Is.
N. vitiana (Bttg.). Viti Is.
N. norfolkensis (Sykes). Norfolk I.
N. lifouana (Gass.). Lifu.
N. mariei (Crosse). New Caledonia.
N. quadrasi (Mlldff.). Guam.
N. eapensis (Bttg.). Yap, Carolines.
N. ponapica (Mlldff.). Ponape, "
N. moluccana (Bttg.). Amboina.
N. gonioplax (Pils.). Mauritius.

Ia. Section *Nesopupilla* P. & C. A collateral group of the Hawaiian Islands, differing by the sculpture of smooth rib-striae without cuticular edges or pitting of the surface, having one or two furrows behind the lip, over the palatal folds; lamellae as in typical *Nesopupa*.

N. plicifera Anc. Oahu.
N. waianaensis C. & P. Oahu.
N. litoralis C. & P. Oahu.
N. dispersa C. & P. Oahu to Hawaii.
N. baldwini Anc. Maui.
N. b. centralis Anc. Hawaii.
N. b. subcostata C. & P. Molokai.
N. b. lanaiensis C. & P. Lanai.

II.

The angular lamella is long, strong, curving to join the lip insertion as in *Nesopupa*, but the columellar lamella is straight or slightly curved upward at the inner end, being less specialized than in *Nesopupa*. Here are placed several sections not directly related.

IIa. Section *Cocopupa* P. & C. Surface minutely pitted, without riblets.

N. cocosensis (Pall.). Cocos Island.

IIb. Section *Nesodaggs* C. & P. Surface with spaced ribs with cuticular edges and rugose intervals; angular lamella strong in front.

N. wesleyana Anc. Hawaii to Oahu.
N. w. gouveiae C. & P. Hawaii.
N. w. tryphera C. & P. Kauai to Molokai.
N. w. rhadina C. & P. Molokai, Maui, Lanai and Oahu.
N. thaanumi Anc. Oahu, etc.

IIc. Section *Indopupa* P. & C. Similar, but with sculpture like typical *Nesopupa*; the angular lamella low in front. Oriental Region.

N. moreleti (A. D. Br.). Borneo, Philippines.
N. moellendorffi (Bttg.). Philippines.
N. filosa (Th. & Stol.). Burma.
N. brevicostis (Bs.). Barrackpore.
N. salemensis (Blf.). Kalryen Hills.
N. cinghalensis (Gude.). Ceylon.

IId. Section *Afripupa* P. & C. Sculpture of close rib-striae without cuticular edges. The last three species referred to this section with doubt.

N. griqualandica (M.&P.) S. Africa.
N. farquhari (Pils.). S. Africa.
N. bisulcata (Jick.). Abyssinia.
N. b. rhodesiana (Pils.). Rhodesia.
N. (?) iota (Preston). Brit. E. Africa.
N. (?) micra (Pils.). Mauritius.
N. (?) nannodes (Q. & M.). Philippines.

IIe. Section *Helenopupa* P. & C. Surface smooth.

N. turtoni (Smith). St. Helena.

III.

Section *Insulipupa* P. & C. Angular lamella low throughout, straight, joining the outer lip; surface as in *Nesopupa*, pitted; form rather cylindric. Oriental and Ethiopian Regions, Mascarene Islands. The last four species are placed in this section with some doubt.

N. malayana (Issel). Borneo, Philippines.
N. barrackporensis (Gude). Barrackpore.
N. corrugata (Prest.). Rhodesia.
N. minutalis (Morel.). Comoros.
N. megalomastoma (Malz.). W. Africa.
N. (?) comorensis (Pils.). Comoros.
N. (?) incerta (G. Nev.). Bourbon.
N. (?) ventricosa (H.Ad.). Mauritius.
N. (?) celebensis (T. C.). Celebes.

IV.

Angular lamella small, short, or not emerging to the lip insertion; inner end of the columellar lamella not turning downward.

IVa. Section *Infranesopupa* C. & P. Striae without cuticular edges. Hawaiian Islands.

N. limatula C. & P. Maui.
N. dubitabilis C. & P. Molokai.
N. d. kaalaensis C. & P. Oahu.
N. anceyana C. & P. Hawaii.
N. subcentralis C. & P. Hawaii.
N. bishopi C. & P. Maui.
N. forbesi C. & P. Hawaii.
N. infrequens C. & P. Kauai.

IVb. Section *Limbatipupa* C. & P. Striae or riblets having cuticular edges. Hawaiian Islands.

N. newcombi (Pfr.). Hawaii to Kauai (numerous varieties).
N. oahuensis C. & P. Oahu.
N. kauaiensis Anc. Kauai.
N. singularis C. & P. Oahu, Maui.
N. alloia C. & P. Kauai.

IV. Section —. Delicate lines of growth; angular lamella remote from the lip insertion.

N. proscripta (Smith). Christmas Island, near Java.

Hawaiian Nesopupillid Groups.

By C. Montague Cooke and H. A. Pilsbry.

The Hawaiian species of this genus cannot readily be classified with those of other regions. The characters elsewhere used for defining groups do not apply. They appear to have had an independent evolution. A pitted surface, so commonly seen in other islands, is not found here. There has been mature adaptive radiation; besides the terrestrial forms there are many living on the bark of trees, others on foliage; some in relatively dry, others in very humid habitats.

In arboreal, and especially in folicolous species there is a tendency towards degeneration of the teeth, which culminates in the species referred to *Pronesopupa*, which may be genetically related to the Limbatipupæ. This tendency may be traceable to the absence or rarity of predaceous insects, which are probably much more numerous on the ground than on bark and foliage.

The authors have seen all of the Hawaiian Nesopupæ and Pronesopupæ except "*Vertigo*" *bacca* Pease. The types of the species of Ancey and of Cooke & Pilsbry are in the Bishop Museum, paratypes or topotypes of all but *N. alloia* and *N. forbesi* are in the museum of the Academy.

Section *Nesopupilla* P. & C., new section.

While closely related to the typical Nesopupæ by the form of the angular and columellar lamellæ, these shells differ in sculpture and by the sulci of the last whorl.

They are minute shells with nearly smooth, minutely granulose embryonic whorls, the third, fourth and last whorls costulate (except in E. Maui and Hawaii specimens of *N. baldwini*); costæ without membranous edges, rather closely and evenly spaced. There are two nearly parallel sulci on the back of the last whorl, separated by a rounded ridge. The angular lamella is long, slightly sinuous, extending to the margin of the aperture; palatal folds long, the upper emerging nearly to the margin; columellar lamella rather short, ending abruptly in a swelling, its inner termination deflected downwards, al-

most at a right angle, and extending to the base of the columella. Type *N. waianaensis.*

They are usually found close to the ground in rather damp places on stones, dead leaves, fallen twigs and the like.

The unidentified *Vertigo bacca* Pease is like these species in having the last whorl concentrically bisulcate, but nothing is said of palatal folds. The very brief and incomplete description follows.

"*Vertigo bacca* Pse. T. cylindracea, abbreviata, tenuiuscula, dextrorsa, perforata, laevigata; apex obtusus; anfr. 4, rotundati, ultimus concentrice bisulcatus; apertura fere circularis, in pariete aperturali bilamellata, columella subunidentata; labrum vix eversum; pallide fusca.

"Hab. Kalapana, insulae Hawaii" (Pease, Proc. Zool. Soc. London, 1871, p. 462).

No dimensions were given. Subsequent authors have added nothing to the above account. Pease further remarks: "The above description was drawn up several years since from specimens collected at Kalapana, district of Puna, Island of Hawaii; as they have been lost, I furnished the precise locality to enable collectors to recover the type."

Key to the Species of Nesopupilla.

a^1. Angular lamella extending to outer margin of peristome or united to the outer lip-insertion by a thick callus.

b^1. Angular lamella terminating on the parietal wall, united to the lip insertion by a thick callus; only the lower sulcus on the back distinctly impressed. *N. plicifera*, no. 1.

b^2. Angular lamella united to the outer margin of the peristome; two furrows behind the lip clearly defined.

c^1. Lower palatal fold accompanied by a short fold near its outer end. *N. waianaensis*, no. 2.

c^2. Lower palatal fold *not* accompanied by a short lamella: Spire tapering near the summit.

d^1. Whorls weakly convex; length of shell more than 1.7 mm. *N. litoralis*, no. 3.

d^2. Whorls convex; length of shell less than 1.65 mm. *N. dispersa*, no. 4.

a^2. Angular lamella terminating on the parietal margin near the insertion of the outer lip, not united to the lip insertion by a thick callus. *N. baldwini*, no. 5.

1. NESOPUPA PLICIFERA Ancey. Pl. 27, figs. 1, 2, 3.

"Shell small, ovate, dark reddish brown, somewhat thin, slightly shining, except for the apex obliquely and closely plicate, plicæ smooth, distinctly perforate. Spire obtuse, ovate or cylindrically ovate. Whorls 5, noticeably slightly convex, suture impressed and simple, the last whorl tapering at the base, concentrically sulcately impressed, with the sulcus corresponding to the lower palatal lamella, slightly compressed about the umbilical crevice. Aperture hardly oblique, receding slightly at the base, ovately truncate, furnished with lamellæ, as follows: two parietal, of which the upper angular extends to the upper margin, and is connected with the outer margin; strongly elongated; the lower [parietal lamella] is large, a little deeper seated, extending slightly spirally. One small, acute, tooth-like, columellar. Finally, two elongated palatals, parallel, the upper almost reaching the margin. Peristome brown, thickened, narrowly expanded, with distant margins, united by an inconspicuous callus, the upper subangularly produced outwardly. Length 1.5, diam. hardly 1, aperture 0.5 mm. long. Oahu, Nuuanu (Thaanum)" (*Ancey*).

Nesopupa plicifera Anc. Proc. Malac. Soc. London, vi, 1904, p. 122, pl. vii, f. 14. Type 18703, paratypes 18740 Bishop Museum.

Ancey's material consists of the type and 4 paratypes. The angular lamella is slightly curved and is united with the junction of the outer lip by a thick callus, forming, with the upper palatal fold, an almost circular sinulus. In immature specimens of 4½ whorls, from the type locality on the slopes of upper Nuuanu, just south of the Pali, the embryonic whorls are almost smooth, under a high-power lens very minutely granulose for the first 1⅔ whorls, then, almost abruptly rather strong, sharp, oblique costæ set in. In adult

specimens carefully compared with the type but with better preserved surfaces, the third and fourth whorls are distinctly costate; on the last whorl the costæ are at first well developed near the suture, becoming weaker below; the interstices are very minutely striate with lines of growth. The base is compressed and prominent. There is a narrow, rather deep concentric sulcus on the back of the last whorl, just above the lower palatal fold, but no twisted sulcus just in back and parallel with the peristome, and merely a flattening over the upper palatal fold. In the holotype the costæ are about .055 mm. apart on penultimate whorl and the shell has the following measurements: length 1.53, diam. 0.95, greatest length of apert. 0.61 mm. There are about 5¼ whorls and the outer margin of the aperture is not flattened. This is not the case in most of the adults examined; for nearly all the fully adult specimens have 5½ whorls, and the outer margin of the aperture is slightly flattened.

The typical form is distributed over the whole Koolau Mountain range of Oahu. It is exceedingly abundant, if one has the patience to look for these minute forms, and can nearly always be found on the dead leaves of ieie (*Freycinetia*) wherever this plant occurs. It is occasionally found on other dead leaves, but rarely on stones. In one or two isolated cases the junior author has found typical specimens under moss on trunks of living trees. A single example of the typical form from the Waianae Mts. is in the Bishop Museum collection.

Occurring with typical examples are a few slightly larger specimens from upper Kaliuwaa and Kaipapau, Oahu. They differ only in that the outline is slightly more cylindrical and the shells are slightly longer. One with 5½ whorls measures: Length 1.71, diam. 0.92, apert. 0.6 mm. in greatest length.

2. Nesopupa waianaensis C. & P., n. sp. Pl. 27, figs. 4, 5, 6.

The shell is minute, perforate (umbilicus minute, deep, semicircular in outline), ovately conic, snuff-brown, distinctly costulate except on the embryonic whorls, shining, quite thin, somewhat translucent. Spire with convex outlines, and rounded apex; individual whorls convex, separated by a rather

deep suture. Whorls 5, the first rather large, nearly smooth, under a high-power lens very minutely wrinkled; the second slightly narrower than the first, becoming costulate rather abruptly near its termination; the rest of the whorls increasing slowly and evenly, regularly and strongly costulate; riblets strongly oblique, with rounded edges, on the penultimate whorl about 0.055 and on the last whorl about 0.14 mm. apart (or partly obsolete); the interstices microscopically wrinkled, the wrinkles short; last whorl slightly broader than the penult, tapering to the base, scarcely ascending near the aperture, bisulcate, the sulci deep, corresponding to the palatal plicæ, the lower strongly curved, deep, broad, remote from the peristome, the upper arched, not quite so deep, nearly reaching the peristome, the two separated by a convex ridge. Aperture irregularly truncate-ovate, small, slightly oblique, contracted, its outer margin slightly sinuous, its lip insertions converging, nearly united by a thick callus. Angular lamella long, slightly curved, slender, not very high, extending to the margin of the outer lip just before its insertion. The parietal lamella is deeper seated, stronger and slopes outward. The columellar lamella is strong, at first horizontally entering, then descending around the columella. The upper palatal fold is long, lamella-like, nearly reaching the peristome, with a depression just in back of its outer end. The lower palatal fold is very deeply seated, with a dentiform nodule close to and below its outer end. The outer margin of the peristome is slightly thickened within, scarcely expanded, the columellar margin broadly expanded.

Length 1.41, diam. 0.8, diag. length of aperture 0.5 mm. Cotype.

Length 1.41, diam. 0.85, diag. length of aperture 0.52 mm. Cotype.

Oahu: Waianæ Mts. at Pukaloa, in the open valley under stones near the "Hunter's Cabin," type loc.: Lualualei, near the head of the valley (Cooke); Kawaihapai at the western end of the range, fossil in soil of the plain and slopes of the foothills (Cooke & Pilsbry).

This species is closely related to *N. plicifera*. The angular

lamella is proportionally slightly weaker than that of *N. plicifera* and is attached to the outer lip rather than the parietal wall; the lower palatal fold is accompanied by a dentiform nodule which does not appear to be developed in any specimens of *plicifera*; the lip insertions converge more and are nearly united by a thicker callus. Externally it has two strong furrows on the last whorl.

3. NESOPUPA LITORALIS C. & P., n. sp. Pl. 28, fig. 1.

The shell is minute, perforate and shortly rimate, cylindrical, the upper third convexly conic, whitish in its fossil state, the last four whorls obliquely costate. Spire nearly cylindrical with slightly convex outlines, tapering above to a rather blunt apex, individual whorls only weakly convex, separated by an impressed suture. Whorls 5½ to 5⅔, the first and second of nearly equal width, the rest increasing very slowly and regularly; the embryonic shell, under a strong lens, almost smooth for about 1½ whorls, the costæ at first rather weak, blunt, the rest of the whorls evenly costate, costæ oblique, with blunt edges, about 0.07 mm. apart on the penult and 0.11 apart on the last whorl, the interstices nearly smooth. Last whorl nearly cylindrical, tapering gradually towards the base, ascending very slightly to the aperture, bisulcate on the back, the sulci corresponding to the palatal plicæ, the lower sulcus shallow, broad, strongly arched, terminating at a slight distance from the peristome, the upper, shallower, wide, nearly parallel almost reaching the peristome, the two separated by a rounded ridge. Aperture truncate-ovate, rather small, contracted within, its outer margin very slightly sinuous, slightly oblique, perpendicular, the lip-insertions united by a thick callus. Angular lamella strong, long, slightly diverging from the parietal, and nearly equal to the latter in height, extending nearly to the margin of the peristome and united with it just outside of the lip insertion. Parietal lamella strong, quite oblique, deeply penetrating. Columellar lamella rather strong, at first transverse to the axis, then abruptly turning downward at right-angles. The upper palatal fold is long, strong, extending to the inner margin of the peristome, with a de-

pression just back of its prominent outer end. The lower palatal is deeply immersed, higher within, slightly sinuous. The outer and basal margins of the peristome are uniformly, slightly thickened within, not expanded; the columellar margin is broadly expanded.

Length 1.83, diam. 1; greatest length apert. 0.61. Cotype, B. M.

Length 1.75, diam. 1.03; greatest length apert 0.63. Cotype, A. N. S.

Oahu: Ewa, type loc., very abundant under stones on the coral plain below "Sisal" (Cooke); Diamond Head (Cooke & Pilsbry); found only fossil. Cotypes 11065, Bishop Museum, and 44694 A. N. S. P.

The typical form of this species is easily distinguished from *N. waianaensis* by its larger size, more cylindrical form and less convex whorls. From *N. plicifera* it is recognized by its more tapering summit, but especially by the thickened parietal callus, and the angular lamella terminating on the outer lip rather than on the parietal callus, though it is very near the junction of the two.

4. NESOPUPA DISPERSA C. & P., n. sp. Pl. 27, figs. 7, 8.

The shell is minute, perforate (umbilicus, extremely minute, open, deep) sub-cylindrical, whitish or brownish in its fossil state; the last three whorls distinctly costulate; opaque. Spire sub-cylindrical, extended, with slightly convex tapering outlines, rather obtuse at the summit, individual whorls moderately convex, separated by a rather shallow suture. Whorls 5⅓, the embryonic large, the second slightly wider than the third near its initial stage, nearly smooth, under a strong lens very minutely punctate, the riblets beginning rather abruptly near the end of the second whorl; rest of the whorls increasing slowly and regularly, distinctly finely and evenly costate, the costæ slightly oblique, about 0.07 apart on the penult and 0.09 on the last whorl, with the interstices minutely granulose; last whorl slightly broader than the penult, subcylindric, tapering gradually toward the base, its last third straight, hardly ascending at the aperture, bisulcate behind the aperture, the

sulci corresponding to the palatal plicæ; the lower sulcus is strongly arched, shallow, broad, terminating at a little distance back of the aperture, the upper longer, shallower, not as strongly curved, extending nearly to the peristome. Aperture truncate-ovate, scarcely oblique, its outer margin slightly sinuous, lip insertions converging somewhat, sometimes united by a thin callus, thickened at and near the lip insertion. Angular lamella long, high, of nearly uniform height, nearly parallel to the parietal, extending to the margin of the outer lip; parietal lamella more deeply seated, strong, long and somewhat oblique. Columellar lamella strong, deeply seated, at first transverse to the columella, then abruptly turned downwards almost at a right angle and extending to the base of the columella. Upper palatal fold strong, long, with a slight depression back of its outer end, its margin nearly touching that of the angular lamella; extending nearly to the margin of the peristome. The lower palatal fold is deeply immersed, long, strong within, tapering gradually to its anterior end. Peristome with the outer and basal margins uniformly thickened within, the columellar margin narrowly, triangularly arched above the umbilicus.

Length 1.53, diam. 0.86, greatest length of apert. 0.5 mm.

Oahu: Makua, type loc. (Forbes & Cooke), and Lualualei (Cooke), in the Waianae Mts.; Kailua (Pilsbry, Cooke), Waimanalo, Rocky Hill, Manoa, Kahala, Malaekahana, Kahuku and Kawailoa (Cooke) in the Koolau Mts.

Molokai: Kalaeokailio Pt., Mauna Loa, Shifting Sands and Moomomi (Cooke & Pilsbry).

Lanai: Mahana Gulch *a single living specimen*, and Western End (Forbes).

Kahoolawe: Kanapou, (Stokes, Forbes) and Schooner Bay (Pilsbry and Cooke).

East Maui: Kanaio and Auwahi (Fleming).

Hawaii: Puuwaawaa (Thurston), Kona (Thwing, Gouveia), Huehue, Kapulehu and Waiaha (Gouveia). All specimens fossil from more or less recent beds, except the single fresh specimen from Mahana Gulch, Lanai. Type 11066 Bishop Museum, paratypes 42942 Bishop Museum and 44707 A. N. S. P.

A very variable and widely distributed little species. Specimens from different colonies and islands vary considerably from the typical form described above. The most important races may be briefly described as follows:

a. The shells from Rocky Hill and Manoa, Oahu, have slightly blunter apices than the typical lot.

b. Those from Kahuku and Kailua are slightly smaller but agree in other characters.

c. Specimens from Kalaeokailio Pt., Molokai, are slightly longer and narrower in proportion to their length.

d. Lanaian and East Mauian specimens are almost identical with the type lot.

e. Specimens from Kahoolawe have more convex whorls and the outlines of the spire are also more convex.

f. The shells from Hawaii are slightly smaller, cylindrical in outline and with fewer and closer costæ.

Shells from some of the different deposits have the following measurements:

a. Length 1.53, diam. 0.86, greatest length apert. 0.55 mm.; Rocky Hill, Oahu.

a. Length 1.6, diam. 0.9 mm. Diamond Head, Oahu.

b. Length 1.35, diam. 0.8, greatest length apert. 0.5 mm.; Kahuku, Oahu.

b. Length 1.38, diam. 0.8, greatest length apert. 0.5 mm.; Kailua, Oahu.

c. Length 1.6, diam. 0.83, greatest length apert. 0.55 mm.; Kalaeokailio Pt., Molokai.

c. Length 1.55, diam. 0.9 mm. Moomomi, Molokai.

d. Length 1.5, diam. 0.86; greatest length apert. 0.52 mm.; Western End Lanai.

d. Length 1.45, diam. 0.82, greatest length apert. 0.55 mm.; Kanaia, E. Maui.

e. Length 1.53, diam. 0.86, greatest length apert. 0.55 mm.; Kanapou, Kahoolawe.

f. Length 1.43, diam. 0.75, greatest length apert. 0.52 mm.; Puuwaawaa, Hawaii.

5. NESOPUPA BALDWINI Ancey. Pl. 27, figs. 9, 10.

"Shell shortly cylindrical-oblong, openly yet minutely perforate, brownish red, with a silky sheen, almost destitute of sculpture except for very thin lines of growth hardly visible under a strong lens. Spire obtuse. Whorls 5½, convex, the first three increasing rapidly in diameter, the rest nearly equal, with an impressed suture. The last oblong, scarcely swollen, slightly attenuate at the base, contracted back of the aperture by two shallow sulci parallel to the suture; slightly ascending in front. Aperture vertical, outwardly dilated angulate above the middle, truncate ovate, armed with plicæ or lamellæ as follows: parietals 2, of which one, the angular, is elongate, but shorter than the next; the other, nearly median, more deeply seated, long; one columellar, acute, dentiform; and two elongate palatals, corresponding to the exterior sulci, parallel, of which the upper almost reaches the margin. Peristome narrow, unicolorous, brown, slightly thickened, except at the columella, slightly expanded, with quite distant margins, the exterior of which is slightly sinuous above. Length 1.5, diam. 0.8, alt. of apert. about 0.5 mm. Molokai (Baldwin); Kaupakulua, Maui (Baldwin.) (Ancey.)

E. Maui; Kaupakalua (Baldwin), Kailua (Cooke), Mahiku (Forbes). W. Maui: Hahakea, Waihee (Cooke), Honokahau (Forbes). Molokai: abundant on the wooded eastern part (Thaanum, Forbes, Pilsbry, Cooke). Lanai: "top of Mountain" (Forbes). Hawaii: Keehia (Thaanum), Laaloa (Gouveia). Holotype 18698 Bishop Museum.

Nesopupa Baldwini ANCEY, Proc. Malac. Soc. London, vi, 1904, p. 122, pl. 7, fig. 13, with var. *centralis* Ancey.

This species and *N. plicifera*, are certainly very closely related. In *baldwini* the shell is darker colored, with slightly more convex outlines, the surface is smoother, the costulæ much weaker, closer and finer; the lip insertions are more remote, the angular lamella not being united with the outer lip by a thick callus. The columellar lamella is transverse to the columella, ending within in a rather prominent knob.

In the typical form from Kaupakalua, Maui, the rib sculp-

ture of the group is almost completely wanting. The furrows behind the lip are only weakly impressed, the upper one wholly lateral, the lower extending to the dorsal line. Both angular and parietal lamellae are long, the former reaching the thickened edge of the parietal callus near the insertion of the lip, the parietal lamella somewhat immersed, regularly curved in a basal view. The deeply placed columellar lamella is much thickened at the inner end, but is hardly bent downward. Lower palatal fold is deeply immersed, as usual. The upper palatal does not have a depression preceding the outer end, such as is seen in the Oahuan species. Ancey's type has the following dimensions: length 1.6, diam. 0.98, greatest length of aperture 0.67 mm. These measurements are slightly greater than Ancey gave, but the specimen was labelled *type* in his handwriting. A paratype measures: length 1.65, diam. 1 mm.

Specimens from West Maui are more like Molokai shells than those of East Maui.

Var. *centralis* Ancey. A little smaller and less cylindric, whorls 5, otherwise scarcely differing from the type (*Ancey*).

Hawaii: Olaa (Thaanum).

Very close to the typical Mauian form. In an Olaa specimen from Thaanum (no. 79991 A. N. S. P.) the surface shows no ribs, but there are some striae on the last fourth of a whorl. The upper palatal fold is indicated externally by a slight impression, the lower by a shallow, broad concavity, both being quite short for this species. It measures, length 1.65, diam. 1.05 mm.

Specimens from Keehia, Hawaii, collected by Mr. Thaanum are almost exactly similar to Ancey's type specimen. They are less distinctly costulate than those of Lanai, West Maui and Molokai.

5*a*. *Nesopupa baldwini subcostata* P. & C., n. subsp. Pl. 27, figs. 11, 12.

The surface is distinctly and closely costulate, the riblets not very strong, sometimes irregularly developed. Sulcus over the lower palatal fold well marked, the upper one shallow

or nearly obsolete. Angular and parietal lamellae about as long as in the typical form, nearly straight, the parietal emerging further than typical.

Length 1.6, diam. 1 mm.

Length 1.48, diam. 0.95 mm.

Widely distributed on the wooded part of Molokai, the type from upper Kaunakakai, along the pipe-line trail. It occurs as far west as Puunea, north of Meyer's lake.

5*b*. *Nesopupa baldwini lanaiensis* P. & C., n. subsp. Pl. 27, figs. 13, 14, 15.

The surface has weak ribs, or largely obsolete, last whorl with *both sulci deep*, surface strongly convex between them; base swollen. Angular and parietal lamellae somewhat longer than in typical *baldwini*. Columellar lamella with the inner knob somewhat turned down.

Length 1.5, diam. 0.9 mm.; 5½ whorls.

Lanai.

Section *Infranesopupa* C. & P., new section.

The shells are minute, dextral (except for *N. infrequens*); angle lamella *short*, not reaching the margin of the aperture, parallel to the parietal; upper palatal plica much shorter than the lower, neither of which is accompanied by a sulcus on the back of the last whorl; with a slight swelling just back of and parallel to the margin of the aperture; columellar lamella obliquely seated, not descending, when viewed from above slightly sigmoid. Type *N. limatula*.

They are usually found on the fronds of ferns or leaves of low plants, but occasionally on the trunks of trees.

Key to Species of Section Infranesopupa.

a^1. Shell sinistral. *N. infrequens*, no. 12.

a^2. Shell dextral.

b^1. Adult shells nearly 2.1 mm. in length.

c^1. Surface, between striæ, covered with minute anastomosing wrinkles. Maui.

N. bishopi, no. 10.

c^2. Surface, between striæ, minutely granulose. Hawaii. *N. forbesi*, no. 11.

b^2. Adult shells less than 1.9 mm. in length.

c^1. Aperture of adult shells always furnished with a minute basal fold. *N. d. kaalaensis*, no. 7*a*.

c^2. Basal fold usually absent, only present in very rare individual instances.

d^1. Adult shells minute, less than 1.4 mm. in length. Molokai. *N. dubitabilis*, no. 7.

d^2. Adult shells more than 1.5 mm. in length. Maui, Hawaii.

e^1. Palatal plicæ very short. Hawaii.

f^1. Shells broadly ovate to globosely ovate, parietal and angular lamellæ well separated. *N. anceyana*, no. 8.

f^2. Shells nearly cylindric, angular lamella usually dentiform, placed close to the parietal. *N. subcentralis*, no. 9.

e^2. Palatal plicæ longer. Maui. *N. limatula*, no. 6.

6. NESOPUPA LIMATULA C. & P., n. sp. Pl. 28, figs. 6, 10.

The shell is minute, sub-perforate (perforation very minute, almost closed), ovate, the last two whorls hazel, apical whorls much paler; rather thin; translucent with a silky sheen, microsopically striate. Spire with convex outlines and a rather obtuse apex; individual whorls convex, separated by a rather deep suture. Whorls 5 to 5¼, the embryonic 1¾ whorls convex, almost smooth, under the microscope very minutely punctate, viewed with oblique light the points arranged in spiral lines, glossy; the remaining whorls faintly striate, striæ slightly flexuous, very low, evenly spaced, the interstices and striæ covered with a fine network of minute wrinkles only seen under the microscope. The last whorl is rotund at the back, ascending slightly near the aperture, a little contracted behind

the lip, the contraction preceded by a low, wide swelling parallel to the margin of the aperture, near and at the base. Aperture truncate-ovate, scarcely oblique, nearly perpendicular, the outer margin slightly rounded, the columellar margin nearly straight, margins united by a very thin minutely punctate parietal callus. Angular lamella short, upright, not extending to the margin of the aperture. Parietal lamella long, strong, bent obliquely outwards. Columellar lamella strong, slanting downwards, deeply seated, entering almost horizontally in front, its inner end ascending; the upper and lower palatal plicæ rather long, slightly converging backwards, extending to a little distance within the margin of the aperture; the lower one quite stout. Peristome thin, expanded at the columella and base, the upper outer portion erect.

Length 1.65, diam. 1.1, aperture (diag.) 0.65 mm.

E. Maui: Ainahou and Palikou in Haleakala Crater (Cooke) and Ukulele (Forbes, Cooke). All specimens taken on the fronds of living ferns. W. Maui: Maunahooma (Forbes and Cooke) Honokaoo (Forbes). Type 11067 Bishop Museum, paratypes 38489 Bishop Museum and 44692 A. N. S. P.

Apparently a widely dispersed species on East and West Maui. All the specimens from E. Maui, were found at over 6,000 ft. elevation; those from W. Maui 2,000 ft. elevation. The single specimen collected by Mr. Forbes at Ukulele has a rather short, lamella-like fold between the upper and lower palatal plicæ, otherwise it agrees perfectly with the typical specimens from Ainahou. A second specimen collected by Cooke from near the same spot is longer, slightly narrower with more convex outlines, lighter and uniformly colored and with *short* palatal plicæ. This specimen measures: Length 1.9, diameter 1.07, aperture (diag.) 0.75 mm. 5¼ whorls. West Maui specimens are slightly smaller, more compact and the apertural lamellæ are not only more strongly developed but are also longer. A specimen from Maunahooma measures: Length 1.55, diam. 1.1 mm.; apert., greatest length 0.67 mm.

