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LAND MOLLUSCA  
OF  
NORTH AMERICA  
(NORTH OF MEXICO)

By

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VOLUME I

PART 1

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## PREFACE

More than fifty years have passed since publication of the last general work upon land mollusks of the United States and British America, W. G. Binney's *Manual of American Land Shells*, 1885. I believe that no one publishing work on our land mollusks at that time is still living. The progress of a generation of malacologists is thus to be recorded here, in addition to a summary of the previous work which we inherited.

In the limits set for this work, it is not possible to cover all aspects represented in the work of many naturalists during the past half century. Only the fundamental subjects, description, classification and distribution of our land snails are treated somewhat fully. The *HELICACEA*, comprising more than half of the species and subspecies of our fauna, form the subject of the present volume.

American land snails have been a favorite study with me since boyhood; during most of that time chiefly as an occupation of evenings and in the intervals of other work. A field acquaintance with them, begun as a student in Iowa, has been continued in vacations and collecting trips in the southern Appalachians, the Ozark region of Missouri and Arkansas; in Oklahoma, Texas, New Mexico, Arizona and many other states. But in much of the territory covered in this book, materials were gathered chiefly by friends and correspondents. Among these I may mention especially, Mr. James H. Ferriss, who shared his collections with the Academy, and Dr. H. Burrington Baker, whose work in the southern Appalachians and in Montana, Idaho and Oregon, generously placed at my disposal, has greatly extended our facilities. In the mountain states we have had many contributions from the late Professor Junius Henderson and from Professor T. D. A. Cockerell. In California, Mr. Allyn G. Smith and George Willett were especially helpful. Mr. E. P. Chace and Mrs. Chace supplied valuable material, and Dr. S. S. Berry contributed paratypes of many species. Dr. A. F. Archer gave series of his extensive collections from Michigan to Alabama, and Mr. John P. Oughton supplied Canadian material. Many others, whose names appear in the text, have assisted with particular species or essential data.

(iii)

I am also indebted for information and the loan of precious type material to Dr. Paul Bartsch of the National Museum, Mr. William J. Clench of the Museum of Comparative Zoölogy, Dr. G. Dallas Hanna and Leo G. Hertlein of the California Academy of Sciences, Dr. Frank C. Baker, University of Illinois, Dr. Stanley T. Brooks, Carnegie Museum, and Mr. Calvin Goodrich, Museum of Zoology, University of Michigan. Dr. Bernard Rensch lent type material from the Zoologisches Museum in Berlin, and Lieut.-Col. A. J. Peile compared various specimens with types in the British Museum. The book is much the better for this friendly cooperation.

In the Academy the long task of preparing the work has been constantly encouraged by the President, Mr. C. M. B. Cadwalader, whose interest made the publication possible. Mr. J. A. G. Rehn, Chairman of the Publication Committee, gave liberally of his time and expert knowledge of engraving and printing. Mr. V. S. L. Pate assisted in preparing the manuscript for the press. In the proofreading I owe much to Mr. C. Bernard Peterson's accurate eye. He also prepared the Index.

Finally, the illustrations of shells, which, in a descriptive work on mollusks are considered as essential as the text, have mostly been prepared by Miss Helen Winchester, whose collaboration has been indispensable to the usefulness and the appearance of the work.

## CONTENTS

	PAGE
NEW FAMILIES, SUBFAMILIES, GENERA AND SUBGENERA DEFINED IN VOLUME I .....	VII
NEW SPECIES, SUBSPECIES AND FORMÆ DEFINED IN VOLUME I, PART 1 .....	VIII
INTRODUCTION: MEASUREMENTS AND COLORS — ILLUSTRATIONS — TYPES — REFERENCES — STAGES OF GROWTH — SPECIES AND SUBSPECIES — GENERA — SYNOPTIC KEY TO NEW GENERA OF PART II .....	XI
SYSTEMATIC TREATMENT .....	1
FAMILY I. HELICIDÆ .....	1
Genus <i>Helix</i> .....	2
Subgenus <i>Helix</i> , s. s. ....	3
Subgenus <i>Cryptomphalus</i> .....	4
Genus <i>Cepaea</i> .....	6
Genus <i>Otala</i> .....	11
Genus <i>Helicigona</i> .....	11
Genus <i>Theba</i> .....	12
FAMILY II. HELICELLIDÆ .....	14
Genus <i>Hygromia</i> .....	16
Subgenus <i>Trichia</i> .....	16
Genus <i>Monacha</i> .....	20
Genus <i>Helicella</i> .....	21
Subgenus <i>Trochoidea</i> .....	22
Genus <i>Cochlicella</i> .....	22
FAMILY III. HELMINTHOGLYPTIDÆ .....	24
SUBFAMILY CEPOLIINÆ .....	25, 26
Genus <i>Cepolis</i> .....	26
Subgenus <i>Hemitrochus</i> .....	28
SUBFAMILY HELMINTHOGLYPTINÆ .....	25, 31
Genus <i>Monadenia</i> .....	31
Genus <i>Helminthoglypta</i> .....	63
Subgenus <i>Helminthoglypta</i> s. s. ....	69
Subgenus <i>Charodotes</i> .....	170
Genus <i>Micrarionta</i> .....	201
Subgenus <i>Micrarionta</i> s. s. ....	204
Subgenus <i>Eremarionta</i> .....	204, 226
Subgenus <i>Xerarionta</i> .....	204, 214
Subgenus <i>Plesarionta</i> .....	204, 212
SUBFAMILY SONORELLINÆ .....	25, 267
Genus <i>Sonorella</i> .....	267
Subgenus <i>Sonorella</i> s. s. ....	273

	PAGE
Subgenus <i>Masculus</i> .....	377
Subgenus <i>Sonoranax</i> .....	391
Subgenus <i>Myotophallus</i> .....	393
SUBFAMILY HUMBOLDTIANINAE .....	26, 395
Genus <i>Humboldtiana</i> .....	395
FAMILY IV. CAMAENIDAE .....	410
SUBFAMILY OREOHELICINAE .....	412
Genus <i>Oreohelix</i> .....	412
Subgenus <i>Oreohelix s. s.</i> .....	419
Subgenus <i>Radiocentrum</i> .....	540
SUBFAMILY AMMONITELLINAE .....	412, 554
Genus <i>Polygyrella</i> .....	555
Genus <i>Ammonitella</i> .....	555, 560
Genus <i>Polygyroidea</i> .....	555, 563
Genus <i>Glyptostoma</i> .....	555, 567
FAMILY V. POLYGYRIDAE .....	Part II
Genus <i>Trilobopsis</i> .....	xvi
Genus <i>Triodopsis</i>	
Subgenus <i>Cryptomastix</i> .....	xvii
Genus <i>Allogona</i> .....	xvii
Subgenus <i>Dysmedoma</i> .....	xvii
Genus <i>Vespericola</i> .....	xvii
FAMILY VI. SAGDIDAE .....	Part II
INDEX .....	i

NEW FAMILIES, SUBFAMILIES, GENERA AND SUBGENERA  
DEFINED IN VOLUME I

	PAGE
Helminthoglyptidae .....	24
Cepoliinae .....	25, 26
Helminthoglyptinae .....	25, 31
Sonorellinae .....	25, 267
Humboldtianinae .....	26, 395
Charodotes .....	68, 170
Plesarionta .....	204, 212
Masculus .....	273, 377
Sonoranax .....	273, 391
Myotophallus .....	273, 393
Pleurodontites .....	411
Oreohelicinae .....	412
Ammonitellinae .....	412, 554
Trilobopsis .....	xviii
Allogona .....	xix
Dysmedoma .....	xix
Vespericola .....	xix
Cryptomastix .....	xix

NEW SPECIES, SUBSPECIES AND FORMAE DEFINED IN  
VOLUME I, PART 1

NOTE.—Named "forms" are treated as subspecies.

	PAGE
<i>Hygromia hispida tonsilis</i> .....	18
<i>Monadenia fidelis columbiana</i> .....	43
<i>Monadenia fidelis coloba</i> .....	49
<i>Monadenia fidelis badia</i> .....	49
<i>Helminthoglypta tudiculata imperforata</i> .....	76
<i>Helminthoglypta allynsmithi</i> .....	85
<i>Helminthoglypta tularensis sequoia</i> .....	153
<i>Helminthoglypta napaea fresno</i> .....	156
<i>Helminthoglypta napaea wawona</i> .....	157
<i>Helminthoglypta napaea yosemitensis</i> .....	158
<i>Helminthoglypta proles mariposa</i> .....	197
<i>Micrarionta ruficincta labiosa</i> .....	207
<i>Micrarionta ruficincta celo</i> .....	207
<i>Micrarionta gabbi maxima</i> .....	208
<i>Micrarionta sodalis micromphala</i> .....	211
<i>Micrarionta redimita inconstans</i> .....	220
<i>Micrarionta tryoni carinata</i> .....	222
<i>Micrarionta intercisa callojunctis</i> .....	225
<i>Micrarionta intercisa ductor</i> .....	225
<i>Micrarionta intercisa puer</i> .....	225
<i>Micrarionta rowelli acus</i> .....	234
<i>Micrarionta avawatzica eremita</i> .....	261
<i>Sonorella sabinoensis dispar</i> .....	297
<i>Sonorella galiuensis superioris</i> .....	303
<i>Sonorella verdensis</i> .....	304
<i>Sonorella imperatrix</i> .....	320
<i>Sonorella animasensis</i> .....	322
<i>Sonorella superstitionis</i> .....	332
<i>Sonorella micromphala</i> .....	333
<i>Sonorella coltoniana</i> .....	336
<i>Sonorella rosemontensis</i> .....	348
<i>Sonorella odorata populna</i> .....	369
<i>Sonorella fragilis</i> .....	394
<i>Oreohelix strigosa montrosensis</i> .....	437
<i>Oreohelix strigosa nogalensis</i> .....	442
<i>Oreohelix peripherica weberiana</i> .....	454
<i>Oreohelix haydeni hesperica</i> .....	475
<i>Oreohelix haydeni perplexa</i> .....	476
<i>Oreohelix metcalfei florida</i> .....	513
<i>Oreohelix socorroensis magdalenae</i> .....	515
<i>Glyptostoma newberryanum mimus</i> .....	572



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

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#### ERRATA

Page 203, line 26, for *destinctions* read *distinctions*.

Page 205, *M. aquaealbae*, under Fig. 138, was misspelled *acquaealbae*.

Page 427, in the paragraph below table of measurements lines 12 to 16 from foot of page, wherever Fig. 282 occurs read Fig. 279.

## INTRODUCTION

*Measurements, colors, etc.*—Measurements are now always taken with a caliper rule, parallel to lines indicated in Figure A; but in actual practice, the greatest diameter measurable is generally used with strongly depressed helicoid or discoidal shells. The diameter strictly at right angles with the axis cannot easily be measured so exactly. In comparing modern measurements with those of old descriptions it must be remembered that most older authors used a flat rule, and they usually measured the height of helicoid shells along the shell axis, instead of to the edge of the basal lip of aperture. One cannot expect modern measurements of a type-specimen to agree exactly with those published fifty or a hundred years ago.

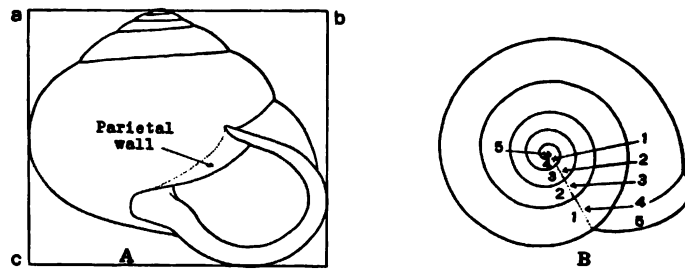


Fig. A, diagram to show method of measuring: a-b, diameter; a-c, height. B, count of whorls.

The older authors, and many to this day, gave two diameters, greater and lesser or major and minor, in measuring helicoid shells. This was a hangover from the Pfeifferian era when genera were much more heterogeneous than at present. In shells with simple lip, such as *Retinella* or *Mesomphix*, or those with irregular coil, the minor diameter is significant, though even so, it might better be expressed as the ratio of minor to major diameter. In shells with expanded or reflected lip, the minor diameter is superfluous in practical work, as nobody uses it when given. It appears in this work only in quoted descriptions.

The proportion of height to diameter (h/d ratio) is taxonomically useful in a broad way, but in species of many of our genera it is subject to great individual variation.

The whorls are, of course, numbered from the apical down, as in the right-hand column in Figure B; but in counting them it appears to me easier to count from the last one up to the first, as in the left-hand numerals, Figure B.

Colors, except in some of the quoted descriptions, are those of Ridgway's Color Standards and Nomenclature. For use with land shells, this work is not wholly satisfactory, as more nuances and dilute tints of the browns are needed. But, while particular hues are often characteristic, it must be admitted that shells frequently show a wide range of individual variation in color as well as in tone. The term "horn color" or "corneous," used by some authors, might well be discarded. It dates back to the time when articles made of horn were in use. The translucent, grayish-white tints intended can be otherwise expressed more intelligibly. It was not used by Ridgway, and we have no standard showing just what tint is meant.

The terms used in descriptions of pallial organs and genitalia are sufficiently shown in page 3, Figures 1, 2 and page 65, Figure 31A.

As to illustrations of medium or large snails, I have found natural size figures, with enlarged details, where necessary, to be more readily recognizable than the enlarged figures sometimes given, which are usually too big to look natural, and not large enough to show the details of sculpture. In this work, most halftone figures were prepared by Miss Helen Winchester, when not otherwise credited.<sup>1</sup> The original line drawings of shells and anatomy are by the author.

*Terminology of stages of growth.*—As some of the terms for stages of growth have often been used in descriptive and other matter relating to helices, the terms originated by Alpheus Hyatt are explained here so far as applicable to gastropods.

*Embryonic.* From fertilization of the egg to culmination of podocyst and other specially embryonic structures. Since the shell record of the succeeding stage (nepionic) is extremely brief, the term embryonic is practically used to cover the stage ending with birth or escape from the egg capsule. The shell in the embryonic stage usually has a special sculpture, as in page 226, Figure 112, following an initial smooth or radially rippled fraction of a whorl, or it is smooth throughout, and thus more or less unlike the following whorls.

*Nepionic.* Decadence and disappearance of specially embryonic structures. The snail assuming the final form externally. Very short in land snails; when distinguishable in a shell it is indicated by a striate or smoothish streak, or a slight contraction, at the end of the embryonic part.

*Neanic.* Youth, from birth up to completion of the shell, which is usually coincident with the beginning of reproductive activity.

*Ephobic.* Stage of maturity. Shell and lip usually become thicker.

---

<sup>1</sup> A few halftone figures in *Sonorella* and *Oreohelix* taken from papers published thirty years ago or more, were not made by Miss Winchester.

*Gerontic*. Old age, often expressed by irregular roughening of sculpture, thickening of the lip, and, finally, more or less marked loosening of the coil, as in page 525, Figure 343: 1-14, representing an extreme instance.

Each of these stages may be subdivided by use of the prefixes ana-, meta-, para-. Thus *ananeanic* signifies an early neanic substage; *meta-neanic*, mid-neanic; and *paraneanic*, a late neanic substage, or almost full grown.

The collector should take a few young shells, as the sculpture of the embryonic stage is often so delicate that it is frequently imperfect or entirely lost from the apices of adults.

*Types*.—The term type, which has served without ambiguity for many years, seems to me preferable to "holotype" which is equivalent in meaning, both referring to the specimen originally described of a species or subspecies. Reference to the museum number and the location of type specimens is included in the Distribution paragraph, immediately following the type locality, these abbreviations being used:

- A.N.S.P. Academy of Natural Sciences of Philadelphia.
- C.A.S. California Academy of Sciences.
- M.C.Z. Museum of Comparative Zoölogy.
- U.S.N.M. United States National Museum.

Names of other institutions and collections are written in full.

When an author specifies "cotypes," or when there are several examples in his original lot, neither specified as type, one specimen has often been taken as a "lectotype". In a few other cases, where the type material has been lost, a "neotype" has been selected. "Paratypes" are specimens other than the type, which were before the author of a species and more or less directly referred to in the original account.<sup>1</sup>

*References*.—To save space in a work already too long, the references to literature have been restricted to those thought to be most useful. Many European references to the older species, though useful in their day, have now only a minor historic interest; those concerned with them are referred to the works of W. G. Binney and L. Pfeiffer. As W. G. Binney's several monographs of 1869, 1878 and 1885 contain substantially the same descriptive matter and figures of shells, reference has usually been made only to the *Terrestrial Mollusks V*, 1878, as this contains Binney's anatomical work, and reprints of the exquisite figures of Volume III.

In only special cases references are given to Tryon's *Monograph of the Terrestrial Mollusca of the United States*, in *American Journal of Conchology* II-IV, 1866-1868; and to his work in the *Manual of Conchology* I-IV, 1885-1888. Several lists, such as the *Classified Catalogue* published in *Nautilus* XI, XII, 1897-8, are also omitted. These publica-

<sup>1</sup> Cf. D. L. Frizzell, *American Midland Naturalist*, 14: 637; *Nautilus* 47: 145.

tions contain many new name-combinations, but little else of present value. Why give storage to useless lumber? I regret that references to most local faunal lists have also been omitted. To quote them for the widely spread species would often require several pages, and the information is in large part covered by the Distribution paragraph under each species.

In dealing with little-known and recently described species my aim has been to give references to all published information.

Misprints of names are not noticed except when likely to cause confusion.

When a species has been named for a locality or a collector mentioned in the Distribution paragraph, it has been thought superfluous to give derivation of the specific name separately. In some other cases the derivation was omitted inadvertently, or in a few it is not known to me.

Dialectics relating to generic nomenclature have been excluded when reference could be made to published discussions. In a few cases some consideration of nomenclatorial matters has appeared necessary.

*Species and Subspecies.*—1. Many of the species of the families treated in this volume are so well defined that their status has never been seriously questioned; but in all large genera there are races which some malacologists will consider species, others subspecies, according to whether they incline towards splitting or towards lumping. The only practicable criterion of species, in most snails and other organisms, is a discontinuity with allied races in some detail or details of structure; the questions of sterility of hybrids, etc., usually not being available. In species of reasonably conservative genera, such as *Mesodon*, the absence of actual intergradation of characters may safely be considered specific, even when the divergence of the forms in question, though constant, is small.

2. Subspecies are theoretically races showing some intergradation with neighboring forms in a small proportion of the individuals, but characterized by having a definably different distribution, geographic or ecologic. This distribution may be contiguous to that of conspecific races, or it may be isolated by geologic, climatic or other conditions, as when races are confined to calcareous soils, to humid places in an arid region, or are insular. In practice, the demonstration of complete intergradation with other races is not insisted on. Most subspecies are recognizably differentiated populations which are not considered sufficiently distinct to be called species. They are merely incipient species, in which the discontinuity is incomplete, or is not strongly pronounced. In some cases, that of *Triodopsis tridentata juxtidentis* for example, the geographic or ecologic segregation which a subspecies should have is not evident. Such subspecies are much in need of further study.

Subspecies may be rather distinct over large areas, like the trans-Mississippian *Triodopsis albolabris alleni*, or they may be indefinitely

bounded, both as to characters and geographic relations, although typically quite distinct, like the races of *Mesodon appressus*.

3. There is a third racial category, the "forms" of the present work. My first intention was to use this term only for ecologic forms, those whose peculiarities are presumably owing to the action of some special factors of their station on a genotypically unchanged stock; as in the case of colonies of constantly small individuals of species normally larger (as in forms of *Oreohelix concentrata*, *O. strigosa*, *Stenotrema hirsuta* and many others), or colonies of thin shells from humid forest, deficient in lime, of species which are normally thicker in dry limestone districts. However, it must be admitted that in a part of such cases the inference as to genotypic constitution of the forms is merely presumptive, in the absence of experimental data.

The term *forma* has also been used for forms which show some differentiation, consistent in the colony, but either below the grade usually associated with subspecies, or restricted to single or few colonies, thus having a much narrower range than is usually covered by a subspecies, and without noticeable difference in the local conditions. "Forms" or "little races" of this kind are numerous in *Oreohelix*. They seem to be equivalent to the "microgeographic species" of Dobzhansky.

4. Variable snail populations appear usually to be mixtures composed of individuals of different genetic composition existing in intergenerant colonies. They are often readily separable into two or several lots according to their phenotypic characters. Examples are seen in most colonies of *Mesodon thyroidus*, which contain examples with and those without a parietal tooth, and colonies of *Cepolis* or *Oreohelix* containing both banded and plain shells, or *Oreohelix jugalis vortex*, where the lots are divisible into banded and flammulate shells. If there is no advantage in either condition, the mixed population will continue indefinitely.<sup>1</sup>

Most of the variation within colonies appears to be of this nature. Mutations which appear tend to spread, when not disadvantageous or lethal; and they may affect any part of the organism, such as count of teeth of the radula, or of ribs of the jaw, as well as the shell. These several categories below the species have been all treated by some authors as subspecies, and in our rigid system of nomenclature there is no other provision for them, but it is lumping different phenomena under one term.

The number of recognizable subspecies and "forms" in our fauna is very great. In the text following, their characters have been given in all cases where names have been applied, even when the distinctions appear trivial or ill founded, in order that the reader may have before him all data possibly bearing on racial nomenclature. Moreover, I have tried

<sup>1</sup> Hardy, G. H., Mendelian proportions in a mixed population. *Science*, 28: 49. 1908.

throughout the work to give the views of other authors as well as my own, usually by liberal quotations. It is to be expected that my decisions as to the status of forms may sometimes require revision. Many of the published names belong to the terminology of variation rather than to taxonomic nomenclature, and they cannot properly be used at trinomials.

From the time of Férussac to about 1870, and in some countries later, authors frequently followed their descriptions of shells by terms denoting variations of size, form or color, such as *minor*, *major*, *maxima*, *depressa*, *dentifera*, *unicolor*, *alba*, *fasciata* and the like, sometimes prefixed by "var." (hence the feminine form), or more often by a Greek or Roman letter,  $\alpha$ ,  $\beta$ ,  $\gamma$  and so on. They were not intended to denote geographic races or subspecies in the sense these terms are used now, but rather as variations within the species. Often there was no definition other than that implied by the name. J. W. Taylor in his Monograph of the Land and Fresh-water Mollusca of the British Isles used the terms variety and sub-variety for variations of this character; and examples are given in this volume, pages 7, 8, 14 and 30. Identical terms were frequently used for the variations of successive species of one genus.<sup>1</sup> It would obviously be improper to apply the rules governing binomial and trinomial names today to this variation terminology of the Pfeifferian era. The attempt to incorporate it into our nomenclature would raise many perplexing questions of priority and of adequacy of definition. Moreover their introduction would prejudice a number of well-established specific names.

*Genera.*—Although the classification of land shells has occupied much of my time for many years, the systematic position and significance of the Ammonitellinae, and *Oreohelix*, and much of the arrangement of the Polygyridae, have been worked out for the first time in this volume. Except in the subfamily Polygyrinae, where genera and subgenera rest mainly upon characters of the shell alone, the genera of our helices are largely based upon internal structure, which has proved to be remarkably constant in long series of species dissected. In almost all cases there are correlated shell characters by which the genera are readily recognized.

*Key to new names in Part 2.*—In order that new generic and subgeneric names appearing in Volume I may all bear the same date, a synoptic key to those to appear in Part 2 is given here.

a. Penis without a sheath, the penial retractor and the vas deferens terminal; no flagellum

b. A well developed epiphallus present; aperture trilobed

*Trilobopsis* new genus, type *Helix loricata* Gld.

---

<sup>1</sup> Many such instances may be found in any volume of Pfeiffer's *Monographia Heliceorum*, and in other works of that period. Sherborn did not enumerate the terms in question in his *Index Animalium*.



- b'*. No epiphallus; duct of spermatheca slender, short  
*Polygyra* and others.
- a'*. Penis provided with a sheath (sometimes imperfect), the retractor muscle inserted on epiphallus or vas deferens, with strands running to penis at end of sheath
- b.* A short but free flagellum present; spermatheca of medium length, not divided into duct and bulb; epiphallus long; penial sheath tenuous ..... *Ashmunella*.
- b'*. No free flagellum; spermatheca distinctly divided into bulb and duct, short
- c.* Penis containing a large "stimulator;" sheath mainly adnate  
*Allogona* new genus, type *Helix profunda* Say.
- d.* Stimulator simple; eastern ..... Subgenus *Allogona* s.s
- d'*. Stimulator divided; western  
*Dysmedoma* new subgenus, type *Helix townsendiana* Lea.
- c'*. No stimulator; sheath well developed; duct of the spermatheca swollen
- d.* A verge at apex of penial cavity  
*Vespericola* new genus, type *Polygyra columbiana pilosa* Hend.
- d'*. No verge in the penis, which tapers somewhat distally, the limit of penis and epiphallus not obvious externally ..... *Triodopsis*.
- e.* No trace of a flagellum; eastern ..... Subgenus *Triodopsis* s.s.
- e'*. A concealed trace of flagellum; western  
*Cryptomastix* new subgenus, type *Polygyra mullani olneyae* Pils.



## SYSTEMATIC TREATMENT

### Superfamily *HELICACEA*

The superfamily Helicacea in North America includes a few species of two families of snails of European origin: I, *HELICIDAE*, medium or large snails, usually with banded shells, having one dart sac with two tubular, simple or branching mucous glands inserted close to its base, the spermatheca on a long duct which usually bears a branch. II, *HELICELLIDAE*, of medium or small size, with the dart sac often twinned, sometimes wanting, the tubular mucous glands when present inserted well above it on the vagina; spermathecal duct medium or short, never branching.

There are four American families which are separable, so far as our genera are concerned, as follows:

1. Dart sac or sacs and mucous glands present, the latter club-shaped, globular or irregular (not tubular or finger-shaped), inserted close to the base of the dart sac; talon short, concealed in the albumen gland; shell usually with a band above periphery, or sometimes with three or many bands, the lip from simple to reflected, not toothed .....III. *HELMINTHOGLYPTIDAE*  
No dart apparatus; talon exposed .....2
2. Right and left ocular and pharyngeal retractor muscles united in a single band posteriorly; talon tuberculose; jaw ribbed; shell with reflected lip, often toothed.  
V. *POLYGYRIDAE*  
Right ocular retractor free from the left except at its columellar insertion; jaw not ribbed; lip of the shell simple, not expanded or reflected .....3
3. Moderately strong shells of medium or rather large size .....IV. *CAMAENIDAE*  
Thin, frail and small shells (less than 6 mm. in diameter) .....VI. *SAGDIDAE*

### Family I. *HELICIDAE*

Large and medium sized shells, umbilicate or closed, varying in shape from globose to lens-shaped or rarely cylindrical; one-colored or with 1 to 5 bands; peristome from simple to reflected.

**Genitalia:** The penis contains a papilla or a short verge, is provided with a retractor muscle, continued in an epiphallus and usually a flagellum. On the vagina there is one dart sac containing a 2- or 4-bladed dart; in the crotch between vagina and dart sac are inserted two mucous glands, which are tubular, varying from simple to many-branched. Spermathecal duct long, usually with a branch (the diverticulum), the spermatheca round or oval, lodged near base of kidney, being caught over an artery.

**Free retractor muscles:** The pharyngeal retractor is united posteriorly for a long distance with the left ocular-tentacular-pedal band, the right ocular-tentacular-pedal band being free to its posterior insertion. The right ocular retractor lies between penis and vagina.

The kidney is short, projecting but little in front of the pericardium in typical *Helix*, but with a longer, narrower, forward extension in *Cepaea* (Figure 1).

Jaw ribbed, or rarely smooth.

**Distribution.**—Western part of the Palaearctic Region; a single American species, *Cepaea hortensis* (L.), from Newfoundland to Massachusetts, mainly insular.

As colonists we have species of *Helix*, *Cepaea*, and one *Theba*. Though apparently thriving, being locally abundant and well-developed where introduced, they have not spread over the country generally as European Limacidae have done, remaining usually urban or suburban. The same observation applies to the introduced Helicellidae.

#### HELIX Linnaeus

*Helix* Linnaeus, 1758, Syst. Nat., Ed. X, pp. 645,758.—De Montfort, 1810, Conchyl. Systém. 2: 231, type *Helix pomatia*.

The large or moderate sized shell is globose or depressed-globose, imperforate or quite narrowly umbilicate, the embryonic whorls smooth; typically five-banded, but often with fewer or no bands. Genitalia: penis containing a papilla or verge, the epiphallus well developed, flagellum long. The large dart sac contains a 4-bladed dart with fluted base. The two mucous glands are usually divided and subdivided into long tubular branches. Spermatheca lodged near the heart, on a long duct which is almost always branched. Jaw with few strong ribs.

*Distribution*.—Western part of the Palaearctic Region, in Europe, North Africa and nearer Asia.

*Helix* is the leading genus composing the group "Pentataenia" of Adolf Schmidt (1855), so named from the five bands of the shells, a pattern Schmidt found was associated with a special anatomic structure. The positions of these bands are invariable, but some or all may be wanting or coalescent as a specific or often an individual characteristic. For convenient reference a band formula has been devised. "The typical pentataeniate shell has five bands, three above the periphery and two below, and its formula is accordingly 12345. If a band is missing, a 0 is placed in its stead; thus 12045 has the third band missing, while 00000 is the formula for a bandless shell. If two or more bands are coalesced, they are enclosed in parentheses thus, 12(345). If a band is imperfectly developed, it is indicated as a small figure below the line, thus 12,45. If a band is split into two, the number is repeated, as 1233(45). The formula should always be taken from near the mouth of the shell."<sup>1</sup>

In countries bordering on the Mediterranean, *Helix* is represented by a very large number of species, which were classified in numerous subgenera. Many Continental malacologists now treat these divisions (such as *Cepaea*, *Otala*, *Eobania*) as genera. Paul Hesse (in Rossmäessler's Iconographie, n. F., vols. 14, 16) and others have shown that these groups, originally based upon features of the shells, often have characteristic anatomic peculiarities also. We follow the prevalent European usage in the nomenclature of the few species colonized in America.

This group of Europe and Asia Minor is represented in North America by two species, of which *H. aspersa* has become a permanent resident. ('Ελαΐ, coiled.)

<sup>1</sup> Adapted from T. D. A. Cockerell.

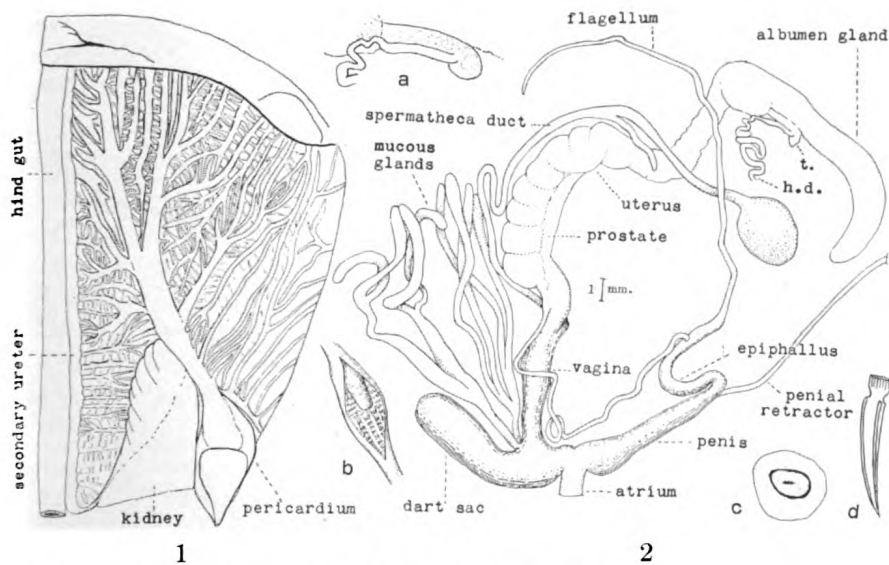


Fig. 1. Lung, kidney and heart of *Helix aspersa*.  
 Fig. 2. Genitalia of *Cepaea hortensis*; a, talon and end of hermaphrodite duct more enlarged; b, penis opened to show verge; c, section of penis and verge; d, dart; h.d., hermaphrodite duct; t, talon.

Subgenus HELIX *s. str.*

*Cochlea* DaCosta, 1778, British Conchology, p. 67; *cf.* Winckworth, Proc. Malac. Soc. Lond., 17: 106, type *Helix pomatia*.

*Pomatia* Leach in Turton, 1831, Man. L. & Fr.-W. Sh. Brit. Is., p. 45, for *Pomatia antiquorum* = *Helix pomatia*.

*Callunea* Megerle [von Muhlfield], Scudder, 1882, Nomencl. Zool., p. 56. Type *Helix pomatia* L.

*Megastoma* Megerle, Scudder, 1882, Nomencl. Zool., p. 204. Type *H. pomatia* L.  
*Helicogena*, in part, Férucciac, 1819, Tabl. Syst. Fam. Limaç., p. 27.

*Helix pomatia* Linnaeus (Figure 3 a) is a large, rather thin, globose shell with wrinkled surface, showing rather weak spiral lines. The color is chamois with rather wide cinnamon-brown bands according to the formula 1(23)45, or sometimes (123)45. The bands may be either distinct or ill-defined. The aperture is large, the lip pecan brown, a little expanded, becoming broadly reflected at the columella, partly covering the umbilicus.

Height 36 mm., diameter 35 mm.;  $4\frac{1}{2}$  whorls.

This snail was found in Jackson, Michigan, by Dr. Phil. Marsh, and investigated in 1937 by Dr. A. F. Archer (*Nautilus* 51: 61-63). It was planted there about 1932 by an Italian resident, and has spread over the gardens and small orchards of the Union Street block, between 3rd and 4th Sts., but not to other blocks. It is abundant, but is not known to damage vegetation noticeably. The figures and description are from some of these specimens. Whether it will become a permanent resident remains to be seen. There is an old record "Milwaukee, Wisconsin, P. Wells" (*Chadwick, Nautilus*, 19: 58); perhaps merely a stray shell.

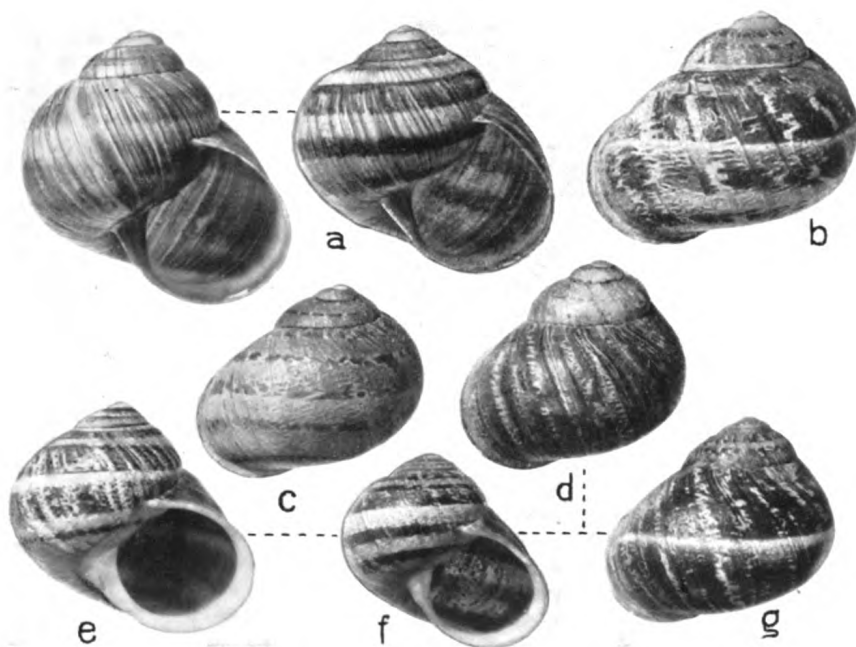


Fig. 3. a, *Helix pomatia*, Jackson, Mich.; b, *Helix aspersa*, Pacific Grove; c, Carlsbad, Cal.; d-g, Charleston, S. C.

Subgenus CRYPTOMPHALUS (Agassiz) Charpentier

*Cryptomphalus* "Agassiz", Charpentier, 1837, Nouv. Mém. Soc. Helvet. Sci. Nat., 1: 5.—Pilsbry, 1889, Man. Conch., 4: 234, type *H. aspersa*.

***Helix aspersa* Müller**

Figure 3, b-g.

*Helix aspersa* Müller, 1774, Verm. Hist., 2: 59.—A. Binney, 1851, Terr. Moll., 2: 116 (New Orleans, Charleston, S. C., Nova Scotia, coast of Maine).—W. G. Binney, 1859, Terr. Moll., 4: 51, pl. 77, fig. 4 (Charleston).—Stearns, 1881, Ann. N. Y. Acad. Sci., 2: 129 (introduced in San José about 1858; old Santa Barbara record doubtful); 1900, Science, (N. S.), 11: 655.—B. F. Koons, 1884, Bull. U. S. Fish Comm., 4: 87.—Keep, 1899, Nautilus, 13: 60 (Pacific Grove); 1902, 15: 119 (San José, Oakland, Los Angeles).—M. Smith, 1907, Nautilus, 21: 57 (introduction in La Jolla).—Berry, 1909, Nautilus, 23: 74; 1916, 30: 37 (Redlands).—Taylor, 1910, Monogr. L. & Freshw. Moll. Brit. Is., pp. 236, 272.—Orcutt, 1919, Nautilus 33: 64 (La Jolla, San Diego).—P. Viosca, 1928, Nautilus, 41: 139 (New Orleans).—Field, 1930, Nautilus, 44: 30 (Hondo River, climbing trees; above Point Conception under ice plant).—Ivan Johnson, 1918, Journ. Ent. & Zool., Pomona Coll., 10: 14.

*Pomatia aspersa* Müll., Binney, 1878, Terr. Moll., 5, Bull. Mus. Comp. Zoöl., 4: 380, fig. 265, 266.

The shell is imperforate or nearly so, obliquely globose, yellow, typically with 1(23)45 bands of chestnut-brown to chocolate, the bands interrupted by yellow flecks or streaks. Embryonic  $1\frac{1}{2}$  whorls smooth, the rest striate, last whorl with rather coarse, unequal wrinkles of growth and a network of low anastomosing wrinkles. The last whorl descends in front. Lip reflected, white, dilated over and usually closing the umbilicus.

Height 29 mm., diameter 32 mm.; 4½ whorls. Charleston, S. C.  
 Height 33 mm., diameter 38 mm.; 4½ whorls. Berkeley, Cal.

*Distribution.*—Western Europe, borders of the Mediterranean and Black Sea. Introduced in the Atlantic Islands; South Africa; Australia, New Zealand etc.; Haiti; in many places in Mexico, Chile, Argentina, and in the United States as follows:

**SOUTH CAROLINA:** gardens and churchyards in lower wards of Charleston (Mazyck).

**LOUISIANA:** New Orleans (A. Binney, P. Viosca); Baton Rouge (W. G. Binney).

**CALIFORNIA:** Berkeley, Oakland, San José, Santa Clara, Carmel, San Luis Obispo, above Point Conception, Pasadena, Los Angeles, Redlands, Claremont, Carlsbad, La Jolla, Pacific Grove, San Diego.

This peregrine snail inhabits gardens and cultivated land chiefly, preferring calcareous soils.

The records of *H. aspersa* from Portland, Maine, have been investigated by Mr. Arthur H. Norton (*Nautilus*, 49: 113, 1936) who traced all to a specimen sent to Dr. Gould, recorded by Wyman, 1839 (*Am. Journ. Sci.*, 37: 392). Many active conchological collectors in Portland since that time have not found the species there or elsewhere in Maine. A. Binney's Nova Scotia record has not been confirmed. In 1883, August 31, B. F. Koons liberated seven *H. aspersa* from Queenstown, Ireland, on the north side of Bush Island, at the end of Long Neck, Woods Hole, Mass. Whether they survived has not been reported.

Specimens from St. Peter's churchyard, Charleston, S. C., (Figs. 3 d-g), are rather small and dark, some with the typical 1(23)45 banding, but many with confluent bands (12345) or (123)(45). They measure from 23.5 x 29 mm. to 30 x 31 mm. Those from Mr. Mazyck's garden, 56 Montague St., are similar. Others received more than fifty years ago from W. G. Binney are lighter colored, like Taylor's plate 23, upper figures, representing typical *aspersa*. New Orleans shells are partly typically banded, partly (123)45, and some very light like Figure 3 c. They were said by A. Binney to have been brought from Spain.

West Coast shells from San Diego, Los Angeles County, Pasadena and above Point Conception are mainly as in Figures 3 b and f; some with bands reduced as in Figure 3 c, the size medium or small, 24 to 28 mm. in diameter. At Pacific Grove they run from 26 x 29 mm. to 32.5 x 35.3 mm., with bold chocolate bands much interrupted, formula 1(23)45. Specimens from Carmel, Monterey Co. and San José are heavily marked with interrupted chestnut-brown bands. Oakland and Berkeley shells often tend to have bands (123)45.

(*Aspersus*, speckled.)

## CEPAEA Held

*Tachea* Leach in Turton, 1831, Man. L. & Fr.-W. Sh., Brit. Is., p. 33. Not *Tachea* Fleming, 1822.

*Cepaea* Held, 1837, Isis (von Oken), p. 910.—Herrmannsen, 1846, Ind. Gen. Malac., 1: 199, *H. nemoralis* L. designated type.

*Hystriónica* Megerle, Scudder, 1882, Nomencl. Zool., p. 171 ("= *Tachea* Leach").

The shell is imperforate, smoothish, subglobose with conoid spire; bright colored, usually yellow, with five dark bands, any or all of which may be absent. Lip expanded, thickened within, the columellar margin straightened, reflected and adnate to the base.

The genitalia (Figure 2, *C. hortensis*, Bard Harbor Hill, Newfoundland) differ from native west American forms by having the two mucous glands inserted distinctly upon the vagina, slightly above the dart sac. They are slender, the branches finger-like or slightly spatulate at the ends. The large dart sac contains a 4-bladed dart. The globose spermatheca is lodged near the base of the kidney, its very long, slender duct bearing a short branch or "diverticulum". The penis contains a short verge. The talon is very much reduced, its trabeculae and the hermaphrodite duct (which runs nearly to its apex) visible through the same thin envelope.

The European group of garden snails is represented in America by one apparently native and one introduced species.

(Κηπαῖος, of a garden.)

***Cepaea hortensis* (Müller)**

Figure 4 a-k.

*Helix hortensis* Müller, Verm. Hist., 2: 52.—A. Binney, 1851, Terr. Moll., 2: 111, pl. 8.—R. Bell, Canad. Nat. & Geol., 4: 215 (distribution in Gulf of St. Lawrence); copied by Johnson, 1908, Nautilus, 21: 130.—J. H. Thomson, 1885, Journ. Conch., 4: 373 (Gay Head).—Cockerell, 1890, Nautilus, 3: 139; 1899, Nautilus, 13: 32.—Hanham, 1896, Nautilus, 10: 98 (Quebec, etc.).—Winkley, 1904, Nautilus, 17: 121.—Dall, 1905, Harriman Alaska Exped., 13: 20.—Johnson, 1906, Nautilus, 20: 73-80, 95 (Curtain I., Prince Edward I.; Cape Porpoise near Kennebunkport, Me.; Orleans and Cohasset, Mass.).—Taylor, 1910, Monogr. L. & Freshw. Moll. Brit. Is., Helic., p. 326.—Johnson, 1913, Nautilus, 27: 83 (islands in Casco Bay); 1915, 29: 83 (Martha's Vineyard).—Mazyck, 1914, Nautilus, 27: 107 (White Bull I., Me.).—Glover M. Allen, 1915, Nautilus, 28: 131 (Great Spruce Head I., Penobscot Bay, in shell-heap with the extinct *Mustela macrodon*).—Winkley, 1916, Nautilus, 29: 109 (Nantucket, Martha's Vineyard).—Wurtemberg, 1920, Nautilus, 33: 71 (prehistoric shell-heap on Mahone Bay, about 75 miles west of Halifax).—DeChamplain, 1929, Nautilus, 42: 102.

*Tachea hortensis* W. G. Binney, 1878, Terr. Moll., 5: 378, figs. 262, 263.

*Helix subglobosa* A. Binney, 1837, Boston Journ. Nat. Hist., 1: 485.

The imperforate shell is yellow (primrose yellow to olive-yellow, or rarely ecru-olive), uniform or with 1 or 5 bands of chestnut-brown or carob-brown, or sometimes pale or dilute color, and often interrupted by a growth-rest on the last whorl. Surface glossy, with fine wrinkles of growth. The lip is white.

Height 18 mm., diameter 20.5 mm.; 5½ whorls. Magdalen Island.

Height 13 mm., diameter 17 mm.; 4½ whorls. Nantucket.

Genitalia (Figure 2). The two mucous glands are unequal, one branching near the base, the branches long, the other dividing further up, the branches short. Each gland divides into two, and these divide again, forming four branches. The penis has concentric ridges in the upper part of the cavity, irregularly longitudinal ones further forward (Fig. 2 b). The five-banded Newfoundland specimen dissected measures 19.5 mm. in diameter.



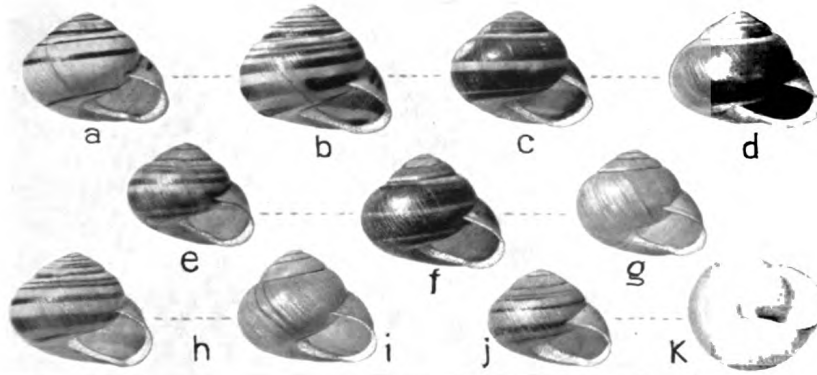


Fig. 4. *Cepaea hortensis*: a-d, Basin I., near Coffin I., Magdalen Is.; e-g, St. John's Bay, Newfoundland; h, i, Inner Green I., Portland, Me.; j, k, Nantucket, Mass.

*Distribution.*—Central and northern Europe; Iceland; in America from Newfoundland and Quebec to Nantucket, Mass., as follows:

QUEBEC: Plains of Abraham (Mrs. Sheppard, 1829); Rimouski, 1 or 2 miles from the St. Lawrence; Gaspé Basin; Bonaventure I.; Percé at 1200 feet elevation; Anticosti I.; Basin, Grindstone and Alright, Magdalen Islds. NEWFOUNDLAND: Highlands of St. John, Ingornachoix Bay, Bonne Bay, Bay of Islands and Conception Bay. ST. PIERRE and MIQUELON. PRINCE EDWARD ISLAND: Bloomfield, Douglas and Souris. NOVA SCOTIA: Halifax, Yarmouth and vicinity, East Jordan, Digby Neck, Cape Breton I. NEW BRUNSWICK: Grand Manan. MAINE: Wass. I., Washington County; Bar Harbor, Little Duck I., 8 miles south of Mt. Desert; Matinicus Is.; Pumpkin Knob, Sheepscot Bay; Seal Rock, Little Egg Rock, Sprucehead, Knox County; Little Duck I., Isle au Haute, Brown Cow, Inner Green and Cliff Islands in Casco Bay. NEW HAMPSHIRE: Wood Island, Portsmouth. MASSACHUSETTS: Cape Ann region, Salt, Eagle, House, Little and Outer Gooseberry Is., Kettle I., mainland at Manchester, Magnolia, Gloucester, Bass Rocks, Rockport; Old Harbor, Cohasset; High Pines near Duxbury; Cape Cod at Chatham, Provincetown cemetery; Snow's Point, Chappaquiddic I., and (in shell-heaps) near Gay Head, Martha's Vineyard; Nantucket and Tuckernuck I.

There are also unlocalized records from Vermont and Long Island, N. Y. A specimen from Labrador in the British Museum has somewhat transparent bands with the formula 10345. These old records need confirmation. Johnson's paper of 1906 should be consulted for earlier bibliography of *C. hortensis* in America.

Cockerell has reported on collections from two localities in Massachusetts, using names for the color forms according to the English manner. From Magnolia he records: "Var. *pallida* Ckll., pale purplish or purplish-brown, without bands. Var. *quinquevittata* Moq., yellow with five bands. Var. *rubrozonata* Ckll., straw colored with five red-brown bands. Var. *subalbida* Locard, very pale yellow or whitish, bandless. Var. *lutea* Moq., pale yellow and bandless. Var. *luteohybrida* Ckll., same color but the lip tinged pale brown. Var. *subglobosa* Binn., greenish or brownish-yellow or

honey color, parietal wall pale yellow, sharply defined from the darker (external) part of the shell, outer wall within white." In a lot from Rockport he found "Var. *subglobosa* Binn., shell greenish, 00000 or 00<sub>3,4</sub>0. Var. *arenicola* MacGillivray, bands colorless, translucent, 12345. Var. *subalbida* Loc., yellowish white or very pale yellowish, 00000 or 003<sub>4,5</sub>. Var. *lutea* Moq., yellow, 00000, 003<sub>4,5</sub>, 1234<sub>5,5</sub>, 0034<sub>5</sub>, 12345, 123(45), (123)(45)", and other band mutations.

The unicolored pale yellow color-variety *subglobosa* Binn. was described from Salt Island, near Gloucester, Mass., and occurs in pure colonies also in Provincetown cemetery, at High Pines, Duxbury, Mass., and in Newfoundland at South Head, Conception Bay, Doctor Hill, on the Straits of Belle Isle, summit of Killdevil Mt., Bonne Bay, and doubtless in other places.

The distribution of *Cepaea hortensis* in America has been discussed by R. F. Scharff, C. W. Johnson and others. The presence of this species of European type on the islets of a thousand miles of American coast has been an enigma. The Rev. H. W. Winkley was the first to suggest that it has come down from pre-glacial times. Dall recorded it from Pleistocene deposits near Portland; Glover Allen and Wurtemberg from other prehistoric deposits in Maine. Scharff<sup>1</sup> advocated the hypothesis of migration from Europe over a former arc of land postulated to extend from Scotland by way of Iceland and Greenland to Labrador. This hypothesis is also favored by J. W. Taylor, and there appears to be a large body of evidence from plant distribution in favor of a "late Tertiary and Pleistocene uplift of the Arctic lands".<sup>2</sup> The alternative hypothesis has been suggested that *C. hortensis* in late Pliocene, or more likely in the Yarmouth interglacial interval, acquired such a distribution as *Zoogenetes harpa* and some other species have now—from northern Europe by way of Siberia, Alaska, and the Hudson Bay region, to eastern Canada and New England. The extinction of *C. hortensis* over the greater part of this hypothetic Asiatic and American range is accounted for by later glaciation which did not cover the outlying eastern coastal points. The absence at present of any traces of *C. hortensis*, recent or fossil, on the Pacific seaboard or elsewhere along this route is a serious objection to this view. The question seems to be still an open one.

In America the species does not appear adapted to conditions inland. As Johnson has pointed out, it is a calciphile, and our northeastern coast is almost exclusively granitic. The barren coastal islands make up in lime and moisture what they lack in vegetation.

(*Hortensis*, living in gardens.)

<sup>1</sup> Scharff, R. F. Distribution and Origin of Life in America, 1911, pp. 13, 30. On the Evidences of a former Land-bridge between northern Europe and North America, Proc. Royal Irish Acad., vol. 28, 1910.

<sup>2</sup> See Fernald, 1931, *Rhodora*, 33: 61.

***Cepaea nemoralis* (Linnaeus)**

Figure 5 a-g.

*Helix nemoralis* Linnaeus, 1798, Syst. Nat., Ed. X, p. 773.—W. G. Binney, 1869, L. & Fr. W. Sh. N. A., 1: 182 (Burlington, N. J.).—Prime, 1894, Nautilus, 8: 70 (Flushing, Astoria, Lloyd's Neck, L. I.).—Pilsbry, 1889, Nautilus, 3: 51 (Lexington, Va., first found in 1886).—Cockerell, 1889, Nautilus, 3: 73, 87 (color variation, and tendency to split bands); also 1894, Nautilus, 8: 92, and 1897, Science, (N. S.), 5: 985 (further Lexington records).—Harn, 1891, Nautilus, 4: 137 (Western Pa.).—Rowley, 1893, Nautilus, 6: 131 (Baraboo, Sauk Co., Wis.).—J. L. Howe, 1898, Amer. Nat., 32: 913-923 (variation, Lexington, Va.).—M. D. Barber, 1918, Nautilus, 31: 107 (Knoxville, Tenn.; transplanted from Lexington 1910).—Cockerell, 1918, Nautilus, 31: 133 (variation at Knoxville).—Ortmann, 1926, Nautilus, 39: 73 (Lynchburg, Campbell Co., Va.; first noticed 1922).—C. W. Johnson, 1927, Nautilus, 40: 93 (Marion, Mass.).—Pilsbry, 1928, Nautilus 42: 42 (Owen Sound, Ontario; first found about 1890).—Stanley T. and Betty W. Brooks, 1934, Nautilus, 47: 96 (color variation, Hot Springs, Va.; imported from Holland).—Duncan McConnell, 1935, Amer. Nat., 69: 614-619; also 1936, Nautilus, 50: 15 (variation and distribution in Lexington, Va.) Clench, 1939, Nautilus 52: 108 (Warm Springs, Va., ¼ mile south of town; first noticed about 1935).—Taylor, 1910, Monogr. L. & Fr.-W. Moll. Brit. Is., p. 274 (distribution; variation in Europe).—Daphne Aubertin, 1927, Proc. Zool. Soc. Lond., pp. 553-581 (anatomic variation etc.).

*Tachea nemoralis* L., Binney, 1878, Terr. Moll 5: 379, fig. 264; 1885, Man. Amer. L. Sh., Bull. U.S. Nat. Mus. no. 28, p. 468, fig. 512.

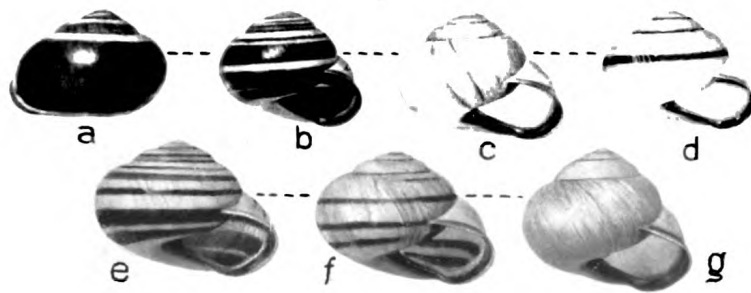


Fig. 5. *Cepaea nemoralis*: a-d, Burlington, N. J.; e-g, Lexington, Va.

The shell is imperforate, depressed-globose, some tint or shade of yellow, red or olive, one-colored or having from 1 to 5 bands, in color from cinnamon to almost black. Surface not very glossy, having a few wrinkles of growth and malleate in places. The last whorl is well rounded and descends in front. The lip is expanded and thickened within, walnut or a darker shade of brown, the parietal wall of the same hue.

Height 18.5 mm., diameter 24 mm.; barely 5 whorls. Flushing, L. I., New York.

*Distribution*.—Central and western Europe; introduced in America:

ONTARIO: Owen Sound and Meaford, on southern Georgian Bay. MASSACHUSETTS: Marion; G. L. Archer estate, Stetson Road, Norwell, Plymouth Co. (planted from Marion, Mass). NEW YORK: Long Island at Flushing (1906) and Astoria; Lloyd's Neck (formerly; extinct before 1894). NEW JERSEY: Burlington. VIRGINIA: Lexington, Hot Springs, Staunton, Lynchburg and Warm Springs. TENNESSEE: Knoxville.

Specimens from Lexington have been planted at Blairsville, western Pennsylvania (Howe, 1898, p. 920); from Burlington, N. J., at West Cliff,

Custer Co., Colorado (Cockerell); but whether they still survive is not recorded. A dubious record is Baraboo, Sauk Co., Wisconsin (a single shell picked up by a child 1893).

*C. nemoralis* is usually larger, more solid and more depressed than *C. hortensis*; it is less glossy, and the lip and parietal wall are of a permanent brown to almost black color. The dart differs, having simple blades, whilst those of *hortensis* are bifid, the edges double. There are also some differences in the mucous glands and the proportions of other organs, as Daphne Aubertin has pointed out.

"The varieties of *Cepæa nemoralis* are classified according to the following principles: First, variation in the ground-color of the shell, with the name *libellula* for yellow shells, *rubella* for pink shells, *petiveria* for pale brown or fawn-colored shells, etc. Secondly, variation in the banding, for which a band-formula is used," as explained on page 2.

Of the earliest known American colony W. G. Binney wrote: "In 1857 I imported some hundred living specimens from near Sheffield, England, and freed them in my garden in Burlington, N. J. They have thriven well and increased with great rapidity, so that now (1865) the whole town is full of them". At the present time, after eighty years, these snails are still confined to the town, where they are abundant in some gardens and in several urban cemeteries and churchyards. I have not found them in surrounding country. Prominent features of the Burlington colony are the prevalence of red ground, and the large proportion of bandless shells.

There have been several importations into America, apparently at least five or six, all but that at Burlington, N. J. probably by accidental carriage with imported plants. The variations of an animal in a new environment being of great interest, several studies of American colonies have been made, the most extensive papers relating to the Lexington, Virginia, colony, by Cockerell, Howe and McConnell.

McConnell (1935) concludes that in the Lexington colony "there has been a marked decrease in the frequency of the more complicated patterns, and this is regarded as a decrease in the tendency toward development of variations through adaptation of the species to its new American environment. The bandless pattern has appreciably increased in frequency during the thirty-two year period. There have been other changes of lesser consequence."

In America up to this time only statistical methods have been used in studying the variation of *C. nemoralis*. But it is excellent material for breeding experiments, and many points of interest remain to be worked out. Some account of this work has been given by A. W. Stelfox, 1918, Journ. of Conch. 15: 268-275.

(*Nemoralis*, inhabiting woods.)

Other European Helicidae reported, but which can scarcely be considered well established residents, follow.

*Otala (Eobania) vermiculata* Müller,<sup>1</sup> (Figure 6 d), occurring since about 1918 in Jackson Square, New Orleans, is whitish with four or five (1(23)45 or 12345) chestnut-brown to chocolate bands, which are more or less maculate and speckled with white on the upper surface; the peristome white. A New Orleans specimen measures height 18.5 mm., diam. 28 mm., 5 whorls. The species inhabits Mediterranean countries.

*Otala lactea* Müller,<sup>2</sup> (Figures 6 a-c). The whitish shell has 1(23)45 dark bands closely speckled with white, or it may be buff, nearly uniform or with fine darker or gray mottling partly in bands. Surface minutely dented or poc-marked, and with very fine, partly indistinct spiral striation. Aperture and peristome liver-brown to almost black. Diam. 27.5 to 36 mm.

It inhabits southern Spain and north Africa. The figures represent specimens from Pass-a-Grille, near St. Petersburg, Florida. It was reported in 1931 by Mrs. W. G. Fargo, who stated that they were introduced by the owner of a curio shop, who imported them from Morocco. It occurs on papayas and a large lily. Mr. D. L. Emory reports that owing to fires it is now (1937) hard to find at Pass-a-Grille. Mr. A. J. Nitzsche found *O. lactea* on Cockspur Island, in the mouth of Savannah river, Georgia, some years ago. It is still common there, chiefly on yucca. The circumstances of its introduction are not known. Mazyck, 1913, reported two fresh specimens found on the beach at Sullivan's Island by Ravenel in 1874. Living specimens of this species can be obtained in foreign markets of many cities, as it is imported for food by Mediterranean peoples.

*Helicigona (Arianta) arbustorum* (Linnaeus). (Figure 6e.) "Adult living specimens of this common British and European land snail were collected by Dr. Robert Bell in the middle of July, 1885, on grassy slopes facing the sea, near the narrows of St. Johns Harbor, Newfoundland. So far as the writer is aware, this is the first time that this species has been found, in a living state, on the American side of the Atlantic. Dr. Bell says that many wrecks of vessels take place on this part of the coast, and that a little farther to the south of the locality where these snails were found, there is a small patch where the common heather (*Calluna vulgaris*) grows. This marks the spot, he adds, where an emigrant ship was stranded, and the beds of the emigrants, which were stuffed with heather, were taken ashore and emptied out." (J. F. Whiteaves, 1904, *Ottawa Naturalist* 17: 192; reprinted in *Nautilus* 17: 131.)

<sup>1</sup> O. F. Müller, 1774, *Verm. Hist.*, 2: 20. Italy.—Viosca, 1928, *Nautilus*, 41: 139.

<sup>2</sup> O. F. Müller, 1774, *Verm. Hist.*, 2: 19. Cf. Junius Henderson, 1936, *Nautilus*, 50: 72 (Cabbage Key near Pass-a-Grille, Fla.).—Van der Schalie, 1938, *Nautilus* 51: 132.—*Helix irrorata* Say, 1822, *Journ. Acad. Nat. Sci. Phila.*, 2: 370 (Northumberland Co., Pa.); *Amer. Conch.*, part 6, cover.

The sole reference to this species in America is reprinted above. Until its continued existence is confirmed it seems a rather doubtful member of the American fauna. The figure is from an English specimen. It belongs to the subfamily Helicigoninae, not otherwise known from the western hemisphere.

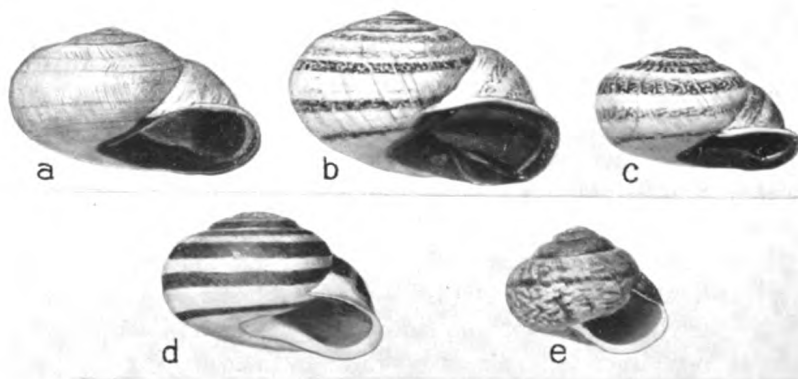


Fig. 6. a-c, *Otala lactea*, Passe-a-Grille, Florida. d, *Otala (Eobania) vermiculata*, New Orleans. e, *Helicigona (Arianta) arbustorum*.

#### THEBA Risso

*Theba* Risso, 1826, Hist. Nat. Eur. Mérid., 4: 73.—Gray, 1847, Proc. Zool. Soc., p. 173, *Helix pisana* designated type.

*Xerophila* Held, 1837, Isis, p. 903.—Herrmannsen, 1849, Ind. Gen. Malac., 2: 712, *Helix pisana* Müller designated type.

*Euparypha* Hartmann, 1844, Erd- und Süßwasser-Gasteropoden, p. 204, for *Euparypha rhodostoma* = *Helix pisana* Müller.

The medium sized subglobose-depressed shell is narrowly umbilicate, opaque, light colored and usually with numerous bands and lines variable in number and position. The last whorl scarcely descends in front. Aperture but slightly oblique, the lip thin, thickened within, expanded only at the columellar insertion.

There is no flagellum. The dart sack has a median fleshy ring. On the vagina above it two large, simple, club-shaped mucous glands are inserted. Spermathecal duct long, having a branch near its base. Dart, according to J. W. Taylor, is very small, scarcely 2 mm. in length, in structure conforming to those of the pentataeniata group; it has a short, straight shaft, expanding rather abruptly at the base, and provided with four symmetrically disposed blades, their edges split into diverging flanges. Base terminating in a distinct annulus composed of from 14 to 16 rodlets.

*Distribution*.—The few species of this genus inhabit southern Europe, north Africa, and the Atlantic islands.

(Θήβη, Thebes, application not apparent.)

**Theba pisana** (Müller)

Figure 7.

*Helix pisana* Müller, 1774, Verm. Hist., 2: 60.—Taylor, 1911, Monogr. L. & Freshw. Moll. Brit. Is., 3: 368, pl. 30, 31.—Oreutt, 1919, Nautilus, 33: 63 (La Jolla, 1914-1918).—Cockerell, 1924, Amer. Nat., 58: 190.—A. J. Basinger, 1927, Monthly Bull. Dept. Agric. St. Cal., 16: 51, text figs.—Hanna, 1933, Nautilus, 46: 139.—J. L. Baily, Jr., 1935, West Coast Shells, p. 300.

The subglobose-depressed shell is narrowly, partly covered umbilicate, opaque, rather strong. Ivory yellow, with many unequal vandyke brown bands and lines, usually in part interrupted into dots or dashes; or often uniform ivory yellow (except for some cinnamon streaks or stains). Surface not glossy, having fine, unequal wrinkles of growth cut by numerous impressed spirals; the embryonic  $1\frac{1}{2}$  whorls smooth, glossy. The last whorl descends but little in front. The aperture is but slightly oblique. Peristome sharp, thickened within, expanded only at the columellar insertion.

Height 13 mm., diameter 18 mm.;  $4\frac{1}{2}$  whorls; or somewhat smaller.

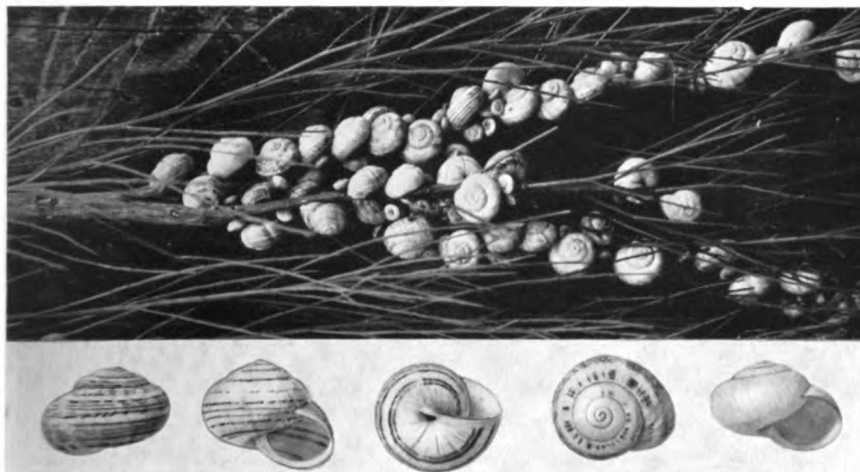


Fig. 7. *Theba pisana*, La Jolla. Above, aestivating group, from photo by F. W. Kelsey.

*Distribution.*—Mediterranean countries, western France, southwestern England and Wales, locally in Ireland. Introduced in the Atlantic Islands, South Africa, Somaliland, Perth, West Australia and in the United States as follows:

**CALIFORNIA:** San Diego County at La Jolla (1914); Greenwood Cemetery, San Diego (prior to 1924). Orange County near Seal Beach and over the line into Los Angeles County; inland between Midway City and Garden Grove (1932).

This common species of Mediterranean countries was first noticed in La Jolla in June, 1914. It increased rapidly, becoming a nuisance from its abundance, and by defoliating trees of the citrus fruits and other plants, though no great damage seems to have been done. Vigorous measures were

taken to exterminate them, by the use of poison sprays, poison bait, hand picking and burning.

It has been stated that the California stock came from Belgium in the packing of plants.<sup>1</sup> Some of those first found are preserved in the San Diego Natural History Museum.

They are said to pair after the rains early in November and deposit the eggs several inches down in the ground a few weeks later. The period of incubation is about 20 days, or more in dry weather. In the summer they do not seek cool, dark places, like most of our native snails, but aestivate on plants, fences and the like, or sometimes under stones.

Professor Cockerell examined a lot of 221 shells from La Jolla, finding the following color-patterns:

“*Pisana* proper, with numerous bands; 351 shells, of which more than 20 have the banding confined to the region just before the aperture. Variety *bifrons* Moquin-Tandon, with the banding confined to the lower part of the shell, below the periphery; 122 shells. Variety *alba* Shuttleworth, whitish, tinged with ochreous, unbanded or with slight traces of bands; 213 shells. Variety *subzonata* Bourguignat, with broad pale fulvous bands above and below the periphery, and often a more distinct basal band; 25 shells. Variety *interrupta* Moquin-Tandon, with a very slender, more or less broken (punctiform) peripheral band, and usually some more or less interrupted banding below; 7 shells. Variety *punctella* Moquin-Tandon, a more extreme form of the last, with series of dots in place of bands; 2 shells. Variety *sagittifera* Taylor, with arrowhead-like markings, but in our specimen they are confined to the region just before the aperture; one shell, not adult.”

(*Pisana*, of Pisa, the original locality.)

## Family II. HELICELLIDAE

*Fruticolidae* (*Fruticolinae* + *Xerophilinae*) von Ihering, 1929, Abh. Arch. f. Molluskenk., 2, Heft 2, p. 50.—Hesse, 1931, Zoologica, 31, Heft 81, p. 105. Not of Lindholm, 1927.

Shell generally perforate or umbilicate, of medium or small size, variable in form, from turritid to lens-shaped, and in color from uniform to many-banded. Peristome reflected or simple.

Genitalia with 0 to 2 dart sacs, often accompanied by empty accessory sacs; the dart, when present, simple or two-bladed, without a fluted base. Mucous glands short, usually more than two, tubular, simple or branching, situated well above the dart sac or sacs; sometimes the dart apparatus is wanting. Spermatheca duct of medium length or short, never branched (Fig. 8 b). The kidney is rather narrow, more than double the length of pericardium. Jaw plaited or ribbed. Central and lateral teeth usually with ectocones (Fig. 8 a).

A family of the western Palearctic Region.

<sup>1</sup> E. P. Chace, in letter. Taylor does not report it from Belgium, but states that specimens from Algiers were planted on dunes there in 1868. A large colony has been found recently by Dr. W. Adam at Mariakerke. It seems more likely that the California stock came from England or southern Europe.



This family differs from the Bradybaenidae<sup>1</sup> of Eastern Asia by the slender, tubular form of the mucous glands, situated high on the vagina, well removed from the dart sac. The irregular, "Euadenia" type mucous glands of Bradybaenidae open through an accessory sac on the dart sac, or sometimes directly at the base of the latter.

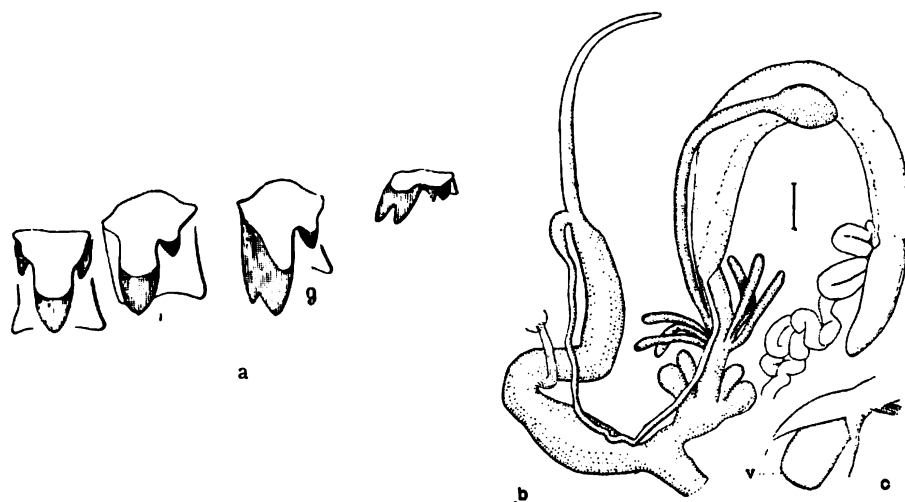


Fig. 8 a, *Helicella elegans*, teeth of a Charleston specimen, drawing by W. G. Binney. b, c, *Hygromia striolata*, genitalia of a Quebec specimen. v, verge. (Scale line = 1 mm.)

Five species which have been introduced locally in North America belong to four genera of two subfamilies.

**HYGROMIINÆ:** Right ocular retractor passing through the crotch between penis and vagina.

Thin, small (8-12 mm. in diameter), narrowly umbilicate, depressed shells, brown or corneous, uniform or with a light peripheral band; surface often hairy; lip very little expanded .....*Hygromia*

**HELICELLINÆ:** Right ocular retractor lying to the left of the genitalia.

Thin, of 15-20 mm. in diameter, smooth, depressed-globose, narrowly umbilicate; the lip simple or expanded .....*Monacha*

Calcareous, opaque, whitish, conic or depressed, narrowly umbilicate; the lip simple .....*Helicella*

Thin, high conic, being higher than wide, variegated; the lip simple ....*Cochlicella*

<sup>1</sup> Bradybaenidae equals Eulotidae of many authors; Fruticicolidae Lindholm, 1927, Arch. f. Molluskenk., 59: 120. Lindholm's family name is not used here because it is based upon *Fruticicola*, which can scarcely be more than a subgenus of *Bradybaena*, and this has been shown to be of earlier date (Proc. Malac. Soc. Lond., 21: 147). Moreover the connotations of the name *Fruticicola* have been for many years with European snails of a different family; cf. Hesse, 1921, Arch. f. Molluskenk., 53: 55, and elsewhere.

## HYGROMIA Risso

*Hygromia* Risso, 1826, Hist. Nat. Eur. Mérid., 4: 66.—Herrmannsen, 1847, Ind. Gen. Malac., 1: 547, type *Helix cincitella* Drap.—H. Watson, 1919, Proc. Malac. Soc. Lond., 13: 120, (anatomy).

The shell is of moderate or small size, thin, narrowly umbilicate, moderately depressed, with carinate, angular or rounded periphery; brown or whitish, either plain or with a white peripheral band. Peristome expanded basally, the columellar margin reflected.

Penis continued in an epiphallus and short flagellum. Vagina bearing a dart sac and accessory sac (or in some forms such as *Trichia* these are paired). Darts simple or with 2 or 4 blades. Mucous glands finger-shaped, usually 8, inserted on the vagina in front of the origin of spermathecal duct. Spermathecal duct medium or rather long, not branched. The right ocular retractor passes between penis and vagina.

The only members of this large European genus occurring in America belong to the subgenus *Trichia*.

(Ἵγρός, wet.)

## Subgenus TRICHIA Hartmann

*Trichia* Hartmann, 1840, Erd- und Süßwasser-Gasteropoden Schweiz, p. 41.—Herrmannsen, 1849, Ind. Gen. Malac., 2: 587, type *Helix hispida* L.—H. Watson, 1919, Proc. Malac. Soc. Lond., 13: 130.

*Fruticicola* (Held, 1837), of Von Martens, 1860, W. G. Binney, 1878, and many other authors, but not as restricted by Herrmannsen, 1847, to the type *Helix fruticum* Müller.

*Trochulus* (Chemnitz, 1786),<sup>2</sup> Lindholm, 1927, Arch. f. Molluskenk., 59: 122, 138, q. v. for further synonymy.

The shell is hairy, at least when young; periphery rounded or angular. Mesocones of marginal teeth not bifid. Dart sacs together with their empty accessory sacs symmetrically paired. Mucous glands tubular or lightly enlarged towards the ends, short, seated on vagina below insertion of spermatheca duct. The dart is without blades.

Many Continental malacologists recognize *Trichia* as a genus separate from *Hygromia* on account of its duplicate dart sacs and the features of the shell. The classification of Hygromiinae is a complex problem, and for the purposes of this work it has seemed best to follow the arrangement of Hugh Watson, J. W. Taylor and other British authorities.

(Τριχίας, hairy.)

**Hygromia hispida** (Linnaeus)

Figure 9 b.

*Helix hispida* Linnaeus, 1758, Syst. Nat., Ed. X, p. 771 (Sweden).—Hanley, 1855, Ipsa Linnaei Conchylia, p. 368.

*Hygromia hispida* Linn., Tryon, 1866, Amer. Journ. Conch., 2: 308, pl. 5, fig. 2 (Halifax).—Lermond, 1908, Nautilus, 21: 109 (occurrence in Me.).—Taylor, 1916, Monogr. L. & Fr.-W. Moll. Brit. Is., pt. 22, p. 17.

*Fruticicola hispida* Linn., W. G. Binney, 1878, Terr. Moll. 5, Bull. Mus. Comp. Zool., 4: 345, figs. 228, 229.—Thomson, 1885, Journ. Conch., 4: 372.

*Helix hispida* var. *concinna* (Jeffer.), Cockerell, 1899, Nautilus, 3: 87.

<sup>1</sup> Chemnitz was not consistently binomial in vol. 9 of the Conchylien Cabinet. The citation of *Trochulus hispidus* Chemnitz by Beck does not render it acceptable, since he did not adopt the name.

The shell is thin, umbilicate, depressed, with low conoidal spire of convex, slowly increasing whorls, the last rounded at periphery and base. Slightly translucent, dilute cinnamon-brown with (usually) an ill-defined paler or whitish zone at the periphery, the early whorls light or whitish. Surface is glossy, finely, rather irregularly striate and marked with small papillae, rather widely and unevenly spaced (and probably bearing deciduous hairs when freshly formed). The aperture is elliptical-lunate, the lip thin and at the basal margin a little expanding, dilated at the columellar insertion. It is strengthened by a callous rib within the columellar and basal margins.

Height 5.3 mm., diameter 8.1 mm.;  $5\frac{1}{2}$  whorls. Prince Edward I.

*Distribution.*—Europe; northern Asia east to the Amur valley; introduced in America.

NOVA SCOTIA: Halifax (Bland); Charlottetown, Prince Edward I. (Bayard Long, 1912).

QUEBEC: Montreal (Cockerell).

MAINE: Hairless form in Rockland and Thomaston, Knox County (N. W. Lermond, Geo. H. Clapp).

(?) MASSACHUSETTS: Martha's Vineyard near Gay Head (J. H. Thomson).

18171

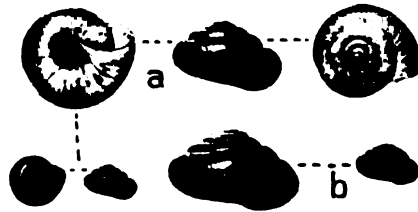


Fig. 9. a, *Hygromia hispida tonsilis*, Rockland, Me. b, *H. hispida*, Prince Edward I. (Actual size and  $\times 2$ )

The Halifax specimens seen are not hairy, but they show rather widely spaced papillae, evidently hair scars, on the last whorl as in Figure 9 b. Those from Prince Edward Island are similar. I have not seen Montreal specimens. No recent naturalist seems to have found *H. hispida* near Gay Head, Martha's Vineyard, where Thomson recorded finding it some years before 1885.

According to Hanley the Linnean type was the form which Jeffreys called *Helix concinna*, less globose than the traditional *hispida*, with wider umbilicus, and "the hairs are more scattered and easily shed". All of the Canadian references apply to this form. No American shells I have seen are hairy, as the species is represented in Taylor's figures on his plate V.

(*Hispida*, bristly.)