7. Nesopupa dubitabilis C. & P., n. sp. Pl. 28, fig. 9.

This shell is smaller than *N. limatula*, more shortly ovate

in outline. Fully adult specimens have but 4⅔ convex whorls. The surface of the shell is more closely, finer and more evenly striate. Length 1.38, diam. 0.95; apert. greatest length 0.55 mm.

Molokai: Poholua (type loc.), 2,500 ft. elevation; Kamoku and Kawela (Cooke); Ualapue (Forbes); Western ravine, head of Kamalo (Cooke & Pilsbry). Type 11068, Bishop Museum, paratypes 35150 Bishop Museum and 44728 A.N.S.P.

This species is undoubtedly closely related to *N. limatula* from which it is here considered as a separate species not only by its geographical distribution but by its much smaller size, form, etc.

In an immature specimen with 3¼ whorls the shell is openly perforate, lighter colored than in the adults. The embryonic whorls, under the microscope, are very minutely and closely granulose, the granules do not appear to be arranged in any particular order. The delicate, slightly oblique striæ appear rather abruptly at about 1½ whorls.

Specimens from the western ravine at the head of Kamalo are somewhat larger:

Length 1.55, diam. 1.05 mm.

Length 1.5, diam. 1 mm.

7*a*. *Nesopupa dubitabilis kaalaensis* C. & P., n. subsp. Pl. 28, fig. 13.

Specimens from Oahu are very similar to *N. dubitabilis* in size and form. They differ, however, in that adult specimens are always furnished with a minute basal fold slightly subcolumellar in position. This fold has not been observed in specimens from Molokai. It is somewhat immersed, low, short, lamella-like rather than nodular.

Two gerontic specimens show considerable variation in their lamella character. In the first there is a rather long, low swelling between the two palatal plicæ, and the parietal lamella is continued nearly to the margin of the aperture, ending in a low broad nodule. In the second there is a minute nodular infraparietal lamella.

An average adult measures: Length 1.45, diameter 0.97; aperture, greatest length 0.92 mm.

Oahu: Waianae Range at Mokuleia (Cooke), and Kaala, eastern spur, about 2,500 ft. elevation under bark of lehua trees (Bridwell). Type 11069 Bishop Museum; paratypes 42720 Bishop Museum and 44709 A. N. S. P.

8. NESOPUPA ANCEYANA C. & P., n. sp. Pl. 28, figs. 2, 3.

The shell is somewhat like that of *N. limatula* but longer, broader and usually with but 4½—5 whorls. Shell compact, broadly ovate to globosely ovate, antique brown to buckthorn brown, the lower whorls indistinctly, minutely striate, the striæ and their interstices covered with microscopic, irregular hair-like wrinkles. Spire with convex outlines; whorls convex, separated by a rather deep suture. The embryonic whorls are microscopically punctate with a few indistinct spiral lines just above the suture; last whorl slightly swollen just back of the aperture and scarcely flattened over the palatal plicæ. Aperture irregularly triangular, with broadly rounded angles, lip-insertions scarcely converging. Angular lamella short, lamella-like, rather widely separated from the parietal. Parietal lamella long, strong, and nearly perpendicular to the parietal wall; columellar lamella very short, deeply seated, horizontally entering, and slightly slanting downwards noticeably turned upward at the inner end, and in old specimens continued up the columella as a low callous ridge. The two palatal plicæ are *very short*, not approaching the peristome, nearly parallel and rather widely separated.

Length 1.78, diam 1.15; apert., greatest length 0.73 mm.; 5 whorls.

Length 1.53, diam. 1.1; apert., greatest length 0.7 mm.; 4½ whorls.

Hawaii: Olaa (Thaanum, Ancey coll.; Lyman); Kilauea (Cooke), Piihonua and Humuula (type loc.; Forbes). Type 11072 Bishop Museum; paratype 39300, Bishop Museum and 44723 A. N. S. P.

This species is most easily distinguished from *N. limatula* of Maui by the much shorter palatal folds; from *N. subcentralis* by its broader and more ovate outlines, smoother surface, its shorter and broader aperture; the rather distantly

spaced parietal and angular lamellæ, the angular being usually slightly longer and stronger than in *centralis*, and also by the wider spaced and more nearly parallel palatal plicæ.

A single specimen in the Ancey collection from Olaa is almost identical with Humuula specimens.

Near the edge of the crater of Kilauea specimens are very abundant on the low growing kukaineenee (*Coprosma*). They are smaller than the typical form, globosely ovate, and have but 4½ whorls. One of these specimens measures: Length 1.53, diam. 1.04, apart. 0.67 mm. The above measurements are of an average specimen. A number of slightly smaller specimens occur in most of the lots collected near Kilauea. At first glance they have the appearance of immature shells and are almost globular in outline. The peristome, however, is thickened. In these specimens the angular lamella is very short. One of them with 4⅓ whorls measures: length 1.25, diam. 1.05, apert. 0.61 mm.

In some specimens from the margin of Kilauea iki (fig. 3), the angular and parietal lamellae are quite close together, and the palatal folds are less widely spaced than in typical *anceyana*.

Length 1.7, diam. 1.1 mm., aperture 0.66 mm.

Length 1.5, diam. 1.1 mm.

9. NESOPUPA SUBCENTRALIS C. & P., n. sp. Pl. 28, fig. 8.

The shell is minute, sub-perforate (perforation very minute), nearly cylindrical, in its fossil state pale brownish white, often with a broad lighter peripheral zone, rather thin, hardly translucent, under a strong lens closely, quite evenly but weakly obliquely striate. Spire with convex outlines. The summit convexly conic, apex obtuse; individual whorls slightly convex and separated by a rather shallow suture. Whorls 5, the embryonic smooth for 1½ whorls, the faint striae beginning rather abruptly at this point; last whorl subcylindric, tapering towards the base, somewhat flattened over the palatal plicæ, very slightly swollen back of outer margin of peristome. Aperture broadly truncate-ovate, hardly oblique, perpendicular, lip-insertions remote. Angular lamella short, low, tooth-

like, deeply seated. Parietal lamella well developed, strong, perpendicular to the parietal wall. Columellar lamella short, horizontally entering, slanting downwards, inwardly, ending abruptly. Two palatal plicæ rather short, lamella-like, nearly parallel and rather remote from the peristome, the lower one more immersed. Peristome slightly thickened within, expanded slightly except for the upper outer margin which is thin and erect. Length 1.7, diam. 0.98; apert., greatest length 0.7 mm.

Hawaii: Palihoukapapa (type loc.), very abundant in the fossil deposits (Henshaw, Thaanum); Mana (Thaanum), rather rare. Living specimens on the Flow of 1823, 7,000 ft. elevation (Forbes); Waihou; S. Kona, on ferns (Gouveia). Type 18699 Bishop Museum; topotypes 36654, Bishop Museum; 44699 A. N. S. P. and in the Thaanum coll.

Nesopupa baldwini var. *centralis* Anc., Henshaw, Journ. of Malacology, xi, September 1904, p. 63.—Ancey, same Journal Sept., 1904, p. 67; not *N. b. centralis* Ancey, Proc. Malac. Soc. Lond. vi, June, 1904, p. 122.

This species is closely related to *N. anceyana*, but the contour is narrower, the palatal folds less widely separated, as are also the angular and parietal lamellae.

Mr. Ancey named the Palihoukapapa specimens in his collection (now in the Bishop Museum) *Nesopupa baldwini* var. *centralis*, but the original locality of *N. b. centralis* was Olaa; at the time it was described no Palihoukapapa material had been under examination. Moreover, a form of *N. baldwini* occurs at Olaa, and the present species has not been found there. The identification was apparently a hasty one, as *N. baldwini* and its varieties have dorsal sulci, lacking in this species.

Living examples collected by Forbes at about 7,000 ft. elevation, in the lava flow of 1823, are referable to this species. They are almost similar in size, though the living form has slightly more convex whorls; the color is brussels brown on the last whorl, gradually becoming paler above but none of the specimens have a pale peripheral zone. The surface has an oily sheen and under a strong lens is minutely closely

wrinkled; the lamellæ and plicæ of the aperture have about the same development as in specimens from Palihoukapapa, except that the angular lamella is slightly longer and stronger. One of the specimens measures: length 1.83, diam. 0.98, apert. (diag.) 0.73 mm.

There is but a single slight difference between these specimens and those collected by Gouveia at Waihou. In the latter the angular lamella is considerably longer, otherwise they agree perfectly.

10. Nesopupa bishopi C. & P., n. sp. Pl. 28, fig. 4.

The shell is minute, perforate (perforation very minute, nearly closed), nearly cylindrical, argus brown, lighter colored above, rather thin, translucent, with an oily sheen, minutely very weakly striate. Spire with nearly parallel outlines below, tapering above to a somewhat obtuse apex. The individual whorls somewhat convex, separated by a rather shallow, suture. Whorls 5½, the embryonic 1½ nearly smooth, under a strong lens minutely indistinctly punctate; rest of the whorls faintly striate, striæ weak, oblique, discontinous; under the microscope the whole surface is seen to be covered with minute short wrinkles; last whorl cylindrical, tapering towards the base, ascending slightly and slowly near the aperture. Flattened outside of the palatal plicæ, having a very small impression over the lower one, and slightly swollen just before reaching the aperture. Aperture truncate-ovate, scarcely oblique, nearly perpendicular, the lip insertions remote, not united by a callus. Angular lamella deeply seated, weak, short, about one-half the height of the parietal; parietal lamella stronger, emerging further, nearly perpendicular to the parietal wall; columellar lamella weaker than in most species of this group, short, horizontally inserted on the columella and deeply seated. Two palatal plicae of about equal length, rather short, not approaching the peristome and nearly parallel, the upper emerging slightly further than the lower. Peristome very slightly thickened, the columellar margin expanded, the lower and outer margins nearly erect. Length 2.08, diam. 1.1; apert., greatest length 0.8 mm.

E. Maui: Haleakala Crater, near Crystal Cave, under stones on the floor of the Crater (Cooke). Type 12465 Bishop Museum, paratype 44696 A. N. S. P.

As far as known only three specimens of this species have been collected. It differs principally from *N. limatula* from the same island, by its larger size and weaker lamellæ.

11. Nesopupa forbesi C. & P., n. sp. Pl. 28, fig. 5.

The shells are larger than any of the other species from Hawaii, thinner and more transparent, more glossy, orange-citrine and with very low almost evenly spaced striæ, the interstices not wrinkled as in living examples of *centralis* or *anceyana*. Spire oblong with very convex outlines, tapering gradually to the apex. Whorls 5, the embryonic almost smooth, hardly granulose under the microscope, the evenly spaced rather distant low striæ beginning almost abruptly near the middle of the second whorl. Last whorl ascending slightly, swollen back of the aperture and hardly flattened over the palatal plicæ. Aperture irregularly trapezoidal with rounded angles, the lip-insertions remote, united by a thin callus. Angular lamella minute, almost dentiform, deeply seated; parietal deeply seated, long, strong, perpendicular to the parietal wall; columellar rather strong, deeply seated, slanting downwards; two palatal plicæ short, rather deeply seated, converging inwardly, the lower considerably larger than the upper. Peristome tinged with a darker color than the rest of the shell, erect, very faintly thickened within. Length 2.08, diam. 1.22; apert., greatest length 0.85 mm.

Hawaii: Huumula (Forbes). Type 39288 Bishop Museum.

Only two specimens of this rare species are known at present. Both were taken by Forbes on plants in a large *kipuka* in the 1855 Flow, about half way between Halealoha and Ainahou, at about 5,000 ft. elevation. The size of this species easily distinguishes it from the other species from Hawaii. From *N. bishopi* it is most easily separated by its lighter color, thinner shell more convex outlines, and the surface, which is very minutely granular rather than wrinkled in the interstices between the striæ.

12. NESOPUPA INFREQUENS C. & P., n. sp. Pl. 28, fig. 7.

The shell is *sinistral*, minute, sub-perforate (perforation very minute), nearly cylindrical, buckthorn brown, thin, translucent, hardly glossy; under a strong lens the surface is very minutely, closely and obliquely wrinkled, the wrinkles hair-like, rather short, more or less anastomosed. Spire with convex outlines, gradually tapering towards the apex, individual whorls slightly convex, separated by a rather narrow suture. Whorls 5, the embryonic nearly smooth, under a strong lens minutely granulose, the granules apparently arranged in transverse rows, the minute striæ gradually appearing at about the middle of the second whorl. The last whorl tapers gradually to the base, ascending slightly near the aperture, slightly flattened over the palatal plicæ, and only faintly swollen back of the aperture. Aperture scarcely oblique, nearly perpendicular, irregularly truncate-ovate, lip-insertions remote, united by a thin transparent callus. Angular lamella short, lamella-like, deeply seated; parietal strong, high, emerging further than the angular, perpendicular to the parietal wall; columellar lamella rather short, strong, deeply seated, indistinctly slanting downwards; two palatal plicæ not approaching the peristome, rather short, nearly parallel. Peristome very slightly thickened within, arched above the columella, slightly expanded on the lower margin, the outer margin erect. Length 1.65, diam. 0.98, apert. (diag.) 0.65 mm.

Kauai: Halemanu, on a tree trunk; also on ferns (Cooke). Holotype 15489 Bishop Museum.

It is the only sinistral Hawaiian *Nesopupa* known. Besides its sinistral coil, it is easily recognized from the other species of *Nesopupa* by the slightly coarse anastomosing striæ of the lower whorls.

One of us (Cooke) recently collected probably about 40 specimens in different localities, the extreme points probably six miles apart. It has a different habit from any of the true Nesopupæ; all the specimens taken in 1919 were on the fronds of ferns (*Asplenium arnottii*). A single one, the type, had previously been found on a tree.

Section *Nesodagys* new section.

Surface like *Limbatipupa*, but there is a long, lamella-like angular lamella reaching the lip.

The two species included in this section are more or less intermediate between *Limbatipupa* and *Nesopupa*.

a^1. Shell oblong to ovate, embryonic whorls granulose. *P. wesleyana* and sub-species, no. 13.

a^2. Shell short, almost globose, embryonic whorls minutely spirally striate. *P. thaanumi*, no. 14.

13. Nesopupa wesleyana Ancey. Pl. 29, figs. 1, 2.

"Shell oblong, thin, perforate, scarcely shining, under a strong lens granulate, brown-corneous, ornamented with oblique and distant, more or less deciduous, membranous costulæ, slightly wavy on the last whorl. Spire *oblong*, slightly obtuse. Whorls 5, separated by an impressed suture, the last oblong, ascending slightly towards its end, tapering gradually towards the base, slightly dilated near the aperture. Aperture vertical, truncate-ovate, very slightly receding at the base, nearly equal to ⅓ of the length, brownish within, 5-plicate; peristome not continuous, expanded and reflexed throughout, slightly thickened, sublabiate, with a unicolorous brownish lip. Angular lamella arcuate, elongate, slightly bent; parietal a little more deeply seated, nearly median in position; columellar lamella acute, deeply seated; two elongate, parallel palatal, the lower more deeply seated. Length 2, diam. 1, aperture about 0.75 mm." (*Ancey*).

Hawaii: Hilo, 4 miles Olaa road, type locality (Thaanum, Cooke); Glenwood (Pilsbry); Waipio Pali (Henshaw, Thaanum); Rainbow Falls (Cooke); Puna (Thurston); fossil at Puuwaawaa (Thurston), Huehue (Gouveia) Palihoukapapa (Thaanum, Henshaw). Kahoolawe; fossil at Kanapou (Forbes & Stokes). E. Maui: Kaupakalua (Baldwin), fossil at Kanaio and Auwahi (Fleming). W. Maui: Waiakapu and Waihee (Forbes), Hahakea and Iao (Cooke). Oahu: Ahuimanu (Cooke), Kamanaiki (Gouveia) fossil at Kailua (Pilsbry). No typical specimens of this species have been

seen from Kauai. Type 18704, Bishop Museum; paratypes 18707 Bishop Museum, 44727 A. N. S. P. and in Thaanum coll.

Nesopupa wesleyana ANCEY. Proc. Malac. Soc. London. vi, June 1904, p. 123, pl. 7, fig. 16.

This species is easily recognized from *P. newcombi* by its more cylindrical spire and the long, lamella-like angular lamella. Typical *P. wesleyana* is usually found on rather damp rocks, though it is occasionally taken on rather smooth-barked trunks of trees. It does not seem to possess as many varieties or races as *P. newcombi* and the few varieties, noted below, are much more constant in all their characters than those of *P. newcombi.*

The embryonic whorls are rounded, scarcely lighter colored than the rest of the shell, under a strong lens very minutely granulose, the granules not appearing to be arranged in any regular manner.

In the typical form the angular lamella is situated parallel to the parietal inwardly, curving outwards in front and uniting to the outer lip at a slight distance back of the outer margin. It descends rather abruptly in front but gradually at the inner end. Sometimes there is a slight depression or notch just back of outer end. This is very well represented in fossil specimens collected by Pilsbry at Kailua, Oahu. The parietal lamella is strong, rather deeply seated and nearly perpendicular to the parietal wall. The columellar is deeply seated, perpendicular to the columella and rather long. The lower palatal is somewhat deeply seated, long, parallel to, but stronger than the upper. The upper palatal extends nearer to the margin than the lower, inwardly its free margin is slightly bent towards the lower palatal. Externally there is a slight impression over it.

A somewhat larger fossil race was found by Messrs Thaanum and Henshaw at Palihoukapapa. The whorls are slightly flatter than in the typical form. One of the specimens measures: Length 2.15, diam. 1.22, apert. (diag.) 0.86 mm. 5½ whorls.

The type specimen has the following dimensions: Length

1.95, diam. 1.15, apert. (diag.) 0.8 mm. The color of fresh typical specimens from Hilo, Hawaii is buckthorn-brown.

13*a*. Form *gouveiæ* C. & P. Pl. 29, fig. 4.

A very small race of *wesleyana* was found by Gouveia at Hookena, and by Forbes at Kapua, both localities in South Kona, Hawaii. In this form the outline is narrowly ovate, tapering above. The aperture is truncately ovate, its outer margin hardly flattened. Whorls 4⅔. In cross section the upper palatal is only slightly bent; the angular unites with the outer lip at a slight distance from the margin. Length 1.65, diam. 0.98, apert. (diag.) 0.73 mm. Type 11081 Bishop Museum, paratype 39429 Bishop Museum, and 44732 A. N. S. P.

13*b*. Form *tryphera* C. & P. Pl. 29, fig. 3.

A form which is usually smaller than the typical and which appears to occur in pure colonies, has the upper palatal fold, abruptly bent in the middle, the inner half descending towards the lower palatal fold. A few of the specimens from Oahu (Nuuanu, Makiki and Moanalua, coll. by Spalding), are nearly equal to the typical form in size, but the majority of the colonies are decidedly smaller. Embryonic whorls similar to those of the typical form.

Typical examples of this form have been taken from the following localities: Kauai: Lihue. Oahu: Palolo (type loc.), Tantalus, Nuuanu and Kaipapau, in the Koolau Range; Palehua and Popouwela, in the Waianæ Range. Molokai: Puunea and Mapulehu (Thaanum). Except for the larger form from Oahu mentioned above the examples are remarkably uniform in size and other characters. Length 1.75, diam. 1.1, apert. (diag.) 0.8 mm. 4¾ whorls (Palolo). Type 11082 Bishop Museum, paratypes 15422 Bishop Museum and 44714 A. N. S. P.

13*c*. N. w. *rhadina* C. & P., n. subsp. Pl. 29, fig. 13.

The shell is slender, oblong, usually tapering above, brussels brown, convex, closely and regularly marked with well-developed membranous costæ. Spire with convex outlines.

Whorls 5½, very convex. The embryonic whorls are more coarsely granulose than any of the forms noted in this subgenus. The granules for the first half whorl are arranged longitudinally, giving the appearance of striæ; at about the beginning of the second whorl the very faint transverse striæ appear to be made up of uniting granules. These striæ gradually become stronger with the growth of the shell, the granules persisting in the inter-costal spaces, gradually becoming fainter and disappear about the end of the second whorl. Aperture truncate-ovate, the outer margin hardly flattened, the lip insertions slightly converging, furnished with 5 lamellæ. Angular lamella somewhat thickened and calloused in front, slender and thin inwardly, lower than the parietal. Columellar lamella slightly slanting downward. The upper palatal fold is equal to if not higher than the lower, not quite as deeply seated, and slightly shorter. Length: 2.32, diam. 1.15, apert. (diag.) 0.85 mm. Type 11083 Bishop Museum, paratypes 35126 Bishop Museum and 44726 A. N. S. P.

Molokai: Poholua, type locality (Cooke); Kilohana and Puukolekole, Kamalo (Pilsbry and Cooke); Kalihi, Puunea, Waikolu (Cooke); Mapulehu (Thaanum); fossil specimens from Mauna Loa, Moomomi, Kalaeokailio (Cooke).

This subspecies was at first considered as a separate species, but on comparing the large series of both *wesleyana* and *rhadina* in the Bishop Museum collection it appears to be better to consider both forms as belonging to the same species. *N. rhadina* is easily recognized from *wesleyana* by its more convex whorls, darker color and narrower outlines.

Living examples of this subspecies are only taken under the loose bark of trees or in moss growing on tree trunks. It is never found abundantly, due to the amount of time consumed in finding only a few specimens. The most usual habitat is under loose bark of the lehua (*Metrosideros polymorpha*).

On the flat east of the peak, Puukolekole, it varies in size and shape.

Alt. 1.95, diam. 1.18 mm.

Alt. 2.15, diam. 1.3 mm.; decidedly ovate-conic.

Alt. 2.25, diam. 1.3 mm.; subcylindric.

In forest at the head of Kamalo there is a large, stout, cylindric form with the laminae of the surface more crowded, and generally having an interpalatal fold. Length 2.4, diam. 1.25 mm. This may be called form *kamaloensis* (pl. 29, fig. 9).

Kauai: This sub-species has been taken in several localities and is probably well distributed over the whole of the mountainous area of the island. It is also occasionally found in some of the fossil deposits of the lowlands. The specimens from this Island are fairly typical. They are slightly more tightly coiled than the typical form and the outlines are a little more convex. A typical example, from back of Lihue, measures: Length 2.3, diam. 1.1, apert. (diag.) 0.83 mm. A fossil specimen from Limahuli is decidedly smaller, more conical in outline and there are but 5 whorls. Length: 1.95, diam. 1.05, apert. (diag.) 0.75 mm.

Oahu: This sub-species is widely distributed over the Koolau range but is not represented by a large series in any of the lots. From the Waianæ Mts. only a very few examples seem to have been taken. It is also found, though only in a few isolated cases abundantly, in a number of the fossil deposits from this island. Most of the specimens are considerably smaller than the typical form from Molokai. Pl. 29, fig. 7 represents a fossil specimen from Kahuku coral bluff.

Specimens taken from a few of the lots in the Bishop Museum collection showed the following measurements.

Length 2.02, diam. 1.1, apert. (Diag.) 0.79 mm. 5 whorls; Manoa—Palolo ridge (Cooke).

Length 1.9, diam. 1.0, apert. (Diag.) 0.75 mm. 5 whorls; Waimano (Gouveia).

Length 1.95, diam. 1.1, apert. (Diag.) 0.8 mm. 5 whorls; Waialaeiki (Gouveia).

Length 2.08, diam. 1.08, apert. (Diag.) 0.76 mm. 5¼ whorls; Popouwela, Waianae Mts. (Cooke).

Length 1.8, diam. 0.95, apert. (Diag.) 0.7 mm. 5 whorls; Malaekahana, fossil (Cooke).

Length 2.0, diam. 1.07, apert. (Diag.) 0.76 mm. 5 whorls; Kahuku, fossil (Cooke).

Length 2.25, diam. 1.13, apert. (Diag.) 0.85 mm. 5¼ whorls; Manoa, fossil (Cooke).

Maui: Specimens of this subspecies from the highlands of West Maui, have the apices much eroded giving the appearance of a very blunt spire. The whorls are very convex and the outlines are almost cylindrical. The surface is covered with rather low, close, membranous costæ. A well preserved specimen (the apex of which is not much eroded) measures: Length 2.35, diam. 1.22, apert. (diag.) 0.97 mm. 5½ whorls.

Specimens from East Maui are similar to those from West Maui.

Lanai: I have seen only two specimens of this sub-species from Lanai. Both were collected by Forbes and each came from a different locality. Both specimens appear to be more closely related to the Molokaian form than the Mauian. One of them measures: Length 2.15, diam. 1.15, apert. (diag.) 0.86 mm. 5¼ whorls.

No specimens of this subspecies have been seen from Hawaii, and so far as I know up to the present time it has not been taken on that island.

14. NESOPUPA THAANUMI Ancey. Pl. 28, figs. 11, 12.

"Shell dextral, minutely rimate-perforate, of a pleasing corneous buff color, ornamented with rather distant, weak and very deciduous, silvery shining, membranous costulæ; somewhat conic-ovate, obtuse. Whorls 4½, convex, suture impressed; the upper quite minute: the last sub-saccate, shortly ovate, scarcely tapering at the base, ascending slightly towards its end, very lightly impressed outwardly back of the aperture. Aperture erect, truncate-oval, sub-rotund, extended outwardly and bent in front (above the middle portion of the dextral margin), armed *with strong white lamellæ* as follows: an arcuate angular, elongate but short, extending to the margin; a little more deeply seated parietal lamella, entering deeply; a transverse, internal columellar; and 2 palatals, the upper seated a little nearer the margin, both elongate but not very long. Lip narrowly expanded, with quite distant insertions. Length 1.33, diam. 1.0, alt. apert. 0.5 mm. (*Ancey*).

Hawaii: Olaa (D. Thaanum), type 18701 Bishop Museum, topotypes 44678 A. N. S. P.; Glenwood, in moss on tree trunks, abundant (Thaanum, Pilsbry).

Nesopupa thaanumi (Ancey), Proc. Malac. Soc., London, vi, June 1904, p. 123.

Unfortunately the holotype from the Ancey collection is badly broken. This species is very abundant in the type locality, where it is found on tree-trunks, living among and on the fronds of a loose-growing species of moss. Under similar conditions this species has been found in nearly all the Hawaiian Islands. *P. thaanumi* is somewhat similar to *P. wesleyana tryphera*. Its shell is, however, smaller, more compactly coiled, much lighter colored and the aperture is more crowded with the five lamellæ. It has apparently some relationship to the species included in *Nesopupa ss.* It differs from all the species of the latter by its more convex whorls and especially by the membranous character of its rather distant riblets. Immature specimens from the type locality have the embryonic whorls very minutely *spirally* striate. The angular lamella is strong, long and slightly sinuous, high in front, tapering gradually backward, and does not terminate on nor is it joined to the outer lip, but extends to the margin of the parietal wall. In this character it resembles species of *Nesopupa ss.* with this distinction: that in *thaanumi* this lamella is stronger, with a more sinuous margin and the outer portion is not parallel to the parietal, but is distinctly bent towards the outer lip. The parietal lamella is only slightly more deeply seated than the angular, and emerges almost to the margin on the parietal wall. It is very strong, high and long, and is nearly perpendicular to the parietal wall. The columellar lamella is very strong, horizontally seated, rather long, diminishing rather abruptly inward, there turning upwards and accompanying the columella as a mere thread. The two palatal folds are nearly parallel, about equal in height and length; the lower slightly more deeply seated; the upper extending nearly to the margin of the outer lip, with its free edge abruptly bent, almost at a right angle, towards the lower palatal.

Length 1.4, diam. 1.0, apert. (diag.) 0.65 mm. Whorls 4⅔ (topotype).

Length 1.56, diam. 1.0, apert. (diag.) 0.63 mm. Whorls 4½ (topotype).

Ancey's type specimen, according to my method, measures 1.53 mm. in length.

This species has not yet been reported from Kauai.

Oahu: widely distributed over the Koolau range; up to this time none have been seen from the Waianæ Mts. Shells of the different colonies differ but slightly from each other in size and otherwise agree very closely. Most of the specimens are slightly lighter colored than those from Hawaii.

Length 1.51, diam. 1.0 apert. (diag.) 0.64 mm., 4⅔ whorls: Waialae-iki.

Length 1.4, diam. 0.98, apert. (diag.) 0.61 mm., 4½ whorls: Nuuanu.

Length 1.53, diam. 1.02, apert. (diag.) 0.64 mm., 4¾ whorls; Kaliuwaa.

Lanai: I have been able to examine but two specimens of this species collected on Lanai. Both specimens agree closely with the typical form. One of them measures: length 1.47, diam. 0.98, apert. (diag.) 0.65 mm., 4½ whorls.

Maui: This species is only known to have been taken from three localities on West Maui, and one from E. Maui. Like the specimens from the other islands, all the Maui specimens agree closely with the typical form. A specimen from Honokahau measures: length 1.43, diam. 1.02, apert. (diag.) 0.64 mm., 4½ whorls.

Section Limbatipupa C. & P., n. sect.

The shells are minute, brown to greenish-brown; the free margins of the costulæ membranous and sometimes slightly prolonged into sharp membranous points; the 5 primary lamellæ and folds present in most species, the angular lamella either shortly lamelliform, nodular or absent. Type *N. newcombi.*

The species composing this section are differentiated by their

sculpture and the short, lamella-like, or nodular angular lamella, which is sometimes lacking.

The species are rather closely connected; however, they seem to be sufficiently differentiated from each other, and may be easily recognized. *N. newcombi* is by far the most variable species of the family found in the Hawaiian Islands, and a number of quite distinct races have here been grouped under this name without subspecific rank.

Key to the Species of the Section Limbatipupa.

a^1. Angular lamella absent or represented by a slightly swollen callus.

b^1. Whorls 4, embryonic whorls minutely spirally striate, diameter about 70% of total length.

N. alloia, no. 19.

b^2. Whorls 4½-5, embryonic whorls granulose, diameter about 60% of total length. *N. singularis*, no. 18.

a^2. Angular lamella nodular or short lamelliform.

b^1. Costæ prominent, thin, membranous.

c^1. Upper palatal fold short lamella-like.

N. newcombi, no. 15.

c^2. Upper palatal fold absent or nodular.

N. oahuensis, no. 16.

b^2. Costæ low, with very narrow membranous margin.

N. kauaiensis, no. 17.

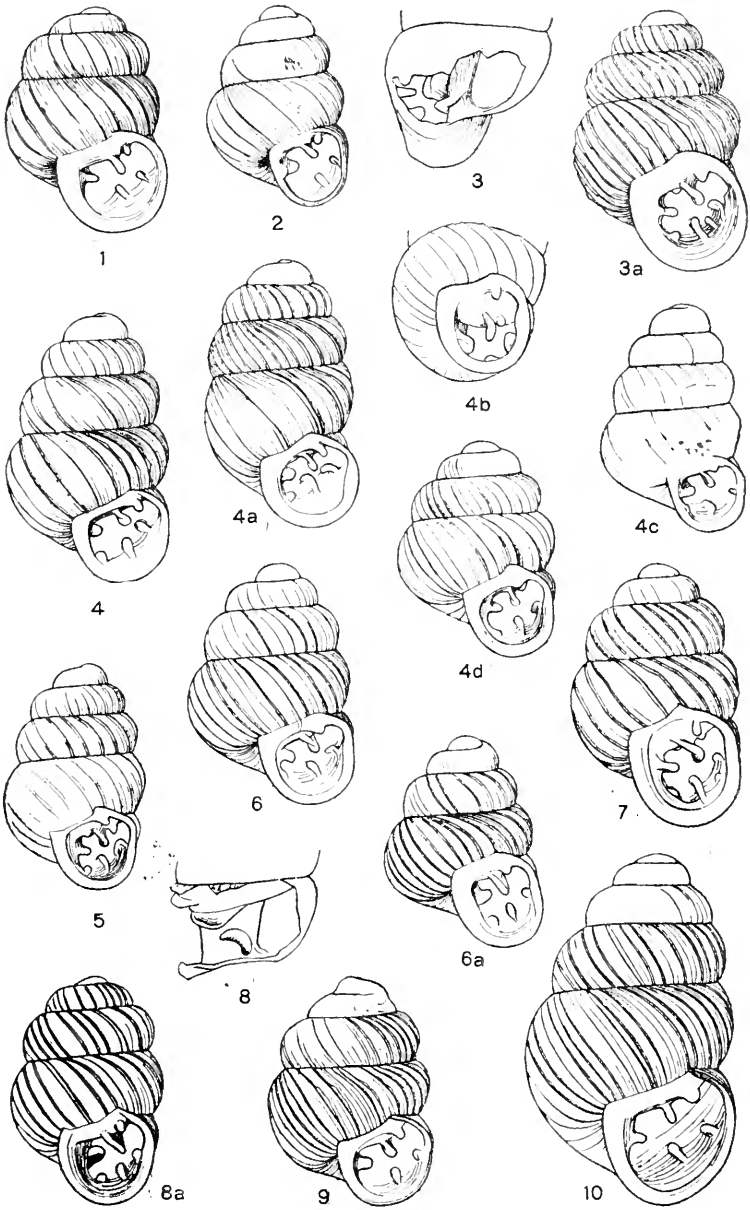
15. NESOPUPA NEWCOMBI (Pfr.). Page 309, fig. 1.

The shell is minute, perforate (perforation very minute, circular), ovate, brownish olive, thin, somewhat translucent, slightly shiny, uniformly and widely costulate, the riblets with membranous margins, about 15 on the last whorl. In some specimens they are slightly spiniferous just above periphery. Intercostal spaces minutely striate (striæ short, parallel). Spire conic with convex outlines, apex obtuse; individual whorls convex, separated by a rather deep suture. Whorls 4¼, the embryonic 1½ whorls are microscopically granulose, the granules apparently arranged in transverse rows, the membranous costæ appearing abruptly in about the middle of the

second whorl. The rest of the whorls are costate. Last whorl large, rotund, tapering towards the rounded base, scarcely ascending near the aperture. Aperture nearly circular, scarcely oblique, perpendicular, the lip insertions approaching and united by a thin callus. Angular lamella short, lamella-like, united to the outer lip by a thick callus for about half its height and not extending to the parietal margin. Parietal lamella more deeply seated, large, strong, nearly perpendicular to the parietal wall. Columellar lamella strong, transversely seated and slightly slanting downward. Two palatal plicæ rather deeply seated, nearly parallel, the lower slightly stronger than the upper. Peristome expanded, its outer and lower margins thin, membranous; very slightly thickened within; columellar margin dilated above the umbilicus. Length 1.65, diam. 1.1, aperture, greatest length 0.79 mm.

Explanation of figures, page 309.

Fig. 1. Nesopupa newcombi (Pfr.). Typical. 18714BM. Waipio, Kauai.
2. N. newcombi seminulum. 23375BM. Kapua, Hawaii.
3, 3*a*. N. newcombi multidentata. Type. 15316BM. Glen Ada.
4. N. newcombi angusta. Type. 20227BM. Kipu, Kauai.
4*a*-4*d*. N. newcombi interrupta. 44760. Kaelepulu, Kailua.
5. N. newcombi interrupta. Type. 42673BM. Waiaha, Hawaii.
6, 6*a*. N. newcombi interrupta. 1½ miles west of Kahuku. 44761.
7. N. newcombi disjuncta. Type. 17219BM. Mokuleia.
8, 8*a*. N. newcombi gnampta. Type. 12526BM. Luakaha, Nuuanu.
9. N. kauaiensis (Anc.). 20608BM. Kipu, below the Gap, Kauai.
10. N. kauaiensis (Anc.). 20730BM. Kipu, slopes of Haupu, Kauai.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Hawaiian Islands (Pfeiffer); Hawaii (Boettger, Pease), Waipio Valley (Thaanum). Lanai, Maunalei Gulch (Forbes); Mahana, Kaihalena (Spalding). Molokai, Mapulehu, (Thaanum and Cooke); Puulua and Kalihi (Cooke). Oahu, Palolo, Tantalus, Makiki (Cooke), Waialaeiki (Bridwell), Pauoa (Gouveia).

The above is the distribution of the typical form as known at present. More or less distinct races of this species have been taken on all the main islands except Niihau.

? Pupa newcombi PFR., Proc. Zool. Soc. London, 1852 (1854), p. 69; Monographia Heliceorum Viventium, iii, 1853, p. 530.

Pupa newcombi PFR., Monographia Heliceorum Viventium, iv, 1859, p. 682.—KUESTER, Conchyl. Cab., Pupa, 1859, p. 172, pl. 20, f. 23, 24.—BOETTGER, in von Martens, Conchologische Mittheilungen, i, 1881, p. 56, pl. 11, f. 12; pl. 12, f. 13.—ANCEY, Mémoires de la Société Zoologique de France, v, 1892, p. 709.—*Nesopupa newcombi* PILSBRY, Proc. A. N. S. Phila., 1900, p. 433.

Vertigo costulosa PEASE, Proc. Zool. Soc. London, 1871, p. 462.—*Pupa costulosa* PFR., Monographia Heliceorum Viventium, viii, p. 408.—ANCEY, Mém. de la Soc. Zool. de France, v, 1892, p. 711.

This is one of the most variable species of shells found on the Hawaiian Islands. The typical form, with five lamellæ in the aperture, appears to be rather uncommon. Specimens with from 6 to 10 lamellæ and folds are found on nearly all the islands of the group. In some cases these races are found in nearly pure colonies, in others individuals representing two or more races are found in a single colony.

Nearly 350 specimens from 33 colonies were closely examined and among them 40 different lamella-formulæ were noted. The presence and form of almost all the lamellæ seem to be variable characters except in a very few races. The only teeth found in all the specimens were the columellar, lower and upper palatal. In one (probably pathological) specimen the parietal and angular lamellæ were absent, and in another the parietal lamella was lacking. Except for extremely rare

specimens the presence of these two lamellæ must be considered as a constant character.

Two distinct forms of the angular lamella were found; in the first this lamella is reduced to a nodular or a short lamella-like form. This is usually united to the outer lip by a thick callus sometimes of more than half its height. In most cases it does not extend to the margin of the parietal callus, while in others it not only reaches the margin but is continuous with it, forming a low descending ridge along the callus of the margin. In the second form the angular lamella is discontinuous. It is represented by a low nodule seated deep within and to the outside of the parietal lamella, followed by a short interval with no indication of any thickening, and terminating near the angle with the usual nodule, as in fig. 4*b*. Forms with this character of the lamella are abundant in the Pleistocene deposits on nearly all of the islands.

The parietal lamella is always strong and usually slants slightly outwards, but is often perpendicular to the parietal wall; in some cases the free margin is slightly sigmoid. The infra-parietal lamella is usually represented by a low nodule-like swelling, rather deeply seated. In a very few cases specimens were found in which this lamella is discontinuous as described in the case of the second form of the angular lamella. The supra-columellar and subcolumellar lamellæ are only present in a few specimens. They are never lamelliform, but appear as low callous swellings. The columellar lamella is always strong, horizontally entering, and generally slanting slightly downwards and emerging nearly to the outer margin of the columella. In most cases it terminates rather abruptly at the back and follows the margin of the columella upward as a low thread-like swelling. In two races, one from Kauai and the other from Oahu, the inner portion of this lamella is turned abruptly downwards terminating at the base of the columella, as in typical *Nesopupa*. The subcolumellar lamella, when present, is usually represented by a low elongate swelling parallel to the basal fold. The basal fold when present is generally lamelliform and reaches about half the size of the lower palatal. An infrapalatal fold is found only occasion-

ally. It is more deeply seated than the outward termination of the lower palatal fold, and has a low lamella-like form. The lower palatal fold is always present; it is deeply seated and generally much stronger than the upper palatal. The interpalatal fold is usually low, lamelliform, and more deeply seated than either the upper or lower palatals. Like the lower, the upper palatal fold was present in every specimen examined. The suprapalatal fold, when present, is nodular in form and is ordinarily seated about half way between the termination of the upper palatal fold and the inner margin of the peristome.

The outline of the shell varies from narrowly conic-ovate to broadly ovate. There are from 4 to 4⅔ whorls in adult specimens.

The number of costæ on the last whorl varies from about 15 to nearly 30. In each of the different colonies the number of costæ is nearly uniform.

Typical specimens of *newcombi* from Oahu are slightly larger than those examined from Hawaii. Otherwise they agree fairly closely. A specimen from Palolo has about 17 costæ on the last whorl. It measures: length 1.75, diam. 1.1 apert. (diag.) 0.73 mm., 4½ whorls. Another specimen from Tantalus measures: length 1.83, diam. 1.2, apert. (diag.) 0.79 mm., 4½ whorls. In all the specimens from the latter locality there are from 25 to 28 costae on the last whorl. Lanai specimens are somewhat smaller than those from Hawaii. They have about 20 costae on the last whorl. The outline of the shell is globosely-ovate. An adult specimen with 4½ whorls measures: length 1.53, diam. 1.1, apert. (diag.) 0.67 mm. Molokai specimens are very similar to those from Oahu. An adult shell with 4¼ whorls measures: length 1.72 diam. 1.05 apert. (diag.) 0.73 mm.

When typically developed the minor races can be determined by the following key.

a^1. Columellar lamella straight or slightly upturned within.

b^1. Angular lamella a short lamella or tubercle only.

c^1. Form rather broadly ovate-conic.

d^1. With 5 or 6 teeth.

Length about 1.75 mm., typical *newcombi*.

Length about 1.5 mm., form *seminulum*.

d^2. With 9 or 10 teeth. form *multidentata*.

c^2. Form narrower. form *angusta*.

b^2. Angular lamella interrupted, having a low inward lamella.

c^1. Aperture with 5 or 6 teeth. subsp. *interrupta*.

c^2. Aperture with 7 or 8 teeth. form *disjuncta*.

a^2. Inner end of the columellar lamella turned downward. subsp. *gnampta*.

Pfeiffer originally described this species thus:

"*P. newcombi* Pfr. T. subperforata, ovata, tenuis, longitudinaliter costata, haud nitens, diaphana, saturate fusca; spira inflata, apice acutiuscula; anfr. 4 convexi, ultimus $\frac{2}{5}$ longitudinis subaequans, basi rotundatus; apertura obliqua, semicircularis, edentula; perist. tenue, vix expansiusculum, margine columellari subreflexo.—Long. 2, diam. 1 mill. (Mus. Cuming. et Coll. Nr. 2.) Habitat in insulis Sandwich (Newcomb)."

This description appeared first in the *Monographia Heliceorum*, later in Proceedings of the Zoological Society of London. It will be noted that he termed it *edentulous*. Subsequently, in the *Monographia* iv, 1859, he characterized his former description as incomplete, and reprinted it except that in place of the word *edentula* he substituted "dentibus 4 profundis coarctata: 1 parietali compresso, 1 subtransverso ad columellam, 2 in palato;" the rest of the description, the measurements, habitat, and collector standing unchanged.

It has been surmised that he confused two species, one toothless, like *P. admodesta*, the other dentate; but a more likely supposition is that he did not see the teeth at first. This is clearly what he implied by calling his first description "*incompletus*."

The supposed types of *newcombi* in London, examined by one of us (Cooke) are typical specimens of *N. wesleyana* Anc.; doubtless they had been substituted for the original examples. Boettger has described the true *newcombi* from specimens in

the Pfeiffer-Dohrn collection. The same author has stated that *Vertigo costulosa* Pease, according to specimens from Pease, is completely synonymous. Yet obviously Pease confused two species in his description, as he says that the last whorl is sometimes shortly bisulcate towards the lip. This is not true of any form of *N. newcombi*, and probably indicates that he had also a *Nesopupilla*.

15*a*. Form *seminulum* (Boettger). Page 309, fig. 2.

"The shell is smaller, narrower, more elongate, horn-brown, more often the angular lamella is less distinct. Length 1.5 to 1.75; diam. 1 to 1.25 mm." (*Boettger*).

Hawaii: (Boettger, Thurston, Gouveia). W. Maui: Waihee, Lahaina (Forbes, Cooke). E. Maui: Alalele (Cooke). Molokai: Mapulehu (Thaanum). Oahu: Tantalus, Nuuanu and fossil at Rocky Hill (Cooke), Waiawa and Waialaeiki (Spalding). Kauai, various localities (Cooke).

Pupa newcombi var. *seminulum* BOETTGER in von Martens, Conchologische Mittheilungen i, 1881, p. 58, pl. 12, f. 14. Not *Pupa seminulum* Lowe, 1852.

Except for a slightly narrower form, as Boettger has already pointed out, this variety differs in no way from some of the various races of *P. newcombi*. In fact some of the narrower forms mentioned above are not proportionately broader than the measurements given by Boettger would indicate. The name is preoccupied, but as its value is rather uncertain it is not renamed at this time.

A number of shells from different localities have the following measurements:

Length 1.5, diam. 1.0 mm. 4½ whorls; Kapua, Hawaii; 23375.

Length 1.53, diam. 0.98 mm. 4½ whorls; Puuwaawaa, Hawaii; 39784.

Length 1.65, diam. 1.05 mm. 4½ whorls; Lahaina, W. Maui; 20967.

Length 1.8, diam. 1.1 mm. 4⅔ whorls; Waihee, W. Maui; 39012.

Length 1.53, diam. 0.98 mm. 4¼ whorls; (fossil) Rocky Hill, Oahu; 39832.

Boettger mentions only five lamellæ in the typical form of this species. In most of the races examined by us, a low lamelliform basal fold is present.

15*b*. Form *multidentata*. Page 309, figs, 3, 3*a*.

An easily recognized form that is widely distributed on Oahu is somewhat larger than the typical form. Living examples are only found on damp moss-covered stones. The aperture is usually furnished with 9 or 10 lamellæ and folds, the infraparietal, suprapalatal and basal being present in all the specimens examined. The interpalatal was present in about 90% of the specimens, and the infrapalatal and subcolumellar in about 20%. Angular lamella not very long, lamelliform.

Length 1.9, diam. 1.12, apert. (diag.) 0.83 mm.; 4⅔ whorls. Glen Ada, Nuuanu.

Length 1.95, diam. 1.3 mm. Glen Ada, type.

15*c*. Form *angusta*. Page 309, fig. 4.

The most abundant form on Kauai, and one which is nearly uniform in all its characters, is longer and slightly narrower than the typical form; the angle lamella is somewhat longer than in the form already described. A low lamelliform basal fold is always present. There are about 20 riblets on the last whorl and most of the shells are somewhat darker in color than the other forms. An adult specimen with 4¾ whorls measures: length 1.96, diam. 1.15, apert. (diag.) 0.73 mm. A similar form though slightly smaller is found on Oahu. An adult specimen with 4¾ whorls measures: length 1.83, diam. 1.1, apert. (diag.) 0.73 mm.

15*d*. *N. newcombi interrupta* C. & P., n. subsp. Page 309, figs. 4*a*–6*a*.

In the following races the angle lamella is discontinuous; there is a nodular outer and a lamelliform inner portion. From a number of fossil deposits of Kona, Hawaii, specimens

have been collected by Thwing and Gouveia. The infraparietal and basal folds are usually present. One of the specimens from Waiaha, Hawaii, measures: Length 1.65, diam. 0.98, apert. (diag.) 0.64 mm.; 4⅔ whorls.

A number of fossil specimens of this form were also found at Kanapou, Kahoolawe, by Forbes and Stokes. In these the infraparietal lamella was present in about half of the specimens; the basal fold was present in all. One of them measures: length 1.85, diam. 1.07, apert. (diag.) 0.65; 4½ whorls.

In a fossil deposit at Kainaio, E. Maui, a few specimens were found by Fleming. These are the smallest so far as seen. In nearly all the infraparietal and basal folds are present. One measures: length 1.47, diam. 0.98, apert. (diag.) 0.61; 4¼ whorls.

This form is exceedingly abundant in a fossil deposit on the northern slope of Mauna Loa, Molokai. In slightly more than half the specimens the infraparietal was present. The basal fold was noted in all but one example. In a few specimens infrapalatal or interpalatal plicæ were seen, and in two instances both of them were present in the same specimen. An average shell measures: Length 1.7, diam. 1.12, apert. (diag.) 0.67; 4½ whorls.

In Oahu this form is exceedingly abundant in fossil deposits, and living examples are not uncommon; most of the living *newcombi* from the Waianæ Mts. belong to form *interrupta*.

It sometimes varies extraordinarily in shape, 4*a-d* representing selected specimens from Kaelepulu, Kailua where it is an abundant Holocene fossil. The inner portion of the angular lamella is sometimes wanting. Figs. 6, 6*a* are from an average and a short example from the coral bluff west of Kahuku, showing variations in teeth. The abundance of this and other species of Pupillidae in this deposit is astonishing. Fig. 6 measures, length 1.7, diam. 1.2 mm.

Length 1.55, diam. 1.02 mm., whorls 4½; fossil, Kailua; (fossil).

Length 1.59, diam. 1.1 mm., whorls 4⅓; fossil, Kahuku; (fossil).

Length 1.73, diam. 1.1 mm., whorls 4½; fossil, Rocky Hill.

Length 1.72, diam. 1.17 mm., whorls 4½; fossil, Ewa, Waianæ Mts.

Length 1.78, diam. 1.1 mm., whorls 4⅔; fossil, Lualualei, Waianæ Mts.

Length 1.78, diam. 1.1 mm., whorls 4⅔; fossil, Palolo.

15*e*. Form *disjuncta*. Page 309, fig. 13.

In another slightly distinct form, with a discontinuous angular lamella, a race which is widely distributed on Oahu, the infraparietal, inter-palatal, suprapalatal and subcolumellar, as well as the basal are almost uniformly present. No specimens of this race were found in fossil deposits. In a very few cases the supra- and subcolumellar infrapalatal folds were also noted. It is larger than form *interrupta*.

Length 1.86, diam. 1.2 mm.; whorls 4½, Mokuleia, Waianæ Mts.

Length 1.78, diam. 1.17 mm.; whorls 4½, Moanalua.

Length 1.65, diam. 1.1 mm.; whorls 4½, Kalihi.

15*f*. *N. newcombi gnampta* C. & P., n. subsp. Page 309, figs. 14, 15.

A widely distributed form of Oahu, is nearly typical except that *the inner end of the columellar lamella turns abruptly downward* forming a right-angle, with its inner leg terminating at the base of the columella. One from Luakaha, Nuuanu, measures: length 1.65, diam. 1.05, apert. (diag.) 0.73 mm.; 4½ whorls. Specimens from Kauai, with a similar columellar lamella, are slightly larger, one of them measuring: length, 1.78, diam. 1.1, aperture (diag.) 0.79 mm. 4½ whorls.

16. NESOPUPA OAHUENSIS C. & P., n. sp. Pl. 29, figs. 11, 12.

The shell is minute, perforate, broadly ovate-conic, buckthorn-brown, thin, slightly translucent, rather dull, marked with distant, weak, thin, membranous riblets (about 15 to 18 on the last whorl), the intercostal spaces minutely striate, striæ parallel. Spire with slightly convex outlines, tapering above to a rather sharp apex. The individual whorls are very convex, separated by a deep suture. Whorls 4⅔, the em-

bryonic, under the microscope, minutely granulose, the minute, even, close striæ appearing abruptly at about the middle of the second whorl; last whorl large, saccate, tapering towards the base and rounded about the margin of the perforation, ascending slightly and slowly near the aperture. Aperture scarcely oblique, nearly perpendicular, irregularly truncate-ovate, slightly flattened on the right margin and arched towards the upper insertion. The lip insertions distant but somewhat converging and united by a thin callus. Angular lamella punctiform, seated somewhat within the margin and united to the outer lip by a very thin callus. Parietal lamella more immersed, nearly perpendicular to the parietal wall, lamella-like, high and short. Columellar lamella small, short, deeply placed, nearly horizontal, the edge slightly slanting downward. Lower palatal fold rather deeply placed, short, rather high, lamella-like; upper palatal, when present, not so deeply seated, weak, low, almost punctiform. Peristome expanded, the outer margin rather thin, the inner margin slightly thickened. Length 2.15, diam. 1.5, aperture 1 mm.

Oahu: Nuuanu Valley at Luakuha falls, type locality (Cooke) Ahuimanu (Spalding). Type 11075 Bishop Museum; paratypes 12559 Bishop Museum and 44695 A. N. S. P.

This species is very closely related to *P. kauaiensis*; it differs, however, by the thinner and lighter colored shell; the spire is shorter and broader and the aperture is larger than in the latter species; also, the membranous costæ are more distinct and stronger. In *P. oahuensis* the upper palatal fold is reduced to a minute tubercle, hardly lamella-like in form. In most of the specimens examined it appears to be entirely lacking.

This species has only been taken, so far as known, on damp rocks at the sides of waterfalls. Its larger size and shorter lamellæ easily separate it from the various forms of *P. newcombi*.

17. NESOPUPA KAUAIENSIS Ancey. Pl. 29, figs. 5, 6; page 309, figs. 9, 10.

"Shell sub-oblong, short, corneous-brown, obliquely wrinkled

with close and somewhat rough growth riblets, minutely perforate, scarcely shining, somewhat thin. Spire obtuse, shortly subcylindrical but yet slightly conic-tapering. Whorls 5, convex, regularly increasing, suture impressed; the last shortly ovate, swollen, somewhat saccate, hardly ascending in front, not laterally compressed, rotund about the umbilicus. Aperture slightly oblique, not sinuate, truncate-subcircular, hardly effuse, furnished with tooth-like lamellæ, as follows: two parietal, one of which, the angular, is small tubercle-like, and the second, parietal, median or nearly median, is elongate, more deeply seated, ending abruptly. An acute, small columellar; and 2 short, nearly equal palatals, slightly elongate, parallel. Peristome narrowly expanded and thickened on all sides, slightly more dilated at the columella, livid, with quite distant margins. Length 2, diam. 1.33, apert. 0.75 mm." (*Ancey*).

Kauai: Kipu (type loc.), Kipukai, Koloa, Halemanu, Haena, Wainiha and Kalalau (Cooke); Nounou Mts. (Dole). Type 18700 Bishop Museum; topotypes 20733 Bishop Museum and 44724 A. N. S. P.

Nesopupa Kauaiensis ANCEY, Proc. Malac. Soc., London, vi, June 1904, p. 124, pl. 7, f. 17.

The type specimen measures, length 2.15, diam. 1.4, apert. (diag.) 0.86 mm. Interstices of costæ granulose, the granules arranged in rows, costæ granulose; apical whorls eroded, the exact number could not be made out.

The original specimens of this species were collected on the Kupu side of Haupu. Specimens in the Bishop Museum from near the original locality agree very closely with Ancey's type now in the Bishop Museum. One of these specimens, carefully compared with the type, has 4½ whorls, the color is argus-brown. The costæ are lower, closer and more evenly spaced than in typical *P. newcombi*; their edges only very narrowly membranous. The embryonic whorls are distinctly granulose when viewed under a strong lens; the angular lamella is short, punctiform and seated close to the margin of a rather thick parietal callus. The parietal lamella is shorter than that of *P. newcombi*, deeply seated and nearly perpendicular to the parietal wall. The columellar lamella

is rather short, thickened and low; the two palatal are short, nearly parallel, the lower nearly twice as high and long as the upper. An average specimen measures: length 2.1, diam. 1.4, greatest length apert. 0.86 mm. At a somewhat higher elevation the shells are slightly larger. One such measures: length 2.6, diam. 1.55, apert. 1.04 mm.

On the same ridge, but nearer the sea and at a slightly lower station, the shells are much smaller. Among thirty examples taken at random, 12 had the five normal lamellæ in the aperture; in 18 there was in addition a more or less minute basal fold. In this small race of *kauaiensis* the specimens at first glance have the appearance of typical *newcombi*. They are most easily recognized by the less expanded and more heavily thickened peristome and the lower and less membranous ribs, of which there are about 30 on the last whorl. A specimen of this small race (p. 309, f. 9) measures: length 1.63, diam. 1.16, aperture 0.73 mm.; 4½ whorls. This race is widely distributed on Kauai, in rather damp situations on rocks.

18. NESOPUPA SINGULARIS C. & P., n. sp. Pl. 29, fig. 8.

The shell is minute, perforate (perforation very minute, nearly circular) ovately conic, with a short base, clay color, thin, translucent, rather dull, the surface rather closely ribbed-striate, a few of the striæ, especially on the back of the last whorl (rather distantly and more or less evenly spaced) are more strongly developed and furnished with membranous edges; under a microscope the whole surface covered with very minute wrinkles. Spire with convex outlines tapering gradually to the semi-globular apex; individual whorls very convex, separated by a deep suture. Whorls 4¾; the embryonic minutely granulose, the granules more or less arranged in transverse rows, the striæ beginning gradually at about 1½ whorls. The last whorl is sub-saccate, rounded about the umbilicus, the last ⅓ nearly straight. Aperture hardly oblique, nearly perpendicular, almost a complete circle, lip-insertions nearly united, connected by a rather thick, short white callus. Angular lamella usually absent, sometimes

indicated by a low indistinct swelling; parietal lamella strong, deeply seated, slanting outwards; columellar lamella strong, deeply seated, slanting downwards, the inner end abruptly turned upwards, following the columella as a thickened rounded ridge; two palatal folds rather short, parallel when seen through the shell from the back, rather remote from the peristome, of almost equal size. Peristome with a uniform whitish thickening within, the margin expanded, thin, of the color of the shell. Length 1.57, diam. 0.9, aperture (diag.) 0.58 mm.

Oahu: Kaliuwaa, on the rocky walls of the canyon, near the waterfall (Cooke); West Maui: Honokahau (Forbes). Type 11077 Bishop Museum; paratypes 19842 Bishop Museum and 44697 A. N. S. P.

This species is separated from *newcombi* by its narrower outline, lighter color, circular mouth and the almost complete absence of an angle lamella. It is rather remarkable that the only two known colonies of this species should be from different islands. The species seems to be abundant where found, as 36 specimens were taken at Kaliuwaa and 13 at Honokahau. The Maui specimens are slightly larger with more convex outlines, and are darker-colored, with slightly more numerous and stronger developed membranous ribs than those from Oahu. One measures: length 1.56, diam. 0.95, apert. (diag.) 0.67 mm.; 4⅔ whorls.

19. Nesopupa alloia C. & P., n. sp. Pl. 29, fig. 10.

The shell is very minute, perforate, shortly ovate, isabella color, thin, slightly translucent, scarcely shining, marked with thin, distant rather high membranous costæ (about 19 on the last whorl), the inter-costal spaces minutely granulose-wrinkled. Spire short, summit convely conic, the individual whorls convex, separated by a deep suture. Whorls 4, the first minutely granulose and very faintly spirally striate, the oblique, delicate riblets beginning at about the middle of the second whorl; the penult whorl is closely costulate, swollen; the last whorl convex, tapering towards the base, scarcely ascending near the aperture. Aperture rather large, truncate-

oval, hardly oblique, slightly diagonal, lip-insertions distant, hardly converging. There is no trace of an angular lamella: parietal lamella very strong, upright, oblique, slanting outward; columellar lamella rather strong, deeply seated, horizontal, and perpendicular to the inner margin of the columella; lower palatal fold short, lamella-like, rather deeply seated; upper palatal nearly equal and parallel to the lower, but not so deeply placed. Peristome expanded, its outer margin very thin, membranous, the inner margin slightly thickened. Length 1.4, diam. 0.98, apert. (diag.) 0.62 mm.

Kauai: Hanapepe falls, on *Trichomanes* (Heller). Type 11078, paratype 20176 Bishop Museum.

This most interesting little species was found by Mr. Forbes on mounted fern specimens collected by Heller, and now in the Bishop Museum herbarium. It is represented by two specimens which agree very closely, though one of them is slightly broken near the summit. This species was at first considered a not quite fully developed *P. thaanumi*. Comparison with nearly adult specimens of *thaanumi*, shows that the angular lamella is present in that species before the peristome is at all thickened. *P. alloia* is easily distinguished from *P. singularis* by its blunter summit, shorter and broader outline and fewer whorls.

II. Cocos Island species.

Section *Cocopupa* P. & C., n. sect.

The shell is minutely pitted with very little striation, the teeth typical for *Nesopupa* except that the inner end of the columellar lamella does not turn downward; last whorl not distinctly furrowed back of the lip.

Cocos Island, in the Pacific about 550 miles southwest of Panama, has several species which have been referred to *Ochroderma*, a genus of the Caroline Islands; but this relationship has not been fully established by anatomical comparison (see Vol. XVIII, p. 325). In the Galápagos Islands, however, there is a truly Polynesian snail, *Tornatellides chathamensis* (Vol. XXII, 201); so that the occurrence of the Polynesian

group *Nesopupa* at the eastern rim of the Pacific is not unprecedented.

20. NESOPUPA COCOSENSIS (Dall.). Pl. 30, figs. 10, 11.

"Shell small, reddish brown, rather pointed, with nearly five rounded whorls; apex paler, polished, rather blunt; last whorl much the largest; base rounded with a well-marked umbilical pit; aperture wider behind, the posterior part of the outer lip and the pillar lip broadly reflected, the anterior outer and basal margin narrow; the pillar and outer lip united by a thin callus; lamellæ according to Sterki's formula .ABDE, comprising one columellar and two parietal folds, and, on the outer wall well within the peristome, two narrow little-elevated ridges, of which the anterior is shorter. Axial length of shell 2.2, of aperture .8, width of last whorl 1.5, of aperture .8 mm." (*Dall.*)

Cocos Island, on leaves (Heller and Snodgrass).

Vertigo cocosensis DALL, Proc. Acad. Nat. Sci. Phila. 1900, p. 98, pl. 8, f. 13.

"The chief peculiarity of this species is that the surface, which looks silky under an ordinary hand lens, when more magnified is seen to be punctate all over, recalling *V. variolosa* Gould, of Florida, which, however, differs in form, size and dental armature" (*Dall*).

By the color, sculpture and teeth this species appears most nearly related to those of Polynesia, but differs by the simpler columellar lamella, which does not curve down at its inner end. It is the only member of the genus found on the American side of the Pacific.