*Hygromia hispida* form *tonsilis* new form. (Figure 9 a.) In Maine this form is abundant in quarries (limestone) at Rockland, where Mr. Lermond found it in 1904. This form is without hairs or hair-scars and may be referable to the var. *depilata* Alder of Taylor's Monograph, but that name is not valid, being a homonym. If a special name is needed for these shells which are hairless at all stages of growth, they may be called *H. hispida tonsilis*, type locality Rockland, Me. The shells are small, height 4.3, diameter 7.5 mm., 5½ whorls. The color is often uniform, brownish isabella color, but some are paler along the periphery. Mr. Lermond writes: "In 1904 I found a snail considerably smaller in size than *Polygyra fraterna* Say, and very numerous on walls of old lime quarries, on wooden sidewalks and on the under sides of rocks from the lime quarry at Rockland, Knox County, Maine. In 1905 I found them quite as plentiful in and about old lime quarries at Thomaston, and in 1906 collected them in a garden in the same town under cabbage plants. They literally 'swarmed' on the ground and on the under side of the cabbage heads. This garden is on the banks of 'Mill River,' and near a lime kiln. This season (1908) I found them just as numerous."

(*Tonsilis*, shorn.)

***Hygromia striolata* (C. Pfeiffer)**

Figure 10 b.

*Helix rufescens* Pennant, of British and many Continental authors prior to 1913. Not *H. rufescens* Pennant, 1777 = *Arianta arbustorum* juv.; cf. E. A. Smith, 1913, Ann. Mag. Nat. Hist., (8), 11: 263; Journ. Conch., 14: 36; also Kennard and Woodward, 1913, Ann. Mag. Nat. Hist., (8), 11: 428.

*Helix rufescens* Pennant, Whiteaves, 1861, Canad. Nat. & Geol., 6: 452.—W. G. Binney, 1869, L. & Fr. W. Sh. N. A., 1: 159, f. 275.—Hanham, 1896, Nautilus, 10: 99.—Latchford, Ottawa Nat. 1: 107; 1893, Ottawa Nat. 7: 132.

*Fruticicola rufescens* Penn., W. G. Binney, 1878, Terr. Moll. 5, Bull. Mus. Comp. Zoöl., 4: 346, fig. 230; 1886, 2nd Suppl. Terr. Moll., Bull. Mus. Comp. Zoöl. 13: 23.—Thomson, 1885, Journ. Conch., 4: 373.

*Helix striolata* C. Pfeiffer, 1828, Naturgeschichte deutscher Land- und Süßwasser-Mollusken, 3: 28, pl. 6, fig. 8 (common in gardens of Heidelberg).

*Hygromia striolata* (C. Pfr.) Taylor, 1916, Monogr. L. & Fr.-W. Moll. Brit. Is., pt. 22, p. 3.—J. Oughton, 1938, Nautilus, 51: 137 (occurrence at Toronto).

*Helix montana* Studer, 1820, Naturwiss. Anz. allgem. Schweiz. Gesellsch. ges. Naturwiss. No. 11, p. 86.<sup>1</sup>—C. Pfeiffer, Idem, p. 33, pl. 6, fig. 10. Schlossberg bei Heidelberg).

The shell is thin, narrowly umbilicate, depressed, with low conoidal spire and convex base, obtusely angular at periphery, somewhat translucent, of a very dilute tawny-olive or brownish olive-buff tint, with an indistinct paler band at periphery. Surface rather glossy, finely but unevenly striate and with some coarser wrinkles of growth. The whorls are closely coiled. The aperture is broadly lunate. Lip thin and sharp, not expanded, but slightly dilated at the columellar insertion; a little distance within the thin margin a white thickening or very low, wide rib is seen.

<sup>1</sup>"Die Schale matt, ohne sonderlichen Glanz, oft regular gestreift; mit runden Gewinden; auf dem Jura, mit und ohne weisse Binde; mit einer solchen hiess sie sonst *H. circinnata*." (Studer.) Switzerland.

Height 7 mm., diameter 11 mm.; 6 whorls.  
 Height 6.1 mm., diameter 10.3 mm.  
 Height 6 mm., diameter 11 mm.

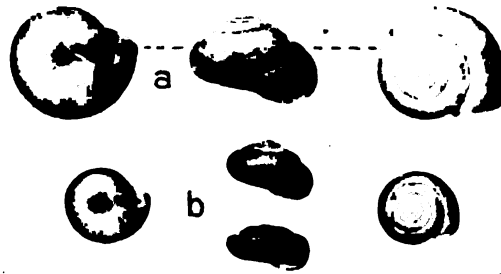


Fig. 10. a, *Monacha cantiana*, Quebec. b, *Hygromia striolata*, Quebec. (Actual size.)

*Distribution.*— Central Europe, France and England; introduced in America.

**QUEBEC:** Very abundant throughout the city, especially on the cliffs and city walls; extends along the cliffs some distance up the St. Lawrence; a large colony at St. Sauveur, a few up River St. Charles, and a small colony on the Isle d'Orleans close to the ferry landing (Hanham). Levis (Abbé Begin). Plains of Abraham, Quebec (Whiteaves, 1861, Bayard Long, 1930).

**ONTARIO:** Ottawa (Latchford); in Rockcliffe Park (G. E. Fairbairn, May 24, 1937). Toronto (J. Oughton).

**NOVA SCOTIA:** Halifax (T. Bland).

**MASSACHUSETTS:** Naushon I., Buzzard's Bay (J. H. Thomson).

This shell has somewhat the general appearance of *Zonitoides* (*Ventridens*) *gularis* or *Z. intertextus*. It is smaller than *Monacha cantiana*, more closely coiled, and with a subangular periphery. The height of the spire varies individually; in one lot I found the h/d index from 54.5 to 66.

It was probably introduced in colonial times. A shell from the Plains of Abraham noticed by Mrs. Sheppard, 1829, (Trans. Lit. and Hist. Soc. Quebec, 1: 194), was probably this species, as Binney suggested, though if so it was poorly described. Justice Latchford planted several hundred from Quebec in the Exhibition grounds, Ottawa, in 1893.

The record from Halifax rests upon a set of shells received from Bland through A. D. Brown, therefore more than fifty years old. That from Massachusetts rests upon J. H. Thomson's report that it was found living on the south side of Naushon Island near the "French watering place" in 1859 or 1860. Also reported from Goat Island, Niagara Falls, May 1912, by Rev. C. E. Y. Kendall. The Toronto colony was discovered by Mr. and

Mrs. John Oughton in November, 1937, in a small ravine on Rosedale Valley Drive, 15 minutes walk from the Royal Ontario Museum. It has apparently been there for some years. They were probably among living shells of *Cepaea nemoralis* and *hortensis* imported by Mr. E. V. Rippon from Upper Norwood (Crystal Palace), Kent, England, in 1894. The *Cepaeas* have disappeared, but *H. striolata* is abundant. Its variation, etc. has been described by Oughton, 1938, *Nautilus* 51: 137.

*Nomenclature*.—Known as "*Helix rufescens* Pennant" for more than a century, another name for this snail had to be found when E. A. Smith discovered that Pennant's type specimen is a young *Arianta arbustorum*. He proposed to substitute the name *Helix montana* (Studer) C. Pfeiffer. Kennard and Woodward preferred *H. striolata* C. Pfr. Westerlund had recognized the "species" *rufescens*, *striolata* and *abludens* Loc. in Great Britain, and these together with *montana* on the continent; but by English and American standards these several names apparently pertain to forms of a single species. I would be content with Smith's selection of the name *montana* Studer, but as *striolata* C. Pfr. seems to be accepted now by Taylor and other British authors, that name is used. The Quebec importation was probably from France.

Genitalia figured from a Quebec specimen, Fig. 8 b, showing the paired dart sacs, each accompanied by an empty accessory sac, the mucous glands inserted well above the dart sacs, and at c, the large verge (v) in the penis.

#### MONACHA Fitzinger

*Monacha* Fitzinger, 1833, Syst. Verz. Oesterr. Weichth., in Beitr. zur Landesk. Oesterr., 3: 95.—Gray, 1847, Proc. Zool. Soc. Lond., p. 173, type *Helix carthusiana*.

*Theba* Risso, of many authors, but not as restricted by Gray to the type *Helix pisana*.—Hesse, 1931, Zoologica, 31, Heft 81, p. 32 (anatomy).

The shell is thin, depressed, narrowly umbilicate, the periphery rounded or keeled; lip slightly or not expanded, thickened within.

Penis with epiphallus and a short flagellum, but often lacking retractor muscle. Dart sac rudimentary or represented by an empty, evertible sac, the finger-shaped or branching mucous glands inserted well above it. Spermatheca irregular, its duct of medium length. The right ocular retractor lies to the left of the genitalia, as in *Helicella*.

(Μονᾶχος, a monk.)

#### *Monacha cantiana* (Montagu)

Figure 10 a.

*Helix cantiana* Montagu, 1803, Testacea Britannica p. 422, Suppl. pl. 23, fig. 1.—F. R. Latchford, 1885, Amer. Nat. 19: 1111.—A. W. Hanham, 1896, *Nautilus*, 10: 99.

*Theba cantiana* (Montagu), Taylor, 1917, Monogr. L. & Freshw. Moll. Brit. Is., pt. 23, p. 78.

*Fruticicola cantiana* Montagu, W. G. Binney, 1886, 2nd Suppl. Terr. Moll., Bull. Mus. Comp. Zool., 13: 23, pl. 1, fig. 13.

*Helix cantiana* var. *minor* Moq., Cockerell, 1889, *Nautilus* 3: 87.

The thin shell is narrowly umbilicate, globosely depressed, somewhat translucent, the upper surface whitish, or with some brown tint on later whorls, the lower surface dilute snuff-brown. Surface glossy, with fine, weak and irregularly developed striation and some coarser growth wrinkles. Last whorl with well rounded periphery and base, descending very little in front. The aperture is broadly lunate; the lip thin, very slightly expanded, shortly dilated at the columellar insertion, strengthened by a narrow white or brown-tinted rib a short distance within the edge.

Height 11.7 mm., diameter 17 mm.; 5 $\frac{3}{4}$  whorls.

Height 10.5 mm., diameter 15.5 mm.; 5 $\frac{3}{4}$  whorls.

*Distribution*.—Europe: In the Netherlands, western Germany, France and England;<sup>1</sup> introduced in Canada.

QUEBEC: cliff below the citadel (Litchford); cliff bordering the Plains of Abraham and extending to the citadel, not noticed in the city (Hanham).

ONTARIO: Hamilton (G. K. Gude).

This shell is larger than *Hygromia striolata*, with wider last whorl, which is not in the least angular at periphery. The color is distinctly brown, as in Taylor's plate 9, figures of specimens from Boston Spa, Yorks., which resemble the Quebec shells closely; American *H. striolata* being much paler. In one lot of rather small shells from "Cape Diamond", Quebec, the tint is as light as in *H. striolata*.

*M. cantiana* was first reported from Quebec by Chief Justice F. R. Litchford, who collected it in company with *H. striolata* August 12th, 1885.

(Described from the county of Kent (*Cantium*), England, whence the name.)

#### HELICELLA Férussac

*Helicella* Férussac, 1821 (Jan.), Tabl. Syst. Fam. Limaç., p. 41; June edit., p. 37.—Herrmannsen, May 1847, Ind. Gen. Malac., 1: 507, "typus *H. ericetorum* Müll".—Pilsbry, 1895, Man. Conch., 9: 245; 1921, Proc. Malac. Soc. Lond., 15: 39.

*Xerophila* of most XIX Century authors, not *Xerophila* Held as restricted by Hermannsen to the type *Helix pisana*.

The shell is calcareous, opaque, umbilicate; in form from conic to depressed; white or cream colored, often with dark bands variable in number and position. Lip scarcely or not expanded, usually thickened within.

Penis continued in an epiphallus and short flagellum. Dart sacs 1 to 4, the finger-shaped mucous glands inserted well above them. Spermathecal duct branchless, of medium length or rather short. The right ocular retractor passes to the left of the genitalia.

Radula with ectocones on all of the teeth, but sometimes weak on the centrals (Fig. 8a, *H. elegans*). Jaw ribbed.

*Distribution*.—Europe, chiefly southern, north Africa and nearer Asia. (*Helicella*, diminutive of *Helix*.)

<sup>1</sup> Various forms probably not specifically distinct occur in southern Europe and nearer Asia, from Sebastopol and Palestine to Portugal. See Taylor, *l. c.* p. 94.

## Subgenus TROCHOIDEA Brown

*Trochoidea* Brown, 1827, Ill. Conch. Gr. Brit. & Ire., explanation of pl. 41, for *T. terrestre* Brown = *Helix elegans* Gmel.—Pilsbry, 1922, Proc. Malac. Soc. Lond., 15: 39, footnote 3.—Hesse, 1934, Zoologica, 33, Heft 85, p. 12.

*Turricula* Beek, 1837, Ind. Moll., p. 10; not of Schumacker, 1817.

*Trochula* Schlüter, 1828, Kurz. syst. Verzeichn., p. 7. Type *H. elegans* Gmel.

*Xeroclivia* Monterosato, 1892, Att. Accad. Palermo, (3), 2: 25 ("esempio *H. pyramidata*").—Kennard & Woodward 1926, Syn. Brit. Non-Mar. Moll., p. 223, type *H. elegans*.

Rather small, narrowly umbilicate, opaque, earthy shells, trochiform and acutely keeled.

(*Trochoidea*, like the marine genus *Trochus*.)

**Helicella elegans** (Gmelin)

Figure 11.

*Helix elegans* Gmelin, 1791, Syst. Nat., Ed. XIII, p. 3642.

*Helix terrestris* Chemnitz, Mazyck, 1876, Proc. Acad. Nat. Sci. Phila., 28: 127, fig. (teeth); 1913, Contrib. Charleston Mus., 2: 6.

*Turricula terrestris* Chemn., W. G. Binney, 1878, Terr. Moll. 5: 349, figs. 282, 283, pl. xv, f. m (teeth).

*Xeroclivia elegans* (Gmel.), Kennard and Woodward, 1926, Syn. Brit. Non-Mar. Moll., p. 223.

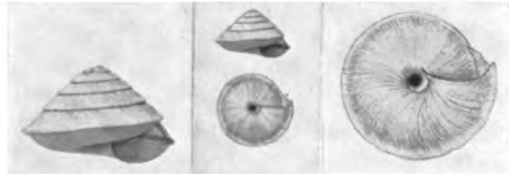


Fig. 11. *Helicella elegans*, Charleston, S. C. (Actual size and  $\times 2$ .)

The umbilicate shell has a conic spire, a strongly pinched out peripheral keel which projects above the suture, and a feebly convex base. Cartridge-buff to light buff with a few olive-buff streaks and dots. First  $1\frac{1}{2}$  whorls smooth, glossy, the rest matt, closely and finely striate. The small aperture is trapezoidal; the peristome thin and sharp, channeled at end of the keel.

Height 6 mm., diameter 9.6 mm.;  $6\frac{1}{2}$  whorls.

*Distribution*.—Mediterranean coasts of France and Spain; Balearic Is.; Morocco to Tunis.

**SOUTH CAROLINA:** introduced in Charleston (Logan St.; St. Peter's churchyard).

The Charleston form is rather small, moderately elevated, and never banded. It was first noticed in 1875, by Wm. G. Mazyck, who collected the specimens figured. Clench, Rehder and Archer found it abundant in 1931. W. G. Binney's woodcut of the teeth is reprinted in Figure 8a.

**COCHLICELLA** Férussac

*Cochlicella* Férussac, 1820, Tabl. Syst. Fam. Limac., p. 52.—Gray, 1847, Proc. Zool. Soc. Lond., p. 173, no. 461, type *H. conoidea* (*Helix conoidea* Drap.)

The perforate or narrowly umbilicate shell is small, conic, higher than wide, of about 6 whorls; varying from opaque white with brown bands or



flecks, to largely "corneous" with opaque white streaks. Aperture small, the lip thin and simple, reflected at the columellar margin.

The anatomy of the genotype of *Cochlicella* stands in need of further investigation, for which material is not at hand. It appears to be quite similar to *Helicella* in most respects.

According to Hesse, in *C. ventrosa* "there is a fusiform appendicula 1.5 to 2 mm. long, on the atrium opposite the penis, which on its thickened posterior end bears a number of thin, simple or forked blind tubes (mucous glands?); I count 4-6 branches. The moderately long boot-shaped bursa is similar to that of *C. acuta* in shape. Penis fusiform, the retractor inserted at its forward end. It runs out in a little acute flagellum".

It remains to be seen whether *C. ventrosa* stands nearer to *C. conoidea* Drap. than to *acuta* Müll., as with present information it appears to differ somewhat from both.

"*Cochlicella*" *acuta* Müll. (*Helix barbara* L. of many authors) has been carefully described by several anatomists.<sup>1</sup> It is clearly distinct from *Cochlicella ventrosa* generically, and should be called *Longaeva acuta* (Müll.).<sup>2</sup> The penis has a peculiar calcareous collar, a long epiphallus and a very short flagellum. Dart sac and mucous glands are lacking, but the former is thought by Overton to be represented by a long hollow organ ("vesicule vermiforme" of Rzymowska) seated upon the atrium. This may be comparable to the similar organ on the vagina of *Monacha*, which is considered a modified dart sac.

(*Cochlicella*, diminutive of *κοχλίας*, snail shell.)

***Cochlicella ventrosa* (Férussac)**

Figure 12 a-c.

*Bulimus ventricosus* Draparnaud, 1805, Hist. Nat. Moll. France, p. 78, pl. 4, figs. 31, 32. Not *B. ventricosus* Bruguière, 1792.

*Helix ventrosus* Férussac, 1820, Tabl. Syst. Fam. Limaç., p. 52, based upon preceding reference, *inter alia* (La Syrie, l'Italie, l'Andalousie).

*Cochlicella ventricosa* Drap., Mazyck, 1897, Nautilus, 10: 105; 1913, Contrib. Charleston Mus., 2: 6.—Hesse, 1934, Zoologica, 33, Heft 85, p. 31, pl. 6, fig. 53a, b, (anatomy).—J. L. Baily, 1935, West Coast Shells, p. 301.

*Bulimus ventrosus* Fér., Stearns, 1900, Science (N. S.), 11: 657.

The shell is thin, perforate, high conic; pale brown, profusely streaked and flecked with opaque cartridge buff (sometimes lacking on the last whorl). Surface rather glossy, weakly striate, the striae stronger below the suture. Periphery and base convex. The aperture is rounded-oval, the lip thin, columellar lip reflected.

<sup>1</sup> W. Moss and F. Paulden, 1892, Trans. Manchester Micr. Soc., pp. 75-79.

H. Overton, 1903, Journ. Malac., 10: 126.

T. Rzymowska, 1914, Rev. Suisse Zool., 22: 277-319.

<sup>2</sup> *Longaeva turrata* Muhlfeld, Menke, 1828, Synops. Meth. Moll. p. 15; 2nd edit. 1830, p. 27, as synonym of "*Bulimus acutus* (*Helix acuta* Müll., Fér.)."

*Elisma fasciata* Leach in Turton, 1831, Man., p. 84, as synonym of *Bulimus fasciatus* = *Helix acuta* (Müll.), which many authorities have identified with the inadequately defined *Helix barbara* L.

Length 8.5 mm., diameter 5 mm.; 7 whorls. Charleston.  
 Length 7.8 mm., diameter 4.8 mm.;  $6\frac{1}{2}$  whorls. Sullivan's Island.  
 Length 9 mm., diameter 4.6 mm.;  $7\frac{1}{4}$  whorls. Oakland.

*Distribution.*—Mediterranean countries; introduced in Bermuda and the United States.

**SOUTH CAROLINA:** Moultrieville, Sullivan's Island (W. G. Mazyck, 1896). Gardens of Beaufain St. and 56 Montague St., Charleston (Mazyck).

**CALIFORNIA:** gardens in Oakland (H. Hemphill, 1899).

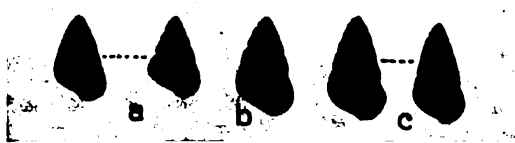


Fig. 12. *Cochlicella ventrosa*: a, Sullivan's I.; b, Charleston; c, Oakland, California. ( $\times 1\frac{1}{4}$ .)

All of the American specimens seen are of the streaked and speckled form, not banded. Those from Sullivan's Island often have no light markings on the last whorl, which is of the translucent brownish tint often called "corneous". Some of the Oakland shells are narrower than usual in the species, and all have nearly a whorl more than the South Carolina shells.

(*Ventrosus*, pot-bellied.)

### Family III. HELMINTHOGLYPTIDAE

The shell varies from globose to conic, depressed or lens-shaped, umbilicate or closed, generally banded. The peristome is not toothed, though there may be internal folds; the lip is usually expanded, sometimes reflected. In a few genera (*Xanthonyx*, *Metostracon*) the shell is more or less degenerate.

The penis usually contains a verge, and it is continued in an epiphallus and flagellum. There is a dart sac or sacs and one or two mucous glands, which are club-shaped, globular or irregular, opening at the base of the dart sac (but in the genera *Sonorella* and *Tryonigens* the dart apparatus is lacking). Spermatheca oval or oblong on a long duct (except in *Epiphragmophora*). Talon short, blunt, and buried in the albumen gland (except in *Averellia*).

The rather narrow kidney is between two and three times the length of the pericardium.

Free retractor muscles: The pharyngeal and left ocular bands are united posteriorly, the right ocular being free to the posterior insertion, and passing between penis and vagina.

The jaw is either ribbed or smooth. Central and inner lateral teeth generally without side cusps.

*Distribution.*—Pacific slope north to Sitka; Florida Keys; Mexico, Central America and the West Indies; Andes from Ecuador to western Argentina.

The American dart-bearing helices are here assembled in the family Helminthoglyptidae. They appear to be as widely deployed structurally as those of the Old World, though the genera and species are less numerous, and the distribution less general. About fourteen genera now recognized fall into no less than eight strongly differentiated groups here ranked as subfamilies, though they are partly more distinct than the Eurasian families. Four of these subfamilies occur in the United States, but all extend also beyond our limits southward. The South American subfamily Epiphragmophorinae is isolated both geographically and structurally.

In the Manual of Conchology, vol. IX, the American dart-bearing helices were associated closely with those of eastern Asia. Further studies indicate that the relationship is not intimate. While there cannot be much doubt that the *Belogona* had a Palaearctic origin, the migration to America seems to have preceded the differentiation of existing Palaearctic families.

In all of the subfamilies the penis is continued in an epiphallus and flagellum, and all of our genera except *Helminthoglypta* and *Micrarionta* possess a verge. The details of structure vary in the several genera. The dart is either simple or two-bladed. The tail is rounded above in all our subfamilies.

*History.*—These snails were first associated together by the author in 1895, with additions in later papers (Man. Conch., 9: 176-200, 1895; Proc. Malac. Soc. Lond., 4: 24, 1900; Proc. Acad. Nat. Sci. Phila., 79: 166, 1927, and others). Thiele (1931) gave the name Epiphragmophorinae to this assemblage of genera, adding two genera now placed in other families; but as *Epiphragmophora* Doering is an aberrant genus by its very short spermathecal duct, it seems better to restrict that subfamily name to that genus, and use a different name for the family.<sup>1</sup> The family name is not based upon that of the senior genus, *Cepolis*, because there is a family Cepolidae in fishes, based upon the genus *Cepola*.

The four subfamilies represented in America north of Mexico are distinguished as follows:

**CEPOLIINAE:** Dart sac seated on an extension of the atrium. Mucous gland globose, its short duct inserted near apex of the dart sac, the whole enclosed in a thin envelope which bears a two-parted ductless gland at its base. Spermathecal duct moderately long, without a branch.

**HELMINTHOGLYPTINAE:** Dart sac seated on an extension of the atrium. Mucous gland single, club-shaped, or of two irregular branches opening by a single duct, or divided into two glands opening by separate ducts at base of the dart sac. Spermathecal duct long, sometimes with a branch (diverticulum).

**SONORELLINAE:** Epiphallus long but flagellum very short. No dart apparatus. Spermatheca on a long duct without branch. Talon short, concealed.

<sup>1</sup> Thiele's "genus" *Epiphragmophora* comprises, in my opinion, four genera of two subfamilies.

**HUMBOLDTIANINAE:** Four dart sacs inserted at one level around the vagina. Four mucous glands concrescent in a ring adnate on the vagina, their ducts incorporated into its walls. Tail not keeled or serrate above. Spermatheca on a long duct having a branch.

Or, by the shells alone, our members of these subfamilies can be roughly characterized thus:

Shell globose-conic, rather solid, the outer lip not expanded, columella pink. (Florida).  
**CEPOLIINAE**  
 Shell globose to depressed or lens-shaped, usually with a band above the periphery; outer lip simple or expanded. (West Coast) .....**HELMINTHOGLYPTINAE**  
 Shell depressed, umbilicate, light colored with a band above the periphery; lip expanded. (*Sonorella* is not distinguishable from *Eremarionta*, of the preceding subfamily, by the shell alone). (Arizona, New Mexico) .....**SONORELLINAE**  
 Shell large, subglobose, of few (4) whorls; three-banded; the lip thin, not expanded. (Western Texas) .....**HUMBOLDTIANINAE**

#### Subfamily CEPOLIINAE

Except for the single species of the Florida Keys, this subfamily is confined to the Greater Antilles and Bahamas. Of the two genera, *Cepolis* occurs over all of this area, *Polymita* only in eastern Cuba.

#### **CEPOLIS** Denys de Montfort

*Cepolis* Denys de Montfort, 1810, Conchyl. Systém., 2: 150 (*Cepolum* on p. 151).—Pilsbry, Man. Conch., 9: 177.

The helicoid shell is narrowly umbilicate or closed, of globose-conic to depressed shape, the embryonic shell smooth, the later whorls either smoothish, rib-striate or spirally malleate, varying from unicolored to conspicuously streaked or banded, the bands irregularly disposed. Peristome expanded or simple and sharp, reflexed at columella, which is generally thickened with an oblique callus, sometimes a tooth; lip otherwise toothless but occasionally there is a callous fold within the mouth.

Genitalia (Fig. 13, *C. varians*, Key Biscayne). The atrium is large and extended in a sac bearing the dart sac. Penis slender, containing a verge; the long epiphallus bears the penial retractor muscle; flagellum long. The vagina is short. The spermatheca has a long unbranched duct. The dart sac, upon a long atrial sac, contains a needle-shaped, hollow dart, with expanded and coronate base, and is surmounted by a globular mucous gland with thick, muscular walls, plicate internally and lined with long follicles. It communicates with the summit of the dart sac through a short duct inserted at one side of the summit. The globular mucous gland, dart sac and atrial sac are enveloped in a voluminous diaphanous membrane, at the anterior edge of which there is a gland consisting of two long, flat lobes united basally. This gland appears to be ductless, excreting apparently into the membranous sheath of the dart apparatus.<sup>1</sup> This membranous envelope of the dart apparatus arises from the apex of dart sac, and is

<sup>1</sup> In 1895 (Man. Conch., 9: 177) I stated that the two-lobed mucous gland was inserted at base of the dart sac; this was apparently accepted by Wiegmann who dissected *C. (Coryda) dennisoni*, (Nachrbl. deutsch. Malak. Ges., 33: 15). It was a natural inference, but was based upon incomplete observations.

connected above with a cord of connective tissue running up the columellar border of the coiled uterus.<sup>1</sup>

The right ocular retractor lies in the penioviducal crotch.

The jaw (of *C. varians*, Fig. 13 E) is rather strongly arcuate with a low median projection on the lower margin, its face smooth save for some slight wrinkles parallel with the margin. Under the microscope with transmitted light a very close vertical striation appears in its texture, but I believe that this does not roughen the surface.

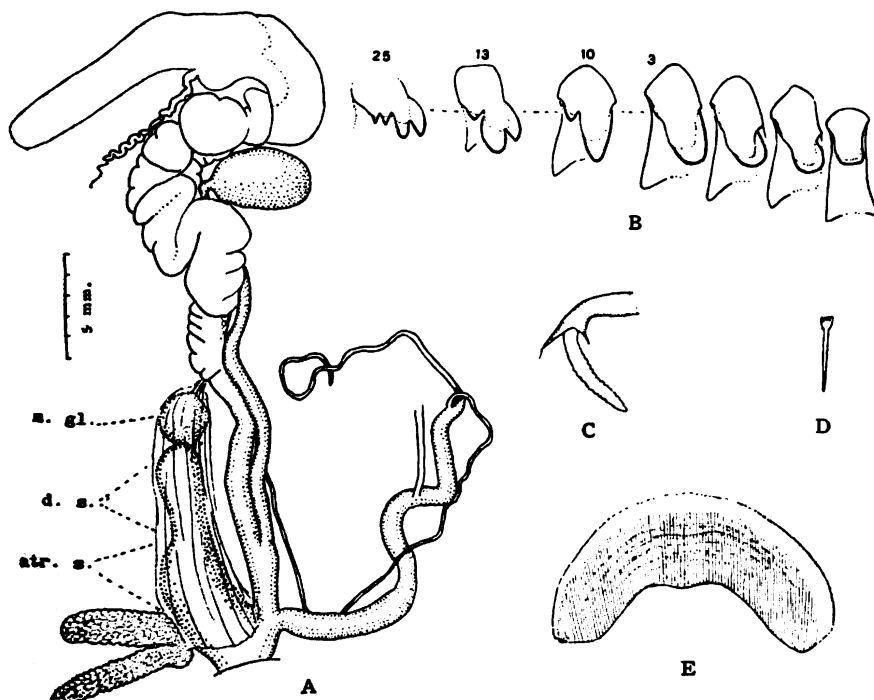


Fig. 13. *Cepolis varians*: A, genitalia. B, teeth. C, verge. D, dart. E, jaw. Atr. s., atrial sac; d. s., dart sac; m. gl., mucous gland.

The radula (*C. varians*, Fig. 13 B) has 33.133 teeth. Central tooth with long, rather narrow basal-plate about double the length of the cusp, which is short and blunt, without ectocones. Lateral teeth are also rather narrow, but the cusps longer, their cutting edges quite blunt or rounded; no ectocones, though some show a very narrow overhanging edge in place of it. The ectocone appears weakly about the eighth tooth, and is well developed on the tenth. The marginals have strongly developed endocone and ectocone, the latter becoming bifid further out. The basal-plates are short. Several outermost marginals are irregular with imperfect cusps.

<sup>1</sup> Dr. Von Ihering (1929, *Die Nephropneusten*, pp. 68-70) interpreted this "string of connective tissue" (Pilsbry, 1895, *Man. Conch.*, 9: 177) as a "ductus receptaculo-uterinus," the vestige of a primitive triaul genital system. Wiegmann called it "ein Bindegewebsband". As Von Ihering's knowledge of the genus was solely from the publications of Wiegmann, 1901, and myself, 1895, it is evident that this "duct" is one of the flights of fancy which enliven his essays.

TYPE: *C. nicolsinianum* Montf. = *C. cepa nicolsiniana*; Haiti.

*Distribution*.—Greater Antilles, Bahamas and southern Florida. There are eight subgenera of *Cepolis* and about ninety species, of which one occurs in our limits, probably drifted or hurricane-carried from the Bahamas. The genus comprises both terrestrial and arboreal species, the former brown, with or without one or two bands, the plant-living forms opaque, white or light colored, usually with numerous bands, dots or streaks.

*Cepolis* is closely related to *Polymita*, which occurs only in eastern Cuba, and is distinguished chiefly by its specialized dentition. These two genera are the only belogonous helices of the West Indies. They stand isolated in the series by the unique dart apparatus, the mucous gland duct entering at one side of the apex of the dart sac, while in all other genera the duct or ducts enter at its base. The membranous extension of the mucous gland is analogous to that of *Helminthoglypta*, but that genus has nothing like the two-lobed gland which is appended to the base of the membranous envelope in *Cepolis*.

*Cepolis* was represented in the Lower Miocene of western Florida (Tampa Silex bed) by several species of the subgenus *Plagioptycha*, allied to species still existing in the Bahamas and Haiti. *Cepolis latebrosa* (Dall), *C. instrumosa* (Dall), *C. direpta* (Dall), *C. crusta* (Dall), *C. cunctator* (Dall). All were described as *Helix*. See Dall, 1890, Trans. Wagner Inst., 3: 8-11; 1915, Bull. 90, U. S. Nat. Mus., pp. 22-24.

(De Montfort gave no etymology for *Cepolis*. Herrmannsen suggested the Latin *cepa*, an onion; but Montfort did not mention that vegetable, though he said that the color is that of an apricot.)

#### Subgenus HEMITROCHUS Swainson

*Hemitrochus* Swainson, 1840, Treat. Malac., pp. 165, 330, for *H. hoemastoma* Sw. = *varians* Mke.

*Polytaenia* Von Martens, 1860, Die Heliceen, p. 129, for *Helix multifasciata* W. & M.

The globose-conic or globose-depressed shell is rather solid, opaque, usually variegated with bands, streaks or dots on a white ground; umbilicus narrow or closed. Aperture without internal prominences, the lip simple or expanded, thickened within, reflected at the columellar insertion.

A group of the Bahamas and southern Florida, with a related series in Cuba. *C. varians* lives on low herbage not far from the shore. Our specimens do not seem separable from those found widely spread throughout the western Bahamas; and it was apparently drifted or hurricane carried to Florida from there.

(*Hemitrochus*, half a *Trochus*; a hybrid Greek and Latin word.)

#### *Cepolis varians* (Menke)

Figure 14 a-f.

*Helix varians* Menke, 1829, Verzeichn. ansehn. Conchylien-Samml. Freiherrn Malsburg, p. 5.—Pfeiffer, 1848, Monogr. Hel. Viv., 1: 238; Conchylien Cabinet 2: 221, pl. 99, figs. 1-5.—Binney & Bland, 1869, L. & Fr. W. Sh. N. A., 1: 184, figs. 324, 325.

*Helix carnicolor* Férussac, 1821, Tabl. Syst. Fam. Limaç., p. 45, no. 293.<sup>1</sup>—Pfeiffer, 1841, Symbol. Hist. Helic., 1: 37.—Deshayes, 1850, in Férussac, Hist. Nat. Moll., 1: 205, pl. 29 A, figs. 14-17.—Reeve, 1851, Conch. Icon. Helix, pl. 58, fig. 283.

*Hemitrochus hoemastomus* Swainson, 1840, Treat. Malac., p. 331, fig. 19 (p. 165).

*Helix submeris* Mighels, 1844, Proc. Boston Soc. Nat. Hist., 1: 187, (Key West).

*Helix polychroa* A. Binney, 1851, Terr. Moll., 2: 123, pls. 46, 47 (Cape Florida, Key Biscayne, Bartlett).

*Helix rhodocheila* A. Binney, 1851, Terr. Moll., 1: 109, 119, 128, 153 (not described).

The rather solid shell is obliquely perforate, globosely conic, white, typically with a carob-brown band above the periphery and two lighter, somewhat spotted bands, one in the middle of the upper surface, the other midway on the base; but variously banded and streaked forms are also common. Embryonic whorls usually rose colored, smooth. Later whorls smoothish, with low, uneven growth lines. The last whorl descends in front and is broadly rounded at periphery. Aperture oblique, the peristome sharp, thickened within, marked by the bands, the columellar margin sloping, and with the parietal callus of an old rose color.

Height 16 mm., diameter 15.5 mm.;  $5\frac{1}{2}$  whorls. Key Biscayne.

Height 18.5 mm., diameter 16.2 mm.;  $5\frac{3}{4}$  whorls. Key Biscayne.

Height 12.2 mm., diameter 14 mm.; 3 whorls. Key Biscayne.

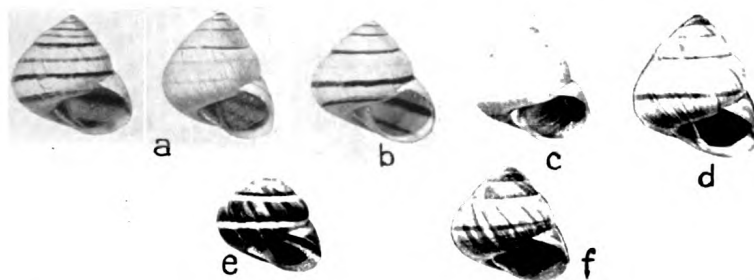


Fig. 14. *Cepolis varians*: a, c, Biscayne Key; b, Miami Beach; d, Lower Matecumbe, and f, Upper Matecumbe Key.

FLORIDA: Peninsula opposite Miami, Virginia and Biscayne Keys, Matecumbe Keys.

BAHAMAS: South Bimini Key, Abaco, Berry Islands, Andros, New Providence, Eleuthera, Highborn and Exuma Keys to Great Exuma, Rum Key.

Menke's description<sup>2</sup> is inadequate, though accurate as far as it goes; and as the name *variens* was accepted by his friend and co-worker, Dr. Louis Pfeiffer, its identity with our species need not be questioned. As the present location of the Freiherr von Malsburg's type lot is unknown, I am

<sup>1</sup> Férussac did not define his species but cited figures in Chemnitz with a "?". It was first defined by Pfeiffer in 1841.

<sup>2</sup> "Testa subgloboso-conoidea, subperforate, fasciata, columella rosea". There are no dimensions, no figure and no locality. Menke described a var. *b*, which is possibly some other species.

selecting Nassau, New Providence as the type locality, and A.N.S.P 44475a as neotype. *H. carnicolor* and *H. hoemastomus* were based upon practically the same form and therefore are absolute synonyms. New Providence may be taken as type locality of all. *H. submeris* from Key West was a specimen like my Figure 14 e, but with a white umbilical area. *H. rhodocheila* = *polychroa* are Key Biscayne shells, defined to cover banded, streaked and white forms.

The description and measurements above apply to Florida shells. It varies a good deal in elevation of the spire. Some Bahaman shells are larger and more elevated than any seen from Florida.

At the northern colony, on the ocean beach of the peninsula opposite Miami, the shells are (1) three-banded, the middle band nearly black, the others usually lighter or dotted, or (2) lacking the upper band, or (3) streaked with chestnut, which forms spots where the streaks intersect the two weak bands.

On Virginia Key and Key Biscayne, 3-banded (this, Fig. 14 a, left, being the usual Florida pattern), with two-banded and rose-tipped white shells (as in Figs. 14 a, b, c), predominate. Formerly the chestnut streaked forms occurred, if Binney's figures were all from Biscayne shells. A pure colony of white shells with minutely pink-tipped spire (Fig. 14 e) was found by Tom McGinty at the northeast end of Biscayne Key. On Upper and Lower Matecumbe Keys nearly all of the shells seen are copiously streaked with chestnut, with a central dark band, the basal band and less frequently the upper band being only weakly visible or often wanting (Fig. 14 d, f). The streaked form with peripheral white band (Fig. 14 e), is said to occur on Key West, but those I possess are not definitely localized. In a Florida lot from A. Binney there are also streaked shells, with dark followed by white at periphery, and also similar to Figure 14 e except that the streaks are conrescent into nearly uniform chestnut-brown to black, the peripheral band white.

If Latin terms are needed for the color-mutations of *C. varians* the following can be used: form *variens*, Figure 14 a, left, also a right and b; form *rosalba*, Figure 14 c; form *virgata*, Figures 14, d, f; form *submeris* (Mighels), Figure e, typically with white umbilical area also, as in *Terrestrial Mollusks*, 3, pl. 46, fig. 3. These terms should not be used as trinomials, as I do not consider that they stand for subspecies.

In the Bahamas many other color-patterns occur, but three-banded shells, similar to Fig. 14 a, left, often with stronger bands, are perhaps the most generally spread pattern.

The genitalia of a Key Biscayne example are drawn in Figure 13 a. The atrium has thick walls which are irregularly folded inside. The penis and epiphallus are thin-walled. Length of penis 9 mm., verge 5 mm., epiphallus 12 mm., flagellum 13 mm.

(*Variens*, variable.)



## Subfamily HELMINTHOGLYPTINAE

This subfamily is confined to the Pacific States, from southern Alaska to Lower California.

The shell usually has a dark band above the periphery, bordered by pale bands. Some of the xerophilous species become many-banded and variegated. There are several patterns of apical sculpture.

*History.*—W. G. Binney, following Von Martens, classified most of the species of this subfamily in the genus *Arionta*, a few in *Aglaja* and *Euparypha*. Carl Semper, about 1885,<sup>1</sup> in a review of Binney's anatomic work, expressed his belief that the American should be separated from the European *Ariontae*, pointing out the differences. In 1895, when I adopted the name *Epiphragmophora* Doering for the dart-bearing helices of western North America, I had not seen the original publication, my knowledge of the anatomy of the genus being from the Zoological Record. Subsequently, when Doering's description and figures became available, the error of considering the Argentine and Californian helices congeneric was apparent. They are not closely related, though some of the shells are quite similar. Von Ihering's contention (1892 to 1929) that the North and South American helices of this form belong to the *Arianta-Campylaea* (*Helicigona*) group (*Helicigoninae*), opposed by me in 1895, has been refuted, so far as *Epiphragmophora* is concerned, by Hesse (*Arch. Molluskenk.* 62: 137. 1930).

The three genera of Helminthoglyptinae are characterized thus:

1. Dart sac inserted on the atrium, bearing a single club-shaped mucous gland; penis proper very short, containing a short verge; spermathecal duct without a branch.  
*Monadenia*
- Two mucous glands; penis of moderate length ..... 2
2. Dart sac upon a long extension of the atrium; two oblong mucous glands uniting to a single duct opening at base of dart sac, their distal ends extended in ducts terminating in spreading membranes; spermathecal duct bearing a branch or diverticulum ..... *Helminthoglypta*
- Dart sac seated on the vagina; two mucous glands varying in form, their separate ducts inserted in the crotch between dart sac and vagina; spermathecal duct sometimes branched ..... *Micrarionta*

## MONADENIA Pilsbry

*Aglaja*, in part, Von Martens, 1860, *Die Heliceen*, p. 122.—Binney, 1869, *L. & Fr. W. Sh. N. A.*, 1: 161; 1878, *Terr. Moll.*, 5, in *Bull. Mus. Comp. Zoöl.*, 4: 350.

*Aglaja* Binney, 1890, *Bull. Mus. Comp. Zoöl.*, 19: 213. Not *Aglaja* Albers, 1850, nor of Renier, 1804.

*Monadenia* Pilsbry, 1895, *Man. Conch.*, 9: 198, type *Helix fidelis* Gray.

Helices of moderate or large size, the shell umbilicate with depressed last whorl and low or conic spire, the periphery often angular in the neanic stage, rounded to carinate in adults; usually having a dark band above the periphery with pale borders above and below. Peristome slightly or not

<sup>1</sup> *Reisen im Archipel der Philippinen*, 3: 245.

expanded above, the basal margin narrowly reflected. Embryonic shell of about  $1\frac{1}{2}$  whorls densely granulose, irregularly, or in oblique trends.

Penis very short and stout, containing a short, fleshy verge; epiphallus and flagellum rather thick, with large cavity. Penial retractor inserted at the middle of epiphallus. Atrium capacious. There is a single long mucous gland, its duct inserted at base of the dart sac, which is seated on the lengthened atrium, and contains a two-bladed dart. Vagina extremely short. Spermatheca duct long, not branched.

Jaw solid, strongly arched, with five to ten strong ribs. Radula without side cusps on central and lateral teeth; marginals with bifid inner cusp and usually simple outer.

TYPE: *Monadenia fidelis* (Gray).

*Distribution.*—Sitka, Alaska, to the San Francisco Bay counties (Alameda County), and inland from Shasta County south to Mariposa County, California. These handsome snails often occur in abundance in Washington, Oregon and northern California, but are more local southward. In the Sierra Nevada counties they occur only on limestone according to J. G. Cooper; the discontinuity of suitable terrains appears to have led to the formation of local races.

The species are highly variable, and the number of local races which can be recognized by name with advantage to science is uncertain; opinions of those most competent to judge are at variance. The chain of forms is nearly complete from *fidelis* to *infumata*, and from *mormonum* to *hillebrandi*; but there seem to be minor interruptions permitting the definition of species and sub-species. Further exploration will probably efface some of the distinctions which have been drawn, but it will also bring new races to light. I have not had the advantage of field experience with snails of this genus.

The shells are not very unlike those of *Helminthoglypta*, though there are certain differences, such as the tendency to peripheral angulation in the neanic stage, and the even granulation of the embryonic shell, without superposed papillae such as occur in *Helminthoglypta*; but the structure of the penis and of the single mucous gland, and the unbranched spermathecal duct, are important differences. No closely related genera are known. The Philippine *Tricheulota* and *Helicostyla* are somewhat similar in dart apparatus, at least superficially.

*History.*—*Aglaja* Albers, 1850, was proposed for *Helix ghiesbreghti* Nyst only. This Mexican species is not congeneric with *M. fidelis*. The group (as *Aglaja*) was enlarged by von Martens in 1860, several South American snails and *H. fidelis* being added, and *Helix audouiniana* Orb. was designated type,—an unlawful procedure. Binney used *Aglaja* for the species *fidelis*, *infumata* and *hillebrandi*. In 1895 (Man. Conch., 9: 198) *Monadenia* was substituted for Binney's *Aglaja*, the group was anatomically characterized, and *H. mormonum* transferred to it.

*Anatomy.*—W. G. Binney figured the genitalia of *M. fidelis*, *M. infumata* and *M. mormonum*. His figures and descriptions are unsatisfactory, and he did not recognize that *mormonum* was congeneric with the other species. In the Manual of Conchology, 9, pl. 59, I figured genitalia of *fidelis* and *mormonum*. Hanna has given a figure of the genitalia of *M. churchi*. The general proportions vary in the several species dissected, which fall into two little groups distinguished thus:

1. Mucous gland many times longer than the dart sac; atrium rather short and wide; flagellum about as long as penis plus epiphallus. *M. fidelis*, *M. f. subcarinata*, *M. infumata*.

2. Mucous gland not greatly longer than the dart sac; atrium long and rather narrow; flagellum decidedly longer than penis plus epiphallus. *M. mormonum*, *M. churchi*,<sup>1</sup> *M. hillebrandi*.

This grouping is in harmony with the characters of the shells and the distribution, species of the first group being more northern and towards the coast, while the second group comprises forms of the interior west of the Sierra Nevada, and as a whole further south, though the groups overlap in latitude. The subspecies of *M. fidelis* and of *M. mormonum*, and the elusive *M. circumcarinata*, remain to be dissected. The last should belong to the second group.

The internal structure of the penis and its appendages is shown in Figs. 15: b, 2b, 3b, 4b, 6b. The fleshy pilaster of the unusually large cavity of the flagellum (Fig. 15: 2b) terminates where the vas deferens enters (Fig. 15: 1b, showing short portions of flagellum, left, and epiphallus, right, laid open). A similar ridge reappears in the epiphallus (Fig. 15: 3b). The longitudinal section of the penis (Fig. 15: 5b) shows its structure sufficiently. In *M. fidelis subcarinata* the thick walls of the verge taper to thin edges around the wide opening. The section drawn in Figure 15: 6b is from near the end of the verge. The dart sac is oblong, on a broad extension of the atrium. The spermathecal duct is not branched in any of the species dissected. It is 21 mm. long in *M. hillebrandi*. I found no penial retractor muscle in this species. Measurements in mm. follow:

	Penis	Epiphallus	Flagellum	Vagina	Mucous gland
<i>M. fidelis subcarinata</i> .....	5	7	10	3	21
<i>M. hillebrandi</i> .....	2	6	25	..	7

The jaw (Fig. 15: d, *M. fidelis*, Nesqually, Wash.) is strong, with high, unequal ribs strongly denticulating the margins. In the specimen figured there are eight larger and several narrow ribs. W. G. Binney found six ribs in *fidelis*, seven to nine in *infumata*.

The radula (Fig. 15: e, *M. fidelis*, Nesqually) has 51.150 teeth. Centrals are rather long, with the mesocone nearly as long as basal plate. Laterals wider; both central and lateral teeth lacking ectocones, being unicuspid. On

<sup>1</sup>The figure of *M. churchi* does not show the short, stout penis found in other species, but I think it was overlooked. It was not shown in my figure of *mormonum* (1895), also by an oversight, as I find it on renewed examination of that species.

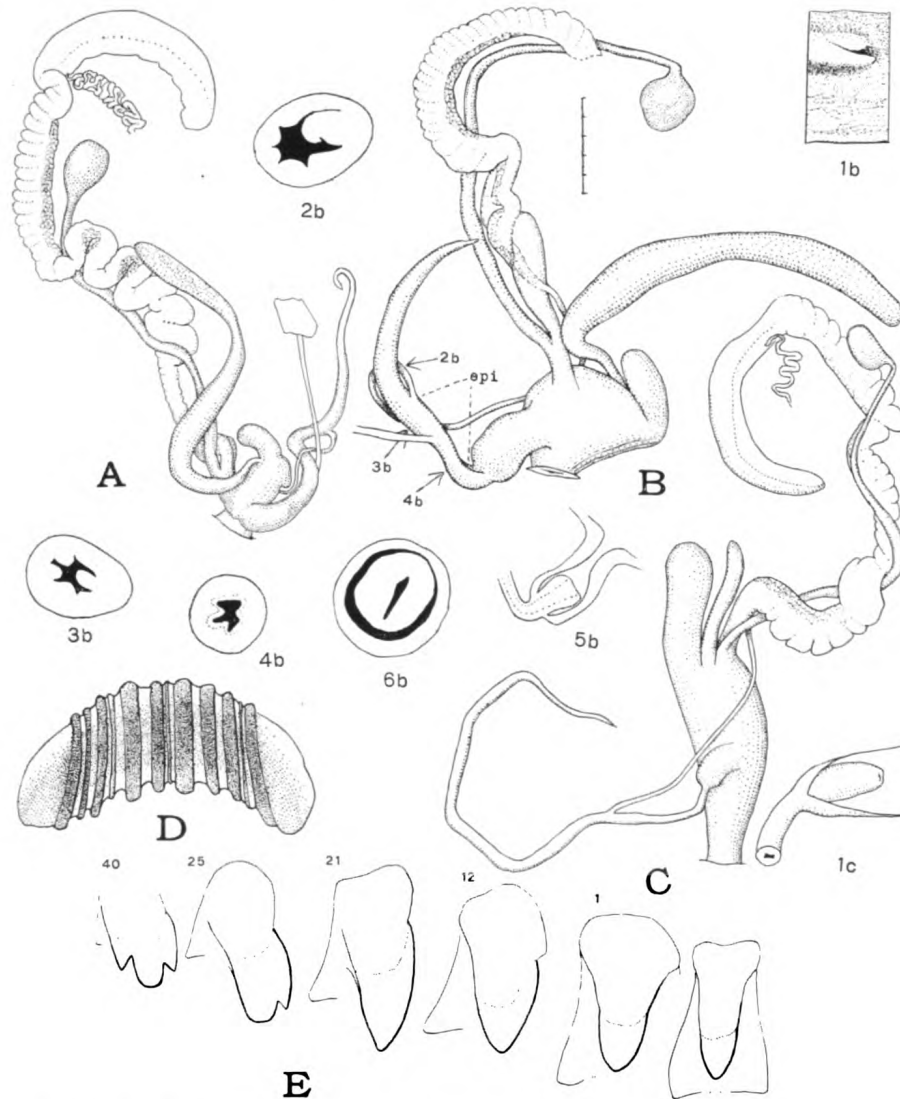


Fig. 15. A, *Monadenia fidelis*, genitalia. B, *M. fidelis subcarinata*, 6 miles above Carlotta, Cal.: 1b, epiphallus at entrance of the vas deferens; 2b, transverse section near lower end of flagellum; 3b, 4b, sections of the epiphallus; 5b, longitudinal section of penis (diagrammatic); 6b, transverse section of penis and verge; epi, epiphallus. c, *M. hillebrandi*, Alder Creek, Mariposa Co., Cal.: 1c, penis opened showing the verge. D, jaw of *M. fidelis*, Nesqually, Washington. E, teeth of same. (Scale line = 5 mm.)

the marginals the long cusp is split into endocone and mesocone. Further out an ectocone appears. The outer marginals are very short with variable cuspidation, the endocone and ectocone sometimes twinned.

*Paleontology*.—*Monadenia* is known from the John Day Lower Miocene of Oregon in two species of the *M. fidelis* type, and another thought to be related to *M. mormonum*.

MONADENIA (?) MARGINICOLA (Conrad). *Helix (Zonites) marginicola* Conrad, 1871, Amer. Journ. Conch., 6: 315, pl. 13, fig. 9, Bridge Creek, John Day Basin, Oregon. Hanna (Univ. Oregon Pub., 1, no. 6, p. 3, 1920) believes that "it will be found to be related to the *mormonum* group."

MONADENIA ANTECEDENS (Stearns). *Epiphragmophora fidelis antecedens* Stearns, 1900, Proc. Wash. Acad. Sci., 2: 653, pl. 35, figs. 1-3. North fork John Day River, at angle of the big bend, John Day Basin, Oregon.

MONADENIA DUBIOSA (Stearns). *Helix (Epiphragmophora ?) dubiosa* Stearns, 1902, Science, (N. S.), 15: 153; 1906, Univ. Cal. Publ., Bull. Dept. Geol., 5: 68, figs. 3, 4 (as "*dubosia*"; corrected on p. 69). John Day Valley, Oregon.

(Μόνος, single, ἀδῆν, gland.)

**Monadenia fidelis** (Gray)

Figure 16 a, b, c, i.

*Helix fidelis* Gray, (Oct. 25), Proc. Zool. Soc., p. 67 (no locality).—Newcomb, 1865, Amer. Journ. Conch., 1: 342, 350.—Binney & Bland, 1869, L. & Fr. W. Sh. N. A., 1: 161, fig. 278.—Cooper, 1868, Amer. Journ. Conch., 4: 229-239.

*Helix nuttalliana* Lea, 1839, Trans. Amer. Phil. Soc., 6: 88, pl. 23, fig. 74 (Fort Vancouver to the Ocean).—A. Binney, 1851, Terr. Moll., 2: 159, pl. 18.

*Helix oregonensis* Lea, 1839, Trans. Amer. Phil. Soc., 6: 100, pl. 23, fig. 85 (Wahlamat near junction with Columbia R.). Not Lea, 1866, Journ. Acad. Nat. Sci. Phila., (2), 6: 155 (Point Cypress, Cal.). Cf. Edson, 1912, Nautilus, 26: 49; Hanna, 1922, Nautilus, 36: 12; and Henderson, 1936, Univ. Colo. Studies, 22: 253.

*Aglaja fidelis* Gray, Binney, 1878, Terr. Moll., 5: 350, pl. 18; pl. IX, fig. c, and XIV, fig. e (anatomy); 1885, Man. Amer. L. Sh. p. 121, fig. 90.

*Epiphragmophora fidelis* Gray, Pilsbry, 1895, Man. Conch., 9: 198, pl. 59, fig. 81, (genitalia).—Randolph, 1899, Nautilus, 13: 25 (variation at Seattle).—Gifford, 1901, Nautilus, 14: 144.—Whiteaves, 1902, Ottawa Nat., 16: 92.—Dall, 1905, Harriman Alaska Exp., 13: 21.—Edson, 1912, Nautilus, 25: 18.—Malone, 1918, Nautilus 31: 72 (albinistic).—Hanna, 1921, Nautilus, 35: 34 (supposed occurrence near San Francisco Bay).—Bowles, 1922, Nautilus, 36: 61 (said to eat bird's eggs).—Jackson, 1923, Nautilus, 36: 144 (in tree 35 ft. up, Blaine, Ore.).

*Monadenia fidelis* Gray, Berry, 1930, Nautilus, 43: 142 (San Juan I.).—Chace, 1935, Nautilus, 46: 142 (Endert's Beach).—Cockerell, 1935, Nautilus, 49: 35 (living animal, Prairie Creek, Cal.).

*Monadenia fidelis fidelis* (Gray), Henderson, 1929, Univ. Colo. Studies, 17: 71, fig. 28; 1936, Univ. Colo. Studies, 23: 253.

*Aglaja fidelis* var. *flavus* Hemphill, 1892, in Binney's 4th Suppl., Bull. Mus. Comp. Zool., 22: 185 (Chehalis and San Juan Is., Wash., and Port Orford, Ore.).

*Monadenia fidelis flava* (Hemph.), Henderson, 1929, Univ. Colo. Studies, 17: 73 (Elkton and Oswego, Ore.).

The shell is umbilicate, the umbilicus contained about ten times in the diameter, last whorl depressed, with rounded periphery, spire conoidal. Color ochraceous tawny above (varying to Naples yellow or lighter) with occasional wide dark growth-rest blotches or streaks, and a carob brown or darker band immediately above periphery and showing above the suture on 2 or 3 whorls of the spire; immediately below the periphery a Naples yellow or paler band, generally a little narrower than the dark band above it; base chestnut brown typically (but varying to darker or almost black in many localities); usually with one or more narrow pale radial streaks. The surface

is glossy, rather strongly, unevenly striate above, more weakly below, and marked with rather weak impressed spiral lines (sometimes very weak, and on the base subobsolete). Aperture with a white lining and dark bands; the outer lip narrowly expanded, narrowly reflected at base, dilated at the insertion, white or pale ochraceous-buff.

Height 20 mm., diameter 31 mm.;  $6\frac{1}{2}$  whorls. Vancouver, Wash.

Height 23 mm., diameter 32.5 mm.;  $6\frac{1}{2}$  whorls. Portland, Ore.

Height 23.5 mm., diameter 34 mm.;  $6\frac{3}{4}$  whorls. Portland, Ore.

Height 26.5 mm., diameter 38 mm.;  $6\frac{3}{4}$  whorls. Portland, Ore.

In young shells of  $2\frac{1}{2}$  whorls the initial  $1\frac{3}{4}$  whorls have, after the smooth tip, a close sculpture of granules which run somewhat into radial lineolation near the upper suture, and elsewhere are partly arranged in protractive and retractive trends; on the following half whorl there is a sparser granulation, in places formed into thin, protractive lines. This sculpture is lost by wear in adult shells.

ALASKA: Sitka, near the Hot Springs (Dall).

BRITISH COLUMBIA: Sumas Prairie, Fraser R. valley, to 6000 ft. (J. K. Lord); Chilliwak Lake; Growler Cove, Broughton Strait, Union Bay, Lasqueti I.; Malaspina Inlet; N. point Texada I. (Dall).

VANCOUVER ISLAND: south of Union and lower end Cameron Lake (C. M. Cooke); Esquimalt Harbor; Wallace I., off east coast (A. A. Olsson); Victoria, Nanaimo and Comox (Dall).

WASHINGTON: Whatcomb Co., Birch Bay. Island Co., San Juan I. Skagit Co., LaConner. Clallam Co., Port Angeles, Drier. King Co., Seattle. Pierce Co., Nesqually. Thurston Co., Olympia. Cowlitz Co., 8 mi. N. of Kelso. Clark Co., Vancouver. Pacific Co., Port Ellis, Holcomb.

OREGON: Clakamas Co., Oregon City. Columbia Co., above Mist, Veronica. Coos Co., Coos Bay, Marshfield, Bandon, Riverton, Empire. Curry Co., Agness, Port Orford. Douglas Co., Elkton, Umpqua, Roseburg, Glide and W. of Scottsburg. Josephine Co., Grave Creek. Jackson Co., Green Mt. Pass. Lane Co., Springfield, Eugene. Marion Co., Salem. Multnomah Co., Troutdale. Tillamook Co., Blaine. Washington Co., Portland.

CALIFORNIA: Siskiyou Co., Siskiyou Mountains (Brewer). Mt. Shasta, a small form (Binney & Bland). Delnorte Co., Ender's Beach, 5 miles from Crescent City, Smith River 9 miles east of Crescent City, Lighthouse Island, Crescent City, Requa (Chace). Humboldt Co., south of mouth Klamath R. (Chace); Cape Mendocino (Rowell).

This handsome snail was described by Gray,<sup>1</sup> without locality, from a rather small brown specimen, diameter about 33.5 mm. I have selected the vicinity of Vancouver, Washington, for type locality, as specimens agreeing well with Gray's account occur there and southward (Portland, Oregon). Fort Vancouver was made the main western depot of the Hudson's Bay Fur Company in 1824, and frequent shipments to London doubtless originated there.

<sup>1</sup> "*Helix fidelis*. Hel. testa depressiuscula, late perforata, pallide brunnea, profunde striata, periostraca tenui pallida induta; spira conica, convexa; anfractibus elevatiusculis, citissime majoribus, fascia suturali notatis, ultimo rotundato antice brunneo; apertura obliqua; peristomate albo, subreflexo; fauce postice alba, antice brunnea. Axis 11, diam. 15 lin. Var. spira paulo depressiore." (Gray.)

The same general type of shell extends southward in the Willamette valley. At Oregon City the color is a shade darker. The height of spire varies in all lots; in the Vancouver-Portland area I find the h/d index from 65 to 74; in Gray's type about 73, but he had a more depressed shell also. A very low shell from the Columbia River has h/d index of 58.5.

The names *Helix fidelis*, *H. nuttalliana* and *H. oregonensis* were all, I believe, applied to examples of the same race and from the same district. This is practically the conclusion reached by Hanna, 1922.

"The animal varies in color, and is about 78 mm. long when crawling. The more brightly colored ones are reddish, a dull 'old rose,' finely tuberculate all over, the intervals between the tubercles grey, producing a mottled effect, especially on anterior part of animal. Mantle grey; tentacles red, blackish at end; foot-fringe narrowly bright red; sole very pale grey. Dark specimens are blackish, very dark, the caudal end dark brown, but the foot-fringe still red. There is no trace of a dark, dorsal stripe, such as is found in the Japanese *Euhadra*; instead of this, some show distinctly a broad pale reddish dorsal stripe, on three rows of tubercles, the areas on each side of this blackish. Keep refers to the beauty of the animal, and the 'tinge of red in its complexion,' but Binney describes it as 'dull ocher, slaty towards the tail.'" (Cockerell.)

According to P. B. Randolph, a favorite place for depositing eggs is in the heavy bark of some old fir stump a foot or more from the ground. A few pass the winter in trees 20 feet or more from the ground. The broad leafed maple is a favorite retreat. It is often found on coniferous trees, which most snails avoid. The finding of this arboreal snail accidentally in a bird's nest led to the suspicion that they prey upon the eggs.

Small individuals of *fidelis* occur in many places. Randolph gave the diameter of Seattle shells as 27 to 38 mm. A specimen from Umpqua River Valley, Oregon, measures 26.3 mm. When such small shells occur in the company or neighborhood of larger forms, dwarfing by unfavorable local conditions of humidity or food seems probable. In some places, where all are small, as in the case of *minor* Binney, the possibility of racial status has to be considered. Information indispensable for an understanding of such forms could be obtained by transplanting to some region of large shells.

In several lots from Vancouver Island the diameter runs from 28.5 to 36 mm. Either brown or yellow may predominate on the upper surface, the base chestnut-brown or lighter. On Wallace Island, Olsson found shells with band and base black or almost black, upper surface varying as above, diam. from 30.5 to 36 mm., umbilicus typical; but the shape is often much depressed, height 19 diam. 35 mm., others being moderately elevated. In this lot are two albinistic shells, white under an ecru-olive periostracum, measuring 23.3 x 36.3 mm., 7½ whorls, and 19 x 30.6 mm., 6½ whorls. A "large but very pale var." was reported by Ingersoll from Sumass Prairie, Fraser River, B. C. Washington *fidelis* seen are mainly nearly typical. In

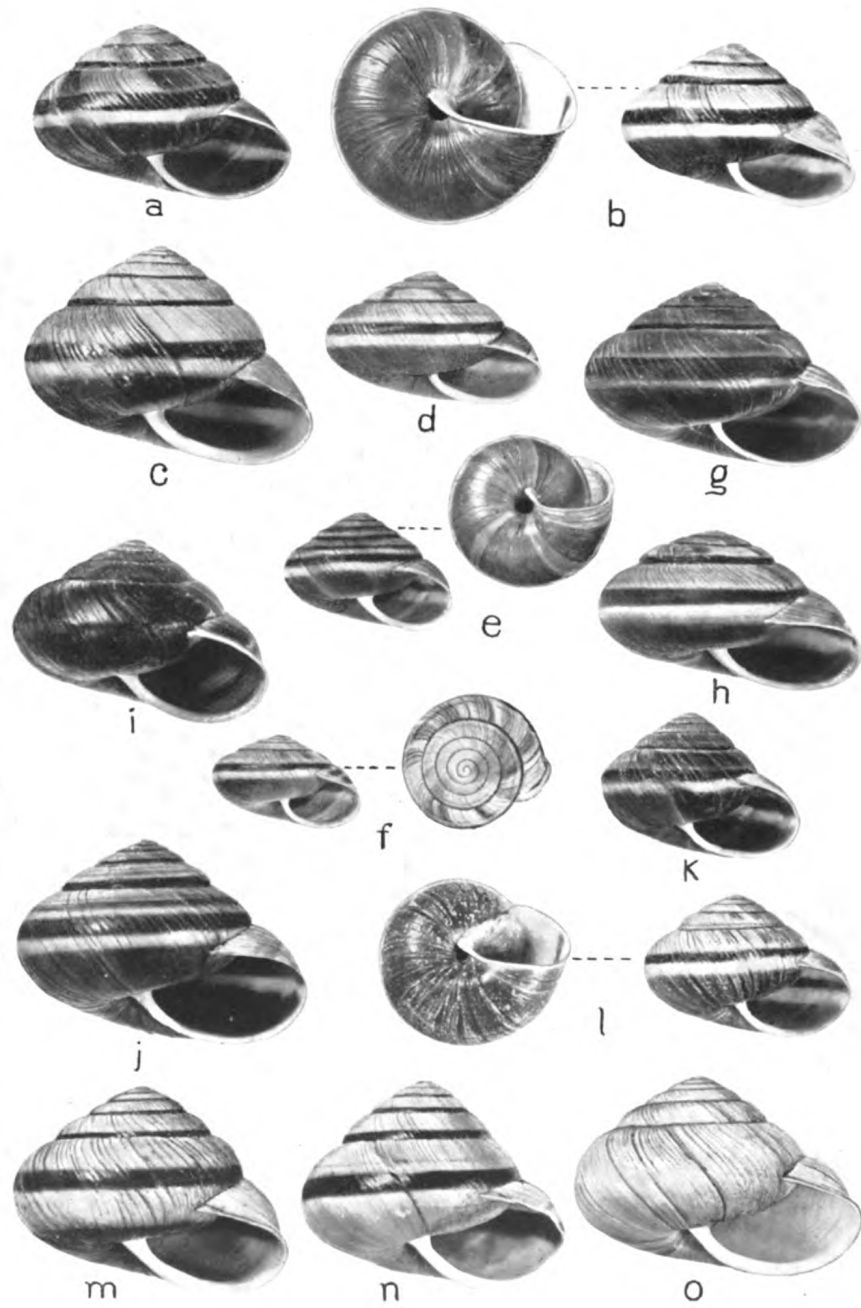


Fig. 16 (explanation at bottom of page 39).



some lots the streaks or maculae are lacking on the upper surface, which may be from chestnut to colonial buff, sometimes in the same lot. In one individual from bluffs north of Seattle the yellow band below periphery is double the width of the blackish band. The typical form from the Vancouver, Washington, district has been described above (Fig. 16 b). Quite similar shells were found at Point Ellice, at the Columbia mouth, and south in Oregon to Empire on the coast and Douglas County (Fig. 16 c) inland. The size and degree of elevation are variable. Thus in a lot from Gladstone Park, Oregon City, selected specimens measure 25 x 39 mm., 29 x 36 mm., 24 x 32 mm. Two from Empire measure 30 and 35 mm. in diameter.

In northwestern California there is often a tendency to form one or two rather distinct bands above the black one, as south of the mouth of Klamath River, Del Norte County, and near Requa (E. P. Chace). On Lighthouse Island, Crescent City, shells are small, 29-32 mm. in diameter, and in some there is a continuous wide zone on the upper surface, as dark as the supra-peripheral band. Along Craig's Creek, 14 miles east of Crescent City, the shells are melanistic, glossy black, with a weakly traced light band below the periphery (Fig. 16 i). All of the shells from this region are very glossy. The Siskiyou Mts. and Cape Mendocino records are from Cooper, 1868.

In specimens from the bluff facing Ender's Beach, 5 miles south of Crescent City, *M. fidelis* shows unusual variation in pattern and form, according to E. P. and E. M. Chace. "There are 8 definable color patterns with many intergrades. These are (1) Dark base with dark top (dark brown to red brown). (2) Dark base with multilineate top. (3) Dark base with lemon yellow top. (4) Light, lemon yellow, base, with dark multilineate top; 1 only. (5) Light, lemon yellow base, with light multilineate top. (6) Light, lemon yellow base, with lemon yellow top. (7) Base light at the umbilicus shading to brown toward the periphery, with light multilineate top. (8) Base light at the umbilicus shading to brown towards the periphery with lemon yellow top. These all have the dark band at the periphery bordered by narrow light bands in the darker specimens." Some of them measure: 23.2 x 37 mm., 27.4 x 36.4 mm., 21.8 x 35.8 mm., 25.4 x 35.8 mm., 16.7 x 27 mm.

In two unlocalized Oregon shells from W. M. Gabb the suprapерipheral band is present, with the weak trace in places of a narrow band above it, the base without markings. A similar but higher shell was taken by E. P. Chace at Ender's Beach, 5 miles south of Crescent City, California (Fig. 16 n). These mutations are transitional to Hemphill's *flava*.

(*Fidelis*, dependable.)

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Fig. 16. a-c, *Monadenia fidelis*: a, Portland, Ore.; b, Hayden Island, Columbia River; c, Douglas, Oregon. d, e, f, *M. fidelis minor*, The Dalles. g, *M. fidelis columbiana*, Carson Spring, Wash.; h, near Mt. Hood, Ore. i, *M. fidelis*, melanistic, Craig's Creek, Cal. j, *M. fidelis beryllica*, Pistol River, Ore. k, l, *M. fidelis pronotis*, Point St. George, near Crescent City, Cal. m, *M. fidelis*, Oregon. n, *M. fidelis* transitional to *flava*, Ender's Beach 5 miles south of Crescent City. o, *M. fidelis* form *flava*, near Oregon City.

Form *flava* Hemphill. (Figure 16 o.) White under a periostracum of colonial buff to olive-ocher tints, with a few darker growth-rest streaks, and fading to whitish towards the apex. Typically the periphery is faintly subangular in front. Sculpture as in *fidelis*.

Height 23.5 mm., diameter 31.8 mm. Hemphill's type.

Height 26 mm., diameter 37.6 mm. Near Oregon City.

Height 25.3 mm., diameter 34 mm. Klamath River.

WASHINGTON: Chehalis and San Juan Islands.

OREGON: Port Orford (Hemphill), Type 7145 C.A.S. Elkton (R. D. Goss), and Oswego (E. P. Chace, Henderson). Gladstone Park near Oregon City (J. G. Malone).

CALIFORNIA: South of mouth of Klamath River, Del Norte County (E. P. Chace).

This is merely an albinistic or xanthic mutation, in no sense a race; it may occur apparently in any *fidelis* colony. The Klamath River specimen seen is distinctly angular in front. Randolph states that at Seattle the proportion of *flava* found is about one in a hundred (Nautilus, 13: 25).

**Monadenia fidelis beryllica** Chace

Figure 16 j.

*Monadenia fidelis beryllica* E. P. & E. M. Chace, 1935, Nautilus, 49: 48.

"Differs from other races of *fidelis* in the basal coloration, which is deep green, hellebore green of Ridgway being the predominating shade. Upper surfaces ranging from brown to straw in color but always with a tinge of green. All other characters varying as in the *fidelis* of Del Norte Co., California. Maximum diameter of type 38.1 mm., minimum diameter 32.3 mm., altitude 29 mm." (E. P. & E. M. Chace.)

OREGON: In a patch of trees and brush near the mouth of Pistol River, Curry Co. Type 122A Chace Collection.

In the type "colony the mature shells were quite uniform in size (35 to 40 mm. in diameter) and light-colored tops predominated. Mr. Smith found a colony of very similar shells beside the highway three miles north of Wedderburn. We visited this colony later, finding conditions and shells very similar to those at Pistol River. In a colony near the mouth of Hunter's Creek (three miles south of Gold Beach) the shells are more variable in top coloration and the green is a little less prominent. The colony at Port Orford looks very much like *fidelis* var. *pronotus* Berry, except that they have a distinctly green base. Like *pronotus*, they are living under grass and weeds on the ocean bluff. A set of nine shells was picked up while making a hurried trip from Bosley Butte to the Chetco River. This locality is about fifteen miles from the coast and a little more than that from the mouth of the Pistol River. These shells are the greenest we have ever seen. In some specimens the green of the base extends up over the periphery almost to the suture, making the usual dark peripheral band with light borders very inconspicuous.

"In addition to these five strong colonies we have taken scattering shells belonging to this form in six other localities all in Curry Co., and the absence of any shells of the usual coloration points to this green form as a good geographic race." (Chace and Chace.)

In this lovely form the umbilicus is very narrow, 2 to 2½ mm., and about half covered by the columellar lip.

(*Beryllus*, a beryl.)

***Monadenia fidelis celeuthia* Berry**

Figure 17.

*Monadenia fidelis celeuthia* S. S. Berry, 1937, *Nautilus*, 40: 122, fig. 2.

"Shell of but moderate size and heaviness, conic, usually fairly well elevated; umbilicate, the umbilicus narrowly permeable to the apex, and having a diameter varying from  $\frac{1}{8}$  to  $\frac{1}{10}$  the maximum diameter of the shell. Whorls usually about 6½, the last with the superior portion descending rather

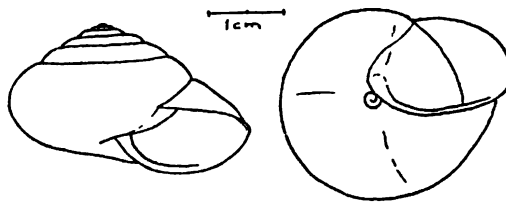


Fig. 17. *Monadenia fidelis celeuthia* (after Berry).

abruptly in front. Aperture ovate, deflected from the vertical axis about 45–50°, the lower border scarcely flattened. Peristome but little everted or thickened above, but more so below and quite strongly reflected over the margin of the umbilicus, the edges converging and connected across the whorl by a thin whitish callus. Sculpture of nepionic whorls badly eroded in all specimens seen, but evidently consisting of a very fine and close papillation minutely grilled out by very fine retractorily slanting grooves, the descending ones being a trifle the more distinct. Lines of growth on succeeding whorls very strongly developed, wholly dominating the delicate system of grooved-out spiral sculpturing which covers the entire surface of the shell, and can readily be discerned by the naked eye, although a little less distinct below. Color of base varying from chestnut to a dark liver brown, the spire variously toned on clouded sayal brown to snuff brown. Periphery conspicuously decorated with a sharp spiral band of bright seal brown about 2 mm. wide, set off both above and below by a similar or more often somewhat narrower band of warm buff or sayal brown, the upper of which may blend insensibly into the ground color of the spire or be set off by a narrower and relatively inconspicuous band of hazel. Some specimens, including the type, show two or three narrow hazel bands which continue nearly to the apex of the spire, while one specimen from Prospect has the lower buff band in its turn set off from the chestnut base by a narrow band of hazel.

"Max. diam. of type 30.1 mm., min. 25.1 mm., alt. 19.3 mm.; diam. umbilicus 2.8 mm.; 6½ whorls". (Berry.)

Smaller paratype, 27.2 x 17.3 mm.; 6 whorls.

OREGON: Trail, Rogue River Valley, Jackson County, Type 6205 Berry Collection. Also Prospect, Oregon.

"This very handsome, small race of *fidelis* seems well set off from the typical form not only by its small size, thinner shell, and less conoidal spire, but by the prevalence of multiple banding. In general appearance it resembles some of the more southern members of the genus more than any other Oregon or Washington form I have seen. All the characters noted are very constant in the material in hand indicating that a well-marked race is represented. Two specimens taken farther up the valley at Prospect, Oregon, have, however, a notably wider umbilicus than those from Trail. Otherwise they are very similar. The banding details are unusually beautiful." (Berry.)

I have not seen specimens.

(Κελευθήτης, a traveller.)

**Monadenia fidelis minor** (W. G. Binney)

Figure 16 d, e, f.

*[Algaia] fidelis* var. *minor* W. G. Binney, 1885, Man. Amer. Land Sh., Bull. U.S. Nat. Mus., no. 28, pp. 121, 493, fig. 91.

*Monadenia fidelis minor* (Binney), Henderson, 1936, Univ. Colo. Studies, 23: 253. (Restricted to The Dalles form).

The shell is smaller and thinner than *fidelis*, colonial buff to cartridge buff, the base dilute russet or dilute chestnut, with a few or many pale radial streaks, the supraperipheral band somewhat darker; between band and suture the color varies from cartridge buff to ochraceous-tawny, in either case with oblique streaks or maculae of brown, and usually one or two faintly traced spiral bands. Under the microscope the upper surface shows patches of minute lineolation over a somewhat irregular surface produced by displaced spirals. The lip is thin, narrowly reflected below.

Diameter of Binney's type figure 25.2 mm.; topotypes measure from height 12 mm., diameter, 20 mm., 5½ whorls, to height 15.2, diameter 24 mm., 6 whorls.

OREGON: The Dalles, the larger shells found among leaves, the smaller among rocks (H. Hemphill).

By the microscopic sculpture this small race, at the eastern limit of the genus, resembles the large forms from farther west at Carson and near Mt. Hood, more than the typical *fidelis* from still farther west. In the latter microscopic lineolation is almost or quite obsolete.

(*Minor*, smaller.)

A form from the east side of Upper Klamath Lake, about 13 miles north of Klamath Falls, Oregon, collected by H. B. Baker (Fig. 18 e) is moderately solid and opaque, rather dull, the base and band very dark carob-brown to chestnut-brown, with the pattern of *fidelis* except that there is often a weak russet band above the blackish one. Surface with microscopic lineolation, distinct in some individuals, reduced to a few small patches in others. 16 x 24 mm., 6 whorls; 14.8 x 21.3 mm., 5¾ whorls; 13.3 x 21.7 mm., 5½ whorls.

It is obtained by digging in stone piles, and is common on both sides of the lake. This was reported as *M. fidelis minor* by Henderson, and is probably what Edson recorded from Klamath as *Epiphragmophora mormonum* (Nautilus, 26: 49). Whether it is genetically related to *M. fidelis minor* or is a similar but independent small race is not easy to decide.

**Monadenia fidelis columbiana** new subspecies

Figure 16 g. h.

At Carson, Skamania County, Washington, near the Columbia river, a dark form was taken by J. G. Malone. (Fig. 16 g). The supraperipheral black band is very wide, about 5 mm., often with a narrow light border above, the rest of the upper surface chestnut brown; yellow band below periphery usually very narrow; base carob brown. Diameter 35.5 to 39 mm., whorls 7. In these shells the upper and peripheral regions are more or less dull, and show microscopic lineolation such as is described for *M. fidelis subcarinata*, though somewhat less distinct. On the typical *fidelis* such lineolation is only very weakly developed, and indeed, usually hardly noticeable. South of the Columbia in Oregon similar shells were taken by Mr. Malone near the Salmon River, 12 miles from Mt. Hood, at Tawney's Hotel, 1600 feet elevation (Fig. 16 h). The shells are more depressed, height 21 mm., diameter 35.5 mm., with a wider light band below the periphery, the surface above the black band ochraceous buff with chestnut brown or tawny blotches, or running largely into chestnut brown. These shells with those from Carson, Washington, form a rather distinct race of the Columbia valley, which may be called *columbiana*, the type being 115581 A.N.S.P. (Fig. 16 h).