The shell is ovate, deeply rimate, tawny, when not dulled by age, with a brighter cinnamon-rufous lip; densely and very minutely pitted, and with weak striae of growth. The last whorl has a slight impression over the upper palatal fold. The teeth are grayish-white. The angular lamella curves outward and in old individuals joins the termination of the outer lip, as in fig. 11. The high parietal lamella is somewhat curved. The columellar lamella slants downward somewhat, enters horizontally and is not turned down at the inner end.

The two palatal folds are well developed, not very long, either subequal, or the upper somewhat shorter; the lower decidedly further in. The peristome is expanded and in old shells thickened. Its outer border is bent in a little in the region of the upper palatal fold. Parietal callus thin.

Length 2.2, diam. 1.35 mm.; 5 whorls.

III. Polynesian, Micronesian and Melanesian Species.

Section *Nesopupa* proper.

Nesopupæ with the surface more or less pitted or pitted-granose, striae with membranous edges often present. Angular and parietal lamellae strong and long, the former curving outward to join the end of the outer lip; inner end of the columellar lamella bent downward; palatal folds present.

Nesopupae of the typical group inhabit high islands of all Polynesia and Micronesia, the East Indies and Mascarene Islands, probably also Melanesia, having thus a very wide distribution.

All of the Polynesian species were considered varieties or subspecies of *N. tantilla* by Dr. Boettger, whose revision is the main work on them. In the absence of evidence of intergradation it seems more logical to recognize the various island forms as species. No doubt many more remain to be discovered, as no adequate search has been made for the minute shells of Polynesia. Probably arboreal species will be found, as in Hawaii.

(*Polynesia.*)

Beck mentioned two undescribed species. *Alæa pitcairnensis* Beck, and *Alaea millium* Beck, Index Molluscorum 1837, p. 85. Pitcairn Island. Names and locality only.

21. Nesopupa tantilla (Gould). Pl. 30, figs. 1 to 4.

Shell very minute, of an oval form, obtuse at summit, and composed of about four convex whorls, of which the upper ones are irregularly marked with delicate longitudinal bars, and the lower one, under a magnifier, appears to be roughened by minute, irregular granulations. Color whitish. Aperture

somewhat four-sided, rounded at the corners, the lip slightly expanding and the throat armed with five teeth, one on the columella, one at the base, one on the outer lip, and two unequal approximate ones on the middle of the transverse lip. There is a small umbilical fissure. Length 1/15, width 1/20 inch (*Gould*).

Society Islands: Tahiti at 2000 ft. (Conthouy, U. S. Exploring Exped.) Tahiti, Huaheine, Borabora and Maupiti (Garrett). Also reported from the Marquesas, Paumotu Archipelago, and as far west as Viti, but these forms require critical comparison.

Pupa (*Vertigo*) *tantilla* Gould, Proc. Bost. Soc. N. H. ii, 1847, p. 197; Expedition Shells p. 33.—*Vertigo tantilla* Gould, U. S. Expl. Exped., xii, Mollusca and Shells, 1852, p. 92, pl. 7, f. 105, *a*, *b*.—Garrett, Journ. Acad. Nat. Sci. Phila. viii, 1881, p. 400 (Cook's or Harvey Islands); ix, p. 84; Bull. Soc. Malac. France, iv, 1887, p. 34 (Marquesas).—*Pupa tantilla* Gld., Pfr., Mon. Hel. Viv. iii, 557.—Boettger, Conchol. Mittheil. i, 1881, p. 49, pl. 10, f. 1.—"*P. pazi* Crosse" Ancey, Bull. Soc. Malac. France, iv, 1887, p. 35, footnote.

This senior member of the group differs from its allies by the smaller number of teeth, 5, or when an interpalatal is developed, 6. The inner end of the columellar lamella turns down less than in related forms.

The type specimen, 5505 U. S. N. M., labelled as the original of Gould's figure 103, is drawn in pl. 30, figs. 1, 2, 3. The surface is minutely confluent-pitted or pox-marked with traces of striae as usual in the Polynesian group. The last whorl has a rather short and shallow furrow over the upper palatal fold. Angular lamella high, straight within, then well curved out to join the lip. Parietal lamella curved. The columellar lamella is horizontal, its inner end curving downward, but far less than in *N. pleurophora* or *armata*. The upper and lower palatal folds are rather short, subequal, and between them a small interpalatal stands. It is hard to see, and evidently was overlooked by Gould; (but in other specimens it is wanting). There is no basal fold or subcolumellar lamella, but in oblique view a very weak, hardly noticeable trace of a subcolumellar

tubercle may be seen. The peristome is thickened a little, well expanded.

Length 2.25, diam. 1.3 mm.; nearly 5 whorls (type).

Length 2, diam. 1.35 mm.

Garrett, in his several lists, included *dunkeri*, *armata*, *pleurophora* and *dentifera* as synonyms of *tantilla*, which he says ranges from the Society to the Viti Islands, and is found beneath rotten wood, under stones, and among decaying leaves. Boettger gives *tantilla* an equally wide range, but he distinguishes 5 varieties and 2 subspecies. In the absence of intergrading individuals it appears more logical to rank part of these as species. Typical *tantilla* is at present known positively from Tahiti only. Mr. Ancey mentioned a *P. pazi* Crosse, stating that it does not differ specifically from *tantilla*; but I cannot find that Crosse described such a species.

22. NESOPUPA PLEUROPHORA (Shuttleworth). Pl. 30, figs. 5, 6.

Shell minute, rimate-perforate, shortly ovate, thin, slightly striate, beautifully ribbed with very thin, widely-spaced lamellæ, sometimes vanishing, rufous chestnut, somewhat pellucid, slightly glossy. Spire rounded, obtuse. Whorls 5, strongly convex and somewhat inflated, the last rounded at the base. Suture deep. Aperture rounded auriform, with seven folds: angular lamella strong; parietal strongly elevated, somewhat immersed; two columellar lamellæ, the upper strong, lower small; three immersed palatal folds, the middle one smaller. Peristome expanded, callous-lipped, whitish, right margin angularly sinuous above, somewhat tuberculate below the sinus.

Length about 2, diam. 1½, aperture ¾ mm. (*Shuttl.*).

Marquesas Islands and Tahiti (Verreaux).

Pupa pleurophora SHUTTLEWORTH, Bern. Mittheil., 1852, p. 296.—PFR., Monogr. Hel. Viv., iii, 560.—[*Pupa tantilla*] var. *pleurophora* Shuttlw., BOETTGER, Conchol. Mittheil., i, 1881, p. 51, pl. 10, f. 3.—*Pupa dunkeri* ZELEBOR, in Pfr., Monographia, vi, 1868, p. 333 (Taheiti).

Tahiti may be selected as the type locality. Under the microscope the surface is irregularly granose or vermiculate-

granose, more or less noticeably striate, with sparse traces of cuticular riblets in some specimens, probably well developed in fresh shells. There are 8 teeth: angular and parietal lamellæ strongly developed, columellar strong but deeply placed, turned down at its inner end; there is a subcolumellar, usually invisible in direct front view; upper and lower palatals are subequal, not very long, and converge somewhat inwardly; interpalatal smaller; and there is a small tubercular suprapalatal.

Length 1.9, diam. 1.15 mm.

Length 1.8, diam. 1.1 mm.

It differs from *N. tantilla* by the smaller aperture, the more numerous teeth and by having the inner end of the columellar lamella turned more strongly downward, much as figured for *N. armata*. Still, it may prove to be a race of that species. *N. armata* has a much larger upper palatal fold, and appears to be quite distinct.

Pupa dunkeri Zelebor, whose MS. description was printed by Pfeiffer, is supposed to be identical with *pleurophora*. The description follows.

"*P. Dunkeri* Zelebor. T. dextrorsum convoluta, ovato-cylindrica, apice obtuso, umbilici rima capaci, crassa, striis et granulis tantum oculo armato conspicuis holosericeo-splendens, purpureo-fusca aut flavescente-olivacea; spira sensim increscente, anfr. quatuor vel quinque valde convexis sutura profunda conjunctis; apertura semiovata plicis septem vel novem coaretata; plica magna et altera in radio, minima et duabus magnis incrassatis profunde intrantibus, quae cum aperturae margine conjunctae valde prominent, superiore aperturae pariete, quae cum ora, vix conspicua dentiformi in pullis deficiunt in toro aperturae, collocatis; margine aperturae mediocre incrassato rotundato paulo reflexo, non conjuncto, rufescente-fusco, in speciminibus clarioribus obscure rufescente-violaceo.—Alt. 2, lat. 1⅛ mill. Habitat in insula Taheiti." (*Zelebor* in Pfr.)

23. Nesopupa armata (Pease). Pl. 30, figs. 9, 12, 13.

The shell is ovate, cinnamon-brown, darker behind the lip, with a tawny peristome and not much gloss. The surface is densely pitted or vermiculate-wrinkled, with irregular oblique

striation, which is most noticeable on the penult and next earlier whorls. The whorls are strongly convex, the last having a long but not very deep impression behind the lip, descending obliquely from the upper palatal position. The peristome is expanded and heavily thickened within, excavated at the sinulus. The angular and parietal lamellæ are much longer than in *N. tantilla* but similar in shape, the angular being straight within, then curving out to join the lip, the parietal well curved and entering deeply. There is a well-developed infraparietal lamella. The columellar lamella is deeply placed, ascending slowly within, then abruptly bent downward along the axis (fig. 9). Below it a tubercular subcolumellar nodule projects; this is probably a displaced basal fold. Within the outer lip there is a thin, high, diagonally descending upper palatal fold and a small, tubercular suprapalatal. The lower palatal fold is immersed, basal in position, straight, and shorter than the upper.

Length 2.2, diam. 1.3 mm.; 5⅓ whorls.

Society Is.: Borabora (Garrett).

Vertigo armata PEASE, Proc. Zool. Soc. Lond., 1871, p. 461. *Pupa armata* Pease, PFEIFFER, Monographia, viii, p. 407 (copied from Pease).

Described from the type, figured from the type and another of the type lot, no. 48315 M. C. Z. It is well distinguished by the oblique, lamellar upper palatal fold, the wholly basal lower palatal, the long lamellæ of the parietal wall and numerous teeth, 8 in all. Fresh specimens evidently have cuticular laminæ on the striæ. Pease says "interdum remote, tenuiter filocostata . . . filis albidis"; but these have been worn from the type specimens. *N. tongana* (Bttg.) appears from the description to be somewhat similar.

24. NESOPUPA PAIVAE (Crosse). Pl. 30, figs. 7, 8.

"Shell not very deeply umbilicate, ovate-ventricose, thin, subpellucid, pale chestnut; spire with obtuse somewhat flattened apex. Whorls 4½, very convex, the embryonic 1¼ smooth, whitish, flattened, the rest ventricose, impressed with rather oblique, somewhat distant striæ, easily seen without a

lens, the last whorl ascending, about equal to the spire, rounded-tapering at base. Aperture truncate-rounded, violaceous-fleshy, narrowed by 9 teeth: on the parietal wall 3, the first rather large, somewhat projecting forward and continuous with the lip, the second largest, entering, the third minute; on the columellar margin 2 unequal teeth within; in the basal and outer margins 4 deeply placed teeth. Peristome somewhat expanded, reflected, the margins separated, columellar margin spreading, broadly expanded, the middle of the outer margin more or less bent in.

"Length 1.75 to 2, diam. 0.75 mm." (*Crosse*).

Gambier Islands (Crosse); Mangareva (Pease). Paumotu Group (Bttg.).

Pupa paivae CROSSE, Journ. de Conchyl., xiii, 1865, p. 218, pl. 6, f. 5.—PFEIFFER, Mon. Hel. Viv., vi, 333.—*Vertigo paivae* Cr., PEASE, P. Z. S., 1871, p. 474, Mangareva.—[*Pupa tantilla*] var. *paivae* Crosse, BOETTGER, Conchol. Mittheil., i, p. 50, pl. 10, f. 2.

Boettger, who had specimens (pl. 30, figs. 7, 8) given by Crosse to Pfeiffer, notes the discrepancy between Crosse's term *ovato-ventricosa* and his measurement of diameter, ¾ mm. He notes the relationship to *pleurophora*—"so great that a specific separation from this, and therefore also from typical *P. tantilla* Gould, is evidently not to be thought of." He gives the following comparative description:

Shell rather thick, pale brown, more distinctly costulate; last whorl more tapering and anteriorly dilated funnel-like. Aperture generally 7-toothed: 1 angular, 1 or 2 parietals, the inner one smallest, often wanting; columellars 2, the lower one small; palatals 3, equidistant and subequal. Peristome generally discontinuous, somewhat thickened. Length 1⅞ to 2, width 1⅛ to 1¼ mm.

25. NESOPUPA DENTIFERA (Pease). Pl. 30, fig. 14.

"Shell cylindric, rather solid, perforate, dextral, longitudinally obliquely very finely striate, rufous- or yellowish-chestnut. Whorls 4, convexly rounded, the last shortly bisulcate behind the lip. Aperture nearly circular, biplicate posteriorly, columella 1-plicate, base 3 or 4-toothed; lip

slightly reflected, peristome a little thickened, not continuous. Alt. 1.75, diam. 1 mm. (*Pse.*).

Cook or Hervey Is.: Aitutaki, in forests near the seashore (Garrett).

Vertigo dentifera PEASE, Proc. Zool. Soc. London, 1871, p. 462.—*Pupa dentifera* Pse., PFEIFFER, Monogr., viii, p. 408.—[*Pupa tantilla*] var. *dentifera* Pease, BOETTGER, Conchol. Mittheil., i, p. 52, pl. 10, f. 4.—*Vertigo tantilla* GARRETT, Journ. A. N. S. Phila., viii, 401.

The original locality given by Pease, "Roratonga," was an error on the part of Pease. Garrett, who supplied the types to Pease, states that he collected them on Aitutaki.

The shell is oblong, somewhat cylindroid, cinnamon-brown, opaque, with little gloss. Surface is densely pitted, with unevenly developed oblique striæ or traces of them, strongest below the suture. Whorls convex, the last having a long, somewhat oblique furrow in the upper palatal position, terminating at the lip. The peristome is well expanded and thickened within except at the sinulus, colored like the outside. The rather long angular lamella is straight within, anteriorly curving outward and joining the lip some distance from its insertion. Parietal lamella about as long as the angular, more immersed, somewhat curved. The columellar lamella is deeply placed, small in a front view; below it is a small immersed subcolumellar lamella, visible in an oblique view. There are three rather short, deeply placed palatal folds, the interpalatal a little shorter, the lower palatal nearly basal in position. The upper palatal, foreshortened in the figure, is moderately long, laminiform.

Length 2, diam. 1.15 mm.; length of aperture 0.8 mm.; 5 whorls.

This description and the figures from the two cotypes of the Pease collection, no. 48314 Mus. Comp. Zool. The shells were quite dirty, this doubtless accounting for the discrepancies between Pease's description and that now given.

26. NESOPUPA GODEFFROYI (Boettger). Pl. 31, figs. 13, 14.

"Shell smaller [than *tantilla* Gld.], more conic-ovate, the

last whorl lower. Aperture smaller, semioval, 8-toothed, the teeth stronger, white; 1 prominent, angular lamella, arcuately connected with the peristome; 2 parietals, the outer one curved below, the interior very small; 2 columellar lamellæ, compressed, high; 3 rather deeply placed palatals, equidistant and subequal. Peristome discontinuous, whitish-lipped, somewhat thickened at the receding sinulus, the middle of the outer margin produced forward.

Length 1.75, diam. 1 mm." (*Bttg*).

Samoa Islands.

[*Pupa tantilla*] var. *godeffroyi* Bttg., Conchologische Mitt-heil., i, p. 53, pl. 10, f. 5. — *? V. tantilla* Gould, Garrett, Proc. A. N. S. Phila., 1887, p. 138 (Samoa Is.).

Although showing much peculiarity, this form may be viewed as a variety of *P. tantilla* Gld., as it approaches it very nearly in the dentition, and by its shell characters it may be recognized almost with certainty that a close blood relationship unites it to that species (*Bttg.*).

27. Nesopupa tongana (Boettger). Pl. 31, figs. 15, 16, 17.

Shell more conic [than *tantilla*] the whorls more distinctly and generally more distantly membranous-ribbed, the last with protracted base and anteriorly more distinctly dilated funnel-like, in the middle having a long longitudinal furrow. Aperture a little larger, always oblique, rhomboidal, little compressed basally, 6 to 8-toothed: one emerging sigmoid angular; the rest of the teeth deeply placed, 2 parietals, 1 or 2 columellars, 2 or 3 palatals, of which the upper is much the largest, lamelliform, inside approaching close to the larger parietal lamella, and entering deeply with it; the lower 1 or 2 palatals small and very deeply placed. Peristome brownish lipped, somewhat thickened below the sinulus, the margins joined by a thin callus.

Length 2⅛ to 2¼, width 1¼ mm." (*Bttg.*).

Tonga group: Tonga Tabu.

Pupa tongana O. Semper in Museum Godeffroy Catal., v, 1874, p. 89 (name and locality Tongatabu only).—[*Pupa tantilla*] var. *tongana* O. Semper, Boettger, Conchol. Mittheil., i, 1881, p. 54, pl. 10, f. 6 and 11, f. 7.

Dr. Boettger remarks that this gives the impression of a separate species, mentioning the long, deeply penetrating upper palatal fold and the funnel-like extended aperture; yet he ranks it as a subspecies of *tantilla* on account of the analogous upper palatal of *tantilla* var. *dentifera* Pse., and the near agreement in form of the last whorl in *tantilla* subsp. *vitiana*.

28. NESOPUPA VITIANA (Boettger). Pl. 31, figs. 18 to 23.

"Shell more solid [than *tantilla* Gld.], more globulose, the spire almost exactly conic, the apex always more acute. Riblets more delicate and less distant. Otherwise it is more like subsp. *tongana* Semp. in the last whorl and aperture, but 5 to 6-toothed: 1 angular, 1 parietal, 1 or 2 columellar lamellæ, 2 or 3 palatal folds, the upper one hardly lamelliform and not larger than the lower. Peristome with the margins either separated or joined by a very thin callus, distinctly labiate, a little thickened below the sinulus (*Boettger*).

"Length 1.75 to 2, width 1.25 to 1.4 mm. Oneata; pl. 31, f. 18-21.

"Length 1.75, width scarcely 1.25 mm. Viti Levu; pl. 31, f. 22, 23.

Viti group: Oneata, Vanua Balava, Kanathia and Viti Levu (Godeffroy Mus., and according to Alb. Mousson).

[*Pupa tantilla*] subsp. *vitiana* BOETTGER, Conchol. Mitth., i, p. 55, pl. 11, f. 8-10.—*Pupa tantilla* Gould, MOUSSON, Journ. de Conchyl., 1870, p. 127. — ? [*Vertigo tantilla*] var. *oneatensis* of Boettger, according to ANCEY, Bull. Soc. Malac. France, iv, 1887, p. 34, footnote (Oneata, Viti).

What appears chiefly to characterize the Viti Island form is the constant, ventricose-conic shape of the shell, which of course differs quite conspicuously from the purely ovate shape of typical *P. tantilla* Gould of Tahiti (*Boettger*).

Ancey says that Boettger described a var. *oneatensis* of *Vertigo tantilla*, the type being in his collection; but no such description exists to my knowledge, and the form referred to is probably *vitiana*.

(*Species of Melanesia.*)

Alaea annaensis Beck, Index Molluscorum, 1837, p. 85. I. Annaa. No description.

Pupa condita n. sp., with var. *b, zonata*, of Gassies, Journ. de Conch., xvii, 1869, p. 73, Art Island, New Caledonia. This is said by Crosse (Journ. de Conchyl., 1894, p. 303) to be a marine shell of the genus *Rissoa*, in poor condition.

29. NESOPUPA NORFOLKENSIS (Sykes). Pl. 31, fig. 26.

Shell subperforate, pyramidate-ovate, yellowish, somewhat shining, obliquely striate, apex rather obtuse. Whorls 5½, convex, the last (with the peristome) about half the length of the shell. Aperture ovate, 7-toothed: two parietal teeth, 2 columellar teeth, 3 palatals, the upper one smallest. Peristome white, a little thickened, somewhat reflected, the outer margin forming an obtuse angle. Length 4, maximum diam. 2.3 mm. (*Sykes*).

Norfolk Island, in the crevices of the back of a Dracena (Brit. Mus.).

Vertigo norfolkensis SYKES, Proc. Malac. Soc. London, iv, Oct., 1900, p. 145, pl. 13, f. 3.

An interesting little form with tumid whorls. Six of the teeth are of about the same size, but the lower parietal and upper palatal are very small (*Sykes*).

The figure shows a sinistral and rather strongly sculptured shell, with the lower (parietal) lamella longer than the upper (angular).

30. NESOPUPA LIFOUANA (Gassies). Pl. 31, fig. 25.

The shell is widely umbilicate, very small, finely and regularly striate, shining, of reddish corneous, uniform color with an uneven zone of reddish-brown at the periphery of the last whorl. Spire conic-cylindric, with the summit obtuse, mamillate. Suture crenulate and rather deep. Whorls 6 to 6½, convex, the last whorl forming one-third the total length. Aperture oblique, oval, contracted at base, having 4 folds and lamellæ arranged as follows: one on the columella, descend-

ing and entering deeply; two parietal, the first very small, running inward and descending, the second very large, placed far forward, projecting beyond the peristome, a little oblique towards the right side but perpendicular to the axis. Finally, the last tooth is placed within the base of the lower margin, and is a lamina which runs from right to left. The peristome is thick, reflected, excavated at the upper right margin opposite the large fold which projects beyond it, and which causes the peristome to form a quite distinct callous projection in ⅔ of the right margin.

Length 4, diam. 2½ mm. (Gassies).

Loyalty group: Lifu. Lives under ferns and in the moss (R. P. Lambert).

Pupa lifouana Gassies, Faun. Conch. N. Caléd., part 2, 1871, p. 98; Journal de Conch., xxi, 1873, p. 53, pl. 2, f. 8.— Sowerby, Conch. Icon., pl. 4, f. 28. — Pfeiffer, Mon. Hel. Viv., viii, 376.

31. Nesopupa mariei (Crosse). Pl. 31, fig. 24.

Shell narrowly perforate-rimate, subglobose, ventricose, rather thin, subtranslucid, seen under a strong lens to be very delicately, subobliquely striatulate, fleshy-buff, unicolored. Spire moderately elevated, the apex obtuse. Suture impressed. Whorls 4¼, convex, the last scarcely one-third the length, slightly contracted near the aperture. Aperture subvertical, lunate-rotund, colored like the outside. Peristome very strongly thickened, reflected, violaceous; the columellar margin short, the basal rounded, the outer slightly sinuous, towards the insertion somewhat emarginate, tapering, somewhat scrobiculate externally. Parietal margin with two minute teeth, the larger near the insertion of the outer lip, the other more deeply placed, not conspicuous.

Length 2, diam. scarcely 1.5 mm.; aperture 1.5 mm. long, scarcely ⅔ mm. wide (*Crosse*).

New Caledonia: near Noumea (E. Marie).

Pupa mariei Crosse, Journ. de Conch., xix, 1871, p. 202; xx, 1872, p. 358, pl. 16, f. 3; xlii, 1894, p. 303.

(*Species of Micronesia.*)

32. NESOPUPA QUADRASI (Mlldff.). Pl. 32, figs. 7, 8, 9, 10.

Shell subperforate, oblong-ovate, thin, sculptured with very delicate, rather widely-spaced riblets, silky, brown. Whorls 5, convex, slowly increasing, separated by a deep suture, the last slightly ascending in front, compressed at base, distinctly pitted behind the lip. Aperture nearly vertical, rounded-triangular, the peristome well expanded, with a brown thickening, the margins converging, right margin deeply sinuate, with a noduliform callus. Angular lamellar rather high, curving outward, and together with the nodule of the external lip forming an elliptical sinulus; 2 parietal lamellæ, one strongly elevated, entering deeply, the other smaller; 2 columellar lamellæ; 3 deeply placed palatal plicæ, of which the right one is rather long and lamelliform.

Length 1.9, diam. 1 mm. (*Mlldff.*).

Length 1.75, diam. 1.05 mm., aperture 0.8 mm.

Marianne Islands: Guam (Quadras).

Vertigo (*Ptychochilus*) *quadrasi* MOELLENDORFF, Nachr. d. Malak. Ges., xxvi, 1894, p. 17.

This species is closely related to *N. moreleti*, but it differs by the presence of a small interpalatal fold, or in one specimen two, and the subcolumellar lamella which is rather deeply placed (and may be a displaced basal fold). There is sometimes a suprapalatal fold, as in *N. moreleti*, these specimens having 9 or even 10 teeth. The cuticular laminæ are often fugacious, and the surface then is somewhat pitted.

This species has been distributed by dealers under the unpublished name *Pupa marianarum* Q. et M.

33. NESOPUPA EAPENSIS (Boettger). Pl. 31, figs. 27, 28.

"Differing from *P. tantilla* Gould by the perforate-rimate shell, oblong-ovate, the whorls more rapidly increasing, less convex, the last nearly half the total length, hardly impressed externally towards the aperture. The aperture is larger, rather high, truncate-subovate, 5-toothed, the teeth not very strong; angular small, rather deeply placed, scarcely con-

nected with the margin; 1 parietal, 1 columellar, 2 palatals, opposed cross-like to the others, not very deeply placed. Peristome widely separated, a little reflected, somewhat thickened within, the outer margin not thickened at the sinulus and scarcely sinuate.

"Length 2, width 1⅛ mm." (*Bttg.*).

Caroline Islands: Yap (Mus. Godeffroy). Pelew Islands (Kubary).

Pupa eapensis Bttg., in Conchologische Mittheilungen, 1881, p. 56, pl. 11, f. 11.—*Vertigo* (*Ptychochilus*) *eapensis* (Bttgr.), Moellendorff, Journ. of Malac., vii, 1900, p. 112.

34. Nesopupa ponapica (Mlldff.).

Shell perforate-rimate, ovate-oblong, delicately and distantly costulate, silky, brown. Spire subcylindric below, conoid above, the apex obtuse. Whorls 5, moderately convex, the last somewhat compressed at base, with a deep, long external impression behind the aperture. Aperture nearly vertical, rounded-trapezoidal, the peristome moderately expanded, having a reddish lip, externally distinctly sinuate, the margins joined by a very thin callus. Teeth 6, the columellar receding; palatals 3, the lower two deeply placed, short, the third long, strong; angular lamella strong, entering deeply; parietal remote from the margin, approaching the angular.

Length 1.75, diam. 1 mm. (*Mlldff.*).

Caroline Islands: Mpomp, Ponape (Kubary).

Vertigo (*Ptychochilus*) *ponapica* Moellendorff, Journal of Malacology, vii, March, 1900, p. 113.

"This minute shell belongs to the group of *V. tantilla* Gld., and might be considered, like the preceding form [*eapensis*], to be merely a representative subspecies of that species, widely distributed over Polynesia" (*Mlldff.*).

IV. Nesopupæ of the East Indies and Philippines.

N. moluccana is a typical *Nesopupa* related to Polynesian species. The other known species belong to groups common to the rest of the Oriental region, or to Africa also.

Key to Vertigininæ of the East Indies.

*a*¹. Angular and parietal lamellæ diverging forward, the former connecting with the outer lip.

*b*¹. Angular lamella small and low; 5 or 6 teeth.
N. malayana, no. 39.

*b*². Angular lamella strongly developed; 5 to 10 teeth.

*c*¹. Shell cylindric-oblong, palatals readily visible.

*d*¹. Irregularly striate with largely cuticular riblets at intervals, often fugacious; frequently minutely pitted.

*e*¹. Without interpalatal folds.

*f*¹. Length 1.8 to 2.15 mm.
N. moreleti, no. 36.

*f*². Length 1.5 mm.
N. moellendorffiana, no. 37.

*e*². With 1 or 2 interpalatal folds, 7 to 10 teeth in all; Guam.
N. quadrasi, no. 32.

*d*². Having fine, close rib-striæ without cuticular edges; length 1.4 to 1.6 mm.; Philippine Islands. *N. nannodes*, no. 38.

*c*². Shell globose-ovate; palatals, except the upper, deeply immersed; 1.36 x 1.12 to 1.45 x 1.1 mm.
N. moluccana, no. 35.

*a*². Angular lamella short, remote from the upper termination of the outer lip.

*b*¹. Diam. less than half the length; 2.25 x 0.9 mm.; Christmas Island. *N. proscripta*, no. 41.

*b*². Diam. more than half the length; 2 x 1.2 mm.
N. selebensis, no. 40.

*a*³. No angular lamella; parietal and columellar lamellæ present (*Costigo*).

*b*¹. One or two palatal folds; striate, with spaced hairlike riblets; Moluccas. *Costigo saparuana*, p. 366.

*b*². No palatal folds; no cuticular riblets; Busuanga.
Costigo calamanica, p. 367.

Section *Nesopupa* proper.

35. NESOPUPA MOLUCCANA (Boettger). Pl. 32, figs. 11, 12.

Shell small, with long, deep rima, globose-ovate, brown, silky. Spire short with convex sides, the apex obtuse. Whorls 4, a little convex, separated by a distinct suture, striate and moreover ornamented with delicate, membranous, very widely separated riblets, the last whorl distinctly compressed at the base, ascending above, towards the aperture dilated funnel-like, and with a long, rectangular lateral impression; three-sevenths the total length of the shell. The aperture is large, subvertical, truncate-oval, slightly impressed at the sinulus, with 6 or 7 teeth. Peristome expanded, thickened below the sinulus, calloused, violaceous, the margins joined by a light callus. Angular lamella very strong, emerging, joined to the margin of the peristome, curved, parallel within with the strong, receding parietal lamella; one acute palatal tooth deeper in the region of the sinulus more distinct, the others, 2 or 3 parietals [palatals] and one columellar very deeply placed, scarcely visible.

Length 1⅜, diam. 1⅛, alt. and width of aperture ⅝ mm. (*Boettger*).

Moluccas: Ema, southern Amboina (Strubell).

Vertigo (*Ptychochilus*) *moluccana* BTTG., Bericht Senck. naturf. Ges., 1891, p. 269, pl. 3, figs. 11, 11*a*.

This species is remarkable for its short, broad shape, the very strong angular and parietal lamellæ, and the deep immersion of the lower palatal and columellar. In the single specimen seen, a topotype having Strubell's label, the cuticular riblets are mainly wanting. The surface shows some granulation or pitting in places, as in the Philippine species. The last whorl has a horizontal impression behind the lip, over the upper palatal fold, and further back there is a flattening over the lower palatal, giving the base a pinched appearance. The very large parietal lamella curves towards the columella inwardly. There is a small but erect supra-palatal fold, and below it, more immersed, the laminar upper palatal. A small very deeply immersed interpalatal fold and

a larger lower palatal are partially concealed by the parietal lamella. The columellar lamella is far within, not visible in a front view. Its inner end turns abruptly downward and along the pillar.