**Monadenia fidelis pronotis** Berry

Figure 16 k, l.

*Monadenia fidelis pronotis* S. S. Berry, 1931, Nautilus, 44: 122.

"Shell small for the species, heavy, the spire conic and usually well elevated; whorls 6 to 6½. Aperture scarcely descending above, the peristome little thickened or everted above, but more definitely reflected below and with a moderate umbilical flare. Umbilicus more or less covered but usually permeable, its diameter contained about 13 times in that of the shell.

"Periostracum almost completely dehiscent on mature shells but where persisting on young specimens showing a well developed spiral sculpture on the upper surface.

"Ground color ashy white to dark brown above, zoned by a wide supraperipheral band of dark brown and usually one or more lighter bands between this and the suture; base uniformly brown, but the shade varying in intensity in different shells.

"Maj. diam. 27.5, alt. 18.7, diam. umbilicus 2.0 mm." (Berry.)

CALIFORNIA: Point St. George, near Crescent City, Del Norte County; occurring alive in some abundance (E. P. & E. M. Chace). Holotype 6961 S. S. Berry Collection; paratypes in the collections of the Academy of Natural Sciences of Philadelphia 152414, Emery P. Chace, and S. S. Berry.

This race differs from the typical form of *M. fidelis* by its narrower umbilicus, less depressed last whorl and the more convex base. The loss of periostracum appears traceable to the maritime situation. The smallest adult seen has a diameter of 23.6 mm.

**Monadenia fidelis semialba** J. Henderson

Figure 18 a.

*Monadenia semialba* Henderson, 1929, Nautilus, 42: 80; Univ. Colo. Studies, 17: 74.

*Monadenia fidelis semialba* Hend., Eyerdam, 1937, Nautilus, 51: 63.

"In *fidelis* the base is uniformly dark chestnut, dark brown or nearly or quite black. The Rosario specimen, which I call *semialba*, has all the characters of *fidelis* except that the base, from the periphery nearly to the umbilicus, is creamy white, sharply bounded above by the dark peripheral band of *fidelis*, and bounded below not quite so sharply by a broad dark brown band encircling the umbilicus. Width of type specimen 29 mm., height 18 mm." (Henderson.)

The base is naples yellow with a large black area around the umbilicus; supraproperipheral band black, most of the surface above it russet with a few wide blackish-brown streaks. Sometimes there are stains or interrupted bands of russet on the base.

Diameter up to 36 mm.

WASHINGTON: Rosario State Park, Fidalgo Island (E. C. Nelson), Type 16042 Univ. Colo. Mus. On the steep rocky wooded slope between Reservation bay and Rosario beach in an area of about  $\frac{1}{4}$  mile long by 250 yards wide (W. J. Eyerdam, E. P. and E. M. Chace).

"It is found mostly amongst the large rocks and in the grass and underbrush amongst the rocks. No specimens could be found in the adjacent deeper forest. The typical form of *fidelis* is found intermingled . . . with *M. semialba*, which is very limited in its range. The color of the living animals of both forms seems to be identical." (Eyerdam.)

In an old lot labelled "Oregon", from Dr. Amos Binney, two are colored like *semialba* except that the umbilical dark patch is larger. The yellow periostracum remains in one, is lost from the spire in the other (fig. 16 m). They have the form of *fidelis*.

(*Semialba*, half white.)

**Monadenia fidelis ochromphalus** Berry

Figure 18 b.

*Monadenia fidelis ochromphalus* Berry, 1937, Nautilus, 50: 28.

The shell differs from *M. f. fidelis* chiefly by the small size, the somewhat larger umbilicus, contained about 7.7 to 10.5 times in diameter and by the color, which is similar to *fidelis* except that there is a yellow (old gold) area around the umbilicus. Surface polished.

Height 19.1 mm., diameter 31.7 mm., width umbilicus 4.1 mm.;  $6\frac{1}{2}$  whorls. Other specimens from 29.6 to 32.7 mm. diameter.

"Color of animal: dorsum fawn color to wood brown, more or less heavily suffused darker (bone brown to clove brown) with a light median line on the ridge, sometimes more or less maculated, the tail consistently paler; sole buffy brown to grayish olive, widely margined fuscous to fuscous-black." (Berry.)

CALIFORNIA: Etna Creek, about 2½ miles above Etna, Siskiyou County (Leo Shapovalov and M. Hanavan). Type 7767 Berry Coll.; paratypes 7768 Berry coll., 168710 A.N.S.P., others in collections of Allyn G. Smith, E. P. Chace, U.S.N.M., Stanford Univ. "Taken alive 'on ground, on leaves and sticks, on concrete walls of irrigation ditch, and on mossy boulders and stones, several days after showers'; some ovipositing" (Shapovalov).

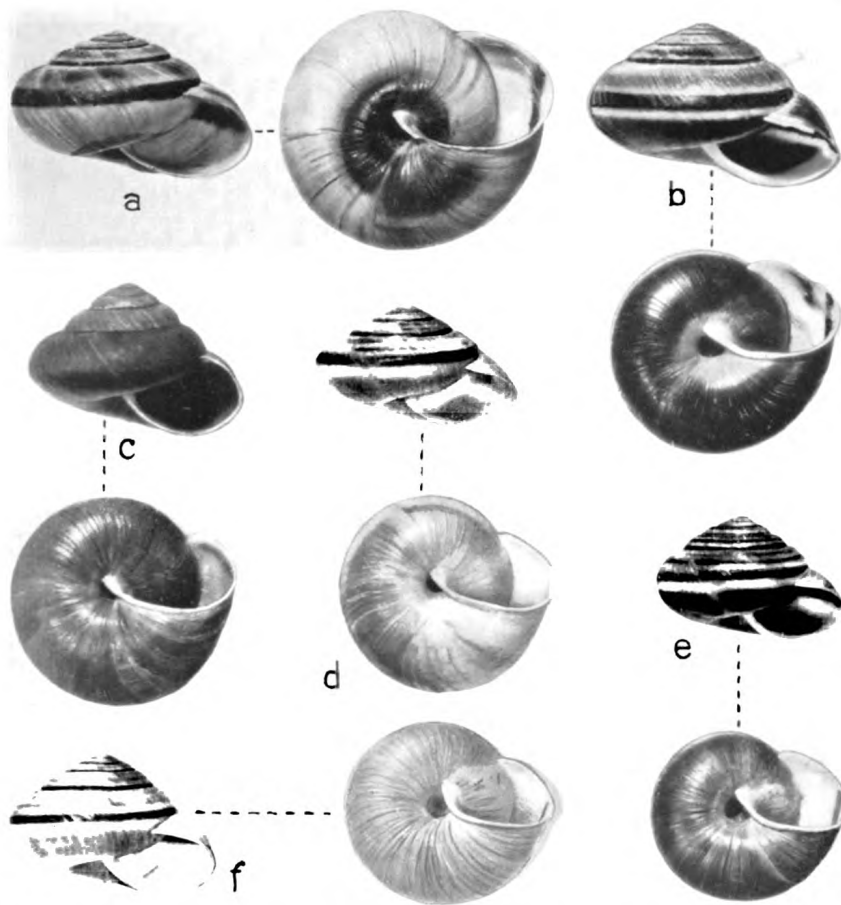


Fig. 18. a, *Monadenia fidelis scialba*. b, *M. f. ochromphalus*. c, *M. f. coloba* form *badia*. d, *M. f. coloba*. e, *M. f. minor*, Upper Klamath Lake. f, *M. f. leonina*. (a, topotype; b, f, paratypes; c, d, types.)

"It may appear questionable to describe a subspecies characterized by so little other than color, but the shells of this beautiful race are very characteristic in appearance and the open yellow umbilicus centering the polished black-brown base is a conspicuous feature seen by me in no other

lot of *fidelis* from any locality whatsoever. As the race seems uniform in the characters noted and apparently strongly localized, it will be useful to have a name for it. That proposed is derived from the Gr. *ὄχρος*, yellow, + *ὄμφυλος*, umbilicus." (Berry.)

***Monadenia fidelis leonina* Berry**

Figure 18 f.

*Monadenia fidelis leonina* Berry, 1937, *Nautilus*, 51: 29.

"Shell small and thin for the group, translucent by transmitted light, depressed to low-conic in outline; umbilicate, the umbilicus openly permeable to the apex and having a diameter on the average about one-ninth the maximum diameter of the shell; umbilical suture deep. Whorls  $5\frac{3}{4}$  to  $6\frac{1}{4}$ , convex. . . . Peristome little everted or thickened above, moderately so below, especially near the umbilicus, the edge of which is partly roofed by the columellar flare. . . . Sculpture of nepionic whorls finely heavily wrinkly-granulose, the granules very crowded and for the most part showing arrangement in a pattern with both protractive and retractive alignment, passing into the weaker and much more distant papillation of the succeeding whorls, which on the adolescent and mature whorls becomes entirely obsolete; lines of growth very strongly developed, the major wrinkles well-spaced and almost rib-like on the earlier post-nuclear whorls, relatively finer, closer, and more irregular on the later whorls, which also carry weak traces of an incised spiral sculpture. Color of shell: spire cream-buff to isabella color, sometimes with one or two narrow bands of cinnamon brown, or sometimes with a single wider band of dark olive buff, or sometimes unbanded save for the conspicuous wide supra-peripheral band of a lustrous and very dark liver brown (deeper and blacker than any of the Ridgway colors), 1.3 to 1.7 mm. wide, which may be either simple or varyingly bordered above and below with a rather narrower zone of ivory yellow or deep olive buff; base isabella color, either uniform or suffused dresden brown, more rarely a uniform dark liver brown.

"Max. diam. 24.1 mm., min. diam. 20.5 mm., alt. 15.4 mm., diam. umbilicus 2.8 mm.;  $6\frac{1}{4}$  whorls." (Berry.)

Paratypes from 12.9 x 21.7 mm.,  $5\frac{3}{4}$  whorls, to 21.5 x 26.8 mm., umbilicus 3.1 mm.

CALIFORNIA: Beaver Creek about one mile above mouth, Siskiyou County (Leo Shapovalov). Type 7687 Berry Coll.; paratypes in collections of Allyn G. Smith, E. P. Chace, U.S.N.M. and A.N.S.P. 168711.

"The special characteristics of this very distinct race are the small size, thin translucent shell, completely permeable umbilicus, reduced banding, generally pale yellowish coloration, and sharply contrasted heavy peripheral band. . . . The name selected, besides doing honor to the discoverer, finds additional significance in its suggestion of the tawny hues of the shell.

"These snails were found by the collector in some numbers on dead alder leaves near the stream and likewise on alder trunks to a height of about nine feet." (Berry.)



**Monadenia fidelis klamathica** Berry

Figure 19.

*Monadenia fidelis klamathica* Berry, 1937, Nautilus, 51: 31.

“Shell of but moderate size and heaviness, low-conic or low pyramidal-conic, umbilicate; the umbilicus steep-walled, distinctly permeable to apex, and having a maximum diameter in the type specimen of about one-ninth the major diameter of the shell, but in other specimens usually narrower ( $1/12$  to  $1/14$  the diameter of the shell). Whorls about  $6\frac{1}{4}$  or a trifle less,



Fig. 19. *Monadenia fidelis klamathica*, paratype (Phot. Cal. Acad. Sci.).

convex, the last with the superior portion distinctly descending in front. Aperture ovate, somewhat flattened below, and deflected from the vertical axis about  $48^\circ$ . Peristome sinuous, distinctly everted below and especially at the umbilicus, the outline of which thus becomes laterally indented, but only slightly expanded on the upper segment; the edges converging and connected by a thin but evident callus.

“Surface of first  $1\frac{3}{4}$  turns densely and closely set with diamond-shaped papillae usually eroded in mature shells, separated by narrow grooves, of which the obliquely descending are rather more distinct than the obliquely ascending ones, but the arrangement not always wholly regular. Lines of growth absent or difficult to make out on the first turn and a half, but quite strong on the succeeding quarter turn, after which the diamond-shaped papillation abruptly ceases, but the growth wrinkles, becoming further accentuated, are henceforth the dominant periostracal ornamentation. Surface of main portion of shell smooth and polished, unsculptured both above and below save for the lines of growth and a very finely incised almost microscopic spiral striation.

“Color a much richer and darker chestnut brown, or a glossy light seal brown on the spire, and with a conspicuous tri-colored band bordering the periphery, the dark central stripe of about 2.5 mm. thickness being approximately the color of the base of the shell and in rich contrast to the stripe just below it which is of a thickness of 1.5 mm., and is ochraceous buff to yellow ocher in color. The uppermost band of hazel is slightly narrower than the lowermost and less conspicuous. Max. diam. 33.2 mm., min. diam. 27.4 mm., alt. 19.6 mm.; diam. umbilicus 3.6 mm.; whorls  $6\frac{1}{4}$ .” (Berry.)

A paratype measures height 18.6 mm., diameter 30.2 mm., umbilicus 2.2 mm.;  $6\frac{1}{8}$  whorls.

CALIFORNIA: Along Oak Flat Creek, near Klamath River, Siskiyou County, under logs (Allyn G. Smith). Type 6011 Berry Coll., paratype 2714 A. G. Smith Coll.

"The distinctive characters are the comparatively small size, low-conic form, polished surface, and rich dark coloring, set off by the bright ochraceous banding. In the open funicular umbilicus of some of the shells the suggested approach is toward *M. mormonum*, which it also approaches in habitat as nearly as any member of the true *fidelis* series which the present writer has seen." (Berry.)

I have not seen this race. The figures are from photographs of a paratype kindly supplied by Mr. A. G. Smith.

***Monadenia fidelis subcarinata* (Hemphill)**

Figure 20 c, d.

*H[elix] fidelis*, black variety, often subangled, Cooper, 1868, Amer. Journ. Conch., 4: 224.

*Aglaja fidelis* Gray, black elevated form approaching *infumata*, Binney, 1890, 3d. Suppl., Bull. Mus. Comp. Zoöl., 19: 213, pl. 10, fig. A, B.

*Aglaja fidelis* var. *subcarinata* Hemphill, in Binney, 1892 (January), 4th Suppl. Terr. Moll., Bull. Mus. Comp. Zoöl., 22: 185.<sup>1</sup>

The shell has the general size and shape of *M. fidelis* except that the periphery is somewhat angular. Spire conoidal. Clove brown to black, the spire often lighter. The surface is matt except the central part of the base which is usually polished. Sculpture of moderately coarse, low striae and many impressed spirals; under the microscope a dense, wavy lineation is seen in the general direction of lines of growth; typically there are in places short, irregular scattered ridgelets, as if pinched up, spirally directed or descending forward, or reduced to short pointed pustules. Aperture is as in *M. fidelis*, the peristome buff-pink (or sometimes white).

Height 25.5 mm., diameter 38 mm.; 6 $\frac{3}{4}$  whorls.—Hemphill's syntypes measure: 23.3 x 36 mm., 23 x 34.7 mm., 23 x 34.5 mm.

CALIFORNIA: Humboldt Co., near Eureka (Hemphill). Syntypes 5630-32 C.A.S. Jordan Creek near Scotia (E. P. & E. M. Chace); 6 miles above Carlotta in dense fern growth in redwood forest (Wharton Huber).

This race differs from *M. infumata* by the less depressed shape, the blunter peripheral angle and the less roughened periostracum. It is almost exactly intermediate between *fidelis* and *infumata*. In some examples the black band of *fidelis* shows above the suture on some whorls of the spire. I do not believe it to be a hybrid form.

The diameter is usually from 35 to 40 mm. There is much variation in the development of the pinched-up periostracal ridges, which may be mere elevated points, or short little ridges, or conerescent into oblique, raised lines in places, almost as in *infumata*. They are very rare or absent in some shells. The microscopic lineation converges locally to these elevations, giving a peculiar spotted appearance under a low power lens.

<sup>1</sup> Mr. Hemphill incidentally mentioned *subcarinata* as one of the varieties of *Helix fidelis* (Zoe, 2: 314, Jan. 1892), from the "region north of San Francisco Bay". There was no word of definition or any indication that the name was new. It is therefore not a valid name according to Article 25 of the International Rules of Zoological Nomenclature. It cannot prejudice any subsequent use of the same name. Whether Hemphill's article appeared before or after Binney's Fourth Supplement is not known, and is immaterial.

Xanthic individuals occur. One from near Scotia is ecru-olive, fading to colonial buff on the base, and with several brown streaks; over it the usual dull periostracum. In a few specimens from this place the whole base is polished.

(*Subcarinatus*, somewhat keeled.)

Form *coloba* (Figure 18 d) is rather acutely angular in front. Color naples yellow with a chocolate band on and above the periphery, traces of two narrow brown bands on the upper surface, and on the base some brownish suffusion and radial streaks, which stop about 2 mm. short of the periphery and fade towards the umbilicus.

Height 17 mm.; diameter 26.6 mm.;  $5\frac{1}{2}$  whorls.

Hemphill gave only the locality "California". The specimens are 10644 A.N.S.P. This differs from *M. fidelis leonina* by its strongly angular periphery, smaller umbilicus and brown-streaked base. Whether this form was found with the following dark one is not known. They were separated in Hemphill's lots, but this was his custom with variable forms.

The form *badia* (Figure 18 c) resembles *subcarinata* but is smaller, vandyke brown, somewhat lighter on the spire, not quite so dull, polished in the middle of the base; with the same minute lineolation, but the periostracal elevations described for *subcarinata* are much reduced (often very low). Periphery acutely angular in front, the angle lost or weak near the lip. The h/d index is variable, 64 to 75.

Height 20 mm., diameter 28.3 mm.; umbilicus about 1.6 mm.; 6 whorls. Often smaller, diameter 24 mm.; 10628 A.N.S.P.

These forms are noticed by W. G. Binney, 1890, as "*Aglaja fidelis*, small, black elevated form", Third Supplement, Terr. Moll., Bull. Mus. Comp. Zoöl., 19: 213, pl. 10, figs. c, d, and "small, depressed form", fig. e.

**Monadenia infumata** (Gould)

Figure 20 a, b.

*Helix infumata* Gould, 1855, Proc. Bost. Soc. Nat. Hist., 5: 127 ("brought from San Francisco"); in Binney, Terr. Moll., 3: 13.—W. G. Binney, 1859, Terr. Moll., 4: 15.—Binney and Bland, 1869, L. & Fr. W. Sh. N. A., 1: 162, figs. 279, 280.

*Helix fidelis* var. *infumata* Gld., Cooper, 1875, Proc. Cal. Acad. Sci. 6: 19-24.

*Aglaja infumata* Gld., Binney, 1885, Man. Amer. L. Sh., Bull. U.S. Nat. Mus. no. 28, p. 123, figs. 92-94; 1883, Suppl. Terr. Moll. 5, Bull. Mus. Comp. Zoöl., 9: 156, pl. 4, fig. b, c.

*Campylaea* ? (*fidelis*) *infumata* Gld., Cooper, 1887, Proc. Cal. Acad. Sci., (1), 7: 362; 8: 503-512.

*Aglaja infumata* Gld., Binney, 1890, 3d Suppl. Terr. Moll., Bull. Mus. Comp. Zoöl., 19: 213, pl. 10, fig. f.

*Epihragmophora infumata* Gld., Rowell, 1902, Nautilus, 16: 52 (Occidental, Sonoma Co.).—Button, 1911, Nautilus, 25: 59 (Alameda Co.).—Clapp, 1911, Nautilus, 25: 94 (Muir woods, Marin Co.).

*Epihragmophora fidelis* form *infumata* Gld., Edson, 1911, Nautilus, 25: 18 (Santa Rosa).

The shell is umbilicate, umbilicus contained about  $12-12\frac{1}{2}$  times in diameter, strong though rather thin, depressed, low-conic above, convex below, the periphery strongly angular in front, more obtusely towards the outer lip. Color bone brown or darker, fading to dusky russet on the inner whorls. The apical whorls are as described for *M. fidelis* except that the granules are more strongly coalescent into ridges; in places the surface appears pitted rather than granulose. Surface matt throughout, or with some gloss around umbilicus, the periostracum microscopically wrinkled or lineolate, and pinched up into forwardly-descending narrow ridgelets, usually short, but in places sometimes imperfectly conrescent into protractive raised lines; on the base closely or sparsely papillose, and the lineolation is weaker. The whorls are very weakly convex above, the last descending but little in front. The aperture is dark within, peristome thin, light edged, the basal margin narrowly reflected, at the insertion dilated over a small part of the umbilicus.

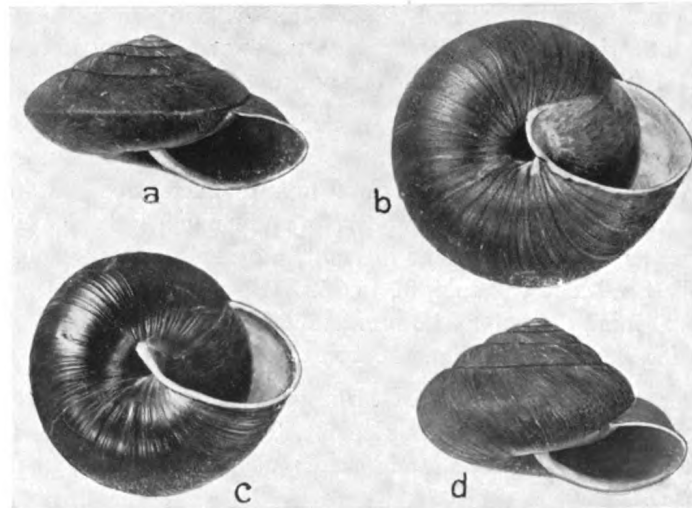


Fig. 20. a, *Monadenia infumata*, near Inverness; b, Marin Co. c, *M. fidelis subcarinata*, 6 miles above Carlotta; d, near Scotia.

"Diam.  $1\frac{1}{2}$  inches, axis  $\frac{4}{5}$  inch." (Gould).

Height 21 mm., diameter 38 mm.; 6 whorls.

Height 22.3 mm.; diameter 39.6 mm.;  $6\frac{1}{2}$  whorls.

CALIFORNIA: Siskiyou County (W. M. Gabb); all the coast counties from Humboldt to Marin; Napa, Solano, Contra Costa and Alameda Counties.

The depressed shape, strongly angular periphery, and the rough lusterless surface, characterize this species. As *M. fidelis subcarinata* is intermediate between *fidelis* and *infumata*, the latter has been reduced to varietal status by J. G. Cooper, followed by many later authors. The intermingling of characters leaves *infumata* little but the more depressed shape, yet I have

not seen actual intergradation. As no great amount of northern Californian material of *infumata* has been examined, the question is left in suspense. The series I have seen from Humboldt to Alameda counties shows but little variation.

Like *fidelis*, it is an arboreal form. Cooper reports it from Haywards under loose bark of dead trees up to 20 feet high, and at Bolinas Bay on the branches of buckeyes.

The single specimens seen from Siskiyou and Humboldt counties were collected by, or at least received from, W. M. Gabb. These records, not yet confirmed by later naturalists, carry the species into the area of *subcarinata* and *fidelis*. The details of distribution of these three allied forms call for further investigation in northern California. Most of the counties further south are represented by several records. The original specimen was "brought from San Francisco". As the species does not occur on the peninsula, it evidently came from Marin Co., or from across the bay eastward.

(*Infumatus*, smoked.)

**Monadenia churchi** Hanna & Smith

Figure 22: 1-5.

*Monadenia churchi* Hanna & Smith, 1933, *Nautilus*, 46: 79, pl. 5, figs. 1-5; pl. 6, fig. 8.

"Shell medium sized, non-carinate, umbilicate; with a somewhat low spire; whorls 5½, evenly rounded; outer lip slightly reflected; color pale brown, with a peripheral band of darker brown than the rest of the shell bounded above and below by light cream-colored bands, the upper about equal in width to the dark band, the lower a little wider; nuclear whorls 1½, sculptured with densely set, wavy, somewhat elongated tubercles arranged roughly in spiral order; remaining whorls with sparse elongated tubercles, grouped principally in a protractive spiral order, more pronounced on the upper surface, becoming obsolete on the lower surface and in the umbilicus. Extremely fine, wavy, axial sculpture is pronounced on the postnuclear whorls and is superimposed on the somewhat irregular, low, axial growth-ridges, but does not extend to the top of the tubercles. This sculpture gives the shell a moderately smooth, dull appearance when viewed without a lens. Alt. 11.3 mm., diam. 20 mm." (Hanna and Smith.)

CALIFORNIA: Lava rock-slide 2.1 miles east of Payne's Creek Station, Tehama Co. (A. G. Smith Feb. 21, 1931), Type 5806 C.A.S. type coll. Topotypes in collections of A. G. Smith, 3729; A.N.S.P. 139613; U. S. N. M.; S. S. Berry and E. P. Chace. Paratype 5807 C.A.S. from Deer Creek, Tehama Co. (E. W. Gifford). Near Butte Creek, Tehama Co., 22 miles east of Chico on the road to Butte Meadows (A. G. Smith), one immature specimen; Deer Creek, Tehama Co. (E. W. Gifford), one specimen, paratype; Grass Valley Creek, Trinity Co., 4 miles west of summit (county line) on the Redding-Weaverville highway (G. D. Hanna); Trinity Alps Camp, Stuart's Fork of the Trinity River, 12 miles northeast of Weaverville, Trinity Co. (G. D. Hanna); Cedar Creek, 6 miles east of Ingot, Shasta Co. (G. D. Hanna and J. L. Nicholson).

"The species has a fairly wide distribution in north-central California. It has been found chiefly in rock-slides but a few specimens were collected

under forest debris in heavy shade. In the series examined the diameter ranges from 17.8 mm. to 23.5 mm.; the altitude ranges from 9.7 mm. to 14.0 mm.

"In many living adult specimens the epidermis, apparently very thin, is badly eroded on the spire. As a result few mature shells in first class condition were found. The tubercles are usually elongate in a protractive spiral direction but do not have any regular arrangement otherwise. The tops of the tubercles are polished and do not bear hairs in most of the individuals examined, but in some of the specimens from Trinity County there is evidence of short blunt extensions of the epidermis in the umbilical region; these do not leave a pit or other mark on the tubercles when they are removed or absent. The shape of the tubercles is usually elongate spirally but this is subject to considerable variation even on the same specimen, some of them being round or pear-shaped.

"The material at hand gives evidence of the existence of several different races, each with minor variations that are not sufficiently pronounced to warrant describing them as subspecies. The paratype from Deer Creek is the largest (alt. 13.6, diam 23.5 mm.) and heaviest shell so far found. It differs from the type and from the others in the type lot by its larger size, somewhat lighter color, more reflected lip, and more thickly set tubercles, which are strong on the base and in the umbilicus as well as on the upper surface. Specimens from Trinity County are darker in color than those in the type lot and the tubercles are crowned sometimes with minute fin-shaped projections of the epidermis." (Hanna and Smith.)

*Anatomy.* — "The individual that was dissected had started to form the outer lip of the shell but this was not complete; on account of this immaturity it is possible that the various organs had not reached their full size and proportions. The presence of the single unbranched mucous gland on the dart sac (Figure 21) proves conclusively that the species should be allied with the group *Monadenia*, as defined by Dr. Pilsbry. The mantle of *M. churchi* has a series of jet-black irregularly-shaped spots, sparsely arranged over the surface. The



Fig. 21. *M. churchi*, genitalia of topotype. (After Hanna.)

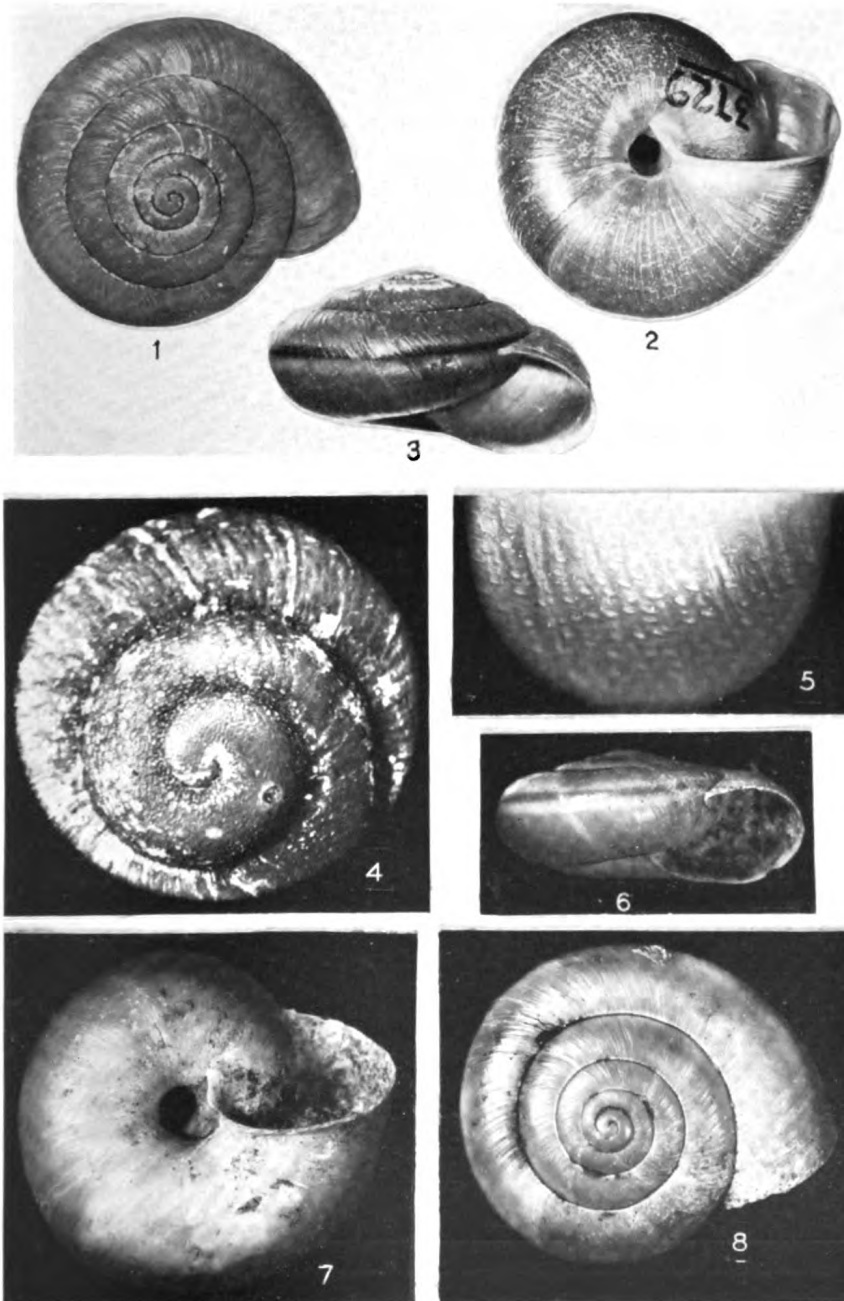


Fig. 22. 1-3: *Monadenia churchi*. Type, diameter 20 mm.; 4-5: paratype. 6-8. *M. troglodytes*, Type, diameter 24.2 mm. (After Hanna and Smith.)

jaw has seven heavy ribs. There are 24 rows of teeth on each side of the central, and the first laterals have a small cusp on the inner side." (Hanna and Smith.)

A half-grown shell from Redding, Shasta County, taken by R. C. McGregor in 1898, is probably referable to *M. churchi*, but it is very distinctly papillose over the base and angular peripherally.

(Named for Mr. Clifford C. Church, who assisted the authors on many field trips.)

**Monadenia troglodytes** Hanna & Smith

Figure 22: 6-8.

*Monadenia troglodytes* Hanna & Smith, 1933, *Nautilus*, 46: 84, pl. 5, figs. 6-8.

"Shell light buff, medium size, widely umbilicate; spire greatly depressed; whorls  $5\frac{1}{2}$  with moderately deep suture; the last whorl slightly depressed near the aperture; outer margin expanded very little, the basal margin somewhat more so; one narrow pale brown spiral band appears just above the periphery, which is bounded above and below by white bands that are slightly wider; surface without markings except growth lines; nucleus consisting of  $1\frac{1}{2}$  whorls marked by radiating wavy riblets. Diameter 24.2; altitude 10.8 mm." (Hanna and Smith.)

CALIFORNIA: Samwel Cave, Shasta County; Pleistocene. Type 32394 Univ. Cal. Dept. Paleont.; paratype 5842 C.A.S. type coll. Also Potter Creek Cave.

The specimens found are semifossil and completely denuded of epidermis. The size varies from 10.1 x 21.6 mm. to 11.3 x 27.5 mm. All are greatly depressed.

"An interesting account of the discovery and exploration of Samwel Cave has been given by E. L. Furlong.<sup>1</sup> The cave is located in carboniferous limestone in Shasta County, California, along the east bank of the McCloud River, 16 miles above its mouth. Potter Creek Cave is in the same county and Wm. J. Sinclair has given an account of the exploration of it.<sup>2</sup>

"In neither account is there a statement regarding the presence of land shells but Mr. Furlong has informed us verbally that in Samwel Cave there was no question but that the shells were in the same stratum with the bones. This of course is borne out by the fact that the species is extinct. There is abundant evidence from mammalian remains that the caves were more or less freely accessible to animals from the outside during the long period of the Pleistocene." (Hanna and Smith.)

(*Τρωγλοδύτης*, living in caves.)

<sup>1</sup> Furlong, E. L., The Exploration of Samwel Cave. *Am. Jour. Sci.*, ser. 4, vol. 22, 1906, pp. 235-247, 3 text figures.

<sup>2</sup> Sinclair, Wm. J., The Exploration of the Potter Creek Cave. *Univ. Calif. Publ. North Am. Arch. & Eth.*, vol. 2, No. 1.



**Monadenia mormonum** (Pfeiffer)

Figure 23.

- Helix mormonum* Pfeiffer, 1857, Proc. Zool. Soc. Lond., p. 109; Monogr. Hel. Viv., 4: 176.—Cooper, 1868, Amer. Journ. Conch., 4: 227; 1875, Proc. Cal. Acad. Sci., 6: 18 (description of animal).
- Arionta mormonum* Pfr., W. G. Binney, 1878, Terr. Moll., 5: 366, fig. 248, pl. xiii, figs. E, F, G; pl. xv, fig. P, anatomy; 1890, 3d. Suppl., Bull. Mus. Comp. Zool., 19: 213, pl. 11, figs. F, G, H (varieties).
- Epiphragmophora mormonum* (Pfr.), Pilsbry, 1900, Nautilus, 13: 128.—Hanna & Rixford, 1923, Proc. Cal. Acad. Sci., (4), 12: 43, 45.
- Epiphragmophora mormonum* var. *cala* Pilsbry, 1900, Nautilus, 13: 128.—Lowe, Nautilus, 30: 94, 95.
- Monadenia mormonum* (Pfr.), Hanna, 1922, Nautilus, 36: 13, 14.



Fig. 23. *Monadenia mormonum*, Mormon Island; actual size. 47178 C.A.S.

“The shell is umbilicate, depressed, rather thin, arcuately striatulate, pale reddish; spire scarcely conically raised; whorls 6, slightly convex, increasing slowly, the last more convex above and below, a little swollen in front, slightly descending, encircled above the middle with a chestnut band bordered on both sides with whitish. Umbilicus of medium size, conic. Aperture is very oblique, ear-shaped lunate; peristome white lipped, its ends converging, the right margin strongly arched, expanded; columellar margin arched and sloping, reflected, expanding above. Alt.  $12\frac{1}{2}$ , greater diam. 29, lesser  $24\frac{1}{2}$  mm.” (Pfeiffer.)

It may be added that the cinnamon-buff color is darker next to the white bands, and fades towards the umbilicus, and there are usually two or three whitish radial streaks marking growth-rests. The first  $1\frac{1}{2}$  whorls are densely papillose except at the smooth tip, the papillae arranged along very obliquely retractive and protractive trends, though not regularly so. The later whorls are practically smooth except for weak growth wrinkles, but in places weak traces of fine, close spiral striae may sometimes be seen under the lens.

Height 15.5 mm., diameter 30.3 mm.; fully 6 whorls. Tuolumne County.  
Height 17 mm., diameter 30.5 mm.;  $6\frac{1}{2}$  whorls. Placerville.

CALIFORNIA: Mormon Island, in the American River, Sacramento County (Newcomb), type locality. Eldorado County at Pioneer Cave (Cooper); Placerville (Hanna). Columbia and Cave City, Tuolumne County (Hanna and Rixford.)

The typical form of *M. mormonum* is known from Eldorado to Tuolumne counties. It is larger, paler, and smoother than the allied races. Probably Cooper's record of fine specimens of *mormonum* taken by Whitney in a

canyon near the place the Calaveras skull was found (near Altaville, Calaveras Co., in the Upper Sonoran zone) may be this form.

According to Dr. Cooper (Amer. Journ. Conch., 4: 226) none of the larger helicoids "are found in the Sierra Nevada above the belts of limestone which crop out on its western slope, though in many places the climate and other conditions seem favorable to them. In fact they are scarce below that level except at and near the limestone belts, and abound only in very limited tracts where it is the prevailing rock."

Tryon has noted that *M. mormonum* is a nocturnal snail (Amer. Journ. Conch., 3: 105).

Specimens taken by Hemphill at Cave City, Tuolumne County, are dull, with the aperture smaller than in the typical form; and the periphery is more or less angular in front. Height 15 mm., diameter 27.2 mm.,  $5\frac{3}{4}$  whorls, to height 14.4 mm., diameter 29.5 mm., nearly 6 whorls.

Cooper has reported *mormonum* from the head of the San Joaquin valley, Fresno Co. (Gabb); also very small specimens from Columbia, Tuolumne County, 2200 feet (Frick), and White Rock, 4 miles east of Placerville, Eldorado County (C. D. Voy), the latter both small and very dark, therefore probably the race *cala*. Both of these places are in the Upper Sonoran zone. The extreme southern record for the species is Mineral King, Tulare County (Stearns, North American Fauna, No. 7, 1893, p. 272). What races these authors had is not known to me. Binney has alluded to the variations of the species in general terms, without localizing them.

In Shasta County, far north of the localities mentioned, a race of *mormonum* has been found in the Upper Sonoran zone at and near the junction of the Pitt with the Sacramento river (Brewer, Gabb). They agree with the typical form in the absence or extreme faintness of spiral striae and in coloration; the shell is smaller and the spire generally higher. They are within the area of *M. churchi*.

Height 13.8 mm., diameter 26 mm.;  $5\frac{1}{2}$  whorls.

Height 14.3 mm., diameter 22.7 mm., 6 whorls.

Height 15 mm., diameter 26 mm.; 6 whorls.

(*Mormonum*, of the Mormons.)



Fig. 24. *Monadenia mormonum cala*, type (a) and paratypes.

Form *cala* Pilsbry (Figure 24). The shell is smaller and less depressed than *mormonum*, darker and more distinctly spirally striate. The spire is

low conic; periphery well rounded. Color between cinnamon-brown and russet, fading towards the umbilicus, the band usually a little darker, bordered by nearly equal buff or whitish bands. Sculpture of crowded granules on the first  $1\frac{1}{2}$  whorls; in the most fully sculptured examples scattered granules are seen on the rest of the spire, but these are often lacking. The last whorl has minute, crowded, unequal spiral incised lines, typically moderately strong, but varying to weak in some specimens.

Height 14.6 mm., diameter 23 mm.; 6 whorls.

Height 13.6 mm., diameter 21.8 mm.;  $5\frac{3}{4}$  whorls.

Height 16.4 mm., diameter 27 mm.; 6 whorls.

CALIFORNIA: Calaveras County Big Trees, 5000 feet, Transition zone (Hemphill, Button), Type 73629 A.N.S.P. Near spring on Lincoln Highway about 23 miles east of Placerville (H. N. Lowe).

While this form seems distinct from typical *mormonum*, there are shells of intermediate characters, and *cala* is probably a superfluous name.

(Καλός, beautiful.)

**Monadenia mormonum buttoni** (Pilsbry)

Figure 25.

*Epiphragmophora mormonum* var. *buttoni* Pilsbry, 1900, Nautilus 13: 128.

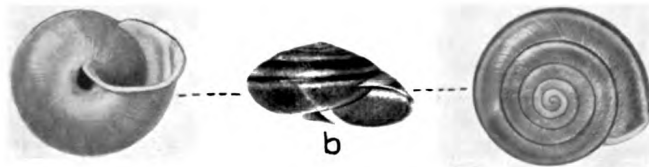


Fig. 25. *Monadenia mormonum buttoni*, type (b) and paratypes.

The shell is smaller and darker than *mormonum*, strongly depressed; the umbilicus is smaller, contained about 10.3 times in the diameter; periphery angular in front. Color cinnamon-brown, fading towards the umbilicus and suture, the band a shade darker, bordered with subequal pale buff bands. Sculpture of close round papillae on the first  $1\frac{3}{4}$  whorls, arranged in oblique retractive and protractive trends, in places somewhat irregular; on later whorls the papillae are pointed or spirally lengthened, sparse and rather irregularly placed, though oblique trends may be seen in many places; they continue over the base, and are about 0.2 to 0.5 apart at the periphery of the last whorl. Where protected, as above the last turn of suture, they bear delicate bristles, about 0.5 mm. long. Between them the surface is very minutely roughened by indistinct wrinkles or low tubercles along lines of growth, and in places there are faint traces of spiral striae. The spire is low conoid.

Height 12.7 mm., diameter 24.5 mm.;  $5\frac{3}{4}$  whorls.

Height 12.5 mm., diameter 23 mm.;  $5\frac{1}{2}$  whorls. Type.

CALIFORNIA: Nassau Valley, Calaveras County (Fred L. Button). Type 73630 A.N.S.P.

This race approaches *M. hillebrandi* in sculpture, but it is not so rough, less dull, less depressed, with a narrower umbilicus. The color is more as in *M. mormonum cala*. The sculpture is much as figured for *M. mormonum loweana*.

**Monadenia mormonum loweana** Pilsbry

Figure 26.

*Monadenia mormonum loweana* Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila., 68: 487, pl. 40, figs. 5-5b.—Lowe, Nautilus, 41: 79.

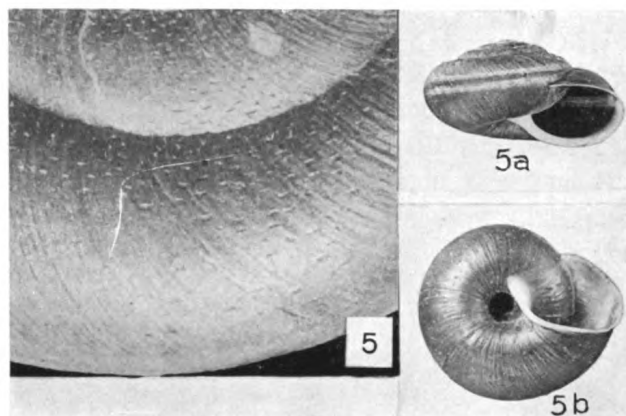


Fig. 26. *Monadenia mormonum loweana*.

The shell differs from typical *M. mormonum* by its dull surface and the sculpture of very fine, close, irregular spiral lines and sparse low papillae lengthened in a spiral direction, obsolete over much of the last whorl and wanting in the umbilical region. There is also a microscopic lineolation or wrinkling in small patches, roughly parallel to growth lines. Umbilicus much wider than in *mormonum* or any of its described subspecies, contained about  $5\frac{1}{2}$  times in the diameter. Color between russet and cinnamon-brown, fading towards umbilicus, and with dilute buff bands somewhat wider than the dark shoulder band between them.

Height 14 mm., diameter 25.5 mm.;  $5\frac{1}{2}$  whorls.

CALIFORNIA: Road to Huntington Lake, in the San Joaquin River Canyon, Fresno County (H. N. Lowe). Type and 3 paratypes 141670 A.N.S.P.

A small example of 21 mm. diameter is distinctly subangular in front. This race approaches *M. infumata* by its dull surface and sculpture, though this is more developed in *infumata*; it is obviously more related to *mormonum*, which has a glossy periostracum. *M. mormonum buttoni* resembles *loweana* in sculpture, but it has a far narrower umbilicus. In one of the young specimens there are very short subtriangular epidermal processes on the low tubercles where protected near the suture, but they are very different from the hairs of *M. m. hirsuta*.

Hanna and Rixford<sup>1</sup> have called attention to the wide variation found in the *mormonum* series. It appears to me necessary to have names for salient local forms, several of them being very distinct in appearance and in the development of sculpture.

***Monadenia mormonum hirsuta*** Pilsbry

Figure 27.

*Monadenia mormonum hirsuta* Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila., 68: 486, pl. 40, figs. 6-8.—Hanna, 1927, Nautilus, 40: 125.

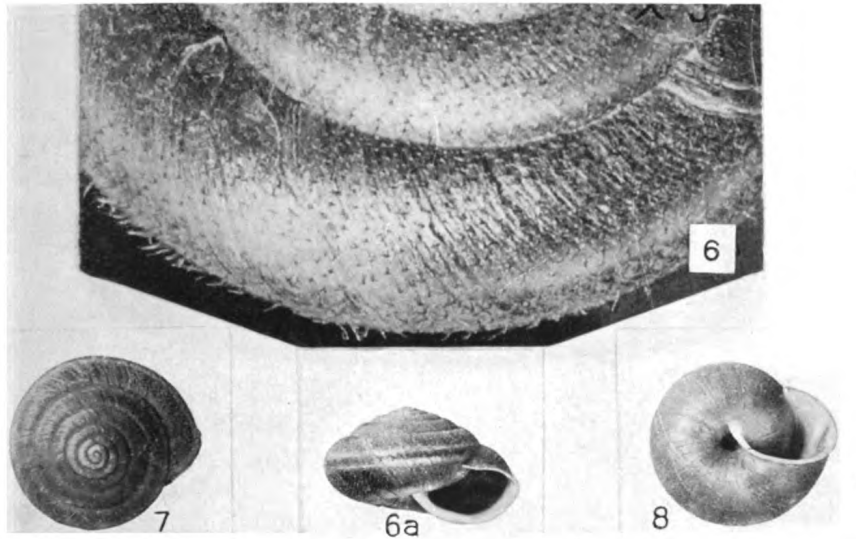


Fig. 27. *Monadenia mormonum hirsuta*.

The shell is depressed, umbilicate, the umbilicus contained nearly eight times in the diameter, rood's brown, with a slightly darker peripheral band with buff bands of nearly equal width above and below it. The surface is dull, the initial  $1\frac{1}{2}$  whorls finely, evenly and rather sharply granular, the granules locally arranged in descending protractive and retractive trends but largely irregularly placed; next whorl also granular; subsequent whorls microscopically wrinkled and set with short, curved bristles standing in oblique trends, though the arrangement is partly somewhat irregular; the bristles on the last whorl are about 0.5 mm. long, 0.4 to 0.7 mm. apart. The whorls increase slowly, the last being indistinctly subangular in front and descending a little to the aperture. Aperture elliptical-lunate, about as in *M. mormonum buttoni*.

Height 14 mm., diameter 22.5 mm.  $5\frac{3}{4}$  whorls. Smallest.

Height 13 mm., diameter 23.4 mm.; 6 whorls.

Height 16.6 mm., diameter 24 mm.;  $6\frac{1}{2}$  whorls.

Height 15.3 mm., diameter 24.8 mm.;  $6\frac{1}{2}$  whorls. Type.

Height 17 mm., diameter 26.6 mm.;  $6\frac{1}{2}$  whorls. Largest.

<sup>1</sup> Proc. Cal. Acad. Sci., 12:43. 1923.

CALIFORNIA: Mountain Pass, Tuolumne County (Hanna & Rixford). Type 2639, paratypes 2640, 2641 C.A.S. type coll.; and 142003 A.N.S.P.

Of the several described races of *M. mormonum*, this stands nearest to *M. m. buttoni* Pils., but the hairs are longer and more persistent and the minute sculpture much coarser. If colonies of intermediate character exist, I have not seen them. "The type lot of this subspecies (21513 C.A.S.) was collected by Dr. Emmet Rixford and me at Mountain Pass, Tuolumne County. This is a point where the road from Stockton to Sonora passes to the right of a large exposure of black basalt. The shells were found among the loose rocks at the base of this lava cliff." (Hanna.)

(*Hirsutus*, hairy.)

**Monadenia hillebrandi** (Newcomb)

Figure 28 a, b.

*Helix hillebrandi* Newcomb, 1864, Proc. Cal. Acad. Sci., 3: 115, 181.—Cooper, 1865, Am. Journ. Conch., 1: 344; 1868, Amer. Journ. Conch., 4: 227.

*Aglaia hillebrandi* Ne., Binney, 1885, Man. Amer. Land Sh., Bull. U.S. Nat. Mus. no. 28, p. 124, fig. 95. 1883, 1st Suppl. Terr. Moll., Bull. Mus. Comp. Zool., 11: 156.

*Monadenia hillebrandi* A. G. Smith, 1934, Nautilus, 48: 70.

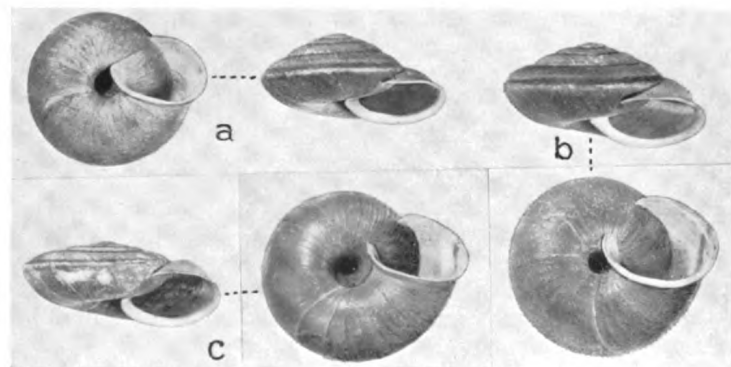


Fig. 28. a, *Monadenia hillebrandi*, Mariposa; b, near Wawona. c, *M. hillebrandi yosemitensis*, type.

The shell is depressed, with angular periphery and low, conoid spire; umbilicate, the umbilicus contained about  $8\frac{1}{2}$  (8 to 10) times in the diameter. Surface matt, cinnamon brown or a little darker, the early whorls, convexity of the base and sutural region often paler; upon and above the peripheral angle two buff bands enclose a brown band slightly darker than the ground color. The first  $1\frac{2}{3}$  whorls are densely papillose, the papillae in places showing arrangement in protractive and retractive trends; following whorls are densely granular and minutely wrinkled, the wrinkles short, obliquely spiral; the last whorl or two having also spaced papillae bearing short, stiff hairs where unrubbed. The whorls increase slowly, the last descending in front. The aperture is strongly oblique, whitish within, showing the bands; outer and basal margins are narrowly reflected, columellar margin dilated.

Height 12 mm., diameter 23.2 mm.  $5\frac{1}{2}$  whorls. Alder Creek.

Height 11.3 mm., diameter 23.7 mm.;  $5\frac{3}{4}$  whorls. Mariposa.

Height 12.3 mm., diameter 24.2 mm.; 6 whorls. Mariposa.

Height 13 mm., diameter 27 mm.;  $5\frac{1}{2}$  whorls. Near Wawona.

CALIFORNIA: Calaveras County (Binney). Tuolumne County (Voy), Newcomb's type locality. Mariposa County at Mariposa (Gabb); Cold Springs, within 25 miles north of Mariposa (Cooper); Lower Chilnuana Falls near Wawona, 5000 feet, and Alder Creek, Yosemite National Park (Allyn G. Smith).

The depressed shape, angular periphery and dull, rough surface more or less hairy on the last whorl where well preserved, distinguish this species. All the localities are in the Upper Sonoran zone, so far as known.

According to Newcomb the animal is of a reddish brown color, with the tentacles of a smoky hue; tentacular sheaths darker than the body, which is small, slender, finely granulated and unusually long and tapering behind. He had Mariposa specimens.

"*Monadenia hillebrandi* has been one of the most difficult of the California land shells to get, on account of the back-breaking work required to find it. It can be taken easily however if the proper method is used. Within its range, which is limited apparently to Mariposa County at elevations above 3500 feet, locate large masses of broken granite, with moss along the bases of the piles or ledges. Go over the moss for mucous tracks, which, if plentiful, indicate good hunting. Then, go out at night about nine o'clock with a gasoline lantern and *hillebrandi* will be out crawling; the snails come out plentifully at night from deep among the granite blocks where they hide during the day. The resting places must be dry, for the snails come out all covered with dust. This method beats rolling rocks for them; in about three hours' hunting on two consecutive evenings recently, the haul was 250 adults and 26 immature, the largest of which I have ever heard." (Allyn G. Smith.)

(Named for the botanist Dr. William Hillebrand, author of a flora of the Hawaiian Islands.)

***Monadenia hillebrandi yosemitensis* (Lowe)**

Figure 28 c.

*Epiphragmophora hillebrandi yosemitensis* Lowe, 1916, Nautilus, 30: 95.

The shell is darker than *hillebrandi*, almost natal brown (of Ridgway), with the usual two light bands bordering the darker band above periphery. Much depressed, the spire only slightly convex. *Umbilicus wider*, contained about  $5\frac{1}{2}$  times in the diameter. The last whorl is distinctly papillose, having microscopic wrinkles between the papillae, usually in the direction of growth lines.

Height 11 mm., diameter 26 mm.;  $5\frac{1}{2}$  whorls (type). A paratype in Lowe collection measures 10.2 x 23.5 mm.

CALIFORNIA: Yosemite Valley, in a rock slide near Vernal Falls (H. N. Lowe), Lectotype 114782 A.N.S.P. Camp Curry (Witmer Stone).

On account of its depressed shape, wide umbilicus and somewhat diverse sculpture, this Transition Zone form appears to be subspecifically distinct from *hillebrandi*, which inhabits an adjacent zone westward. In an immature shell a few of the papillae bear short bristles.

**Monadenia circumcarinata** (Stearns)

Figure 29.

*Helix* var. *circumcarinata* Stearns, 1879, Ann. N. Y. Acad. Sci., 1: 316, 3 figs.; 1902, Nautilus, 16: 61, 83.

*Arionta mormonum* var. *circumcarinata* Stearns, Binney, 1885, Man. Amer. Land Shells, Bull. U.S. Nat. Mus. no. 28, p. 142, fig. 121.

*Epiphragmophora circumcarinata* Pilsbry, 1902, Nautilus, 16: 62.



Fig. 29. *Monadenia circumcarinata*, paratype.

The shell is openly umbilicate, depressed, discoidal, with a peripheral keel. The last two whorls are convex below the suture, a little impressed next to the keel, flattened below it, the base convex towards the umbilicus. The first  $1\frac{1}{2}$  whorls have papillae densely arranged along curved trends, not entirely regular, as in *M. mormonum*. On following whorls there are scattered papillae, and the later ones are minutely and densely granose-wrinkled and coarsely sculptured with strong, unequal ribs following growth lines, unequally spaced, being crowded in some places, further apart in others. The aperture is oblique, angular at the periphery. Peristome moderately thickened, rather narrowly reflected basally, slightly impinging on the umbilicus, the ends connected by a thin parietal callus. "Color above, light straw-brown; beneath, fading to a pale horn. One adult shows a narrow pale brown revolving band about 1 mm. wide immediately above the carinate periphery, above which is a pale horn-colored revolving band of equal width. Below the periphery (i.e., below the carina) there is evidence of another paler band but this is less distinct. On the other adult the revolving bands are not clearly defined, but on the young shell the banding is well developed and clear cut."

"Height .36 to .37, greater diameter .92 to 1.01, lesser. .75 to .86 inch." (Stearns.)

Height 11 mm., diameter 26.8 mm.;  $5\frac{1}{2}$  whorls.

CALIFORNIA: "Near Turlock, Stanislaus Co." (A. W. Crawford). Type U.S.N.M., paratypes 7607 C.A.S. and 10633 A.N.S.P.

This species is very distinct from all of our helices except the superficially similar *Oreohelix elrodi* which differs by its wider umbilicus, less reflected lip, the minute sculpture of both embryonic and later whorls and the color.



*M. mormonum* and *M. hillebrandi* seem to be the most nearly related species.

The paratype figured is bleached, but Mr. Allyn G. Smith has supplied the above description of the color from paratypes in the California Academy collection, together with the following notes: "The California Academy has two adults and one immature specimen of *M. circumcarinata* (Stearns). All three appear to have been living shells when collected. They are C.A.S. 7607, collected by A. W. Crawford, who has so far been the only one to find this snail, although many good collectors have searched for it. There is no doubt that it is a lost species for the present, and its locality remains an enigma. Crawford was a peculiar chap from all accounts. He was an expert cabinet-maker who, when the spirit moved, would quit his job, go off on a wild binge and disappear for as long as several weeks or months. He would return, supposedly when his cash ran out, usually with a lot of land snails. He was secretive about his wanderings, and for this reason his localities are not now considered too reliable. His labels generally do not tell exactly where he made his finds. One of his trips resulted in at least forty or fifty *M. circumcarinata*, that are now pretty well scattered among older collections."

It has been found but once. Dr. Stearns became satisfied that Crawford's locality was incorrect, and thought that it might be from near Columbia, Tuolumne County. Some lucky collector has still to learn the secret of its happy mountain valley.

(*Circumcarinata*, keeled around.)

#### HELMINTHOGLYPTA Ancey

*Helminthoglypta* Ancey, 1887 (June), The Conchologist's Exchange, 1: 76.

*Helix*, *Arianta* and *Arionta*, in part, of many authors, not *Arianta* Leach, 1831 (mt. *Helix arbustorum* L.).

*Epiphragmophora* subg. *Helminthoglypta* Pilsbry, 1895, Man. Conch., 9: 193, in part, and of other American authors; not *Epiphragmophora* of Doering, 1875.

Helices of moderate or large size, the shell globose or depressed with conic or low spire and open or covered umbilicus; periphery rounded at all stages of growth. Embryonic shell of  $1\frac{1}{2}$  to  $1\frac{3}{4}$  whorls; after the smooth tip and a few radial ripples it has sculpture of close, microscopic, waved, radial wrinkles, over which there are papillae in forwardly descending trends (often indistinct or practically absent). Adult sculpture of simple growth lines or with spiral engraved lines, malleation, papillae or granulation also. A dark band revolves above the periphery (sometimes absent). Peristome narrow, expanded outwardly, usually reflected at base, dilated at columellar insertion.

Genitalia, (Fig. 31): The slender penis has a small cavity, nearly filled by (usually 4) longitudinal ridges. It contains no papilla or verge; epiphallus and flagellum are well developed, the penial retractor inserted on the former. The vas deferens passes around the dart apparatus. Atrium large, prolonged in a sac, with the short dart sac at its summit. Two

oblong, thick-walled mucous glands unite to a single duct opening into the atrial sac at base of dart sac; distally the mucous glands communicate by narrow ducts, reflected at their summits, into broad, thin membranes which partially or wholly envelop the dart apparatus.

Free muscles (*H. callistoderma*): Pharyngeal and left ocular retractors united in the posterior fourth of their length the right ocular separate throughout. Both ocular-tentacular bands bear strong lateral pedal muscles. Right ocular passes through the penioviducal crotch.

In *H. exarata* the kidney is more than double the length of the pericardium and less than one-third the length of lung. The secondary ureter is an open groove in the last third of its length. The lung is copiously veined on both sides of the principal vein (Fig. 30 d, *H. nickliniana*).

The jaw has strong ribs, usually five or six, projecting at both margin often unevenly spaced (Fig. 30 a-c).

Radula (Fig. 31 d, *H. tudiculata subdola*): Central and lateral teeth are unicuspid, the cusps usually projecting a little beyond the basal plates of the median teeth, becoming longer outwardly, and bifid on the marginal teeth, about the thirtieth tooth an entocone appears. The outer marginals have shorter cusps, sometimes irregular as in the one figured.

(Ἑλμινς, -ιθός, worm, γλυπτός, sculptured.)

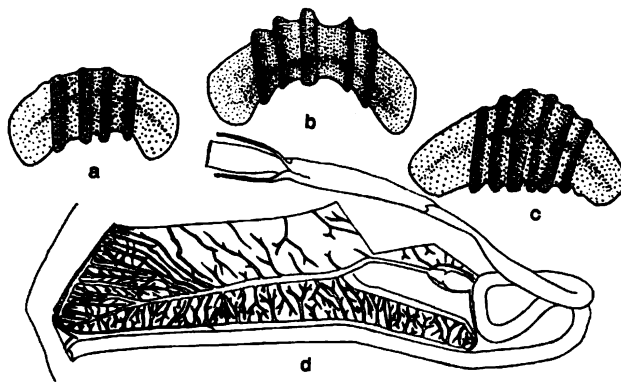


Fig. 30. Jaw of: a, *Helminthoglypta cuyamacensis*. b, *H. tudiculata subdola*. c, *H. napaea yosemitensis*. d, pallial organs of *H. nickliniana*, Vanatta del.

TYPE: *Helix tudiculata* Binn., by original designation.

*Distribution*.—Lower California to southwestern Oregon, west of the Sierra Nevada. Below our limits *Helminthoglypta* is present on Guadalupe Island, *H. hannai* Pils. and *H. hannai diodon* Pils., and on the Lower Californian mainland, *H. peninsularis* (Pils.)<sup>1</sup> and other species.

So far as I know, no sinistral shells have been found in this genus; Dr. Hanna and Mr. A. G. Smith have seen none in the large numbers they have handled. Albinism, partial or complete, is not uncommon; in a few cases most individuals of a colony may be lacking in pigment or retain only the yellow tint of the periostracum.

<sup>1</sup> Described as *Sonorella peninsularis*. *Nautilus* 29: 100.

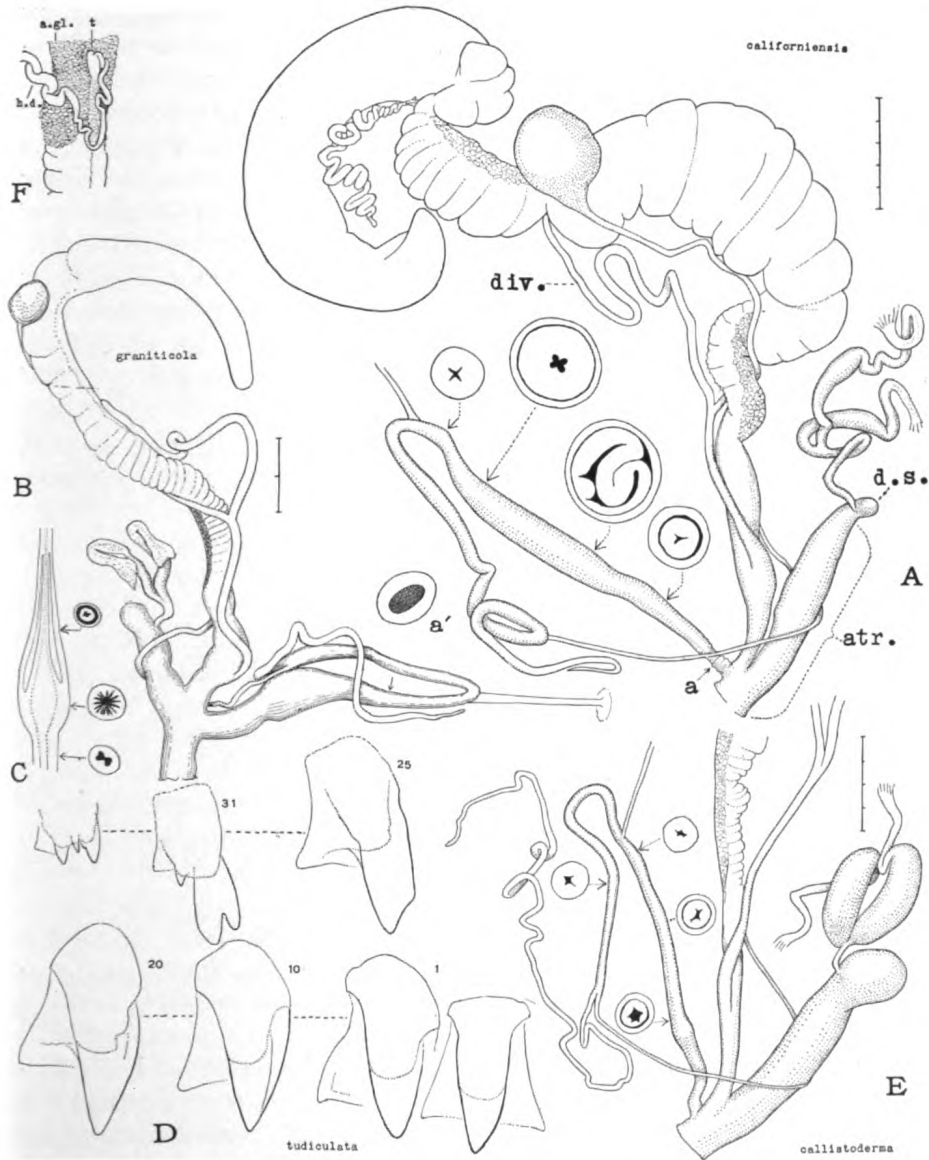


Fig. 31. Genitalia of *Helminthoglypta*. A, *H. californiensis* form *vineta*; at a' a section near base of penis. B, *H. graniticola*. C, diagrammatic longitudinal section of penis of same, the duct in stippled line; with three transverse sections. D, *H. tudiculata subdola*, teeth. E, *H. callistoderma*. F, *H. umbilicata* f. *cuestana*, detail of hermaprodite duct and talon. agl., albumen gland; atr., atrial sac; div., diverticulum of the spermathecal duct; d.s., dart sac; h.d., hermaphrodite duct; t, talon.

*Paleontology.*—Fossil land shells which appear referable to this genus are rare and imperfectly preserved. *H. tudiculata* occurred in the Pleistocene of Dead Man's Island, San Pedro, and *H. traski* var. in the bluff at Mission Beach, San Diego Co. (A. G. Smith Coll.). The Eocene snails *Helminthoglypta obtusa* Anderson & Hanna, 1925,<sup>1</sup> from the Tejon of Live Oak Creek, Kern Co., and *H. (?) stocki* Hanna, 1934, from the Upper Eocene Sespe deposits, Simi Valley, Ventura Co., have been thought to be helminthoglypts. *Helix leidyi* Hall & Meek, White River beds, Oligocene of Wyoming, and *Helix veterna* Meek & Hayden, 1861, from the Wind River Eocene, Wyoming, which resemble West Coast Helminthoglyptidae more than any other family of our fauna, hardly seem referable to *Helminthoglypta*. *Helix veterna* M. & H. is genotype of *Glyptertes* Pilsbry, 1892<sup>2</sup> and of the synonymous *Pseudolisinoe* Wenz, 1923.<sup>3</sup>

*Notes on the Anatomy and Classification.*—The only study of the teeth of *Helminthoglypta* is that of W. G. Binney (1878, Terr. Moll., 5: 353), who examined eleven species, finding all very similar.

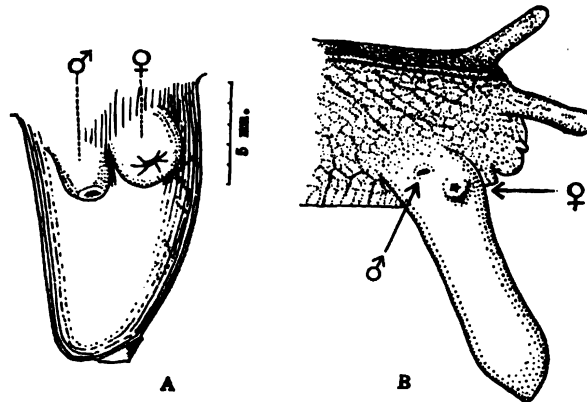


Fig. 32. Everted atrial sac of: A, *Helminthoglypta umbilicata* form *cuestana*, and B, *H. nickliniana*. Openings of penis and vagina indicated by the signs ♂ and ♀ respectively.

The atrium is much enlarged in *Cepolis*, *Monadenia* and *Helminthoglypta*, the dart sac inserted upon it, but in the first two the penis has a verge or papilla, and apparently still functions. In *Helminthoglypta* the penis contains no verge and appears not to be evertible, that function being taken over by the long atrial sac as illustrated in Fig. 32. *Micrarionta* is a less evolved genus with the atrium normal, very short, and the dart sac inserted on the vagina.

<sup>1</sup> See J. Henderson, Fossil Non-marine Mollusca of N. A., for references to this and the following species.

<sup>2</sup> Proc. Acad. Nat. Sci. Phila., 1892, p. 394.

<sup>3</sup> Fossilium Catalogus, Animalia, pt. 18, p. 366.

The epiphallus is of somewhat smaller caliber than the penis, but there is usually no definite external differentiation. In the typical subgenus *Helminthoglypta* there is a difference internally; in a section it is seen that the epiphallus has a solid wall, the penis an internal body free from the outer tube. In comparative measurements it would be easier to consider epiphallus and penis as a unit. The penial retractor is always on the epiphallus, a short distance beyond the limit of the penis.

In *Helminthoglypta* and most *Micrariontae* the glandular bodies of the mucous glands have membranous extensions, which in their fullest development more or less envelop the whole dart apparatus, as in Figures 73A and 89. In other figures this envelope has been removed. In somewhat different form, this appears in *Cepolis* also. In *Monadenia* there seems to be no trace of this structure, and in small *Micrariontae* it is almost lost, though represented by the anterior recurvature of one or both of the mucous glands.

The spermatophores of *Helminthoglypta* are long and slender with thin but stiff yellowish or reddish walls, smooth except for some seam-like lines lengthwise. Those I have found were lodged in the diverticulum of the spermathecal duct, which is thus an accessory spermatheca, which has taken over the function of the latter. The spermatheca is globular or oval, its duct more slender than the diverticulum.

The darts do not seem to be detached during mating. In the large number of *Helminthoglyptidae* I have dissected I have never found them loose in the tissues.

With the exceptions of Figures 31B, 89 and 92, all the figures of *Helminthoglypta* genitalia are drawn as seen from the ventral sides.

C. Semper, 1870, figured genitalia of *H. nickliniana* and *H. arrosa*. Binney, 1878<sup>1</sup> figured the genitalia of *H. arrosa*, *nickliniana*, *ramentosa*, *sequoicola* and *traski*. He examined also *tudiculata*, *exarata*, *californiensis*, *diabloensis*, *dupetithouarsi* and *carpenteri*, in which the genitalia were said to be "as in *nickliniana*". His figures show that these species are congeneric, but they are so lacking or indefinite in details that they have no value for determining relationships within the genus. Dr. Ingles in 1935<sup>2</sup> made a comparative study of the genitalia and jaws of *H. nickliniana*, *H. tudiculata*, *H. cypreophila*, *H. arrosa holderiana*, *H. californiensis* and *H. berryi*, finding small differences in some details of penis and mucous glands. These species belong to the *nickliniana-tudiculata* series, in which the genitalia are very much alike, these organs appearing less differentiated than the shells.

<sup>1</sup> W. G. Binney in earlier papers, Proc. Acad. Nat. Sci. Phila., 1874-5 and Ann. Lyc. Nat. Hist. N. Y., 1874-5, gave outline figures of genitalia, preliminary to his work of 1878, Terr. Moll., vol. 5.

<sup>2</sup> Lloyd G. Ingles, Proc. Malac. Soc. London, 21: 265-274, plates 29, 30.

The present author, 1895, figured genitalia of *H. nickliniana* and *H. cuyamacensis*. Studies for this volume show that there is considerable structural diversity in the genus. Species which have been dissected up to this time fall, according to the genitalia, into two main groups (subgenera) and minor divisions, indicated in the following key. The species which have been investigated for the characters used are mentioned under each division.

1. Penis thick-walled with no outer tube, as shown in sections in Fig. 84; common duct of mucous glands short, the dart sac large.  
(Subgenus *Charodotes*): *H. traski*, *H. petricola*, *H. proles*  
Penis double-walled, having an outer tube, as in sections shown in Fig. 31 A.  
(Subgenus *Helminthoglypta* s. str.) 2
2. Dart sac small, much shorter than the common duct of the mucous glands.  
*H. berryi*, *H. californiensis*, *H. nickliniana*, *H. diabloensis*, *H. arrosa*,  
*H. tudiculata*, *H. allymiana kernensis*, *H. cypreophila*, *H. allymsmithi*  
Dart sac large, about as long as, or longer than, the common duct of the mucous glands .....3
3. Penial inner tube short, its cavity enlarged with multiplicate wall in the swollen portion of penis .....*H. graniticola*  
Penial inner tube long, its cavity nearly filled by few (usually four or five) main longitudinal ridges.  
*H. dupetithouarsi*, *H. umbilicata*, *H. ayresiana*, *H. walkeriana*, *H. cuyamacensis*,  
*H. callistoderma*, *H. tularensis*, *H. napaea wawona*, *H. napaea yosemitensis*

In following pages the four divisions indicated by anatomy have been subdivided into seven series based upon form and sculpture of the shell. Many species have not been dissected, and could be placed in the series only by shell characters, which are sometimes ambiguous. Much further work is needed, especially in the revision of the fifth to seventh of the following groups.

By comparison of the ranges given for these series of snails with the insular and peninsular Tertiary lands of western California shown in the paleogeographic maps of Reed and others, it will be seen that from at least the Miocene on, there are suggestive correspondences. Some of the groups do not seem to have strayed far from the Miocene islands or peninsulas where they were presumably evolved.

Subgenus *HELMINTHOGLYPTA* s. str. This is a group of many species, races and minor local forms. By characters of the dart apparatus and shell the species fall into six series, not rigidly definable, but at least the first four seem to be natural groups.

1. *H. tudiculata* Series.—Globose or globose-depressed, with sculpture of growth wrinkles below the suture, generally malleate in the peripheral region or throughout; not granulose, but sometimes with some granulation behind the lip; last whorl wide. This series extends from just below the Lower Californian boundary to southern Oregon, from Kern county north being an inland group.

2. *H. nickliniana* Series.—Globose or globose-depressed, with sculpture of (1) fine striae cut into granules by obliquely descending impressions, or (2) profusely malleate, with or without fine striae cut by impressed spirals. This series extends from Monterey County to southwestern Oregon, in and west of the coast ranges, and is most fully developed in counties around San Francisco Bay.

3. *H. ayresiana* Series.—The depressed-globose shell is dull, with incised spiral lines cutting the striae. Santa Barbara Channel Islands and ocean coast of Santa Barbara County.

4. *H. dupetithouarsi* Series.—Depressed, closely coiled, with firm, dark colored, smoothish or malleate shell; not granulose, but often with papillae in diagonal series on the spire. Coast and Coast Range from Santa Barbara to Sonoma Counties.

5. *H. callistoderma* Series.—Upper surface or the whole shell more or less covered with minute papillae or very short hairs; not malleate. San Diego County to Tulare County.

6. *Mohave Desert* Series.—Mainly small, smoothish or microscopically papillose shells, of which the affinities are definitely known in *H. graniticola* only.

Subgenus CHARODOTES: 7. *H. traski* Series.—Sculpture of growth striae and engraved spiral lines, or without the latter; early whorls, or the whole shell, set with minute papillae in obliquely descending trends; usually not malleate. Distributed from Lower California to Santa Barbara County, and inland northward to Mariposa County.

#### Subgenus HELMINTHOGLYPTA *s. str.*

The penis has an inner body free from the outer tube. Structure otherwise as described for the genus generally.

The structure of the penis is illustrated in Figure 31 A, where a transverse section of the epiphallus, at the left, and four sections of the penis are drawn. The outer tube does not extend to the base, where communication with the atrium is through a short neck with simple wall, as in Figure 31 A, a, a'. The structure of penis and epiphallus is shown in Figure 31 E also, the two sections above being through the epiphallus, the lower two through the penis.

#### HELMINTHOGLYPTA TUDICULATA SERIES

Globose to globose-depressed, narrowly umbilicate (or rarely imperforate) shells, with wide last whorl and sculpture of rather sharp striae or ridges of growth below the suture, followed by malleation (but sometimes very weakly developed). No spiral lines and no granulation except sometimes behind the lip and in the umbilicus. Genitalia about as in the *nickliniana* series, the dart sac being small and far shorter than the common duct of the mucous glands.

*Distribution.*—From the northwestern border of Lower California to southern Oregon, inland except in southern California.

Segregation of the *tudiculata* and the *nickliniana* stocks into two series is a matter of general appearance and geographic distribution rather than of structure. Ingles has pointed out the close resemblance of the genitalia, and a sculptural difference between *tudiculata* and some non-granulose forms of *arrosa* is hardly apparent. However, it seems that there are two natural groups, though only weakly differentiated.

The sequence of species is from the south northward.

**Helminthoglypta tudiculata** (Binney)

Fig. 33 a.

*Helix tudiculata* Binney, 1843, Boston Journ. Nat. Hist., 4: 360, pl. 20; 1851, Terr. Moll., 2: 117, pl. 16.—Newcomb, 1865, Amer. Journ. Conch., 1: 345.—Binney and Bland, 1869, L. & Fr. W. Sh. N. A., 1: 165, fig. 286.—(?) Jousseau, 1879, Bull. Soc. Zool. France, 4: 124.—Hadley, 1916, Nautilus, 30: 83, fossil (?) in Orange Co.

*Arionta tudiculata* Binn., Cooper, Amer. Journ. Conch., 5: 209. W. G. Binney, 1878, Terr. Moll., 5: 357, pl. ix, fig. e, teeth; 1883, Bull. Mus. Comp. Zool., 11: 158.

*Epiphragmophora tudiculata* Binn., Kelsey, 1906, Nautilus 20: 61, pl. 4 (Pamoosa canyon 15 mi. north of Escondido, San Diego Co.).

*Helminthoglypta tudiculata* (Binn.), Berry, 1928, Journ. Ent. & Zool., Pomona Coll., 20: 79.—Ingles, 1935, Proc. Malac. Soc. Lond., 21: 268, pl. 29, figs. 2, 3, anatomy (Murray Dam near San Diego, and Glendora, Los Angeles Co.).

*Helix tudiculata* var. *Binneyi* Hemphill, 1890, in Binney, 3rd Suppl., Terr. Moll., Bull. Mus. Comp. Zool., 19: 219.

The shell is narrowly, nearly covered umbilicate, dilute cinnamon-brown, fading to buckthorn brown on the base and in bands above and below the carob-brown shoulder band. Surface rather glossy. After the very small smooth initial tip there are a few coarse wrinkles, more or less broken into oblong granules, followed by one whorl of extremely fine, close wrinkle and granular sculpture, upon which spaced papillae are superposed, partly in obliquely radial order, partly irregular. The post-embryonic sculpture consists of minute granulation, some weak wrinkles of growth, and spaced papillae in forwardly-descending series. Few if any papillae are visible beyond the middle of the antepenult turn, and in most adult shells the papillae are much obscured or lost. The last whorl has rather sharp, smooth, unequal growth-wrinkles below the suture (and sometimes extending upon the base), which are typically lost in a profuse, even malleation over most of the surface, but sometimes part of the growth wrinkles are apparent through the malleation, which fades out around the umbilicus. The last whorl descends slowly in front and is well rounded. Aperture dull brown within, showing the dark and light bands, the peristome white, rather narrowly expanded in the outer part, scarcely so above, narrowly reflected at base and dilated nearly over the umbilicus (or rarely closing it).

Diameter  $1\frac{1}{2}$  inches (Gould).

Height 24.4 mm., diameter 33.4 mm.;  $5\frac{3}{4}$  whorls.

Height 20.7 mm., diameter 27.7 mm.;  $5\frac{1}{2}$  whorls.



LOWER CALIFORNIA: San Antonio Canyon north of Johnson's ranch and Punta Banda (L. G. Ingles). Nachoguero Valley (Dall).

CALIFORNIA: San Diego (type, coll. by Andrew Belknap). Mission Valley (Kelsey). Oceanside (Grace Eaton). Laguna Beach, Orange County (J. Bequaert). Near Los Angeles, and Millard Canyon near Pasadena (Pilsbry). Glendora (Ingles).

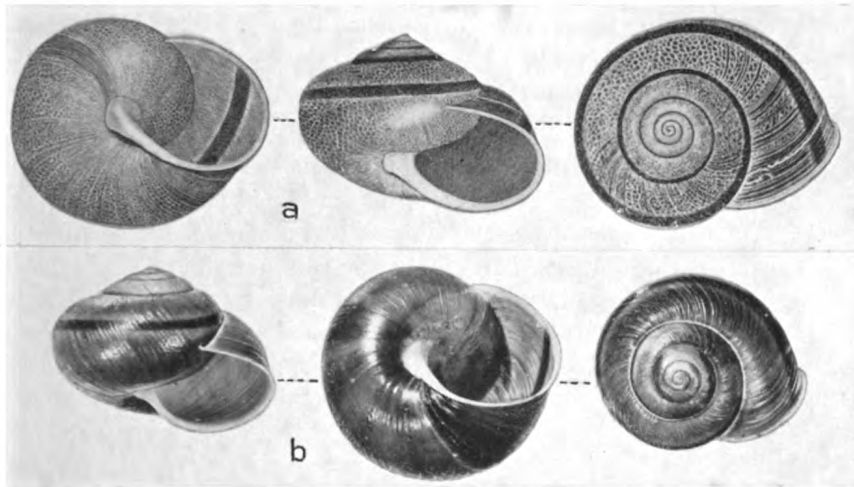


Fig. 33. a, *Helminthoglypta tudiculata*, type (after Binney). b, *H. tudiculata grippi*, type and paratypes.

The typical form of this widely spread species appears to be restricted to the western parts of San Diego, Orange and Los Angeles Counties, but the distinction from *H. t. subdola* from farther inland is rather arbitrary in some cases. Specimens from Laguna Beach measure 28.2 to 31 mm. in diameter. From Millard's Canyon, Pasadena, 25.5 to over 30 mm.

The first  $1\frac{1}{2}$  whorls are minutely, closely and irregularly granulose, and the following whorl or two often show some scattered papillae, but this sculpture is usually worn from adult shells. Some examples show a few incised spiral lines on the profusely malleate last whorl below the suture. There is no fine granulation behind the lip. Figure 33 a, reproduced from Binney, is the most copiously malleate form of the species, agreeing with specimens received from W. G. Binney and others, collected around San Diego, San Antonio Canyon, Lower California, and north along the coast to Laguna Beach. A profusely malleate form which I found low in Millard Canyon back of Pasadena is not distinguishable, I think. One measures, height 23 mm., diameter 31.5 mm., but some others from Pasadena (S. N. Rhoads) are smaller, down to about 28 mm. in diameter.

In Mission Valley, near the pumping station, San Diego County, the shells are narrowly umbilicate to imperforate, very glossy, buckthorn brown

with darker streaks and suffusion, and a rather wide (2 mm.) band. There is less malleation than the typical form, the sharp striae along growth lines being more developed. Adults measure 28 to 33.5 mm. in diameter. This form is intermediate between *tudiculata* and *grippi*, with more malleation than the latter.

It lives among bushes and plants back of Pacific Beach near San Diego. At Murray Dam, near San Diego, Mr. Ingles found it "in the leaf mould between loose rocks, under very moist conditions". Inland Mr. Kelsey found it aestivating in crevices of large rocks.

In *tudiculata* from Oceanside the mantle over the lung shows only very faint traces of spots, being nearly uniform light gray.

An albinistic individual has been described as follows: *Helix tudiculata* var. *binneyi* Hemphill "is of a uniform greenish yellow color, without blotches or markings, except a very faint trace of a band at the periphery. . . Mountains of San Diego Co., Cal. Only one specimen found." Mr. Allyn G. Smith has kindly examined Hemphill's unique type (2481 CAS. type coll.), and reports that it "is no more nor less than an albino *tudiculata* (*s.s.*). The C.A.S. shell is a beautiful living specimen, heavily malleate except for a small area around the umbilicus and another just behind the reflected aperture. Compared with typical *tudiculata* from San Diego and vicinity it is slightly more depressed but is still well within the range in variation of the typical form. If aberrant albino forms are to be named, then *binneyi* should stand. In my opinion such forms should not be given subspecific status and it would be better to throw them into synonymy."

An immature shell of this albino form received from Dr. Fred Baker, is from Murphey's canyon, Mission Valley, San Diego County. It was labelled *binneyi* by Hemphill, and agrees with the description above.

(*Tudiculatus*, beaten, refers to the "hammered" surface.)

***Helminthoglypta tudiculata grippi* (Pilsbry)**

Fig. 33 b.

*Epiphragmophora tudiculata grippii* Pilsbry, 1913, *Nautilus*, 27: 37, 49, pl. 3, figs. 15-17.

"The shell is thin, imperforate, more globose than *tudiculata*, strongly striate above, smoother and very glossy below, not malleated, or with only slight traces of malleation. Color dark raw umber or passing into dark olive, with a conspicuous dark chocolate band above the periphery, bordered with ecru-olive. Sutural line citrous yellow. First four whorls russet or sometimes salmon-buff. Columellar lip spreads and is adnate over the umbilicus."

Height 24 mm., diameter 32 mm. Type.

Height 21.4 mm., diameter 26.7 mm.; 5½ whorls.

CALIFORNIA: Santee, 18 miles from San Diego (Wm. C. W. Gripp). Type and paratypes 105300 A.N.S.P.

Of this charming snail Mr. Allyn G. Smith writes: "I consider *grippi* to be distinct from *binneyi* and therefore from *tudiculata* s.s. Its lack of malleations, high gloss, somewhat higher spire, and more globose body whorl (especially below the periphery) give it an unusual aspect for a shell of this group. I have collected it in San Diego River gorge, near San Diego. Apparently *grippi* is a localized form. The colonies, however, are not always pure, as partially malleated shells are sometimes found along with the smooth ones."

**Helminthoglypta tudiculata subdola** (Hemphill)

Fig. 34 a-d.

*Helix tudiculata* var. *subdola* Hemphill, 1890, Nautilus 4: 41.

[*Arionta tudiculata*] var. *subdola* Hemph., Binney, 1892, 4th Suppl. Terr. Moll., Bull. Mus. Comp. Zool. 22: 187.

*E[piphragmophora] tudiculata convicta* Hemph., Pilsbry, 1913, Nautilus 27: 49.

*Epiphragmophora tudiculata rufiterrae* Berry, 1916, Univ. Cal. Pub. Zool., 16: 109.

"Shell narrowly umbilicated; globosely depressed, of a dark yellowish color, surface somewhat shining, covered with oblique striae, interrupted by numerous wavy lines and oblong blister-like wrinkles, hardly perceptible to

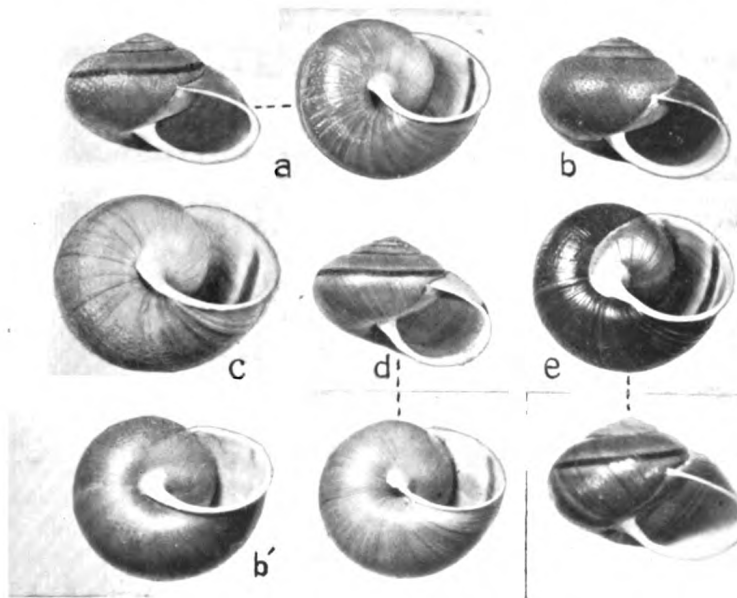


Fig. 34. a, *Helminthoglypta tudiculata subdola* (topotypes of *rufiterrae* Berry). b, b', *H. tudiculata subdola* form *convictus*, type. c, d, *H. tudiculata subdola*, San Jacinto valley. e, *H. tudiculata imperforata*, type, Ontario.

the naked eye; whorls  $5\frac{1}{2}$ , convex, striped by a single chestnut band, double margined by lighter ones; spire very little elevated, suture well impressed; lip simple reflected, and nearly covering the umbilicus, its terminations approaching and joined by a thin callus; umbilicus narrow and small. Height  $\frac{5}{8}$  inch, greatest diameter 1 inch, lesser  $\frac{7}{8}$  inch." (Hemphill.)

Height 17 mm., diameter 24.5 mm.; 5½ whorls.

Height 20.7 mm., diameter 29.2 mm.; 5½ whorls. San Jacinto Valley.

CALIFORNIA: San Jacinto Valley, Riverside County (Hemphill) syntypes 2487 to 2490 b, C.A.S. Cerritos, and Tejunga Wash, Roscoe, Los Angeles County; Redlands, San Bernardino County; Riverside, Riverside County.

The umbilicus is a little more open than in typical *tudiculata*. Shells from Hemphill are a dull, dilute brown above, fading to dilute buffy olive or honey yellow at base, the light-bordered band chestnut-brown. The sculpture varies about as in San Diego *tudiculata*. San Jacinto Valley shells vary a great deal in size, as Hemphill mentions that there are specimens far smaller than his type measurements.

*E. t. rufiterrae* Berry (Fig. 34 a) was found among leaves, shrubbery and piles of lumber, and under boards, near the southeastern entrance to Cañon Crest Park, Redlands; common on neighboring hills. Compared with *subdola*, Berry states that "specimens from Hemphill's original material are now before me, and undeniably evidence a close relationship, but the Redlands specimens differ very constantly in their warmer, brighter coloration, much broader and darker color band, swollen base, obese spire, and less spreading outline. A few of the shells show a tendency to approach *subdolos* in one or more of these features, but the majority of these are immature or appear more or less pathologic in some way. Normal specimens so far as seen are quite uniform". Berry gave the diameter of type 27 mm., of largest shell 28 mm., smallest 22.5 mm. In a lot of 20 from Riverside (S. N. Rhoads), the diameter runs from 20.3 to 26 mm. I have seen about 80 shells from five localities mentioned above, including two lots of *subdola* from Hemphill and a series of *rufiterrae* from Dr. Berry. In my opinion they do not bear out Berry's belief that the two are racially separable. I can find no differences between some perfectly normal individuals of these supposed races. From the material available I conclude that while *subdola* is separable from *tudiculata*, it is not practicable to segregate *rufiterrae* also. Unfortunately it is not known exactly where Hemphill collected *subdola*; his locality "San Jacinto Valley" is vague.

(*Subdolos*, deceitful.)

*H. tudiculata convictus* (Hemphill), of which the type, 86896 A.N.S.P. is figured (Fig. 34, b, b') was briefly defined as "small, copiously malleate, without a band at the shoulder". The locality on Hemphill's printed labels is Los Angeles Co. (not San Diego Co., as recorded in *Nautilus*, 27: 49 by error). It is moderately solid. The color is buckthorn brown, slightly lighter at base and where the brown band should be, and under close examination a very faintly traced band can be seen in places. The reflected lip conceals but is not closed over the umbilicus. Height 18 mm., diameter 26.3 mm.; 5½ whorls. While this is recognizable as a color-form, it does not

appear separable subspecifically from forms here grouped under *subdola*, being merely a bandless mutation. The name *convictus*, mess-mate, probably hints that it consorted with banded shells.

**Helminthoglypta tudiculata angelena** Berry

Fig. 35.

*Helminthoglypta tudiculata angelena* Berry, April, 1930, Jour. Ent. & Zool., Pomona Coll., 30: 21, figs. 7, 8.

"Shell fairly large, of moderate weight and thickness, spire low-conic; whorls usually a trifle under 6, moderately convex between the very distinct sutures, enlarging regularly and quite rapidly till near maturity when the

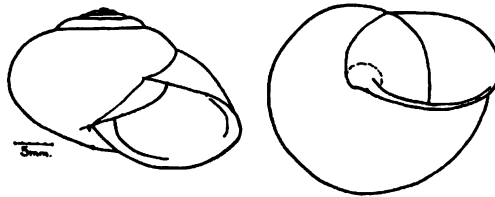


Fig. 35. *Helminthoglypta tudiculata angelena*. (after Berry.)

tumid body-whorl expands somewhat more rapidly and descends strongly above to the aperture; base tumid, axis permeable. Aperture rounded-ovate to nearly circular, strongly oblique; peristome whitish, only moderately thickened, narrowly reflected above and more strongly so below where it terminates in the strong columellar flare, nearly or quite closing the narrow umbilicus. Embryonic whorls swollen; rather coarsely radially wrinkled following the initial smooth stage, then very finely wrinkled-granulose, with the usual overlying system of small, distant, decurrently serial, rounded papillae, the whole of this sculpture becoming suddenly much reduced on the first post-embryonic whorl, and shortly thereafter entirely obsolete; remaining whorls with strong, irregular growth-lines, the two concluding whorls covered with close malleations, which become finer and weaker basally; region immediately behind lip minutely irregularly granulose; spiral sculpture reduced to a few weak interrupted incised lines on the body-whorl below the suture, and occasional very weak traces on the base, although in some specimens, they may be quite sharply and strongly developed on the umbilical slope. Periostracum polished; upper surface saccardo's umber, paling to buffy brown on spire; base tawny-olive to sayal brown; the sharply contrasting, conspicuous, supraperipheral band of dark warm sepia about 2 mm. wide, and bordered above and below by slightly narrower zones of dark olive-buff." (Berry.)

Max. diameter 29.5 mm., min. diameter 23.9 mm., altitude 20.2 mm.; 5½ whorls. Type.

Paratypes from max. diameter 31.6 mm., min. diameter 25.2 mm., altitude 20.6 mm.; 5½ whorls, to max. diameter 26.3 mm., min. diameter 21.2 mm., altitude 18.4 mm.; 5½ whorls.

CALIFORNIA: Throughout the Los Angeles Basin. Lower end of San Timoteo Canyon on northeast side, near Redlands (L. G. Ingles). Type 8654 Berry Collection; paratypes 6458 Berry Collection; others to be deposited in the collections of San Diego Museum of Natural History, Stanford University, Academy of Natural Sciences of Philadelphia, United States National Museum and A. G. Smith.

"The present subspecies is found practically throughout the Los Angeles Basin and its tributary canyons, its range thus covering a good part of Los Angeles County and adjoining areas in Ventura, Orange, Riverside, and San Bernardino Counties. I have seen specimens apparently referable to *angelena* from as far east as lower Mill Creek Canyon in the San Bernardino Mountains, Tremont Park and Perris in Riverside County, as far south as the vicinity of Anaheim, and as far west and north as Bardsdale in Ventura County. Farther east in San Bernardino and Riverside Counties it yields ground to the subspecies *rufiterrae* (Berry) and *subdola* (Hemphill), forms so nearly allied that collecting in intervening territory may find their point of intergradation too imperceptible to justify continued recognition of both. Further south near the southern border of Riverside County forms more like typical *tudiculata* occur. From *tudiculata* s. s. the present form is differentiated by its smaller size, more polished surface, lower spire, and less strongly malleated surface, as well as usually by its rather warmer and lighter coloring. It is larger, more elevated, and darker than *subdola* or *rufiterrae*, and the umbilicus as a rule is more completely occluded.

"The race is named for the Los Angeles Basin, nearly throughout which it is a characteristic snail wherever conditions are proper for its existence. It should be noted that around Upland and Ontario, however, we find rather commonly a curious and very handsome smaller form with a rounder, much inflated body-whorl, and smoother periostracum, not at all typical of the subspecies *angelena* as herein described." (Berry.)

**Helminthoglypta tudiculata imperforata** new subspecies

Fig. 34 e.

The shell is imperforate (or with a very narrow crevice behind the lip); smaller and usually much less malleate than *tudiculata*, very glossy; dresden brown, passing into a yellower shade on the base, the borders of the chestnut-brown band yellow. Aperture larger and peristome better developed than in *H. t. subdola*. Type and paratype measure 19.2 x 27 mm., 5½ whorls, and 16.4 x 24 mm., 5½ whorls. The h/d index is variable, the highest and lowest shells in a lot of 21 from Ontario measuring 21 x 26.6 mm., and 18.6 x 28 mm.

CALIFORNIA: Ontario, San Bernardino County (R. H. Tremper), Type 91714a A.N.S.P. Near Claremont, Los Angeles County (C. F. Baker).

In both localities albinistic specimens also occurred, reed yellow to colonial buff, without a band.

It has considerable resemblance to small examples of *H. tudiculata grippi*. I presume that *imperfurata* is distinct from *angelena*, which I have not seen, as Dr. Berry had paratypes of my race about a year before he described *angelena*. This local race, not occurring south of Cajon Pass, perhaps may be found all along the foothills of the Cucamonga range (the next north of the San Antonio Mts., which terminate at the Cajon Pass). Some small *tudiculata* forms from farther west resemble *imperfurata* but are slightly perforate and mostly more malleate, such as sets in A. G. Smith Coll. from the bed of San Gabriel River, and Arroyo Seco in Los Angeles county near Pasadena.

**Helminthoglypta berryi** Hanna

Fig. 36.

*Helminthoglypta berryi* Hanna, 1929, Proc. Cal. Acad. Sci., (4), 18: 217, pl. 24, figs. 7-9.—Ingles, 1935, Proc. Malac. Soc. Lond., 21: 270, 273, pl. 30, figs. 1, 4 (genitalia and jaw).

“Shell of medium size, *globose*, composed of  $5\frac{1}{2}$  well-rounded whorls; suture deep; umbilicus completely closed in the holotype, almost closed in the paratype; white or pale brown, bandless (in all specimens seen); upper portion of whorls sculptured with irregular growth ridges, almost ribs; lower portion of body whorl with a series of malleations, becoming pits in some cases; these pits roughly arranged in spiral order and almost obliterate the



Fig. 36. *Helminthoglypta berryi*, after Hanna; (middle figure enlarged).

growth lines near the margin of the shell; the line of demarcation between the series of growth ridges above and the malleations below is very sharp and is approximately in the position of the color band as usually developed in this genus; aperture large and capacious; outer lip moderately reflected; terminations of peristome connected by a wash of callus over the body whorl. Diameter (holotype) 22.5 mm., height 21 mm.; diameter (paratype 1493) 23 mm., height 21 mm.” (Hanna.)

CALIFORNIA: Eight miles northeast of Bakersfield, Kern Co. (G. D. Hanna). Type 1492 CAS. About three-fourths of a mile north of Kern River and four miles east of Oil City (Hanna). Kern River oil field (S. S. Berry).

In the topotype received the demarcation between the close, strong striae above and the peripheral and basal malleation while abrupt seems less sharp than described for the type. It has been assumed to be closely allied to

*H. californiensis* on account of the similar globular shape; but the sculpture is quite different, of the *tudiculata* pattern by its rather sharp growth-ridges above, followed by malleation. The genitalia, figured by Ingles, show a swollen penis, a small dart sac, and the mucous glands "have very little neck at the point of bifurcation". Length in mm.: penis + epiphallus 18; flagellum 8; vagina 2.5; spermathecal duct 32; diverticulum 39. *H. berryi* appears to be a somewhat isolated species of the *tudiculata* stock, parallel to *H. californiensis* in the *nickliniana* stock, but not directly related to the latter.

According to Hanna, the first known specimens of this remarkable species were found in 1926 about two miles north of Poso Creek and five miles east of the mouth of Granite Creek. These were somewhat imperfect. Better material was found in 1927, one and one-half miles southeast of the top of Round Mountain, about three-fourths of a mile north of Kern River and four miles east of Oil City; this is the type locality. Fragments were seen scattered in other places. It is evident that the species is fairly widely distributed in this district.

"All of the shells found were dead, but the one made the holotype has the epidermis and the pale brown color preserved. All were found on the slopes of dry, barren, ashy hills, usually, but not always, on northern slopes. No rock outcrops occur near where the shells were found, but invariably they were in torn-up earth where cattle had trampled during wet weather. This peculiar habitat, with the pale color and absence of a band, leads to the supposition that the animal is a burrowing form. After having collected snails rather extensively in the forests and among the rocks of California, I was most astonished to find this one on soft, powdery, ashy hills." (Hanna.)<sup>1</sup>

L. G. Ingles found living *berryi* in foothills of the Tehachapi Mountains in covered rock slides and buried boulder beds. They were active in summer two feet below the surface.

(Named for Dr. S. Stillman Berry.)

**Helminthoglypta allyniana** (Berry)

Fig. 37 c.

*Epiphragmophora tudiculata allyniana* Berry, 1920, Proc. Cal. Acad. Sci., (4), 10: 54, pl. 4, figs. 1a-1c.

"Shell moderately thin, low-conic to depressed-globose, strongly umbilicate, the umbilicus narrow and steep-walled, but permeable to the apex and having a diameter of about one-eleventh the major diameter of the shell. Whorls about 6, convex, the last strongly inflated and somewhat descending

<sup>1</sup>"Since this was written Dr. Berry has collected living specimens of what appears to be the same species in the Kern River oil field and the characters as outlined are confirmed in most respects; the living shell seems thinner than the dead ones upon which the description was based. The habitat is definitely proved not always to be ashy hills as at first supposed." (G. D. Hanna.)



in front. Aperture rounded, ample, and very oblique, its deflection about  $40^\circ$ . Edges of peristome converging and connected by a thin parietal callus. Periostracum quite glossy, but roughened over most of the later whorls by numerous fine incremental lines and a very fine, close malleation like small hammer dents, the latter becoming obsolete on the higher portions of the spire and in the immediate vicinity of the umbilicus. Color a dull cinnamon or prout's brown, becoming yellowish and paler in the umbilical region, and with a dark liver brown band of a width of about 1.5 mm. on the shoulder, bordered above and below by a light yellowish-brown band of about equal width with the dark band and with its mate opposite, or the lower in some cases a little the wider. Max. diameter 32 mm., min. 25.5 mm., alt. 20 mm., diameter umbilicus 3 mm.; 6 whorls." (Berry.)

Paratypes measure from 16.6 x 26.3 mm. to 18.8 x 32.3 mm.

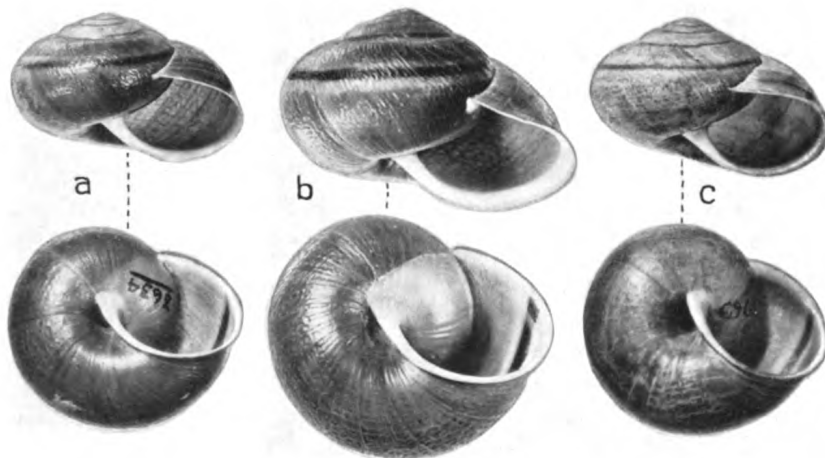


Fig. 37. a, *Helminthoglypta allyniana kernensis*, Poso Creek, Kern Co. b, *H. allyniana rex*, Tule River Indian Reservation, Tulare Co. c, *H. allyniana allyniana*, Jasper Road, Merced R., Mariposa Co.

CALIFORNIA: Jasper Point, Mariposa County, Type 4850 Berry Collection, paratypes in collection of the California Academy of Sciences and of Allyn G. Smith, no. 1969. Bagby, Mariposa County (Allyn G. Smith). La Grange, and banks of the Tuolumne River at Waterford, Stanislaus County (Chace).

"This large and fine race cannot be confused with any of the described subspecies of *tudiculata*, unless it be the *E. t. umbilicata* Pilsbry from San Luis Obispo County. The latter is likewise a relatively depressed, finely malleate, umbilicate form, but is well distinguished from its Sierran relative by its smaller, less tumid, heavier, and much more solid shell, lighter color, more conspicuous banding, and more polished surface." (Berry.)

Typically it is larger, more solid and more openly umbilicate than *H. cypreophila*. Paratypes show some granulation on the back of the lip and

within the umbilicus, as in *cypreophila*. In a specimen labelled Mariposa, from W. G. Binney, this granulation is not visible. "Five shells from Waterford, Stanislaus County, collected by the Chaces, are smaller than the type lot, the largest measuring height 17.4, diam. 25.2 mm., 5½ whorls, the smallest 14, 21.5 mm., 5 whorls. The umbilicus is slightly smaller. All have an evanescent rose-purple tint in the aperture." (A. G. Smith.)

A rough sketch of the anterior genitalia of *H. allyniana kernensis* made some years ago is reproduced in Figure 38, as the specimen is lost. The proportions of the penis are as in *H. tudiculata subdola*, but both penis and flagellum are decidedly shorter than in *H. cypreophila*, and the connection of vagina and atrial sac appears longer. The mucous glands appear to be more reduced, in the sketch. Further examination is needed.

Is *H. allyniana* to be ranked as a "good species" or as a southern appanage of *H. cypreophila*? This may still be considered questionable; but, abetted by Allyn Smith, I have taken the former alternative.

(Named for Mr. Allyn G. Smith.)

**Helminthoglypta allyniana kernensis** Berry

Figs. 37a, 38.

*Helminthoglypta tudiculata kernensis* [typographical error] Berry, 1929 (Oct.), *Nautilus*, 43: 40; corrected to *kernensis*, Berry, 1930 (Apr.), 43: 138.

*Helix (Arionta) tudiculata* W. G. Binney, Stearns, 1893, *N. A. Fauna*, no. 7, p. 272 (Three Rivers, Tulare Co., 850 ft. elevation).

"Shell helicoid, large, low rounded-conic, tumid, rather thin, heavily malleated above as in *tudiculata* s. s. and similar in most respects to the typical race as found in the vicinity of San Diego except that the shell is more depressed and is *conspicuously umbilicate*, the umbilicus only a trifle covered by the columellar reflection of the peristome. Max. diameter 30.4, alt. 19.7, diameter umbilicus 2.7 mm." (Berry.)

Mantle variegated with irregular pale gray spots.

CALIFORNIA: Poso Creek, Kern County, under moist logs (L. G. Ingles & M. Smith). Type 6863 Berry Collection, paratype 152593 A.N.S.P.

"This large, conspicuously umbilicate and malleate race of the most widespread southern Californian helicoid appears to be a common and characteristic form in Kern County and is at hand from many localities there." (Berry.)

A topotype is figured (Fig. 37 a). The greener hue and decidedly less covered umbilicus differentiate it from southern *tudiculata*. The umbilicus is less widely open and the malleation is somewhat stronger than in *H.*

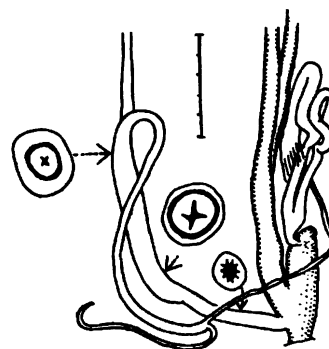


Fig. 38. *Helminthoglypta allyniana kernensis*, genitalia.

*allyniana*. In a paratype from Poso Creek there are distinct granules within the umbilicus and behind the lip. In one of those from three miles east of bridge on Woody Road, Poso Creek (A. G. Smith) I find no granulation, though in another it is conspicuous. It is larger and darker than *H. cypreophila*.

**Helminthoglypta allyniana rex** Church & Smith

Figs. 37 b, 39.

*Helminthoglypta tudiculata rex* Church & Smith, 1938 (Jan.), *Nautilus*, 51: pl. 8, figs. 10, 11, 12; 1938 (Apr.), p. 119.

“Shell helicoid, very large for the species, moderately thick; spire low, with an angle of  $125^{\circ}$ ; whorls, 6, the last well-rounded and rapidly expanding to form a sub-circular aperture of unusually large proportions; lip simple, not thickened, moderately reflected except at the base where the reflection is sufficient to conceal about one-half of the umbilicus, connected between terminations by a thin wash of callus; umbilicus rather small, being contained about 14 times in the major diameter of the shell. Nuclear whorls 2, finely granular under a lens of medium power except for the nucleus itself, which is glassy at the tip followed by a short wrinkled zone, the remainder of the nuclear whorls being relatively smooth. Sculpture of the early postnuclear whorls consists of low but well-developed, closely spaced, growth ridges of unequal strength. Weak malleations begin to show on the second whorl



Fig. 39. *Helminthoglypta allyniana rex*. (After Church & Smith.)

from the last, becoming rapidly stronger until on the last whorl they are so exceedingly large and coarse that they dominate the entire appearance of the shell. They cover the last whorl except in the umbilical region and for a short distance behind the lip, where they become obsolete. Color much as in *tudiculata* s. s. but darker and with a more greenish cast, especially on the body whorl; the raised edges of the malleations are considerably lighter in color than the pits, thus making them stand out more sharply. The dark brown revolving band is nearly 2 mm. wide and is set off by two light-colored zones, each having almost the same width. Max. diameter 39.1 mm.; min. diameter 30.8 mm.; alt. 27.2 mm.” (Church & Smith.)

**CALIFORNIA:** Under granite boulders along the tree-shaded initial terrace above the bed of the Middle Fork of the Tule River, about 2 miles above and east of Springville, at the boundary of the Sierra National Forest, Tulare County (C. C. Church and G. D. Hanna), Type 7189 C.A.S.; paratypes in Academy of Natural Sciences of Philadelphia, San Diego Society

of Natural History, Los Angeles Museum, and private collections of E. P. Chace, S. S. Berry and A. G. Smith. Also a second lot (C.A.S. No. 28181), from 8 miles east of Porterville, Tulare Co., same collectors. Tule River Indian Reservation, 18 miles east of Porterville (Wharton Huber). Visalia (J. G. Cooper) and Cramer (Hemphill), Tulare Co.

“The most striking characters of this subspecies are its uniformly great size, the extremely heavy malleation on the body whorl, and the light color of the edges of the malleations in comparison with the much darker color of the pits. While it is not believed that mere size should be the sole criterion in naming a new species or subspecies, it is believed that this shell exhibits a sufficient number of other different characters to warrant giving it a name. We believe we are safe in the assertion that this represents the largest known California land snail.

“It is most nearly related to *H. tudiculata kernensis* Berry, but in addition to larger average size it has a heavier shell, is more conspicuously and coarsely malleated, is darker and generally more greenish in color, and lacks the wide open umbilicus of *kernensis*. Some smaller adult specimens of *rex* approximate *kernensis* in size, however, so it is possible that with additional collecting in intervening territory an intergrading series linking the two subspecies may be found.

“The range in size at the type locality is as follows:

“Largest: Diameter 42.6 mm., height 28.6 mm., 6 whorls.

“Smallest: Diameter 33.3 mm., height 23.0 mm., 5 $\frac{1}{4}$  whorls.

“Average of 17: Diameter 38.4 mm., height 26.7 mm., 6 whorls.

“Of the 17 adults measured 5 had a maximum diameter of 40 mm. or more, and 9 were larger than 38. In the University of California is a lot of 5 shells (No. 2503) labeled ‘Tulare Co., Calif., D. O. Mills collection’ ranging from 34.8 to 37.8 mm. but which did not exhibit the coarse malleation so characteristic of *rex*. We have examined two lots of shells smaller than *rex* but larger than *kernensis* found by one of us (Church) beside the small canal 3 miles east of Porterville on the Tule River and also among weeds and willow and cottonwood leaves near the dry bed of Deer Creek where it enters the valley. Shells collected near Porterville by Hemphill (C.A.S. Nos. 8802-8805, incl.) are identical with those from Deer Creek. Young shells of what appears to be this smaller race (A.G.S. No. 5495) were collected at Bartlett Park on the South Fork of the Tule River, 12 miles east of Porterville.” (Church & Smith.)

Shells collected by Wharton Huber in the Tule River Reservation measure 34.6 to 37.8 mm. diameter (Fig. 37 b). Those from Cramer and Visalia are between 34 and 35 mm. In one of the Tule River lot the interior of the umbilicus is papillose, and Mr. Smith reports granulation behind the lip in one of the type lot; but in other specimens of *rex* examined there are

no granules behind the lip or in the umbilicus. Such sculpture appears to be a vanishing character in this race.

(*Rex*, king.)

**Helminthoglypta cypreophila** ('Newc.' Binney and Bland) Fig. 40: 1-6.

*Helix cypreophila* Newc., W. G. Binney & T. Bland, 1869, L. & Fr. W. Sh. N. A., 1: 166, fig. 287 (Copperopolis).

[*Arionta tudiculata*] form *cypreophila*, Binney, 1892, Bull. Mus. Comp. Zoöl., 22: 187, pl. 2, figs. 7, 8.

(?) *Helix (Arionta) cypreophila* Newc., Stearns, 1893, N. A. Fauna, no. 7, pt. 2, p. 272 (Three Rivers, Tulare Co., 850 ft. elevation).

*Epiphragmophora tudiculata colusaensis* Bartsch, 1919, Nautilus 22: 126 (about a mile southeast of Sites, Colusa Co., G. Willett).

*Helminthoglypta tudiculata cypreophila* ('Newc.' B. & B.), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila., for 1926, 78: 485, pl. 39, figs. 5, 6; pl. 40, figs. 1-4a.—Hanna, 1933, Nautilus, 46: 83, pl. 6, fig. 9, genitalia (1 mi. west of Columbia, Calaveras Co.).—Ingles, 1935, Proc. Malac. Soc. Lond., 21: 268, pl. 29, fig. 6; pl. 30, fig. 6, genitalia and jaw (butte near Chico, in rock slides).

The shell is rather thin, globose-depressed, narrowly, nearly covered umbilicate; olive-lake with honey yellow and buffy-citrine streaks, or somewhat darker, isabella color or ecru-olive, having a narrow chestnut-brown band inclosed in narrow pale bands. Embryonic whorls about  $1\frac{1}{2}$ . After a very small, smooth tip there are a few coarse granulose wrinkles, followed by extremely fine, closely crowded wavy and finely granulose radial wrinkles, or the radial arrangement may be lost in an irregular granulation. Near the end of the second whorl the surface is still microscopically granulose, and spaced papillae are superposed, partly in obliquely descending series. These continue upon the third whorl, but not on those later. They are not visible in any mature shells examined. Following whorls are finely, rather sharply striate. On the last whorl this striation predominates below the suture, but is interrupted by a rather profuse malleation in the peripheral region and base, where the striation is only quite weakly developed. "Immediately behind the lip the surface is *minutely granulose*, especially back of the upper angle and in the umbilicus." The peristome is white, expanded above, the outer and basal margins narrowly reflected, at the columella dilated, covering about half of the umbilicus or more.

Height 16.7 mm., diameter 27 mm.;  $5\frac{1}{2}$  whorls. Calaveras Co.

Height 17.4 mm., diameter 25 mm.;  $5\frac{1}{2}$  whorls. Calaveras Co.

Height 15.3 mm., diameter 23.5 mm.;  $5\frac{1}{2}$  whorls. Calaveras Co.

Height 19.6 mm., diameter 29.6 mm.;  $5\frac{1}{2}$  whorls. Tuolumne Co.

Height 16 mm., diameter 24 mm. Snelling, Merced Co.

Height 14 mm., diameter 22.8 mm. 5 mi. West of Raymond, Madera Co.

CALIFORNIA: Lower foothills of the eastern slope of the interior valley from Fresno County north to Tehama, and westward across the Sacramento River, but east of the Coast Range, into Colusa County; known from the following counties: Fresno, Merced, Madera, Mariposa, Tuolumne, Calaveras, Placer, Yuba, Sutter, Colusa, Butte and Tehama. Type from Copperopolis, Calaveras County (Newcomb).

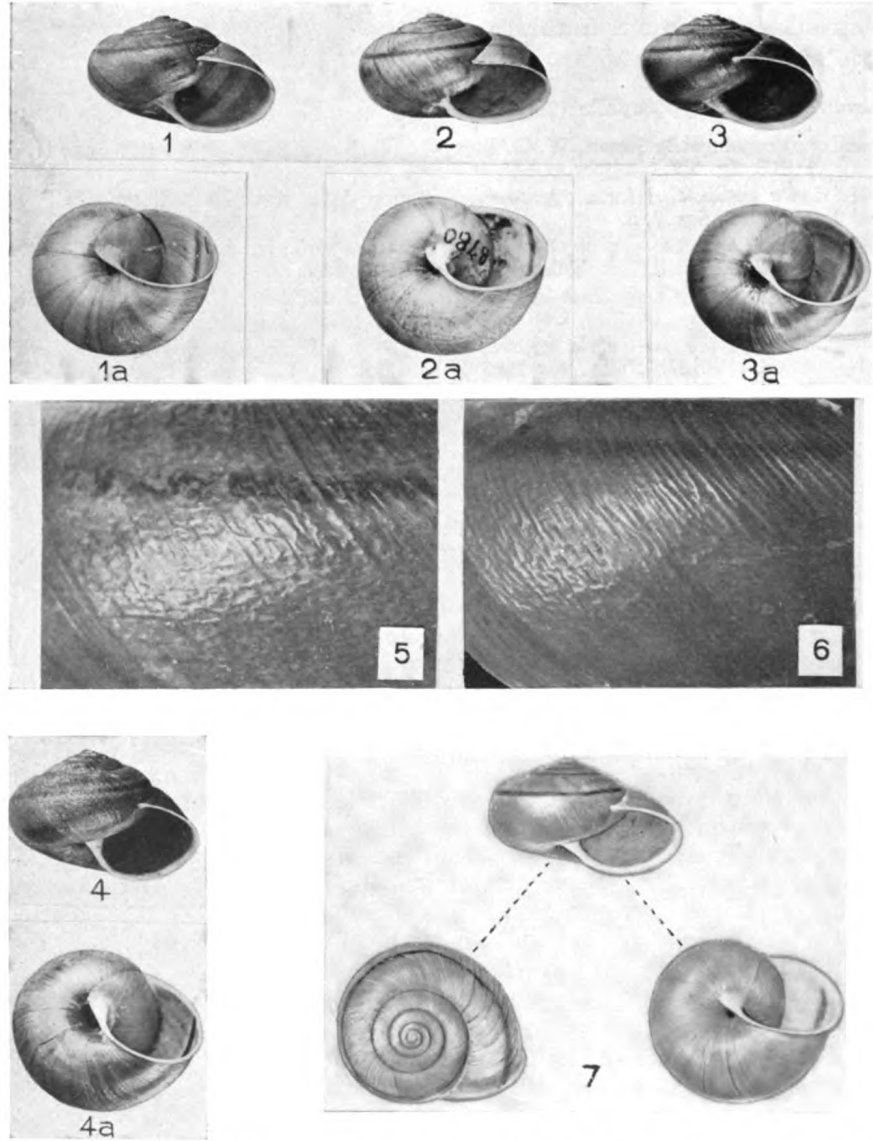


Fig. 40. 1, 1a, 6. *Helminthoglypta cyrcophila* (type of *colusacensis*). 2, 2a. *H. cyrcophila*, Brown's Valley, Yuba Co. 3, 3a, 4, 4a, 5, *H. cyrcophila*, Calaveras Co. 7, *H. allysmithi*. (Figs. 5 and 6, x 5.)

The absence of spaced papillae on the nuclear whorls and the presence of granulation behind the lip separate this species from the southern *tudiculata* stock. I have verified the presence of papillae on early neanic whorls in Fresno specimens only, as there are no young shells in other lots

at hand, and these papillae, if present, seem to become effaced in the adult stage. *H. tularensis* and *H. t. sequoia* are smaller, thinner shells, with papillae in diagonal series well developed on the spire. *H. cypreophila* varies widely in size, and in the degree of malleation of the last whorl.

The type of *colusaensis*, kindly lent me by Dr. Bartsch (Fig. 40: 1, 1a, 6) measures, height 16, diameter 24.4 mm. Its band is rather light, the pale borders weakly marked. There is less malleation than in some Calaveras specimens, though it is fairly well developed. *Colusaensis* has no racial characters distinct from *cypreophila*. It lives in the same life zone. A specimen of *H. cypreophila* from Brown's Valley, Yuba Co., No. 8780 C.A.S., collected by Hemphill, measures, height 15.2 mm., diameter 25 mm., being rather depressed for this subspecies. The color is between ecru-olive and deep colonial buff. It is finely malleate on the last half whorl but elsewhere striate with very slight traces of malleation, (Figs. 40: 2, 2a). The largest see, from Tuolumne County, measures 19.6 x 29.6 mm. Those from Merced and Madera Counties are small. All have the prelabral granulation of their race, though it is sometimes weak.

Topotypes from Copperopolis collected by Allyn G. Smith were dissected. The mantle is profusely marked with small irregular black spots and dots partly confluent into irregular figures, on a pale ground. The foot is dark grayish brown fading towards the edges and on the tail. Genitalia (Fig. 41c, Copperopolis) with very long penis with quadrangular cavity (Fig. 41: c 1c). Flagellum also long, nearly half the length of penis and epiphallus. The very small dart sac is on a long atrial sac. Mucous glands only moderately swollen, with long and voluminous continuations which envelop the whole dart apparatus and part of the vagina (removed in the figure). The peduncles of mucous glands branching from the long common duct are quite thick. Vagina long. The spermatheca is oval. Diverticulum about equal to the other branch in length, but decidedly stouter. It contained slender spermatophores of orange rufous color. The proportions in this topotype are about as in dissections made by Hanna and by Ingles, but Ingles found the atrial sac shorter in specimens from Chico, Butte County.

(*Cypreophila*, lover of cypress.)

***Helminthoglypta allynsmithi* new species**

Fig. 40: 7.

The shell is depressed-globose, umbilicate, thin, similar in form to *H. cypreophila* except that the spire is lower. Whorls of the spire rather closely coiled, the last whorl very wide. Color between honey-yellow and isabella color, with a rather narrow russet to cinnamon-brown band bordered with indistinct bands lighter than the ground color. The surface is somewhat dull above, more glossy at the base. The embryonic  $1\frac{1}{2}$  whorls after some irregular wrinkles, have an irregular, microscopic and shallow radial rugosity, upon which a few low and inconspicuous papillae may be seen (in

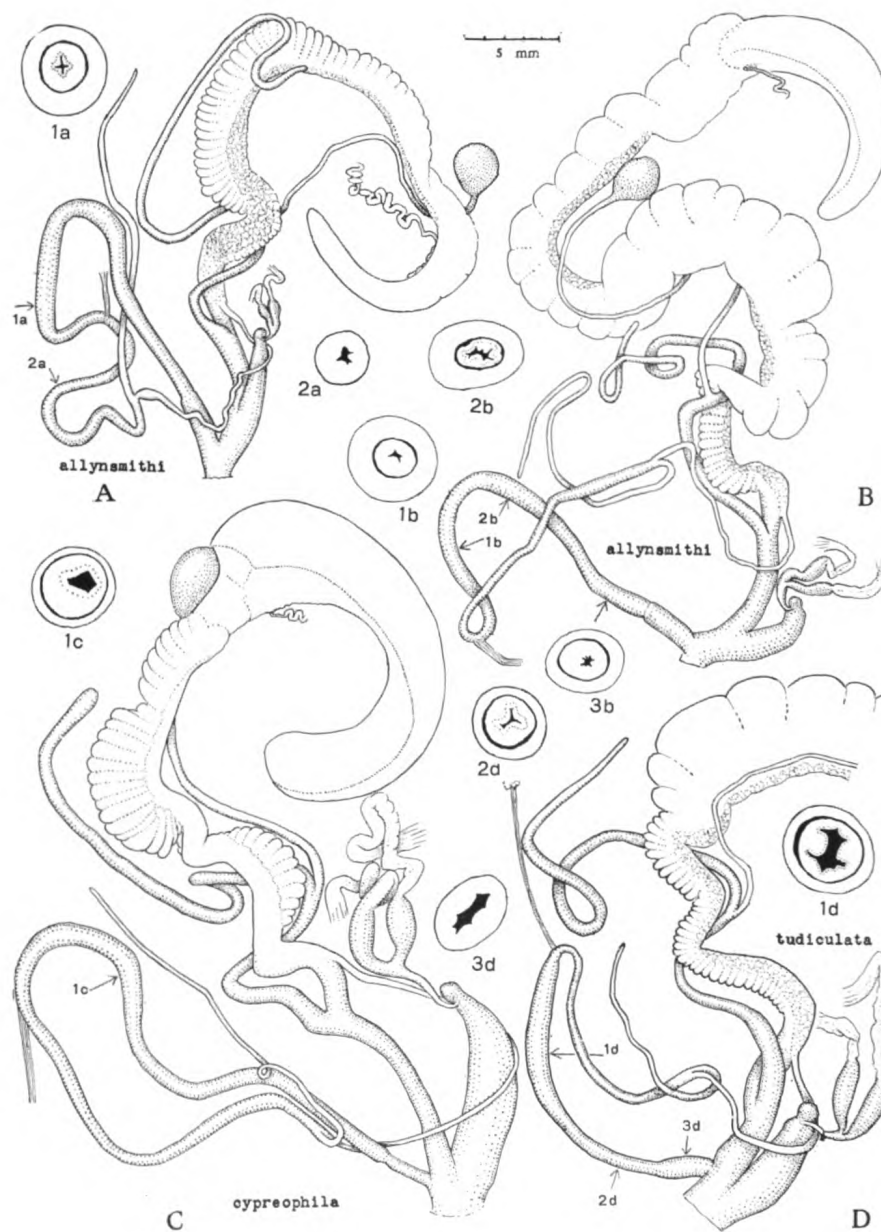


Fig. 41. A, *Helminthoglypta allynsmithi*, 5.3 miles below El Portal; B, 3 miles below El Portal. C, *H. cypreophila*, Copperopolis. D, *H. tudiculata subdola*, mountains west of Riverside. (Scale line refers to large figures only.)



the best preserved examples). Following whorls are very lightly marked with low growth wrinkles, over which there is an almost obsolete granulation in some places. The last whorl has weak growth wrinkles and no malleation, but under the microscope a dense irregularly spiral lineolation may be seen in proper light. Indistinct traces of granulation appear behind the lip and within the umbilicus. The large aperture has a somewhat brownish vinaceous tint within. The lip is nearly white, narrowly expanded in its outer and basal arcs, somewhat thickened within, broadly dilated half over the umbilicus at the columellar insertion.

Height 14.7 mm., diameter 25.1 mm.;  $5\frac{1}{2}$  whorls. Type.

Height 16.6 mm., diameter 26.9 mm.;  $5\frac{1}{2}$  whorls.

CALIFORNIA: Merced River Canyon 3 miles below El Portal, Mariposa County (Allyn G. Smith), Type 173940 A.N.S.P., from 4136 A. G. Smith Collection. Also 5.3 miles below El Portal in the same canyon (A. G. S.).

The shell is thinner and lighter colored than *H. cypreophila*, not malleate, with the granulation behind the lip very much reduced. The most important differential character from *H. cypreophila* is that the vagina and the atrial sac leading to the dart sac are more extensively united in *H. allynsmithi*, than in any other *Helminthoglypta* dissected, but in *cypreophila* they are separate to the atrium proper. Less important differences are the smaller bulbous part of the mucous glands and their shorter common duct. *H. tularensis* (Hemph.) differs by the large dart sac and numerous other proportions of the genitalia, as well as by having papillae in protractive series on the spire and a decidedly narrower umbilical perforation.

The localities for this species are around 1500 feet elevation, being well below those of *H. napaea yosemitensis*.

Two specimens were dissected, one (Fig. 41 B) from three miles below, and another (Fig. 41 A) from 5.3 miles below El Portal. The foot is slate olive; sole isabella color in the middle, light brownish olive at the sides. Mantle buff, with irregular black spots and dots.

Genitalia (Figs. 41 A, B). The very long penis has at the base a collar-like thickening of the wall, 2.5 mm. long. It has a thick muscular outer tube. The cavity of the inner tube is rather small in the upper and lower parts (Figs. 41: 1b, 3b) and larger in the slightly swollen median part (Fig. 41: 2b). The epiphallus, a little shorter than the penis, bears the very short retractor muscle near its lower end. In section (Fig. 41: 2a) it has an irregularly cruciform cavity and solid wall. The dart sac proper is very short, less than one mm. in length though the entire atrial sac is about 6 or 7 mm. long, the part above entrance of vagina about 5 mm. Mucous glands very small, with rather short common duct and with the usual irregular membranous extensions. Vagina about 6 mm. long. It is inserted farther up than usual on the atrial sac which bears the dart sac. Spermatheca is shortly oval, on a long duct which has a long branch or diverticulum arising about 9 mm. from base of spermathecal duct. Measurements in mm. follow:

Penis and epiphallus	Flagellum	Dart sac and atrium	Vagina	Diverticulum	Fig.
39	19	6	6	24	41 B
41	19	7	6	..	41 A

**Helminthoglypta hertleini** Hanna & Smith

Fig. 42.

*Helminthoglypta hertleini* Hanna & Smith, 1937, Nautilus, 51: 16, pl. 1, fig. c.

“Shell thin and delicate, pale golden brown, with a very narrow band of a darker shade, bounded below by an equally narrow band of a lighter shade; whorls five, regularly increasing in size; surface marked with fairly coarse growth ridges, and very irregularly scattered papillae; nuclear whorl with faint growth lines and a finely roughened surface; aperture not expanded; peristome simple and scarcely reflected (except in the umbilical region) and slightly thickened interiorly; umbilicus narrow, half covered by the reflected basal wall. Max. diameter 18.5 mm.; min. diameter 15.3 mm.; altitude 12.5 mm.; diameter umbilicus about 2 mm.” (Hanna & Smith.)

OREGON: A lava rock slide 6.6 miles east of the junction of the Klamath Falls road with U. S. Highway No. 99, Jackson County; north side of road, Type 7094 and paratype 7095 C.A.S. (H. B. Baker, J. L. Nicholson & G. D. Hanna, July 26, 1929).

CALIFORNIA: Near mouth of the canyon of the Shasta River, Siskiyou County (E. P. Chace).

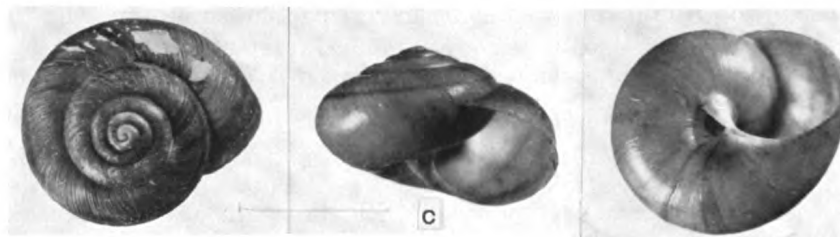


Fig. 42. *Helminthoglypta hertleini* (after Hanna & Smith). ( $\times$  about  $\frac{5}{8}$ .)

“The above is a description of the holotype; 17 additional specimens, mostly dead and imperfect, were collected at the same place. These indicate that the species is fairly constant in its characters; the largest shell is 22.6 mm., in diameter and the smallest is 17.8 mm. No species belonging to this group of the genus has been found within a long distance of the present locality. We have noticed in collecting members of the *H. cypreophila* group, that to the northward in the volcanic country shells become smaller and relatively thinner than at the type locality in Calaveras County, California. The form here described seems to be at or near the extreme northern range; it has lost the reflected peristome, and most of the surface markings; the bands are much less prominent and the shells are thin and

delicate, somewhat like some of the high mountain forms such as *tularensis* (Hemphill)." (Hanna & Smith.)

"*H. hertleini* lacks any distinct evidences of papillation, even on the nuclear whorls (in the Chace lot from Siskiyou Co.); otherwise it has all the earmarks of relationship to *tularensis*." (A. G. Smith.)

The umbilicus is far wider than in *H. napaea*, which also lacks papillae, and it seems to be an independent northern derivative of the *cypreophila* stock.

(Named for Leo George Hertlein, of the California Academy of Sciences.)

#### HELMINTHOGLYPTA NICKLINIANA SERIES

The umbilicate or imperforate shell is more or less granulose by the decussation of striae by spiral or forwardly descending impressed lines, or sometimes it is malleate. The dart sac is quite small, the mucous glands excrete through a common duct which is far longer than the dart sac. The flagellum is usually less than half the length of epiphallus and penis (Fig. 43).

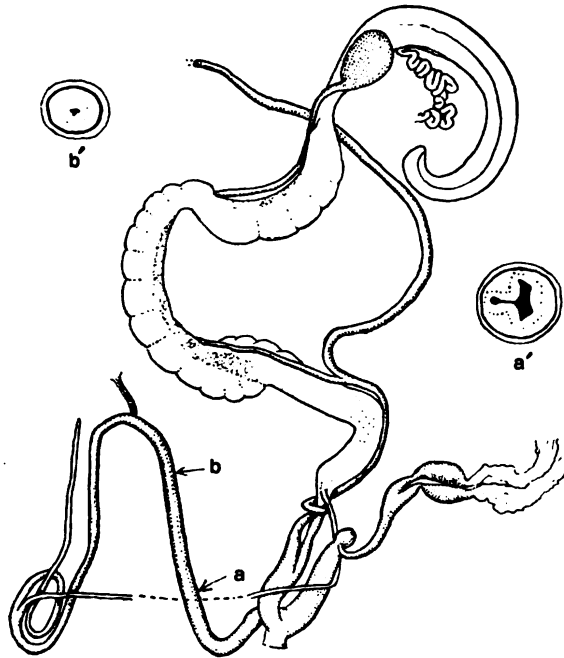


Fig. 43. *Helminthoglypta diabloensis*, genitalia.

The genitalia are very much alike in species of this group, but there are some differences in the proportions of the mucous glands, shape of the base of penis and size of penis cavity which may repay further examination. Dr. Ingles, who has investigated the anatomy of several species, gave a diagram of the affinities of those he examined, but without explanation of his reasons, which are not apparent. At present the shell characters seem more marked than the anatomic, and indicate this grouping: *californiensis*, *nickliniana*, *contracostae*—*diabloensis*—*exarata*, *arrosa*. The sequence of species in the following account is from the south northward.

**Helminthoglypta californiensis** (Lea)

Fig. 44.

(*Californiensis*)

*Helix californiensis* Lea, 1838, Trans. Amer. Phil. Soc., n. s., 6: 99, pl. 23, fig. 79.—  
Cf. Cooper, 1870, Amer. Journ. Conch., 5: 209, and Bartsch, 1937, Nautilus, 51: 36.

(*Vincta*)

*Helix vincta* Valenciennes, 1846, Voy. de la Venus, Moll., pl. 1, figs. 2 a-c.—Reeve, 1852, Conch. Icon. Helix, pl. 115, figs. 660 a, b.—Cooper, 1870, Amer. Journ. Conch., 5: 209.

*Helix californiensis* Lea, Gould in Binney, Terr. Moll., 2: 121, pl. 6, fig. 2.—Binney, 1869, L. & Fr. W. Sh. N. A., 1: 170, figs. 295-297.—Hemphill, 1891, Zoe, 1: 335.

*Arianta californiensis* Lea, Binney, 1878, Terr. Moll., 5: 365, pl. ix, fig. s, teeth; 1885, Man. Amer. L. Sh., p. 130, fig. 104, excl. varr.

*Epiphragmophora californiensis* Lea, Edson, 1911, Nautilus, 25: 68.

*Helminthoglypta californiensis* (Lea), Ingles, 1935, Proc. Malac. Soc. Lond., 21: 269, pl. 30, figs. 3, 5, genitalia and jaw.

“Shell globose, imperforate, granose, brown, one-banded; whorls 5; aperture nearly round; outer lip reflected; columella smooth. Diameter .7, length .6 of an inch.” (Lea.)

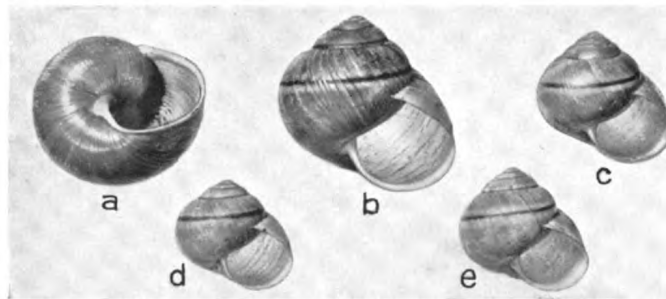


Fig. 44. a, b, *Helminthoglypta californiensis* form *vincta*, Cypress Point. c, *H. californiensis*, Point Pinos; d, e, rocks off Cypress Point.

The shell is thin, globose, as high or higher than wide, perforate; dull citrine with lines and dots of buff. Surface rather glossy.  $1\frac{1}{2}$  embryonic whorls densely microscopically wrinkled radially, the wrinkles irregular, with some inconspicuous papillae sparsely disposed in oblique forwardly descending series. This sculpture worn away in adult shells. Following whorls striate, with papillae in oblique series (often indistinct). Last whorl

with fine, fold-like striae which in places are cut into oblong granules by obliquely descending impressions; coarser striae at intervals; the base smoother, not granulose. The whorls increase slowly at first, the last one very large, descending to the aperture. The aperture is as wide as high, the outer lip narrowly expanded, baso-columellar margin narrowly reflected, at the columella dilated over and almost closing the narrow umbilicus.

Height 16.8 mm., diameter 16.7 mm.; 5½ whorls. Rock off Cypress Pt.

Height 19.6 mm., diameter 21.3 mm. Largest, Rock off Cypress Pt. (A.G.S. coll.).

Height 15 mm., diameter 15.7 mm.; 5 whorls. Rock off Cypress Pt.

Height 14.8 mm., diameter 15.3 mm.; 5 whorls. Pt. Pinos.

CALIFORNIA: Cypress Point, Monterey peninsula, on off-lying rocks, under ice plants (*Mesembryanthemum*), (Bartsch). Form *vincta* on mainland of the Point, among dead cypress needles. "Found most abundantly at Point Pinos, sparingly at Point Cypress and Point Lobos, and at a few intermediate localities covering a distance of about twenty miles. It is usually found in the loose sand at the base of plants and small shrubs; I have counted as many as one hundred collected around the roots of a purple sea aster." (Edson.)

This strictly maritime species is more globose than any other Californian land snail except *H. berryi*. Lea's type is about 15 mm. long, according to his measurement.<sup>1</sup> Specimens agreeing with it were collected by Dr. Bartsch in 1920 at Cypress Point, on a rock a few feet off shore, where the shells are probably dwarfed by the saline conditions. On the mainland opposite these rocks the typical *vincta* occurs. Mr. A. G. Smith informs me that "The 'rock' off Cypress Point is merely a small mainland area that has become separated by a channel cut by the sea. I collected there this summer and found both the small form (*californiensis*) and the small race of *dupetithouarsi*, the latter all dead except for 2 young shells. Because of erosion, this area will not be able to support snails much longer; there is not much good cover left to protect them. However, on the south side of Pt. Lobos typical *californiensis* is exceedingly common under the beach aster, of which there are large masses. The Point is now a State Park with strict supervision to keep its natural state so that a good locality for the typical form will probably always be available."

Similar small specimens occur at Point Pinos (S. S. Berry, 1908), the shells being small, delicate, less marked with yellow lines than the large form *vincta*. The smallest seen is 14.8 mm. long (Fig. 44 c), but others

<sup>1</sup> It should be noted that J. G. Cooper (1870) believed Lea's shell to be a form of *nickliniana* or "*redimita*." The original figure certainly recalls the former species, and if drawn from the type of *californiensis* is incorrect, as it does not agree with proportions indicated by Lea's measurements; the latter are also inexact for what we now call *californiensis*. Records of *californiensis* (*vincta*) from near San Francisco and "Klamath County" are erroneous.

are larger, 18.5 x 19.3 mm., and 18.6 x 18.4 mm., both with  $5\frac{1}{2}$  whorls. Nuttall probably picked it up here, as this place is not far from Monterey.<sup>1</sup>

Form *vincta* (Valenciennes). Figures 44 a, b. The large form of the species is that figured as *H. vincta* by Valenciennes. The granulation is generally more extensive than in the small form, but usually there appears to be very little difference otherwise except in the larger size. There are  $1\frac{3}{4}$  embryonic whorls. After the smooth tip and some radial wrinkles it is densely, microscopically corrugated radially, with a few papillae in forwardly descending trends, or in some shells papillae are not noticeable; post-embryonic whorls have irregular striation and papillae in oblique trends, up to the penult whorl.

Height 25.3 mm., diameter 26.6 mm. Largest, Cypress Point, (A.G.S.).

Height 23 mm., diameter 23.3 mm.;  $5\frac{1}{2}$  whorls. Cypress Point.

Height 22.2 mm., diameter 22.2 mm.;  $5\frac{1}{2}$  whorls. Cypress Point.

Height 20.7 mm., diameter 21.5 mm.;  $5\frac{1}{2}$  whorls. Cypress Point.

Height 19.5 mm., diameter 19.7 mm.; 5 whorls. Cypress Point.

Height 17.4 mm., diameter 18.3 mm. Smallest, Cypress Point, (A.G.S.).

Hemphill gave the extremes of size as height 28, diameter 25 mm., and 19 x 16 mm. He notes that the band is frequently absent. Valenciennes's type figure is 23 mm. long.

"I do not believe that *vincta* is worthy even of the appellation of 'form', and, of course, is far from being a valid subspecies. The wide difference in size appears to be due entirely to ecological conditions, principally food and moisture, of which *vincta* undoubtedly has an abundance of both, while *californiensis* does not, at least in the same degree. *Vincta* is almost always found under dense masses of moist weeds under the cypress trees; *californiensis* normally grows in exposed locations, nearer the ocean, either under mats of beach aster (*Mesembryanthemum*) or in sand under masses of the perennial yellow bush-lupine." (A. G. Smith.)

*Anatomy.*—The mantle is marbled with ragged gray spots. Genitalia, (Fig. 31 A): The small dart sac contains a two-bladed dart. The oblong mucous glands unite into a long common duct, and distally pass into long appendages which spread into broad, thin, translucent membranes partially enveloping the mucous glands and dart sac. The penis consists of a thick-walled, muscular inner tube which becomes adnate to the outer wall at both ends and is free from it in the whole middle portion, as shown in sections illustrated. It has a small cavity nearly filled by about 4 longitudinal ridges. The atrium has a few low, flat longitudinal welts within. Length of penis 15 mm., epiphallus 14, flagellum 13, spermatheca and duct 32, diverticulum 22 mm.

<sup>1</sup> Lea gave the locality "St. Diego, Upper California. Professor Nuttall" for *H. californiensis* and *H. nickliniana*. Returning from Hawaii, Nuttall reached Monterey (where these species must have been collected) in March, 1836. In April he coasted southward to Santa Barbara, San Pedro and San Diego, and in May sailed for home around the Horn. See Francis W. Pennell, *Bartonia* No. 18, 1936, p. 38, pl. 3.

**Helminthoglypta nickliniana** (Lea)

Fig. 45 a, b, b', c, d.

*Helix nickliniana* Lea, 1838, Trans. Amer. Phil. Soc., 6: 100, pl. 23, fig. 84. Binney, 1851, Terr. Moll., 2: 119.—W. G. Binney, 1859, Terr. Moll., 4: 7; 1869, L. & F. W. Sh. N. A., 1: 166, fig. 288.—Newcomb, 1865, Amer. Journ. Conch., 1: 343, in part.—Semper, Reisen, Landmoll., pl. 14, fig. 19 (anatomy).

*Helix californiensis* Lea, Reeve, 1852, Conch. Icon., Helix, pl. 115, fig. 661.

*Helix arboretorum* Valenciennes, 1846, Voy. de la Venus, Moll., pl. 1, figs. 1 a-c.

*Helix arboretorum* Valenciennes, Voy. de la Venus, Moll., pl. 1, figs. 3 a-c.

*Arionta nickliniana* Lea, Binney, 1878, Terr. Moll., 5: 357, pl. ix, fig. F; pl. xiii, fig. c (anatomy).

[*Arionta californiensis*] var. *nickliniana* Lea, Binney, 1885, Man. Amer. L. Sh., p. 131, fig. 105.

*Epiphragmophora nickliniana* Lea, Edson, 1911, Nautilus, 25: 68, 70.

*Helminthoglypta nickliniana* (Lea), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 477, pl. 36, figs. 5-7.—Ingles, 1935, Proc. Malac. Soc. Lond., 21: 267, pl. 29, figs. 1, 4, genitalia and jaw.

The shell is subglobose-conoid, very narrowly, obliquely, umbilicate, rather thin; closely mottled, the general color olive-buff to chamois or cinnamon-buff, a little lighter below the rather narrow chestnut-brown band above the periphery. Surface with little gloss; first  $1\frac{3}{4}$  whorls microscopically subrugose radially, the later whorls covered with narrow close retractive striae which are cut into oblong granules by oblique, forwardly-descending (or sometimes ascending) impressions, and on the last whorl more or less malleation. The whorls increase slowly at first, the last one very large, descending slowly in front. The broadly lunate aperture is mottled within. Peristome white, narrowly reflected, somewhat thickened within, dilated over and nearly covering the umbilicus.

Height .7, diameter .9 inch (Lea).

Height 20.5 mm., diameter 26.4 mm.;  $6\frac{1}{4}$  whorls. Stanford University.

Height 20.4 mm., diameter 28.5 mm.; 6 whorls. San Mateo Co.

Height 15.5 mm., diameter 20.3 mm.;  $5\frac{1}{2}$  whorls. San Francisco Co.

CALIFORNIA: From north of Santa Rosa, Sonoma County, southward on both sides of San Francisco Bay to Monterey and western San Benito County. Type locality Monterey (Thomas Nuttall);<sup>1</sup> Type 106746 U.S.N.M., Pinnacles National Monument (A. G. Smith).

The color varies in different lots and sometimes in the same lot, some shells having a more yellow, others a more cinnamon hue. Several lots from redwood forest, San Mateo Co., are dilute sepia colored. Albino shells from San Mateo and Alameda counties are marguerite yellow with some ecru-olive streaks. The sculpture varies in wide limits: it may be almost as profusely granulose as *ramentosa* or again the granulation may be weak or developed only in places. Mr. Edson mentions "a set of twenty *nickliniana* from a small canyon in the foothills back of Palo Alto, from which it is possible to select as many different forms, running from a high spire with the lip almost entirely reflected over the umbilicus to low spire

<sup>1</sup> See footnote under *H. californiensis* for Nuttall's localities.

with a widely-open umbilicus. The reticulated surface and the purplish color of the nacre inside the aperture are present in all of the forms of *nickliniana*. In some localities the color band is obsolete." The size also is variable; in an Oakland set the diameter runs from 19 to 23 mm. and the umbilicus is closed. Specimens from a stream bed, under wild celery,

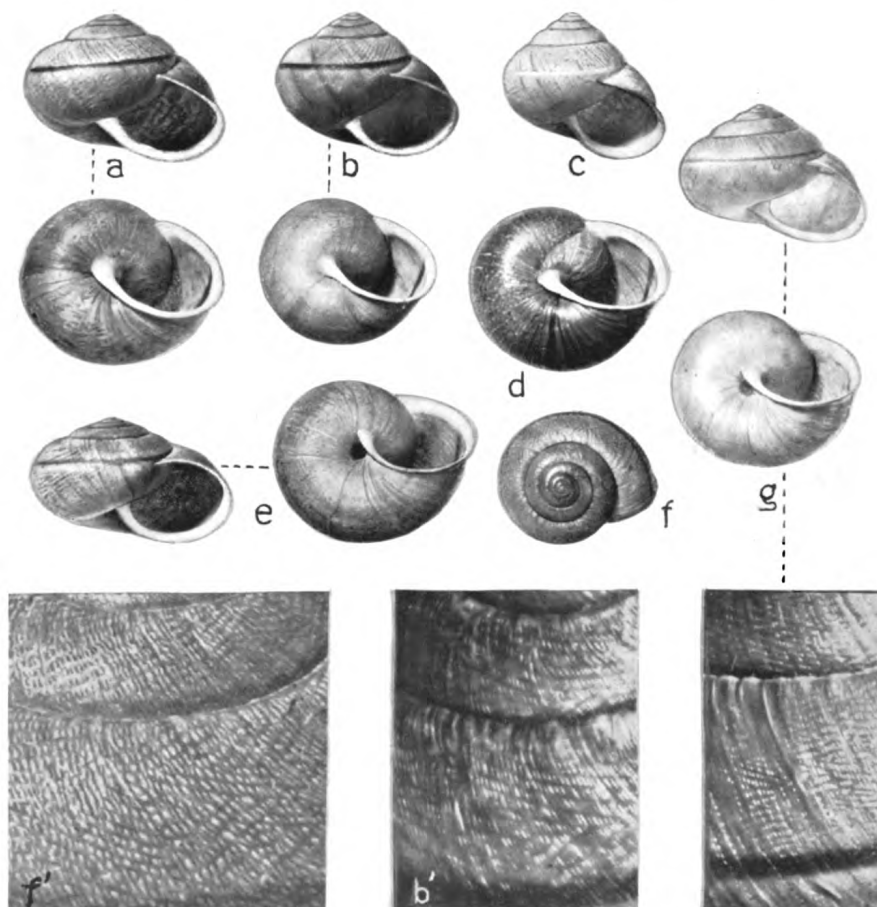


Fig. 45. *Helminthoglypta nickliniana*: a, Stanford University; b, b', near Oakland; c, d, San Mateo Co. *H. nickliniana ramentosa*: e, San José; f, f', Contra Costa Co. g, *H. nickliniana bridgesi*, neotype. (Lower figures,  $\times 4\frac{1}{2}$ .)

back of the Bolinas Beach Club House, Marin County (Chace Collection), measure: largest, height 17.9, diameter 24.1 mm.,  $5\frac{1}{2}$  whorls; smallest 16.3 x 21.7 mm.,  $5\frac{1}{2}$  whorls. Small shells, 21–23 mm. diameter, the umbilicus closed, are before me from Point Isabel, Contra Costa County.

In a lot from Bolinas collected by Hemphill, the diameter is 23 to 24 mm.; in another lot, 17 to 18.5 mm. with  $5\frac{1}{2}$  whorls. Some examples of this lot



seem scarcely distinguishable from selected shells of *H. n. awania* (Bartsch) from Point Reyes, though in most *awania* the granulation is wholly or almost effaced. At Tomales, Hemphill collected a small form of *nickliniana*, diameter 18 to 19 mm. These shells also approach *awania*, but differ by the more distinct granulation (Fig. 46, lower row).

"The shells from the Pinnacles National Monument are a puzzle. They are of the general size and shape of *nickliniana*, but the extremely narrow umbilicus is hardly covered at all in some, while in others it is partly to almost completely covered. The sculpture is more heavily granular than any *nickliniana* I have ever seen, the granules being usually much elongated and irregularly arranged in series. In one or two shells of the lot the axial sculpture is cut by rather prominent spiral striations. Several shells have malleated areas, both above and below. Thus, this lot of shells exhibits some but not all in any individual of the combined sculpture of *ramentosa*, *anachoreta*, *bridgesi*, *contracostae*, and *diabloensis*, which, when combined also with size and shape of *nickliniana*, presents quite a mixture. There are 11 shells in the lot, all dead, but showing the characters well. It might almost be worth a subspecific name, but I would hesitate to describe it only on dead specimens." (A. G. Smith.)

The distribution given above is from Edson. Specimens seen are from the following counties: Marin, San Francisco, San Mateo, Santa Cruz, Monterey, Contra Costa, Alameda and Santa Clara. Newcomb's record from Klamath Co.,<sup>1</sup> California, was clearly an error.

(Named for P. H. Nicklin.)

The following subspecies of *H. nickliniana* are recognized:

1. *H. nickliniana*. Subglobose-conoid, very narrowly, obliquely umbilicate, the striae cut into oblong granules by oblique impressed lines; some malleation. Coastal and subcoastal counties from Monterey to Sonoma.

2. *H. n. awania*. Similar but small, diameter 15-20 mm., without granulation. Pt. Reyes, Marin County.

3. *H. n. ramentosa*. Depressed-globose with more open umbilicus, the granulation coarser, extending over the base. Eastern Bay counties, Solano to San Benito.

4. *H. n. bridgesi*. Similar to *ramentosa* in umbilicus, but less coarsely granulose, larger and with more conic spire. San Pablo to Mt. Diablo.

5. *H. n. anachoreta*. Similar to *ramentosa* but less coarsely and regularly granulose. Counties north of San Francisco Bay, Sonoma, Napa, Lake and Mendocino.

**Helminthoglypta nickliniana awania** (Bartsch)

Fig. 46: 1-4.

*Epiphragmophora tudiculata awania* Bartsch, 1919, Proc. Biol. Soc. Wash., 32: 247.

*Helminthoglypta nickliniana awania* (Bch.), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 478, pl. 36, figs. 1-4.

<sup>1</sup> See Nautilus, 50: 105 for location of this former county.

"Shell very small, elevated helicoid, dark horn colored, streaked with fine retractively slanting lines of brown and an occasional dark variceal streak. There is also a slender brown spiral band present at the periphery, which is edged on either side by a lighter zone. Nuclear whorls one and a half, feebly wrinkled and obsoletely granulose. Postnuclear whorls well rounded, appressed at the summit, marked by coarse retractively slanting wrinkles, the last one and a half turns being decidedly malleated. The middle whorls show a few fine spiral striations near the summit. Base inflated, strongly rounded, marked by the continuation of the axial wrinkles and strong malleations. Aperture large, subcircular, oblique; peristome slightly expanded and reflected, white; interior of the aperture pale brown when viewed directly, horn colored when seen by transmitted light, showing the peripheral band and the two lighter zones bordering it. Alt. 13.4 mm., diameter 16.4 mm.; 5.3 whorls." (Bartsch.)

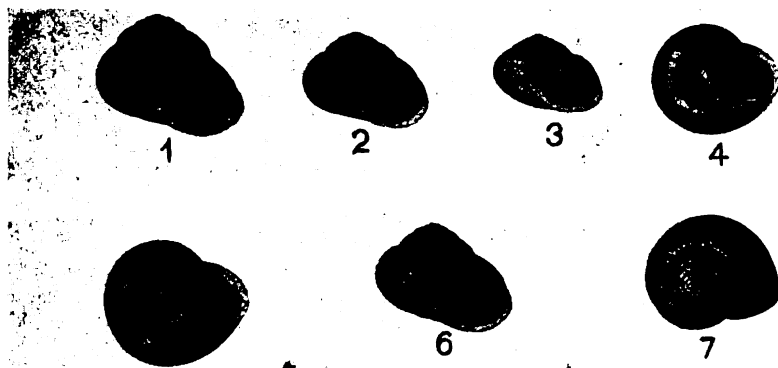


Fig. 46: 1-4, *Helminthoglypta nickliniana awania*, Point Reyes. 5-7, *H. nickliniana*, Tomales.

CALIFORNIA: Point Reyes, Marin County, on the steep southern slope at extreme west end, under *Mesembryanthemum* (H. N. Lowe, A. G. Smith). Type 336831 U.S.N.M.

Specimens of the original lot from Point Reyes are figured. It is a race of *H. nickliniana* which appears to have been dwarfed by the conditions of existence on an exposed granitic headland. Together with the reduction in size, the *nickliniana* sculpture of oblong granules has become obsolete, though characteristic traces of it are present locally in occasional individuals. The specimens figured are from 14.3 to 19.3 mm. in diameter.

From the lot of forty-six topotypes collected by him in 1918 and 1920 Mr. A. G. Smith gives the following extremes of size. There are no albinos or bandless individuals in either lot.

Height 13.9 mm., diameter 14.9 mm.	Smallest shell, but tall.
Height 13.7 mm., diameter 19.9 mm.	Largest shell, fairly low-spined.
Height 14.7 mm., diameter 18.3 mm.	Fairly large tall shell.
Height 11.4 mm., diameter 17.0 mm.	Fairly small low-spined shell.

**Helminthoglypta nickliniana ramentosa** (Gould)

Fig. 45 e, f, f'.

*Helix ramentosa* Gould, 1856, Proc. Boston Soc. Nat. Hist., 6: 11; Terr. Moll., 3: 12.—Newcomb, 1865, Amer. Journ. Conch., 1: 344.—Cooper, 1875, Proc. Cal. Acad. Sci., 6: 16.

*Helix reticulata* Pfeiffer, 1857, Malak. Blatter, 4: 87; Novit. Conch., 1: 120, pl. 34, fig. 47.—Binney, 1869, L. & F. W. Sh. N. A., 1: 169, fig. 294.

*Arionta ramentosa* Gld., Cooper, 1870, Amer. Journ. Conch., 5: 208.—Binney, 1878, Terr. Moll., 5: 364.

[*Arionta californiensis*] var. *ramentosa* Gld., Binney, 1885, Man. Amer. L. Sh., p. 133, in part.

The globose-depressed shell is thin, rather narrowly umbilicate, of dilute cinnamon-buff color, with a narrow brown band with indistinct pale borders. Sculpture of close growth striae cut into an even pattern of small oblong granules by oblique impressions, usually descending forwardly but in places irregular, and continued upon the base. Peristome narrow, white, thickened within, the upper margin expanded, basal reflected, at the columellar insertion dilated over about one-third of the umbilicus.

Height [axis]  $\frac{1}{2}$  inch, diameter  $\frac{3}{4}$  inch (Gld.).

Height 16.8 mm., diameter 26.3 mm. San José.

Height 16 mm., diameter 24 mm.;  $5\frac{2}{3}$  whorls. Santa Cruz Mts.

Height 14 mm., diameter 21 mm.;  $5\frac{1}{2}$  whorls. Contra Costa Co.

Height 17.8 mm., diameter 24.5 mm. to height 19.2, diameter 29.7 mm. Mission Peak.

CALIFORNIA: Between Coalinga and Parkfield, Monterey County (Hanna & Church). Upper end of Cienaga Valley, San Benito County (A. G. Smith). Santa Cruz Mts. (Mrs. A. E. Bush), Gilroy Hot Springs (A. G. Smith), and San José, Santa Clara County. Mission Peak, 25 miles southeast of Oakland, Alameda County, type locality.<sup>1</sup> Contra Costa County (A. D. Brown Coll.). Benicia, and Mare Island near Benicia, Solano County (J. C. Cooper).