Length 1.45, diam. 1.1 mm.

Section *Indopupa* n. sect.

Aperture having a strong angular lamella connecting with the outer lip, and typically a somewhat pitted surface, as in *Nesopupa*, but the columellar lamella is horizontal or ascends slightly at the inner end. Type: *N. filosa* (Theob. & Stol.).

36. NESOPUPA MORELETI (Brown). Pl. 32, figs. 1, 2, 3, 6.

Shell perforate, ovate, thin, costate, pellucid, tawny. Spire convex, the apex obtuse. Whorls 6, convex, the last more than one-third the length, ascending in front. Aperture nearly vertical, somewhat rounded, with fine lamelliform teeth: one columellar; two parietal, the left one largest, the right deeply incised in the middle; one basal, one palatal. Peristome white, strongly reflected, flexuous.

Length 2¼, diam. 1 mm. (*Brown*).

Labuan Island, on the north coast of Borneo (Brown). Philippines (Quadras).

Pupa moreleti A. D. Brown, Journ. de Conch., xviii, 1870, p. 393.—PFR., Monogr. Hel. Viv., viii, 391. — E. A. SMITH, Ann. and Mag. N. H. (6), xiii, p. 458 (Bunguran, Natuna Group, *Everett*).

As this species has not been figured and the description is somewhat inexact it has been misunderstood by some authors. The record from the Natuna group is uncertain, as Mr. Smith states that his examples did not agree fully with the description of *moreleti*.

N. moreleti stands close to *N. moellendorffi* Bttg., which is probably a small race of the same species. As specimens from Cebu are not at hand, and the size is less than in any of the series of *moreleti* seen, both forms are left standing for the present.

The outline is cylindric-oblong, the last two whorls almost

equal in diameter. The color is near olive-buff, the shell slightly translucent with but little gloss. There are narrow riblets at wide, unequal intervals, chiefly on the penult whorl, and under the microscope weak interstitial striæ and some irregular pitting are visible. The whorls are strongly convex. The last whorl has a rather deep, horizontal impression behind the outer lip, over the upper palatal fold. The aperture has five to eight teeth. The angular lamella is strong and curves outward to join the outer margin. It is low in front, with a depression before the higher part inward; this seen foreshortened was what Brown referred to as *medio valde inciso*. The parietal lamella is very high, strong and long, also curved. Infraparietal small, elongate. Columellar lamella is strong and ascends a little inwardly. There is a small transverse basal tubercle in the most fully developed shells, but wanting or very inconspicuous in some apparently adult. The two palatal folds are long, the lower one longer and more deeply immersed. In some individuals there is a small, tubercular suprapalatal. The peristome is well expanded and strongly thickened within, the callus whitish. Sinulus defined by a thickening in the outer lip.

Length 2, diam. 1.2 mm.; scarcely 5 whorls.

Length 2.15, diam. 1.2, aperture 0.85 mm.; 5⅓ whorls.

The variation in number of teeth is due to the absence in some examples of the basal, suprapalatal and infraparietal. Figures 1-3 represent specimens from A. D. Brown. There is a set of *moreleti* in the collection labeled "*P. punctilucens* Issel, Borneo," probably = [*Pupa* (*Istmia*)] *punctilium* Issel, Borneo, Paetel, Catalog, 4th edit., 1889, ii, p. 303, nude name.

Shells from Peñon de Bintuan agree well with the Labuan form, having 8 teeth, the developed sculpture well developed.

Length 2.2, diam. 1.23 mm.; 5 whorls.

Small examples from Montalban have a suprapalatal and a small basal fold but no infraparietal. The riblets are few and weak. Length 1.8, diam. 1.15 to 1.2 mm.

Both of the above lots were from the Quadras collection, and labeled *Pupa moellendorffi* Bttg.

37. NESOPUPA MOELLENDORFFI (Boettger). Pl. 32, figs. 4, 5.

Shell small, shortly punctate-rimate, conic-oval, thin, corneous-fulvous, silky. Spire conic with moderately convex sides, the apex rather acute. Whorls 4½, a little convex, separated by a deep suture, striatulate and ornamented with very oblique, distant, deciduous riblets, the last whorl two-fifths the altitude, very slightly ascending to the aperture, the middle part spirally impressed and somewhat compressed at the side below. Aperture oblique, somewhat heart-shaped, with 5 to 7 whitish teeth: on the parietal wall 2 or 3, the middle one lamelliform, receding, longer, the left tooth small, sometimes disappearing, the right or angular emerging and either contiguous to or connected with the upper lip margin; upper columellar lamella strong, above the middle of the columella, the lower one small and sub-basal, sometimes disappearing; palatals two, distant, lamelliform. Peristome acute, little expanded, the middle of the right margin a little drawn forward.

Length 1½, diam. ⅞, alt. aperture ½ mm. (*Boettger*).

Philippines: Mt. Licos, Cebu. Also lives on Siquijor, Mindanao, Masbate, Luzon, Katanduanes.

Ptychochilus moellendorffi BOETTGER, Bericht Senck. Ges., 1890, p. 252, pl. 9, f. 4.—*Vertigo moellendorffi* Bttg., MOELLENDORFF, Abh. nat. Ges. Görlitz, xxii, 1898, p. 152.

"Thinner shelled, narrower and more slender than all the rest of the species" according to Boettger, whose figures are copied.

Very close to *N. moreleti*, probably not specifically distinct.

38. NESOPUPA NANNODES (Quadras & Moellendorff), n. sp. Pl. 32, fig. 13.

The shell is broadly rimate, oblong, the spire tapering slowly below, then rapidly to the obtuse apex; light brown. Sculpture of fine, close rib-striæ, straight, oblique, a little paler and narrower than the intervals, the first 1½ whorls smoothish. The whorls are strongly convex, parted by a deep suture, the last slightly pitted behind the lip over the upper palatal fold. The aperture is subvertical, 6-toothed: angular

lamella high, rather thin, curving outwardly to join the callus in the posterior termination of the lip. Parietal lamella larger; columellar lamella well developed, subhorizontal; a small basal fold where the columella curves into the basal margin. The two palatal folds are strong, the upper one high but rather short, the lower more immersed, long, entering deeply. The peristome is well expanded, thickened within, the outer lip rather strongly bent inward in the middle.

Length 1.55, diam. 0.9 mm.; 4⅔ whorls.

Length 1.4, diam. 0.9 mm.

Philippine Archipelago: Bohol (Quadras).

Vertigo nannodes Quadr. et Mlld., Moellendorff, Abhandl. Naturforsch. Ges. Görlitz, xxii, 1898, p. 152, no description.

This species is distinguished by its fine, regular rib-striæ and the absence of accessory teeth. It is also smaller than the related forms. The columellar lamella enters horizontally, its inner end not turned either up or down. The specimen described and figured is from Quadras.

N. nannodes is similar to *Afripupa* in sculpture and probably belongs to that section.

Section *Insulipupa* P. & C., n. sect.

Angular lamella straight, low, joining the outer lip but not penetrating much beyond the outer end of the parietal lamella. Columellar lamella straight or slightly turned up at its inner end. Type *N. minutalis* (Morel.).

39. Nesopupa malayana (Issel.). Pl. 32, figs. 14, 15, 16.

Shell very minute, rimate, cylindric-ovate, ornamented with oblique, rough, lamellar riblets under a strong lens; corneous buff, translucid. Spire tapering, the apex obtuse. Whorls 6, a little convex, parted by an impressed suture, the last about one-third of the total length, slightly ascending at the aperture, a little compressed in the middle. Aperture nearly semioval, vertical, 6-toothed: two deep parietal teeth; two columellar, the lower one smaller; two lamelliform palatals. Peristome reflected, the right margin sinuate, columellar oblique, lightly arcuate (*Issel*).

Length 2¼, width 1¼ mm. (*Issel*).

Borneo (Damon). Philippine Islands (Moellendorff, Quadras).

Vertigo malayanus Issel, Molluschi Borneensi, in Ann. Mus. Civ. Genova, vi, 1874, p. 416, pl. 5, f. 30-32.—*Staurodon moreleti* (A. D. Brown), Boettger, Bericht Senckenb. Ges., 1890, p. 252, not *Pupa moreleti* A. D. Brown.

Figures 14, 15 are copied from Issel. He explains that the second columellar tooth is small and was inadvertently omitted by the draughtsman.

I have provisionally identified this shell with specimens from Manila and Masbate, which are the *Staurodon moreleti* of Boettger and von Moellendorff, reported from Cebu, Busuanga and Luzon, and in Moellendorff's *Verzeichnis* from the entire Philippine Archipelago. But in material seen there is no basal or second columellar tooth (there being but 5 teeth), and the angular lamella is less erect than figured by Tapparone Canefri. These specimens are, in fact, not specifically distinct from *N. barrackporensis* (Gude). They differ from *N. minutalis* (Morel.) by being more rugose. A Manila example (pl. 32, fig. 16) is here described.

The shell is cylindric-oblong, hazel or somewhat darker in color, somewhat glossy, rather coarsely striate, and under the microscope *densely pitted or vermiculate-granose*. The whorls are moderately convex. The aperture has five teeth. The angular lamella is low, diverging forward from the parietal, joining the outer margin. Parietal high and long, slightly curved. The columellar lamella is strong, nearly horizontal, but ascending a little inwardly. There is no trace of a subcolumellar or basal. The two rather short palatal folds are rather deeply placed. The peristome expands rather broadly but is hardly thickened within. There is no perceptible parietal callus.

Length 2, diam. 1.1 mm.; 5 whorls.

40. Nesopupa selebensis (Tapp. Can.). Pl. 31, fig. 2.

Shell minute, subrimate, subovate, very thin, corneous-brown. Spire a little elevated, the apex obtuse. Whorls 5,

subconvex, ornamented with frequent membranous riblets, the last usually nearly smooth, somewhat compressed behind the aperture, about two-thirds the total length of the shell. Aperture rather large, subquadrate above. Peristome a little expanded and somewhat reflected throughout, the margins separated. Apertural folds 4 or 5: angular minute, parietal larger, somewhat sinuous, diverging from the angular; columellar moderate; palatals 1 or 2, the upper one larger.

Length 2, width 1.2 mm. (*T. C.*).

Celebes: Macassar (Beccari).

Pupa (*Vertigo*) *selebensis* Tapparone Canefri, Ann. Mus. Civ. Genova, xx, 1884, p. 171, pl. 1, f. 12, 13.

Systematic position doubtful.

41. Nesopupa proscripta (E. A. Smith). Pl. 31, fig. 1.

Shell minute, oblong, cylindric, umbilicate, brownish-corneous, striate with delicate lines of growth. Whorls 5, very convex, separated by a deep, slightly oblique suture, the last whorl slightly ascending, impressed behind the lip. Lip pale, expanded, somewhat reflected, the outer margin slightly projecting inwardly in the middle. Aperture five-toothed: two unequal parietal teeth, a minute columellar, and two subequal, lamelliform palatals, distant from the edge of the lip.

Length 2.25, diam. 0.9 mm. (Smith).

Christmas Island (in the Indian Ocean south of the western extremity of Java, lat. 10° 25′ S., lon. 105° 42′ E.): Flying Fish Cove. Type in British Museum.

Jaminea proscripta Smith, Ann. and Mag. Nat. Hist. (7), xvi, Nov. 1905, p. 551, fig.

This species is much more slender than *N. selebensis*, which from the description seems to have similar teeth. There is a similar form on Teniimber Is., I believe still undescribed, and known to me by imperfect shells only. These species have the angular lamella short. It is remote from, not running to the upper termination of the outer lip, thereby differing from *N. malayana*.

V. Species of India and Ceylon.

Three of these species, *filosa*, *brevicostis* and *salemensis*, belong near *N. moreleti* and its East Indian allies. *N. barrackporensis* is not specifically separable from Philippine specimens referred to *N. malayana*, described from Borneo, and is also related to species of the Comoros and Africa. The teeth of *N. cinghalensis* have not been described or figured in sufficient detail for a decision, but it is probably near *barrackporensis*. The Nesopupa fauna of the Oriental Region is thus quite homogeneous.

Specimens of *filosa* and *barrackporensis* have been examined, the accounts of the others being compiled.

Angular lamella curved, rather high; shell ovate.
Length 2 mm., irregularly striate. *N. filosa*, no. 42.
Length 1.5 to 1.75 mm.
N. brevicostis, no. 43; *N. salemensis*, no. 44.
Angular lamella low, straight; shell cylindric; length 2 mm.
Seven teeth. *N. cinghalensis*, no. 45.
Five teeth. *N. barrackporensis*, no. 46.

Section *Indopupa* P. & C.

42. Nesopupa filosa (Theob. & Stol.). Pl. 31, figs. 9, 10.

The shell is ovate, imperforate but shortly rimate, dull, cinnamon-buff, thin, having rather strong but unequal striæ widely but unequally spaced, the intervals vermiculate-granose. Outlines of spire convex, the summit obtuse; penult whorl large, strongly convex; last whorl having a slight impression behind the outer lip, over the upper palatal fold. Aperture with 5 teeth: angular lamella rather low in front, higher within, curved, joining the outer lip. Parietal lamella high, slightly sinuous, not entering very deeply. There is usually a vestigeal infraparietal tubercule, so low that it is readily overlooked. Columellar lamella rather deeply placed, subhorizontal. Two rather short palatal folds, the upper low, lower much higher. The peristome is narrowly reflected, colored like the shell, slightly thickened, thinner at the sin-

ulus, which is not very well defined. Parietal callus scarcely noticeable.

Length 2, diam. 1.25 mm.; 4½ whorls.

Burma: Arakan coast, rather abundant (Theobald).

Pupa filosa THEOBALD & STOLICZKA, Journ. Asiatic Soc. Bengal, xli, pt. 2, 1872, p. 333, pl. 11, f. 8.—HANLEY & THEOBALD, Conch. Indica, pl. 160, f. 5.—*Pupilla filosa* Theob. & Stol., GUDE, Fauna Brit. India, Moll. ii, p. 287.—*Nesopupa filosa* PILS., Man. Conch., xxiv, p. 140, 366, pl. 25, f. 10, 11.

It is characterized by the large size of the last and penult whorls, giving it a somewhat cylindric outline, and the rather weak teeth of the large aperture, as compared with *N. moreleti*, which is related. There are only five distinct teeth, as the infraparietal is so small that it was overlooked by Theobald and Stoliczka, though present in their type lot.

The figures represent the type (fig. 10) and a paratype from the lot of four in coll. Indian Museum. Before seeing these specimens the original figures had been copied on pl. 25, figs. 10, 11 of Vol. xxiv, under the impression that it was a *Gastrocopta*.

43. NESOPUPA BREVICOSTIS (Benson). Pl. 31, fig. 11.

"Shell rimate-perforate, cylindric-ovate, corneous, apex obtuse. Whorls 4½, rapidly increasing in length, the last not ascending, one-third the length of the shell, upper whorls convex, remotely semicostulate above, last and penult whorls rather flattened, the lower half of the rest also silky, bearded. Aperture rounded-oval, 5 to 6 plicate: a short angular fold; an oblique, more deeply placed parietal; a single columellar; two or three palatals, deeply placed; peristome expanded, subreflected.

"Length 1.5, diam. scarcely 1 mm." (*Bens.*).

India: Barrackpore, Bengal (Bacon).

Pupa brevicostis BENS., Ann. Mag. N. H. (2), iv, August 1849, p. 127.—KÜSTER, Conchyl. Cab., Pupa, p. 136, pl. 17, f. 20-22.—*Pupilla brevicostis* Bens., GUDE, Fauna British India Moll., ii, p. 288, f. 104.

"Taken by Dr. J. F. Bacon on the trunk of a tamarind

tree at the Cantonment of Barrackpore, near Calcutta, during the rainy season of 1848. Out of several individuals forwarded to me, overland, by letter in a quill, two reached me alive, and creeping about when supplied with moisture enabled me to verify their affinities. The lower pair of tentacula is deficient or inconspicuous, as in Vertigo; the upper pair carry the eyes at their summits. The shell is often carried at an angle of 45°'' (*Benson*).

Mr. Gude has figured a specimen from the British Museum measuring 1.75 x 1.1 mm. Fig. 11 is a copy of this. The type cannot be found. ''The species is characterized by the lamellate striæ and the short spire as compared with the diameter'' (*Gude*).

44. NESOPUPA SALEMENSIS (Blanford). Pl. 31, figs. 7, 8.

''Shell rimate, ovate-oblong, obliquely striate, tawny. Spire elevated, conoidal, the apex obtuse; suture impressed. Whorls 4½, the upper ones somewhat convex, the last about two-fifths the total length, excavated in the middle, behind the aperture, arcuately ascending in front, compressed near the suture and below. Aperture reniform, columella receding, calloused above; two compressed parietal teeth. Peristome expanded, the outer lip flexuously excavated, one-toothed.

''Length 1.6, diam. 1, alt. aperture 0.6 mm.'' (*Blanf.*).

India: Kalryen Hills (Foote).

Ennea salemensis BLANF., Journ. Asiatic Soc. Bengal, XXX, 1861, p. 359, pl. 2, f. 8. — *Pupa salemensis* Blanf., PFR., Monogr. Hel. Viv., VI, 1868, p. 318. — HANLEY & THEOBALD, Conch. Indica, 1876, pl. 160, f. 9.—*Pupilla salemensis* Blanford, GUDE, Fauna Brit. India, Moll., ii, p. 289.—*Pupa salemanensis* Sowerby, Conch. Icon., XX, 1876, *Pupa*, pl. 7, f. 62.

Mr. Gude remarks that it appears much nearer *brevicostis* than to *Pupa seriola* with which Blanford compared it. The figures are copied from Blanford and Conchologia Indica.

45. NESOPUPA CINGHALENSIS (Gude). Pl. 31, figs. 5, 6.

''Shell narrowly perforate, almost rimate, cylindrical ovate, rather solid, very minutely striatulate, the earlier whorls

corneous, the later ones rufous. Spire convex, apex obtuse, suture impressed. Whorls 5, slightly convex, the last flattened and scrobiculate behind the peristome, shortly ascending, slightly compressed and subangulated around the extremely narrow perforation of the umbilicus. Aperture oblique, broadly obovate, furnished with seven denticles, 2 compressed, elongate, on the parietal wall, 2 very minute and deeply seated, on the columella, 3 also very minute and deeply seated, on the palatal wall. Peristome rufous, slightly thickened and reflexed; outer margin slightly inflexed, basal margin rounded, columellar margin obliquely ascending and slightly dilated above.

"Long. 2, diam. 1 mm." (*Gude*).

Ceylon. Type in the British Museum.

Pupilla cinghalensis GUDE, Fauna of British India, Moll., ii, 1914, p. 286, fig. 108.

"This new species is based on a specimen from Ceylon, without precise indication of habitat, acquired by me some years ago at a sale. It differs from *P. barrackporensis*, its nearest ally, in having seven instead of four denticles in the aperture, and in having the peristome fulvous instead of white" (*Gude*).

Section *Insulipupa* Pils.

46. NESOPUPA BARRACKPORENSIS (Gude). Pl. 31, figs. 3, 4.

This species was placed in *Gastrocopta* with a mark of doubt in Vol. xxiv, p. 135. Specimens sent from the Indian Museum, labeled by Nevill "*Pupa (Vertigo) brevicostis* = *V. indica* Pfeiffer," now at hand (pl. 31, figs. 3, 4), described below. They are apparently the Barrackpore examples noticed by Nevill in his Hand List Moll. Ind. Mus., i, p. 197, and which Mr. Gude surmised were *barrackporensis* (= *indica* Pfr. not Benson). If so, the low angular lamella was overlooked by all who have described the species. Mr. Sowerby's two wretched figures (Conch. Ind. and Conch. Icon.) appear to show it indistinctly. In renaming the shell Mr. Gude added nothing to the definition or illustration, though he had the types and other specimens under examination, and must

have been aware of the inadequacy of the published data. The original description may be found in Vol. xxiv, p. 135.

The shell is imperforate, shortly rimate, cylindric, cinnamon-buff. First 1½ whorls smoothish, the rest having uneven oblique striæ, mainly obsolete or blurred on the last two whorls, which have a minute vermiculate-granose sculpture, varying in distinctness on different specimens. The upper whorls are quite convex, the last two much less convex; last whorl having a broad, shallow impression behind the lip, over the upper palatal fold, both palatals showing through the shell as light spots. The squarish-oval aperture is longer than wide, having five teeth: angular lamella is quite low, diverging from the parietal and joining the outer lip. The parietal lamella is much the largest tooth. It is thin but high, directed obliquely and a trifle sinuous. The columellar lamella is situated high on the columella and rather deep within, ascending a little as it enters, and the edge is directed obliquely downward. The two palatals are well developed, the lower a little deeper within and longer. The lip is slightly lighter than the exterior, well expanded, with hardly any thickening. A parietal callus is scarcely visible.

Length 2, diam. 1.12 mm.; barely 5 whorls.

These shells do not differ materially from the Philippine specimens which I have identified as *malayana* Issel; yet as I have examined the types of neither species, and the original account of *malayana* is somewhat discrepant, the species are both allowed to stand provisionally.

This Indian species has much stronger microscopic rugosity and less prominent oblique striæ than *N. minutalis*. It differs from *N. corrugata* chiefly by the well-developed palatal folds, but it is also a little smaller than that species.

VI. Species of the Mascarene Islands and Comoros.

The islands of the western Indian Ocean have representatives of three genera of three subfamilies of Pupillidæ. One of these, the genus *Gastrocopta*, has been considered in Vol. xxiv, p. 127. They are small, white-toothed shells in which

the angular and parietal lamellæ are concrescent into one sinuous lamella.

The Vertigininæ have been very poorly described, and only two of the nine species are at hand for examination. One subgenus, *Nesopupa*, is common to these islands and Polynesia; another, *Insulipupa*, is common to the East Indies, India, the Mascarene Islands and Africa. Several other species, in the absence of specimens or adequate figures, cannot safely be classified. The species *borbonica* and *desmazuresi* resemble the East Indian group *Costigo* in teeth, and have provisionally been placed there.

Key to Species.

a^1. Aperture having both angular and parietal lamellæ.

b^1. Angular lamella strongly developed, rather long and high; columellar lamella entering deeply, dilated and curving downward at the inner end (*Nesopupa*).

c^1. Length 2.5 mm., about 8 teeth.
N. gonioplax, no. 47.

c^2. Length 1.5 mm., at least 5 teeth.
N. micra, no. 48.

b^2. Angular lamella small and much lower than the parietal; columellar lamella subhorizontal, not turned down within (*Insulipupa*).

c^1. Species of the Comoros, having 5 or 6 teeth.

d^1. 2 x 1 mm. *N. minutalis*, no. 49.

d^2. 1.5 x 0.75 mm. *N. comorensis*, no. 50.

c^2. Bourbon; 4 to 5 teeth, 1 or 2 palatals.
N. incerta, no. 51.

c^3. Mauritius; angular, parietal and columellar lamellæ only, no palatals. *N. ventricosa*, no. 52.

a^2. Parietal lamella present, but no angular; 1 columellar, 2 palatals.

b^1. 2.5 x 1.33 mm.; Bourbon. *Costigo borbonica*, p. 367.

b^2. 2.25 x 1 mm.; Rodriguez. *Costigo desmazuresi*, p. 368.

a^3. No teeth on the parietal wall; columellar lamella, basal and two palatals present; apex very obtuse; length 2 mm.
"*Vertigo*" *praslinensis*, no. 53.

Section *Nesopupa* proper.

47. NESOPUPA GONIOPLAX n. sp. Pl. 33, figs. 8, 9, 10.

The shell is ovate, cinnamon-brown, the peristome more reddish, the teeth paler. The surface has little gloss, and under the microscope shows some rather weak growth-wrinkles and a dense, very shallow pitting or minute malleation. The whorls are convex, the last having behind the lip two furrows, one lateral, the other sub-basal, diverging forward, and corresponding to the upper and lower palatal folds. The aperture has subparallel sides, straight parietal callus and strongly curved base, the peristome well expanded, somewhat thickened, at the sinulus thinner and retracted. The angular lamella is very strong, curved, joining the outer lip, diverging forward from the very strong parietal lamella, the inner end of which is bent towards the columella. There is a small infraparietal, rather deep within. The columellar lamella enters nearly horizontally, then deep within on the axis after rising a little it turns downward forming a broad plate, only imperfectly seen from in front but prominent from the back (fig. 9). There is a small basal fold at the junction of columellar and basal margins. The upper and lower palatal folds are sinuous, strong, and converge inwardly. A small suprapalatal stands above them, making 8 teeth in all.

Length 2.5, diam. 1.55 mm.; 5 whorls.

Mauritius (Morelet collection from Nevill, type 64093 A. N. S. P.).

The most remarkable character of this snail is the dilation and deflection of the columellar lamella. Nothing of this structure is seen in *N. moreleti* and others of that group, which are otherwise similar. Though the shells came from Nevill, according to Morelet's label, I cannot find that either G. Nevill or H. Adams described the species. The following species is apparently its nearest affinity.

48. NESOPUPA MICRA, new name. Pl. 33, fig. 4.

The shell is deeply rimate, ovate-cylindric, thin, very lightly striate, silky, brownish-corneous. Spire convex, apex obtuse.

Whorls 5, convex, the last obtusely angular around the umbilical crevice, narrower and bisulcate behind the aperture. Aperture truncate-oval, vertical, with two parietal lamellæ, the right-hand one prominent, left one remote. Peristome a little expanded, the right margin sinuous, provided with two entering folds. Length 1.5, diam. 0.75 mm. (*H. Ad.*).

Mauritius: Bamboo (G. Nevill).

Pupa (Pupilla) exigua H. ADAMS, Proc. Zool. Soc. Lond., 1868, p. 13, pl. 4, f. 4. Not *Pupa exigua* Say, 1822.

Adams did not mention a columellar lamella, but it is seen in his figure. The species is perhaps related to the preceding or to the Continental *bisulcata* group. It is smaller and narrower than *N. gonioplax*, with different sculpture.

Section *Insulipupa* P. & C.

Probably *N. ventricosa* H. Ad., which lacks palatal folds, belongs to this group. In that case *Insulipupa* would include the subgenus *Pagodella* H. Adams, Proc. Zool. Soc. London, 1867, p. 304, monotype *Pupa ventricosa* H. Ad.; not *Pagodella* Swainson, 1840.

49. NESOPUPA MINUTALIS (Morelet). Pl. 33, figs. 1, 2, 3.

Shell minute, rather deeply rimate, acutely subcylindric, corneous-tawny, somewhat shining, smooth, the apex obtusely conoid. Whorls 5½, a little convex. Aperture regularly oval, 6-plicate: one lamelliform angular; one transverse parietal; a rather prominent columellar; and three nearly equidistant punctiform teeth in the outer margin. Peristome simple, a little expanded, the margins separated. Length 2, diam. 1 mm. (*Morelet*).

Comoro Is.: Mayotte, on the islet of Dzaoudzi, on the bark of an Acacia.

Pupa minutalis MORELET, Journ. de Conchyl., vol. 29, 1881, p. 231, pl. 10, f. 5.

The form is cylindric with obtuse, rounded or convexly conic summit. The surface is rather dull with some irregular striation. The angular lamella is quite low, forwardly diverging from the parietal and joining or almost joining the outer

lip. Parietal lamella high, rather long; columellar strong, subhorizontally entering, its crest slanting downward. There are two quite short palatal folds, the lower one somewhat the larger and more immersed. The upper palatal is sometimes very small. According to Morelet "trois denticules, visibles à la loupe, sont placées sur le côté libre du peristome, à des distances à peu près égales l'une de l'autre"; one of these must be a basal fold; but no basal is to be seen in the specimens examined, and Morelet's figure shows only parietal and columellar teeth. The outer lip is well expanded. In a series received from M. Marie it is not thickened, though whitish; in another set, also from Mayotte, there is a distinct though rather thin callous thickening, and the teeth are larger.

Length 2, diam. 1.15 mm.; slightly over 5 whorls.

Length 1.8, diam. 1.1 mm.; 5 whorls.

This species, as Dr. Boettger has already noted, is related to the East Indian *N. malayana*. It differs from that species by the smoother surface, which has very little pitting or granulation.

50. NESOPUPA COMORENSIS n. n. Pl. 33, fig. 5.

The shell is minute, deeply rimate, ovate, glossy, brownish-corneous, the apex rather obtuse. Whorls 5, convex, joined by an impressed suture, the last slightly ascending, somewhat compressed at the base. Aperture semioval, with two parietal lamellæ, another columellar, and two small teeth in the basal margin. Peristome somewhat expanded, the margins subparallel. Length 1.5, diam. 0.75 mm. (*Morelet*).

Comoro Is.: Anjouan (Bewsher); Mayotte (Marie).

Pupa monas MORELET, Journ. de Conchyl., vol. 27, 1879, p. 310, pl. 12, f. 4; vol. 31, 1883, p. 196. Not *Pupa substriata* var. *monas* Westerlund, 1871.

As specific and varietal names are held to have the same status in nomenclature, the name of this species has to be changed.

51. NESOPUPA INCERTA (G. Nevill). Not figured.

Shell very closely resembling *Vertigo (Pagodella) ventri-*

cosa H. Ad., from Mauritius; there are, however, two parietal teeth and within the outer lip a distinct, well-developed tooth, with occasionally another small, indistinct one close to it; the columella is slightly more dilated and subangulated (*Nevill*).

Bourbon: near Salazie, in company with *V. pupula* Dh. (G. Nevill).

Vertigo (Pagodella) incerta G. Nevill, Journ. Asiatic Soc. Bengal, vol. 39, pt. 2, 1870, p. 413.

"This most perplexing of shells can only be distinguished from *Pagodella ventricosa* H. Ad. (Proc. Zool. Soc., 1867, p. 303) by the different dentition of the aperture; of the latter I found about 40 specimens, to all appearance full grown and in first-rate condition, some of them, to my mind, very old specimens; in none of them were there any signs of any teeth whatever within the outer margin of the aperture! Of the Bourbon species, I only found 5 specimens, one evidently young, the other 4 full grown and all showing the peculiar characteristics pointed out in my description. Still the resemblance is so striking that I think no naturalist would hesitate to avow that they must at no very remote period have had a common origin; there is, indeed, just the chance that at Mauritius a similar variety may exist, but, from the number of specimens I found there, I doubt it exceedingly. I have, however, written to Mr. Dupont at Mauritius to ask him to kindly examine all he can possibly procure of this species, and to see if he can find any trace of the apertural teeth, which give such a different appearance to my *V. incerta*" (*Nevill*).

It is curious that anyone could write so much about a shell and tell so little.

52. Nesopupa ventricosa (H. Adams). Pl. 33, fig. 6.

Shell deeply rimate, ovate, rather thin, obliquely striatulate, pale brown; spire convexly conic, the suture impressed. Whorls 5, somewhat convex, the last ventricose, rounded at base. Aperture semioval, provided with a compressed, entering parietal fold and a tooth at the insertion of the right

margin; peristome simple, slightly expanded, the margins joined by a callus, right margin somewhat sinuous, columellar margin dilated above. Length 2.5, diam. 1.75 mm. (*H. Ad.*).