The shell is more depressed than *nickliniana*, with the umbilicus less covered and the granulation of the surface coarser, more strongly and evenly developed; malleation very feeble or wanting. The pattern of oblong granules continues over the base in *ramentosa*, but is obsolete there in *anachoreta*.

It appears to inhabit all of the counties east of San Francisco Bay, but is not found in the north Bay counties. Southward it extends into Monterey and San Benito counties, inland. Dr. E. von Martens reported "*Helix ramentosa* Gould im Centralpark in New York, vermuthlich mit Pflanzen eingeschleppt" (Sitzungsber. Ges. Naturforsch. Freunde zu Berlin, Nr. 9, 1882, p. 141). Perhaps the collector, Dr. Arthur Krause, misplaced a label. He had been in San Francisco.

<sup>1</sup> In 1870 Dr. Cooper stated that "Dr. Newcomb sent Gould the types from Benicia". In 1875 he said "Dr. Newcomb informs me that the types sent by him to both these authors [Gould and Pfeiffer] were from Mission Peak". Both authors gave the locality "California". Pfeiffer's type reached him through Cuming. The type should be in the Gould collection in the N. Y. State Museum, Albany.

Binney finally (1885, p. 133-135) lumped some rather different snails under *ramentosa*. His synonym "*H. parkeri* Tryon" was Tryon's substitute name for *Helix bridgesi* Tryon, 1866, not of Newcomb, 1861, and pertains to the Central American *Averellia* (*Trichodiscina*) *coactiliata* (Fér.). Tryon himself forgot what it was he had named *parkeri* (cf. Man. Conch. 4: 73). Binney's figure 108 is *H. contracostae*. Figure 111, from Watsonville, seems more like *nickliniana* than *ramentosa*, being imperforate; but I have not seen the shell. In his Second Supplement (Bull. Mus. Comp. Zool., 13: 45), Binney included all of the *nickliniana* group as varieties under *Arionta californiensis*. Edson did not think *ramentosa* and *nickliniana* distinguishable, as they are connected by intermediate examples.

(*Ramentosus*, with a profusion of twigs.)

**Helminthoglypta nickliniana bridgesi** (Newcomb)

Fig. 45 g.

*Helix bridgesi* Newcomb, 1861, Proc. Cal. Acad. Sci., 2: 91; 1865, Amer. Journ. Conch., 1: 344.

*Aglaja bridgesi* Newc., Tryon, 1867, Amer. Journ. Conch., 3: 161, pl. 11, fig. 29.

*Helix bridgesi* Newc., as synonym of *H. reticulata* Pfr., Binney, 1869, L. & Fr. W. Sh. N. A., 1: 169, fig. 294; as synonym of *Arionta ramentosa*; 1878, Terr. Moll., 5: 364, fig. 246; 1885, Man. Amer. L. Sh., p. 134, fig. 110.

"Shell deeply umbilicate, depressly globose, plicately striate and covered with minute granulations, translucent grayish horn color; within tinted with purple, with a narrow, encircling, central brownish band; spire conical; whorls 6, convex; suture well impressed; aperture roundly lunar; lip expanded and reflected, of a pale lilac color. Diameter 27 mill., alt. 19 mill., aperture diameter 13 mill., alt. 11 mill." (Newcomb.)

CALIFORNIA: San Pablo, Contra Costa County (Newcomb). Lectotype 26132 a, Cornell University Collection.

"But a solitary specimen of this shell has been obtained . . . Its nearest approach to any described California species is to *H. ramentosa* Gld., which is much smaller, more solid in structure with a more depressed spire, lighter color and more scaly granulations. From *H. nickliniana* Lea it is readily distinguished by its large umbilicus and difference in form." (Newcomb, 1861.)

"This species has been found only in the neighborhood of San Pablo, in Contra Costa Co. It has the sculpture of *ramentosa* but finer, and the form of *nickliniana*, but with a more oblique aperture and more pointed and elevated spire." (Newcomb, 1865.)

Newcomb's original type has apparently been lost. In 1867 he furnished Tryon a specimen from his No. 26132 for figuring. This specimen, still in the Newcomb collection, is represented in my Figure 45 g. It measures: height 18.1 mm., diameter 25 mm.; 6½ whorls. The smallest in the same lot of four is 21.2 mm. in diameter. The sculpture is exactly as in some

*nickliniana*, being finer and less regularly developed than in *ramentosa*. The umbilicus is smaller than in *anachoreta*, 2 mm. wide in the shell figured, but its width varies in the four examples. It is from one-fourth to a half covered by the reflected columellar lip.<sup>1</sup>

A specimen from the same lot was lent to Binney and figured by him in 1869, as a synonym of *H. reticulata*. These figures were reprinted in his later monographs.<sup>2</sup>

Mr. A. G. Smith gives the following notes: "It is not particularly common although it has a tendency to colonize, unlike *nickliniana* s. s., which is found in the same general locality. I have found it in tall grass and weeds, under patches of Canada thistle, and sometimes sparingly in rock piles. Colonies when found are in thistles or grass. It ranges over the open hillsides of the west slope of the Berkeley Hills in the suburbs of Berkeley known as Thousand Oaks, in Alameda Co., and Kensington, in Contra Costa Co. It is also found along San Pablo Creek, where it apparently gives way to *diabloensis* further into the hills. Also, I have a lot of 4 shells of this subspecies from Perkins Canyon on the east slope of Mt. Diablo, which indicates that *bridgesi* is probably more widespread than originally thought. My largest shell, a "bone" from San Pablo Creek, measures: height 17.5, diameter 28.8 mm."

"*H. bridgesi* seems to be most closely related to *contracostae*, but it is a large shell, less depressed, and has a somewhat less regular granular sculpture, not arranged spirally as in *contracostae*. The pale lilac color within the aperture is a characteristic of both shells. One of the major differences from *anachoreta* is the absence of malleations."

This subspecies has been treated at perhaps undue length because it has not been properly understood. It is at best only a weakly differentiated race of *nickliniana*.

(Thomas Bridges (1807-1865), for whom this race was named, was an English botanical collector, working chiefly in Chile, but from 1856 to 1865 on the coast, California to British Columbia. Died at sea of malaria contracted in Nicaragua in 1865.<sup>3</sup>)

<sup>1</sup> There is another lot of four shells labelled *H. bridgesi*, Alameda Co., in the Newcomb collection. One of them has been marked "type", but not in Newcomb's hand. It agrees with the size assigned, measuring 19.3 x 27 mm., but it is imperforate. All of this lot are imperforate, and agree fully with specimens of the form of *nickliniana* seen from around Oakland.

<sup>2</sup> In the Third Supplement, (Bull. Mus. Comp. Zoöl., 19: 214), left hand figures, Binney figured what he called "the depressed variety of *A. bridgesi*"; but these figures have no bearing on the identity of Newcomb's species. They were reprinted in his Manual, (Fig. 109). They look like *anachoreta*. No locality was given.

<sup>3</sup> Dall, 1866, Proc. Cal. Acad. Sci., 1: 236.—I. M. Johnson, 1928, Contrib. Gray Herbarium 81: 98.

**Helminthoglypta nickliniana anachoreta** (W. G. Binney)

Fig. 47.

*Helix anachoreta* W. G. Binney, 1857, Proc. Acad. Nat. Sci. Phila., 9: 185; 1859, Boston Journ. Nat. Hist., 7: 11, pl. 2 (76), fig. 5; reprinted in Terr. Moll., 4: 11, pl. 76, fig. 5.

*Helminthoglypta nickliniana anachoreta* (W. G. B.), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 478, pl. 36, fig. 8-11. Hanna, 1927, Nautilus, 40: 124.

The shell differs from *H. nickliniana* by the greater depression, larger diameter and especially the much more open umbilicus which is only in small part concealed by the reflected columellar lip. In sculpture it falls within the range of variation of *H. nickliniana*. It is densely granulose

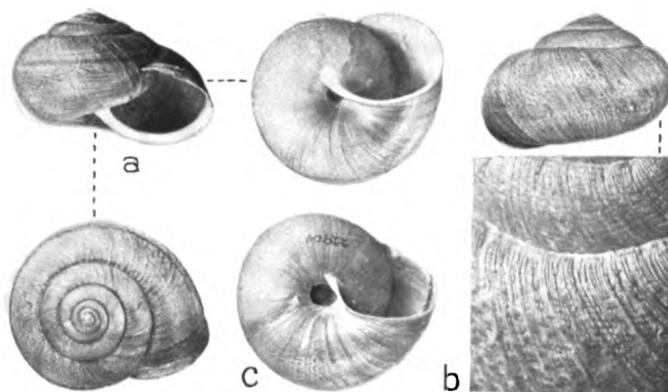


Fig. 47. *Helminthoglypta nickliniana anachoreta*; a, c, four miles above Upper Lake; b, typical coloration.

throughout, or in some examples, smoother around the umbilicus, and there is a shallow malleation over most of the last whorl. Usually there is a rather narrow cinnamon-brown band with an indistinct pale border below, but this border is lacking in Sonoma Co. examples seen.

“Alt. 14 mm., diameter 26 mm.” (Binney.)

Height 16.3 mm., diameter 27 mm.; 5½ whorls. Upper Lake, Lake Co.

CALIFORNIA: Napa County on the north side summit of Mt. St. Helena, also at the foot, southern slope (A. G. Smith). Sonoma County at Mark West Springs and Glen Ellen (Smith). Lake County, on rocky, wooded land west of the road, about 4 miles north of the town of Upper Lake, at the north end of Clear Lake (G. D. Hanna). Near Clear Lake Oaks, and across from Clear Lake Highlands, three miles north of Lower Lake (Smith). Mendocino County from north of Blue Lakes (Smith). Marin County at Kentfield (Smith).

*H. nickliniana anachoreta* is close to *ramentosa*, but less regularly granose and generally more malleate. It is known only from the counties north of San Francisco Bay, and appears to be an inland, not a coastal form. No definite type locality was given by Binney.

This race was described from a bandless individual, such as Figure 47 b, a typical specimen from the old collection of the Academy of Natural Sciences of Philadelphia. Absence of the dark band is not a racial character of course, but only a mutation occasionally seen in this and other species. Mr. Smith notes that specimens in his collection from Kentfield and Glen Ellen are without trace of malleation.

Specimens from Upper Lake, Lake County, California, No. 22904 C.A.S., collected by Dr. G. D. Hanna, extend the known range of this subspecies northward and also, I believe, in elevation, as they were collected at about 1500 ft. The specimens show the same variation in sculpture as those from Sonoma County, with granulation partly irregular, along the striae of growth, like Fig. 47 b, partly in protractive trends like Fig. 49: 2a. There is considerable variation in width of the umbilicus, which is contained from  $6\frac{1}{2}$  to  $9\frac{1}{4}$  times in the diameter of the shell. In several of the eight specimens a faint pale border may be seen above the dark band, lacking in others; all having a light border below the band. The distinctness of the malleation varies; in some of the shells it is only weakly developed.

Height 19.5, diameter 27.5 mm.;  $6\frac{1}{2}$  whorls.

Height 18.3, diameter 26.0 mm.; 6 whorls.

Height 16.3, diameter 27.0 mm.;  $5\frac{1}{2}$  whorls.

(*Ἀναχωρήτης*, a recluse.)

**Helminthoglypta contracostae** (Pilsbry)

Fig. 48; fig. 49:3.

*A[rionta] ramentosa*, small var., Binney, 1885, Man. Amer. L. Sh., p. 133, fig. 108.

*Epiphragmophora californiensis* var. *contracostae* Pilsbry, 1895, Nautilus, 9: 72.

*Epiphragmophora contracostae* Pilsbry, 1897, Nautilus, 11: 54, 59.

*Epiphragmophora arnheimi* Dall, 1896 (Apr. 23), Proc. U. S. Nat. Mus., 18: 6 (no description; refers to Binney's fig. 108). 1897, Proc. U. S. Nat. Mus., 19: 375 (description).

*Helminthoglypta contracostae* (Pils.), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 479, pl. 37, figs. 3-11.—Hanna, 1927, Nautilus 40: 124, 125.

The depressed shell is rather solid, umbilicate, the umbilicus contained about eight times in the diameter, only a small part of it covered by the reflected columellar lip. The general color is chamois, with a deeper or antimony yellow streak behind the lip and a rather narrow cinnamon-brown band with a narrow, inconspicuous light border below. Sculpture of fine, uneven, partly thread-like striae unevenly cut into small rounded and oblong granules by impressions which have a more or less spiral trend parallel to the suture, but are often interrupted or irregular, sometimes descending forwardly in small patches as in others of the *nickliniana* group; on the base the granulation is in more regularly spiral order. The  $1\frac{1}{2}$  embryonic whorls have weak, irregular granules and short wrinkles. The lip is but little expanded and is well thickened within, especially the basal and columellar margins.

Height 12.5, diameter 18.3 mm.;  $5\frac{1}{2}$  whorls. Type.

Height 14.0, diameter 20.2 mm. Topotype.

Height 11.7, diameter 18.0 mm. Topotype.

CALIFORNIA: Contra Costa County at Byron Hot Springs (E. H. White, A. G. Smith). Type and paratypes 10712 A.N.S.P. San Pablo (J. S. Arnheim). Isabel Point (Mrs. A. E. Bush). Lake County, on a small island near southern end of Clear Lake about half a mile above outlet, and on a knoll in marshland west of outlet; elevation about 1500 feet. (G. D. Hanna.)

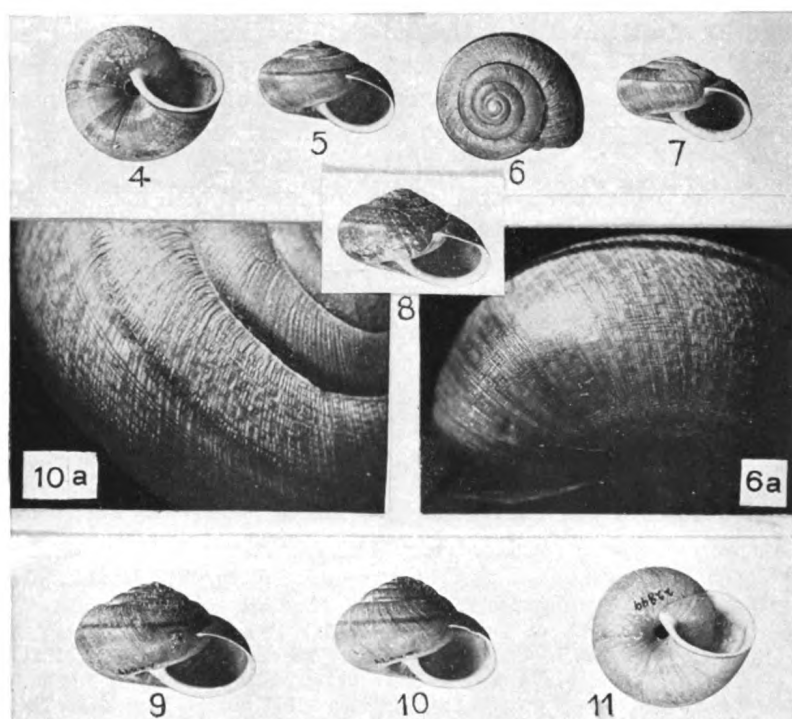


Fig. 48. *Helminthoglypta contracostae*. 4-6a, Byron Hot Springs; 7, San Pablo; 8-11, Clear Lake.

By the sculpture it belongs to the *nickliniana* group, but the granulation is mainly in spiral trends, though sometimes oblique in places. It is more solid and compact than *nickliniana* and its races, with smaller aperture and more thickened lip, but it may eventually be considered a subspecies of that multiform species. *H. diabloensis* has more closely coiled whorls.

"This appears to be a shell of the mud flats along the shore on the east side of San Francisco Bay in the general vicinity of San Pablo, as well as from the mud flats at Byron Springs, the type locality. At these places definite colonies are to be found under low bushes, in tall grass, and under *Salicornia*. Shells from the Bay shore are darker, heavier, and less shining than the topotypes I have collected recently. Also the revolving band is frequently narrower." (A. G. Smith.)



Two lots of *H. contracostae* were taken by Dr. G. D. Hanna at Clear Lake, Lake County. One adult from an island, (Fig. 48: 8), is a rather thin form having fine, practically typical granulation, a rather wide last whorl and fully  $5\frac{1}{2}$  whorls. Height 13, diameter 20 mm. The other lot, from a knoll west of the outlet (Figs. 48: 9, 10, 10a, 11) is practically typical in color and solidity, but shows spiral impressed lines more emphatic and continuous than in Contra Costa County examples, though in this respect there is considerable variation among the Clear Lake specimens. These shells are also a little larger than the Contra Costa County form, with  $5\frac{1}{2}$  to very nearly 6 whorls. Two measure 15.4 x 23 mm., and 14 x 21 mm. Figured specimens 8-11 are 2642-2645 C.A.S. type collection.

**Helminthoglypta diabloensis** (Cooper)

Fig. 49: 1-2 a.

*Helix* . . . very likely a new species, J. G. Cooper, 1866, Proc. Cal. Acad. Sci., 3: 260.

*H[elix] diabloensis* Cooper, 1868, Amer. Journ. Conch., 4: 221 (based solely on preceding reference).

*Lisinoe diabloensis* Cooper, 1872, Proc. Acad. Nat. Sci., 24: 150, pl. 3, figs. G, 2, 3, 4G.

*Arionta diabloensis* Coop., W. G. Binney, 1878, Terr. Moll., 5: 368, fig. 250, pl. ix, fig. r, teeth; 1890, 3d Suppl., Bull. Mus. Comp. Zoöl., 19: 214, right figs.

[*Arionta californiensis*] var. *diabloensis* Coop., W. G. Binney, Man. Amer. L. Sh., p. 135, figs. 112, 113.

*Helminthoglypta diabloensis* (Coop.), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 480, pl. 37, figs. 1-2a.

"There is a single specimen of *Helix* in the State Collection, supposed to have been obtained in the Mount Diablo range by Prof. Brewer, which closely resembles the small form of *H. sequoicola* in shape, but being nearly bleached is too imperfect to describe minutely, though very likely a new species. It is remarkable for having seven whorls, while the former and *H. mormonum* of the same size have but six; it is also less compressed than the latter, and the umbilicus is less covered. The color where remaining is shining gamboge yellow (faded?) with a *single* very narrow band *above* the middle, not showing the pale band on each side of it that is so marked in others of the group. The sculpture seems to have been very *slightly* malleated, and with the faint lines of growth cut by smooth depressed waved grooves transversely, and thus obliquely to the sutures (while those of *H. traskii* are parallel). Diameter maj. 0.95; alt. 0.40 inch." (Cooper, 1866.)

"Shell depressed, turbinata, below a little concave, whorls  $6\frac{1}{2}$  to 7, umbilicus large, peristome white, expanded, somewhat thickened, above descending; color yellowish-brown, paler beneath, with a dark-brown zone above the periphery, margined below by yellowish, visible on three whorls; epidermis shining, finely rugose-malleate, lines of growth often obliquely cut by delicate grooves, obscure revolving ridges around umbilical region. Young shell not subangled. Animal pale purplish-gray. Diameter maj. 0.75 to 0.95, min. 0.65 to 0.80; alt. 0.40 to 0.55 inch." (Cooper, 1872.)

Height 14.3 mm., diameter 23 mm.;  $6\frac{1}{2}$  whorls. Oakland.

Height 13.6 mm., diameter 20 mm.;  $6\frac{1}{2}$  whorls. Oakland.

CALIFORNIA: Near Oakland (Hemphill). Hills back of Berkeley and west slope of Grizzly Peak, (A. G. Smith); Alameda County Hills back of St. Mary' College, Moraga; San Pablo Creek below reservoir dam, and two miles east on the highway to Walnut Creek; Orinda Country Club; Bay shore at Giant, in drift at waters edge near mouth of San Pablo Creek; all in Contra Costa County (A. G. Smith). Colusa County, and in the Diablo Range at Cedar Mountain, twenty-five miles southeast of Mt. Diablo, among oaks and cypresses (J. G. Cooper). West side of Pacheco Pass near the top, under rocks, Santa Clara County (A. G. Smith). Yolo County (Hemphill). Geysers, Napa County (Newcomb).

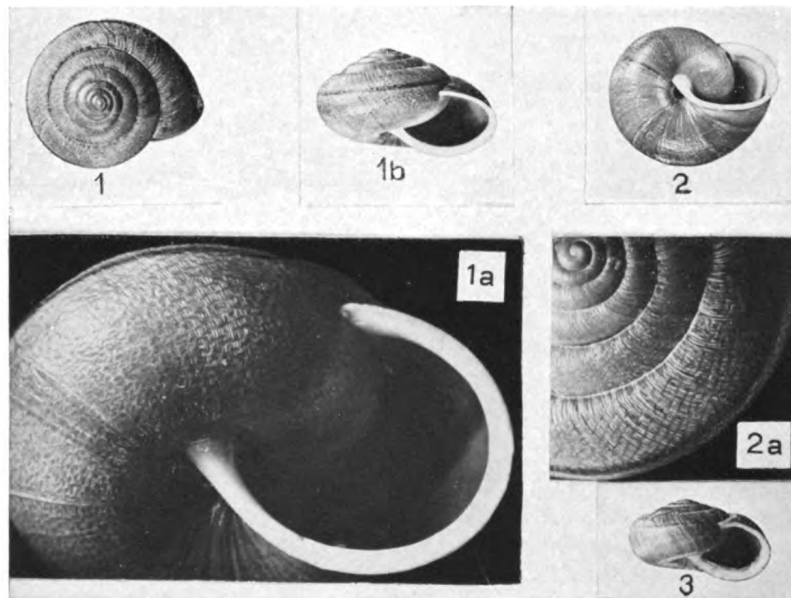


Fig. 49. 1-2a, *Helminthoglypta diabloensis*, near Oakland. 3, *H. contracostae*, Point Isabel.

The chief characters of this species are: its depressed form, the large number of whorls of the closely coiled spire—from over six to seven—and finally the sculpture, consisting of fine striae cut into oblong beads by forwardly descending impressions, or often irregularly, in the upper surface, and on the base close circular series of malleations without granulation except in front of the aperture. The color is between ecru-olive and olive-ocher. The pale borders of the band are often inconspicuous. The umbilicus is generally a little wider than in Figure 49: 2.

The type locality is not certainly known. The type specimen, "supposed to have been obtained in the Mount Diablo Range by Prof. Brewer" has been lost. Cooper later surmised that it came from where Brewer crossed

the range near Idria, lat. 36° 30', which led Edson (*Nautilus* 25: 70) to suspect that *diabloensis* was a form of *traski*. Cooper himself (1879) once suggested a relationship between *diabloensis* and *traski*. In his last treatment of the species (1872) Cooper stated that "the first specimen [was] obtained by Prof. Brewer 'east of Mount Diablo,'" and he redescribed and figured the species from Cedar Mountain, 25 miles southeast of Mount Diablo. There appears to be no sufficient basis for the surmise that Brewer got the original specimen of *diabloensis* near Idria; he probably picked it up in Contra Costa or in Alameda county. The range of the species as now known is from Pacheco Pass in southern Santa Clara county to Napa and Yolo Counties, in the Upper Sonoran zones. The northern limit given needs renewed examination, but the records are based upon specimens of undoubted *diabloensis*. It will probably be found over the Merced county line. Cooper's San Luis Obispo record doubtless pertains to some form of *H. umbilicata*.

There appears to be no reason to believe that Cooper's second description related to anything different from the original *diabloensis*. In both descriptions it is made perfectly clear that the raised striae along growth lines are cut by forwardly descending impressions, tangential to the suture (Fig. 49: 2a) as in other forms of the *nickliniana* group. *H. traski*, in which there are incised spirals parallel to the suture, is thus excluded from consideration.

"After considerable work with a microscope I find that many shells in my lots of *diabloensis* are papillate. In fact, all of my best shells, those that have just reached maturity and that show no erosion are conspicuously papillate under 40 diameters. My conclusion is that this species is normally papillate on the earlier whorls (hirsute in the very young stage), the papillations appearing also within the umbilicus. It is usually a shell rather dark in color, with medium high spire, glossy epidermis, with 6-7 whorls. It is a snail of the foothills, frequently found in rock piles, but more often under logs, brush, or other deciduous cover. It ranges from Alameda and Contra Costa Cos. south at least to the lower boundary of Santa Clara Co. It does not normally live near San Francisco Bay or the ocean. In San Pablo Valley it is found with *bridgesi*, and in the Berkeley Hills with *nickliniana* s. s. I have not found it yet in association with *ramentosa*." (A. G. Smith.)

A specimen from San Pablo Valley, Contra Costa County, collected by A. G. Smith was dissected. The foot is slate colored. Mantle light-buff, finely and profusely spotted-reticulate with black. Genitalia (Fig. 43): Outer tube of the penis thin, the cavity of the inner tube larger than usual. Penial retractor short, on the lower part of the epiphallus. The dart sac is very small, on a long atrial sac. Mucous glands with swollen pedicels where they unite to form the common duct, which is quite long. The diverticulum or accessory spermatheca is very long. The talon is extremely short, blunt,

and imbedded in the albumen gland. Lengths in mm. follow: Penis 15; epiphallus 20; flagellum 17; vagina 5; dart sac with atrial sac 6; diverticulum 35+, arising 13 mm. from base of spermathecal duct. The specimen was strongly contracted and hard; the measurements would be somewhat greater in a relaxed preparation.

**Helminthoglypta exarata** (Pfeiffer)

Fig. 50.

*Helix exarata* Pfeiffer, 1857, Proc. Zool. Soc. Lond., p. 108 (California?); Monogr. Hel. Viv., 4: 268.—Newcomb, 1865, Amer. Journ. Conch., 1: 344.—Binney, 1869, L. & Fr. W. Sh. N. A., 1: 168, fig. 292.

*Arionta exarata* Pfr., Cooper, 1870, Amer. Journ. Conch., 5: 207.—Binney, 1878, Terr. Moll., 5: 363, fig. 244, pl. ix, fig. o, teeth; 1890, Bull. Mus. Comp. Zool., 19: 213, pl. 11, figs. d, e.

*Epiphragmophora exarata* (Pfr.), Berry, 1908, Nautilus, 22: 40.

The shell is solid, moderately depressed with low-conic spire; umbilicus contained about 10 times in diameter, one-third or less covered by the columellar dilation. The whorls of spire are rather closely coiled, the last

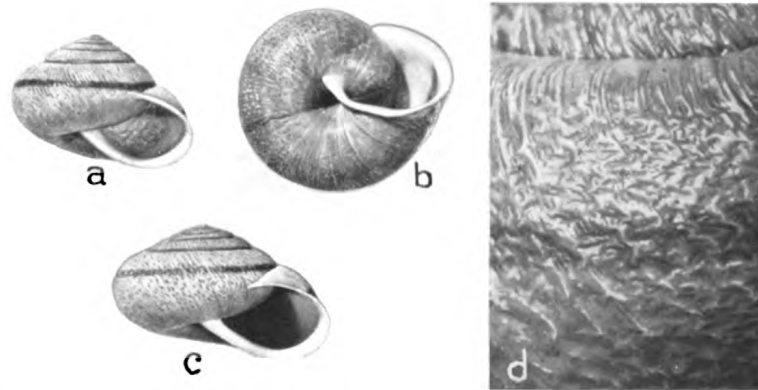


Fig. 50. *Helminthoglypta exarata*, Santa Cruz.

whorl descending a little in front. Maize yellow with whitish or faintly pink tinted spire, and a rather wide chestnut-brown band above the periphery. Apical half whorl finely wrinkled, the next whorl smooth; the 2 or 2½ following whorls are rather coarsely striate, after which the striae become irregular, and on the last whorl form a close but irregular network of wrinkles, the intervals of a darker tint (Fig. 50 d). The aperture is white and banded within. Peristome white, reflected, somewhat thickened within.

Height (axis) 16 mm., diameter maj. 30 mm. (Pfeiffer's type.)

Height 17.8 mm., diameter 28.7 mm.; 6½ whorls. Santa Cruz.

Height 19.8 mm., diameter 28.7 mm. Santa Cruz Mts.

Height 18 mm., diameter 26.1 mm.

CALIFORNIA: Santa Cruz Mountains, north as far as Pescadero, San Mateo County, inland to near Los Gatos, Santa Clara County, and to Sergeant on the San Benito County side of the Pajaro River.

Closely similar to *H. arrosa*, but it lacks granulation over the malleate surface, the wrinkle-malleate pattern is usually stronger, the umbilicus larger, spire less elevated, and the peristome is thicker. Except the first, these are differences of degree, yet *exarata* and *arrosa* appear to be quite distinct species. J. G. Cooper reported seeing intermediate specimens, but gave no details.

Pfeiffer's unlocalized type was a shell of maximum size. I have seen none quite so large.<sup>1</sup> The smallest seen has a diameter of 22.2 mm. In some small shells the striae are irregular, but scarcely meshed together. Occasionally the brown band is wanting. Allyn G. Smith writes: "*H. exarata* is unusually constant in color, with one exception. This is a series of dark-colored shells (C.A.S. 22912) taken by Hanna at Pescadero, San Mateo Co., that may be described as sooty brown to a lead gray color tinged with brown. There are 13 shells in the lot. In the California Academy collection is another lot colored much the same (C.A.S. 8859), collected by Hemphill, and labeled '*Helix* var. *exarata*, Sta. Cruz, Cal., dark form.' Along with the Pescadero lot Hanna also took a dark form of *nickliniana*. As the blackish form of *arrosa* also comes from this same general neighborhood, I conclude that there is some soil or food constituent that produces melanism in the land snails living there. Sometimes, though not always, the epiphragm of *exarata* is tinted a pale pink. This is never true of *arrosa* to my knowledge.

"Also I have not seen any *exarata* that could be considered as intermediate between it and *arrosa*, as reported by Cooper. The largest shell I have measured is in C.A.S. lot 8856, collected by Hemphill, 31.2 mm. diameter, from near Watsonville, Santa Cruz County. I have several shells from 29 to 30.0 mm. My smallest shell measures 22.8 mm. diameter."

(*Exaratus*, furrowed.)

**Helminthoglypta arrosa** ('Gld.' W. G. Binney)

Fig. 51 a-e.

*Helix aeruginosa* Gould, 1855; Proc. Boston Soc. Nat. Hist., 5: 127; 1857, in Binney, Terr. Moll., 3: 12. Not *Helix aeruginosa* Pfeiffer, Reeve, Conch. Icon. Helix, fig. 1265 (June, 1854).

*H[elix] arrosa* Gould, in W. G. Binney, 1858 (April), Proc. Acad. Nat. Sci. Phila. for 1857, p. 185.—Gould, 1862, Otia, p. 215.—Binney, 1869, L. & F. W. Sh. N. A., 1: 163.—Cooper, 1870, Amer. Journ. Conch., 5: 206.—Semper, Reisen im Archipel Philippinen, 3, pl. 15, fig. 13, genitalia.

*Arionta arrosa* Binney, 1878, Terr. Moll., 5: 354, fig. 238, pl. ix, fig. D and pl. xiii, fig. 1, anatomy; 1885, Man. Amer. L. Sh., p. 126, fig. 97, with varieties *A. holderiana*, fig. 98, and *A. stiversiana*, fig. 99; 1890, 3rd Suppl., Bull. Mus. Comp. Zool., 19: 213, pl. 11, figs. A, B, C.

*Epiphragmophora arrosa* (Gld.), Pilsbry, 1895, Man. Conch., 9: 199, with form *obscura*.—Hanna, 1921, Nautilus, 35: 35 (San Mateo Point).

<sup>1</sup> Binney mentioned an individual of 40 mm. diameter, but it must be *arrosa*. The fossil specimen from near Cape Mendocino, mentioned by Cooper, must also be *arrosa*.

*Helminthoglypta arrosa* (Gld.), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila., 78: 482.—  
Ingles, 1935, Proc. Malac. Soc. Lond. 21: 269, pl. 29, fig. 5; pl. 30, fig. 2,  
genitalia and jaw.

“Shell globose-conic, rather solid, umbilicate; indented and very minutely granulate; color, varied reddish-olivaceous and yellow, and encircled with a brown band; 7 convex whorls; aperture rounded-ovate; lip reflected, flesh colored; throat livid. Diameter  $1\frac{3}{8}$  inch, axis  $\frac{1}{3}$  to  $\frac{9}{16}$  inch. Brought from San Francisco by Dr. Bigelow” (Gould).

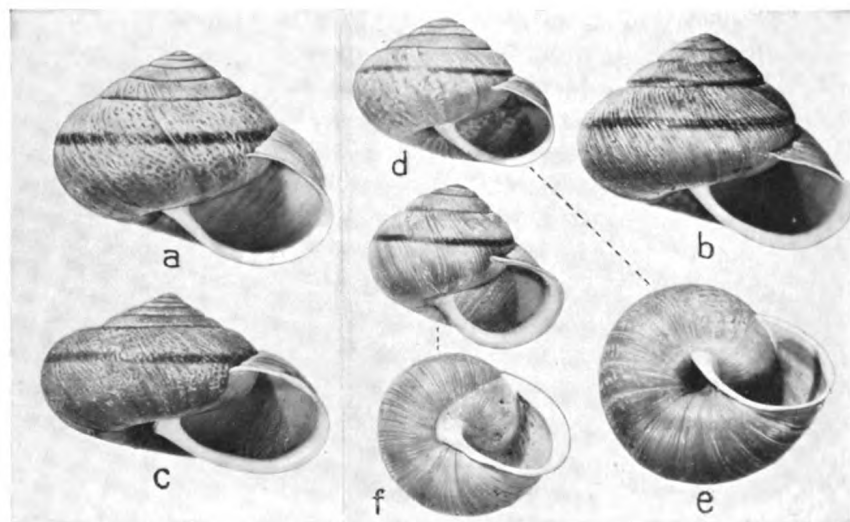


Fig. 51. a, *Helminthoglypta arrosa*, Bolinas; b, west side Tomales Bay near Inverness; c, Santa Cruz; d, e, near southern boundary San Francisco Co. f, *H. arrosa expansilabris*, type and paratype.

The color varies; naples yellow or chamois with some streaks of honey yellow or isabella color, or more or less passing into buckthorn brown or cinnamon-brown, the band chestnut-brown, without light borders. Rarely albinistic primrose yellow individuals occur, without a band (Coyote Island, San Mateo Co.). The striation is irregular, largely lost in the copious and coarse malleation and transverse wrinkling of the surface; over all is a fine granulation produced by wrinkles along the lines of growth, cut into granules. The umbilicus is narrow and one-third to a half covered by the dilated columellar lip. The peristome is somewhat thickened within, well expanded, reflected basally; usually white (at least in museum specimens), but sometimes it has a violaceous tint.

Height 28.5 mm., diameter 39.5 mm.; 7 whorls. Marin County.

Height 23.2 mm., diameter 33.4 mm.; 7 whorls. San Mateo.

Height 18.7 mm., diameter 27 mm.; 7 whorls. S. boundary, San Francisco Co.

CALIFORNIA: Coast counties from Santa Cruz to Marin, Sonoma, and as far north as the Navarro River, Mendocino County.

This large snail appears to be generally distributed in the coast counties. It varies a good deal in size, the large form 35-40 mm. diameter being typical; "the largest *arrosa* so far seen has a major diameter of 40.5 mm., which places it among the biggest of our Pacific Coast land snails", according to Smith and Chace. In the same colony there are often large and small individuals, and in some lots all are small; thus extremes seen from Palo Alto, Santa Clara County, have a diameter of 26.7 and 30.6 mm. In a lot of 4 from near the southern boundary San Francisco County, the size runs from 26.7 to 30 mm. (Fig. 51 d, e). The elevation of the spire varies more than usual; an abnormally high Marin County shell taken by Hemphill measures 30 x 37.3 mm.,  $7\frac{1}{2}$  whorls. Others from Marshall's, Marin County (C.A.S. 8819) measure 28.5 x 32.4 mm. and 27 x 30.7 mm. Normally proportioned shells were taken there also.

There is a dark chestnut-brown to blackish brown color variety, collected by Hemphill at Pigeon Point, San Mateo County, 10658 A.N.S.P., also 5341 and 5342 C.A.S. This was listed as form *obscura* (Man. Conch., 9: 199), but not defined. Similar shells are found also at St. Gregorio and in a canyon back of Half Moon Bay, San Mateo County, Swanton and Big Trees, Santa Cruz County, A. G. Smith Collection.

Whether Cooper's variety *holderiana* is really separable from *arrosa* proper must be decided by those who have had field experience over the Bay counties. All of these forms of *arrosa* have substantially the same sculpture, and show more or less of the fine granulation mentioned in the description.

(*Arrosa*, gnawed.)

Californian conchologists now recognize the following subspecies of *arrosa*:

1. *H. arrosa arrosa*. Shell large and strong, 30 to 40 mm. in diameter, rarely somewhat smaller. Range from the Santa Cruz mountains along the coast of San Mateo County, and north of the Bay from Marin to Navarro River, Mendocino County.

2. *H. arrosa holderiana*. Similar to *arrosa* but smaller, about 23 to 32 mm. in diameter. Foothills back of the Bay in Alameda County; southern Marin County to Cape Mendocino, Humboldt County; it is inland in Marin and Sonoma Counties, reaching the coast in Mendocino County.

3. *H. arrosa stiversiana*. Shell thin, light colored, of medium or rather small size, diameter 22 to 28 mm. Coastal in Marin and Sonoma Counties, from the Pt. Reyes region to Fort Ross.

4. *H. arrosa miwoka*. Small, thin high-coned shells of about 14 to 26 mm. in diameter. End of Pt. Reyes peninsula and a few miles inland. Intergrades fully with *stiversiana*.

5. *H. arrosa williamsi*. Similar to *holderiana*, but with higher spire and narrower umbilicus; cinnamon-brown, with very little malleation or none; diameter about 25 mm. Hog Island in Tomales Bay.

6. *H. arrosa pomoensis*. A large (diameter 39 mm.) flattened race, heavily malleated. A shell of the heavily redwood-timbered canyons of Mendocino County, generally well inland.

7. *H. arrosa mattolensis*. Large, diameter 29 to 41 mm., with the last whorl more globose than any other form of *arrosa*, and the spire, in apical view, narrower. Coast between Cape Mendocino and Shelter Cove, Humboldt County.

8. *H. arrosa expansilabris*. Compact, globose-turbinate, with conic spire and rimate or closed umbilicus, moderately solid, with strongly expanded lip, somewhat malleate but not granulate. Diameter 22 to 26 mm. Coastal part of Humboldt County.

9. *H. arrosa mailliardi*. Thin, subglobose, very narrowly umbilicate, light colored, slightly malleate but not granulate, peristome narrow. Northwest angle of Humboldt County and coast of Del Norte County, California, and in Douglas and Jackson Counties, Oregon.

**Helminthoglypta arrosa holderiana** (Cooper)

Figs. 52 a-c, 53, 55: 1.

*H[elix] arrosa* var. *holderiana* Cooper, 1875, Proc. Cal. Acad. Sci., 6: 166.

*A[rionta arrosa] holderiana* Cooper, Binney, 1885, Man. Amer. L. Sh. p. 127, fig. 98.

*Epiphragmophora exarata* var. *rubicunda* Rowell, 1902, Nautilus, 16: 52 (Occidental and Freestone, Sonoma Co.).

*Helminthoglypta arrosa marinensis* Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 482, pl. 38, figs. 1-3; pl. 39, fig. 1.

“Specimens have the color and seven whorls of typical *arrosa*, but in form and sculpture approach *ramentosa*, being examples of the law of inferior development in a warmer climate, retaining characters of the young of the type. They measure 1.05 to 1.28 by 0.60 to 0.75 inch.” (Cooper.)

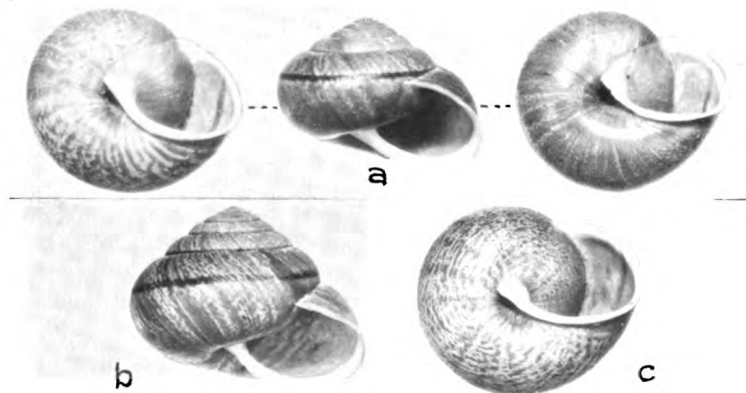


Fig. 52. a, *Helminthoglypta arrosa holderiana*, Moraga Valley; central figure the neotype. b, Form *rubicunda*, Freestone; c, Fairfax.

The malleation of the surface though copious is not so coarse and conspicuous as in *arrosa*, and the minute granulation of the upper surface is well developed, which suggested Dr. Cooper's rather misleading reference to *H. ramentosa*. Color between ochraceous-tawny and cinnamon-brown, with



streaks and reticulation of chamois. The lip is somewhat thickened within, and its reflection covers less than half of the rather open umbilicus. Specimens from the head of Moraga Canyon on Lake View Park Road, back of Oakland, collected by Allyn G. Smith measure:

Height 20 mm., diameter 28.3 mm.; 7 whorls. Neotype.

Height 19.1 mm., diameter 28.6 mm.; 7 whorls.

Height 18.3 mm., diameter 28.3 mm.;  $6\frac{3}{4}$  whorls.

CALIFORNIA: East side of San Francisco Bay along the first range of hills opposite the Golden Gate, for fifteen miles north and south (Cooper). Head of Moraga valley back of Oakland (A. G. Smith), Neotype 171335 A.N.S.P. Canyon back or Claremont (Woodbridge Williams).



Fig. 53. *Helminthoglypta arrosa holderiana*, form *marinensis*, middle figure the Type.

The distribution recorded above applies to the typical form of *holderiana* only. This weakly characterized subspecies, smaller than typical *arrosa* of the coast counties, is here understood to include several forms which have been named but seem scarcely definable, ranging from the foothills back of the Bay in Alameda County, northward through Marin, Sonoma, Mendocino, and according to Allyn Smith, into Humboldt County at least as far as Cape Mendocino. The geographic separation of the Alameda and Marin County herds may point to convergent rather than genetically related forms, yet the shells do not appear separable.

The form called *rubicunda* Rowell (Fig. 52 b, c), is intermediate between *arrosa* and *holderiana* in size, being larger than the latter. The color is a network of maize-yellow wrinkles on a tawny-olive ground, or the yellow may be reduced to streaks on a hazel ground, the dark band rather narrow. Umbilicus, malleation and granulation as in *holderiana*. Shells from Mr. Rowell measure 25 x 32 mm.,  $7\frac{1}{2}$  whorls, Freestone; 21.3 x 30.5 mm.,  $7\frac{1}{4}$  whorls, Fairfax. Taken by Mr. Rowell at Occidental also. It appears to be the prevalent race in Sonoma Co., and according to Allyn Smith extends along the Mendocino County coast.

*H. arrosa marinensis* Pilsbry, (Fig. 53), was mentioned in lists several times (Nautilus, 1897, 11: 89; 20: 14), and was defined in 1927. It is typically smaller, but does not appear to be separable subspecifically from *holderiana*. It is a small, glossy, copiously wrinkle-malleate form collected

in Marin County by Hemphill and by J. S. Arnheim, the exact locality not stated. Traces of the fine *arrosa* granulation of the upper surface are present, usually weak but sometimes well developed. The type lot, 71432 A.N.S.P., has a mustard yellow to naples yellow cast with isabella color streaks, but in another lot the hue is more ochraceous with tawny-olive streaks.

Height 17.5, diameter 23.7 mm.;  $6\frac{2}{3}$  whorls.

**Helminthoglypta arrosa stiversiana** (Cooper)

Figs. 54, 55: 2, 55: 4, 56.

*[Helix] arrosa* var. *stiversiana* Cooper, 1875, Proc. Cal. Acad. Sci., 6: 16.

*A[rianta arrosa]* var. *stiversiana* Coop., Binney, 1885, Man. Amer. L. Sh., p. 127, 493, fig. 99.

*Helminthoglypta arrosa stiversiana* (J. G. Coop.), Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 482, pl. 38, figs. 16-19; pl. 39, figs. 2, 4.

“A specimen obtained from Dr. Stivers, collected in Marin or Sonoma Co., has but  $6\frac{1}{2}$  whorls, and dimensions agreeing with Lea's figure of “*nickliniana*”, viz.: 1.05 by 0.70 inch. It has, however, numerous impressed grooves on the body whorl, parallel to the suture, as in *townsendiana*, *fidelis*, etc. Others from Point Reyes, Marin Co., are similar, with only 6 whorls.” (Cooper.)

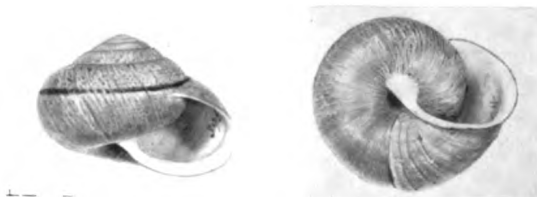


Fig. 54. *Helminthoglypta arrosa stiversiana*, neotype.

The neotype is rather thin but moderately strong, of the usual *arrosa* form, with conic spire and closely coiled whorls; the umbilicus about as in *arrosa*, has but 11 times in the diameter of shell; clay color, with some buff streaks on growth wrinkles and around malleations, with a narrow chestnut-brown band with scarcely noticeable light bordering bands. Sculpture of embryonic whorls lost, the last whorl with unequal wrinkles of growth, and on the upper surface a minute wrinkling along lines of growth, cut into oblong granules by impressed spiral lines; the peripheral region with some malleation, obsolete toward the umbilicus.

Height 18.8 mm., diameter 26.3 mm.;  $6\frac{2}{3}$  whorls.

CALIFORNIA: “Marin or Sonoma Co.” (Dr. Stivers); Tomales, Marin County (Hemphill), here selected as type locality. Specimens in the A. G. Smith Collection from Marin County at edge of Drake's Estero and near the town of Point Reyes; Sonoma County: head of Bodega Bay; Jenner, and two miles north.

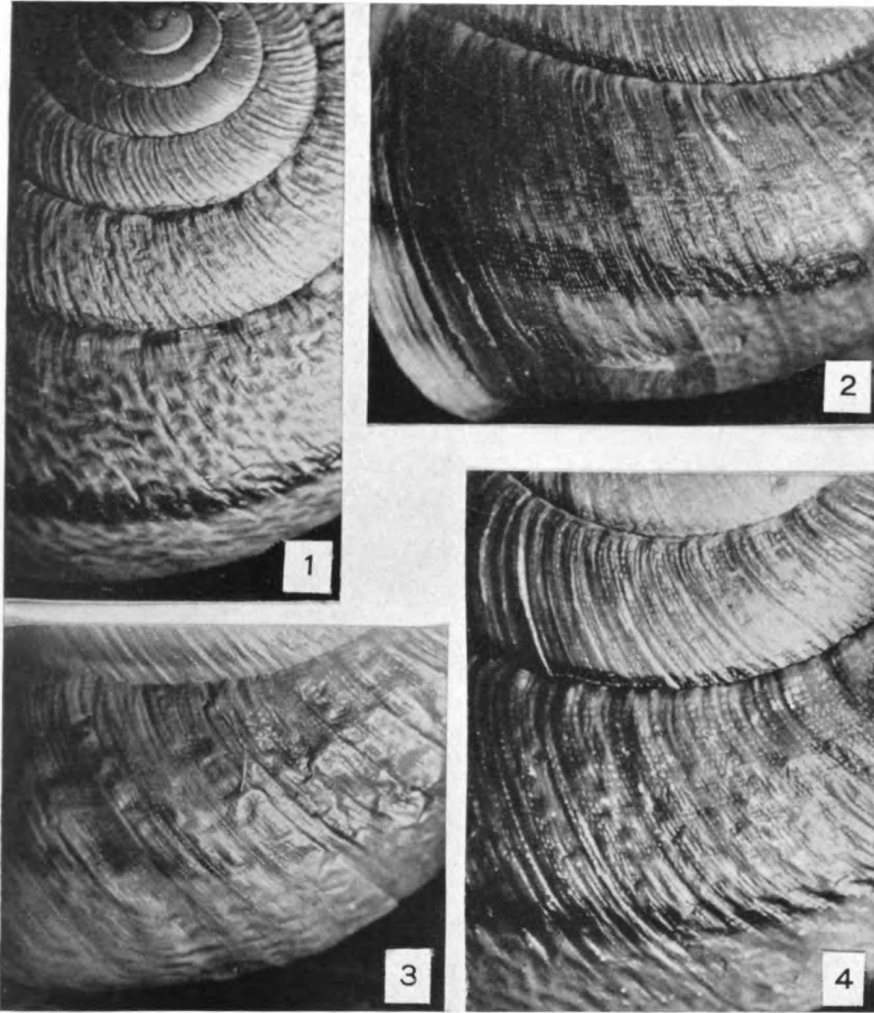


Fig. 55: 1, *Helminthoglypta arrosa holderiana*, type of form *marinensis*, sculpture of Fig. 53: 2. 2, *H. a stiversiana*, Tomales Bay, sculpture of Fig. 56: 17. 3, *H. a miroka*, sculpture of Fig. 57: 4. 4, *H. a stiversiana*, sculpture of Fig. 56: 16. (All  $\times 5$ .)

Dr. Cooper's type was lost in the San Francisco fire, but a specimen sent by him to W. G. Binney is preserved in No. 29584 U.S.N.M. This may be accepted as a neotype of *stiversiana* (Fig. 54). It is without locality, but agrees closely with shells from Tomales, Marin County collected by Hemphill. In some of the Tomales lot the band is narrow, as in the neotype, but others have it double that width, as in Figure 56: 17. The decussate sculpture of the upper surface is variable in development, but

rather well expressed in the neotype, about as in Figure 55: 2. It is weak in some of the Tomales shells. It is well shown in Figure 55: 2, 4.

It is somewhat thinner than *H. arrosa holderiana*, with much less malleation. *H. a. miwoka* is mainly smaller with a higher spire and less sculpture. The umbilicus is generally, but not always, wider than in *miwoka*. Hemp-hill sent these shells out as "*H. nickliniana*".

Height 21.0, diameter 28.0 mm.;  $6\frac{1}{2}$  whorls (Fig. 56: 16). Tomales Bay.

Height 21.5, diameter 28.3 mm.; 7 whorls. Tomales Bay.

Height 17.8, diameter 22.8 mm.;  $6\frac{1}{2}$  whorls (Fig. 56: 17). Tomales Bay.

Shells from the town of Point Reyes in the A. G. Smith Collection are relatively high, light reddish brown, or in one, maize yellow, from 18 x 25.3 mm., 6 whorls, to 23.4 x 28.5 mm.,  $6\frac{3}{4}$  whorls. The umbilicus is almost covered. Those from Jenner are maize yellow, diameter 22.6 to 31.1 mm.

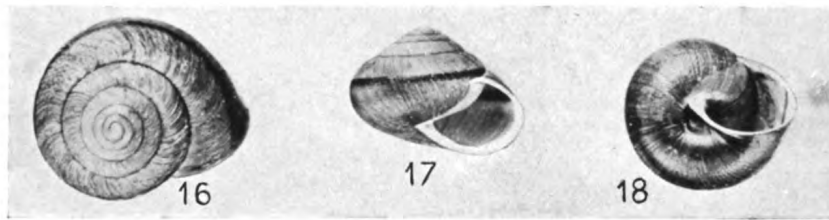


Fig. 56. *Helminthoglypta arrosa stiversiana*, Tomales Bay.

***Helminthoglypta arrosa miwoka*** (Bartsch)

Figs. 55: 3, 57.

*Epiphragmophora californiensis miwoka* Bartsch, 1919, Proc. Biol. Soc. Wash., 32: 248.

*Helminthoglypta arrosa miwoka* Beh., Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 483, pl. 38, figs. 4-9; pl. 39, fig. 3.

Differs from *H. arrosa* by the decidedly smaller umbilicus, contained about 14 or 15 times in the diameter; the shell is smaller, diameter 19 to 27 mm., usually with more elevated spire and much lighter colored periostracum, approaching a chamois tint. The fine granulation and other sculptural features are like *arrosa* in some specimens, but the granulation and malleation are much reduced in others. The surface is rather dull, having less gloss than is usual in *stiversiana*.

"Alt. 17.1 mm., greater diameter 22.1 mm., 6.2 whorls" Type.

Largest, height 18, diameter 25.4 mm.,  $6\frac{1}{2}$  whorls; smallest 13.9, 18.7 mm.,  $5\frac{3}{4}$  whorls; highest, 19.3, 23.7 mm.,  $6\frac{3}{4}$  whorls. Small low shell, 13.8, 19.5 mm.;  $5\frac{1}{2}$  whorls. (Topotypes, A. G. Smith Collection.)

CALIFORNIA: Point Reyes, Marin County (H. N. Lowe), Type 336832 U.S.N.M. Also 12 miles from the Point (Lowe) and near Bell System Transpacific Radio station, about 15 miles in from Pt. Reyes Light (A. G. Smith).

*H. arrosa miwoka* seems to be a dwarfed ecologic form of *stiversiana* characteristic of the granitic region. "Climatically, the Pt. Reyes region is rather unfavorable. High winds prevail, which often exceed 80 miles an hour during winter storms. This may have considerable to do with the small size of *miwoka*, as they live under low bushes and other low cover. No trees grow on the Point." (A. G. Smith.)

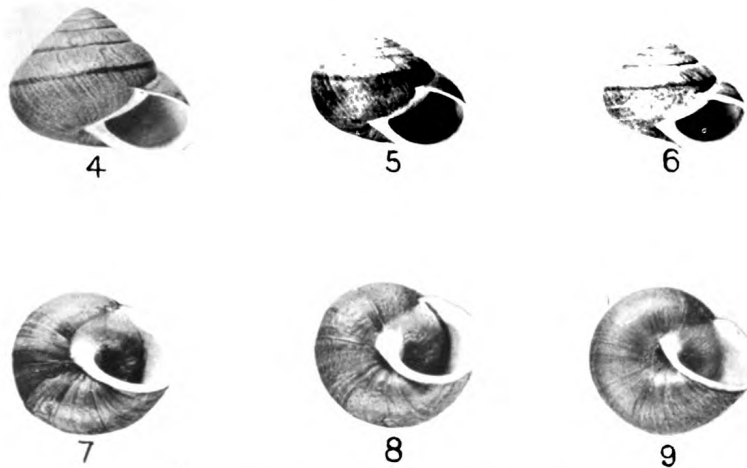


Fig. 57. *Helminthoglypta arrosa miwoka*, Point Reyes.

Twelve miles from the end of the Point, Mr. H. N. Lowe collected a small, elevated form, russet to cinnamon in color, 23-27 mm. in diameter. It is thus intermediate between *H. arrosa stiversiana* and *H. a. miwoka* in size, with the color of the former and the shape of the latter. In this connection it may be mentioned that Cooper referred to a Point Reyes shell as a small form of *stiversiana*. He must have had *miwoka*; but the two merge insensibly into one another. Three bandless individuals are in the set of forty collected by Mr. Smith at the type locality.

(The name is derived from the Miwok, a tribe of Indians who originally inhabited the region, and whom Drake discovered there when he landed in Drake's Bay.)

***Helminthoglypta arrosa williamsi* A. G. Smith**

Fig. 58.

*Helminthoglypta arrosa williamsi* A. G. Smith, Jan. 1938, *Nautilus*, 51: 79, pl. 8, figs. 1, 2, 3.

"Shell of medium size for the species, thin; spire high in relation to the diameter, which gives the shell an unusually elevated appearance, the apical angle being about  $95^\circ$ ; whorls  $6\frac{1}{2}$ , closely coiled, the last globose, descending sharply from the suture to a point near the periphery, below which it is well-rounded, terminating in a subcircular aperture; lip simple, not thickened; peristome only slightly reflected except at its basal termination,

where it partially covers the umbilicus; terminations of peristome connected with a thin callus wash. Umbilicus small, contained about 13 times in the major diameter of the shell. Nuclear whorls nearly 2, smooth but not glassy. The sculpture of the post-nuclear whorls consists of low, irregular growth-ridges, which, on the upper portion of the last three whorls, are cut into round or somewhat elongated granules following a general spiral arrangement. These granules become obsolete below the periphery of the body whorl and disappear in the vicinity of the umbilicus and within it, giving the base of the shell a more polished appearance than the upper portion. Color, cinnamon-brown to buckthorn-brown, with occasional short irregular streaks or flecks of lighter color, encircled with a narrow but well-defined band of liver-brown. The above is a description of the holotype, a fully mature specimen that measures: max. diameter 25.6; min. diameter 21.0; alt. 20.6 mm." (Smith.)



Fig. 58. *Helminthoglypta arrosa williamsi*. (After A. G. Smith.)

CALIFORNIA: Hog Island, a small islet in Tomales Bay, Marin County (Woodridge Williams). Type 7204 C.A.S. Paratypes in collections: the California Academy of Sciences, the Academy of Natural Sciences of Philadelphia, the Los Angeles Museum, the San Diego Society of Natural History, and in the private collections of Dr. S. S. Berry, E. P. Chace, W. Williams and A. G. Smith.

"This unusually high-coned subspecies of *arrosa* is distinguished by the entire absence of malleations that are present on all other forms of this species that have been described. Individuals range in altitude from 18.1 to 23.1 mm., and in maximum diameter from 22.8 to 28.3 mm. An extremely tall shell measures 23.1 x 25.0 mm. (h/d), while a low-coned shell measures 18.1 x 22.8 mm. The number of whorls varies between  $6\frac{1}{4}$  and  $7\frac{1}{2}$ , the average being  $6\frac{3}{4}$ . The umbilicus is partly covered normally although in one individual it is entirely open, and in another it is almost completely closed. The nuclear whorls of the holotype are somewhat worn but on another specimen there is a faint suggestion of the wrinkled structure normal in *arrosa* and its described subspecies.

"*H. williamsi* is related most nearly to *H. arrosa stiversiana* (J. G. Cooper), from which it is distinguished by smaller size, much darker color, and lack of malleations. It has the high cone of *H. a. miwoka* (Bartsch), but is a larger, darker-colored, and smoother shell. The shells are found under brush and weeds on the lower slopes of the island. Although the

colony is a strong one at present it could be severely decimated, if not completely wiped out by indiscriminate collecting. It is therefore sincerely to be hoped that this will not occur for this form probably exists nowhere else and it represents an interesting variation in an extremely variable species of California land snails." (A. G. Smith.)

**Helminthoglypta arrosa pomoensis** A. G. Smith

Fig. 59.

*Helminthoglypta arrosa pomoensis* A. G. Smith, Jan. 1938, Nautilus, 51: 81, pl. 8, figs. 4, 5, 6.

"Shell large and heavy; spire low, with an apical angle of  $130^{\circ}$ . Whorls  $6\frac{3}{4}$ , the last large, full, and evenly-rounded. Aperture subovate; lip simple, not thickened, the upper part descending slightly from the horizontal axis of the shell, hardly reflected above but more so at the periphery and along the basal portion, the amount not being especially prominent. Umbilicus 0.4 mm. in diameter, permeable to the apex, cylindrical, only slightly covered by the basal reflection of the peristome. Nuclear whorls  $1\frac{3}{4}$ , somewhat eroded and not exhibiting any marked structure. The first two and one-half post-nuclear whorls are relatively smooth, marked only by subobsolete



Fig. 59. *Helminthoglypta arrosa pomoensis*. (After A. G. Smith.)

irregular growth-ridges. On later whorls the growth-ridges become stronger until on the last whorl they dominate the sculptural characters of the upper part of the whorl above the periphery. Except on the early whorls the growth-ridges are cut irregularly into round or elongate granules, which appear strongest only upon the upper portion of the body whorl. Fine malleations are superimposed on this transverse sculpture at about the beginning of the last whorl and these rapidly become larger until they are the most prominent structural feature of the shell, extending over the periphery and on to the base, where they gradually grow weaker and disappear in the immediate vicinity of the umbilicus. The result of this combination of sculptural characters serves to give the shell a heavily malleate appearance, which, on closer inspection, is also finely granular. The base is highly polished and shining. Color a dark cinnamon-brown, covered with an irregular network of maize-yellow markings that generally follow the raised edges of the malleations. This light-colored network is interrupted in places by occasional stripes of basic ground-color and is lacking also immediately behind the lip and on the early whorls. Shell encircled with a

clean-cut, liver-brown band, 1 mm. wide. Color within the aperture reddish-violet, showing the band and other evidences of external coloration. The above is a description of the holotype, an unusually fine, fully mature individual measuring: max. diameter 39.3; min. diameter 32.1; alt. 25.0 mm." (Smith.)

CALIFORNIA: Big River near the mouth of Daugherty Creek, Mendocino County, under redwoods (A. G. Smith). Type 7208 C.A.S. Paratype 3929 A. G. Smith Collection.

Two adults and one broken shell found. "This remarkable subspecies of *arrosa* can be recognized immediately by its huge size, heavy malleations, and unique coloration (for the species) of the yellowish network on a dark background. Other examples of this same race have been collected on the Navarro River at the mouth of the North Fork, and in Russian Gulch, both in Mendocino Co. Apparently it is found only near the coast in heavily timbered redwood canyons and is not common, being found so far in pairs or singly. With it has also been collected a smaller but totally different race close to *arrosa* s. s., with which it evidently does not intergrade.

"*H. pomoensis* is not closely related to any other described *arrosa* subspecies. However, *H. arrosa* is so variable, taken as a whole, it is possible that more careful collecting will turn up intergrades between *pomoensis* and a medium-sized, low-coned race of *arrosa* referable to the subspecies described as *rubicunda* (Rowell).

"An indication of the large size of the adult specimens collected may be obtained from the following table of measurements:

Big River, Mendocino County .....	Diameter	39.3 mm.,	alt.	25.0 mm.,	whorls	6½.	Type.
	"	40.5 "	"	25.7 "	"	6¾.	Paratype.
Navarro River, Mendocino County .....	"	40.7 "	"	25.5 "	"	6½.	Type.
	"	36.5 "	"	22.6 "	"	6½.	Paratype.
Russian Gulch, Mendocino County .....	"	37.3 "	"	25.1 "	"	6½.	Type.

"Named for the Pomo, a tribe of Indians formerly living in the vicinity where this snail is now found, who may have used it for food." (Smith.)

***Helminthoglypta arrosa humboldtica* Berry**

Fig. 60.

*Helminthoglypta arrosa humboldtica* Berry, April, 1938. Journ. Ent. & Zool., Pomona Coll., 30: 17, figs. 1, 2.

"Shell of moderate size and thickness, depressed-conic; whorls 6½ to 6¾ moderately convex, the body whorl rapidly widening at the last and descending parietally; aperture large, notably wider than long, oblique; peristome strong, whitish, moderately reflexed above and quite strongly so below, the columellar flare but little accentuated; ends of peristome converging somewhat and connected by a thin wash of callus; umbilicus moderate, steep-walled, contained on the average about ten times in the diameter of the



shell. Embryonic shell very finely and weakly concentrically wrinkled, the wrinkles giving way to the rather coarse irregular growth-lines of the succeeding whorls, often with traces of weak spiral threading which is likewise more or less evident on the base of juvenile specimens, but becomes obsolete on the mature whorls where its place is taken by a minute irregular malleation, best developed on the upper surface of the last half of the body-whorl, and extending over the base as well, where the malleations exhibit a tendency to run together spirally; calloused surface of whorl inside aperture very finely microscopically granulose. Ground color of body-whorl dresden brown, finely mottled on the malleations tawny-olive, usually with a very clear-cut supra-peripheral band of a dark vandyke brown 1 mm. wide or a little more, sometimes bordered below by an indistinct pale area of similar width; upper whorls snuff brown without much mottling, the apex paler." (Berry.)

Max. diameter 31.7, min. diameter 25.3, alt. 18.2, diameter umbil. 3.0 mm.;  $6\frac{1}{8}$  whorls.

Max. diameter 31.3, min. diameter 25.1, alt. 18.7, diameter umbil. 3.2 mm.;  $6\frac{1}{8}$  whorls.

Max. diameter 31.4, min. diameter 25.0, alt. 19.0, diameter umbil. 3.0 mm.;  $6\frac{1}{2}$  whorls. Type.

Max. diameter 29.3, min. diameter 24.0, alt. 18.2, diameter umbil. 2.6 mm.;  $6\frac{1}{2}$  whorls.

Max. diameter 28.2, min. diameter 23.2, alt. 18.3, diameter umbil. 3.2 mm.;  $6\frac{1}{2}$  whorls.

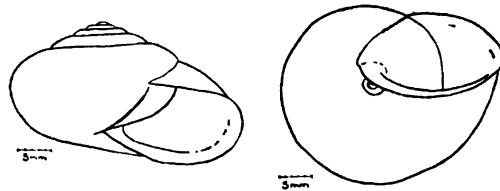


Fig. 60. *Helminthoglypta arrosa humboldtica*. (After Berry.)

CALIFORNIA: Vicinity of Bridge Creek Lumber Camp south of Scotia, Humboldt County (James Cunningham), Type 7085 Berry Collection; paratypes 6175 Berry Collection, others to be deposited in the collections of Stanford University, Academy of Natural Sciences of Philadelphia, San Diego Museum of Natural History and Allyn G. Smith.

"Among previously described races of *arrosa* this appears nearest to *holderiana* (J. G. Cooper) of the Oakland Hills, but is larger, more depressed, lighter in color, has a more elongate aperture, and shows a spiral arrangement of the basal malleations, all characters quite evident as one views series of the two side by side. Furthermore, although larger, the shells examined have from  $\frac{1}{2}$  to  $\frac{3}{4}$  of a whorl less than *holderiana* which continues nearly or quite to a full 7 turns. On one of our specimens the dark suprapерipheral band is wanting although the shell is not otherwise albinistic. The race is named for Humboldt County." (Berry.)

**Helminthoglypta arrosa mattolensis** A. G. Smith

Fig. 61.

*Helminthoglypta arrosa mattolensis* A. G. Smith, Jan. 1938, Nautilus 51: 83, pl. 8, figs. 7, 8, 9.

“Shell large, globose, of fairly heavy texture; spire moderately elevated, the apical angle being  $113^{\circ}$ ; whorls  $5\frac{3}{4}$ , the last rapidly expanding, effuse and evenly rounded, terminating in a capacious aperture; lip not quite mature and therefore thin, slightly expanded above but more so below, where its basal termination half obscures the umbilicus, connected between terminations by an exceedingly thin wash of callus. Umbilicus rather small for the size of the shell, being contained about 16 times in its major diameter. Nuclear whorls 2, smooth but not shining under a magnification of  $\times 40$ . Sculpture of the post-nuclear whorls composed of low, irregularly spaced growth-ridges that gradually increase in size until on the last three whorls they become the most prominent sculptural feature. On the body whorl there are several broad malleated areas or bands, extending from suture to base, being wider at the periphery. The last of these areas lies just behind the lip and covers about one-eighth of the body whorl. On this



Fig. 61. *Helminthoglypta arrosa mattolensis*. (After A. G. Smith.)

the malleations are large and coarse, but on two similar but smaller areas preceding it the malleations are smaller and finer. The malleated areas are also sculptured with transverse ridges, much lower than the growth-ridges and spaced so closely that from two to six or seven lie between each major pair. These finer ridges are cut by spiral striations that vary considerably in strength but are sufficiently incised to produce a marked granular appearance above the periphery, the granules, where prominent, being much elongated. The spiral striations can be seen only under a magnification of about  $\times 14$  and are stronger above than below where they are more closely spaced on portions of the base where they are visible. Color yellow-brown with occasional cinnamon-brown streaks, the most heavily malleated area being of the darker color and marked with lighter colored flammulations. Shell encircled with a clean-cut liver-brown band about 2 mm. wide. The above is a description of the holotype, a fine but recently matured individual measuring: max. diameter 36.7; min. diameter 28.6; alt. 27.2 mm.” (Smith.)

CALIFORNIA: On the coast between Cape Mendocino and the mouth of the Mattole River, Humboldt County, living shells being found among the fallen leaves of madrone trees, *Arbutus menziesii* (G. Dallas Hanna). Type 7209 C.A.S.; paratypes in collections Cal. Acad. Sci., A.N.S.P. 171336, Los Angeles Mus., San Diego Society of Natural History, and the private collections of E. P. Chace, Dr. S. S. Berry, and A. G. Smith. Near Shelter Cove, in southwestern angle of Humboldt County (W. M. Gabb).

"It was altogether astonishing to discover another large race belonging to the *arrosa* group at a locality so far north in California, where one would expect to find *H. a. expansilabris* (Pilsbry) or a low-coned form referable to *H. a. rubicunda* (Rowell). In fact, a single dead shell of this latter subspecies was collected along with the larger shells of *mattolensis*, which is at least partial proof that the two occupy the same habitat. No evidence of intergradation is to be seen in the material at hand. *H. mattolensis* is variable in size, as shown by the following table:

"Largest shell . . . . .	Diameter	38.6	mm.;	altitude	31.2	mm.;	whorls	6 $\frac{1}{2}$ .
"Smallest shell . . . . .	"	29.5	"	"	22.2	"	"	5 $\frac{1}{2}$ .
"Average of 18 adults .	"	32.9	"	"	25.9	"	"	5 $\frac{3}{4}$ .

"The number of whorls ranges from a maximum of 6 $\frac{1}{2}$  to a minimum of 5 $\frac{1}{2}$ . The umbilicus of most of the shells in the type lot is almost unobscured by the basal reflection of the peristome, while in several it is half covered; one individual is imperforate.

"Young living specimens vary in color from light horn to cinnamon-brown, and one has the dark band bordered by broader bands of lighter color. The nuclear characters are well shown in these young shells, the nucleus being semi-polished and generally rather smooth except for a crimping of the shell at the tip and along the suture. The presence of occasional papillations leads to the supposition that embryonic shells may be sparsely hirsute.

"This new subspecies of *arrosa* may be recognized at once by its large size, tall spire, and more especially by its exceedingly globose body-whorl and large subcircular aperture. *H. arrosa* s. s. from San Mateo Co. and from the region of Mt. Tamalpais in Marin Co. are equal in size but have an average of one more whorl and do not have as globose a body-whorl. In spite of being at least double the size, it appears to be more closely related to *expansilabris* than to any other described subspecies inasmuch as it has approximately the same ratio of height to major diameter, the same average number of whorls, and a habitat that lies within the range of this subspecies. However, in addition to size, it differs from *expansilabris* in being at least partially umbilicate and in several sculptural characters as well.

“Named for the Mattole River, in the general vicinity of which this snail was discovered. An additional lot was collected this summer by Mr. and Mrs. E. P. Chace at a point ten miles south of Cape Mendocino, in Humboldt Co.” (Smith.)

W. M. Gabb collected this strongly marked subspecies in “Humboldt County,” one of them measuring: height 30.5, diameter 41.6. Also a specimen of 33 mm. diameter near Shelter Cove.

**Helminthoglypta arrosa expansilabris** (Pilsbry)

Fig. 51 f.

*Epiphragmophora arrosa* var. *expansilabris* Pilsbry, 1898, *Nautilus*, 12: 22.

The shell is compact, globose-turbinata, the spire conic, imperforate or with a narrow crevice behind the dilated columellar lip; colonial buff with chamois or darker streaks and a chestnut-brown band without light borders (the band faint or wanting in some lots); rather strongly striate except where a wrinkle-malleate pattern dominates, and without trace of the *arrosa* granulation. The white lip is broadly expanded, reflected basally, thickened within.

Height 20.7 mm., diameter 25.7 mm.; 6 whorls.

Height 19 mm., diameter 22 mm.; 5½ whorls.

CALIFORNIA: Coast of Mendocino County eleven miles north of Fort Bragg; Humboldt County at Capetown on the coast and near Scotia farther inland, north into Del Norte County at least as far as the Klamath River. Humboldt County, near Eureka (Fred L. Button), Type and paratype 71116 A.N.S.P. ¼ mile north of Jordan Creek, six miles south of Scotia, among nettles and brush in thin woods. North end of bridge over Eel River at Rio Dell, about one and a half miles north of Scotia, in thick tangle of briars and nettles. Grizzly Bluff, not far from Grizzly Bluff School, among nettles along the road. Table Bluff Light. Freshwater canyon, near County Park, and Graham Gulch, about nine miles north and east of Eureka. Near Trinidad. Del Norte County at “Dad’s Camp”, face of bluff south of mouth of Klamath River, under nettles, thimbleberry and weeds (E. P. & E. M. Chace).

Except the type lot from Button, all of the localities given are from the Chace’s collection, kindly compiled for me by Allyn G. Smith.

By the high shape, covered or nearly covered umbilicus and absence of granulation, this race differs widely from the southern forms of *arrosa*. *H. a. mailliardi*, which also lacks granulation, is thinner, usually smaller, with less strongly developed peristome and less covered umbilicus.

It is somewhat variable in color and size. A lot of over 100 taken by the Chaces from near Grizzly Bluff school, near the mouth of Eel River, is notable for the usually dark color,—saya brown to cinnamon-brown, with the wrinkles of the malleation buff, though light-colored shells also occur; the carob-brown band is rather wide, up to 1.7 mm., or sometimes wanting. Diameter 18.8 to 26.4 mm., the largest *expansilabris* recorded.

(*Expansilabris*, with spreading lip.)

**Helminthoglypta arrosa mailliardi** Pilsbry

Fig. 62.

*Helminthoglypta arrosa mailliardi* Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila. for 1926, 78: 483, pl. 38, figs. 10-15.—A. G. Smith & E. P. and E. M. Chace, 1932, Nautilus 46: 11-14.

The shell is thin, subglobose, obliquely, very narrowly umbilicate, the umbilicus more than half concealed by the reflected columellar lip; chamois colored, encircled with a narrow, chestnut-brown band with very inconspicuous pale borders above and below. Surface glossy; embryonic  $1\frac{1}{2}$

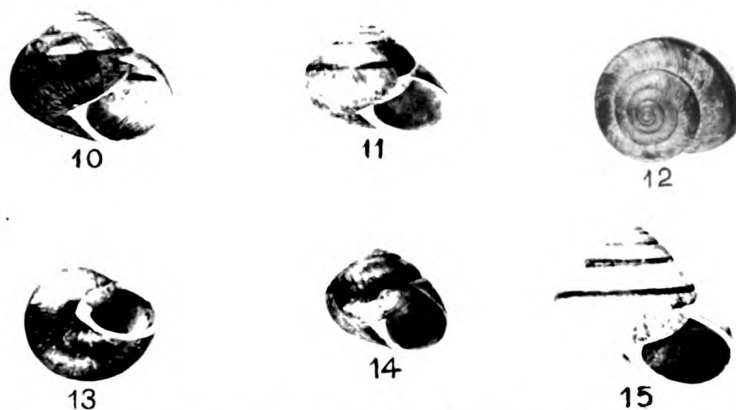


Fig. 62. *Helminthoglypta arrosa mailliardi*, Requa; figure 11, the type.

whorls are nearly smooth, granulate, following whorls with curved, retractive, unequal striae, moderately sharp, fading out on the base; the last whorl has in addition to these, a rather weak malleation, developed locally, but no granulation. The last whorl descends to the aperture and is strongly convex below. The narrow peristome is expanded and moderately thickened within, triangularly dilated at the columellar insertion.

Height 15.3 mm., diameter 20 mm.;  $5\frac{1}{2}$  whorls. Type.

Height 13.3 mm., diameter 17.5 mm.;  $5\frac{1}{4}$  whorls.

Height 14.5 mm., diameter 16.6 mm.;  $5\frac{1}{3}$  whorls.

Height 13.3 mm., diameter 18 mm.;  $5\frac{1}{3}$  whorls.

CALIFORNIA: Humboldt County, on beach near Orick (Dr. E. C. Van Dyke). South side of Klamath R. at mouth (Smith and Chace). Del Norte County at Requa (J. W. Mailliard), Type 2646 C.A.S., Paratype 142005 A.N.S.P., ocean bluff near Crescent City (Chace). OREGON: near Lookingglass, 7 miles south of Roseburg, Douglas County (Smith and Chace). McLeod, between Trail and Prospect, on the Rogue River, Jackson County (A. G. Smith).

The umbilicus is narrow, as in *H. arrosa miwoka* but it is less closed than in *H. a. expansilabris*. By its color and thin texture it resembles *H. hertleini*, but the figure is more globose. It is quite possible, however, that as Allyn G. Smith suggested to me, *mailliardi* may belong to the *tudiculata* series; but for the present it is left near *expansilabris*.

E. P. and E. M. Chace, who collected good series of this race, and Allyn G. Smith, give the following summary of dimensions:

	Orick	Requa	Lookingglass
Average shell .....	14.9 x 18.9	16 x 19.9	13.2 x 18 mm.
Largest shell .....	16.7 x 20.8	18.2 x 21.5	16.9 x 22.4 mm.
Smallest shell .....	12.9 x 17.5	13.3 x 17.5	11.5 x 15.5 mm.
Number meas. ....	18	8	16

The sculpture is variable, a few shells being more inflated than the type, thin and almost smooth, the striae and malleation very weakly developed (Fig. 14). One shell in the type lot is larger and more solid than the rest, 21.6 x 25 mm., 6½ whorls (Fig. 63: 15). It seems possible that this shell is really *expansilabris*; I do not have it at hand for renewed study.

“The known range can be said to extend for about 200 miles on or fairly close to the coast of northern California and southern Oregon, being found farther inland as the more northerly limit of its range is reached.” (Smith & Chace.)

#### HELMINTHOGLYPTA AYRESIANA SERIES

The depressed-globose umbilicate shell has incised spirals cutting the striae on the last whorl. Genitalia characterized by the pronounced contraction of the penis anteriorly, the common duct of the mucous glands being short, or not longer than the large dart sac, and the diverticulum of spermatheca duct and the flagellum are very long.

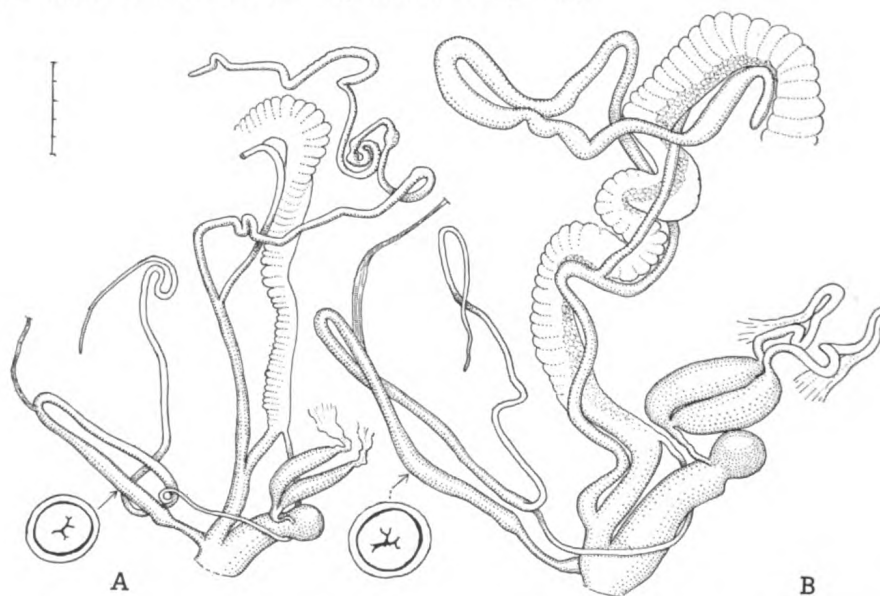


Fig. 63. A, *Helminthoglypta ayresiana*, San Miguel Island. B, *H. walkeriana*, Morro Bay.

Before dissecting these species I thought that they were probably members of the subgenus *Charodotes*. By the anatomy they belong to *Helmintholypta* s. s., but differ from the Nickliniana Series by the large dart sac, the short common duct of mucous glands and the long flagellum. By shell characters they approach some of the Nickliniana Group, such as *H. contracostae*, but in genitalia they are like *callistoderma* and the Dupeithouarsi Series.

**Helminthoglypta ayresiana** (Newcomb)

Fig. 64 a.

*Helix ayresiana* Newcomb, 1861, Proc. Cal. Acad. Sci., 2: 103 (northern Oregon).  
W. G. Binney, 1869, L. & Fr. W. Sh. N. A., 1: 72, fig. 120.

*Aglaja ayresiana* Newc., Tryon 1867, Amer. Journ. Conch., 3: 161, pl. 11, fig. 28.

*Arionta ayresiana* Newc., Binney, 1878, Terr. Moll., 5: 359, fig. 240, pl. ix, fig. H, teeth.

*Helix ayresiana* Newc., Hemphill, 1890, Zoe, 1: 330; (var. from Sta. Cruz Island, p. 331 = *H. a. sanctaecrucis*).

*Helminthoglypta ayresiana* Pilsbry, 1927, Nautilus, 40: 78.—Cockerell, 1937, Nautilus 51: 71.

"Shell with umbilicus partially closed, roundly trochiform, yellowish white, (above) furnished with a broad black band; whorls seven, slowly increasing, moderately convex, superiorly with many rib-like striae and numerous spiral lines deeply impressed, inferiorly pale and with minute decussating striations; suture well marked; aperture roundly ovate; lip slightly reflected; columella moderately expanded. Diameter 22 mill., alt. 15 mill." (Newcomb.)

The shell is depressed with convexly-conoidal spire, narrowly umbilicate, solid, earthy, of from fully 6 to nearly 7 closely coiled whorls. The color is cinnamon-buff or slightly browner, whitish on both sides of the chestnut-brown or darker band (or sometimes the light borders are indistinct). Embryonic  $1\frac{1}{2}$  whorls are microscopically, irregularly wrinkled radially, and with some sparsely scattered pustules in more or less distinct protractive trends. Following whorls irregularly, rather coarsely striate, with scattered papillae, and on the penult whorl, spiral lines. Last whorl with sculpture of unequal fold-like wrinkles, in places coarser, over and between them, fine, close, uneven striae cut into oblong granules by incised spiral lines.

Height 15.3 mm., diameter 23 mm.;  $6\frac{3}{4}$  whorls.

Height 13 mm., diameter 18.6 mm.;  $6\frac{1}{2}$  whorls.

Height 16 mm., diameter 22 mm.;  $6\frac{1}{2}$  whorls. (Newcomb Collection.)

CALIFORNIA: San Miguel Island,<sup>1</sup> especially under bushes of *Astragalus miquelensis* Greene; also fossil in caliche-like deposit of Pleistocene or later age, on top of the island (T. D. A. Cockerell).

The solid, compactly coiled, rather dingy shell, its matt surface marked with strong spiral lines, is characteristic of this island species. In the typical form of San Miguel Island the surface is irregularly subcostulate on the last whorl, or part of it, as in Figure 64 a (upper detail). Hemphill

<sup>1</sup> The original locality, "northern Oregon," being erroneous, San Miguel Island has been selected as type locality, specimens from there agreeing with Newcomb's description and type.

gave the diameters of the largest and smallest from San Miguel Island as 28 and 17 mm. The thin periostracum is often partly deciduous. A fossil, probably holocene, from near the Pleistocene locality, taken by Cockerell, measures 27.3 mm. diameter.

The whorls of *ayresiana* are more closely coiled than in *H. traski* and its subspecies. There is about one turn more than in *H. t. coronadoensis* of equal diameter. *H. contracostae* of the northeastern Bay counties has some resemblance to *ayresiana* in form and sculpture, but the only closely related mainland species is *H. walkeriana*.

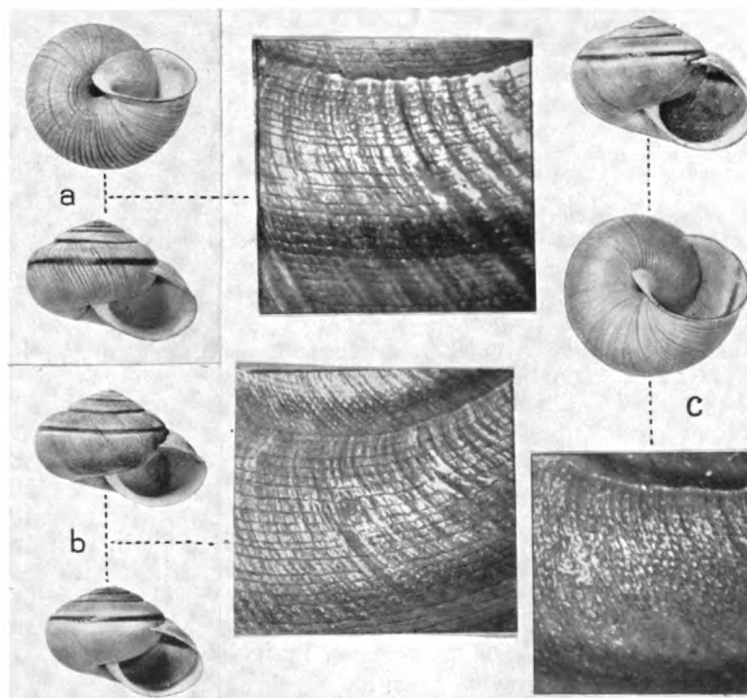


Fig. 64. a, *Helminthoglypta ayresiana*, San Miguel Island. b, *H. ayresiana sanctae-crucis*, type and paratype. c, *H. walkeriana*, Morro Peninsula. Details of sculpture  $\times 4.3$ .

“The living snails are found under and on bushes of *Astragalus miguelensis* Greene, a very characteristic endemic of the northern group of islands. This astragalus acts as a loco-weed on the sheep, and they let it alone; a circumstance which favors the snails. Hemphill says of the San Miguel form of *ayresiana*, ‘frequently bandless’. I must have examined a thousand or more, and there was always a band, though on some shells long dead it was not apparent on casual inspection”. (T. D. A. Cockerell.)

Doctor Newcomb's original locality for *H. ayresiana* was “Northern Oregon,” but a few years later J. G. Cooper gave the locality Santa Cruz.



The original lot, 26038 of the Newcomb Collection, Cornell University, consists of six shells, five of them being like the San Miguel Island form, in which the sculpture is irregular, in part coarse and fold-like, as in the middle upper detail in Figure 64. One of these (26038 *a*) agreeing closely with Newcomb's measurements, has been selected as lectotype. It measures: height 16 mm. diameter 22 mm.;  $6\frac{1}{2}$  whorls. The "authentic specimen" figured by Binney in 1869 was this form, roughly sculptured. The sixth specimen of the Newcomb lot has the smoother surface of the Santa Cruz Island shells, similar to our Figure 64 *b*; but this shell is bleached, only a small part of the band remaining, and it is six-whorled, and was obviously not the subject of Newcomb's description.

The lung is plain, light colored. Genitalia (Fig. 63 *A*) having a penis with free inner tube with unequally four-ribbed cavity and rather thin outer tube. The penial retractor is inserted on lower part of the epiphallus, as usual. Flagellum about as long as the penis and epiphallus together. The dart sac is large. Common duct of the mucous glands very short. Their membranous distal extensions are voluminous and cover most of the atrial sac. The diverticulum of the spermathecal duct is very long, and arises about 10.5 mm. from the base of the duct. Lengths of organs in mm. follow: Penis about 10; epiphallus 12; flagellum 27; penial retractor 6; vagina 4; dart sac with atrial sac 6; diverticulum of spermathecal duct 50. Diameter of shell 21.2 mm. Collected on San Miguel Island by T. D. A. Cockerell.

(Named for W. O. Ayres, ichthyologist, and a secretary of the California Academy of Sciences.)

***Helminthoglypta ayresiana lesteri* Cockerell**

*Helminthoglypta ayresiana lesteri* Cockerell, 1938, *Nautilus*, 52: 24.

"Similar to *H. ayresiana* (Newcomb), but max. diam. 14-16 mm., alt. 10-11.5 mm.; the single band, and the sculpture, with distinct spiral lines, as in *H. ayresiana*. One shell, perhaps not strictly contemporaneous with the others, is larger, max. diameter 20 mm., and more flattened than usual." (Cockerell.)

CALIFORNIA: San Miguel Island, in a Pleistocene deposit containing also fossil bones of elephants and other mammals (T. D. A. Cockerell), Type and paratype 170430 A.N.S.P.

The difference from *ayresiana* is mainly one of size. "The *H. ayresiana* shells from superficial recent or holocene deposits in the immediate vicinity of the elephant locality are unusually large, with max. diameter 24 to 27 mm." (Ckll.)

(Named for Mr. H. S. Lester, who conducted Professor Cockerell to the locality where he had discovered elephant remains some years ago.)

**Helminthoglypta ayresiana sanctaecrucis** Pilsbry

Fig. 64 b.

*Helminthoglypta ayresiana sanctaecrucis* Pilsbry, 1927, *Nautilus*, 40: 78.*Helix ayresiana* Newc., Yates, 1890, *West American Scientist*, 7: 8.

The shell is somewhat more depressed, thinner and darker colored than *ayresiana*, snuff-brown (to verona brown or sayal brown), with a carob-brown band with distinct pale borders. (In specimens lacking the thin periostracum the color is between light pinkish cinnamon and avellaneous). Wrinkles of the surface are low, not rib-like. In specimens of the same diameter there is from a half whorl to a whorl less than in typical *ayresiana*.

Height 15.8 mm., diameter 25.6 mm.; 6½ whorls. Santa Cruz.

Height 15.6 mm., diameter 23 mm.; 5¾ whorls. Type.

Height 11.4 mm., diameter 18.7 mm.; 5½ whorls. Santa Cruz I.

Height 18.7 mm., diameter 26 mm.; 6¾ whorls. Anacapa, fossil.

This is the form of Santa Cruz Island (type 10682 A.N.S.P., coll. by Hemphill) and the Anacapa Islands, California. I have not seen Santa Rosa shells, said to be the same. It was described as "*H. ayresiana* var." by Hemphill, who named it on his labels. I am now inclined to doubt whether it is sufficiently distinct for subspecific rank, though there is some difference, and it is segregated geographically. It occurs both living and fossil on Anacapa, some of the fossils being larger than any recent ones seen, but Hemphill mentions a specimen from Santa Cruz Island 17 x 30 mm. According to Dr. L. G. Yates it was in peril of extermination on Middle Anacapa in 1889, owing to the destruction of cacti on which it lives. He planted colonies on the mainland, but their location was not specified. Whether any of them survived has not been reported.

**Helminthoglypta walkeriana** (Hemphill)

Fig. 64 c.

*Helix walkeriana* Hemphill, 1911, *Trans. San Diego Soc. Nat. Hist.*, 1: 102, pl. 2.*Helix* var. *morroensis* Hemphill, 1911, *Trans. San Diego Soc. Nat. Hist.*, 1: 103.

"Shell umbilicated, globosely convex, rather thin and somewhat transparent, of a reddish brown or chestnut color; spire elevated with an obtuse apex, or with a sharp pointed apex on the narrow, tall forms; whorls 5½ convex, the last well rounded above and below, descending a little in front, bearing a well defined chestnut-colored revolving band just above the periphery, margined by two light yellowish or horn colored zones or bands, all three of about equal width. These bands are rarely absent, but when the central band is absent the marginal bands coalesce and form a faint light revolving zone. I found but one shell with all the bands absent. The sculpturing consists of rather coarse oblique file-like striae of growth cut by numerous, rather fine, well impressed but irregularly spaced revolving grooves, forming in some instances parallelograms or little squares, and numerous rude, rather coarse granules, that occasionally coalesce and are arranged along the striae of growth or are scattered over the upper surface of the body whorl. Below the periphery this sculpturing becomes much modified, and disappears near the umbilicus. The suture is distinct and well impressed; aperture, subcircular and large; peristome simple, very slightly reflected, its ends approaching the basal or columellar end, crowding

and half covering the rather small umbilicus. Greater diameter 26, height 20 mm. Greater diameter 25, height 18 mm. Greater diameter 20, height 14 mm. Greater diameter 18, height 14.5 mm." (Hemphill.)

Height 16.5 mm., diameter 24.5 mm., umbilicus 1 mm.; 5½ whorls.

CALIFORNIA: near San Luis Obispo (Hemphill); Morro Peninsula (M. Schick, M. E. Caruthers, A. G. Smith).

This snail is related to *H. ayresiana*, but differs by being rather thin, more globose, with a very narrow umbilicus and finer sculpture. The shape is more globose, the umbilicus narrower, the surface duller and the color browner than in *H. traski phlyctaena*. Hemphill figured a very high specimen, and gave the size as 20 x 20 mm.; probably pathologic.

The form called *morroensis* Hemphill "differs from the typical form in having the revolving grooves obsolete or extremely faint, and [it] is more profusely granular. Greater diameter 29, height 18 mm., 22 x 16 mm., 18 x 15 mm." "San Luis Obispo Co., among brush and rocks" (Hemphill). From the name, this should be the coastal form from near Morro. From the peninsula I have seen normal *walkeriana*, height 17.5 to 18.5, diameter 24 mm., and a small form about 16.3 x 20.4 mm., in which the spirals vary from distinct to weak or in places subobsolete, the granulation rather sharp, fine and well developed. The sculptural distinction seems too variable in the same lot to admit of separation from *walkeriana*; but I have not seen any of Hemphill's specimens of *morroensis*. *H. walkeriana*, named for Dr. Bryant Walker,<sup>1</sup> is figured from specimens collected and named by Hemphill.

The foot is dark vinaceous drab above, fading to pale vinaceous drab on the sides and tail, the sole very pale buff. Mantle over the lung profusely marbled with gray on a pale ground. Genitalia (Fig. 63 b) much as in *H. ayresiana*, but the common duct of the mucous glands is longer, though still hardly as long as the dart sac. Vagina is very short. As in *ayresiana*, the diverticulum of the spermathecal duct is very long. It is irregularly dilated. The voluminous membranous extensions of the mucous glands envelop the whole dart apparatus and atrium (but are removed in the figure). Length of penis about 15 mm.; epiphallus 22; flagellum 27; vagina 2.5; diverticulum of spermatheca duct 59 mm., arising 18 mm. from base of duct. Specimen dissected from Morro Bay, on sand dunes under *Haploppappus*, collected by A. G. Smith.

#### HELMINTHOGLYPTA DUPETITHOUARSI SERIES

The depressed, umbilicate, firm shell is dark colored, smoothish or malleate, not granulose, but often with papillae in diagonal series on the spire. The dart sac is large. Common duct of the mucous glands about as long as the dart sac (Fig. 65).

<sup>1</sup> Nautilus, 50: 59.

The series is distributed along the coast and in the Coast Range from Santa Barbara county to Santa Cruz and San Benito counties, with an outlying species north of the Bay in Sonoma county.

These shells are more closely coiled than those of the *tudiculata* series, the aperture relatively smaller and the color usually darker. They differ from the Tudiculata Series and the Nickliniana Series especially by the large dart sac, about equal in length to the common duct of the mucous glands. In the other series mentioned the dart sac is small and very much shorter than the common duct of the mucous glands.

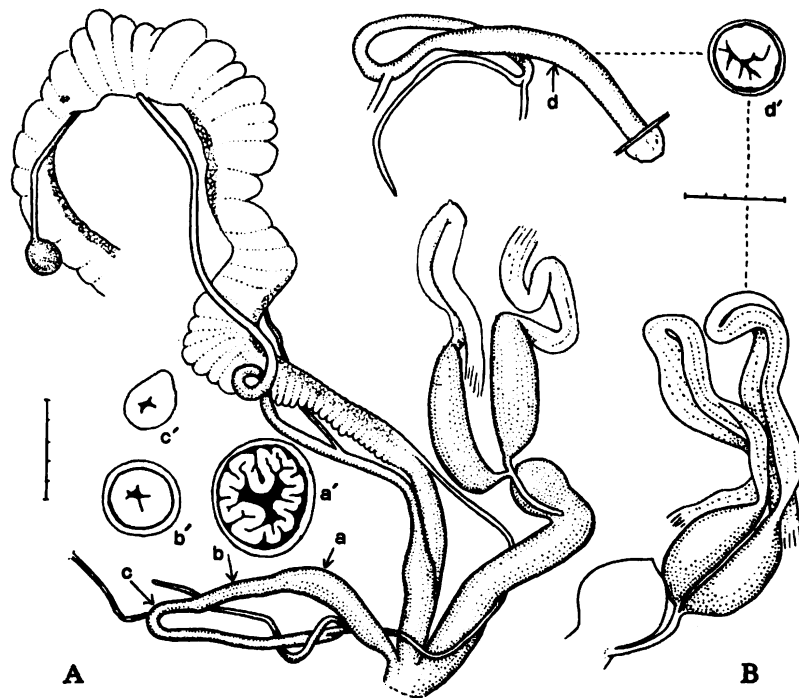


Fig. 65. A, *Helminthoglypta dupetithouarsi*, one mile east of Cypress Point. B, *H. umbilicata* form *cuestana*, penis, dart sac and mucous glands.

***Helminthoglypta cuyama* Hanna & Smith**

Fig. 66.

*Helminthoglypta cuyama* G. D. Hanna & Allyn G. Smith, 1937, *Nautilus*, 51: 15, pl. I, fig. b.

“Holotype, nearly average for the species, thin in texture and with spire strongly depressed; apical angle  $137^{\circ}$ ; umbilicus wide, tapering rather sharply to the apex; whorls six, moderately convex, the last slightly expanded and descending at the aperture; peristome simple, moderately reflected, not thickened and not obscuring the umbilicus, inner end connected with a thin callus wash; nuclear whorls nearly smooth, about two, gradually merging into the later whorls which have more or less regular growth lines;

spiral sculpture absent; surface somewhat shining, indented by fine irregularly shaped malleations arranged in obscure patches at various places on the body whorl; periostracum extremely thin, light golden brown; revolving band dark brown bounded below by a cream colored band nearly as wide, and above by a narrow indefinite band of the same color. Max. diameter, 24.7 mm.; min. diameter, 19.8 mm.; alt., 13.5 mm.; diameter of umbilicus, 3.7 mm." (Hanna & Smith.)

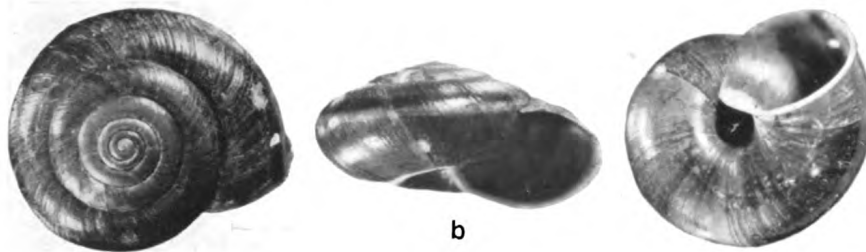


Fig. 66. *Helminthoglypta cuyama*,  $\times 1\frac{1}{2}$ . (After Hanna & Smith.)

Largest,	max. diam.	28.9,	alt.	16.2,	diam. umbilicus	4.2 mm.;	6.25 whorls.
Smallest,	"	18.5,	"	9.3,	"	2.5 "	5.5 "
Highest,	"	24.6,	"	14.9,	"	3.6 "	6 "
Average of 30,	"	23.1,	"	12.5,	"	3.2 "	6 "

CALIFORNIA: In a rock slide of Franciscan chert on the south side of the highway connecting Santa Maria with Maricopa, 23.7 miles east of the first, Santa Barbara County; the locality is two miles west of Cuyama Service Station on Cuyama river (C. C. Church and G. D. Hanna). Type 7088, paratypes 7089, 7090 C.A.S.; topotypes 168628 A.N.S.P.

"Traces of irregularly arranged papillations are visible on some specimens when considerably magnified; in a young living shell the sculpture is somewhat more distinct than in the holotype; each of the sparse papillations of the nuclear whorls in this case is set with a stubby, slightly curved hair; on the remaining whorls the papillations are more numerous and there is a suggestion of quincuncial arrangement; these likewise bear short stubby hairs and the surface appears hirsute when magnified 40 diameters.

"The species seems distinct from others of the group as might be expected from the isolated collecting station. It is smaller and not nearly so polished as *H. willetti* (Berry) and lacks the characteristic spiral sculpture so pronounced in *H. carpenteri*. The shape is similar to *H. ferrissi* (Pilsbry), a species from the southern Sierra Nevada, but it is a thinner, much lighter colored and larger [?] shell with the umbilicus proportionately narrower; comparison in this case has been made with a large series of specimens (No. 27791 C.A.S.) from upper Kern River, collected by Mr. Church.

"In May, 1937, the type locality was re-visited by Mr. George Willett who informs us that he collected a fair series but no living shells and believes, correctly no doubt, that living specimens must be very deep in the rock slide at that time of year. He also reports finding four specimens of another form referable to *H. traskii phlyctaena* (Bartsch) in the same slide." (Hanna and Smith.)

The malleation mentioned in the description is extremely weak in some examples. It is somewhat larger than *H. proles*, with a wider umbilicus, darker color, and nearly a whorl more. It resembles *H. benitoensis*, but has a wider umbilicus, weaker malleation, and the last whorl is a trifle more depressed. It is more depressed than *H. umbilicata*, which is doubtless allied.

**Helminthoglypta umbilicata** (Pilsbry)

Figs. 67 a-e. 68 d.

*Epiphragmophora tudiculata umbilicata* Pilsbry, 1897, *Nautilus*, 11: 60 (name and loc. only); 1898, *Nautilus*, 12: 22 (San Luis Obispo Co.).

*Epiphragmophora dupetithouarsi cuestana* Edson, 1912, *Nautilus*, 26: 37; 1913, *Nautilus*, 27: 37, pl. 3, figs. 13, 14.

*Helminthoglypta umbilicata* (Pils.), Pilsbry, 1924, *Nautilus*, 38: 55.—Field, 1930, *Nautilus*, 44: 30 (Pt. Conception).

*Helix dupetithouarsi* var. *concurus* Hemphill in coll., Pilsbry, 1924, *Nautilus*, 38: 55, in synonymy of *H. umbilicata* (near Morro).

*Helminthoglypta umbilicata cayucosensis* Pilsbry, 1925, *Nautilus*, 38: 104 (bluffs 6 mi. north of Cayucos).

*Helminthoglypta umbilicata lioderma* Pilsbry, in some collections.

The depressed shell has a low-conic spire, rounded periphery and convex, umbilicate base, the umbilicus contained  $7\frac{1}{2}$  (7 to 12) times in the diameter, only in small part overhung by the columellar dilation. Color, old gold to dilute cinnamon-buff in the somewhat faded type lot, but in fresh shells sayal brown, fading to cinnamon or to honey yellow on the base, with a chestnut-brown band above the periphery, about 1.5 mm. wide in the type, a slightly wider pale band below, and a narrower band above it. The surface is glossy. First  $1\frac{1}{2}$  whorls, after the smooth tip and a few wrinkles, with minute sculpture of close waved radial wrinkles, upon which widely spaced, oblong papillae stand in forwardly decurrent series. These papillae continue upon the post-embryonic shell as far as the first part of the fourth whorl in the type (somewhat upon the fifth in some examples). Last whorl rather sharply striate below the suture, the striae largely replaced by a fine, very copious malleation over the peripheral and basal surfaces. There is irregular granulation behind the outer lip, and in the type specimen a few spiral striae below the suture there. The aperture is rounded-oval, the peristome white, thickened, expanded outwardly, reflected at base, the columellar dilation covering part of the umbilicus.

Height 17.6 mm., diameter 29 mm.;  $6\frac{1}{2}$  whorls. Type.

Height 15 mm., diameter 25.2 mm.; 6 whorls.

Height 14.7 mm., diameter 21.5 mm.; 6 whorls.

Height 13 mm., diameter 20.7 mm.;  $5\frac{3}{4}$  whorls.

The mantle over the lung is profusely reticulate-maculate with dark gray to black in Cayucos specimens and *cuestana*.

CALIFORNIA: Salinas River Valley and Santa Lucia Mts., from Castroville, Monterey County, south to the Cuyama River in San Luis Obispo County. Salmon Creek, in the southern edge of Monterey Co. (H. N. Lowe, M. E. Caruthers). San Luis Obispo Co. Type 64228 A.N.S.P. 2 miles south of Piedras Blancas Light (H. N. Lowe); at China Spring, 5 miles north of San Simeon (Caruthers); bluffs 6 miles south of Cayucos (Chace, type of *cayucosensis*, 134843 A.N.S.P.); Old Creek, 3 miles south, and Little Pico Creek, 4 miles south of Cayucos (Caruthers); Morro Creek and Morro Peninsula (Caruthers); Arroyo Grande (R. H. Tremper); Cuyama River valley about 7 miles east of Santa Maria (A. G. Smith). Santa Barbara Co., under ice plants on sandy beaches above Point Conception (Stanley C. Field).

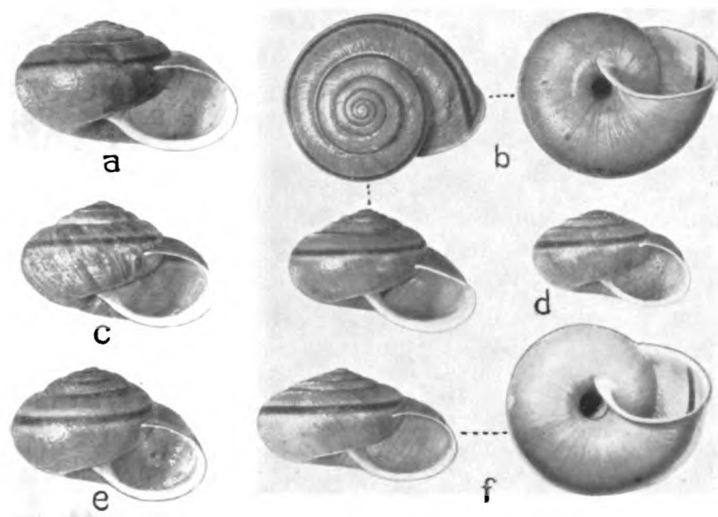


Fig. 67. a, *Helminthoglypta umbilicata*, type. b, Arroyo Grande. c, Cayucos (type of *cayucosensis*). d, near Morro. e, south of Piedras Blancas Light. f, form *cestana*, Cuesta Pass.

This snail replaces *H. dupetithouarsi* southward and eastward, in Monterey County mainly inland, but in San Luis Obispo County apparently found all along the coast where conditions are suitable. It is abundant living on bushes or under the beach aster and "hen-and-chicken" plants, often almost within reach of the spray. "It is a lover of water, and is nearly always found close to it. For example, it is not unusual to find it among water cress." (A. G. Smith.) A northern specimen from Salinas River is figured in Figure 68 d.

It differs from *H. dupetithouarsi* by the larger umbilicus, the greater depression of the last whorl, the lighter color, and by having fewer whorls

by one-half to one turn. The summit is less worn in *umbilicata*, and usually shows distinct papillae, as described above. There is granulation behind the lip, as in *H. cypreophila*.

While quite distinct from typical *dupetithouarsi* in these characters, it must be admitted that light colored southern forms of that species approach *umbilicata*, and collections from southern Monterey Co. are thought by Allyn G. Smith to show that the relation is subspecific. He writes: "*H. umbilicata* is quite variable. The Salinas Valley shells, generally, are smaller and heavier. Along the coast from the Big Sur River south to Salmon Creek they are large, darker, and rather smooth. Shells from the Little Sur River are the smooth form but begin to show the higher spire of *dupetithouarsi*. Shells from Palo Colorado Canyon at Hoffman's Camp are definite intergrades with *dupetithouarsi*. A few miles farther north at the junction of Joshua and Garapata Creeks, the shells begin to look more like *dupetithouarsi*. At Carmel Highlands and Pt. Lobos, the shells are typical *dupetithouarsi*. This is found along the Estero at the mouth of the Carmel River, but 6 miles up the Carmel Valley the shells are *umbilicata*."

In the form I called *cayucosensis* the umbilicus is not larger than in some *dupetithouarsi*, contained 11 to 16 times in diameter, but in others from the same vicinity it is wider, like *umbilicata*. A few Cayucos shells are not more depressed than *dupetithouarsi*. Color between russet and cinnamon-brown, or when denuded very close to pecan brown. It is profusely malleate, as in *umbilicata*, but the amount and intensity of malleation varies somewhat in all lots. Height 16, diameter 25.5 mm., 6 whorls, or smaller, down to 22.3 mm. diameter (Fig. 67 c).

The shells from along Salmon Creek, in the southern edge of Monterey County, differ from *umbilicata* by the very weak development of malleation, hardly apparent in some specimens. I applied the name *H. umbilicata lioderma* to this form, but being in doubt about its status, did not publish it, and the name is mentioned here because Lowe distributed specimens so labelled. The name is useless and should be dropped. In color and number of whorls (very little over six), it is like *umbilicata*; *dupetithouarsi* of equal size having 6½ to 7 whorls, darker color and more strongly contrasting bands.

The form *cuestana* (Edson), Figure 67 f, differs by the still more depressed shape and somewhat wider umbilicus, yet in some examples the difference is small. The figured type (106205 A.N.S.P.) measures height 14.5, diameter 26 mm., umbilicus 8.7 times in diameter, others being slightly less depressed, with the umbilicus a little narrower. It inhabits a wholly different station, Cuesta Pass in the Santa Lucia Mountains, collected by Harold Hannibal; others seen being from the Cuesta grade about 1 mile from the summit, collected by Morris E. Caruthers.



Abundant series of the several forms of *umblicata* collected by Mr. Caruthers, the Chaces, Dr. Tremper, Hemphill and others, have been examined, and lead me to unite a number of forms described as distinct races. I have not seen the Point Conception specimens.

The penis is similar to that of *H. dupetithouarsi*, but the walls of the inner tube are thicker and not grooved externally (Fig. 65 B, d'). The dart apparatus is like *dupetithouarsi*.

(*Umblicatus*, umbilicate.)

**Helminthoglypta dupetithouarsi** (Deshayes)

Fig. 68 a, b, c.

*Helix dupetithouarsi* Deshayes, 1840, Revue Zool. Soc. Cuvierienne for 1839, p. 360 (Monterey); 1841, Guerin's Mag. de Zool., (2), 3, pl. 30.—Binney & Bland, L. & Fr. W. Sh. N. A., 1: 174.—Keep, 1901, Nautilus, 14: 115 (*Helix cypressa* suggested as a more fitting name).—Carlson, 1905, Biol. Bull., 8: 85, figs. (locomotion).—Parker, 1911, Journ. Morph., 22: 168 (locomotion).

*Helix Dupetil-Thouarsi* Deshayes, 1850, in Fér., Hist. Nat. Moll., 1: 169, pl. 97, figs. 8-10.

*Arionta dupetithouarsi* Desh., Binney, 1878, Terr. Moll., 5: 370, fig. 252, pl. ix, fig. R, teeth; 1885, Man. Amer. L. Sh., p. 145, figs. 124, 125.

*Helix oregonensis* Lea, Journ. Acad. Nat. Sci. Phila., (2), 6: 155 (Cypress Point, Cal.).

The depressed shell has a conoidal spire and moderately wide umbilicus, contained 11-12 times in the diameter, and about one-third covered by the

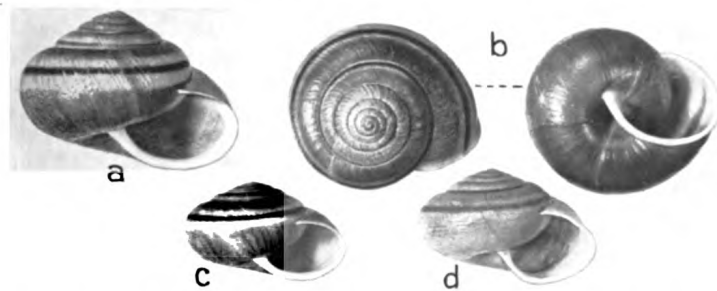


Fig. 68. a, b, c, *Helminthoglypta dupetithouarsi*, Cypress Point. c, dwarf form. d, *H. umblicata*, Salinas River, 15 miles east of Monterey.

dilated columellar lip. Color dilute argus brown (or sometimes paler, buckthorn brown), the spire somewhat russet; above the periphery having a darker band with distinct colonial buff bordering bands. Surface glossy, the last whorl lightly marked with growth striae and (typically) rather finely malleate. The whorls are rather narrow and closely wound. The peristome is white, narrowly expanded, somewhat thickened and reflected below.

Height 25 mm., diameter 30 mm. (Deshayes).

Height 19 mm., diameter 29 mm.; 7 whorls.

Height 18 mm., diameter 25.5 mm.

Height 15.6 mm., diameter 23 mm.; 7 whorls.

Height 13.4 mm., diameter 21 mm.; 6½ whorls.

In Cypress Point specimens the foot and the mantle over the lung are uniform ochraceous-buff.

CALIFORNIA: Monterey (Venus Expedition). Monterey Peninsula and a mile east of Cypress Point; Point Lobos; Carmel Highlands, Carmel Estero and on Wildcat Creek; specimens showing some intergradation with *umbilicata* southward along the coast from Garapata Creek about to Point Sur; all in Monterey Co.

In its typical form on the Monterey peninsula this is a distinct and handsome snail, characterized by the rich dark color with contrasting yellow bands, the closely coiled whorls, and the somewhat weak but copious malleation of the glossy surface. However, there are on the peninsula specimens entirely lacking malleation, or with only inconspicuous traces. The summit appears to become worn at an early age; even the young ones examined are imperfect, showing some rugosity of the embryonic whorls, but no papillae such as are seen in *H. umbilicata*. The whorls are not distinctly papillose as in *H. sequoicola*. At best a few scattered papillae may sometimes be found on the embryonic whorl, and sparsely on the third whorl. It is not granulose behind the lip.

The type was collected in the autumn of 1837 by Captain Abel du Petit-Thouars, commanding the French frigate Venus. It was a shell of maximum size. Most of those collected now are smaller, 25 to 27 mm. diameter. The height of the spire varies in rather wide limits. It occupies a narrow strip of a mile or two width, for at most twenty miles along the coast, enclosed on the east and south by the far greater territory of *H. umbilicata*; and it might be thought to be a mere ecological maritime race of the latter if it were not that in San Luis Obispo County *umbilicata* seems to live under identical conditions on the shore. In case the two are united, the wide-spread form will stand as *H. dupetithouarsi umbilicata*.

Binney's woodcut, imperfectly copied from Deshayes' copperplate, is misleading in showing two strong and equally dark bands. The upper one represents the lower part of the reddish zone below the suture. Berry mentioned finding a "half albino" specimen, and Allyn Smith found a lemon-yellow albino at Cypress Point.

On outlying rocks off the end of Cypress Point Dr. Bartsch found a dwarf ecologic form of *dupetithouarsi* living together with the small, typical form of *H. californiensis*. One of these measures 13.5 x 20 mm., 6½ to 6¾ whorls. Mr. Smith found it as small as 10.7 x 15.8 mm., 5¾ whorls. This colony is approaching extinction (Fig. 68 c).

A. J. Carlson has described a "galloping" mode of locomotion in this snail, the head being lifted free, thrust forward and applied again to the surface, leaving a low arch, through which the back part flows to the new point of contact. There may be two of these arches in progress at the same

time. The mucus track is in form of a series of oblong areas. His observations seem to have been made with snails on the dry surface of a table; ordinarily the snail glides in the usual manner. A similar gait has been described for the European *Helicodonta obvoluta* (Müll.).

It is said that these snails are becoming rather scarce at Cypress Point. Professor Keep accused the jays of preying on them. Lowe and Ferriss thought that squirrels and the clearing up of fallen wood and rubbish account for their scarcity. Shell collectors may be partly responsible for the depleted numbers. There is now a golf course where many shells were found formerly.

Mr. A. G. Smith considers the shells from the junction of Garapata and Joshua Creeks, Palo Colorado Canyon at Hoffman's Camp, and Little Sur River, to be intergrades between *dupetithouarsi* and *umbilicata*. Some from this area, as a lot taken by Dr. Rixford "15 miles south of Monterey" (and thus not far from the Little Sur River), are extremely similar to Monterey region *dupetithouarsi*, having the typical color, little malleation or none, and a rather narrow umbilicus; but typical *dupetithouarsi* should have about a half whorl more in shells of equal size. Three measure:

Height 18.3 mm., diameter 28 mm.; width umbilicus 2.5 mm.; 6½ whorls.  
 Height 19 mm., diameter 26.4 mm.; 6½ whorls.  
 Height 15.6 mm., diameter 24.2 mm.; 6 whorls.

The back is slate-gray, becoming lighter (buffish) towards foot margins and tail. Mantle over lung is uniform buff. Genitalia (Fig. 65 A)—The penis is moderately swollen in the middle, with a thin outer tube and a deeply grooved and folded inner tube (Fig. 65 a') with large cavity. Further back the caliber is smaller and the inner tube simpler (Fig. 65 A, b'). Epiphallus more slender, with thick single wall (Fig. 65 A, c'). Flagellum half as long as penis and epiphallus together. The dart sac is moderately large. Mucous glands large (about 8 mm. long), sausage-shaped, with voluminous, reflected, membranous extensions. Diverticulum of spermathecal duct long. Spermatheca globose, on a very slender duct. Length of penis about 13 mm.; epiphallus 13; flagellum 13; vagina 5; spermatheca and duct 37; diverticulum 30, arising 8 mm. from base. Specimen dissected from 1 mile east of Cypress Point, coll. by U. S. Grant, IV.

**Helminthoglypta dupetithouarsi consors** Berry

Fig. 69.

*Helminthoglypta dupetithouarsi consors* Berry, April 1938. Journ. Ent. & Zool. Pomona Coll., 30: 18, figs. 3, 4.

"Shell of medium size, conic to low-conic; whorls 6½ to 7 (rarely less than 6½), convex, the last descending in front to the edge of or below the band; base tumid, conspicuously umbilicate, the umbilicus steep-walled, permeable to the apex, and contained some 8 to 14 (most commonly 9 to 11) times in the major diameter of the shell; aperture rounded-ovate, oblique; edges of peristome converging a little and connected by a thin wash of callus; lip strong, whitish, distinctly everted, but least so above, very strong below and flaring at the columella over the edge of the umbilicus. Periostracum of embryonic shell very finely, closely, irregularly,

concentrically wrinkled, but any further ornamentation if present quite worn away in specimens seen; subsequent whorls covered with minute dot-like discrete papillae between and over the rather coarse growth-lines; these papillae disappearing near the beginning of the penultimate whorl; remaining whorls sculptured above only by the growth-lines and a little rather weak malleation; base of body-whorl similarly sculptured but the fine malleation better developed, while high magnification reveals discontinuous traces of a very shallow and obscure spiral striation. Color of upper surface auburn, sometimes deepening to chestnut-brown on the earlier whorls; base similar in tone but brighter; supra-peripheral band liver brown, usually about 1.5 mm. wide, and bordered below by a nearly similar, above by a somewhat narrower band of amber yellow." (Berry.)

Max. diameter 25 mm., min. diameter 21.4 mm., alt. 16.1 mm., diameter umbilicus 2.7 mm.;  $6\frac{2}{3}$  whorls. Type.

Paratypes in A. G. Smith Coll. from max. diameter 25.3, min. 20.5, alt. 16.6, umbilicus 2.8 mm., 7 whorls, to max. diameter 19.6, min. 16.5, alt. 12.6, umbilicus 2.3 mm.,  $6\frac{1}{3}$  whorls.

CALIFORNIA: South slope of San Juan Grade, near foot, eight miles northeast of Salinas, Monterey County (Allyn G. Smith), Type 8653 Berry Collection, paratypes 5080 Berry Collection, 2236 and 2664 A. G. Smith

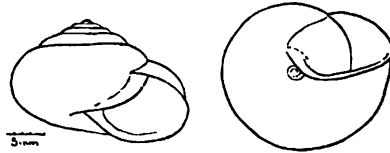


Fig. 69. *Helminthoglypta dupetithouarsi consors* (after Berry).

Collection, others to be deposited in collections of Stanford University, Academy of Natural Sciences of Philadelphia, and United States National Museum.

"Insofar as shell characters go this neat race accords with what might be expected from its geographical station in being almost exactly intermediate between *H. sequoicola* (J. G. Cooper) of the Santa Cruz Mountains, and *dupetithouarsii* (Deshayes) of the Monterey region, and it could be referred to the one of these as a subspecies with very nearly as much propriety as to the other. As compared with typical *sequoicola* from near Santa Cruz, the shells are smaller, heavier, more compact, more narrowly umbilicate, more elevated, and the papillation of the upper surface is less regular and becomes obsolete about one whorl sooner. Compared with typical *dupetithouarsii* from Cypress Point, there is a nearer approach in all gross characters, everything in fact but the papillation and more brightly polished periostracum. In the southern species, however, it must be said that a little papillation is sometimes to be made out on the earlier whorls. In adult shells this is always inconspicuous and frequently not at all clearly

distinguishable, but young shells frequently show it very plainly. The colorbands in *consors* are likewise usually a little wider and more clearly set off than in typical *dupetithouarsii*. Possibly another near relative is *H. benitoensis* Lowe (1930: 42) from The Pinnacles, a species as yet unseen by me. The type-locality of *consors* is almost midway of the combined ranges of *benitoensis*, *dupetithouarsii*, and *sequicola*. It is evident that further collecting in the region should add much to our understanding of the relationships involved.

"Although collected in the same or nearly the same spot, there is a distinct size-difference in the two series collected by Mr. Smith, the lot of 1923 averaging very definitely larger. Whether this observed difference could be construed as seasonal, is one of colonies, or is an accident of the sampling, I have no evidence to offer. Mr. Smith tells me that his experience in the field inclines him strongly to the belief that in this instance at least it is seasonal.

"One beautiful albinistic shell in Mr. Smith's collection is bandless, the apex avellaneous, paling on the slope to ivory yellow, and strongly flushed eeu-olive on the body-whorl.

"The subspecific name is the *L. consors*, 'having an equal share with another,' and has reference to the relationship shown to the two species discussed above." (Berry.)

**Helminthoglypta benitoensis** Lowe

Fig. 70 c.

*Helminthoglypta benitoensis* Lowe, 1930, Nautilus, 44: 43, pl. 5, fig. 1.

"The shell is umbilicate, rather solid, dilute russet, fading to isabella color on the base, having a narrow russet band enclosed between two yellowish-white ones. Spire moderately elevated, whorls 6, somewhat convex, slowly increasing. Surface glossy, with sculpture of fine, rather sharp, slightly retractive lines of growth, and showing microscopic very short hairs or their scars arranged in diagonal series in places on the antepenult whorl, the later whorls finely malleate, the malleation more conspicuous on the base, becoming weak on the last half whorl, which is finely papillose immediately behind the lip. Aperture oblique, oval, banded within. Lip thickened, rounded, expanded above, outer and basal margins reflected, the columellar margin dilated over part of the umbilicus. Type: Alt. 13.5, max. diameter 21.9, min. diameter 17.9, umbilicus 3.5 mm." (Lowe.)

Height 12.3 mm. diameter 21.7 mm.; 6 whorls, paratype. Largest, diam. 24.5 mm., smallest 20.1 mm.

CALIFORNIA: Pinnacles National Monument, western edge of San Benito County (H. N. Lowe). Type 1021 Los Angeles Museum; paratypes 151404 A.N.S.P.

In a paratype sent by Mr. Lowe for figuring the third and part of the fourth whorl are papillose, the papillae small, more widely spaced than in *sequicola*, and developed distinctly only in places. They are scarcely

visible under a hand lens. Umbilicus contained  $8\frac{1}{2}$  times in diameter. It is more depressed than *sequoicola*, *dupetithouarsi* or *umbilicata*. By the papillation this race approaches *H. sequoicola*, and by the color *H. umbilicata*. The aperture is smaller than in related forms, and the peristome is more strongly developed. Probably collected between 1200 and 2000 ft., but Mr. Lowe did not specify the exact locality. Allyn G. Smith informs me that it was not found by him after a thorough search in 1936, and George Willett also failed to turn it up, but one was taken by Mr. Morris Caruthers. It is evidently rare. A paratype is figured; enlarged views of the same specimen illustrated the original description.

**Helminthoglypta sequoicola** (Cooper)

Fig. 70 a, a', b.

*Helix sequoicola* Cooper, 1866, Proc. Cal Acad. Sci., 3: 259; 1868, Amer. Journ. Conch., 4: 223. Binney & Bland, 1869, L. & Fr. W. Sh. N. A., 1: 172, fig. 300.

*Arianta sequoicola* Coop., Binney, 1878, Terr. Moll., 5: 367, fig. 249, pl. ix, fig. J, pl. xiii, fig. A, anatomy; 1883, 3d Suppl., Bull. Mus. Comp. Zool., 19: 213, fig. of sculpture; 1885, Man. Amer. L. Sh., p. 146, figs. 126, 127.

*Helix (Epiphragmophora) sequoicola soquela* Rowell, 1905, Nautilus, 19: 41.

The depressed shell is umbilicate, umbilicus contained nine times in diameter, moderately solid though thin, dilute cinnamon-brown with a chestnut-brown band above periphery, bordered on both sides with pale yellow bands. Surface somewhat glossy, weakly striate, with some fine malleation in the peripheral region. Embryonic whorls microscopically rugose, with sparse papillae? (worn in all seen); subsequent whorls closely papillose in forwardly descending trends, the papillae weak or disappearing on the last whorl, locally developed but weak on the base. The whorls are narrow, closely coiled to the last one which is wide, rounded peripherally, descending but little in front. The aperture is dull purplish vinaceous within. Peristome white, narrowly reflected, the axial dilation impinging but little on the umbilicus.

“Height .42 to .54, diameter .96 to 1.20 inch.” (Cooper.)

Height 15.1 mm., diameter 24.4 mm.;  $6\frac{1}{2}$  whorls.

Height 15.1 mm., diameter 26.5 mm.;  $6\frac{1}{2}$  whorls.

CALIFORNIA: Santa Cruz, among decaying trees in the dampest places, type locality; also for 20 miles northward (J. G. Cooper). Santa Cruz Mts. between Soquel Creek and Skyland (Rev. J. Rowell, for *H. s. soquela*). Also banks of the San Lorenzo River near the Big Trees, Santa Cruz Big Tree Park, Felton, and Soquel Creek, all in Santa Cruz County; banks of the Pajaro River, near Sergeant, San Benito County; south side San Juan Grade, Monterey County (A. G. Smith).

By the shape, coloration and closely coiled whorls of the spire, this species resembles the *dupetithouarsi* group south of Monterey Bay; but it differs by the papillose surface. According to Cooper, the papillae bear deciduous bristles in the young.

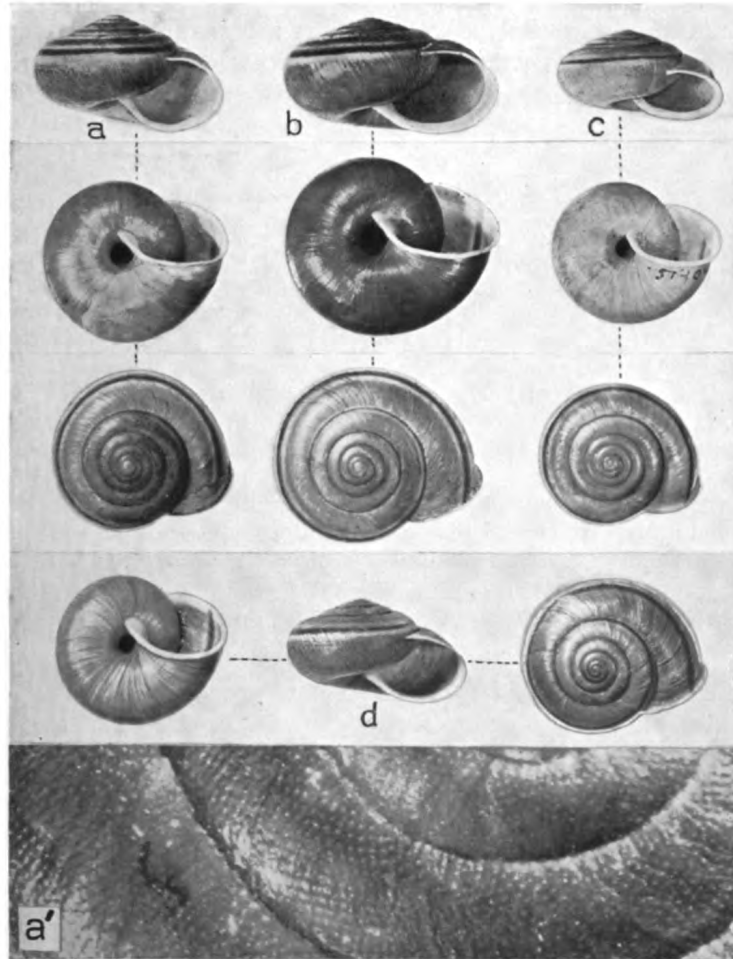


Fig. 70. a, a', *Helminthoglypta sequoicola*, Santa Cruz; b, Soquel Creek (paratype of *sequoila*). c, *H. benitoensis*, paratype. d, *H. sonoma*, type.

Rev. J. Rowell gave the name *sequoila* to a large, depressed, darker colored form from a higher elevation (fig. 71 b). His type is said to measure 12 x 28 mm., 7 whorls (evidently inexact). A cotype (89785 A.N.S.P.) measures 15.3 x 27.8 mm.,  $6\frac{1}{2}$  whorls, having sculpture as in typical *sequoicola*, but the aperture is broader. It does not seem to me to be subspecifically distinct. "I presume Rowell was misled by the difference between fresh and faded shells when he described *sequoila*. All of my lots when collected have had the beautiful dark liver-brown color, those from Soquel Creek being no different from the rest." (A. G. Smith.)

The last locality given above is for a smaller and taller race, according to Mr. A. G. Smith. "In the lot of this is a beautiful almost pure white albino, the only one I have ever seen of this species. *H. sequicola* is not common. Found under logs, but particularly in bramble patches."

(*Sequoicola*, living in redwood groves.)

**Helminthoglypta sonoma** Pilsbry

Fig. 70 d.

*Helminthoglypta sonoma* Pilsbry, 1937, Nautilus, 51: 35.

The shell is rather strongly depressed with low-conic spire, umbilicate, the umbilicus contained about  $7\frac{1}{2}$  times in diameter. Color varying from cinnamon-brown to tawny-olive, paler on both sides of the chestnut-brown band above periphery. Surface glossy, the first  $1\frac{1}{2}$  whorls microscopically and indistinctly wrinkled radially, with a few low, sparsely scattered pustules; following two whorls with fine growth striae and a few scattered papillae; last whorl irregularly wrinkle striate with some shallow malleation at and below the periphery, and faint traces of spiral impressed lines below the suture, near aperture. The whorl scarcely descends in front. Aperture oval, fawn color and showing the dark and light bands inside. Peristome is expanded above, narrowly reflected outwardly and at base, the columellar dilation impinging but little on umbilicus.

Height 13.8 mm., diameter 23.6 mm.; 6 whorls.

Height 13.5 mm., diameter 22.6 mm.;  $5\frac{3}{4}$  whorls.

CALIFORNIA: Monte Rio, Sonoma County, under redwood logs along the highway, (Stanley C. Field), Type and paratype 153680 A.N.S.P. Napa County, in rock slides on south side of Mt. St. Helena, and north of Mt. Veeder (Allyn G. Smith). Aetna Springs, Napa County (Hemphill, in C.A.S.).

Smaller than *H. sequicola*, more depressed, with papillae so few that they are easily overlooked. In apical view the last whorl is wider than in *sequicola* or *benitoensis*. *H. benitoensis* Lowe is very similar to *H. sonoma*, but it is less coarsely striate, the papillation is less reduced, the columellar insertion of the peristome is not carried so far forward, the lip is wider and the aperture smaller.

On the embryonic shell there is a small group of radially lengthened papillae near the suture, following the very small smooth tip, after which the papillae are very sparsely scattered. On the last whorl there are no forwardly descending or spiral impressions cutting the striae into granules, such as are seen invariably in *H. diabloensis*, which is also less depressed than *sonoma*.

The habitat of this snail is remote from that of *sequicola*; possibly the resemblance may be owing to convergence rather than blood relation. Mr. Allyn G. Smith believes that *H. sonoma* is a member of the *nickliniana-diabloensis* assemblage, its relationship being closest with *diabloensis*. He called attention to the hirsute young of *nickliniana* and its allies, the



deciduous hairs leaving very slight and superficial papillae which are mainly lost with later growth, but rarely some may be visible in adult shells. In *H. sonoma* these papillae may prove to be more permanent, though they are rather elusive. The slight spiral lines mentioned in the description are probably inconstant; I am told that they do not appear in part of Mr. Smith's Napa county shells.

If I am right in associating *H. sonoma* with the Dupetithouarsi Series it should have the moderately large dart sac of that group, about equal in length to the common duct of the mucous glands. *H. diabloensis* and its allies of the Nickliniana Series have the dart sac very small and the common duct of the mucous glands is relatively far longer. It is a case where knowledge of the anatomy is essential.

#### HELMINTHOGLYPTA CALLISTODERMA SERIES

The surface of the shell is papillose throughout (or on the spire only). The penis has a double wall. The dart sac is large; common duct of mucous glands about equal to the dart sac in length (Fig. 71).

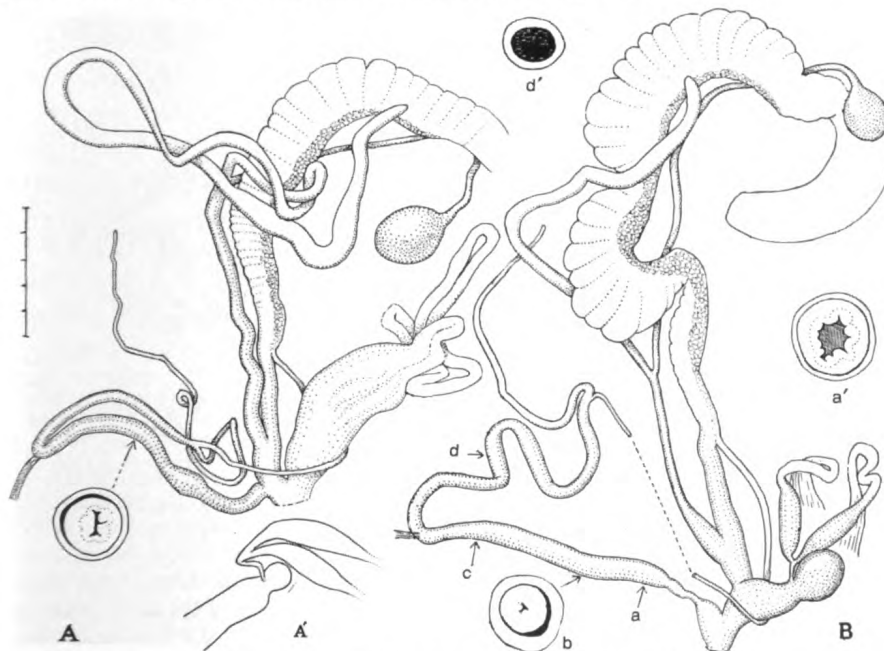


Fig. 71. A, *Helminthoglypta mohaveana* (*riparia*), Oro Grande. B, *H. cuyamaccensis*, Cuyamaca Mountains.

This series was originally formed to contain only species with papillose shells, but for want of a better place, *H. napaea* and its subspecies have been included. These shells are not papillose, but they are similar in anatomic structure.

For the genitalia of *H. callistoderma* see Figure 31 E.

**Helminthoglypta cuyamacensis** (Bartsch)

Fig. 72 a, b.

*Epiphragmophora traskii cuyamacensis* Hemph., Pilsbry, 1895, Man. Conch., 9: 197, 199, pl. 59, fig. 87 (genitalia); 1897, Nautilus, 11: 59.

*Epiphragmophora cuyamacensis cuyamacensis* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 611, pl. 116, figs. 10-12; pl. 117, fig. 8.

*Helminthoglypta cuyamacensis cuyamacensis* (Beh.), Gregg, 1936, Nautilus, 50: 69.

“Shell openly umbilicated, inner lip only slightly reflected over the umbilicus. Surface evenly papillated above and below, excepting a small portion on the rounded part of the base a little behind the aperture, which may be almost smooth” (Bartsch).

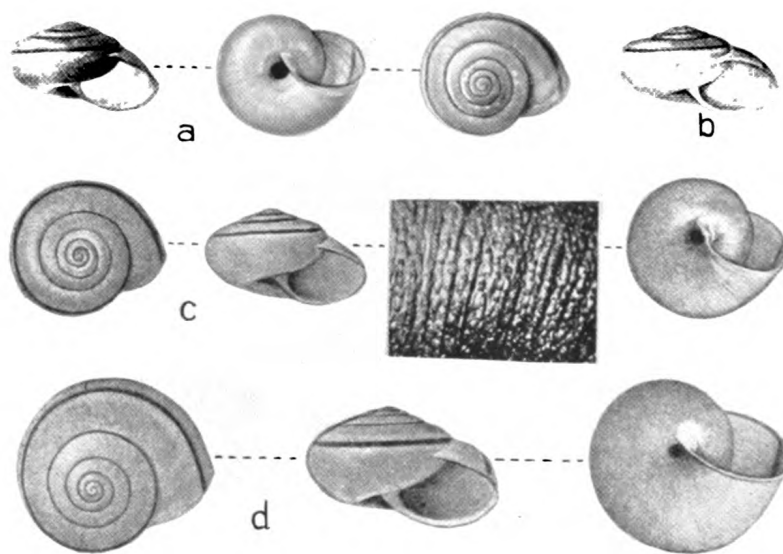


Fig. 72. a, *Helminthoglypta cuyamacensis*, type and paratype; b, above Cuyamaca Lake. c, *H. cuyamacensis venturenensis*, (after Bartsch). d, *H. cuyamacensis avus*, (after Bartsch).

The thin shell is slightly glossy, eery olive in the type lot, some others with a light wash of cinnamon in peripheral region and above, the narrow hazel band with from slightly to distinctly light borders. Embryonic whorls, after the smooth tip and a short, coarsely wrinkled stage, with close, microscopic radial wrinkles which are almost completely broken into an irregular, fine granulation, without superposed papillae. On the last whorl the papillation becomes rather irregular, and in the type and some other shells there are a few rather poorly defined impressed spiral lines on the upper surface. In some smaller shells of the original lot such lines are not visible. The umbilicus is contained about 9 times in diameter. The thin lip is outwardly very narrowly expanded, narrowly reflected basally, dilated at the columellar insertion.

Height 11.7 mm., diameter 19.7 mm.; 5½ whorls. Type.

Height 9.8 mm., diameter 16.7 mm.; 5½ whorls. Smallest paratype.

Height 12.0 mm., diameter 21.0 mm.; 5 whorls. Above Cuyamaca Lake.

CALIFORNIA: Near Cuyamaca Mountains, San Diego County (Henry Hemphill), Type and paratypes 62381 A.N.S.P. Cuyamaca Mts. ¼ of a mile above Cuyamaca Lake, ½ mile south of road at the "beef pasture", under heaps of rotten wood in mixed evergreen and deciduous woods (J. L. Baily and Pilsbry). "San Diego mines" (U.S.N.M.).

The Cuyamaca helminthoglypt has a rather small, depressed greenish-yellow shell, distinctly, finely papillose both above and below.

The genitalia of *cuyamacensis* were figured by me long before the publication of Bartsch, but in the condition of our knowledge of the anatomy of the genus at that time the species could not be identified by my figure, and the matter is further complicated as explained on a following page. With the locality, which I gave in 1897, there would be little doubt of what was intended. I withheld description of the shells because I did not wish to trespass on Hemphill's field. As my introduction of the specific name was inadequate by lacking any information on the shell, I am dating the name from Bartsch's publication.

Two specimens were dissected, Figure 71 B, from the Cuyamaca Mountains three-fourths of a mile above Cuyamaca Lake. The mantle has irregular gray markings. The long penis has a large cavity and thin outer tube (Fig. 71 a'), near where it passes into the slender, single tube, anterior neck. Further back the cavity is small (Fig. 71 b). The outer tube continues to the point marked c in Fig. 71 B. Epiphallus with large simple cavity (Fig. 71 d'). The flagellum is about half as long as the penis and epiphallus. The dart sac is enveloped in the spreading appendage of the mucous glands. Dart sac is large. The vagina enters the atrial sac, its walls being built up shortly in the cavity. The diverticulum of spermathecal duct is only moderately long, decidedly shorter than the diameter of shell.

Measurements in mm. follow, 1 being *cuyamacensis*, 2 *H. mohaveana (riparia)* from Oro Grande, Fig. 71 A.

	Penis and epiphallus	Flagellum	Vagina	Spermatheca and duct	Divertic- ulum	Shell diam.
1. ....	29	13	2	23	15	21
2. ....	19	18	1.5	29	40	17.4

In the Manual of Conchology, 9: 199, pl. 59, figure 87 illustrates the genitalia of a *Helminthoglypta* there referred to as *Epiphragmophora traskii* v. *cuyamacensis* Hemph. A specimen of the same lot is drawn in Figure 73. The alcoholic bodies were received in 1893 from Hemphill without the shells, labeled *Helix traskii* var. *cuyamacensis*, San Diego County. In 1890 we

had received the shells of "*H. traskii* var. *cuyamacensis*" which were figured by Bartsch, and illustrated now in our Figure 72 a.

The question of the possibility that these bodies did not belong to the shells sent has arisen, because the genitalia differ in important characters from the "*cuyamacensis*" obtained in 1933 by Joshua L. Baily and myself.

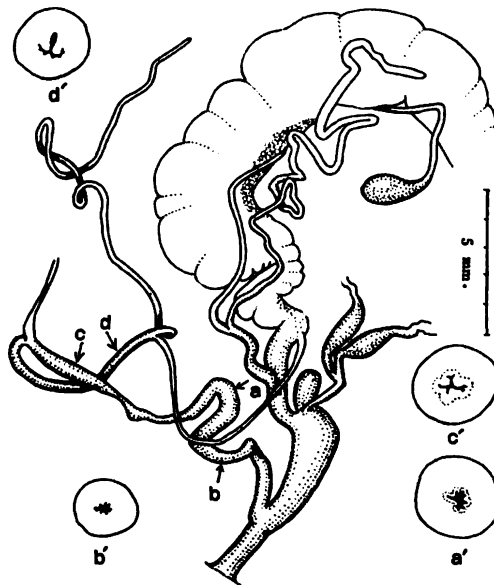


Fig. 73. Genitalia of a *Helminthoglypta* of uncertain status.

The mantle over the lung has irregular, partially anastomosing spots of bone brown to nearly black. Genitalia (Fig. 73). The atrium is decidedly longer than in any other *Helminthoglypta* examined. Penis long with thick, simple wall, the small cavity with numerous ridges (Fig. 73 a, b). The epiphallus is slender towards its entrance into the penis, with a small node, becoming somewhat swollen with three main internal ridges as it approaches the insertion of the penial retractor. The flagellum is nearly as long as penis and epiphallus. The dart sac is of moderate size, being about as long as the common duct of the mucous glands.

The long and moderately capacious atrial sac receives the dart sac and the vagina at its apex (unique in the genus). The cavity has somewhat tuberculose ridges. The mucous glands have a common duct about as long as the dart sac. Vagina is very short, and the diverticulum of the spermathecal duct is very long. Length of organs in mm.: Penis and epiphallus 21, flagellum 18; atrium (from orifice to dart sac) 7; dart sac 2; vagina 1.7; diverticulum 27, arising 3.5 from base of spermathecal duct.

**Helminthoglypta cuyamacensis lowei** (Bartsch)

Fig. 74.

*Epiphragmophora cuyamacensis lowei* Bartsch, 1918, Proc. U. S. Nat. Mus., 54: 523, pl. 83, figs. 1-3. Cf. Gregg, 1936, Nautilus, 50: 69.

"Shell very large, depressed, helicoid, broadly, openly umbilicated, horn colored, with a chestnut band at the periphery which is flanked on each side by a narrow zone, a little lighter than the general color of the shell. Nuclear whorls one and a half, moderately rounded, marked by retractively curved, incremental lines and scattered papillae. Postnuclear whorls marked by somewhat irregularly spaced and irregularly developed, retractive slanting, depressed lirations, which give to the surface a somewhat roughened aspect, and rather strongly developed, elongated papillae which are arranged in series that form curves, slanting in just the opposite direction from the incremental lines. These papillae are rather regularly developed and quite evenly distributed on the upper surface; on the lower surface they are shorter and inclined to be hemispherical. Here, too, they are quite regularly distributed, but a little more densely spaced immediately behind the aperture than on the rest of the shell. Aperture large; outer lip very slightly reflected; inner lip expanded at the base and slightly reflected over the umbilicus; parietal wall covered by a thin callus. Alt. 15.9 mm., diameter greater 26.7 mm., lesser diameter 21.2 mm., 6 whorls." (Bartsch.)

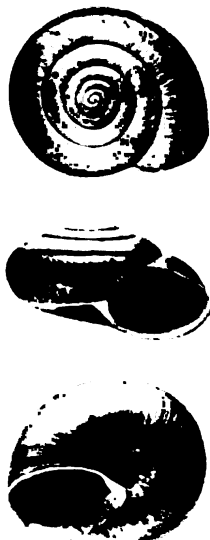


Fig. 74. *H. c. lowei*.  
(After Bartsch.)

CALIFORNIA: Palomar Mts., San Diego County, at 5000 feet (H. N. Lowe). Type 216906 U.S.N.M.

The Palomar Mountains are a detached mass midway between the San Jacintos on the north and the Cuyamacas on the south.

The shell is dark olive buff, with a light wash of cinnamon in a wide zone below the suture. In half-grown shells the oblong pustules bear short, curved bristles, but later the pustules become lower and not bristly.

**Helminthoglypta cuyamacensis avus** (Bartsch)

Fig. 72 d.

*Epiphragmophora cuyamacensis avus* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 610, pl. 116, figs. 16-18.

*Helminthoglypta cuyamacensis avus* Bartsch, Field, 1931, Nautilus, 45: 29.—Gregg, 1936, Nautilus, 50: 67-8.

"This is a giant race resembling the large form of typical *Epiphragmophora traskii*. It has the inner lip reflected over half of the rather narrow umbilicus. The entire upper surface and the inside of the umbilicus are strongly papillose, while the rounded basal portion is almost smooth, the lines of growth being the most conspicuous feature. The spiral sculpture is obsolete. Greater diameter 25 mm. alt. 14.6 mm., 5½ whorls." (Bartsch.)

CALIFORNIA: "Los Angeles Co." Type 120588 U.S.N.M. Tejon Ranch, foothills northwest side of Tehachapi Mountains, Kern County (Stanley C. Field).

Gregg has shown that the original indefinite locality record was probably incorrect, at least for present county boundaries.

(*Avus*, grandfather.)

**Helminthoglypta cuyamacensis venturensis** (Bartsch)

Fig. 72 c.

*Epiphragmophora cuyamacensis venturensis* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 611, pl. 116, figs. 13-15; pl. 117, fig. 7.

"Shell very much like *E. c. cuyamacensis* but with coarser papillation, which does not become obsolete behind the aperture on the rounded portion of the base, but is as strongly developed here as on the rest of the shell. Greater diameter 20.3 mm., alt. 12 mm., 5.6 whorls." (Bartsch.)

CALIFORNIA: Ventura County (L. G. Yates). Type 39642a U.S.N.M.

**Helminthoglypta cuyamacensis piutensis** Willett

Fig. 75.

*Helminthoglypta cuyamacensis piutensis* Willett, 1938 (Oct. 10), Bull. So. Cal. Acad. Sci., 37: 53, pl. 12.

"Shell openly umbilicated, inner lip only slightly reflected over umbilicus. Apex much depressed. Aperture round-oval, oblique, outer lip descending somewhat at the suture. Color about mummy brown, of Ridg-

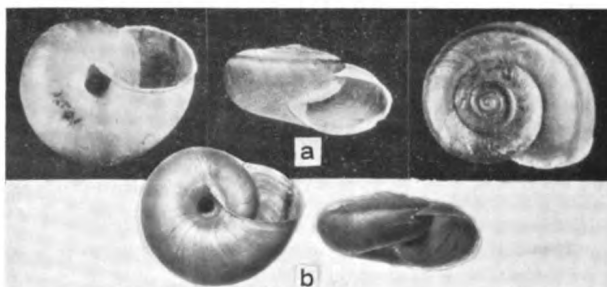


Fig. 75. *Helminthoglypta cuyamacensis piutensis*; a, type (after Willett); b, paratype.

way, lighter on the base; at the shoulder is a darker brown band slightly more than one millimeter in width, bordered above and below by narrower, obscurely defined, lighter bands. Entire upper surface finely papillated, the papillae becoming finer and less distinct on the lower part of the last whorl, where they are most pronounced inside and behind the aperture, and in the umbilicus. No spiral sculpture apparent. Height from umbilicus to apex, 8.2 mm., greater diameter 24 mm., lesser 19.8 mm.; 1½ whorls." (Willett.)

CALIFORNIA: Piute Mountains, Kern County, at a small spring on the Piute Mountain road 10½ miles southeast of its intersection with the Walker Basin-Brodfish road, at about 7000 feet elevation, under and along fir logs,

in pine and fir timber (Willett). Type 1056 Los Angeles Museum, paratypes in collections of California Academy of Sciences, Academy of Natural Sciences of Philadelphia 171221, and George Willett.

"This shell is much flatter above than any other known race of the species. It appears to be larger and less evenly papillated than *H. c. cuyamacensis* and *H. c. venturensis*, and has a much more open umbilicus than *H. c. avus*." (Willett.)

**Helminthoglypta callistoderma** (Pilsbry & Ferriss)

Fig. 76 a, b.

*Epiphragmophora callistoderma* Pilsbry and Ferriss, 1918, Nautilus, 31: 93, pl. 7, fig. 3.—Pilsbry, 1917, Proc. Acad. Nat. Sci. Phila., 69: 47, fig. 1, genitalia.

The shell is very thin, globose-depressed with low-conoid spire, narrowly umbilicate; cinnamon-buff, the base a lighter tint,<sup>1</sup> with a rather narrow (0.8 mm.) chestnut-brown band with an equal border below and a wider one above of olive-buff. Whorls rather closely coiled, the last scarcely

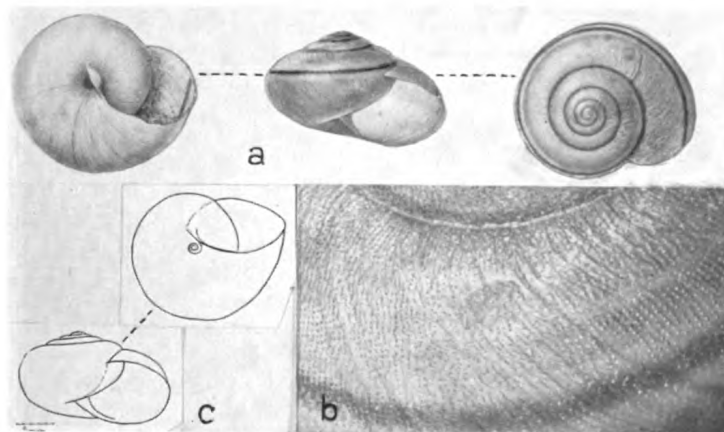


Fig. 76. a, b, *Helminthoglypta callistoderma*. c, *H. orina*. (After Berry.)

descending in front. Surface dull above, somewhat glossy at base. Embryonic shell of  $1\frac{1}{2}$  whorls, the first half a whorl with rather coarse radial wrinkles on a glossy ground, next whorl matt, with microscopic, indistinct radial wrinkles mainly broken into an irregular granulation, with very few vestigial papillae indistinctly visible. Later whorls are covered with close sculpture of oval papillae, rather irregular in arrangement, sometimes in forwardly-descending trends, but elsewhere arrangement along growth striae or in spirals may be more noticeable; about 35 in a square mm. on upper surface of last whorl. Between the papillae is a microscopic sculpture of fine wrinkles, irregularly radiating from the papillae or variable in direction. The aperture is rotund-lunate; peristome thin and sharp in shells seen (none of which are fully adult); at the columellar insertion dilated.

Height 15.6 mm., diameter 23 mm., umbilicus about 2 mm.; nearly  $5\frac{1}{2}$  whorls.

<sup>1</sup> Twenty years ago I wrote "cinnamon-brown fading on the base to tawny olive"; possibly the shells have faded, or I may not have matched the colors exactly.

CALIFORNIA: Margin of Kern River 2 miles north of Bakersfield, Kern County, on an island formed by an irrigation ditch; on dead vegetation at the water's edge (Ferriss and Hand), Type 45307 A.N.S.P.

This fragile species stands apart by its uniform papillation together with a microscopic lineolation comparable to that of some papillose *Monadenia*. The sculpture is far more developed than in *H. sequoicola*. Described from a slightly immature specimen, the largest of seven in our collection. It is unsatisfactory type material, but the sculpture is so unlike other known species that it would be a fault to omit this snail.

The body (in alcohol) is neutral gray, the mantle over lung lighter and profusely spotted-reticulate with black.

(*Callistoderma*, most beautiful hide.)

***Helminthoglypta orina* Berry**

Fig. 76 c.

*Helminthoglypta orina* Berry, 1938 (June 20), Journ. Ent. & Zool. Pomona Coll., 30: 41, figs. 1, 2.

"Shell rather small, thin, the spire strongly depressed; whorls about  $5\frac{1}{2}$ ; body-whorl rapidly enlarging, very tumid at maturity, slightly descending to the lip; base tumid, the very narrow and steep-walled but permeable umbilicus contained somewhat over 14 times in the major diameter. Aperture well rounded, only moderately oblique; peristome unthickened in specimens seen, and with only a slight columellar flare. Periostracum moderately polished; embryonic whorls, following the initial unsculptured fraction of a whorl, covered by a very close and minute wrinkled or wrinkly-granulose sculpture, overlying which appear a few small, well separated, often indistinct, pointed papillae arranged in decurrent series; later whorls very finely and elegantly microscopically wrinkled (a feature best seen on quite young shells or by transmitted light) between the somewhat coarse and irregular growth-wrinkles, and covered everywhere with small, low, rounded or pear-shaped pustulations, continuing to show more or less roughly the decurrent arrangement of their predecessors, but reduced on the base (sometimes almost to obsolescence) except within or about the umbilicus and back of the lip. Upper surface isabella color, a little duller on spire; base ecru-olive; supraproperipheral band of sepia about 1 mm. wide, with a dim secondary band a little paler than the ground-color adnate to it on either side." (Berry.)

8642 Holotype: maj. diam. 20.5, min. diam. 16.3, alt. 12.1, umbilicus 1.4 mm.; whorls  $5\frac{1}{2}$

7233 Paratype:<sup>1</sup> maj. diam. 19.0, min. diam. 15.6, alt. 12.2, umbilicus 1.3 mm.; whorls  $5\frac{1}{2}$

7233 Paratype: maj. diam. 18.5, min. diam. 15.6, alt. 11.7, umbilicus 1.4 mm.; whorls  $5\frac{1}{2}$

CALIFORNIA: Near summit of Breckinridge Mountain, Kern County, 2 live and 1 dead adults, 8 live and 7 dead juvenals, found under broken bark, sticks, and leaves in rather wet places near stream (L. G. Ingles). Holotype 8642 Berry Collection; paratypes, mainly immature, to be deposited in the collections of the United States National Museum, Academy of Natural Sciences of Philadelphia (170936) and Stanford University.

<sup>1</sup> Not quite mature.



"Close relationship with the remarkable *H. callistoderma* Pilsbry of the lower levels appears manifest from the shell characters of this extremely interesting snail. It seems sufficiently distinct, however, in its small size, polished shell, lower spire, and much more weakly developed papillation tending toward obsolescence basally. The more evenly circular aperture is likewise worth noting, yet many students may prefer to regard it as a subspecies of *callistoderma* rather than an independent entity. The entire lack of intergradation with its fellow species in all series seen has been the major influence in my choice of the more radical alternative. The specific name chosen is from the Gr. *oreinos*, found on mountains." (Berry.)

The young paratypes do not seem in any way distinguishable from young *callistoderma*, but I have not seen adult shells.

**Helminthoglypta tularensis** (Hemphill)

Fig. 77.

*Arionta tudiculata* var. *tularensis* Hemphill, 1892, in Binney, 4th Suppl., Bull. Mus. Comp. Zoöl., 22: 187.

*Epiphragmophora tudiculata tularensis* Hemph., Pilsbry, 1913, Nautilus, 27: 49.

*Helix tudiculata* var. *tularensis* Hemph., Hanna, 1938, Nautilus, 52: 7.

The shell is narrowly, nearly covered, umbilicate, very thin, olive lake colored, somewhat dull above, the base glossy and often with some slightly darker narrow growth-rest lines; above the periphery a narrow chestnut



Fig. 77. *Helminthoglypta tularensis*, Fraser's Mill.

band with borders slightly paler than the ground color. The embryonic  $1\frac{1}{2}$  whorls show a very fine, close but weak radial sculpture of wavy wrinkles, in places broken into granules. Later whorls with sculpture of rather coarse, close, unequal, retractive wrinkle-striae above, weakening at periphery and base. Most examples show rather weak malleation of the last half whorl chiefly in the peripheral region and on the base. No spiral striae, or sometimes weak traces of them appear near the suture. The penult and next earlier whorls have decurrent series of low, oblong papillae, rather widely spaced. The extent of the papillose area varies in different specimens. The white lip is narrowly expanded outwardly, narrowly reflected at base, and dilated over about three-fourths of the umbilicus.

Height 14.5 mm., diameter 22 mm.;  $5\frac{1}{2}$  whorls.

CALIFORNIA: "Fraser's Mill",<sup>1</sup> Tulare County (Hemphill), Type and

<sup>1</sup> According to Dr. Hanna (Nautilus, 52:7), Fraser's sawmill was burned about 1888. It stood about an eighth of a mile east of the packing station called Mountain Home. It is on a small flat of the north fork of Tule River three miles west of Baleh Park, a grove of giant trees owned by Tulare County and maintained as a public park. Elevation of the mill site is 6280 ft.

paratypes 8772-8775 C.A.S. Cramer (Hemphill). Tule River Indian Reservation, 30 miles east of Porterville, elevation 6000 feet (Wharton Huber). Panther Creek Giant Forest (J. H. Ferriss).