Mauritius: The Moka ravines (G. Nevill).

Pupa (Pagodella) ventricosa H. ADAMS, Proc. Zool. Soc. London, 1867, p. 304, pl. 19, f. 6.—Pfr., Monogr., vi, p. 308. —*Pagodella ventricosa* H. Ad., G. NEVILL, Journ. Asiatic Soc. Bengal, vol. 39, pt. 2, 1870, p. 413.

G. Nevill writes of *Pagodella ventricosa:* "I found about 40 specimens, to all appearance full grown and in first-rate condition, some of them, to my mind, very old specimens; in none of them were there any signs of any teeth whatever within the outer margin of the aperture."

53. "VERTIGO"(?) PRASLINENSIS (G. Nevill). Not figured.

Shell resembles *Pupa lienardiana* Crosse, from Rodriguez, but the spire is less produced and there is no trace of the conspicuous parietal tooth; apex remarkably obtuse; 4½ whorls which increase very rapidly, the first three more or less cylindrical, the last one moderately convex; smooth, even under the lens no trace of sculpture is discernible; aperture triangular, regularly rounded at base, external margin somewhat obsoletely sinuate; a strongly developed, transverse columellar tooth, three other palatal teeth, equidistant, the middle one the largest, no parietal tooth (*G. Nevill*).

Length 2 mm.

Seychelles Group: Praslin, near the Protestant church, at the foot of a cocoanut tree (Nevill; type in Indian Mus.).

Carychium n. sp., G. NEVILL, Proc. Zool. Soc. Lond., 1869, p. 65. — *Vertigo praslinensis* G. NEVILL, Journ. Asiatic Soc. Bengal, vol. 50, pt. 2, 1881, p. 140.

The position of this species is quite uncertain. It may possibly be a *Gastrocopta* or one of the Pupillinæ. For a shell of this group or of Gastrocopta to have well-developed columellar and palatal teeth and no parietal is anomalous. In dead shells the latter sometimes scales off with the parietal callus. It appears that only one specimen was found.

VII. African Species.

a^1. Angular and parietal lamellæ present.

b^1. Angular lamella rather high, strong and curved.

c^1. Length 3 mm.; nearly smooth. St. Helena.
N. turtoni, no. 60.

c^2. Length less than 2 mm.; closely rib-striate.

d^1. Sculpture of rather coarse, very oblique striæ; shell ovate, white; 1.5 x 1 mm. British E. Africa. *N. iota*, no. 57.

d^2. Sculpture of fine, close rib-striæ; shell brown.

e^1. One broad median external furrow behind the aperture; lower palatal and basal folds rather deeply immersed; length 1.4 to 1.6 mm. S. Africa.
N. griqualandica, no. 54.

e^2. One very slight impression behind aperture; lower palatal but little immersed, basal minute, in subcolumellar position; length 1.6–1.65 mm. S. Africa.
N. farquhari, no. 55.

e^3. One very slight impression behind aperture; palatals rather short; no basal fold; length 1.85 mm. Rhodesia.
N. b. rhodesiana, no. 56*a*.

e^4. Two deep furrows behind aperture; no basal fold; length 1.87 mm. Abyssinia.
N. bisulcata, no. 56.

b^2. Angular lamella short and low; 2.25 to 2.4 mm. long.

c^1. Surface densely pitted; one palatal fold or none. Rhodesia. *N. corrugata*, no. 58.

c^2. Nianing, West Africa.
N. megalomastoma, no. 59.

a^2. No angular lamella; parietal, columellar and two palatal teeth present; length 1.75 mm. Island S. Thomé.
Costigo nobrei, p. 368.

a^3. Aperture without teeth (Genus *Negulus;* Vol. XXVI).

Section *Afripupa* P. & C., n. sect.

Minute Nesopupa with teeth of the typical section except that the columellar lamella does not turn down at its inner end; sculpture of close rib-striæ without cuticular edges. Type *N. griqualandica* (M. & P.).

54. NESOPUPA GRIQUALANDICA (Melv. & Pons.). Pl. 34, figs. 1-4.

Shell very minute, rimate, thin, rotund-cylindric, brown; whorls 5, rather swollen, compressed at the sutures, everywhere closely, longitudinally, finely striate, the last whorl depressed-sulcate in the middle, dorsally towards the lip. Aperture ovate-rotund; peristome thickened, sinuated on the labial [labral] margin, plicate: two parietal folds, very prominent and recurved, a third marginal on the columella, dentiform. Length 1, width 0.75 mm. (*Melv. and Pons.*).

British South Africa: — Cape of Good Hope: Griqualand East (type loc., Sykes); Cradock (Farquhar); Port Elizabeth (Ponsonby coll.). Natal: Pietermaritzburg, Dargle, Tongaat, Edendale (Burnup). Zululand: Dukuduku (Toppin). Transvaal: Pretoria District (Farquhar); Heidelberg (Miss Livingston); Buiskop (Connolly). Rhodesia: Victoria Falls (Connolly).

Pupa griqualandica MELVILL and PONSONBY, Ann. Mag. N. H. (6), xi, Jan. 1893, p. 3, fig. 9; (8), i, Jan. 1908, p. 76, pl. 1, f. 8, 10.—BURNUP, Ann. Mag. N. H. (8), vii, 1911, p. 405. —*Jaminia griqualandica* (Melv. & Pons.), CONNOLLY, Ann. South African Museum, xi, pt. iii, 1912, p. 182.

This species appears to differ from *N. bisulcata* (Jickeli) by the more deeply immersed lower palatal fold, the presence of a basal fold and the deeper external furrow of the last whorl over the upper palatal fold. It is also smaller than Jickeli records.

Melvill and Ponsonby's original description and figure are chiefly remarkable for what was omitted. The dimensions are grossly inaccurate. In their second account two species appear to have been in view, though in the main it relates to the true *griqualandica*.

The shell is distinctly perforate, openly rimate, long-ovate, the spire with convex outlines and very obtuse apex. Color cinnamon, becoming a little darker towards the base and paler towards the apex. First 1½ whorls smoothish (microscopically irregularly granulose), the rest with straight, close, somewhat oblique striæ; the latter part of the last whorl having a broad median furrow running to the lip, convex above and below it, with a shorter impression at the base. The aperture is wider in the upper part, nearly closed by 6 teeth: the angular lamella is subvertical, large, entering deeply, curving towards and joining the outer lip. Parietal lamella very long and high, oblique, directed towards a point above the lower palatal fold. The columellar lamella is rather deeply placed, not very high, and enters horizontally to the dorsal side, where the end tapers and turns upward but very slightly. The upper palatal fold emerges to the peristome, and with the angular lamella defines a nearly closed, oval sinulus; it enters deeply, descending a little. The lower palatal is a long fold, deeply immersed, only partially visible in a front view. The basal fold is short, transverse to the cavity, deeply placed but visible from in front. The parietal callus is rather thin.

Length 1.5, diam. 0.85 to 0.9 mm.; 4½ whorls. Pretoria.

"Length 1.41, diam. 0.83 mm." (Burnup).

"Length 1.6, diam. 0.99 mm." (Burnup, largest specimen).

55. NESOPUPA FARQUHARI Pilsbry. Pl. 34, figs. 7, 8, 9.

Shell perforate, openly rimate, long-ovate, walnut-brown, somewhat glossy. Spire convexly conic, the apex obtuse; first 1½ whorls smooth, the rest closely, somewhat obliquely rib-striate, as in *N. griqualandica;* the latter part of the last whorl flattened and having a quite small and shallow impression behind the lip, over the upper palatal fold. Aper-

ture shaped about as in *griqualandica*, with 6 nearly white teeth. Angular lamella strong, slightly curved, joining the outer lip. Parietal lamella high, oblique, penetrating to the dorsal side. Columellar lamella deeply placed, strong, penetrating to the dorsal side, where it is somewhat enlarged and deflected, then passing into a low callus obliquely ascending the axis. The upper palatal fold is strong, curved, emerging to the peristome, entering deeply. Lower palatal very high, long, somewhat immersed. Basal fold very low and small, on the basal end of the columella. The peristome is pale, well expanded and a little thickened, incurved and thicker in the middle of the outer margin.

Length 1.6 to 1.65, diam. 0.9 mm.; 5 whorls.

South Africa: Grahamstown (J. Farquhar).

Nesopupa farquhari PILS., Nautilus, xxxi, October 1917, p. 50.

While related to *N. griqualandica*, this species differs in numerous particulars. The spire is somewhat longer; the last whorl is far less impressed behind the lip; the angular lamella curves less; the lower palatal fold emerges much further, and is as prominent in a face view as the upper. Finally, the basal fold is even smaller than in *griqualandica*, and is upon the columella. In the other species it stands deep within the base, in a face view being in front of the deeply immersed lower palatal fold.

The Abyssinian *N. bisulcata* has not been directly compared with this species. By the description and figure it differs by being somewhat larger with no basal or subcolumellar tubercle, and the teeth do not appear to be as large as in *farquhari*.

56. NESOPUPA BISULCATA (Jickeli). Pl. 34, figs. 11, 13, 14.

The umbilicate shell is ovate-conic, scarcely glossy, very finely and obliquely costate longitudinally (visible under a lens), brown. The conic spire has an obtuse apex. The 5 convex whorls are separated by an impressed suture, the last whorl forming a third of the total length, is narrowed towards the base, with angular neck, and has two deep furrows. The

vertical aperture is rounded and contracted by 5 folds: the right one of the parietal wall is connected with the termination of the outer lip; the second is more deeply placed. There is a high columellar lamella and two palatal folds, of which the upper emerges to the peristome and unites therewith, the second disappears before reaching it. The peristome is moderately expanded and thickened within, the right margin bent inward by the upper furrow which corresponds to the upper palatal fold. Length 1⅞, diam. 1, aperture ¾ x ½ mm. (*Jickeli*).

Abyssinia: plateau of Rora-Beit-Andu, province of Hamaszen, and on the Keren Mts., Bogos, under rotten leaves, wood and stones (Jickeli).

Pupa bisulcata Jickeli, Malak. Blätter, 1873, p. 107: Fauna der Land- und Süsswasser-Mollusken Nord-Ost-Afrika's, in Nova Acta Acad. Caes. Leop.-Carol. Germ. Nat. Cur., vol. 37, 1875, p. 119, pl. 5, f. 10.

No Abyssinian specimens are at hand, and as Mr. Burnup has observed, Jickeli's figures do not agree in proportions with his measurements. The latter indicate a shell proportioned like the following form.

56*a*. *N. bisulcata rhodesiana* n. subsp. Pl. 34, figs. 5, 6.

The shell is more elongate and cylindric than in *N. bisulcata* according to Jickeli's figures, the penult whorl equalling the last in diameter. The whorls are strongly convex, the striation less regular and not so strong as in *N. griqualandica*. Latter part of the last whorl is a little flattened laterally and close behind the outer lip there is a short furrow above the middle. The teeth are much smaller than in *griqualandica* and *farquhari*, the palatals especially being shorter. No basal or subcolumellar fold is present.

Length 1.85, diam. 1 mm.; 5 whorls.

Rhodesia: Victoria Falls (Connolly).

A specimen of this form was sent with *N. griqualandica*. It differs so much in contour from Jickeli's figures that, taking the locality and faunal zone into consideration, I am disposed to give it subspecific standing. *N. bisulcata* is figured

as evenly rib-striate, like *N. griqualandica*, while in the present form the sculpture is uneven.

57. NESOPUPA(?) IOTA (Preston). Pl. 34, fig. 6*a*.

"Shell minute, ovately pyramidal, thin, white; whorls 5, regularly increasing, the last ascending in front, sculptured with rather coarse, very oblique, transverse striæ; suture somewhat deeply impressed, labrum sinuous, white, scarcely reflexed, the margins not joined, though it is continued for some distance along the parietal wall; aperture almost irregularly triangular, furnished with two oblique parietal lamellæ, of which the lower is the coarser, a short lamella on the outer lip, a coarse basal denticle, and a coarse oblique lamella on the columella.

"Alt. 1.5, diam. maj. 1 mm." (*Preston*).

British East Africa: between Rumruti and Mount Kenia (collector unrecorded).

Ennea iota PRESTON, Ann. Mag. N. H. (8), vii, May, 1911, p. 463, pl. 11, f. 2.

This appears, from the figure, to be a *Nesopupa*. The sculpture seems more like the Indian than the other African species. It is said to be white; if so *when alive*, it is unlike any of the known species. Not seen by the writer.

Section *Insulipupa* P. & C.

58. NESOPUPA CORRUGATA (Preston). Pl. 34, figs. 12, 15.

Shell perforate, small, cylindrical, brownish-bronze color; whorls 5, rather convex, the first three rapidly increasing in both length and breadth, the last two in length only, corrugated throughout, the third and fourth whorls being also obliquely, somewhat irregularly and distantly plicate; suture deeply impressed; umbilicus very narrow; columella whitish, outwardly and rather erectly expanded, obliquely descending; labrum also whitish, somewhat sinuous, dilated below, erect and angulated above; aperture subquadrate, armed with a denticle just below the margin of the labrum, and below and to the left of this an oblique curved lamella on the parietal

wall, a slightly projecting denticle very internally situate on the upper portion of the columella, and a small, rather indistinct basal denticle situated well within, and rather on the right-hand side of the shell. Alt. 2.25, diam. maj. 1 mm. (*Preston*).

Length 2.29, diam. 1.08 mm. (Burnup).

Length 2.25, diam. 1.15 mm.; 5¼ whorls (Connolly coll.).

Rhodesia: Rain Forest, Victoria Falls (M. Connolly).

Jaminia corrugata PRESTON, Ann. Mag. Nat. Hist. (8), ix, Jan. 1912, p. 71, fig. 4.

The initial 1½ whorls appear smooth, but there is a very close microscopic pitted-granose sculpture. The next whorl has rather weak but coarse striation. On the following whorls the surface appears punctate under a lens; when more magnified it is seen to be very closely, irregularly pitted, the pits very irregular in shape. There are also unequal, oblique striæ, conspicuous on the last whorl only immediately below the suture, but noticeable on the penult and earlier whorls. The striation is hardly strong enough to justify Preston's term "plicate". The angular lamella is rather low, straight, extending inward slightly beyond the anterior end of the parietal lamella, diverging from the latter and nearly joining the outer lip. The parietal lamella is high, oblique, and enters rather deeply. The columellar lamella is deeply placed, rather short, ascending very little as it enters. There is a very low but fairly long lower palatal fold in a specimen in Mr. Burnup's collection (fig. 12), but none in the Connolly shell (fig. 15). The peristome is thin, rather well expanded; parietal callus very thin.

The pitting, while similar to that of many Nesopupæ, is unusually copious. By the characters of the teeth it is an *Insulipupa*, standing close to *N. barrackporensis* and *malayana*. Fig. 14 is from a drawing by Mr. Burnup; fig. 15, from a specimen lent by Major Connolly.

59. NESOPUPA MEGALOMASTOMA (Maltzan). Not figured.

Differs from the Comoro Island type [of *Pupa minutalis* Morel.] by the larger shell, the last whorl more lengthened-

effuse downward, more impressed transversely behind the aperture. Aperture larger for the length of the shell, the peristome more expanded. Length 2⅜, diam. 1⅛ mm; aperture 1 mm. high, ¾ wide (*Maltzan*).

West Africa. Nianing, in forest.

Pupa (Staurodon) minutalis Morel., var. *megolomastoma* Maltzan, Nachr. d. Malak. Ges., xxii, April 1890, p. 48.

The name was evidently intended to be *megalomastoma*, and should be so corrected.

VIII. St. Helena Species.

Section *Helenopupa* Pilsbry, n. sect.

Lamellæ and folds as in typical *Nesopupa* except that the columellar lamella curves slightly upward at its inner end; surface nearly smooth.

Like *Indopupa*, *Cocopupa* and *Insulipupa*, this is less specialized than the typical Nesopupæ. It is notable for the smooth surface.

60. Nesopupa turtoni (E. A. Smith). Pl. 33, figs. 11, 14, 15.

Shell minute cylindric, obtusely conic above, whitish, subrimate. Whorls 5 to 6, convex, slowly increasing, parted by a slightly oblique suture, striated with very oblique, very delicate lines, the last whorl hardly descending, with one pit in the middle behind the lip. Aperture small, irregularly subquadrate, hardly a third of the total length, having 6 teeth within, three on the parietal wall, one columellar, two palatal; peristome white, slightly expanded and reflected, continuous, indented above.

Length 3, diam. 1 mm.; aperture ⅔ mm. long and wide (*Smith*).

St. Helena: Sugarloaf Quarry, common; extinct (Turton).

Pupa turtoni Smith, Proc. Zool. Soc. Lond., 1892, p. 268, pl. 22, f. 20, 20*a*.

Like the St. Helena Endodonts, this species has a Polynesian aspect.

In the best preserved specimens the surface is smooth ex-

cept for some very slight lines of growth, and of a somewhat transparent bluish-gray tint. There is a rather long flattening of the last whorl, behind the outer lip, in the middle a very little impressed over the upper palatal fold. Other examples are more chalky and opaque; and when a little worn, long, narrow, external furrows (varying in depth) appear over the upper or over both palatals, often with a little pit above the labral end of the upper one. These furrows are the result of erosion, and not proper to the species in its perfect state.

There is usually a triangular callus where the angular lamella joins the upper termination of the lip, which is more or less detached from the preceding whorl, and often more highly arched than in the example figured. The columellar lamella curves upward a little at its inner termination. There is a basal fold in form of a low tubercle, subcolumellar in position, and so deeply immersed that it is not visible in a face view; but often this is reduced to a slight callus which would hardly be noticed.

Length 2.5, diam. 1.2 mm.; 5½ whorls.

Length 2.2, diam. 1.2 mm.; 5¼ whorls.

These notes are from two lots collected by Capt. Turton. Mr. Smith's measurements are obviously inexact, and do not agree with the proportions of his figures.

Genus CAMPOLÆMUS Pilsbry.

Tomigerus sp., E. A. Smith, Proc. Zool. Soc. London, 1892, p. 267.

Campolæmus Pils., Nautilus, vi, Dec. 1892, p. 96, for *Tomigerus*(?) *perexilis* Smith.

Shell resembling *Tomigerus* in miniature; minute, imperforate but with a long basal suture, obtusely conic, the last whorl distorted, ascending. Aperture slanting upward, with distinct sinulus bounded by the long, emerging angular lamella and upper palatal fold; parietal and columellar lamellæ and lower palatal fold very deeply immersed; lip well expanded.

While this snail is astonishingly like *Tomigerus* in form,

yet the teeth are of Pupillid type, and it is believed that *Nesopupa turtoni* is perhaps the most nearly related of known species. Several other Pupillid groups, such as *Boysia* and *Hypselostoma* have the last whorl turned upward.

1. CAMPOLAEMUS PEREXILIS (Smith). Pl. 33, figs. 13, 16-19.

"Shell dextral or sinistral, minute, obtusely pyramidal, imperforate, whitish or pale tawny. Whorls 5, somewhat convex, slowly increasing, striate with delicate lines of growth, the last whorl strongly ascending in front, constricted behind the lip, furrowed and distorted, also furrowed basally, appressed to the preceding whorl. Spire very obtuse at apex. Aperture transversely ovate, having a nearly circular sinus above, narrowed within; peristome continuous, more or less expanded.

"Length 1.5, greatest diam. 1.5, least 1 mm.; aperture 0.5 mm. long and wide" (*Smith*).

Length 1.55, diam. 1.4 mm.; 5 whorls.

St. Helena: Side Path, and the sinistral form from Sugarloaf Ridge; extinct (Capt. Turton).

Tomigerus(?) *perexilis* E. A. SMITH, Proc. Zool. Soc., 1892, p. 267, pl. 22, f. 19-19*b*.

This shell is remarkable for the upwardly inclined aperture and distorted last whorl, with a long basal suture, as in the South American genus *Tomigerus*.

The first 1½ whorls are smooth and unusually wide; penult and antepenult whorls have unevenly spaced but rather strong, quite oblique striæ; on the last whorl these are much weaker. The emerging angular lamella converges towards the upper palatal fold, forming a shortly oval, nearly tubular sinulus. It penetrates deeply, as far as the anterior end of the parietal lamella. The latter is deeply immersed, its forward end visible in a front view, deep within; becoming a high lamella, it penetrates to the dorsal side. An infraparietal lamella, more deeply placed, not visible in the aperture, penetrates about as far as the parietal. The anterior end of the columellar lamella is visible in an oblique view in the aperture. It also becomes high and penetrates to the

dorsal side, turning downward at the inner end. The upper palatal fold emerges to the lip where it terminates in a rounded prominence. It penetrates very deeply, running obliquely downward. The lower palatal, which is situated far within, appears to consist of two rather short, oblique laminæ meeting below in form of a wide V. The lip is expanded, thickened; parietal callus strong.

Mr. Smith's figure of the sinistral form referred to this species, copied in fig. 13, shows the sinulus less enclosed than in the dextral. In the typical form figured by Mr. Smith (fig. 17) the upper part of the peristome is some distance below the preceding suture. The external pit over the columellar lamella and lower palatal fold is broad and rather deep. The length and diameter are given as equal by Mr. Smith; in one measured the length exceeds the diameter.

Mutation *ascendens*, pl. 33, figs. 16, 18, 19. Suture of the last whorl ascending to the preceding suture. Base more swollen, the pit smaller. Length 1.5, diam. 1.6 mm.

Mut. *contrarius*, pl. 33, fig. 13. Shell sinistral. Known to me by Mr. Smith's figure, here copied, which shows a less completely enclosed sinulus.

Genus COSTIGO Boettger.

Costigo Bttg., Bericht Senck. naturf. Ges., 1891, p. 270, as a section of *Vertigo*, for *V. (c.) saparuana* Bttg.

"Differs from the section *Alaea* by the scarcely glossy shell, densely striate or costulate, the neck simple, without annular callus [crest], a single parietal tooth, no angular. Columellar tooth always present; palatals 0 to 2. Moluccas and Philippines" (*Bttg.*).

This group, which appears very nearly related to *Nesopupa*, is not known to us by specimens. To the species described by Boettger are added a few Mascarene and African forms which agree in teeth. It is probably not a natural group in its present limits—merely a convenience.

1. Costigo saparuana (Boettger). Pl. 31, fig. 12.

Shell small, punctate-rimate, subacutely ovate, corneous-

apex rather acute. Whorls 5, convex, separated by a deep suture, very densely obliquely striatulate and ornamented with distant hair-like riblets, the last whorl somewhat enlarged, rounded basally, ⅔ the height of the shell, more strongly ribbed towards the aperture, and not ascending. Aperture ample, nearly vertical, semioval, slightly angular at the sinulus, 4-toothed, the teeth compressed; 1 parietal, simple, oblique, strong; 1 columellar, horizontal, in the middle of the columella; palatals either 2, widely separated, the lower one stronger, or only a lower fold. Peristome obtuse, narrowly expanded, colored like the outside, the margins joined by a light callus, columellar margin somewhat dilated.

Length 1.75 to 2, diam. 1.125 to 1.25, alt. and width aperture 0.75 mm. (*Bttg.*).

Moluccas: Sirisori on Saparua Island (Strubell).

Vertigo (Costigo) saparuana Bttg., Bericht Senck. naturf. Ges., 1891, p. 270, pl. 3, f. 12, 12*a*.

Distinguished from the externally similar genus *Leucochilus* by the single, entirely simple parietal tooth, from the oceanic Vertigine group *Ptychochilus*, which otherwise is very closely related, by the absolute lack of an angular tooth.

2. Costigo calamianica (Moellendorff). Not figured.

Vertigo calamianica Mlldff., from Busuanga, is mentioned as a new species of the section *Costigo* in von Moellendorff's *Verzeichnis*, Abhandl. Nat. Ges. Görlitz, xxii, 1898, p. 152. It is evidently the form alluded to by Boettger, following his account of *C. saparuana*, in the following terms: "A second species of *Costigo* lives on Busuanga, Catanduanes, Philippines; it is a new species, for which I am indebted to Consul Dr. O. Fr. von Moellendorff, and which has no cuticular ribs in addition to the sharp striation, and in which palatal teeth are lacking."

3. Costigo borbonica (H. Adams). Pl. 33, fig. 7.

Shell deeply rimate, oblong-ovate, thin, nearly smooth, silky, rufous-brown. Spire convexly conic, the apex obtuse,

suture impressed. Whorls 5, a little convex, the last somewhat compressed at base, swollen and pitted behind the aperture. Aperture truncate-oval, subvertical, four-toothed: one entering, compressed parietal tooth, one tooth deep on the columella, two in the palate, the upper one minute. Peristome a little expanded, white-lipped, the margins joined by a thin callus, right margin somewhat sinuous. Length 2½, diam. 1⅓ mm. (*H. Ad.*).

Bourbon (G. Nevill).

Vertigo (Alaea) borbonica H. Ad., Proc. Zool. Soc. Lond., 1868, p. 290, pl. 28, fig. 8.

4. Costigo desmazuresi (Crosse). Pl. 33, fig. 12.

Shell umbilicate, shortly cylindric, thin, translucent, appearing smooth to the naked eye, but really marked with fine, slightly oblique striæ visible only under a lens. Shell a little shining and of a light corneous-tawny color. Spire forming a short cone terminating in an obtuse summit. Suture well marked. Whorls 6, a little convex, the last whorl a little smaller than the spire, slightly tapering and rounded at the base. Aperture subvertical, of rounded semilunar shape and provided with 2 unequal spiral lamellæ [palatal folds] situated deep within. Peristome simple, narrowly expanded, a little reflected, and of a light rosy white; margins separated; parietal and columellar margins provided each with one internal tooth; these two teeth being placed at right angles to one another (*Crosse*).

Length 2.25, diam. 1 mm.

Rodriguez: Pointe aux Coraux (A. Desmazures).

Pupa desmazuresi Crosse, Journ. de Conchyl., xxi, 1873, p. 140; xxii, 1874, p. 227, pl. 8, f. 3.

Crosse remarks that one of the palatal folds is more readily visible than the other, and it only is shown in the figure.

5. Costigo nobrei (Girard). Pl. 34, fig. 10.

Shell rimate, oval, very finely striate, as though vermiculate, corneous, subtransparent. Whorls 4-4½, very convex, with a deep suture, the last whorl contained about 2½ times

in the total length, very distinctly contracted near the aperture, ascending a little, and very distinctly compressed at the base. Peristome simple, reflected. Aperture subvertical, somewhat rounded, toothed: a parietal fold larger than the others, a columellar fold more deeply placed, and two teeth on the outer wall, situated still further within the aperture. Length about 1¾, diam. 1 mm. (*Girard*).

Island of San Thomé: Binda, under the bark of trees, F. Newton.

Pupa nobrei GIRARD, Jornal de Sci., Math. Phys. e Nat. Acad. Real Sci. de Lisboa, (2), iii, no. 10, 1893, p. 111, pl. 1, f. 21.

Compared by Girard with *Pupa corpulenta*, an American *Vertigo*. It has sculpture like the *Nesopupæ*, apparently, but does not appear nearly related to known African forms. By the single lamella on the parietal wall it resembles *Costigo*.

ADDITIONS AND CORRECTIONS, VOL. XXIV

PAGE 95, 12th line from bottom, the references to figures should read: Pl. 28, figs. 2, 3, Ecuador, and pl. 28, fig. 1, Duran.

GASTROCOPTA OF THE MASCARENE ISLANDS. Vol. XXIV, p. 127.

M. Germain has proposed a new genus, *Falsopupa,* for the species *exigua* H. Ad., *microscopica* Nev., *lienardi* (= *lienardiana*) Crosse and *desmazuresi* Crosse (Bull. Mus. Nat. d'Hist. Nat. Paris for 1918, no. 7, p. 521; this number received at the Academy Oct. 14, 1919).

This list contains species of two genera. No diagnosis of the group was given, and no species was selected as type. I take *Pupa lienardiana* Crosse (*Falsopupa lienardi* Crosse of Germain's list) to be the genotype. If the views of the affinities of the Mascarene species expressed in Vol. XXIV, pp. 127-133, are upheld, *Falsopupa* will become a synonym of the typical section of *Gastrocopta.*

Genus ABIDA, vol. XXIV, p. 262.

Add to the synonymy:

Pupa Draparnaud, Tableau des Moll. terr. et fluv. de la France, 1801, pp. 32, 56, for *muscorum* [Drap. not Linné], pygmaea, antivertigo, vertigo [= *pusilla* Müll.], umbilicata, marginata, doliolum, dolium, granum, avena, frumentum, secale, polyodon, variabilis, 4-dens, 3-dens, cinerea, and various species of *Clausilia* and *Balea. Pupa frumentum* may be selected as type. Not *Pupa* Bolten 1798, or *Pupa* Lamarck, 1801.

Deloplecta Agassiz, Nomenclator Zoologicus, 1842-6, Mollusca, p. 29, there said to "= *Pupa*". Agassiz, in the same

work, mentions *Pupa* Humph., Mus. Calonnianum (a *nomen nudum*), and *Pupa* Draparnaud. *Deloplecta* will be considered equivalent to the latter, with the same type, *Pupa frumentum*. Agassiz gives the reference "Charp., Cat. Moll. Suisse, 1837," but the name does not occur in that work.

Pupella SWAINSON, Treatise on Malacology, 1840, pp. 183, 334 (*P. variabilis* here designated as type). Not *Pupella* B. St. Vincent, 1825 (Infusoria).

PAGE 264. Under the caption "Radula", the reference to Proc. Malac. Soc. London should be Vol. II.

PAGE 307, tenth line from bottom, for "Bull. Soc. d'Agric." read: Ann. Soc. d'Agric. The same correction should be made on pp. 311 and 314.

"PUPA" PYRENAICA Boubée.

Pupa hospitii (p. 37) is said to be a synonym of *Pupa (Modicella) pyrenaica* Boubée (B., H. & d'A-A., Fauna Malacologia del Pirineu Català, i, 1818, p. 99). The writer has not seen Boubée's publication. According to Westerlund, *Clausilia pyrenaica* Boubée 1833 is identical with *Pupa pyrenæaria* (Boub.) Mich., and *P. pyrenaica* Boubée 1839 is *P. ringens* (Calliaud) Mich. It is evidently *Abida "pyrenæaria"* which Bofill, Haas and d'Aguilar-Amat had in view. See Man. Conch. XXIV, pp. 278, 288. The status of Boubée's species must be determined by reference to the original publication.

VOLUME XXV.

CHONDRINA GONIOSTOMA (Küster). P. 33. Bofill, Haas and d'Aguilar-Amat consider *Pupa angulata* Fagot (p. 34) to be one extreme of this species, *P. leptocheilos* Fagot (p. 31) the other, the first having the mouth more angular, the second less so (Fauna Malacologia del Pirineu Català, i, 1918, p. 95). As stated in the text, *P. leptocheilos* was proposed as a substitute for *tenuimarginata*.

CHONDRINA ARAGONICA (Fagot). P. 54. *P. saltus* (p. 51) is a form of this according to the authors mentioned above (*op. cit.*, p. 97).

VERTIGO ALABAMENSIS CONECUHENSIS, p. 80. The authority, Clapp, should be substituted for "n. subsp."

VERTIGO OVATA Say. P. 82.

This species occurs also in the southeastern U. S.—Virginia, western North Carolina, Georgia and Florida (Sterki collection); Florida at Snapper Creek hammock, Dade Co., Lower Matacumbe Key and Madeira hammock near the end of the peninsula (Geo. H. Clapp coll.).

VERTIGO VENTRICOSA. P. 94.

Dr. Sterki writes: "I believe that *V. ventricosa* is closely allied to *V. ovata*, not to *V. pygmæa*. I have repeatedly had forms in doubt between the two. Both have essentially the same formation of the palate, and there are small *ovata* with a slight palatal callus, occasionally no infraparietal and a barely vestigeal angular lamella."

VERTIGO HEBARDI Van. P. 103.

Additional localities are: Elliott's, Pumpkin, Lignum Vitae, No Name, Big Pine and Little Palo Alto keys, off south and southeastern Florida, Geo. H. Clapp collection.

VERTIGO CONCINNULA Ckll. P. 121.

The shells illustrated in fig. 1 are from Willow Creek, Mogollon Mts., New Mexico; x 15.

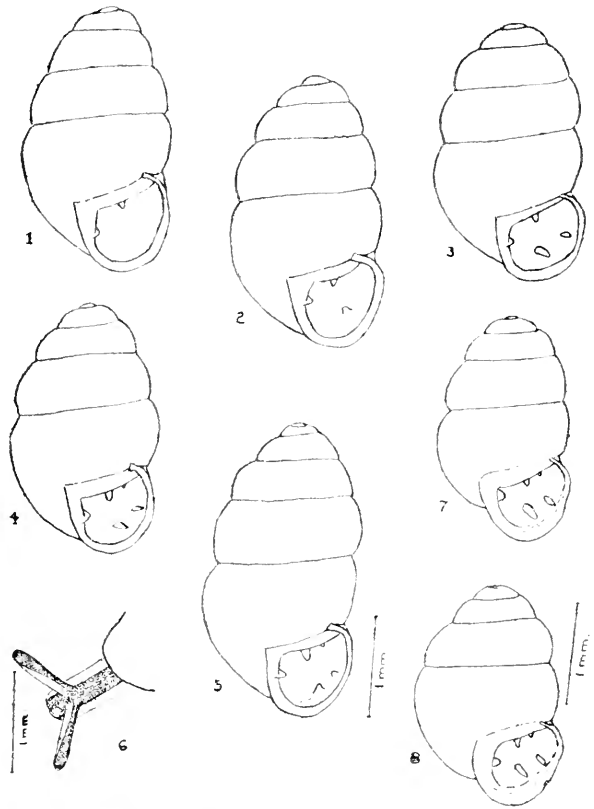
VERTIGO MODESTA (pp. 123-134).

On p. 134 a race of *V. modesta* from near Bluff Lake in the San Bernardino Mts., California, was discussed. It was figured on p. 124, figs. 8, 8*a*, 8*b*. Without locality it would not be possible to separate some specimens from *V. m. castanea*, while others would be as near *V. m. parietalis*. These ex-

tremes, however, are fully connected in the Bluff Lake series, which must thus be treated as a unit. As in the Santa Catalina race of this species (p. 132), albino shells occur in some abundance. As in many other cases, the albino mutation occurs in colonies with the brown shells, and there is no reason to believe that it does not interbreed with them, as has been demonstrated for a number of other such cases. Dr. Berry has described the albino mutation as *V. m. microphasma*. In the writer's opinion the brown shells found with them are of the same race; but the name can be used for the San Bernardino race as a whole, with its several variations and mutations. Though certainly without definite differential characters, it is not, as a whole, either typical *castanea* or typical *parietalis*.

VERTIGO MODESTA MICROPHASMA Berry. Figs. 1-6.

"The shell is cylindro-conic, rimate-umbilicate, thin, very pale horn-color, by transmitted light transparent and colorless. The surface is glossy and distinctly, irregularly, obliquely striate, especially on the upper whorls. The spire tapers from the last whorl, at first gradually, then more rapidly, to the obtuse apex. The whorls are strongly convex, the last with an indentation just back of the aperture over the lower palatal tooth, subsequently with a narrow, abrupt, axial constriction, then swollen to form a low, wave-like crest just back of and parallel to the lip. The aperture is rounded triangular, scarcely constricted on the outer margin, the peristome thickened and porcelain white in color, showing through the back of the shell as a white line, but the sharp lip scarcely reflected except over the columella. The posterior angle of the outer lip curves in rather sharply to the body whorl. The number of teeth varies from 2 to 5. The parietal and columellar lamellæ are always well developed. In addition there is almost always a well-developed lower palatal. A smaller, but variable upper palatal is frequently present, as also a minute angular lamella. All the teeth are porcelain-white in color. "



1-6, VERTIGO MODESTA MICROPHASMA. 7. VERTIGO ALLYNIANA. 8, V. ALLYNIANA mut. XENOS.

"Length of type 2.6; diameter to lip edge 1.5; length of aperture 0.9 mm.; whorls 5.

"*Type:* Cat. no. 2740 of the writer's collection, fig. 2. Paratypes in the Academy of Natural Sciences of Philadelphia, California Academy of Sciences, Southwest Museum, United States National Museum, and the private collections of Mr. George H. Clapp and others.

"*Type Locality:* 7,550 feet altitude, cienaga near Bluff Lake, San Bernardino Mountains, California; under sticks and logs at edge of forest; Nina G. Spaulding, G. E. Dole

and S. S. Berry, August, 1910; 59 specimens in this and neighboring cienagas. Also taken at 7,200 feet altitude, west slope of Falls Creek Canyon, near the narrows about one mile above Dobbs Cabin, Dollar Pass Trail, San Bernardino Mountains, California; under small sticks and pine cones on springy slope; G. E. Dole and S. S. Berry, Sept. 29, 1918; 32 specimens" (*Berry*).

Vertigo modesta microphasma BERRY, Nautilus, xxxiii, Oct. 1919, p. 48, figs. 1-6.

"This very puzzling little mollusk is one of the most beautiful of American Vertigos. It is very close to *V. modesta parietalis* and may also be described as an albinistic race of that subspecies, but it is a protean form and some shells are equally close to *V. modesta modesta* or even to *V. m. castanea*. That it is more than a mere 'albino' of the recognized type is strongly evidenced by its occurrence in such abundance and at scattered localities, as also by the fact that its distribution is by no means coincident with that of any of the other forms mentioned. Nor, although usually associated, do the white or brown shells occur in any apparent regular ratio. At the second locality above cited diligent outlook yielded but three specimens of the brown *parietalis*. It is evidently a comparatively recent offshoot from the parent stock, but the field evidence is that it already is a race with its peculiar characters heritable to a marked degree.

"It seems rather remarkable that such features as the color, shell texture, and similar characters in this form should exhibit such constancy as compared with the variability shown in the development of the lamellæ. In 39 specimens of the type lot now before me, 1 has only 2 teeth (columellar and parietal), 15 have 3 teeth (columellar, parietal, and lower palatal), 9 have 4 teeth (an upper palatal usually the one added), and 14 have a full set of 5 teeth. No mature specimens with fewer than 2 nor more than 5 teeth have been noted. This variation in a single well-defined colony (its members having, as shown by the other characters noted, an undoubtedly close phylogenetic relationship with one another) throws a valuable bit of light on the difficulty of at-

tempting the separation of the various races of the *modesta* series by means of variations in the number of teeth alone. It chances that the specimen chosen as type is one of the 3-toothed forms.

"The animal is bluish-gray or slate in color, the body quite dark, the foot and peripheral portions much lighter and semi-transparent. A rough sketch of the cephalic region of one of the Falls Creek specimens is offered in fig. 6.

"Whether the hereditary value of this race is that of a 'form' or a subspecies can only be shown by the more detailed study which must be left for the future. Until then the personal equation must necessarily largely govern. In any case it will prove useful to have a name for it" (*Berry*).

VERTIGO ALLYNIANA Berry. Fig. 7.

"The shell is minute, short, robust, ovate-conic in outline, thin, dark reddish-brown in color, with only a dull gloss; weakly, irregularly striate. The spire tapers with increasing rapidity from the last whorl to the obtuse apex. The whorls are convex, the last having a shallow but distinct excavation in the palatal region and a weaker one over the upper palatal tooth, the latter extending to the lip, which thus becomes flattened or very slightly indented on its outer segment. The aperture is pyriform in outline, and would be rather small except for the quite flaring lip, which is little thickened and very fragile at the edge. There are 5 teeth constantly developed in all the material examined. The parietal, columellar, and upper and lower palatal lamellæ are well developed, and there is a distinct, though small angular lamella. The columellar is situated well back in the aperture and quite high up on the pillar. The lower palatal is also rather deeply immersed.

"Length of type 2.1; diameter to lip edge 1.3; length of aperture 0.81 mm.; whorls 4¾.

"*Type:* Cat. no. 3764 of the writer's collection. Paratypes in the Academy of Natural Sciences of Philadelphia, and the private collection of Allyn G. Smith.

"*Type Locality:* Donner Lake, California; A. G. Smith, May 30, 1916; 22 specimens" (*Berry*).

Vertigo allyniana BERRY, Nautilus, vol. 33, Oct. 1919, p. 51, fig. 7.—*Vertigo allyniana xenos* BERRY, op. cit., p. 52, f. 8.

"I am not quite certain of the relationships of this small *Vertigo*. The texture of the shell, as well as the shape, are strongly reminiscent of *V. occidentalis* Sterki, a more weakly-toothed species from the San Bernardino Mountains. None of the other species with which I am familiar require any special comparison. *V. corpulenta* (Morse) has a somewhat similar outline, but otherwise does not seem especially close" (*Berry*).

Two paratypes measure:

Length 2.18, diam. 1.4 mm.

Length 2.1, diam. 1.27 mm.

The holotype of *V. a. xenos* measured the same way:

Length 2.1, diam. 1.45 mm.

The latter form, based upon a single shell, found with typical *allyniana*, appears likely to be merely a shape mutation. Variation of contour equal to this is of common occurrence in single colonies of many Vertigos, and in the absence of series sufficient to show that there is racial differentiation they are better left nameless.

In washing a specimen of the typical *allyniana* the color and texture appear to be exactly as in the type of *xenos*.

Mut. *xenos* (Berry), fig. 8. "With the preceding occurred a single specimen of a very similar form having the same number of teeth, but differing abruptly in its shorter, much more robust and swollen outline, its more transparent, glossier texture, and lighter brown color. The columellar tooth is placed distinctly further down on the pillar, and the remaining lamellæ differ slightly from those of the shells described above both in size and position. Length of type 2.0; diameter to lip edge 1.5; length of aperture 0.85 mm.; whorls 4½. *Type:* Cat. no. 4128 of the writer's collection" (*Berry*).

VERTIGO CALIFORNIA ELONGATA (Sterki). Page 142.

The name *elongata* is several times preoccupied in both *Pupa* and *Vertigo*. It may stand as *Vertigo californica longa*.

VERTIGO ROWELLI (Newc.). P. 143.

Two specimens from Oakland, type locality, measure:
Length 2.8, diam. 1.4 mm.; nearly 6 whorls.
Length 2.48, diam. 1.3 mm.; 5½ whorls.

The minute costulation is rather pronounced on the penult whorl. The low, rounded rib-striæ are about as wide as their intervals. On the last whorl they become weak, more and irregularly spaced. The long, convexly tapering spire is rather turrited.

VERTIGO OSCARIANA St. P. 144.

Found at Ft. Lauderdale and Brickell's hammock below Miami by Geo. H. Clapp.

PAGE 146, 15th line, for "columellar fold" read columellar lamella.

VERTIGO MILIUM Gld. P. 146.

Further localities in south and southeastern Florida: Ft. Lauderdale, Brickell's Hammock, Snapper Creek Hammock, Snake Creek Hammock, Pumpkin and Big Pine Keys; Flamingo and Coot Bay, Cape Sable, Madeira Hammock (Geo. H. Clapp coll.).

PAGE 184, 7th line, for "Grenada" read Granada.

P. 212, 8th line, for "*V. angustula*" read *V. angustior*.

VERTIGO THIBETICA (Bens.).

Pupa thibetica Bens. (vol. xxiv, p. 138) has been placed in *Vertigo* by Westerlund; as it is in the Palaearctic fauna, and is said to be smooth, translucent and glossy, this reference is probably correct. It has not been figured.

VERTIGO PUSILLA mut. ALBINA Taylor. Shell translucent-white. Found with the typical form at Portsalon, near Letterkenny, Donegal County, Ireland (J. W. Taylor, Journ. of Conch., vii, 1893, p. 194).

VERTIGO PUPAEFORMIS Pollonera. Vol. XXVI, pl. 5, fig. 10.

Shell small, ovate-cylindric, very lightly striatulate; whorls 6, convex, the last one-third the total length, provided with a strong, transverse callus [crest] anteriorly. Aperture subovate, strongly five-toothed: 1 parietal tooth, 2 columellar, the lower one smaller, and 2 pliciform palatals, the lower one larger. Length 2, diam. 1.25 mm. (*Pollonera*).

Italy: Val Salice, colline di Torino, Pleistocene.

Vertigo (Dexiogyra) pupaeformis POLLONERA, Mem. Reale Accad. Sci. Torino, (2), XXXVIII, 1888, p. 30, fig. 22 of the plate.

This form, which Pollonera states has not been found living in Piedmont or elsewhere, is said to differ from *V. pygmæa* by the less swollen, more cylindric form, the last whorl being less developed.

VERTIGO (ALAEA) TROLLI Fischer and Wenz. Jahrb. nassau. Ver. Nat., vol. 67, 1914, p. 102, pl. 7, f. 27. Upper Miocene of Oppeln.

VERTIGO (? GLANDICULA) GAALI Wenz. Senckenbergiana, i, no. 3, 1919, p. 67. New name for *Pupa* (*Leucochila*) cf. *larteti* Gaal, Mitt. a. d. Jahrb. ungar. geol. Reichsanst., xviii, 1911, p. 68, pl. 2, f. 4.

VERTIGO DIVERSIDENS (Sandb.), this volume, p. 218, includes the following according to Dollfus, Etude sur la Molasse de l'Armagnac, in Bull. Soc. Geol. France (4), xv, 1915, p. 362: *V. laemodonta*, *V. sansanica* and *V. callostoma* Bgt.

VERTIGO RHYNCHOSTOMA Bgt., this volume, p. 219, includes, according to Dollfus, op. cit., p. 363: *V. onixiodon* and *V. micronixia* Bgt. This species was found in the Noulet collection under the name *P. vasconensis* Noulet Ms.

PAGE 220. *Vertigo trigonostoma*, *blumi* and *priscilla* are to be removed from *Ptychalæa* and placed in *Nesopupa*, where they appear to be related to the section *Indopupa*. *Vertigo capellinii* (p. 221) belongs either to *Nesopupa* or to *Ptychalæa*, probably the former.

Paetel's *Catalog* contains many errors in spelling and authorities which are not worth noting here. The following are samples:

[*Pupa* (*Vertigo*)] *curieysii* Dronet. I. Trinidad. Paetel. Catalog der Conchylien-sammlung von Fr. Paetel, edit. 1883, p. 159. Error for *Pupa eyriesii* Dronet.

[*Pupa* (*Vertigo*)] *turgida* Zglr. Illyr. Paetel, op. cit., p. 160.

[*Pupa* (*Alaea*)] *achila* Sow. Hispan. Paetel, op. cit., 4th edit., 1889, ii, p. 293. Error for *Vertigo acheila* Serv.

VERTIGO MURCHISONIAE Moore, Quart. Journ. Geol. Soc. London, xxiii, 1867, p. 557, pl. 15, figs. 11, 12, from the Liassic deposit in Charter-House mine, Somerset, England, is a poorly preserved sinistral fossil, certainly not a *Vertigo*.

EXPLANATION OF PLATES, VOL. XXV.

Except when otherwise stated, the figures were drawn from specimens in the Academy of Natural Sciences. Those marked B. M. after the museum number are in the Bishop Museum, Honolulu.

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Plate 2.

Plate 3.

Plate 4.

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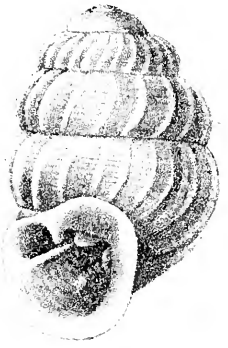

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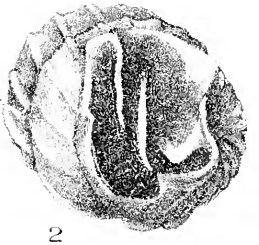

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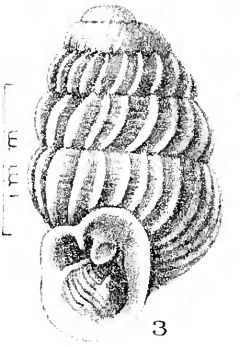

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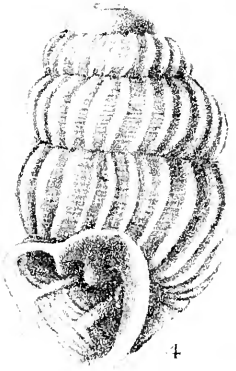

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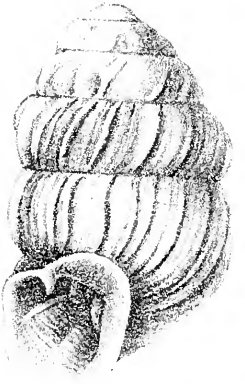

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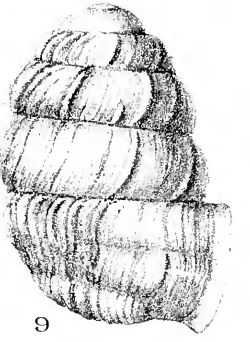

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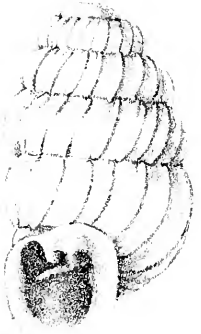

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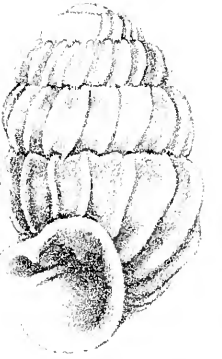

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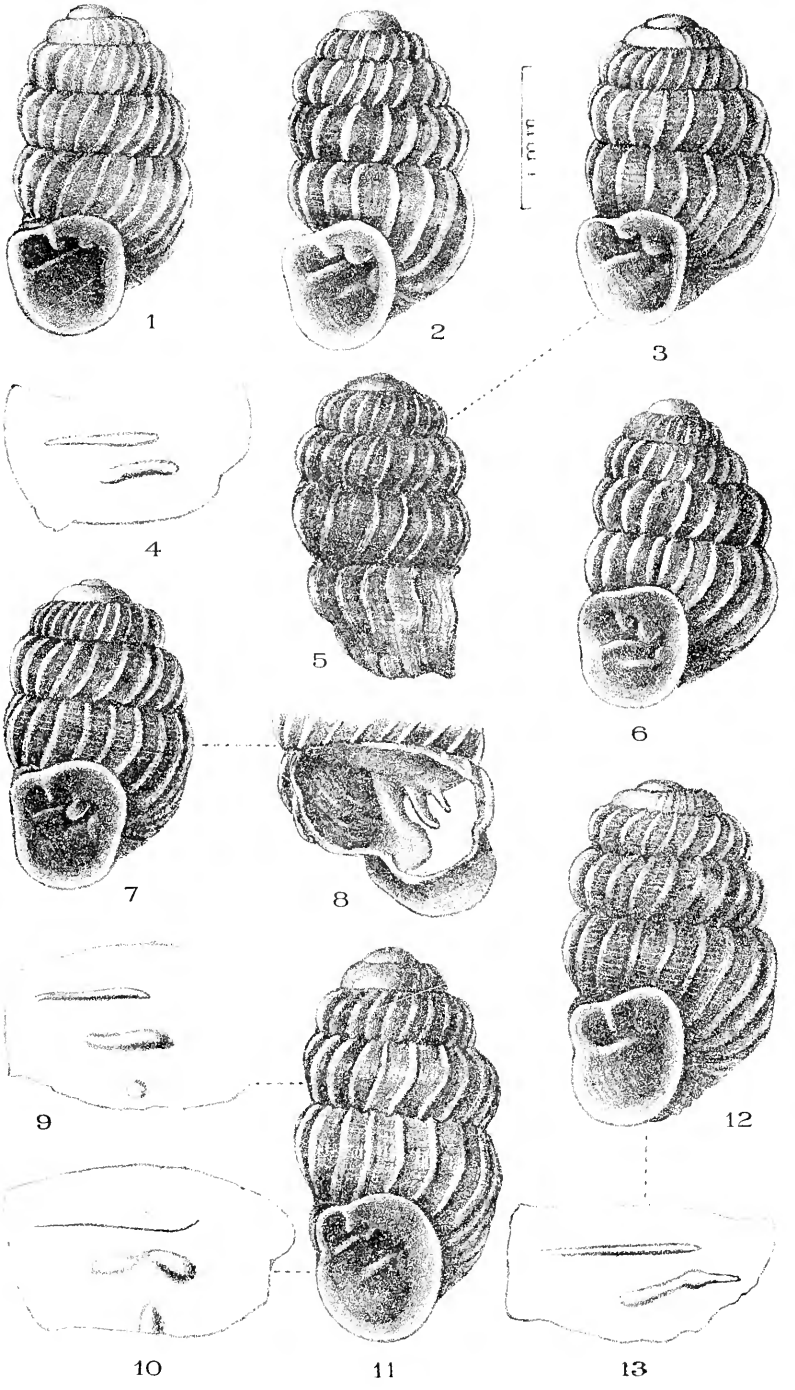
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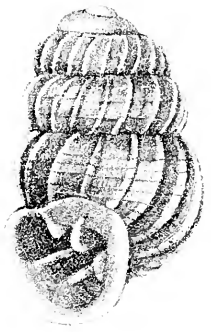

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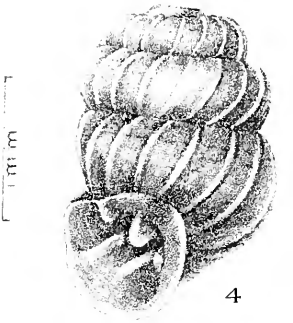

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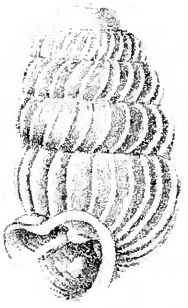

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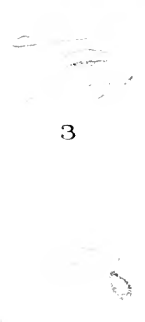

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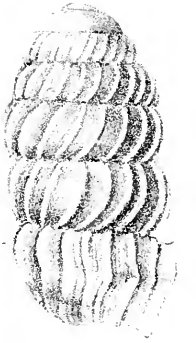

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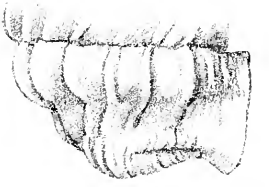

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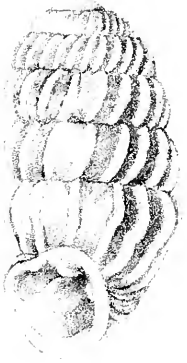

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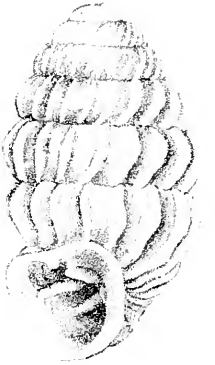

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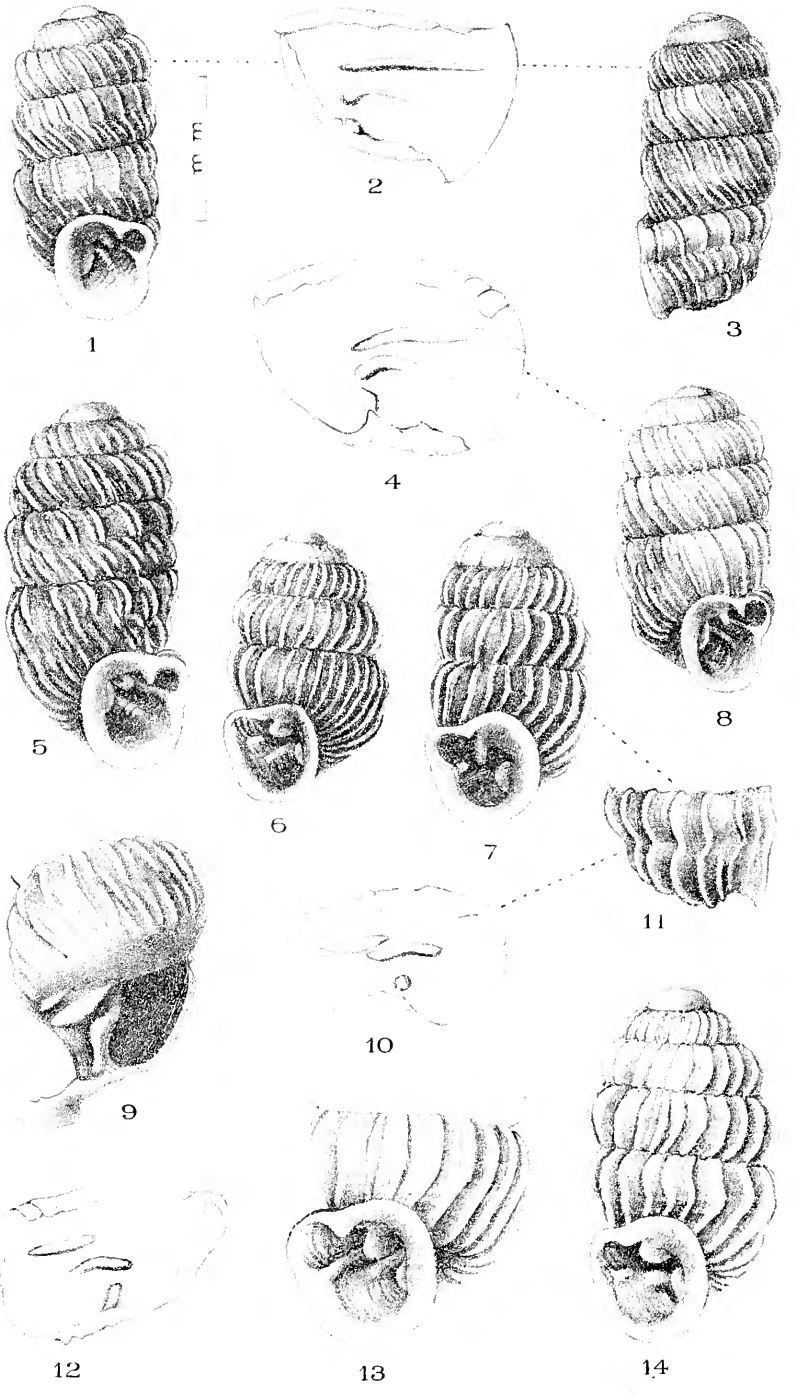
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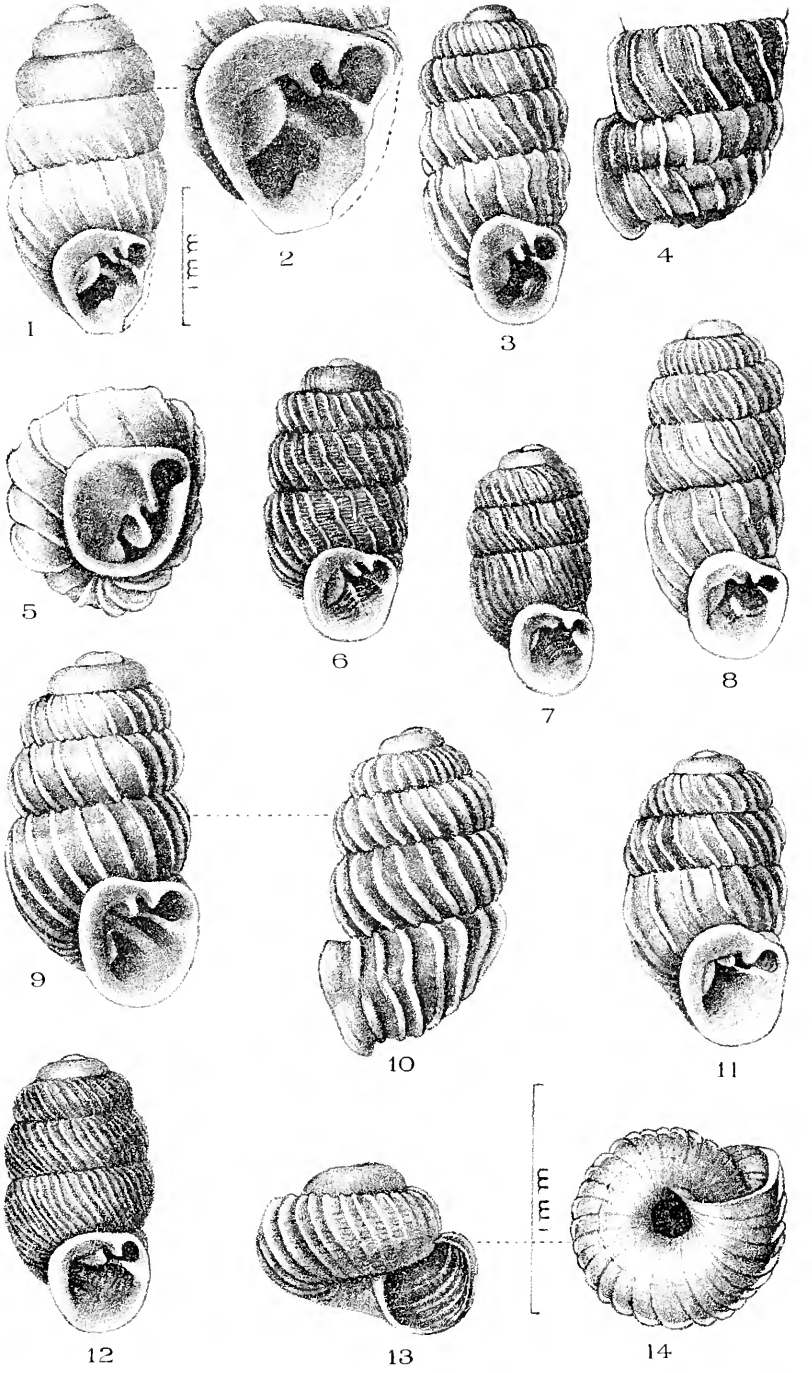
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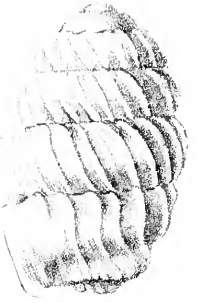
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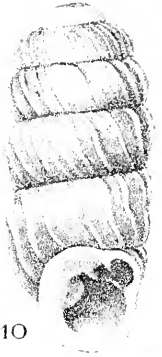
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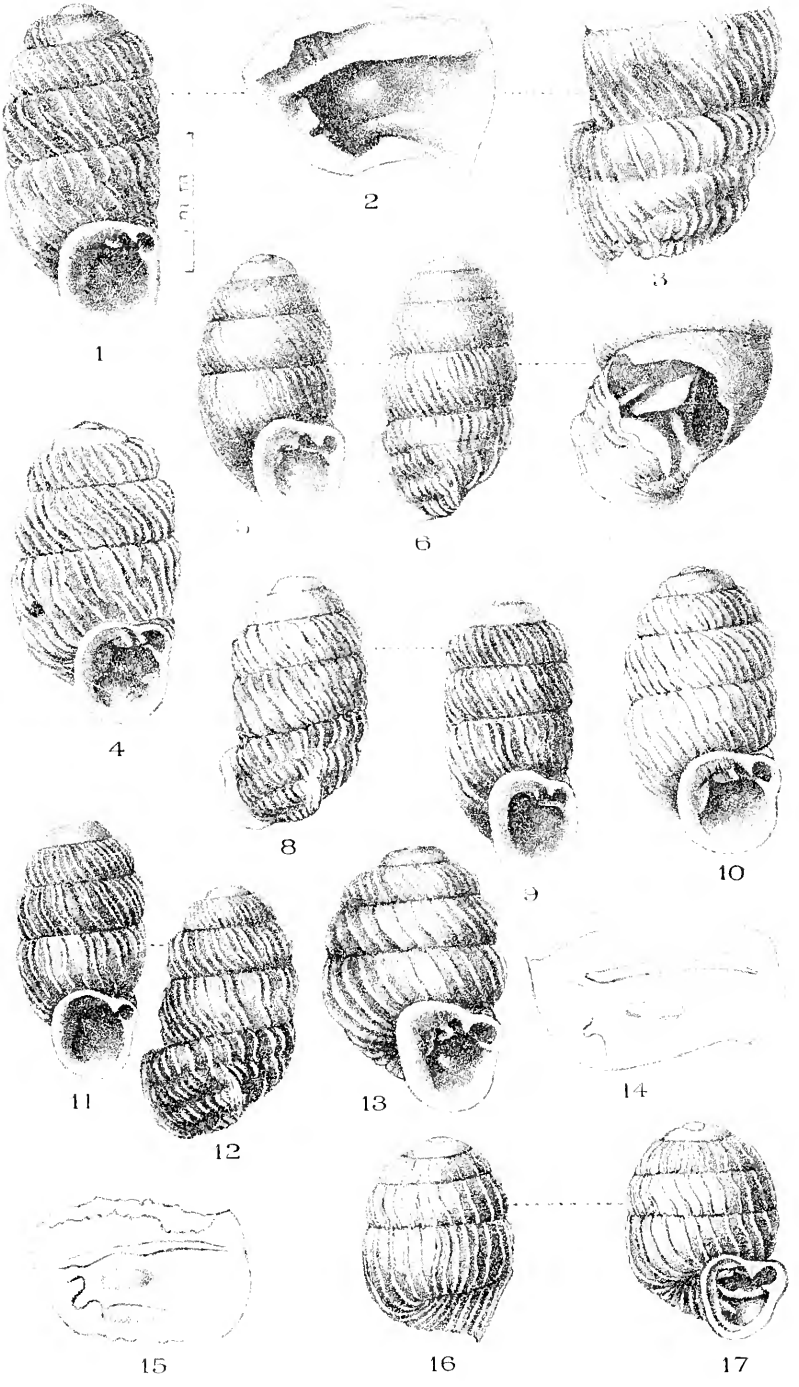
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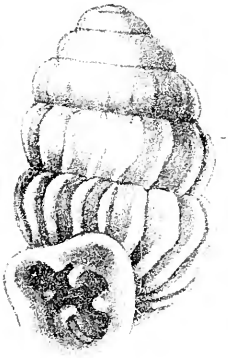