Described and figured from shells received from Hemphill. It is smaller, thinner and greener than *H. cypreophila*, always papillose in diagonal series on some part of the spire, and there is no minute granulation behind the upper margin of the lip, such as *cypreophila* has. Though usually placed with *H. tudiculata*, it does not belong to that series. The lung is copiously spotted with gray, showing through the thin shell.

In the type series of sixteen shells in the California Academy, Dr. Hanna found the diameter to vary from 19 to 26.5 mm., average 22.06 mm., and the height from 12.2 to 18.3 mm., average 14.11 mm. Adult shells collected by him at Mountain Home vary in diameter from 18.8 to 27.3 mm., height 13.4 to 17.2 mm. Living snails were found fairly common under logs,

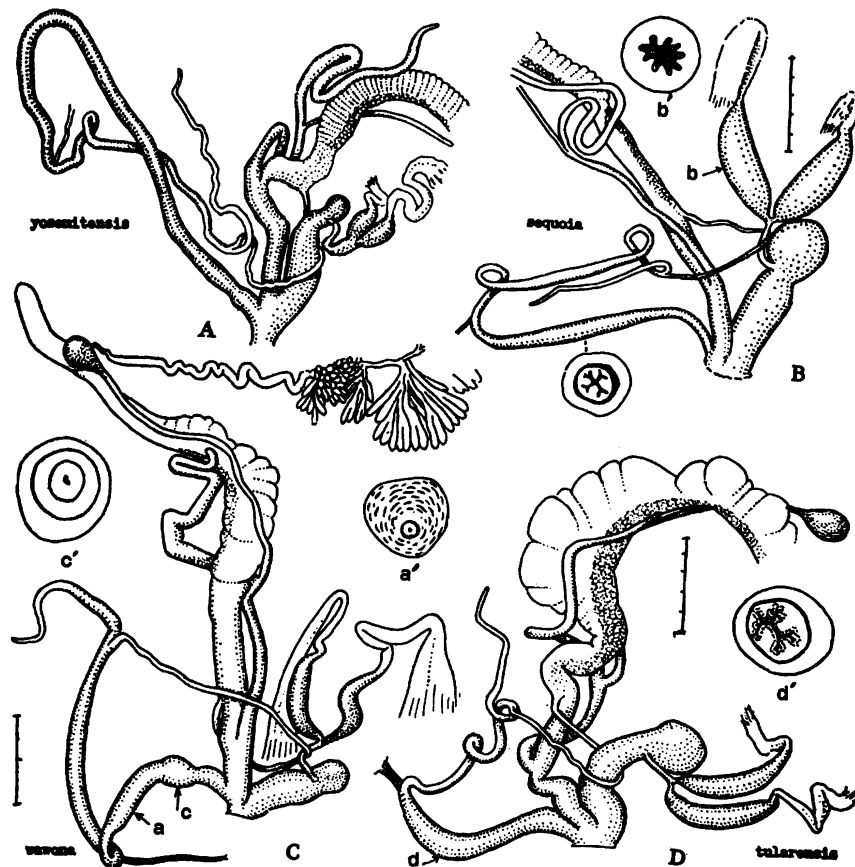


Fig. 78. Genitalia of: A, *Helminthoglypta napaea yosemitensis*, Cascade Creek. B, *H. tularensis sequoia*. C, *H. napaea wawona*. D, *H. tularensis*, Fraser's mill. (Scale lines graduated to mm.).

boards and bark. Dense shade appears to be preferred but was not essential. At Camp Nelson, on the middle fork of Tule River, elevation about 4500 ft., they were even more abundant in similar situations, varying from 21.5 to 27.8 mm. in diameter, 13.9 to 17.8 mm. in height.

Dissection of a very hard specimen collected by Hemphill at Fraser's Mill nearly fifty years ago is drawn in Figure 78 d. The mantle is profusely spotted, much as in *H. cypreophila*. The rather stout penis has a thick outer wall and a rather large cavity nearly filled by the strong ribs (Fig. 78 d'). Penial retractor is very short, 1.5 mm. The dart sac is large. Mucous glands on a common duct shorter than the dart sac. The oblong spermatheca has a very long duct. Lengths in mm. follow: Penis and epiphallus 23; flagellum 10.5; dart sac and atrial sac 9; vagina 4; spermatheca and duct 20; diverticulum 15. On account of contraction, these figures are probably below natural size.

***Helminthoglypta tularensis sequoia* Pilsbry**

Fig. 79 a, b.

*Helminthoglypta sequoia* Pilsbry, 1928, Nautilus, 41: 81.—Lowe, t. c. p. 78.

*Helminthoglypta tularensis pluripuncta* Berry, 1938, Journ. Ent. & Zool., Pomona Coll., 30: 48, figs. 17, 18.

The shell is very thin, depressed-globose with low-conic spire; with narrow, almost covered umbilicus (sometimes wholly covered); between buffy citrine and eceru-olive, fading on the last third of a whorl to deep colonial buff. Above the periphery a narrow (0.8 mm.) amber-brown band revolves. Surface glossy in the middle of the base, elsewhere somewhat dull. After the very small smooth and depressed apex it is radially, densely

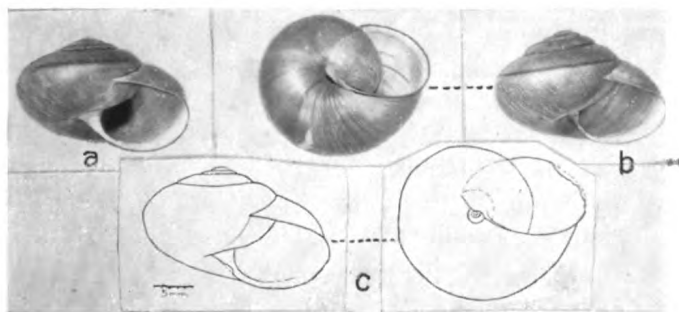


Fig. 79. a, b, *Helminthoglypta tularensis sequoia*, b, the type. c. *H. tularensis pluripuncta* (after Berry).

and very finely wrinkle-granulose for about  $1\frac{1}{2}$  whorls. Near the end of the second whorl the surface is microscopically granulose with very low, weak wrinkles of growth, and set with subregularly spaced smooth papillae in spirally descending (protractive) series. The sculpture continues to the end of the penult whorl, on which the growth-wrinkles gradually become closer. On the last whorl there are low, irregular growth-wrinkles, weaker below the periphery, and the papillae become irregular and fewer. There

are no spiral lines, but weak traces of malleation are visible. Behind the upper arc of the lip there is some granulation in the type, but scarcely discernible in some other examples. The outer and basal margins of the thin lip are narrowly expanded, the columellar margin dilated over and nearly closing the umbilicus.

Height 14.9 mm., diameter 22.7 mm.;  $4\frac{3}{4}$  whorls.

Height 15.5 mm., diameter 22.1 mm.;  $5\frac{1}{2}$  whorls. Type.

CALIFORNIA: Sequoia National Park, Tulare County (H. N. Lowe; also Mead and Ruth French), Type 142857 A.N.S.P., paratypes 142985.

Compared with *H. tularensis* this race is darker colored with a greater development of the papillae, which extend over the last whorl where they are absent in *H. tularensis*. The mantle is cream buff, copiously maculate with black. The genitalia (Fig. 78 B) do not differ in any significant feature from those of *H. tularensis*.

“The lot collected at the type locality by Mr. and Mrs. French contains many young specimens, from the nuclear stage up to at least half-grown. All of these young shells are densely hirsute, a character not true of *tularensis* from the type locality or from Camp Nelson collected by Hanna, except on very young shells. The hairs project from small round papillae and are more widely scattered on the nuclear whorls than on the later ones. On adult shells, these hairs, evidently being deciduous, are not present, and curiously enough, the papillations appear to be ‘deciduous’ also, as they apparently break off or are worn off, leaving impressed scars to show that they were once present. The result gives the shells a pitted appearance, which is plainly seen on some of my shells under a power of  $\times 14$ . Some shells are pitted in this way over the entire whorls, but in none of them do the pits extend to the immediate vicinity of the umbilicus, or within it. Lowe’s shells, which are all adult, show the same characters. Another character of *sequoia*, seen only under times 40 power, is the extremely fine wrinkling of the epidermis. This appears to be the usual thing, whereas in typical *tularensis* it is to be seen only on young shells and rarely in small isolated areas on adult shells.” (A. G. Smith.)

*H. tularensis pluripuncta* Berry does not seem, from the description, to differ from *sequoia*, but I have not seen that shell. The description follows:

*Helminthoglypta tularensis pluripuncta* Berry. (Fig. 79 c.) “Shell of medium size, thin, spire low-conic; whorls  $5\frac{1}{2}$ , moderately convex between the well-marked sutures, quite regularly enlarging until the latter part of the last whorl which expands much more rapidly, is somewhat flattened above, and descends moderately to the aperture; base very tumid, the narrow but steep-walled and permeable umbilicus contained a little more than ten times in the major diameter of the shell; aperture oblique, ample, rounded or rounded-ovate; lip thin, very slightly thickened and expanded below where it broadens into the well developed columellar flare, nearly half covering the umbilicus, its terminations hardly converging and con-

nected by a very thin parietal callus. Embryonic shell, following the minute initial smooth and radially wrinkled stages, very closely and minutely wrinkly-granulose, with a very *weak* and sparse decurrently serial papillation superimposed; post-embryonic whorls as far as the beginning of the last whorl microscopically granulose, with an overlying system of small copious hyphen-shaped papillae in fairly regular recurrently aligned series until the penultimate whorl where they become steadily smaller, more dot-like, and more numerous, and the seriation appears wavy or somewhat chevroned; body-whorl weakly malleate, especially peripherally, the papillation abruptly sparser and weaker, on the last half whorl almost obsolete, except that a fine, close, irregular granulation is again in evidence just back of the lip; incremental striae very weak and wrinkle-like on the early whorls, later becoming somewhat stronger but quite irregular; base smooth except for a very weak minute scattered papillation at first, and the growth lines, microscopic underlying wrinkling, weak malleation, and papillation back of the lip as already noted, this last extending well down into the umbilicus. Spiral sculpture is reduced to a single line on the body-whorl below the suture. Periostracum hardly polished, but translucent, with a silky luster; upper surface light brownish olive; base buffy olive, paling to dark olive-buff back of lip; a narrow bister band about 1.3 mm. wide encircles the shell above the periphery, bordered above by a dim band about as wide of dark olive-buff, and below by a slightly wider band of the same hue. Max. diameter 24.5, min. diameter 19.6, alt. 15.2 mm.; diameter umbilicus (est.) 2.2 mm." (Berry.)

CALIFORNIA: Whitaker Forest, Tulare County, one living adult (L. G. Ingles), Type 7216 Berry Collection.

"This race is represented by a single specimen, but its more open umbilicus, loss of spiral sculpture, and more abundant papillation, persistent to the last half-whorl, preclude its reference to typical *tularensis*. Restudy of some of Hemphill's topotypes of the latter species from Fraser's Mills, together with a small series from Camp Nelson kindly sent me some years ago by Dr. G. D. Hanna, inclines me to consider *tularensis* as specifically distinct from both *tudiculata* (Binney) and *cypreophila* (Newcomb), the juvenile shell sculpture being eminently different. The subspecific name proposed is derived from the L. *plus*, more, + *punctus*, pricked in like a point, and has reference to the sculptural peculiarities which serve to distinguish the race." (Berry.)

**Helminthoglypta napaea** Berry

Fig. 80 a.

*Helminthoglypta napaea* Berry, 1938 (June 20), Journ. Ent. & Zool. Pomona Coll., 30: 48, figs. 15, 16.

"Shell rather small, very thin; spire low-conic; whorls  $5\frac{1}{2}$ , convex, quite regularly enlarging until the very tumid last whorl, which expands more rapidly and descends decidedly to the aperture; suture distinct; base tumid, the umbilicus very narrow and hardly permeable; aperture ample, oblique, rounded-ovate, its terminations slightly converging and connected by a very thin callus; lip thin and sharp above, a little heavier at base and narrowly expanded into the small columellar flare which is applied so closely over

the umbilicus as nearly to occlude it. Embryonic shell, subsequent to the initial smooth stage, very finely and closely wrinkly-granulose, without trace of any superimposed geometric papillation so far as noted; post-embryonic whorls without either incised spirals or papillae; incremental striae inconspicuous, low, wave-like; body-whorl lightly malleated, the malleations weaker on the base. Periostracum with a bright silky luster; upper surface ecru-olive, sometimes clouded with dark olive-buff and citrine-drab; shell encircled above the periphery by a narrow sepia band about 1 mm. wide, supplemented above by a dim deep olive-buff band of about the same width, below by a similar one nearly twice as wide." (Berry.)

"Max. diameter 21.0, min. diameter 17.4, alt. 13.3 mm."

CALIFORNIA: Whitaker Forest, Tulare County, California; 1 living adult and 3 living juvenals taken under Sequoia logs along stream (L. G. Ingles, Oct. 6, 1930), Type 7216 Berry Collection; paratypes 7217 Berry Collection, one deposited in the collection of the Academy of Natural Sciences of Philadelphia, 170937.

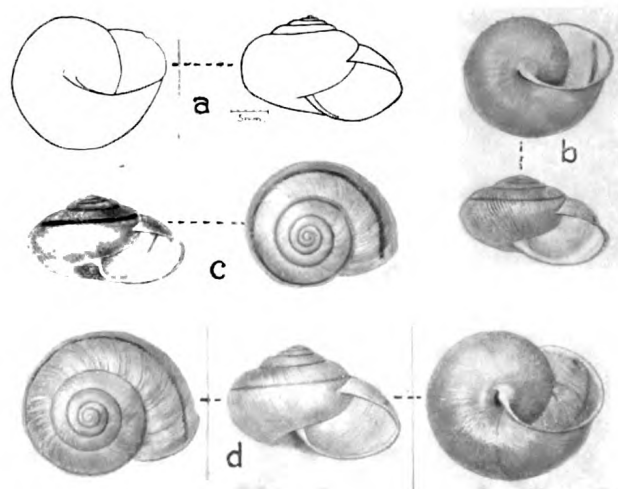


Fig. 80. a, *Helminthoglypta napaea* (after Berry). b, *H. napaea fresno*. c, *H. napaea wawona*. d, *H. napaea yosemitensis*.

"I do not feel entirely certain of the relationships of this snail, but deem it probable that it is not so very distantly akin to the small snail from the Yosemite Valley which has been listed, though surely in error, as *cypreophila* (Newcomb). The latter is a much larger, heavier, and differently shaped shell. The specific name proposed is from the L. *Napaea* (Gr. *napaia*), a nymph of woodland glades." (Berry.)

***Helminthoglypta napaea fresno*** new subspecies

Fig. 80 b.

The shell is proportioned as in *H. cypreophila* except that the umbilicus is very narrow, and barely concealed in a basal view by the dilated

columellar lip; very thin, a little translucent, the axis being faintly visible through the last whorl; between ecru-olive and chamois in color, the latter predominating at base, with a narrow (0.5 mm.) hazel band above the periphery, enclosed in faint light borders. Surface glossy at base, elsewhere somewhat dull, the embryonic whorls with sculpture as in *H. napaea* but weaker, following whorls irregularly striate, not papillose. Last whorl has moderately strong, somewhat uneven striae weaker below periphery, and a rather profuse, shallow malleation. No granulation behind lip or in umbilicus. The aperture is roundly oval, the oblique height of aperture 81.7 per cent of the width (including peristome); outer and basal margins of the thin peristome are narrowly reflected, columellar margin broadly dilated.

Height 11.4 mm., diameter 18.6 mm.; 5 whorls.

CALIFORNIA: Near Ockenden, on the Huntington Lake Road, Fresno County (H. N. Lowe),<sup>1</sup> Type and paratype 142858 A.N.S.P.

While these shells agree in the main with *H. napaea* Berry, there are various discrepancies: the last whorl could not be described as "very tumid"; the aperture is wider, not so high; the columellar dilation is broader; the outer-basal margin of the aperture is more convex than in Berry's figure. The h/d index, about 61.3, is not materially less than that of *napaea*. As the paratype of *napaea* we possess is only half grown, a full comparison could not be made.

**Helminthoglypta napaea wawona** new subspecies

Fig. 80 c.

The shell is more depressed than *H. napaea yosemitensis*; very thin; dark olive-buff with a walnut brown band about one mm. wide, with indistinct pale borders. The last whorl in apical view is wider than in *yosemitensis*. Embryonic whorls are microscopically roughened, partly in radial pattern, with a few low, scattered papillae. Later whorls with moderately strong but very fine wave-like striae and in places showing dense microscopic spiral lineolation. There are very weak traces of sparse, irregular granulation behind the lip. Aperture is higher than in *H. napaea fresno*, the oblique height about 87.7 percent of the width. The peristome is thin, narrowly expanded in the outer and basal margins, dilated half over the very narrow umbilicus.

Height 12.6 mm., diameter 19.3 mm.; 5 whorls.

CALIFORNIA: Alder Creek, Yosemite National Park (three or four miles north of Wawona) at about 5000 feet elevation (Allyn G. Smith). Type 139614 A.N.S.P.

It is unfortunately impossible now to compare the soft anatomy of this form with that of the preceding races referred to *H. napaea*. By the large dart sac and the proportions of the mucous glands and their common duct it resembles *H. tularensis* (Hemph.), but differs in details of penial structure. Both have the penis far shorter than in *H. cypreophila* and *H. allynsmithi*.

<sup>1</sup> See Lowe, Nautilus 41: 79.

The mantle is profusely marked with irregular black spots. Genitalia (Fig. 78 c). Penis short, rather thick, with a swelling near the anterior end, where there is an outer and an inner tube (Fig. 78 c, c') which further back unite into a very thick, muscular outer tube (Fig. 78 c, a'). Epiphallus is somewhat longer than the penis. Flagellum less than half the length of penis and epiphallus. The dart sac is moderately large. Mucous glands with common duct about as long as the dart sac, and having very voluminous extensions enveloping the dart apparatus and atrial sac. The vagina is nearly as long as the atrial and dart sacs. The hermaphrodite gland is very large; the liver scarcely penetrating among its coeca. Lengths of organs in mm.: penis and epiphallus 8.5; flagellum 4; dart sac and atrial sac 2.5; vagina 2; spermatheca and duct 11.

*Helminthoglypta napaea yosemitensis* new subspecies

Fig. 80 d.

The shell is similar to *H. napaea fresno* in sculpture of the nucleus and later whorls except that there is but little malleation, and in fresh specimens a rather indistinct sparse granulation is seen behind the lip. The form is noticeably less depressed. The very narrow umbilicus is somewhat wider than in a paratype of *napaea*, in similarly immature specimens. It is partially covered in adults. The last whorl descends a little in front. The aperture is nearly as high as wide, the oblique height being about 93.4 per cent of the width (including peristome) in the type, being higher than in *H. n. fresno*. The outer lip is very narrowly expanded, becoming reflected at base, and dilated half over the umbilicus.

Height 16 mm., diameter 22.7 mm.; 5½ whorls. Type.

Height 12.9 mm., diameter 19.2 mm.; 5½ whorls. Paratype.

CALIFORNIA: Yosemite National Park, in a rock slide near Vernal Falls, about 4500 feet elevation (H. N. Lowe), Type and paratype 114780 A.N.SP. Between Camp Curry and Vernal Falls (H. B. Baker); Camp Curry (Witmer Stone).

A perplexing form which was first collected, to my knowledge, by Witmer Stone in 1915 and by H. N. Lowe in the year following.

In some small specimens from between Camp Curry and Vernal Falls, at somewhat above 4000 feet, the height 13 mm., diameter 17.3 mm., 5½ whorls, there is a faint close microscopic spiral lineolation between the fine but rather strong, wave-like striae of the last whorl. Distinct traces of this are visible also in a few places on the type specimen.

Genitalia of a specimen from Cascade Creek, Yosemite National Park, received from Allyn G. Smith, are drawn in Figure 78 A. The penis and the vagina are unusually long, longer than in *wawona* or *tularensis*. The pedicels and the adjacent part of the common duct of the mucous glands are thicker than in any of the related forms. Length of penis 25 mm.; epiphallus 15; flagellum 11.5; spermatheca and duct 22; diverticulum 16, arising 9 mm. from base of spermathecal duct. I have not seen the shell of this specimen.



## MOHAVE DESERT SPECIES

This series contains mainly small, smoothish shells, not malleate but usually minutely papillose. *H. graniticola* is a specialized member of the typical subgenus of *Helminthoglypta*. Its whorls are somewhat more closely coiled than in neighboring species. Some of the other species such as *mohaveana* belong to the *cuyamacensis* group. Where others belong cannot be decided definitely until they are dissected. They are here temporarily associated on account of their geographic relations. Distribution as follows:

1. Mountains around Victorville, San Bernardino County: *mohaveana*, *graniticola*, *crotalina*, *jaegeri*.
2. Soledad Canyon, Los Angeles County: *fontiphila*.
3. Mohave and northward, Kern County: *greggi*, *caruthersi*, *isabella*.
4. Panamint Range, Inyo County: *fisheri*.

Soledad Canyon is about 40 miles west of Victorville, Mohave about 60 miles northwest, and the Panamints 100 miles north. *Helminthoglypta* is here in contact with the northwestern limits of the micrariontid subgenus *Eremarionta*, and occupies about the same ecologic place. While the shells of the two genera do not differ much in size and form, they are easily separated by the sculpture of the embryonic whorls, as well as by the genitalia.

As the small helices of Mohave Desert and neighboring territory are rather closely similar, the figures have been grouped on one page to facilitate comparisons.

**Helminthoglypta mohaveana** Berry

Fig. 81 a.

*Helminthoglypta mohaveana* Berry, 1927, Ann. Mag. Nat. Hist., (9), 18: 492, figs. 3, 4; 1930, (10), 6: 192; 1930, Nautilus, 43: 74.

*Helminthoglypta riparia* Berry, 1928 (Feb.), Ann. Mag. Nat. Hist., (10), 1: 278, figs. 7, 8.

"Shell of fair size and thickness, moderately depressed; whorls convex, sutures distinct; last whorl descending for a distance of 8 mm. or more back of the aperture, the latter consequently very oblique. Peristome slightly but distinctly thickened and expanded, usually reflected at the columellar junction so as to partly cover the umbilicus. Umbilicus funicular, and of but moderate width, although permeable to the apex, being contained about  $7\frac{1}{2}$  or 8 times in the diameter of the shell. Spiral sculpture wanting, but practically the entire surface of the shell both above and below very minutely and microscopically papillose, the papillae best seen under fairly high magnification by transmitted light. Such traces as persist indicate a light brown periostracum in life, and a narrow, possibly nearly obscure, brown band encircling the shell just above the periphery. Max. diameter 19.2 mm., min. 15.8 mm., alt. 11.4 mm., umbilicus 2.6 mm.;  $5\frac{1}{2}$  whorls." (Berry.)

Paratypes measure from 16.5 to 19.4 mm. in diameter.

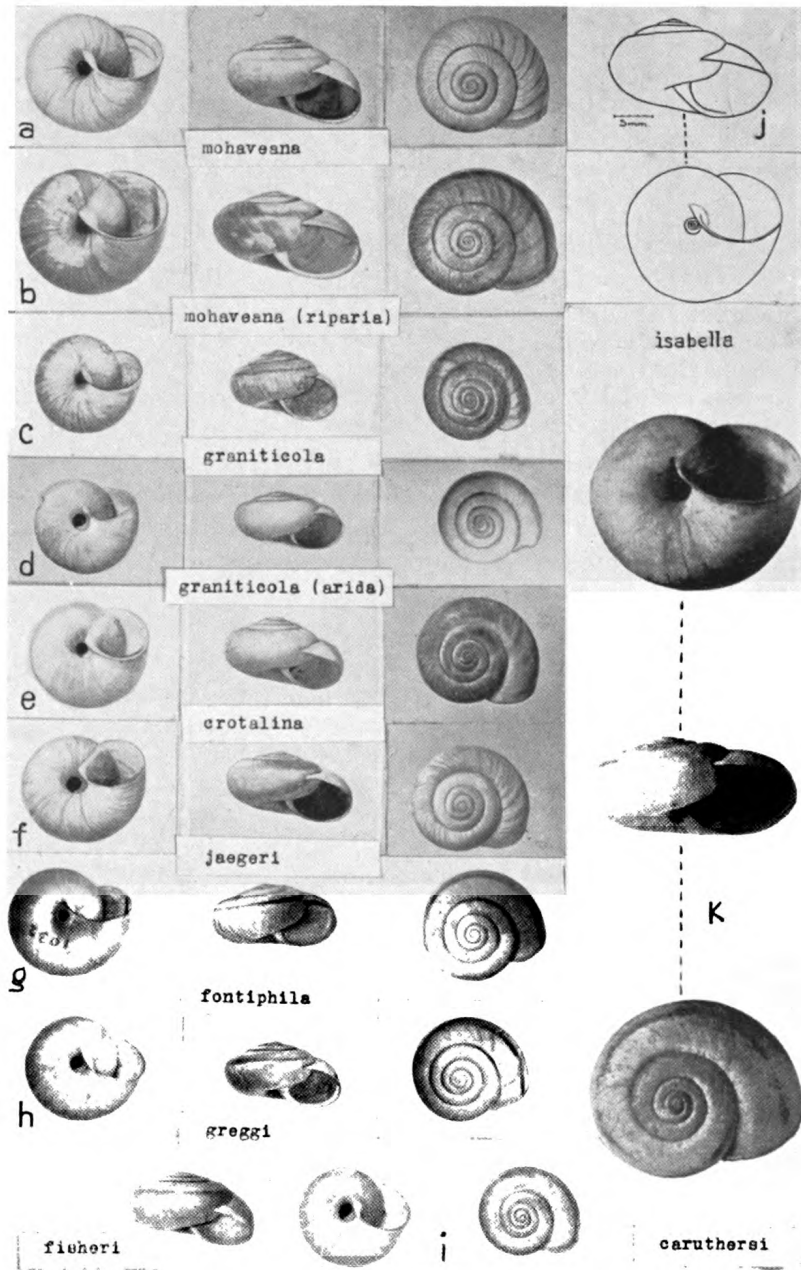


Fig. 81. Mohave Desert species of *Helminthoglypta*; j, after Berry, k, after Willett.

CALIFORNIA: Victorville grade, east side Victor Mts., San Bernardino County, among granite boulders on a hot steep slope; type 6155 Berry Collection, paratypes in collections of Allyn G. Smith and A.N.S.P. 142480. Also at base of rocky cliffs on right bank of Mohave River just above Victorville, living snails found sparingly in aestivation among and under loose rocks (S. S. Berry & W. H. Thorpe, March 4, 1939).

*H. riparia* (Fig. 81 b), now considered a synonym, was thus described: "Shell thin, of moderate size, depressed-conic in outline; whorls convex, the sutural depression well marked; last whorl produced anteriorly and strongly descending just below the aperture. Aperture rounded-ovate, strongly oblique. Peristome slightly thickened, but scarcely at all everted save where it bounds and slightly indents the umbilicus. Umbilicus permeable to apex, but of only moderate width, being contained about  $7\frac{3}{4}$  to 9 times in the diameter of the shell. Spiral sculpture wanting, but almost the entire surface of the shell distinctly and closely papillose under the high-power lens, the papillae of the upper surface showing an evident tendency towards elongation and a ranking in forward-slanting linear series, a condition especially well marked on the earlier whorls; papillae of base and the area within the umbilicus more granular and more irregularly disposed than those of the upper surface; all generally distinct and not confluent. Embryonic shell closely and finely wrinkly-granulose, a few forward slanting series of hyphen-shaped papillae superimposed, which shortly evolve into the more numerous rounded papillations of the general surface. Periostracum thin, often partly dehiscent; in color nearly a uniform deep olive-buff, paling to olive-buff below, encircled just above the shoulder by a narrow snuff-brown band about 1 mm. or less wide, with only a bare hint of a lighter area above and below the band. Max. diameter 17.8 mm., min. 15.2 mm., alt. 10.8 mm., umbilicus 1.8 mm.;  $5\frac{1}{2}$  whorls." (Berry.)

Paratypes measure from alt. 9.6 mm., diameter 16.4 mm., umbilicus 2 mm., 5 whorls, to alt. 10.7 mm., diameter 19.3 mm., umbilicus 2.3 mm.,  $5\frac{1}{2}$  whorls.

Found in a rocky outcrop on west bank of Mohave River above Oro Grande, San Bernardino County; Type 6304 Berry Collection, Topotypes in collections of Emery P. Chace and 146100 A.N.S.P.

"Of all the Mohavean helminthoglyptas this one seems to approach most nearly to the original *cuyamacensis* Pilsbry, and were it not for the widely separated habitat, might easily be regarded as but a subspecies of the latter. It differs most evidently in the more depressed form, looser coiling, smaller number of whorls, lack of spiral sculpture, and more open umbilicus. It is much more heavily papillose than any of its desert neighbors thus far brought to light, excepting possibly the larger and more narrowly umbilicate *mohaveana*, to which it is doubtless quite nearly allied." (Berry.)

In a specimen of *H. mohaveana* (*riparia* Berry) from Oro Grande (Fig. 71 A), the whole animal is cream colored, with a few faint gray markings near the end of the lung. The flagellum is very long, about equal to penis

and epiphallus. The dart apparatus is figured with its envelope nearly entire, the lower detail A showing the covering removed. The vagina appears separate from the atrial sac. The spermathecal duct and diverticulum are both very long, the latter more than double the diameter of the shell. The diverticulum arises further up the spermathecal duct than in *H. cuyamacensis*, 13 mm. from the base of the duct; the same measurement in *cuyamacensis* being 7 mm.

***Helminthoglypta graniticola* Berry**

Fig. 81 c.

*Helminthoglypta graniticola* Berry, 1926 (Nov.), Ann. Mag. Nat. Hist., (9), 18: 490, figs. 1, 2.

*Helminthoglypta graniticola arida* Pilsbry & Field, 1931, Nautilus. 44, pl. 7, fig. 5; 45: 20.

“Shell thin, rather small, moderately elevated; whorls convex, the body-whorl quite tumid above the periphery; sutures strongly grooved out; last whorl but little descending. Aperture rounded, moderately oblique. Peristome reflected slightly at its posterior edge, but not sufficiently to more than barely indent the umbilicus, otherwise hardly at all thickened or expanded. Umbilicus permeable to apex, but rather narrow, contained from  $7\frac{1}{2}$  to 9 times in the diameter of the shell. Spiral sculpture wanting, but almost the entire surface of the shell weakly papillose under high power, the papillae sometimes exceedingly faint and difficult to make out, but in other cases distinctly visible by transmitted light; papillae copious in number, but generally distinct and not confluent. Periostracum thin, near Ridgway's tawny olive in color on fresh empty shells, but paling to a lighter tone on the lower surface and on the spire, with a narrow, often inconspicuous band of snuff brown circumventing the shell just above the periphery. Living shells show a large patch of andover green and deep slate olive on the base where certain portions of the animal show through. Such shells also show a more greenish cast on the spire, and are darker than cleaned specimens. Max. diameter 15 mm., min. 12.8., alt. 8.6 mm., umbilicus 1.8 mm.;  $5\frac{1}{2}$  whorls.” (Berry.)

Paratypes from 13.7 to 15.5 mm. diameter.

CALIFORNIA: North slope of an isolated hill just south of Stewart substation of Southern Sierras Power Company, southeast of Victorville, San Bernardino County, on a steep slope between granite boulders and under dead vegetation in crevices between the larger rocks. Type 6157 Berry Collection, paratypes in collections of Allyn G. Smith and 142481 A.N.S.P.

From *H. cuyamacensis* Bartsch it “differs through its very much smaller size and finer, more even, pustulation”.

A paratype, no. 142481 A.N.S.P., was dissected. Two collected June 11, 1926, were alive when received March 3, 1927, though kept dry.

The foot is dusky drab, the sole paler. On removing the shell the mantle is seen to be cream colored marked with angular black spots; minute black dots outline the veins of the lung.

Genitalia, (Fig. 31 B). The penis is fusiform, strongly swollen in the middle, tapering gradually towards the epiphallus and abruptly contracting

anteriorly into a cylindric part. The internal structure of the penis is peculiar. At its distal end, marked by an arrow in the figure, a slender tube, detached from the external wall, arises; it enlarges gradually, and in the thick part of the penis it becomes adnate to the penial wall all around, and has a cavity stellate in transverse section, with deeply plicate walls, as in Figure 31 c. The anterior, cylindric part of the penis has the cavity somewhat contracted by low folds. This structure is illustrated by the diagram, Figure 31 c and sections. The epiphallus is longer than the penis, the penial retractor inserted at the lower third of its length. Flagellum somewhat longer than epiphallus. The vagina is rather short. Dart sac small, pedunculate, being at the summit of a much longer atrial sac, at the apex of which the mucous gland duct enters. The mucous glands are slightly swollen, their summits reflected, becoming flattened and expanded distally, passing into a thin, transparent membrane which envelops most of the dart apparatus (but is removed in the figure). The subglobular spermatheca is on a very long duct, which bears a long branch or diverticulum. The lengths of the organs follow.

Penis .....	5 mm.	Penial retractor .....	3.5 mm.
Epiphallus .....	7.5 mm.	Spermatheca and duct .	16 mm.
Flagellum .....	10 mm.	Diverticulum .....	10 mm.

(*Graniticola*, living on granite.)



Fig. 82. *Helminthoglypta graniticola* form *arida*, type. (× 2+.)

The form called *H. graniticola arida* Pilsbry & Field, (Figs. 81 d, 82), seems hardly distinct enough to call for a special name. Color between cinnamon-buff and chamois, with a narrow chestnut band above the periphery. The surface is somewhat glossy. First third of a whorl is smoothish, followed by an area of rather coarse radial wrinkles, partly interrupted into oblong granules, continuing nearly to the end of the first whorl, then changing to microscopic, wavy radial wrinkles common to many others of the genus. On the intermediate whorls there are retractive growth wrinkles and forwardly descending series of minute rather inconspicuous papillae, which are scarcely visible on the last whorl, where the wrinkles are smooth or in places slightly roughened. It has the closely coiled whorls of *graniticola*, but the last is a trifle wider in apical view; umbilicus slightly wider, contained  $6\frac{3}{4}$  times in the diameter; shell slightly more depressed. Height 7.5 mm., diameter 14 mm.;  $4\frac{3}{4}$  whorls.<sup>1</sup> It is from a hill opposite cement

<sup>1</sup> By an unaccountable error, the dimensions of a specimen of *H. graniticola* were given for *arida*, in the original account.

quarry, 5 miles north of Victorville, San Bernardino County (Stanley C. Field). Type and paratypes 168672 A.N.S.P.

**Helminthoglypta crotalina** Berry

Fig. 81 e.

*Helminthoglypta crotalina* Berry, 1928 (Feb.). Ann. Mag. Nat. Hist., (10), 1: 276. figs. 5, 6.

“Shell of moderate size and thickness, depressed conic in outline; whorls convex, sometimes with a slight indication of shouldering, the sutures well grooved out; last whorl produced parietally and descending in front. Aperture rounded ovate, oblique. Peristome only slightly thickened and reflected, even at the umbilicus. Umbilicus permeable to the apex, but of only moderate width, usually contained in the major diameter about seven or eight times. Spiral sculpture wanting, but almost the entire surface of the shell weakly papillose under high power, the papillae sometimes faint and hard to make out, but generally quite strong in the interspaces between the growth-lines on the upper surface of the body-whorl and on the base just back of the aperture, being often especially evident when the shell is seen by transmitted light. Incremental striae usually rather sharp and regular. Periostracum thin, its color in the freshest specimens seen a near pinkish buff on the spire, the base lighter. In these shells hardly more than a trace of a peripheral band is evident. Max. diameter 16.4, min. 13.7, alt. 8.7 mm., umbilicus 2.2 mm.;  $5\frac{1}{2}$  whorls.” (Berry.)

Paratypes measure from 8.2 x 15.2, umbilicus 2 mm.,  $4\frac{3}{4}$  whorls, to 9.2 x 18.8, umbilicus 2.3 mm.,  $5\frac{1}{2}$  whorls.

CALIFORNIA: Sidewinder Mine, north end Granite Mountains, San Bernardino County; 66 mature and 12 immature shells, all dead and bleached (E. C. Jaeger). Type 6302 Berry Collection; paratypes 6303 same coll.; others in collections of Allyn G. Smith and 146097 A.N.S.P.

“This species is unrepresented by any fresh or living material, but seems, nevertheless, amply distinct both from the foregoing species [*H. jaegeri*] and from the smaller *graniticola*, which comes from the southern portion of the same mountain range. *Jaegeri* is a more discoid species, with a wider umbilicus, and possibly slightly larger. *Graniticola* is a thinner-shelled, much more compactly coiled form, and is notably more tumid and rounded in contour. *Crotalina* therefore stands in some degree between the two, but its habitat being wholly isolated from that of *jaegeri* by the intervening desert-floor, it does not seem probable that true intergrades actually connecting the species will be found to occur. The application of the whorl at the suture is very weak in this species, and old weathered shells break apart at this point with consequent ease. The specific name selected is derived from *Crotalus*, the generic name of the sidewinder, and has reference to the type-locality.” (Berry.)

After the smooth tip the embryonic whorls have dense sculpture of microscopic radial wrinkles largely cut into very minute granules, over which some papillae lie sparsely in spiral trends.

**Helminthoglypta jaegeri** Berry

Fig. 81 f.

*Helminthoglypta jaegeri* Berry, 1928 (Feb.), Ann. Mag. Nat. Hist., (10), 1: 274, figs. 1-4.

"Shell of moderate size and thickness, depressed-conic in outline, often nearly discoid; whorls convex with well-grooved sutures; last whorl well produced parietally and slightly descending in front. Aperture ovate, strongly oblique. Peristome distinctly thickened, but only slightly reflected, even where it becomes produced as it joins the umbilicus. Umbilicus wide, permeable to the apex, and in diameter usually about one-sixth or one-seventh the diameter of the shell. Spiral sculpture wanting, but almost the entire surface of shell very minutely, weakly, and often quite obsoletely papillose, the papillation especially evident on the lower surface just back of the aperture, but elsewhere usually greatly obscured by the closely crowded and microscopically quite strong incremental striae. Periostracum thin, in color a light buffy brown on the spire of a nearly fresh shell, with the base a tone paler and with a very narrow and rather dim peripheral band of saccardo's umber. A somewhat wider area adjacent to the band above and below it seems to be paler in tone like the base. Max. diameter 17.1, min. 13.8, alt. 8 mm., umbilicus 3 mm.; 5 whorls." (Berry.)

Paratypes measure from 7.2 x 15.3, umbilicus 2.1 mm.,  $4\frac{1}{2}$  whorls, to 8.5 x 19.4, umbilicus 3.1 mm., 5 whorls.

CALIFORNIA: Near Sweetwater Spring, Ord Mountains, San Bernardino County (E. C. Jaeger). Type 6300, paratypes 6301 Berry Collection; others in collections of Allyn G. Smith, and 146096 A.N.S.P.

This snail is extremely similar to *H. crotalina*, but in an apical view of specimens of about equal diameter it is seen that *jaegeri* has about a half turn less than *crotalina*; also, the umbilicus is a trifle wider.

(Named for Professor Edmund C. Jaeger, of Riverside Junior College.)

**Helminthoglypta fontiphila** Gregg

Fig. 81 g.

*Helminthoglypta fontiphila* W. O. Gregg, 1931. Nautilus, 45: 49, pl. 4, figs. 8-10.

*H. cuyamacensis venturensis* Bartsch, S. C. Field, 1931, Nautilus, 45: 29; not of Bartsch; cf. Gregg, 1936, Nautilus, 50: 68.

"Shell small, thin, helicoid, moderately flattened, whorls 5, convex, last whorl descending slightly behind the peristome. Base rounded, umbilicus rather large, patulous, about one-seventh the greater diameter of the shell. Aperture subcircular; peristome thin and not expanded. Color, dark olive-buff, marked on the shoulder of the whorl by a narrow chestnut-brown band which is bordered on either side by a somewhat narrower band, lighter in color than the body of the shell. First two and a half or three whorls finely granulose while the entire remainder of the shell is covered by numerous fine papillae overlying a finely wrinkly-granulose groundwork. These papillae generally appear to be arranged in oblique series and on unworn specimens each papilla bears a minute hair-like periostracal process giving the shell a finely hirsute appearance." (Gregg.)

"Max. diameter 15.7 mm., min. 13.5 mm., alt. 8.7 mm., umbilicus 2.3 mm. Type.

“Max. diameter 16.7 mm., min. 14 mm., alt. 8.8 mm., umbilicus 2.5 mm. Largest paratype.” (Gregg.)

CALIFORNIA: Little Rock Creek Canyon, north side of San Gabriel Mts., Los Angeles County, in a rather restricted area around a spring, west side of road, about one-half mile below dam (Gregg and Chace). Type 1032 Los Angeles Museum, paratypes in collections of W. O. Gregg, E. P. Chace, G. Willett and S. S. Berry. Also taken directly across the canyon below a leaking flume under leaves and rocks which were constantly moistened with cold water. Elsewhere at various localities in Soledad Canyon, Los Angeles County, ranging from 5.5 to 8.5 miles from the Mint Canyon Highway (Solemint service station). This area might be roughly termed as the western half of the canyon proper. They were found in each locality near the Soledad Canyon road, under rotten logs and in piles of brush. Each locality was but a few feet from Santa Clara Creek. By the highway 11 miles from Palmdale, towards Saugus, under dead *Yucca whipplei* (S. C. Field).

“This shell bears a close relationship to the Mohavean group of *Helminthoglypta*. It is the first of that general group to be taken within the limits of Los Angeles County. It is the only one of that group which apparently is found only near streams or springs. It may be distinguished from *H. mohaveana* by the following differences: It is smaller, thinner, flatter, more highly colored and the papillae are finer and bear hairlike processes. It may be distinguished from *H. cuyamacensis venturensis* Bartsch by its much thinner shell, smaller size, more flattened form, thin inner lip which is not expanded, larger and more open umbilicus which is not covered in any portion by the inner lip. The paratype of *venturensis* which I have before me is considerably lighter in color, but that characteristic may be due to fading.” (Gregg.)

The conspicuous papillation, strongly developed on the base also, is characteristic.

(*Fontiphila*, lover of springs.)

***Helminthoglypta greggi* Willett**

Figs. 81 h, 83.

*Helminthoglypta greggi* Willett, 1931 (Apr.), *Nautilus*, 44: 124, pl. 7, fig. 3.

“Shell thin, rather small, depressed conic in outline; whorls convex, sutures grooved; last whorl descending in front. Aperture nearly round, oblique. Outer lip slightly thickened, reflected, and encroaching somewhat on the umbilicus. Umbilicus small, about one-sixth of minimum diameter of shell. Spiral sculpture absent; entire surface of shell minutely, rather weakly papillated, this papillation being greatly obscured on most of the shell by the crowded growth striae. Periostracum thin, light brown, with a narrow, darker-brown band encircling the periphery. Max. diameter 13.5; min. diameter, 11.8; alt., 6.8; umbilicus, 2; number of whorls, 4 $\frac{3}{4}$ . The



largest specimen found has a maximum diameter of 14.6, and minimum diameter of 12.3." (Willett.)

Embryonic  $1\frac{1}{2}$  whorls show, after the smooth tip and some interrupted wrinkles, only a very minute and weak granulation, with a few very indistinct scattered papillae.



Fig. 83. *Helminthoglypta greggi*, type. ( $\times 2$ )

CALIFORNIA: Rock slides on the side of a hill, three and one-half miles south of Mohave, Kern County. This hill is an isolated outlier to the southeast of the Tehachapi Range, and the type locality is about one-half mile west of the Mohave-Los Angeles Highway (George and Ora Willett). Type 1031 Los Angeles Museum; paratypes in Willett Collection and 153643 A.N.S.P.

"The affinities of this shell are plainly with the Mohavean group of *Helminthoglyptas* hitherto known only from the Victorville region. The distance from the type locality of *greggi* to the nearest of these species, *H. mohaveana* Berry, is something over fifty miles, and no species of helicoid has been reported from the intervening territory to date. *H. greggi* is apparently about the size of *H. graniticola* Berry, but differs from that species in much more depressed form, and wider and more open umbilicus. From *H. mohaveana* Berry it differs in smaller size, more depressed and much lighter papillation. From *H. crotalina* Berry, which it resembles in general outline, *greggi* is distinguished by much smaller size, more prominent banding, glossier surface and lighter papillation. It is a pleasure to name this species in honor of Dr. W. O. Gregg, the well-known student of California shells." (Willett.)

***Helminthoglypta caruthersi* Willett**

Fig. 81 k.

*Helminthoglypta caruthersi* Willett, 1934 (Aug. 31), Bull. So. Cal. Acad. Sci., 33: 57, pl. 20.

"Shell large, flattened, openly umbilicated, the inner lip slightly reflected over the umbilicus. Aperture broadly extended, considerably wider than high; lip thin, narrowly reflected, somewhat deflected between the shoulder and the suture; columellar margin dilated. Color yellowish brown with narrow chestnut-brown band at the shoulder (about  $1\frac{1}{2}$  millimeters wide). Spiral sculpture absent; growth wrinkles rather prominent, though uneven and closely spaced. Entire surface covered with fine papillations which are

somewhat worn off on the earlier whorls. Color of animal, drab; spotted, dashed and scrawled with chocolate-brown. Diameter 27.5 mm., alt. 13.4 mm., width aperture 14.2, alt. 12 mm." (Willett.)

CALIFORNIA: Morris Canyon, a branch of Indian Wells Canyon, Kern County, at about 7000 feet (Mrs. Vernon L. Carr). Type 1039 Los Angeles Museum; paratype 6562 Caruthers Collection, in the same canyon (Morris E. Caruthers).

"This species is evidently of the desert group of *Helminthoglyptas* of which *H. fisheri* (Bch.) and *H. mohaveana* Berry are examples. In general features it is perhaps closest to the last named, but differs from it in much larger size, more depressed form, flaring aperture, deflected lip and duller surface". (Willett.)

"On March 25, 1934, Mr. Caruthers and the writer drove to the locality where Mrs. Carr had found the specimen, and camped. A diligent search of the mountain side, which was quite steep and well covered with oak and pinyon trees, was made during the afternoon and again the following morning. A very few fragments, too small to be of value, were brought to light, and Mr. Caruthers was fortunate enough to find one living specimen, about two-thirds grown and in perfect condition. It was adherent to a small stick in a tangle of debris in a gully on the mountain side. This specimen, together with one found by Mrs. Carr, clearly show this snail to be very different from any species known to the writer, and it is, therefore, here named and described. The dead shell, being fully adult, is used as the type and from it the measurements are taken. The description of color, sculpture, etc. are from the paratype." (Willett.)

***Helminthoglypta isabella* Berry**

Fig. 81 j.

*Helminthoglypta isabella* Berry, 1938 (June 20), Journ. Ent. & Zool. Pomona Coll., 30: 42, figs. 3, 4.

"Shell of moderate size, rather thin, strongly depressed-conic; suture well marked; whorls a little over 5, subcarinate in the young, convex on spire, increasing quite regularly at first, then more rapidly; last whorl tumid, especially below, strongly descending above to the aperture; umbilicus of moderate width, open, steep-walled, permeable to apex, contained a little over 9 times in the shell-diameter; aperture rounded-ovate, oblique, the peristome hardly thickened or reflected except a little at the base when passing into the narrow columellar flare; terminations strongly converging, connected by a thin and often scarcely evident parietal wash of callus; upper lip slightly produced. Embryonic shell smooth for the first fraction of a turn, then with a few radial waves or wrinkles which pass into a very close fine wrinkly papillation for about  $1\frac{1}{4}$  whorls, then give way quite suddenly to the discrete rounded microscopic papillations which everywhere heavily stud the post-embryonic whorls, these being primarily arranged in decurrent series, but the regularity lost on the body-whorl; true spiral sculpture wanting, but in some lights sufficient magnification shows faint

spiral reflections on the last whorl, perhaps due to some secondary alignment of the granulations; growth-lines very fine, irregular, wrinkle-like. Periostracum moderately lustrous but unpolished above, more or less glossy on base; upper surface isabella color, dulling to light brownish olive on spire; base cream-buff and chamois to ecru-olive and isabella color; body-whorl with a simple narrow band about 1 to 1½ mm. wide of snuff brown to verona brown; secondary bordering bands pale and barely evident. Maj. diameter 21.3 mm., min. diameter 17.4 mm., alt. 12.3 mm., umbilicus 2.3 mm., whorls 5½." (Berry.)

Paratypes from 12.1 x 21.6 mm. to 11.3 x 19.5 mm.

CALIFORNIA: Under dead yuccas, two miles east of Isabella, Kern County (L. G. Ingles, Dec. 26, 1929, Mar. 4, 1930, and Feb. 24, 1931). Holotype 8641 Berry Collection. Paratypes 7070 Berry Collection; others to be deposited in the collections of the United States National Museum, Stanford University, the Academy of Natural Sciences of Philadelphia (170935), and the private collection of Allyn G. Smith.

"Decidedly the nearest ally of this species is the closely similar *mohaveana* Berry from the desert region of San Bernardino County, and poor specimens of the two might be none too easy to separate. Mature shells of *isabella* in good condition are larger, more depressed, have less convex whorls, a smoother shell, a more rapidly expanding body-whorl, and a wider aperture. The papillation is very much the same that we see in *mohaveana*, but is sharper, more copious, and shows considerable regularity in alignment. Another species which may be nearly related is the insufficiently known *caruthersi* Willett, which, from its locale on the desert side of the same range of mountains, I at first suspected might prove identical. This was before I had access to the description, however, for it appears from that and the figure to be a larger, more depressed shell, with a wider body-whorl and aperture. Compared with *callistoderma* Pilsbry, *isabella* is very much smaller, more depressed, more heavily papillose, and more widely umbilicate. There are also rather decided differences in the pigmentation of the animals.

"This extremely attractive little snail has been named in salutation to Mrs. Isabel (Allyn G.) Smith of Berkeley, while both the type-locality and the Ridgway color-matchings bring to bear strong supporting testimony as to the appropriateness of the name." (Berry.)

***Helminthoglypta fisheri* (Bartsch)**

Fig. 8: i.

*Epiphragmophora magdalenensis*, in part, Dall, 1897, Proc. U. S. Nat. Mus., 19: 339.  
*Sonorella fisheri* Bartsch, 1904 (Oct.), Smithson. Misc. Coll., 47: 197, 188, pl. 30; pl. 33, fig. 3.

[*Helminthoglypta*] *fisheri* (Beh.), Berry, 1930, Nautilus, 43: 73.

"Shell small, depressed, horn-colored, with a moderately broad chestnut band edged by a scarcely perceptible lighter zone encircling the whorls a little above the periphery. This band is covered by the succeeding turns in

all but the last one and one-half volutions. The nepionic stage embraces about one-half of a whorl, is rather depressed, and quite strongly transversely wrinkled. The neanic stage consists of one and one-third turns, which have been described in the definition of the section. Ephebic whorls two and one-half, depressed, moderately well rounded, a little more convex below than above, marked by many strong, wavy, and wrinkled incremental lines and numerous almost round, raised papillae which form oblique, curved, interrupted lines extending from the summit of the whorls forward and downward, and are equally strong between the sutures on the periphery and the base; in the umbilicus, however, they are much heavier, assuming a warty appearance. The last whorl is gradually but considerably deflected at the aperture. Aperture moderately large, rounded oval, very oblique, scarcely at all expanded. Columella slightly expanded at base and but slightly reflected over the umbilicus. Maj. lat. 15.5 mm., min. lat. 13 mm., alt. 8 mm.; aperture: maj. lat. 7 mm., alt. 6.5 mm.; umbilicus about 1.8 mm." (Bartsch.)

CALIFORNIA: Johnson Canyon, Panamint Valley at an altitude of 6,000 ft. (A. K. Fisher and E. W. Nelson). Type 123579, U.S.N.M.; type lot and another lot (123578) collected by Dr. A. K. Fisher and E. W. Nelson on the Death Valley Expedition. Surprise Canyon and Jail Canyon, Panamint Mts. (Ferriss and Chace).

The surface is glossy, the color of topotypes a little browner than tawny olive, becoming slightly paler at base. Those from the other localities are lighter, nearly chamois, the band very lightly sketched. The embryonic shell, of  $1\frac{3}{4}$  whorls, after the smooth tip has a group of radial ripples, after which it is irregularly sculptured radially with very fine striae, irregular, wavy, and dividing on the convexity of the whorl, in some examples partly subobsolete, and a few indistinct papillae in spiral trends. The papillation of following whorls may be irregular or indistinct in places; on the base it is often beautifully regular, but sometimes partly effaced. Topotypes from the original lot, Johnson Canyon, measure: 13.7 to 14.3 mm. diameter,  $4\frac{1}{2}$  whorls.

Height 8.4 mm., diameter 16.5 mm.,  $4\frac{1}{2}$  whorls. Jail Canyon.

Height 9.8 mm., diameter 16.4 mm.; 5 whorls. Surprise Canyon.

#### Subgenus CHARODOTES new subgenus

The shell is umbilicate, moderately or rather strongly depressed, the last whorl usually with incised spiral lines (but these may be faint or absent), the spire with more or less papillation. The slender penis has a small 4-ribbed cavity and a single thick muscular wall. The common duct of the mucous glands is about as long as the dart sac or shorter (Fig. 84).

TYPE: *H. traski* (Newc.).

This group of southern and Lower California is characterized by the simple, thick wall of the penis; other attributes mentioned above are not essential. Three species, *H. traski*, *H. petricola* and *H. proles*, have been

dissected,<sup>1</sup> but several others are provisionally referred here from the sculptural similarity of the shells.

(Χαροδότης, giver of joy, from my pleasure on finding a new structure after dissecting many helminthoglypts of the usual pattern.)

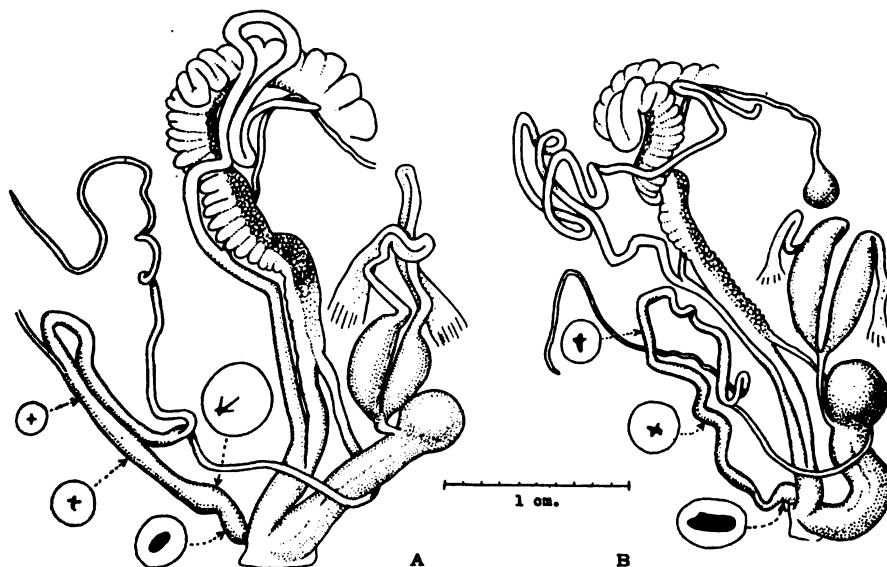


Fig. 84. Genitalia of: A, *Helminthoglypta petricola*, topotype. B, *H. traski* from near Las Cruces, Santa Barbara Co. With transverse sections of the penes.

All of those examined have the same penial structure. In *H. traski* (Newc.), Figure 84 B, and *H. petricola* Berry, Figure 84 A, the flagellum is very long, while in *H. proles* (Hemph.) it is shorter than the penis. *H. traski* has a very long diverticulum on the spermathecal duct, 56 mm. in one measured. All have a rather large subglobular dart sac, and a short common duct of the mucous glands. The other organs are as in *Helminthoglypta* proper.

MEASUREMENTS (IN MILLIMETERS)

	Penis + epiphallus	Flagellum	Dart sac + atrium	Vagina	Diam. shell
<i>H. traski</i> .....	30 to 38	31	13	3.5	28
<i>H. petricola</i> ....	27	32	13	5	ca. 28
<i>H. proles</i> .....	21	10	..	...	19

<sup>1</sup> Hanna dissected *H. similans* and *H. carpenteri* but did not open the penes. These and other species not dissected require examination, as *Charadotes* has no definitely diagnostic shell characters.

**Helminthoglypta traski** (Newcomb)

Fig. 85, a, b, d, e, f.

*Helix traskii* Newcomb, 1861, Proc. Cal. Acad. Sci., 2: 91 (Los Angeles).—Binney, 1869, L. & Fr. W. Sh. N. A., 1: 173, fig. 301.

*L. [ysinoe] frankii* Cooper, 1870, Amer. Journ. Conch., 5: 209. Cf. Binney, 1883, Bull. Mus. Comp. Zool., 11: 158; 1885, Man. Amer. L. Sh., p. 143, as misprint for *traskii*.

*Arionta traski* Newc., Binney, 1878, Terr. Moll., 5: 369, fig. 251, pl. ix, fig. m, pl. xiii, fig. n, anatomy; 1885, Man. Amer. L. Sh., p. 143, fig. 122.

*Epiphragmophora traskii* Newc., Williamson, 1900, Nautilus, 14: 13, aestivation.—Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 609, 612, pl. 114, figs. 1-9, 16-18, with the synonyms *E. t. major* Hemphill, *E. t. verna* Hemph. (pl. 114, f. 13-15), *E. t. saucius* Hemph. (pl. 114, figs. 10-12), and *E. petricola* Berry (pl. 117, figs. 1-3).

*Helminthoglypta traskii* (Newc.), Hanna, 1927, Nautilus, 41: 32.

*Sonorella betheli* J. Henderson, 1914, Nautilus, 27: 123 ("Bright Angel Trail, Grand Canyon").

The shell is moderately solid though thin, depressed with low-conic spire and umbilicus contained about 11 to 14 times in diameter. Cinnamon-buff above, approaching honey yellow on the base, with a chestnut-brown band with buff borders, often indistinct. Surface somewhat glossy. Embryonic  $1\frac{1}{2}$  whorls microscopically wrinkled radially, with few, well separated papillae arranged in forwardly descending series. Following one or two whorls with irregular striae and sometimes some scattered papillae. Last whorl finely, irregularly wrinkle-striate, and engraved throughout with incised spiral lines. The rotund-lunate aperture is avellaneous and banded within, the peristome very narrowly expanded above, somewhat reflected basally, dilated over about one-fourth (to nearly one-half) of the umbilicus.

Height 16 mm., diameter 26 mm. (Newcomb.)

Height 17.2 mm., diameter 26 mm.; 6 whorls. Los Angeles.

Height 15.4 mm., diameter 23.2 mm.; 6 whorls. Los Angeles.

Height 16.3 mm., diameter 26 mm.;  $5\frac{3}{4}$  whorls. Brownstone, Ventura County.

CALIFORNIA: Los Angeles (Newcomb), Type in Newcomb Collection, Cornell University. Ventura and Santa Barbara Counties; old Ft. Tejon, Kern County.

The sculpture of incised spiral lines is characteristic though variable in degree. The size is especially variable. Newcomb's type was a rather large specimen from Los Angeles County. Chace compared the type lot with his material and decided that they were closest to shells from Point Firmin.

The largest measured by Bartsch were from Santa Barbara, height 19.8, diameter 30.2 mm. Some collected near Santa Barbara by W. M. Gabb and by H. N. Lowe are much depressed, 16.5 x 28.7 mm.,  $5\frac{3}{4}$  whorls. These shells are transitional to *H. t. willetti*, having the shape and in some examples the wide umbilicus of that race. They show engraved spirals like those of *traski* above the periphery, but on the base weaker than *traski*, though more distinct than in *willetti*.

Fig. 85. a, b, *Helminthoglypta traski*, Los Angeles. c, *H. traski phlyctaena*, twelve miles east of Las Cruces. d, *H. traski*, Los Angeles; e, Vaquez Rocks; f, Fort Tejon. g, *H. traski coronadoensis* with detail of basal sculpture (after Bartsch). h, *H. traski coelata* (after Bartsch). i, *H. traski pacuimensis* (after Gregg).

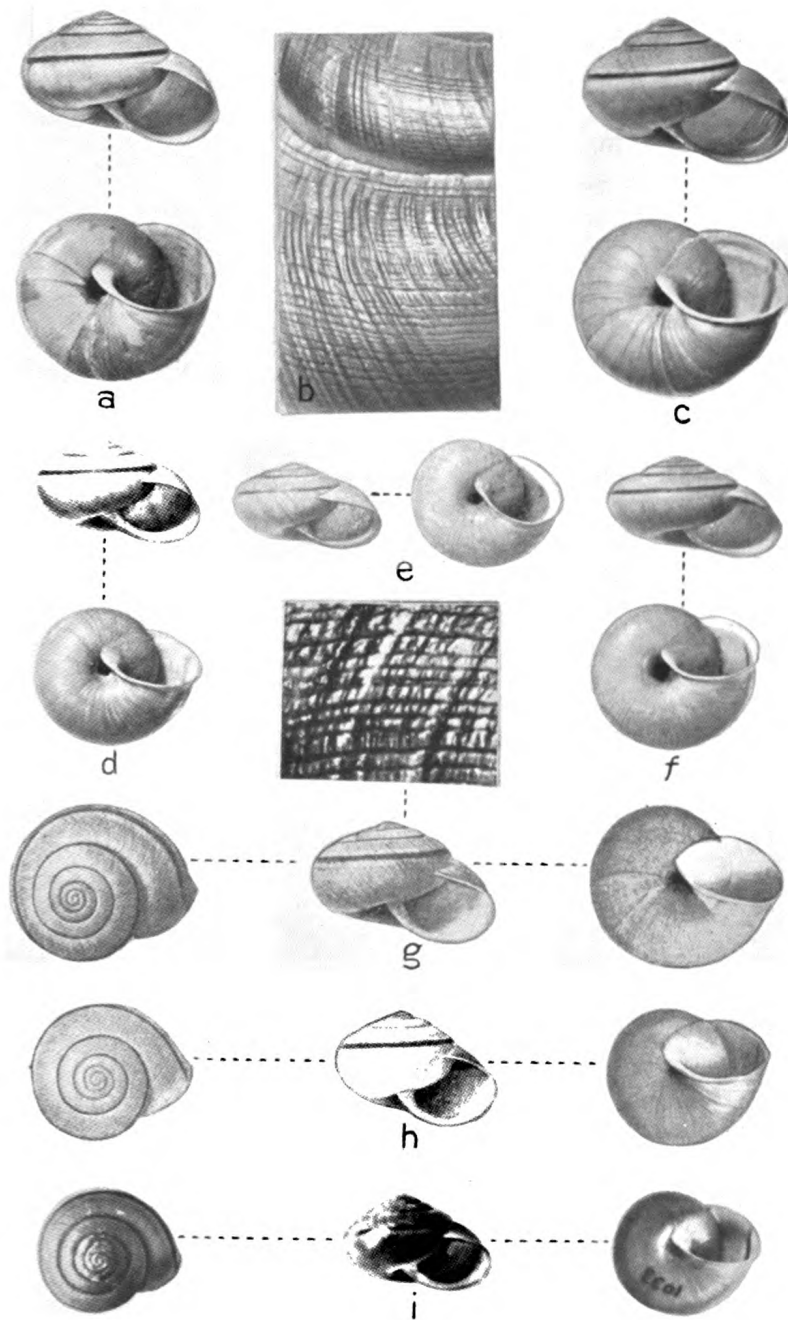


Figure 85 (explanation on page 172).

Many years ago *H. traski* was collected by W. M. Gabb at "Fort Tejon", Grape Vine Canyon, Kern County. One of his specimens is illustrated in Figure 85 f., diameter 22.7 mm. Sculpture typical. In 1927 the entomologist Dr. E. C. Van Dyke collected it again at this long ago abandoned military post of Civil War days. Dr. Hanna, who examined these specimens, could find no difference from southern shells except for slightly smaller size. Quite small ones, diameter 18.6 to 19.6 mm., were taken by S. C. Field from "Vasquez Rocks", about 3 miles off the Mint Canyon highway, Los Angeles County, under roots of yucca. A series of more than one hundred taken by G. Grant in Elysian Park, Los Angeles, shows great variation in size, from height 16.2 mm., diameter 24 mm., to height 10.5 mm., diameter 17 mm.

The forms called *verna* and *saucius* on Hemphill's labels (these names dating from Bartsch's figures, 1916) are specimens which had been injured or diseased in the third and fourth whorl stage; resulting in a merely convex rather than low-conoid spire. Though sometimes reaching full size, 14.3 x 25 mm., 5½ whorls, they are often dwarfed, down to 17 mm. diameter, of 5 whorls. Both are from "Los Angeles Co."

Misled by a mistaken locality given by the collector, Junius Henderson described rather small specimens (diameter 20.5 to 21.5 mm.) as *Sonorella betheli*. In 1913 after visiting the Grand Canyon, where he thought that this shell was picked up, the late Prof. Ellsworth Bethel spent some time in California. His chief interest was botanical. Probably these shells were taken near Los Angeles; the type in University of Colorado Museum and a cotype, 109733 A.N.S.P., both of which I have seen, agree fully with *traski* from that vicinity.

Mrs. M. Burton Williamson found *H. traski* in captivity aestivating on wood above the ground, or in the house climbing to the ceiling.

(Named for Dr. John B. Trask, geologist, and one of the founders of the California Academy of Sciences, in 1853.)

***Helminthoglypta traski misiona* Chace**

Fig. 86.

*Helminthoglypta traski misiona* Chace, 1937. Nautilus, 51: 60, pl. 4, fig. 2.

"Shell low conic, umbilicate, umbilicus about  $\frac{1}{9}$  the greater diameter of the shell, permeable to the apex, nearly  $\frac{1}{3}$  covered by the reflected lip. Whorls 5½, tumid, the last dropping so as to leave the dark peripheral band exposed for  $\frac{1}{3}$  of a turn. Aperture subcircular, moderately oblique. Lip slightly reflected throughout, more so at the umbilicus, white, faintly thickened within, ends connected by a very thin, transparent callus. Color, brownish-olive, slightly lighter on the base, with the usual light-bordered brown band at the periphery. Periostracum thin, very glossy. Growth lines regular, close and fairly strong. Under a 20 X lens the nuclear and early whorls show a finely granular surface; parts of the later whorls show



very faint incised spiral lines. Greater diameter 26.9, lesser diameter 21.7, alt. (umbilicus to spire) 13.2 mm." (Chace.)

Other specimens measure 30.7, 24.6, 14.6 mm., and 29, 22.5, 13 mm.



Fig. 86. *Helminthoglypta traski misiona*.  $\times 14$  (After Chace.)

LOWER CALIFORNIA: A rock slide near the San Diego-Ensenada Highway in La Mision Valley; about 40 miles south of Tia Juana (E. P. and E. M. Chace and Geo. Willett). Type 350 a Chace Collection; paratype in Willett Collection.

"This shell resembles *H. traski phlyctaena* Bartsch from Santa Barbara County in shape, size, color and umbilicus, but is thinner and the spiral sculpture is very much weaker. It resembles *H. t. caelata* Bartsch, geographically its nearest relative, in the faintness of its spiral sculpture, but is larger, more widely umbilicate and is more highly polished. Another neighboring race, *H. t. isidroensis* Bartsch, is smaller, more papillose, and less polished." (Chace.)

***Helminthoglypta traski coelata* (Bartsch)**

Fig. 85 h.

*Epiphragmophora traskii coelata* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 617, pl. 115, figs. 7-9; pl. 117, fig. 10.

"This is a small decidedly inflated race having the inner lip reflected over the very narrow umbilicus covering this half or more than half. All the whorls excepting the last turn are papillose. The spirally incised sculpture is feeble on the upper side of the last one and one-half whorls, and scarcely indicated on the base of the last turn. The type has  $5\frac{1}{2}$  whorls and measures: greater diameter 20.8 mm., alt. 13.7 mm. The other specimen has  $5\frac{3}{4}$  whorls and measures: diameter 21.8, alt. 13.5 mm." (Bartsch.)

CALIFORNIA: The Mesa, back of Pacific Beach, San Diego County. Type 124747 U.S.N.M. Torrey Pines, La Jolla and Pacific Beach (A. G. Smith).

"In my collection are two fossil shells referable to this subspecies from the sandstone bluff at Mission Beach, San Diego Co., probably pleistocene or later. They are larger and of heavier texture than the recent material and measure: height 15.3, diameter 21.9 mm.,  $5\frac{1}{2}$  whorls, and 15.2, 23.2 mm.,  $5\frac{3}{4}$  whorls. Both shells are highly polished and retain the brown band and other slight traces of coloration." (A. G. Smith.)

(*Caelatus*, engraved.)

**Helminthoglypta traski isidroensis** (Bartsch)

Fig. 87.

*Epiphragmophora traskii isidroensis* Bartsch, 1918, Proc. U. S. Nat. Mus., 54: 524, pl. 83, figs. 4-6.

“Shell depressed, helicoid, horn-colored, with a broad chestnut band at the periphery, that is edged on either side by a somewhat lighter zone than the general tint of the shell, which is almost as wide as the brown band. Nuclear whorls one and three-quarters, moderately rounded, densely covered with small papillae, which gives the entire surface a granulose appearance. The succeeding whorls are marked by decidedly, obliquely curved, retractive lines of growth and rows of well rounded, small papillae which form lines practically at right angles to the lines of growth. In addition to this sculpture the last two whorls are marked by rather distantly spaced, somewhat interrupted, feebly incised spiral lines. Base well rounded, with a moderately broad umbilicus, which is almost half covered by the reflected inner lip, marked by strong incremental lines and the weakly incised spiral striations which equal those on the upper surface. The general papillation is absent on the lower surface excepting immediately behind the aperture where there is a dense massing of very fine granules, which is also the case on the upper surface. Aperture large, subcircular; outer lip very slightly reflected; inner lip broadly expanded at the base and reflected to half cover the umbilicus. The type has 5.5 whorls and measures—altitude, 13.5 mm.; greater diameter, 21.3 mm.; lesser diameter, 17.6 mm.” (Bartsch.)



Fig. 87. *H. t. isidroensis*. (After Bartsch.)

CALIFORNIA: Campo San Isidro Mountain on the Mexican border. Type 216907 U.S.N.M., and another specimen were collected by Mr. H. N. Lowe. The other specimen, which is in Mr. Lowe's collection, is not quite mature.

**Helminthoglypta traski coronadoensis** (Bartsch)

Fig. 85 g.

*Epiphragmophora traskii coronadoensis* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 617, pl. 115, figs. 10-12; pl. 117, fig. 9.

*Epiphragmophora traskii chrysoderma* Berry, 1920, Proc. Cal. Acad. Sci., (4), 10: 55, pl. 4, figs. 2a-2c.

“In this island subspecies the incremental lines are much stronger and the spirally incised lines are much wider and more deeply cut than in the other races. The combination of these sculptural elements give a clothlike texture to the entire surface of the shell” (Bartsch).

Alt. 12.4 mm., diameter 20.7 mm., 5.3 whorls. (Bartsch.)

Alt. 15.2 mm., diameter 23.6 mm., 5.7 whorls. (Bartsch.)

LOWER CALIFORNIA: Los Coronados Is. (Hemphill). Type U.S.N.M., South Coronado Island (Willett).

Though outside of our limits, this race is included to complete the account of *traski* forms. The matt surface is pale brownish, fading to dirty white on the base; there is a brown band with indistinct whitish border below; covered with a thin yellow periostracum which is largely dehiscent in adult shells. The smallest adult seen has a diameter of 17.5 mm. Berry mentions that the largest of twelve from South Coronado measures height 15.7, diameter 24.1 mm., 5½ whorls.

Form *chrysoderma* Berry. "Periostracum very thin, strongly dehiscent and almost impossible to preserve in dry specimens; very light golden brown (honey yellow of Ridgway) in color, sometimes showing streaks of a darker hue following the stronger lines of growth, but without any distinct spiral banding or other evident pattern. Shell beneath the periostracum pure white. Alt. 15.5 mm., diameter 24.3 mm., umbilicus 2.2 mm., 5½ whorls." (Berry.)

The diameter varies from 22.7 to 26 mm., according to Berry, but it occurs down to 21 mm. It was collected by Mr. George Willett among loose talus high on the slopes of South Coronado I., near the southern end. A considerable number of specimens was taken. Typical *coronadoensis* was found with *chrysoderma*, but was more abundant on grassy slopes lower down. In a specimen of the original lot (130811 A.N.S.P.), there is a pale though distinctly traced brown band, and the spiral sculpture is weaker than in typical *coronadoensis*, though not differing from some examples of the latter. This xanthic mutation of *coronadoensis* does not merit sub-specific rank, in my opinion.

**Helminthoglypta traski pacuimensis** Gregg

Fig. 85 i.

*Helminthoglypta traski pacuimensis* Gregg, 1931, Nautilus, 45: 48, pl. 4, fig. 5-7.

"Shell helicoid, spire moderately elevated, whorls 5½ convex, slowly increasing, last whorl descending behind the thickened peristome. Base rounded, umbilicus small, permeable to the apex and half covered by the reflected inner lip. Aperture subcircular, oblique; outer lip very slightly expanded, inner lip broadly expanded at the base. Color light golden brown, paler on the base, the shoulder marked with a band of liver brown, bordered above and below by a somewhat narrower band which is lighter in color than the body of the shell. Periostracum somewhat glossy, irregular incremental lines are strongly marked on all whorls; entire surface of shell finely wrinkly-granulose with a strong coarse overlying papillation. This papillation is widely spaced on the body whorl. On the preceding whorls it is more closely spaced and in unworn specimens each papilla bears a minute stubby hairlike periostracal process. The papillation on the younger whorls is noticeably arranged in both oblique and spiral series. The spiral sculpturing which consists of incised spiral lines is moderately developed on the penultimate whorl and is strongly marked over the entire body whorl. The type specimen measures: maximum diameter, 20 mm.; minimum diameter, 16.3 mm.; altitude, 13.5 mm.; umbilicus, 1.7 mm. Paratype, max. diameter, 20 mm.; min. diameter, 16.4 mm.; altitude, 13.5 mm.; umbilicus, 1.7 mm." (Gregg.)

CALIFORNIA: Pacoima Canyon, San Gabriel Mts., Los Angeles County, about one-half mile below prison camp. They were found mostly under bark and fragments of rotten logs. Type 1033 Los Angeles Museum, paratypes in Gregg Collection.

"The only other described form of *H. traski* which bears papilla over the body whorl is *H. traski isidroensis* Bartsch. This form may be distinguished from *isidroensis* by its more strongly incised spiral lines over the body whorl and by the presence of coarse papillae distinctly spaced over the entire under surface as well as upper surface of the body whorl." (Gregg.)

**Helminthoglypta traski fieldi** Pilsbry

Fig. 88 e.

*Helminthoglypta traskii fieldi* Pilsbry, 1930, Nautilus, 44: 66, pl. 5, figs. 2-4.

The shell is more elevated than *H. t. phlyctaena*, the height 74 to 82 percent of the diameter (in *phlyctaena* 60 to 66 percent); umbilicus smaller, about 2 mm. wide; post-nuclear whorls are not papillose or have a few papillae locally; last  $2\frac{1}{2}$  whorls are spirally engraved with lines cutting the striae, strongly developed on the last whorl. Color cinnamon-brown, with a darker, chestnut-brown band, broadly bordered on both sides with chamois. Peristome narrowly expanded, the columellar margin arcuate, reflected.

Height 18 mm., diameter 24.5 mm.;  $6\frac{1}{2}$  whorls.

Height 20.7 mm., diameter 26.3 mm.;  $6\frac{1}{2}$  whorls.

Height 17.6 mm., diameter 21.4 mm.;  $6\frac{1}{2}$  whorls.

CALIFORNIA: Surf, Santa Barbara County, under ice plants and sage on the beach (Stanley C. Field). Type 151516, figured paratypes 152464 A.N.S.P.

The umbilicus is noticeably smaller than in *phlyctaena*, and the columellar lip, in basal view, is distinctly arcuate, while in *phlyctaena* it is nearly straight. No papillation of the intermediate whorls can be made out in the type, but it is locally visible in some smaller examples, two of which were figured in the original account. But this character varies in *phlyctaena* also. *H. t. fieldi* is the coastal form, *phlyctaena* the inland, Coast Range race.

**Helminthoglypta traski phlyctaena** (Bartsch)

Fig. 88 a, b; fig. 85 c.

*Epiphragmophora traskii phlyctaena* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 618, pl. 115, figs. 1-3, 13-15.—Lowe, 1928, Nautilus, 41: 77.

"This is a rather large race in which the two whorls following the nuclear turns are strongly papillose, the papillae being much more numerous and much stronger than they are on the nuclear turns. Greater diameter 28.2 mm., alt. 17.1 mm., 6 whorls." (Bartsch.)

CALIFORNIA: 40 miles north of Santa Barbara (W. G. Blunt). Cotypes 12363 U.S.N.M. Near Las Cruces, and Gaviota Pass, Santa Barbara County (H. N. Lowe). Allyn G. Smith reports it from Toro Canyon back

of Montecito. Also 2 shells (dead) collected by Hanna 3 miles west of Casmalia. Willett reports having found it on the Cuyama River, near Pioneer Grove, which is the type locality of *H. cuyama*; all in Santa Barbara County. Ventura County near Bardsdale (S. S. Berry).

The last and penult whorls have rather strongly cut spiral lines, but in the type and some other examples these lines almost disappear on the base; the next earlier two whorls have papillae in oblique trends, typically distinct but in some individuals weakly developed. These papillae differentiate the race from *traski* proper. It ordinarily runs from 16 x 24.6 mm. to 20.5 x 30 mm.

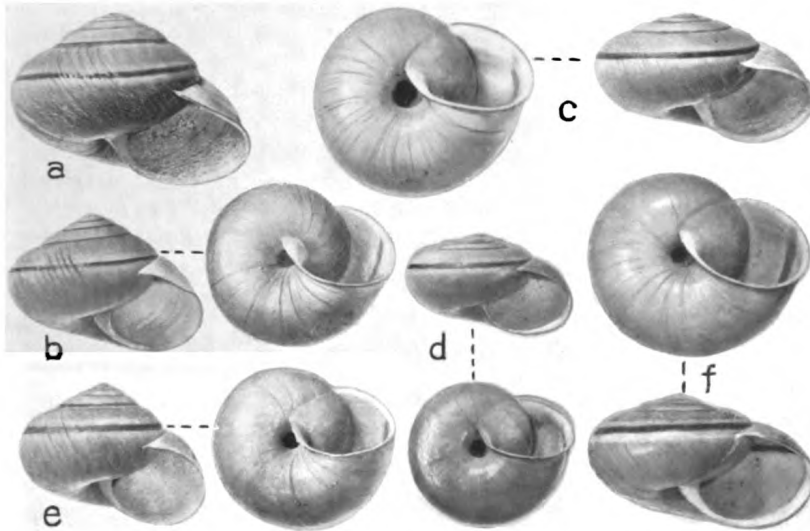


Fig. 88. a, *Helminthoglypta traski phlyctaena*, 40 miles northeast of Santa Barbara; b, near Las Cruces. c, *H. traski willetti*, Gaviota Pass; d, f, Wheeler Spring. e, *H. traski fieldi*, Surf.