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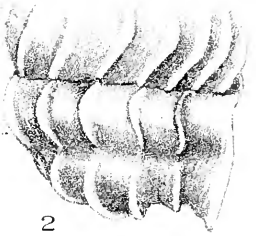

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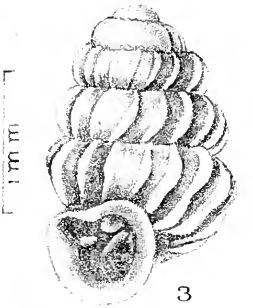

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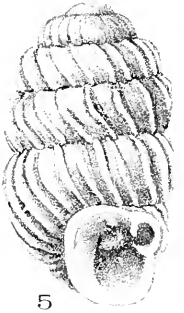

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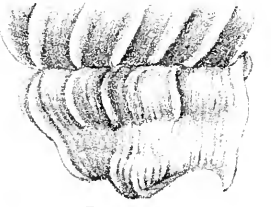

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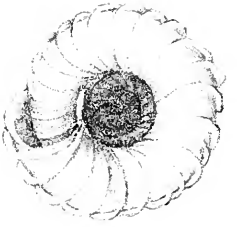

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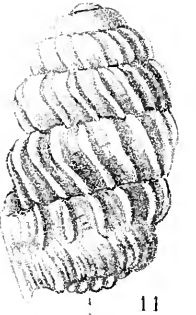

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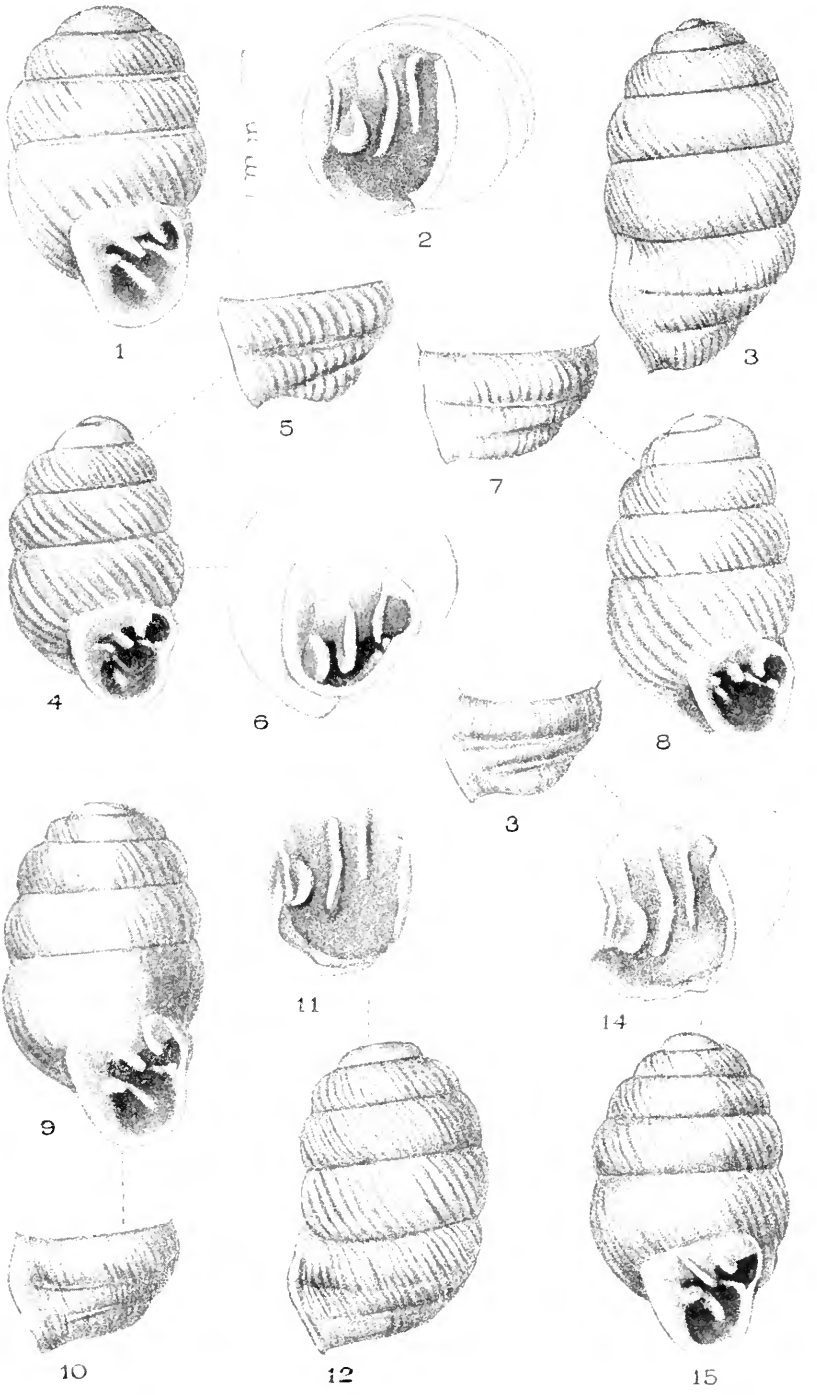
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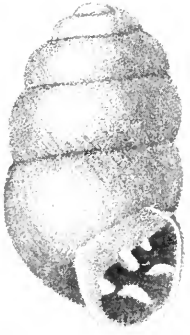

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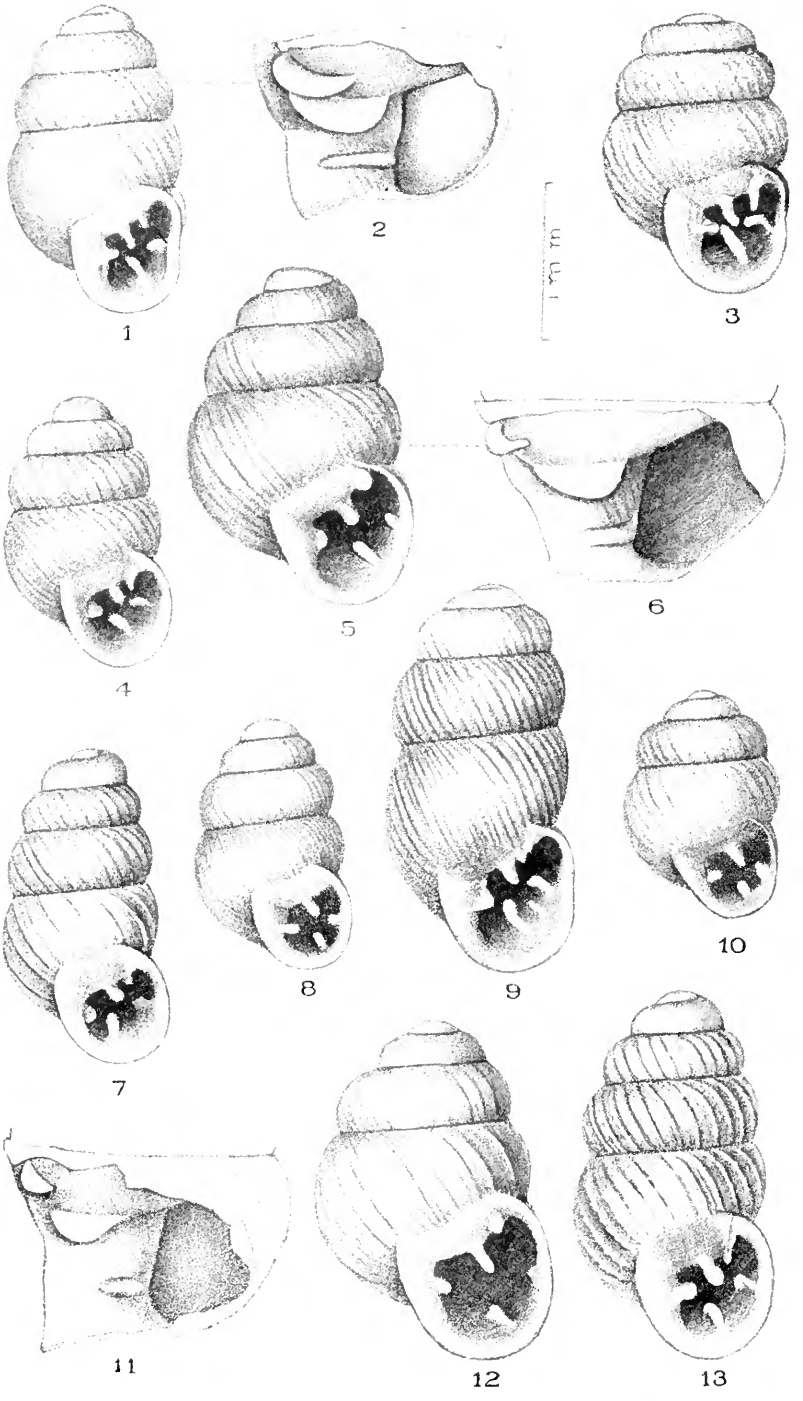
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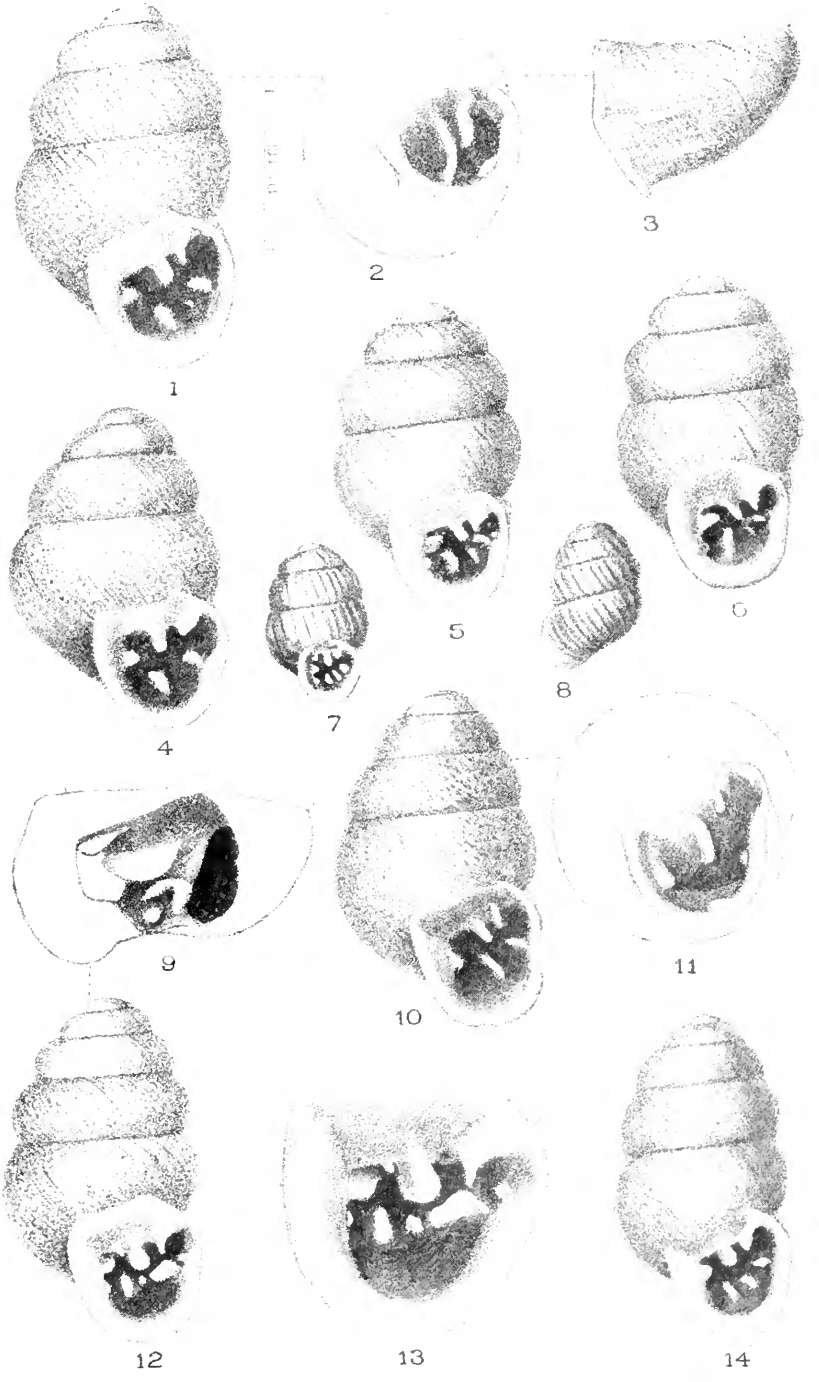
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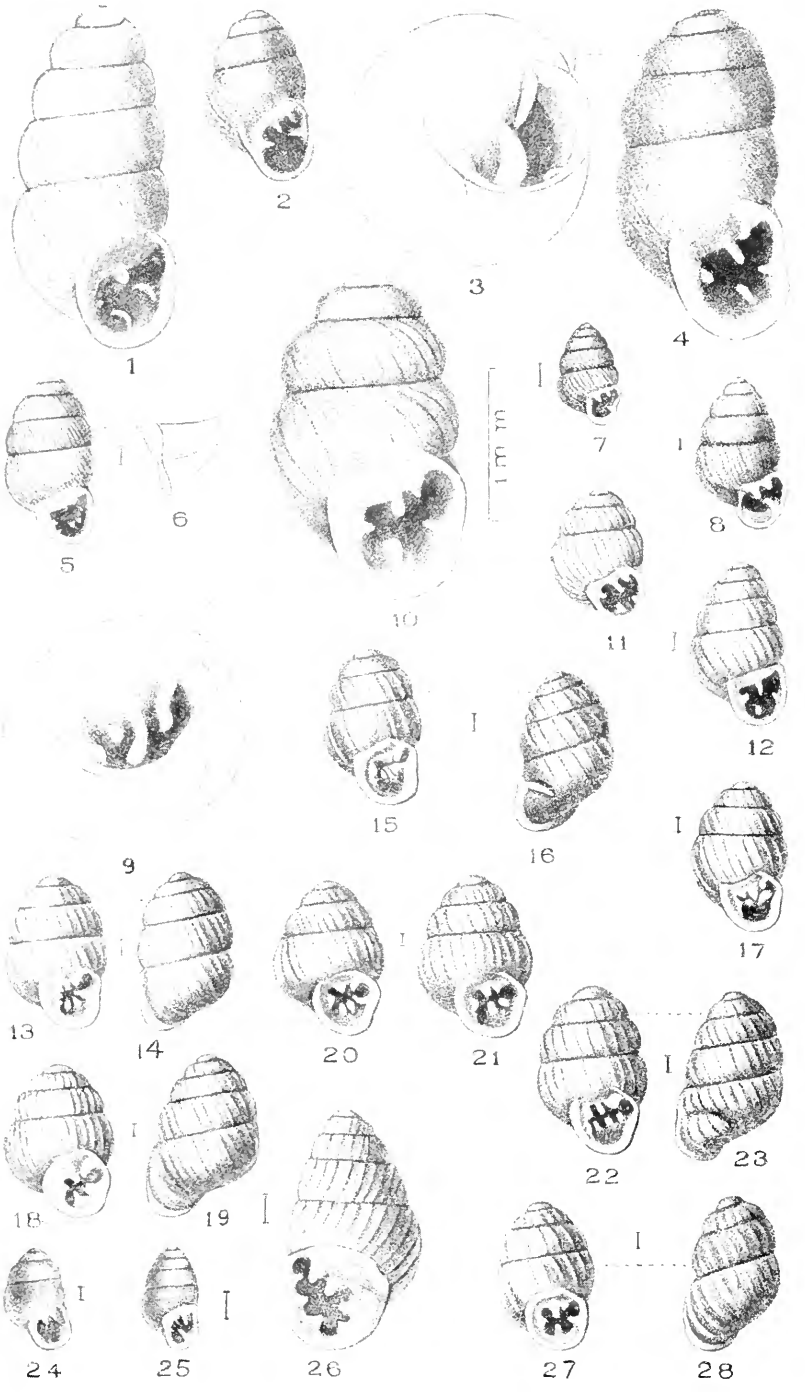
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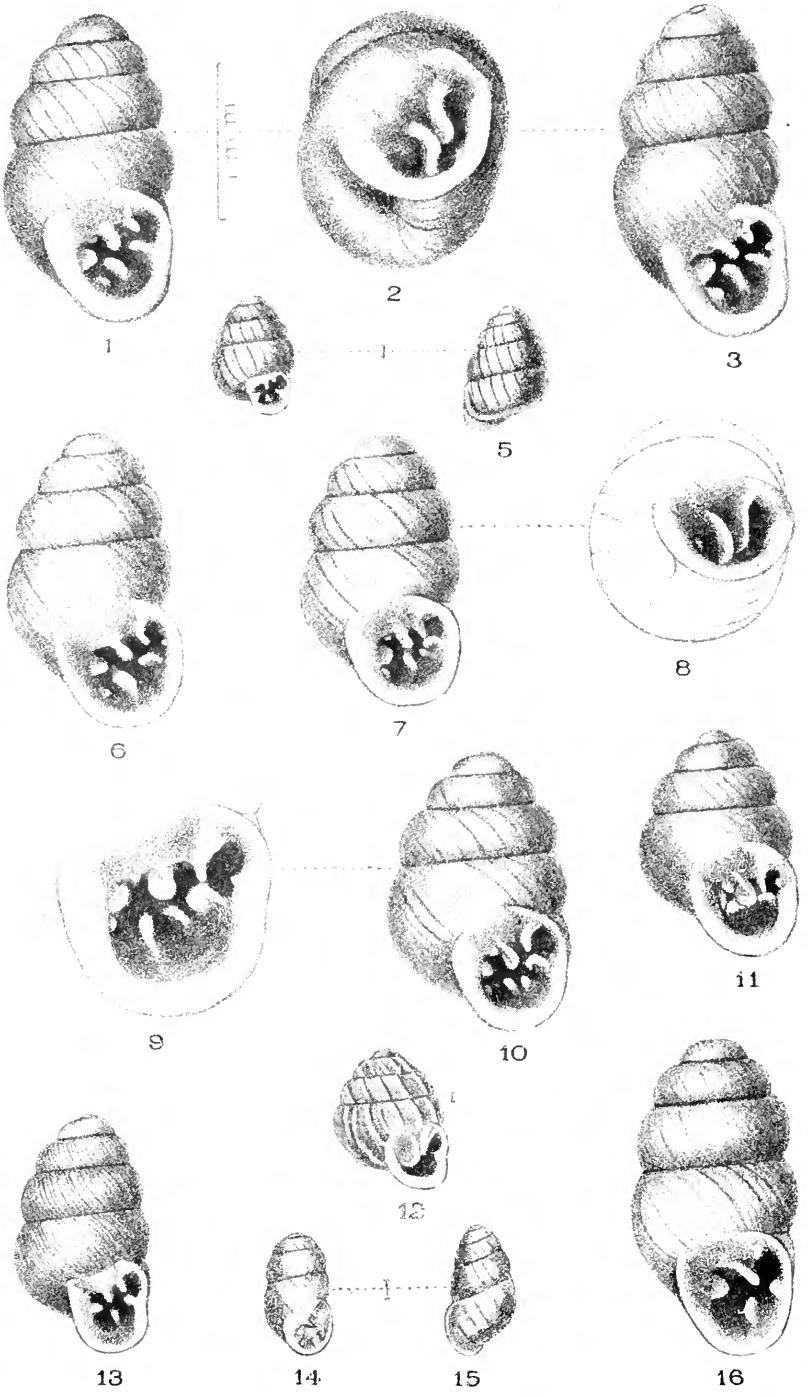
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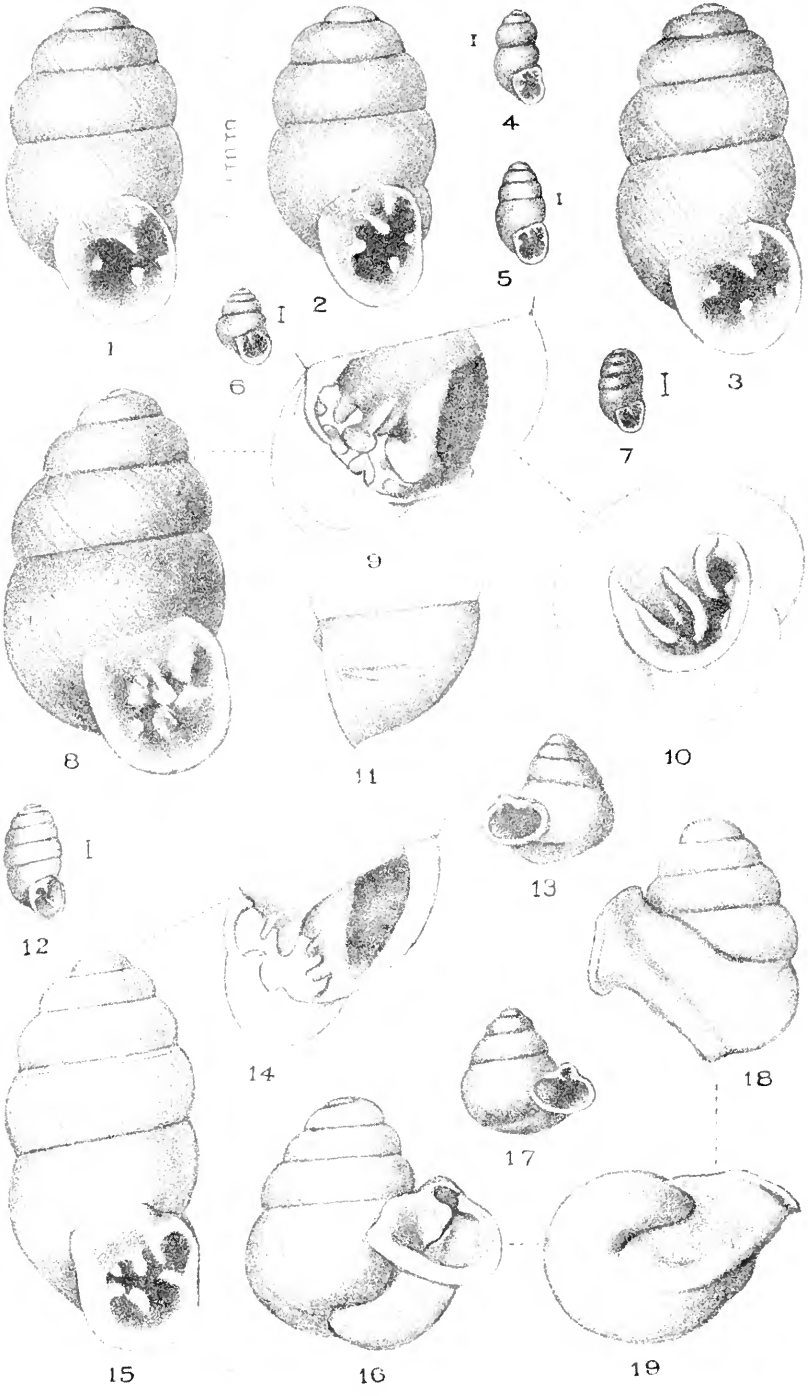
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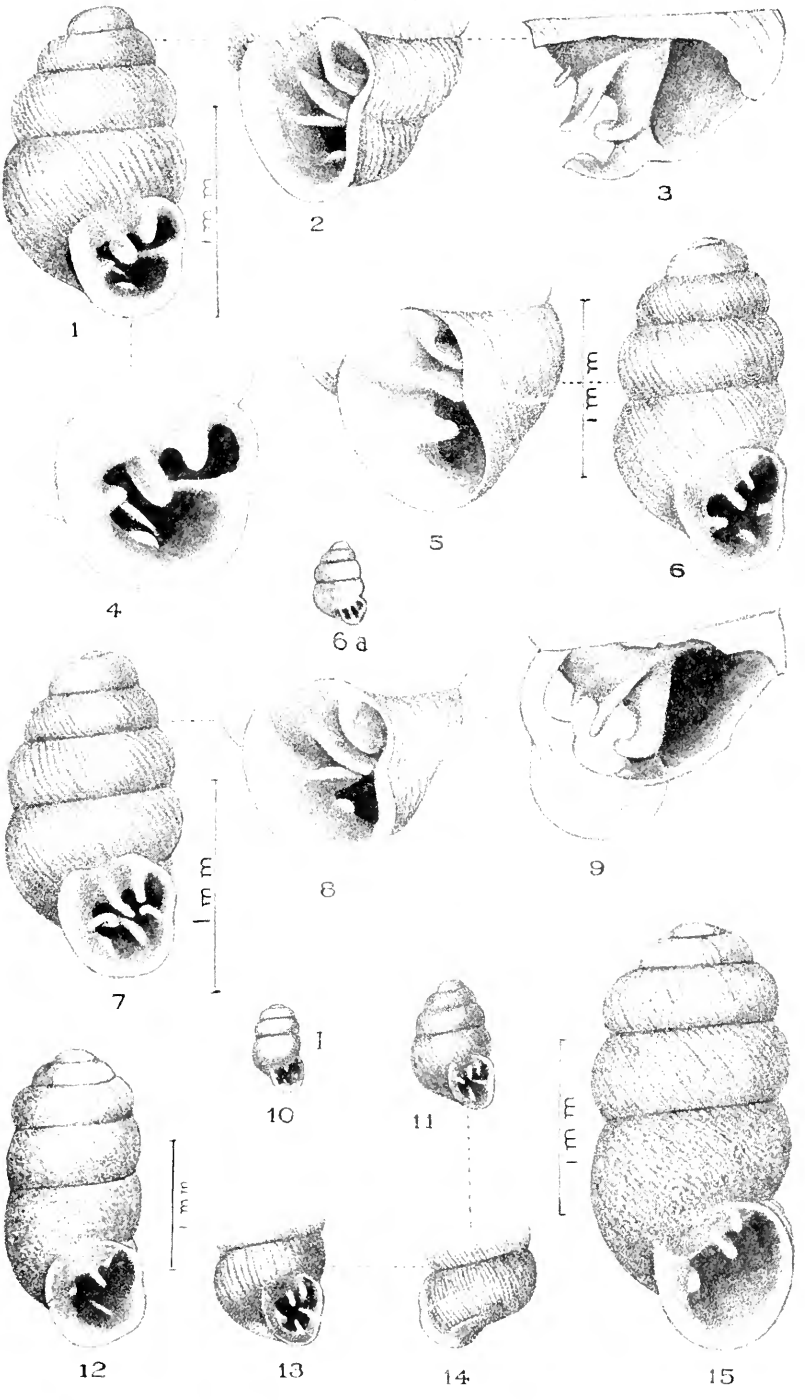
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