In specimens taken by Lowe under sycamore logs 12 miles east of Las Cruces, Santa Barbara County, the mantle is profusely reticulated with gray. The shells are strongly sculptured, about 28 mm. in diameter (Fig. 85 c).

There appears to be an elevated form somewhat intermediate between *phlyctaena* and *willetti* in the Santa Inez Mts., Santa Barbara County, (Fig. 88 a), collected by Lowe. It has the shape of *phlyctaena* but without spiral engraved lines on the base, height 23, diameter 31.8 mm., 6½ whorls. It was found by Allyn Smith "in a brush pile at Matilija Hot Springs, where *willetti* is large and fine. They are the elevated form mentioned from Wheeler's Springs and measure: 17.7 x 25.2 mm., 6 whorls,

and 16.6 x 26.8 mm., 5½ whorls. The live shell shows very weak spiral lines on the base but they are almost obsolete. They are stronger on the upper surface. The dead shell shows no spirals on the base and fairly strong ones above, which do not extend below the band. I think these shells are a form of *phlyctaena* but not sufficiently different to warrant a name."

"Near Buellton, in the Santa Ynez River Valley, Chace and others have taken a form of *traski* similar in some respects to *phlyctaena* but differing considerably in the microscopic sculpture. The periostracum has a dull appearance, whereas *phlyctaena* is highly polished." (A. G. Smith.)

(*Phlyctaena*, a pimple.)

**Helminthoglypta traski willetti** (Berry)

Fig. 88 c, d, f.

*Epiphragmophora traskii willetti* Berry, 1920, Proc. Cal. Acad. Sci., (4), 10: 58, pl. 4, figs. 3a-3c.

"Shell depressed-conic, conspicuously umbilicate, the umbilicus deep, permeable to the apex, and having a diameter about one-ninth to one-eighth the greater diameter of the shell. Whorls about 6½ or a trifle less, convex, the last descending somewhat in front. Aperture ample and very oblique (45°). Edges of peristome converging and connected by a very thin, transparent parietal callus. Lip but little thickened, everted somewhat throughout, but especially at the pillar where it is sufficiently reflected to indent somewhat the otherwise circular outline of the umbilicus. Color varying from near prout's brown to tawny-olive, becoming a little paler and yellower in the umbilical region, and with a clear-cut, deep, liver brown band of a width of about 2.2 mm. on the shoulder, bordered below by a light yellowish band (near naphthalene yellow of Ridgway) of about equal width and above by a much narrower, slightly less clear-cut band of the same color. Periostracum somewhat glossy and with a peculiar sheen. Lines of growth very numerous and quite regular. First half whorl delicately hyaline and nearly smooth except for a few weak incremental waves, with a fine weak papillation sometimes superimposed; next whorl and a half very finely and closely granose or wrinkly granose, with numerous, large, elongate, rather distantly spaced papillae superimposed, the latter arranged fairly definitely in retractorily curved, very obliquely slanting series; papillae on later whorls nearly, or quite, obsolete; spiral sculpture consisting of a weakly developed series of incised lines, barely to be detected on the third whorl, then gradually increasing in strength to the penultimate whorl, but again becoming very weak on the upper portion of the body whorl, and barely, though not quite, obsolete below. Max. diameter 31.1 mm., min. 24.8 mm., alt. 18.4 mm., umbilicus 3.8 mm., 6½ whorls." (Berry.)

(Other examples, diameter 28.4 to 31.6 mm., according to Berry.)

12.3 x 22 mm., 5½ whorls, to 17.7 x 30 mm.; 6 whorls. Wheeler's Spring (Fig. 88 d).

CALIFORNIA: Pine Canyon, Sespe Creek, Ventura County, elevation 3500 ft., (Geo. Willett). Type 4497 Berry Collection, paratypes Willett Collection. Sulphur Mt. Springs and Wheeler's Spring, Ventura County.

A large, richly-colored race, which as Berry remarked is usually in an excellent state of preservation. Its chief "features are the large size, depressed spire, wide umbilicus, weakly developed spiral sculpture, especially on the base, and the rich brown color and prominent spiral banding".

Some lots show a considerable variation in size, as in that from Wheeler's Springs (Figs. 88 d, f).

**Helminthoglypta traski tejonis** Berry

Fig. 89.

*Helminthoglypta tejonis* Berry, 1930 (Apr.), Journ. Ent. & Zool., Pomona Coll., 30: 20, figs. 5, 6.

"Shell large, rather thin, low-conic; whorls  $6\frac{1}{4}$  in one of the largest specimens to  $7\frac{1}{4}$  in the largest, convex, the last well rounded and descending somewhat in front; aperture large, rounded-ovate, oblique; peristome little thickened, for the most part very slightly everted, but nearly straight parietally and well reflected at the columella, its terminations slightly con-

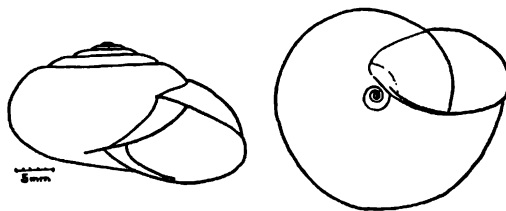


Fig. 89. *Helminthoglypta traski tejonis*. (After Berry.)

verging and connected by a thin parietal callus; base tumid, the umbilicus funicular, permeable to the apex, its diameter contained 9-10 times (in one specimen only 7 times) in the major diameter of the shell. Embryonic shell, succeeding the small initial smooth stage, very finely, closely, evenly wrinkly-granulose, with a few larger, low, elongate, serially decurrent papillations superimposed; first postembryonic whorl nearly smooth, but in perfect specimens very minutely microscopically granulose, with the serial papillae small, dot-like, and very difficult to make out, but their presence confirmed by the fact that the very young shell of this stage is very minutely hirsute with numerous short stubby periostracal processes. Faint spiral grooves transecting the rather coarse lines of growth begin to appear on the latter part of the fourth whorl and become well developed on the upper surface of the remaining whorls; spirals on base of body-whorl much weaker and more wavy than above; umbilical slope somewhat coarsely obliquely wrinkled back of columella. Periostracum thin, somewhat dull; spire a rather light buffy brown, base of shell nearly uniform isabella color, with a narrow supraperipheral band of bister about 1.5 mm. wide, bordered inconspicuously on either side by a similar or slightly narrower area a trifle lighter than adjacent parts of shell." (Berry.)

Max. diameter 30.3, mm., min. diameter 25.5 mm., alt. 17.7 mm., diameter umbilicus 3.1 mm.;  $7\frac{1}{4}$  whorls. Type.

Max. diameter 31.2 mm., alt. 17 mm., umbilicus 3.4 mm.;  $6\frac{3}{4}$  whorls. Paratype.

Max. diameter 24.3 mm., min. diameter 20.1 mm., alt. 13.8 mm., umbilicus 3.6 mm.;  $6\frac{1}{2}$  whorls. San Emigdio Creek.

CALIFORNIA: Two miles above Grapevine Station, old State Highway, Tejon Pass, Kern County (Allyn G. Smith), Type 2267 Berry Collection, paratypes collection Allyn G. Smith and 8651 Berry Collection. Also near Grapevine Station (L. G. Ingles), and San Emigdio Creek, 15 miles southeast of Maricopa, Kern County (Schilling).

"*Tejonis* is one of the largest species or races in the entire *traskii*-series, being nearly or quite as large as the magnificent *willetti* Berry of the Sespe Canyon country. It differs from *willetti* quite conspicuously in the thinner, more translucent, less polished, more horn-colored shell, and much narrower band of a lighter brown. Less conspicuous differences are found in its more compact coiling and slightly greater whorlage in shells of similar size. In sculpture these two forms remain very much alike. The only form known to me from the Kern County area which possess sculpturing of the type described is the much smaller *carpenteri* (Newcomb), which differs not only in size but so very greatly in color, texture, and finish of the shell, that the two have the aspect of very distinct things indeed.

"*Tejonis* has proven to be an exceptionally difficult snail to find in good condition. Subsequent to the discovery of the two original specimens by Mr. Smith, repeated visits to the locality by Messrs. Smith, Ingles, and others have failed to bring to light anything more than a few additional fragments and juvenals. Such evidence as this scanty material affords indicates that this is in the main a species of heavy rock-slides. The specimens from San Emigdio Canyon were apparently picked up on the surface, and are so badly bleached that their present identification must be interpreted accordingly. Surface collecting after heavy rains might conceivably prove a more fruitful method of collecting this species than arduous quarrying.

"The race is named for Tejon Pass." (Berry.)

***Heiminthoglypta carpenteri* (Newcomb)**

Fig. 90.

*Helix carpenteri* Newcomb, 1861, Proc. Cal. Acad. Sci., 2: 103. Binney, L. & Fr. W. Sh. N. A., 1: 171, fig. 298.

*Arionta carpenteri* Newc., Binney, 1878, Terr. Moll., 5: 366.

*Epiphragmophora traskii carpenteri* Newc., Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 617, pl. 115, figs. 4-6.

*Helminthoglypta carpenteri* Newc., Hanna and Smith, 1937, Nautilus, 51: 10, pl. 1, fig. a.

"Shell umbilicate, roundly conical; apex obtuse, obscurely marked with one brown band; well striated; under the lens numerous very minute spiral striations; whorls five and one-half rounded; suture well marked; aperture circular, with margins approximating; lip moderately expanded, at the columella broadly so, but not adherent. Alt. 16.5 mm., diameter 23 mm." (Newcomb.)



CALIFORNIA: Tulare Valley (Newcomb). McKittrick and Maricopa (L. J. Goldman); S. end of Panoche Hills, 4th large creek north of Panoche Cr.; Sec. 19, T18S, R15E, Domingene Ranch Road; Jacalitos Cr.; Arroyo Ciervo, all in Fresno County. Sec. 34, T22S, R18E, Kettleman Hills; E. flank of N. Dome, Kettleman Hills; 1 mile S. of Big Tar Canyon; and extreme S. end of Reef Ridge, all in Kings County. Kern County at NE. cor. Sec. 28, T25S, R18E, on W. side of road from Devils Den to Keek's Station; Wagonwheel Mountain; Carneros Cr., W. side of Kern County; Chico Martinez Creek; N. end of Gould Hills; Upper end of Salt Cr., W. side of Kern County; SE. side of Orchard Peak; 2 miles W. of Maricopa, all in Kern County. (G. D. Hanna & C. C. Church). 1 mile NE. of San Lucas, Monterey County, in the Salinas Valley (F. A. Menken).



Fig. 90. *Helminthoglypta carpenteri*.

"The shells are characterized by a very narrow umbilicus, narrower than in any of the other races except *E. t. coelata*. The incremental lines are rather coarse, while the wavy, spirally incised lines are fine and rather closely spaced." (Bartsch.)

"This snail has long been imperfectly known, for good material has not been available for study and comparison with allied forms until the last few years. Because of the heat and consequent dryness of its habitat, *H. carpenteri* is a difficult shell to find in first-class adult condition. The shells are extremely variable in size, as a subsequent table of measurements shows, and we have good reason to suspect that this variability is due in large part to the variation in rainfall (and therefore in snail food) from season to season. The measurements also show, however, that the general form of the shell is remarkably constant.

"In life the shells are semi-polished, of a beautiful straw color. The dark brown band has one of pale cream color below, and another rather indefinite one of the same color above. Spiral sculpture is faint but easily detected on the last two whorls under a magnification of x 10 and is fairly uniform over the surface of these whorls. The nucleus is not sharply differentiated from the remaining whorls; its sculpture consists (when most perfectly preserved) of a series of tiny papillations, set on a background of

silk-like radial lines of growth. Often neither one of these markings is visible and at best they require excellent illumination and high magnification to be seen at all. Largest shell, from Carneros Creek, Kern Co., 23.6 mm.; smallest, road from Devil's Den to Keck Station, Kern Co., 15 mm.; average of 111 shells, 19.1 mm." (Hanna & Smith.)

"Dead shells of *carpenteri* are strewn over the border of the valley floor and among the foothills on the west side of Fresno, Kings, and Kern Counties. Frequently they are found far removed from what would appear to be suitable snail cover. Living specimens have been found mostly in rock slides on north slopes but sometimes in rather exposed locations. Exposures of Etchegoin, Temblor, Tejon, and Cretaceous sandstones furnish the best cover.

"The coloration of the shell led us at one time to suspect that *carpenteri* might belong to the genus *Micrarrionta*, but an examination of the anatomy, shown in an accompanying figure, indicates at once that it should be retained in *Helminthoglypta*. Even so, there are some striking features to the soft parts. The mantle is grayish-white in color with no other color markings of any kind. The mucous gland is double and located in a membranous sac that permits evagination of the organ, at least in part. The details of the genitalia are believed to be sufficiently shown in the figure (Fig. 91) so that minute description is unnecessary." (Hanna & Smith.)

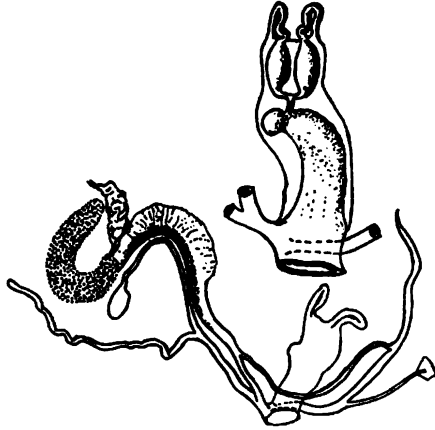


Fig. 91. *H. carpenteri*. Genitalia.  
(After Hanna.)

Dr. Cooper, in a rather confusing paragraph (Amer. Journ. Conch. 4: 221), says that the type of *H. carpenteri* was lost at sea, on the "Golden Gate". The shell from McKittrick, figured by Bartsch 1916 (272943 U.S.N.M.), may be accepted as a neotype. It measures, height 12.5 mm., diameter 19.5 mm.

(Named for Philip P. Carpenter, author of many memoirs on West Coast marine shells.)

#### **Helminthoglypta reediana** Willett

Fig. 92.

*Helminthoglypta reediana* Willett, 1932 (Apr.), Nautilus, 45: 134, pl. 11, figs. 8-10.

"Shell rather small for the genus, moderately elevated; aperture almost circular, oblique; inner lip barely reflected and encroaching slightly on the umbilicus; epidermis horn-colored; last whorl encircled by a reddish-brown band about one-half millimeter in width. Entire upper surface of type

covered with irregular diagonal rows of fine papillae, these papillae merging on the last whorl to form broken, raised lines, which extend over the base almost to the umbilicus. The extent and prominence of this papillation vary somewhat individually; in some specimens it extends onto the base, as in the type, and in others it ceases abruptly at the suture of the body-whorl. Last whorl marked by faint, incised, closely-spaced spiral striations, which are apparent on some parts of the surface and absent on others. Max. diameter, 17.1; min. diameter, 14.8; alt., 10.5; umbilicus, 2.8; number of whorls, 6." (Willett.)



Fig. 92. *H. reediana*, type.  $\times 2$ . (After Willett.)

CALIFORNIA: Lowe Canyon, Monterey County (G. Willett). Type 1030 Los Angeles Museum. Vicinity of Paso Robles (E. E. Hand, G. Willett).

Lowe Canyon, southern Monterey County, "lies between Ranchita and Vineyard canyons, on the westerly slope of the Diablo Range, about one mile east of the Vineyard Canyon road, which runs from San Miguel to Parkfield.

"In general appearance *H. reediana* resembles *H. traski carpenteri* Newc., which occurs on the eastern side of the same range of mountains, but it differs from that species in slightly larger umbilicus and wide-spread papillation. Should specimens be found in the territory intervening between the known ranges of the two forms, they may prove to be but subspecifically distinct, but in the

absence of such material, it is probably best to regard them as different species. Named for Mr. Fred M. Reed, of Riverside, California." (Willett.)

It is not well known, hard to find, and seems to be quite variable, according to Allyn G. Smith. Subgeneric position is doubtful.

**Helminthoglypta similans** Hanna & Smith

Fig. 93.

*Helminthoglypta similans* G. D. Hanna & A. G. Smith, 1937. Nautilus, 51: 13. pl. 1, fig. d.

"Holotype small, thin, with slightly depressed spire; apical angle about  $105^\circ$ ; umbilicus narrow; whorls  $5\frac{1}{2}$ , well rounded, the last more convex below than above the periphery, descending slightly at the aperture; peristome simple, thin, with very little reflection, set at an angle of  $30^\circ$  with the vertical, its basal termination well reflected but only barely obscuring the umbilicus; callus wash between terminations very thin. Nuclear whorls

nearly 2, wrinkled on the first half turn, the wrinkles consisting of low, irregular ridges; these give way on the remaining nuclear whorls to irregularly spaced, rounded papillations, moderately closely placed, which continue over the post-nuclear whorls above and below and into the umbilicus;



Fig. 93. *Helminthoglypta similans*. (After Hanna & Smith.)

on the upper portion of the last whorl these papillations are set more closely and in a somewhat descending spiral arrangement; lines of growth irregular, merging into one another, not prominent; spiral sculpture absent or very faint; periostracum exceedingly thin, brownish-buff, with a revolving dark band bordered above and below by bands much lighter in color than the remainder of the shell; bands not sharply defined. Max. diameter, 25.8 mm.; min. diameter, 13.7 mm.; alt., 9.6 mm.; diameter of umbilicus, about 1.4 mm." (Hanna and Smith.)

CALIFORNIA: Three quarters of a mile southeast of Oil City, Fresno County (G. D. Hanna and C. C. Church). Type 7136 C.A.S. Paleo. Type Collection. Also Fresno County six miles above mouth of Jacalitos Creek (C. C. Church); Eocene Reef just north of Coalmine Creek (Hanna and Church), and Canoas Creek (Hanna). In Kings County, Eocene conglomerate two miles north of Big Tar Canyon (Hanna). Monterey County at mouth of Hamilton Canyon, five miles southeast of King City (F. A. Menken).

"The separation of this form from *H. carpenteri* (Newe.), with which it is sometimes associated in locality range and to which it is similar, is rather difficult in old, white-weathered dead shells. With live or even well-preserved adult dead shells, however, the two are easily distinguished. *H. similans* averages smaller in size but the two overlap in all measurements. No good characters separate them in the nuclear structure or shape of shell. The shell of *similans* is covered with small papillations, lacking in *carpenteri*, which has well-incised spiral sculpture, obsolete or not present at all in *similans*. Also, the growth lines of *similans* join together in an irregular manner, which is not true in *carpenteri*. Shells of living specimens of the latter are more highly polished than the former, which is duller because of its peculiar sculpturing.

"Of the named species of the *traskii* group, *similans* resembles *cuyamacensis*, but this form is larger, has a wider umbilicus, and is much more densely covered with papillations that do not follow any particular arrange-

ment, at least on a series of specimens at hand from Warner's Springs, San Diego Co., California.

"The mantle of the animal of *similans* is densely blotched with black, whereas in *carpenteri* the mantle is entirely free of such markings. Genitalia drawn in Figure 94.

"The range of *similans* lies within that of *carpenteri* along the west side of the San Joaquin Valley. Except for one colony discovered in the drainage of Big Tar Canyon, Kings Co., and another in the Salinas Valley, it has only been found in a limited area in the vicinity of Coalinga, Fresno Co. Usually it seems to occupy rocky hillsides farther removed from the valley floor than *carpenteri*, and this may possibly account for its relatively recent discovery in a well-known territory. The two species do not occur in the same colonies, at least not normally. Dead shells of *similans* have not been found except where there are loose rocks for deep hiding during dry weather. On the other hand, dead shells of *carpenteri* are widely scattered over the surface, often far away from any rocky hiding places, which leads us to believe that this form may often hibernate in cracks or holes in the soil.

"The variation in size of *similans* is considerable, as is shown in the following table based on a series of shells from Coalmine Creek, Fresno Co.

"Largest shell,	max. diameter	18.5 mm.,	alt.	12.0 mm.
"Smallest shell	"	10.7 "	"	6.9 "
"Average of 53 shells	"	14.9 "	"	10.2 " "

Some Californian conchologists have expressed doubt as to the relation of *H. similans* to *H. reediana*. The latter is not yet known by series of good specimens, and its range of variation is not well understood. I have not seen it. Pending further investigation both may stand as species. The subgeneric place of this species is unknown, as the internal structure of the penis has not been investigated.

(*Similans*, imitating.)

**Helminthoglypta petricola** (Berry)

Fig. 95 b.

*Epiphragmophora petricola* Berry, 1916 (Jan. 5), Univ. Cal. Publ., 16: 107; 1920, Proc. Cal. Acad. Sci., (4), 10: 62, pl. 4, figs. 4a-4c; pl. 5.

*Epiphragmophora traskii traskii* Bartsch, 1916 (Dec.), Proc. U. S. Nat. Mus., 51: 612, pl. 117, figs. 1-3.

"Shell depressed, conspicuously umbilicate, the umbilicus having a diameter of about  $\frac{1}{3}$  the greater diameter of the shell. Color a warm golden



Fig. 94. *H. similans*, genitalia.  
(After Hanna.)

brown, becoming a little paler and yellower on the base, and with a broad and very conspicuous dark chestnut-brown band on the shoulder, bordered above and below by a slightly narrower band of a tint lighter than the body of the shell; the color in dead shells soon bleaching to a more yellow tone, becoming a dead white upon the final loss of the epidermis. Lip (except in old specimens) but little thickened and only slightly reflected save at the pillar, where it tends to cover the edge of the umbilicus. Epidermis somewhat glossy (more so in shells found dead, but which have not become bleached). Whorls  $5\frac{3}{4}$ ; neanic whorls showing a very fine granulation, with numerous minute radial wrinkles superimposed; 3 or 4 spirally disposed series of small, distinct, quite regularly spaced, elongate tubercles appear likewise, the latter almost quincuncially arranged, so that they appear ranked in oblique as well as spiral series, but on the later whorls the number of the tubercles increases so rapidly and irregularly that the oblique arrangement is soon lost, the lines of growth at the same time becoming more prominent, and the fine underlying granulation less distinct or even obsolete; sculpture of penultimate whorl transitional toward that of the last whorl, where the tubercles have given way to a series of rather weakly incised spiral lines, more or less interrupted where they cross the lines of growth, and becoming obsolete below the shoulder. Spire varying from very depressed to low conic; whorls convex, the last whorl descending in front. Aperture ample and very oblique. Edges of peristome somewhat converging and connected by a very thin, transparent, parietal callus. On the penultimate whorl a rather high power reveals in certain lights a number of exceedingly delicate, sharp, distantly spaced, oblique, incised lines, intersecting the lines of growth almost at right angles. Greater diameter of shell 29.5 mm.; lesser diameter 23 mm., height from umbilicus to apex 13 mm." (Berry.)

CALIFORNIA: A rocky talus slope on the southeast wall of Mill Creek Canyon, San Bernardino Mountains, near the old road, about  $1\frac{1}{2}$  miles from the canyon mouth, elevation about 3,250 feet (S. S. Berry and Allyn G. Smith). Type 3840 Berry Collection, paratypes in Univ. Cal. and A. G. Smith colls. Trabuco Canyon, Santa Ana Mountains, Orange County (E. P. Chace).

"This fine helicoid, one of the largest of the southern fauna, is distinguished by the aforementioned characters from all others known to me. It perhaps resembles a very large and extremely flattened form of *E. traski* more than any of the other Californian species, and I believe the two species to be rather nearly allied, though the situations in which they are respectively to be found are very dissimilar. The shell is sparsely but distinctly hirsute in the very young stages including the newly emerged embryo.

"The species does not seem to be an abundant one, and several hours arduous labor in turning over large blocks of stone and clearing out the detritus, repeated on several occasions, have yielded to date only a single adult living specimen, all the remainder being immature or merely dead shells." (Berry.)

(*Petricola*, living among rocks.)

**Helminthoglypta petricola zechae** (Pilsbry)

Fig. 95 a.

*Epiphragmophora zechae* Pilsbry, 1916 (Jan. 6). Nautilus, 29: 104, pl. 3, lower figs.  
*Epiphragmophora traskii zechae* Pils., Bartsch, 1916 (Dec.), Proc. U. S. Nat. Mus.,  
 51: 615, pl. 117, figs. 4-6.

The large thin shell is strongly depressed, umbilicate (width of umbilicus contained about seven times in diameter of the shell). The whorls of the spire and as far as the front of the last whorl are dilute cinnamon tinted, then changing to eceru-olive or dark olive-buff; there is a chestnut-brown band at the shoulder (about 2 mm. wide), bordered with inconspicuous, hardly noticeable bands paler than the ground-color. The spire is a little convex, whorls moderately convex, slowly increasing to the last, which is about double the width of the preceding, and descends a little in front. Surface glossy. Embryonic  $1\frac{1}{2}$  whorls are somewhat worn, showing no definite sculpture. First and second following whorls show traces of weak

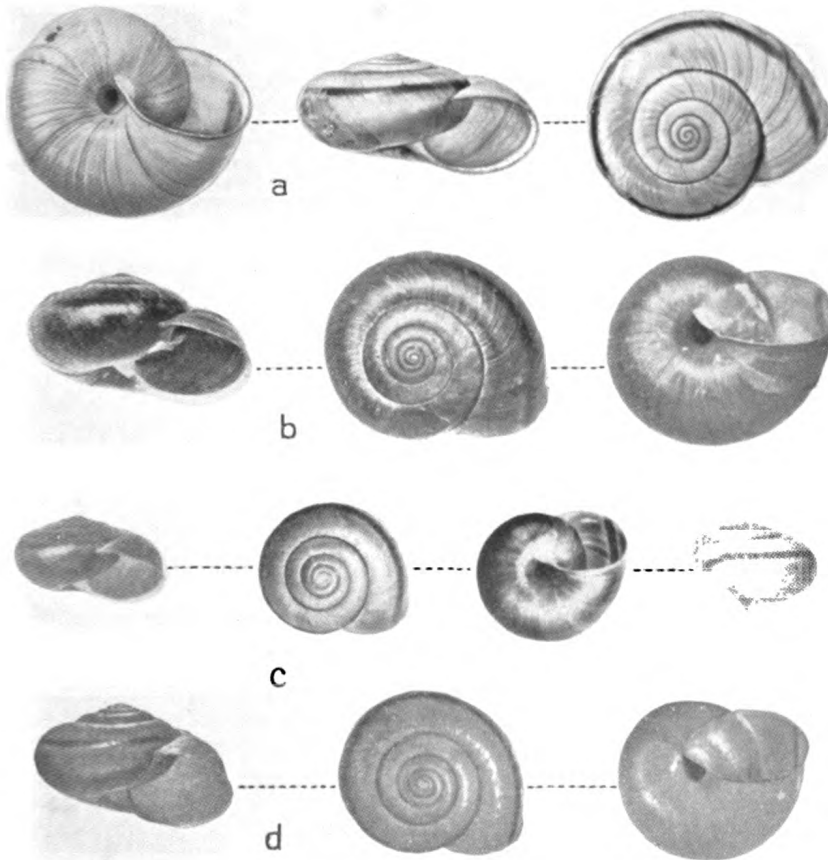


Fig. 95. a, *Helminthoglypta petricola zechae*, type. b, *H. petricola*, type. c, *H. petricola orotes*, type. d, *H. petricola sangabriensis*, type. (Figs. b, c, d after Berry.)

papillae in some places. Last whorl very wide, with low but distinct, irregular striation, and behind the lip closely papillose, less distinctly so behind basal lip. No spiral lines. Aperture bluish-white and banded within broadly lunate, decidedly wider than high. Lip thin, the upper margin scarcely expanded, outer very slightly, basal very narrowly reflexed, the columellar margin broadly dilated.

Height 15.3 mm., diameter 30.7 mm., umbilicus 4.4 mm.; 5½ whorls.

CALIFORNIA: San Antonio Canyon in the San Gabriel Mountains, western edge of San Bernardino County, at about 5000 feet elevation (Miss Lilian Zech), Type 113426 A.N.S.P. Canyons back of Ontario (Tremper) in San Bernardino and Los Angeles Counties. San Antonio and Evey's Canyons, San Antonio Range, San Bernardino County (Chaces).

The absence of spiral lines in this fine snail, together with other sculptural features mentioned above, the different color, depressed form and large size, establish good specific distinction from *H. traski*, but it is apparently only subspecifically separable from *H. petricola*, published a day earlier.

"The specimen was found in a narrow, winding canyon branching from the main San Antonio Canyon at 4700 feet, and at this point, some two or three hundred feet higher as near as I can guess,—only wide enough for the creek bed, then full of rushing water, and the trail. It is a cool, moist, deep canyon, with columbine, lilies and ferns, and on the slopes much bay laurel. The trees were incense cedar and big-cone spruce. The snail lay on a pile of rock artificially heaped up at the creek's mouth, and contained the dead animal when found." (Lilian Zech.)

**Helminthoglypta petricola sangabrielis** (Berry)

Fig. 95 d.

*Epiphragmophora petricola sangabrielis* Berry, 1920, Proc. Cal. Acad. Sci., (4), 10: 62, pl. 4, figs. 6a-6c.

"Shell low-conic, thin, fragile, rather tumid, umbilicate; the umbilicus rather narrow, barely permeable to the apex, and with a diameter about one-twelfth the greater diameter of the shell. Whorls 5½, convex, the last swollen and slightly descending in front. Aperture rounded, sometimes slightly flaring, oblique (40°). Edges of peristome slightly converging and connected by a very thin, transparent parietal callus. Lip only slightly thickened; everted near the pillar so as to indent the circular outline of the umbilicus. Periostracum somewhat glossy, often with a strong satiny sheen or semi-iridescence. Lines of growth numerous and fairly strong, though somewhat irregular. First half whorl when unworn showing rather strong, more or less interrupted, incremental wrinkles, and traces of a strong, coarse, overlying papillation; succeeding turns very finely wrinkly-granulose beneath the retractively slanting lines of small and at first often nearly obsolete papillae, the latter increasing in strength to the penultimate whorl where they are always strongly evident as well as within the umbilicus and to a less degree over the region just behind the aperture on the body whorl; papillae elsewhere on the last whorl more weakly developed. Spiral sculpture obsolete, a few weak traces persisting on the upper surface and peripheral region of the body whorl only. Color light golden brown near buffy citrine, paler and with more of a yellow tone below, with a dark, liver brown band



of a width of about 1.0–1.5 mm. on the shoulder, bordered above and below by a rather narrower band slightly lighter in tone than the body of the shell. Alt. 15.7 mm., max. diameter 26.3 mm., min. 21 mm., diameter umbilicus 2.2 mm.;  $5\frac{1}{2}$  whorls." (Berry.)

CALIFORNIA: Monrovia Canyon, San Gabriel Mountains (George Willett). Type 4848 Berry Collection.

A paratype in the Willett Collection measures 13.8 x 23.8 mm., umbilicus 2.3 mm.,  $5\frac{1}{2}$  whorls. Neither specimen is quite fully mature. Specimens from the San Gabriel Mountains in Millard's Canyon and Eaton's Canyon, north of Pasadena, and from west fork of San Gabriel River, just below the divide, are possibly referable to the same subspecies according to Dr. Berry.

"This mountain race appears to be somewhat similar to Bartsch's *arvus* in shape, size, and the narrow umbilicus, but differs in the *weak* papillation of the upper surface, and the presence of a weak spiral sculpture. From *zechae* Pilsbry it is distinguishable by its thinner, more tumid shell, much narrower umbilicus, and the better developed papillation of the upper whorls. None of the other described races appears to require any special comparison." (Berry.)

**Helminthoglypta petricola orotes** (Berry)

Fig. 95 c.

*Epiphragmophora petricola orotes* Berry, 1920, Proc. Cal. Acad. Sci., (4), 10: 60, pl. 4, figs. 5a–5d; pl. 6.

"Shell thin, translucent, depressed-conic, conspicuously umbilicate, the umbilicus deep, permeable to the apex, and having a diameter about one-ninth the greater diameter of the shell. Whorls about  $5\frac{1}{2}$ , convex, the last descending somewhat in front. Aperture oval and very oblique ( $45^\circ$ ). Edges of peristome converging and connected by a thin, very delicate, parietal callus. Lip but little thickened and only very slightly reflected save at the pillar, where it tends to cover the edge of the umbilicus. Periostracum more or less glossy, often showing quite a high polish. Lines of growth fine and numerous. First half turn weakly radially costate, with a few scattered papillae; next three-fourths of a whorl finely, closely granulate, with fine, weak incremental costations, and, over all, traces of larger papillae; granulation present to some extent on all remaining whorls, but of diminished importance as compared with the suddenly much increased incremental lines and the papillae; latter now seen to be ranked, at least primarily, in the usual obliquely retractively slanting series, almost quincuncially arranged, but the appearance of regularity often lost; maximum development of these papillae attained on the upper surface of the third whorl, still strong on the penultimate whorl, but practically absent from the body whorl except along the suture and within the umbilicus; spiral sculpture very poorly developed, only a few interrupted traces of incised threading being distinguishable on the upper third of the last two whorls, even these becoming entirely obsolete below. Color a warm golden brown, running fairly near a tawny-olive, becoming a little paler and yellower on the base, and with a conspicuous dark (liver brown) band of a width of about 1.5 mm. on the shoulder, bordered above and below by a rather narrower band of a few tints lighter than the body of the shell. Alt. 11.4 mm., diameter 20.4 mm., umbilicus 2.3 mm.;  $5\frac{1}{2}$  whorls." (Berry.)

Height 14 mm., diameter 24.5 mm.; paratype Chace coll.

CALIFORNIA: Near trail, south fork of Warm Spring Canyon, San Bernardino Mountains, elevation 2500 feet (Allyn G. Smith). Type 3905 Berry Collection. Also at 3700 feet near trail just southeast of summit, Warm Spring Canyon (A. G. Smith), and at 6500 feet west of Bridal Veil Falls Canyon, near mouth, above Forest Home, San Bernardino Mountains, in talus (E. P. Chace).

"This neat little helicoid is practically a miniature race of the large *E. petricola* Berry, with which alone it would seem to require any special comparison. From this it differs not only in its much smaller size, but also in its thinner shell, more polished periostracum, and still further reduction of the spiral sculpture. It occurs in the same general region of the San Bernardino Mountains as the typical form, but has only been discovered at localities farther into the mountains, at all of which it appears relatively constant and quite sharply separable from *petricola*.

"Both *petricola* and *orotes* are distinctly papillose over much of the upper surface. A very young *petricola* now at hand from the type locality (Cat. No. 3950, Berry coll.) shows that, when perfect, each papilla bears a minute, stubby, hair-like periostracal process." (Berry.)

(*Orotos*, mountaineers.)

**Helminthoglypta stageri** Willett

Fig. 96.

*Helminthoglypta stageri* Willett, 1938 (Oct. 10), Bull. So. Cal. Acad. Sci., 37: 52, pl. 11.

"Shell large for the genus, depressed, conspicuously umbilicate, about one-third of the umbilicus covered by the reflection of the inner lip. Color light brown, paler on the base, with a dark chestnut-brown band, from one



Fig. 96. *Helminthoglypta stageri*, paratype.

to two millimeters in width, encircling the last whorl at the shoulder; above and below the brown band are rather indefinitely defined light bands, the lower one being about as wide as the dark band and the upper one somewhat narrower. Aperture oval, oblique. Spire depressed; whorls convex, the last whorl descending in front. Nuclear whorls finely but thickly papillated, radiately wrinkled; papillae becoming larger and more widely spaced on later whorls, and hardly apparent on the last whorl excepting immediately behind the aperture and in the umbilicus. Last whorl with no

apparent spiral sculpture. Height, umbilicus to apex, 12.3 mm., greater diameter 31.5 mm., lesser 24.8 mm.; 6 whorls." (Willett.)

CALIFORNIA: Southwest side of Erskine Creek, Piute Mountains, at about 5500 feet, Kern County (G. Willett, K. E. Stager). Type 1055 Los Angeles Museum. Paratypes in California Academy of Sciences, A.N.S.P. 171222, and George Willett.

"This species when inspected without magnification, is surprisingly similar to typical *H. petricola* Berry, from Mill Creek, San Bernardino Mountains. However, considering the distance between the known ranges of the two shells, that several mountain ranges and valleys lie between, and that numerous other species of *Helminthoglypta* occupy the intervening territory, the genetic relationship of the two can hardly be very close. *Stageri* is of slightly more depressed form than *petricola* and appears to lack entirely the incised spiral lines nearly always present in that species." (Willett.)

***Helminthoglypta inglesi* Berry**

Fig. 97 a.

*Helminthoglypta inglesi* Berry, 1938 (June 20), Journ. Ent. & Zool. Pomona Coll., 30: 43, figs. 5, 6.

"Shell fairly large, rather thin, strongly depressed; spire little elevated; whorls about  $5\frac{1}{2}$ , convex, with well marked suture, evenly enlarging until the body-whorl, which expands more rapidly, is very tumid, and descends moderately to the lip; base strongly tumid, the large but steep-walled umbilicus contained about 7.6 times in the major diameter of the shell; aperture oblique, ample, rounded-ovate; lip slightly thickened and moderately expanded except near the suture, its terminations converging and connected by a distinct wash of callus; columellar flare well developed but not encroaching greatly on the umbilicus. Embryonic shell smooth for a fraction of a turn, then passing by way of a few low wavy wrinkles to a very finely and closely wrinkly-papillose state without any evident overlying papillation (in the present material); after about  $1\frac{3}{4}$  whorls the postembryonic sculpture appears as a system of fine low papillae showing a rather obscure decurrent arrangement, gradually disappearing on the fourth whorl, obsolete below, and often quite worn away on the mature shell; final whorls without sculpture except for fine, low, close, irregular papillation near the suture, both above and below near the aperture, and within the umbilicus; spiral striation evident only very rarely as a faint and abruptly terminated trace on the shoulder of the body-whorl between the close, irregular, and often quite heavy incremental wrinkles. Periostracum thin, glossy, often more or less deciduous; upper surface tawny-olive (to avellaneous where partially decorticated); base deep olive-buff around umbilicus to tawny-olive peripherally; suprapерipheral band conspicuous, rather irregular, 1.5 to 1.7 mm. wide, bister, supplemented above and below by rather obscure narrower bands of olive-buff." (Berry.)

7267	Paratype	Max. diam.	25.2,	min. diam.	20.7,	alt.	13.7,	umbilicus	3.2 mm.;	whorls	$5\frac{1}{2}$
A.N.S.P.	"	"	24.6,	"	20.0,	"	13.1,	"	2.8 mm.;	"	$5\frac{1}{2}$
8643	Holotype	"	24.3,	"	19.7,	"	12.2,	"	3.3 mm.;	"	$5\frac{1}{2}$
S. U.	Paratype	"	23.7,	"	19.1,	"	12.1,	"	3.3 mm.;	"	$5\frac{1}{2}$

CALIFORNIA: Horse Meadows, on trail to Sunday Peak, Sierra Nevada Mountains, Kern County (Don Anderson). Type 8643 Berry Collection; Paratypes 7267 Berry Collection; others to be deposited in the collections of the Academy of Natural Sciences of Philadelphia (170933), and Stanford University.

"This species is a handsome one but its peculiar traits appear to lie principally in the absence of characters noted to be present in related forms. In its decidedly more tumid base, more capacious body-whorl, and narrower and more steep-walled umbilicus, it differs from *euomphalodes*, a species shortly to be described, and approaches more closely to typical *petricola* Berry of the San Bernardino Mountains, but it is smaller, has a wider umbilicus, and the almost complete absence of spiral sculpture seems a good distinctive feature.

"The species is named for Dr. Lloyd G. Ingles, now of Chico State College, whose energetic field-work in Kern County has added more than that of any other collector to our knowledge of its snail-fauna." (Berry.)

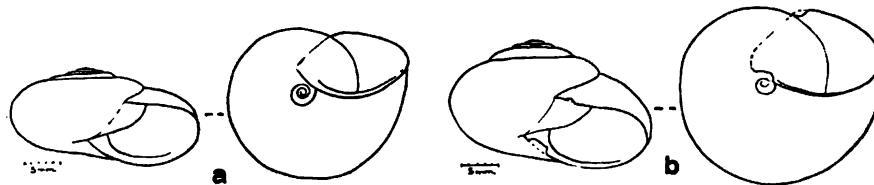


Fig. 97. a, *Helminthoglypta inglesi*. b, *H. liodoma*. (After Berry.)

#### *Helminthoglypta liodoma* Berry

Fig. 97 b.

*Helminthoglypta liodoma* Berry, 1938, Journ. Ent. & Zool. Pomona Coll., 30: 45, figs. 7, 8.

"Shell large, of moderate thickness, low-conic; whorls  $5\frac{1}{2}$ , strongly convex with well-marked suture, evenly enlarging until the latter part of the body-whorl, which expands more rapidly and descends strongly to the lip; base strongly tumid, the rather narrow but deep umbilicus contained 10.6 times in the major diameter of the shell; aperture ample, rounded-ovate, strongly oblique; lip imperfect in specimen seen, but its terminations hardly converging, connected by a thin wash of callus, the well developed umbilical flare partially covering the umbilicus. First half-whorl of embryonic shell rather coarsely wrinkled; succeeding  $1\frac{1}{2}$  whorls finely closely wrinkly-papillose, with apparently a few scattered overlying elongate papillae in decurrent serial arrangement, but these not easy to make out; post-embryonic whorls at first very minutely and obscurely papillose, but subsequently unsculptured save for the numerous fine irregular incremental striae; a faint trace of spiral sculpture only toward the end of the body-whorl close to the suture, with likewise some close fine irregular papillation evident on the upper surface just behind the lip; base smooth throughout except for the incremental striae. Major diameter 26.5, min. diameter 22.7, alt. 16.5, diameter umbil. 2.5 mm." (Berry.)

CALIFORNIA: North Fork of Cottonwood Creek on road to Breckinridge Mountain, Kern County; one dead adult shell in fairly good condition (L. G. Ingles). Type 7160 Berry Collection.

"This is a large species, apparently very closely akin to *inglesi* but distinguishable by its larger size, higher spire, heavier shell, and particularly the narrow umbilicus. There is possibly likewise some affinity demonstrable with the more northern *ferrissi* Pilsbry, an apparently much thinner shelled species with a differently shaped body-whorl and peculiarly reamed umbilicus. It is a great pity that no better material of this very fine snail has come to hand, in the hope of which I have postponed its publication perhaps longer than I should.

"The name, which is suggested by the smooth, unornamented periostracum and sturdy dome-shaped shell, is derived from the Gr. *leios*, smooth + *doma*, house." (Berry.)

***Helminthoglypta ferrissi* Pilsbry**

Fig. 98.

*Helminthoglypta ferrissi* Pilsbry, 1924, Nautilus, 38: 54.

The shell is depressed, thin, umbilicate, the width of umbilicus contained between 7 and 8 times in that of the shell. Of a pale greenish-buff tint



Fig. 98. *Helminthoglypta ferrissi*, type.

with streaks of deeper green (mignonette-green of Ridgway); above the periphery a narrow chestnut-brown band without light borders. The spire has a faintly pinkish tint. Surface is very glossy. The  $1\frac{2}{3}$  embryonic whorls, after the nearly smooth tip, are very densely, irregularly and microscopically wrinkled, the wrinkles waved and interrupted, in places broken into granulation. Following whorls are lightly striate and with a microscopic sculpture of irregular wrinkles in the general direction of lines of growth. This fails on the last whorl, which has fine, unequal wrinkle-striae only, becoming weaker on the base. No spiral lines. The whorls increase slowly at first, but the last widens rapidly, is rounded peripherally and descends to the aperture. The aperture is large, oval-lunate; peristome thin, the outer and basal margins narrowly expanded, columellar margin dilated, covering a small part of the umbilicus.

Height 15.3 mm., diameter 27.2 mm.;  $5\frac{1}{3}$  whorls. Type.

Height 13.5 mm., diameter 24.1 mm.; 5 whorls. Smallest.

CALIFORNIA: Above Tehipite Valley, middle fork of King's River, Fresno County (J. H. Ferriss). Type 134224 A.N.S.P.

About 35 specimens were taken, but very few were in good condition. It is a beautiful species, of a brighter green color than any form of *traski*, and differing in the sculpture, both of embryonic and later stages. Ferriss writes that it was "found on going up a zigzag trail northward several miles after leaving Tehipite Valley and Dome, once in forest rubbish among rocks, again at a crumbling cliff; elevation probably around 7000 feet."

Mr. A. G. Smith informs me that C. C. Church collected a series of this snail one-half mile above Durrwood, in the Kern River Canyon, Kern County.

**Helminthoglypta proles** (Hemphill)

Fig. 99 a, b.

*Arianta traski* var. *proles* Hemphill in Binney. 1892, 4th Suppl., Bull. Mus. Comp. Zool., 22: 187.

*Epiphragmophora traskii proles* Hemph., Pilsbry, 1895, Man. Conch., 9: 199.

*Epiphragmophora traskii proles* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 616, pl. 116, figs. 4-6.—Hanna, 1938, Nautilus, 52: 9 (locality and type).

*Helminthoglypta proles* Bch., Lowe, 1928, Nautilus 41: 78.—Berry, 1938, Journ. Ent. & Zool. Pomona Coll., 30: 47, footnote.

Shell umbilicated, very much depressed, thin, shining, of a dark horn-color; whorls  $5\frac{1}{2}$ , somewhat flattened above, convex beneath, the last slightly falling in front, with a dark band above the periphery, and crowded with strong oblique striae; suture well impressed; umbilicus moderately large and deep; aperture hardly oblique; peristome simple, thin, subreflected, its terminations approaching. Height  $\frac{3}{8}$  inch, breadth  $\frac{1}{4}$  inch. A much flatter and more depressed form than any of the varieties of *traski* that I have seen. There are no revolving microscopical lines, as in *traski* (Hemphill.)

"Shell decidedly flattened, widely, openly umbilicated, thin. The characteristic distantly spaced, obliquely protractively arranged papillation is almost obsolete in the nuclear whorls as well as in the rest of the shell in the present race. Traces of this sculpture can only be seen on absolutely perfect specimens. Only one individual of all the material examined showed this character, the nuclear whorls in all the rest being slightly worn. The incremental lines of the postnuclear turns are not strong and the spiral sculpture which consists of exceedingly fine, faintly incised lines, which are best seen on the penultimate whorl, becomes lost on the last turn, both above and on the base." (Bartsch.) Three specimens from Hemphill measure:

Height 11.3 mm., diameter 21.2 mm.; 5.2 whorls.

Height 10.7 mm., diameter 20.7 mm.; 5 whorls.

Height 9.2 mm., diameter 18.9 mm.; 5 whorls.

CALIFORNIA: "Fraser's Mill" (now Mountain Home, a packing station 3 miles west of Balch Park, at 6280 feet elevation), Tulare County (Hemphill), Type 8681 C.A.S., paratypes 62270 A.N.S.P. Clark's ranch, Mariposa County (R. E. C. Stearns). Southern edge of Sequoia Park, on the south fork of Kaweah River (Lowe).

On the Hemphill lot of *proles* from Fraser's Mills and others from Clark's I cannot see the spiral sculpture mentioned by Dr. Bartsch. Only

one individual shows any noticeable papillation, very sparse, on the third whorl; though single papillae may be found on some others.

The location of Hemphill's type locality has been elucidated by Hanna, *Nautilus* 52: 7. Where "Clark's ranch, Mariposa Co." is, I do not know. Dr. Hanna did not find *proles* at Mountain Home when he was there in 1933.

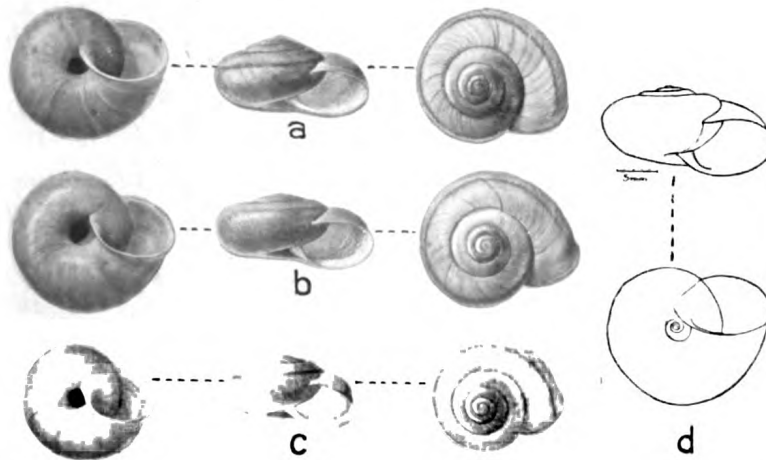


Fig. 99. a, b, *Helminthoglypta proles*, paratypes. c, *H. proles mariposa*. d, *H. proles saccharodytes*. (After Berry.)

Bartsch designated a specimen in the Academy of Natural Sciences of Philadelphia as type, and Berry one in his own collection; but since Hemphill had marked a lot now in the California Academy type collection as his types, the claims of other authors lapse.

(*Proles*, youth.)

***Helminthoglypta proles mariposa* Pilsbry**

Fig. 99 c.

The shell is thinner than in *proles*, less depressed, the last whorl not so wide and the umbilicus wider within. Dilute tawny-olive, paler at base, with a narrow brown band with faint pale borders. Post-embryonic whorls microscopically rugose radially and in places showing a few indistinct, scattered papillae. Last whorl nearly smooth except for fine, low growth wrinkles, not papillose. No spiral striae. The thin peristome is very narrowly expanded. Height 10, diameter 17.3 mm.,  $4\frac{3}{4}$  whorls.

CALIFORNIA: Mariposa Big Trees (H. Burrington Baker). Type and paratypes 158339 A.N.S.P. Between Camp Curry and Vernal Falls, Yosemite Park (H. B. Baker).

Mr. Allyn G. Smith writes: "Common throughout the Yosemite Valley region. I have it from Alder Creek, from North Crane Creek in the Tuolumne Grove of Big Trees (*Sequoia gigantea*) on the Big Oak Flat Road,

from Signal Peak, near Wawona, from Wawona Pt. above the Mariposa Big Trees, from Glacier Pt. on the rim of Yosemite Valley, and at the base of Sentinel Dome, back of Glacier Pt. At this last location the elevation is about 7500 feet. At Wawona Pt. it is 6800 feet. This snail is found at higher altitudes than any other *Helminthoglypta* I have collected. It is found in rock piles or under red fir dead-falls. *H. p. mariposa* is easily a snail of the Upper Transition Zone. In a lot of 10 from Vernal Falls the largest measures 10.6 x 21 mm., 4 $\frac{3}{4}$  whorls, smallest 9.9 x 18 mm., 4 $\frac{1}{2}$  whorls."

***Helminthoglypta proles saccharodytes* Berry**

Fig. 99 d.

*Helminthoglypta proles saccharodytes* Berry, 1938, Journ. Ent. & Zool. Pomona Coll., 30: 46, figs. 13, 14.

"Shell of moderate size, thin; spire much depressed, often almost or quite planulate; whorls 5 to 5 $\frac{1}{4}$ , quite regularly expanding, high-shouldered, strongly flattened above, yet remaining convex between the deeply grooved sutures; last whorl capacious, descending slightly in the flattest shells, considerably more in higher spired ones; base tumid, the wide funicular umbilicus contained about 6 times in the major diameter of the shell; aperture oblique, ample, rounded-ovate; lip but little thickened and only slightly expanded except for the moderate columellar flare which fails to impinge greatly on the umbilicus; lip terminations strongly converging, connected by a weak, washlike callus. Embryonic shell of 1 $\frac{3}{4}$ -2 whorls, at first nearly smooth, then weakly radially wrinkled, becoming almost at once very closely, finely, and delicately radially wrinkled, and eventually wrinkly-pustulose, but without positive traces of any superimposed geometric papillation; post-embryonic whorls with numerous low well-separated dot-like papillations arranged in repetitively decurrent series over a very finely wrinkled surface, these tiny wrinkles soon giving way to a smoother, well polished surface between and over the close and often quite coarse growth-lines. The papillation comes to a stop with curious abruptness, sometimes as early as the beginning of the last whorl, sometimes as late as the final resting stage prior to the mature aperture, but always so far as noted in synchrony with either a major (annual?) resting stage, or a repaired break in the shell; subsequent to this point the shell is strongly polished and quite smooth except for the numerous irregular incremental striae, a little very weak spiral striation on the shoulder, and sometimes the least possible trace of spiral striae on the base a little behind the lip, where a more or less weak granulation is usually to be seen as well. Periostracum smooth and polished, especially on base; upper surface tawny-olive to saccardo's umber; base tawny-olive to deep olive-buff; shell encircled above periphery by a fairly conspicuous natal brown band about 1.5 mm. wide, supplemented above and below by rather narrower obscure semi-translucent bands of chamois or deep olive-buff." (Berry.)

Holotype: Max. diameter 21.5, min. diameter 17.3, alt. 10.6, umbilicus 3.7 mm.; whorls 5 $\frac{1}{4}$ .

Paratypes from 10.4 x 22.2 mm. to 9.5 x 19.2 mm.

CALIFORNIA: Altitude 6000 feet, Sugar Loaf Mountain, Sierra Nevada, Tulare County (K. Dennen). Type 8644 Berry Collection. Paratypes 7034 Berry Collection, others to be deposited in the collections of the United



States National Museum, Academy of Natural Sciences of Philadelphia (170934), Stanford University, and the private collection of Allyn G. Smith.

“ This race differs from typical *proles* (Hemphill) in its larger size, wider and more open umbilicus, wider aperture, more tumid base, and distinct punctuation of the upper surface, as well as in the presence of spiral striations on the upper surface of the body-whorl. The abrupt change in sculpture-pattern coincident with a major resting stage is an exceedingly interesting feature which I do not recall having seen described in other species of *Helminthoglypta*. The name, chosen in reference to the current appellation of the mountain which the race inhabits, comes from the Gr. *sakcharos*, sugar, + *dytes*, inhabitant.” (Berry.)

***Helminthoglypta euomphalodes* Berry**

Fig. 100.

*Helminthoglypta euomphalodes* Berry, 1938 (June 20). Journ. Ent. & Zool. Pomona Coll., 30: 45, figs. 9, 10.

“ Shell moderately large, of medium weight, strongly depressed; spire little elevated; whorls  $5\frac{3}{4}$ , rather flatly convex with well marked suture, quite regularly enlarging, the last descending strongly above to the lip; base rounded, the very wide, open, funicular umbilicus contained about 4.3

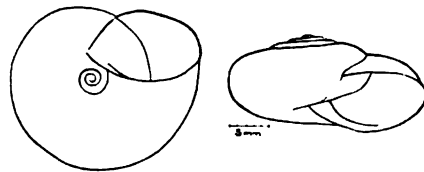


Fig. 100. *Helminthoglypta euomphalodes*. (After Berry.)

times in the major shell-diameter; aperture strongly oblique, transversely ovate, ample, the lip unthickened and sharp above, but thence becoming heavier and reflected slightly into the moderate columellar flare, its terminations moderately converging. Early whorls somewhat rubbed; post-embryonic whorls without sculpturing other than the numerous fine irregular growth-lines until the body-whorl is reached, when one encounters occasional traces (especially noted near resting-stage marks) of every minute, closely placed, rounded papillae, becoming quite strong back of the lip, and on the last half-whorl a system of sharply incised spiral striations becoming increasingly stronger toward and near the suture; base mostly unsculptured except for the very fine growth-lines, but becoming very minutely and closely papillose as the lip and umbilicus are approached. Periostracum smooth, lustrous, especially glossy over base; upper surface dark olive-buff, a little grayer on spire; base isabella color; shell encircled above periphery by a conspicuous sepia band about 1.3 mm. wide, supplemented below by a band of deep colonial buff of about the same width, and above by a somewhat wider band of the same. Max. diameter 25.2, min. diameter 20.7, alt. 12.5, diameter umbilicus 4.0 mm.” (Berry.)

CALIFORNIA: Blodgett's Camp, Greenhorn Mountain, Kern County, a single quite fresh mature dead shell containing the dried animal (L. G. Ingles). Type 7266 Berry Collection.

"This is another fine species represented by only a single specimen. It has quite a distinctive appearance owing to the very flat spire and the possession of the widest and most open umbilicus known to me in any *Helminthoglypta* of its size. In this it suggests the new race of *H. proles* herein described, and material from the intervening areas may not inconceivably show that it is itself but a terminal member of the *proles*-series. It differs from these not only in its much greater size, but in the thicker and whiter inner layer of the shell, and the peculiar subsutural development of the spiral sculpturing. Rather near affinity to the *petricola*-group is likewise suggested. The specific name chosen is from the Gr. *eu*, well + *omphalodes*, umbilicated, and has reference to the outstanding feature of the shell." (Berry.)

***Helminthoglypta tularica* (Bartsch)**

Fig. 101.

*Epiphragmophora traskii tularensis* Hemph., Pilsbry, 1895, Man. Conch., 9: 199 (nude name); 1897, Nautilus, 11: 59 (nude name). Not *Arionta tudiculata* var. *tularensis* Hemphill, 1892.

*Epiphragmophora traskii tularica* Bartsch, 1916, Proc. U. S. Nat. Mus., 51: 615, pl. 116, figs. 1-3.

"Shell subglobose, very dark colored, with the chestnut band very broad. The axial wrinkling of the nuclear sculpture is very strongly developed, the individual wrinkles being finely granulated. The large papilla-



Fig. 101. *Helminthoglypta tularica*, type.

tions, which form the obliquely protractively slanting lines on the nucleus, are not nearly as strongly developed here as on the other races and require search to be seen. This sculpture does not appear to extend beyond the nuclear turns, but is replaced by the incised spiral sculpture which consists of closely spaced microscopic spiral striations and deeper, distantly, irregularly distributed, stronger lines." (Bartsch.)

The shell is thin, with conoid spire, and extremely narrow, half-covered umbilicus; quite glossy, of dilute russet color, fading to whitish around the umbilicus; the wide band, between chestnut-brown and liver-brown, has a whitish border of almost the same width below. The spiral lines are rather shallow, often cutting only the crests of the close striae. The embryonic whorls have crowded radial wrinkles, which are wavy, often interrupted,

and far stronger and coarser than in any form of *traski*. Some papillae are scattered on the second whorl locally in the type, but in another they are very indistinct if present.

Height 15.4 mm., diameter 20.8 mm.; 5½ whorls.

Height 16.4 mm., diameter 20.6 mm.; 5½ whorls.

CALIFORNIA: "Fraser's Mill" (near what is now Mountain Home, a packing station three miles west of Balch Park, at 6280 feet elevation), Tulare County (Hemphill). Type and paratype 70703 A.N.S.P.

The two examples in the type lot though of full size are probably not completely mature, as the outer and basal margins of the lip are thin, sharp and unexpanded. They are closely similar. The color is far darker than *H. tularensis* and of different hue. The shape is far more elevated, the coil closer, and the last whorl narrower in apical view; it descends a little in front. It is a peculiar shell which does not seem closely comparable to any known to me. The specimens were collected by Hemphill, and sent to W. G. Binney, who passed them on to me as a species not known to him.

#### MICRARIONTA Ancey

*Micrarionta* Ancey, 1880, *Le Naturaliste*, 1: 334 (2me année), for *Helix facta* Newc. *Arionta* and *Euparypha* sp., Binney, 1878, *Terr. Moll.* 5.

The helicoid shell varies from subglobose to depressed, umbilicate or imperforate, generally having a band above the periphery, which is normally rounded; peristome from somewhat expanded to reflected.

Genitalia (Figs. 102 A-D).—The atrium is very short. Penis moderately large, containing a short verge or papilla or none; the penial retractor on the epiphallus; flagellum moderate or long. Vagina long, bearing a dart sac near the middle; two mucous glands expanded, flattened and spread upon dart sac, vagina or base of penis, or sometimes free, club-shaped; excreting through separate slender ducts inserted in the crotch between dart sac and vagina. Spermathecal duct long, simple or branched.

The jaw has three to eight strong ribs.

(Μικρός, small + *Arionta*, from ἀρίων, some sort of snail.)

*Distribution*.—Channel Islands and extreme southwestern mainland of California; Lower California and islands;<sup>1</sup> desert region of southern California and adjacent parts of Nevada (?), Arizona and Sonora.

These are snails of semiarid to desert regions, the maritime species living on and under tunas (*Opuntia*) or bushes, or under stones; those of the interior deserts among and under rocks.

On geological evidence an insular or peninsular Tertiary terrain, "Catalinia", has been mapped over the region of the Channel Islands of

<sup>1</sup> Descriptions and figures of Lower Californian micrariontas are contained in: Bartsch, 1904, *Smiths. Misc. Coll.*, 47: 192, 197-8. Berry, 1928, *Journ. Ent. & Zool., Pomona Coll.*, 20: 74-79. Dall, 1900, *Proc. Acad. Nat. Sci. Phila.*, pp. 99-104. Hanna, 1923, *Proc. Cal. Ac. Sci.*, (4), 12: 493-526. Pilsbry, 1913, *Proc. Acad. Nat. Sci. Phila.*, pp. 380-391; 1916, *Nautilus*, 29: 97-102; 1927, *Proc. Cal. Acad. Sci.*, (4), 16: 159-202.

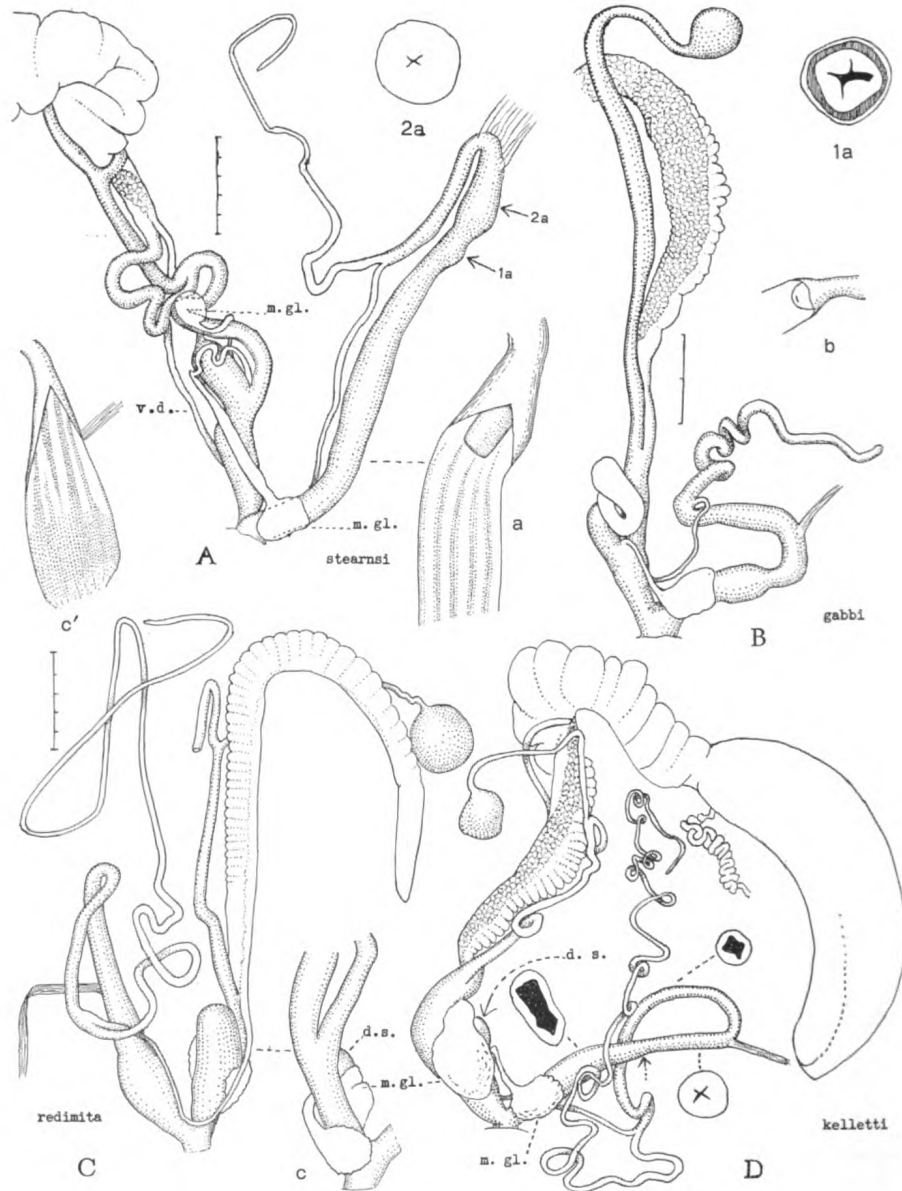


Fig. 102. Genitalia of: A, *Microrionta stearnsiana*, Coronado I.; at a the upper part of penis of another individual opened, showing verge; 1a, section through penis and verge; 2a, section of lower part of epiphallus (the name "stearnsi" on figure A is an error for *stearnsiana*). B, *M. gabbi*, Santa Barbara I.; at b an outline of verge. C, *M. redimita*; at c view of anterior part from above; c', the penis and part of epiphallus opened. D, *M. kelletti*, with sections of penis and epiphallus, d.s., dart sac; m.gl., mucous glands; v.d., vas deferens.

California, in time extending from Lower Miocene to sometime in the Pleistocene, when its foundering was an incident of the intense Pleistocene diastrophism of southern California.<sup>1</sup> This geological hypothesis is supported by the facts of snail distribution, the Channel Islands having a wholly homogeneous fauna which could hardly be understood except by the supposition that the islands had formerly been united.<sup>2</sup> On zoogeographic grounds it may be presumed that Catalinia was at some time continuous southward with the land area mapped by Schuchert (1929) comprising western Lower California and its islands, but at present it is not clear how or when Catalinia connected with this Lower Californian terrain. That such connection existed sometime prior to the Pleistocene is evident from the distribution of several genera mentioned below, having strongly distinct species in the two areas.

The snail fauna of Guadalupe Island, off Lower California, is closely related to that of the Channel Islands. Was Guadalupe the end of a peninsula from Catalinia? Or are the common elements traceable to over-sea drift? I can add nothing to the discussion in a former paper.<sup>3</sup>

The following genera and subgenera are special to or characteristic of Catalinia plus part of Lower California: *Micrarionta* proper, *Plesarionta* and *Xerarionta*, *Glyptostoma*, *Radiocentrum*, *Binneya*, *Striopupilla*, the typical group of *Sterkia*, and *Truncatella*. *Eremarionta* seems to have spread north and east from a Lower Californian center. The weak specific differentiation in California and Arizona does not speak for a long residence in those states.

*History.*—*Micrarionta* was proposed as a subdivision of *Helix* by Ancy (1880) for *Helix facta* and its group, previously included in *Arionta*. Finding the genitalia similar, I added the *kelletti* group (1895, Man. Conch. 9: 197, 200; 1898, Proc. Acad. Nat. Sci. Phila., pp. 68-70), species formerly placed in *Euparypha* and *Arionta*. Later, the desert helices of California and western Arizona, which had been considered *Sonorellae*, were found to have the same type of genitalia. In 1913 (Proc. Acad. Nat. Sci. Phila., p. 380) *Micrarionta* was elevated to generic rank. About 40 species are known.

A Lower California series of about ten species (part of them described as *Sonorellae* in *Nautilus* 29: 97) may belong in part to *Micrarionta*. In that genus the species *M. lohri* Gabb, *M. lioderma* Pils. and *M. evermanni*

<sup>1</sup> R. D. Reed, 1933, *Geology of California*, pp. 5, 252, and elsewhere. R. D. Reed and J. S. Hollister, 1936, *Structural Evolution of Southern California*.

<sup>2</sup> The Santa Cruz island group apparently never formed part of Catalinia, or at all events, no Catalinian trace now exists in their snail fauna. These islands are considered a partially submerged continuation of the Santa Monica transverse range.

<sup>3</sup> Proc. Cal. Acad. Sci., (4) 16: 160. (1927).

Since the above was written T. D. A. Cockerell has published a valuable paper on the Californian islands, discussing both animals and plants: *University of Colorado Studies* 26: 1-20, (1938).

Pils., with some other little-known forms, compose a group which cannot be definitely classified until some are dissected. Other Lower Californian species, such as *peninsularis* Pils. and *inglesiana* Berry, by the apical sculpture are apparently referable to *Helminthoglypta*. None has been dissected.

Binney (1878) figured genitalia of *M. gabbi*, *rufocincta*, *intercisa*, *kelletti* and *tryoni*, but at that time the dart apparatus was not understood and the figures are without value. I have figured *M. facta* Nc., *guadalupiana* Dall, *kelletti* Fbs., *stearnsiana* Gabb, *veatchi* Nc., *pandorae* Fbs., *areolata* Pfr., *wolcottiana* Beh., *xerophila* Berry, *desertorum* P. & F., *hutsoni* Clapp, and *aquaealbae* Berry. The chief divergence within the genus is in the possession of a papilla or short verge in the penis of most species and its absence in some others. This point calls for further investigation in a larger series of species. The form and disposition of the mucous glands are varied specifically, the small eremariontas being the least specialized.

*Paleontology.*—*Micrariontae* are abundant as Pleistocene and later fossils on the Channel Islands. *M. dallasi* M. A. Hanna (1927, Univ. Cal. Pub., Bull. Dept. Geol. Sci., 16, no. 8, p. 330, pl. 57, figs. 8, 11), from the Tejon Eocene, La Jolla Quadrangle, has been referred to this genus on account of its resemblance in size and shape to *M. gabbi*; but the peristome was not preserved in the single example known, and the surface is described as "finely and evenly ribbed-striate". Better material is needed for a positive generic reference.

*Classification.*—*Micrarionta* divides into four conspicuously distinct subgenera, the maritime members having in common a radial sculpture of the embryonic whorls, which however, is often indistinct.

1. Lip reflected throughout; compactly coiled, nearly smooth helices of moderate or rather small size, with a band but no other color markings; insular snails.

Subgenus *Micrarionta*

Lip narrowly to distinctly expanded, not reflected except at axis.....2

2. Depressed, umbilicate or perforate, smooth, with a band but no other variegation; embryonic whorls spirally stippled or netted; inland snails..Subgenus *Eremarionta*  
Subglobose or globose-conic, capacious shells, perforate or closed, usually speckled, streaked or maculate; embryonic sculpture radial when present; coastal and insular. ....3

3. Cavity of the penis continuous with that of the epiphallus (Fig. 102 c').

Subgenus *Xcrarionta*

Cavity of the penis separated by a verge from that of the epiphallus (Fig. 102 a).

Subgenus *Plesarionta*

Subgenus MICRARIONTA *s. str.*

These small, glossy helices with reflected lip are confined to the Channel Islands, with one species, *M. guadalupiana* (Dall), on Guadalupe Island

off Lower California. There are many variable species, races and local forms, imperfectly understood with present materials. Hemphill made abundant collections, but his lots are not localized except by islands, and being assorted by size, form and color, give no idea of the composition of colonies. Similar forms occur on different islands, some of them not distinguishable. New studies in the field must be made of these snails. Meantime, the following species are admitted:

- M. rufocincta* (Newc.), Catalina Island.
- M. gabbi* (Newc.), San Clemente Island.
- M. facta* (Newc.), Santa Barbara Island.
- M. feralis* (Hemph.), San Nicolas and San Clemente Islands.
- M. sodalis* (Hemph.), San Nicolas Island.

If it is sometimes not easy to assort material into these species, difficulties multiply when further division into subspecies and *formae* is attempted.

The genitalia (Fig. 102 B, *M. gabbi*, Santa Barbara I.) show a short atrium, stout penis with folded inner wall and a rounded papilla at apex (Fig. 102 b). The epiphallus and the spirally coiled flagellum are rather large, with large cavity. Penial retractor is inserted on epiphallus. The long vagina bears the dart sac about midway. The slender ducts of the mucous glands are inserted in the crotch between dart sac and vagina, rather widely separated. One gland is club-shaped, bent, ascending and free, the other descending and spread over the basal part of the penis. The spermatheca is globose, on a long, unusually thick and unbranched duct.

**Micrarionta rufocincta** (Newcomb)

Figs. 103 a, b, c.

*Helix rufocincta* Newcomb, 1864, Proc. Col. Acad. Sci., 3: 116. Cooper, 1879, Proc. Amer. Phil. Soc., 18: 285 (distribution).

*Helix rufocincta* Newc., Binney & Bland, 1869, L. & Fr. W. Sh. N. A., 1: 174, fig. 303. Hemphill, 1891, Zool., 1: 332; 1901, Nautilus, 14: 124.

*Arionta rufocincta* Newc., Binney, 1878, Terr. Moll., 5: 371, fig. 253, pl. 9, fig. n; pl. 14, fig. b; pl. 15, fig. o (anatomy); 1892, 4th Suppl., Bull. Mus. Comp. Zool., 22: 188, pl. 1, fig. 3.

"*Helix tenuistriata*" (as "a less developed form of *H. gabbi*"), W. G. Binney, 1869, L. & Fr. W. Sh. N. A., 1: 175, fig. 305; repeated in his later works under *Arionta gabbi*. Not *Helix tenuistriata* A. Binney.

*Epiphragmophora catalinae* Dall, 1900, Proc. Acad. Nat. Sci. Phila., p. 103.

The shell is depressed with low conic spire, umbilicate; dilute cinnamon, the base paler, with a narrow cinnamon-brown band above the periphery, bordered on both sides with whitish bands. The surface has a somewhat silky luster, is faintly marked with wrinkles of growth, and under the lens shows close, fine, engraved spiral lines throughout the last two whorls. The whorls are rather weakly convex, slowly increasing, the last descending but little to the aperture. The aperture is truncate-oval, light russet-vinaceous within, showing the bands; the pale ochraceous-buff to nearly white peristome is strongly but rather narrowly reflected throughout, dilated partly over the umbilicus, its insertions remote, joined by a thin callus.

Height 15.5 mm., diameter 23.2 mm.;  $6\frac{1}{2}$  whorls.

Height 11.3 mm., diameter 18.5 mm.;  $6\frac{1}{4}$  whorls.

"Height 0.4 inch, diameter 0.7 inch." Newcomb, type.

CALIFORNIA: Santa Catalina Island (Newcomb), Type in Cornell University Collection. Also collected by J. G. Cooper, H. Hemphill and many others.<sup>1</sup>

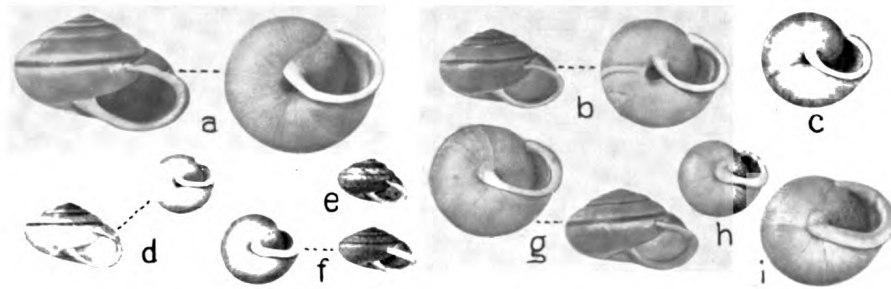


Fig. 103. a, b, c, *Micrarionta rufocincta*; d, form *catalinae*. e, f, *M. rufocincta beatula*; g, form *celo*; h, i, form *labiosa*. (All actual size.)

In this largest of the insular micrariontas of the typical group the spiral lines are more distinctly engraved than in the smaller forms. It often shows a buff growth-rest stripe on the base. The diameter varies down to about 15 mm.; below that size it automatically becomes "*catalinae*".

(*Rufocincta*, girdled with reddish.)

*M. rufocincta* form *catalinae* Dall (Fig. 103 d) was thus described: "It has a small deep umbilicus partly shaded by the reflected pillar lip and a broadly reflected peristome, the ends of which upon the body are not approximated. It measures as follows: Alt. of shell 7, diameter 12, diameter aperture 4.5 mm. There are five and a half rounded whorls and the entire shell is finely spirally striate. It is also found fossil on Santa Barbara Island, but the fossil specimens are often considerably larger than the largest living specimens now known; one measures 15 mm. in major diameter and nearly 10 mm. in height." Collected on Catalina Island by H. Hemphill, type 58548 U.S.N.M.

Many specimens from Hemphill seen are not more nearly localized. Cockerell (*Nautilus*, 42: 99) reported it from the Isthmus, collected by Mrs. M. G. Odell. Dall considered his *catalinae* to be equivalent to W. G. Binney's "*tenuistriata*". The Santa Barbara specimens he mentioned may be a form of *M. facta*.

<sup>1</sup> Dr. Newcomb collected it aestivating on the under surface of stones, in June. He stated that "one dead specimen was found at San Diego" also; but this must have been a stray shell, or a misidentification as claimed by J. G. Cooper (*Amer. Journ. Conch.*, 4: 214).



**Micrarionta rufocincta beatula** Cockerell

Figs. 103 e, f.

*Micrarionta beatula* Cockerell, 1929, *Nautilus*, 42: 99.

"Depressed subglobose, with  $5\frac{1}{4}$  whorls; reddish horn color, rather dull, with peripheral brown band broadly bordered on each side with whitish; surface with fine, indistinct revolving striae; spire very obtuse; umbilicus entirely covered by the reflexed peristome; peristome white, extremely heavy, strongly reflexed. Diameter max. 9.6, min. 8, alt. 5.5 mm.; diameter aperture 4 mm. *M. catalinae* (Dall) is much larger, with much wider aperture, peristome not so heavy in proportion to size of shell, umbilicus exposed; apparently nearer to *M. rufocincta* (Newc.) than to *M. beatula*." (Cockerell.)

CALIFORNIA: Catalina Island, on the grassy slope above Avalon (T. D. A. Cockerell). Lectotype and paratypes 142737 A.N.S.P. Slopes of the canyon back of Avalon (E. M. Gaylord, J. B. Clark, Pilsbry and others).

In this race the umbilicus is nearly or wholly closed, the lip broad and thickened and the size small. In about a hundred seen, from five collectors around Avalon, the diameter runs from 8.5 to 10.8 mm., these extremes being from one lot. It is not often wholly imperforate; usually a minute crevice remains behind the reflection of the lip. The lip is strongly thickened within and reflected broadly for so small a shell. Judging from the series seen, the size does not vary much in this Avalon canyon race. Hemphill named but did not publish two larger forms of *beatula* as follows.

(*Beatulus*, lucky.)

Form *celo* Hemphill, new form. (Fig. 103 g.) Shape and sculpture of *rufocincta* but the umbilicus is wholly covered (or only a minute crevice remains). Lip rather narrow, as in *rufocincta*. Height 10.2 mm., diameter 17.3 mm.; 6 whorls. Catalina I., Type 86653 A.N.S.P., from Hemphill's No. 132. Other specimens measure from 7 x 10.8 mm.,  $5\frac{1}{4}$  whorls, to 12.9 x 21.2 mm.,  $6\frac{1}{4}$  whorls. Whether selected out of the same colony or from different places is not known.

(*Celo*, to conceal.)

Form *labiosa* Hemphill, new form. (Figs. 103, h, i.) Similar to *celo*, but with the lip much more broadly reflected and recurved, its face very much thickened, from light ochraceous-salmon to white. Height 11, diameter 17.1 mm.;  $5\frac{3}{4}$  whorls. Catalina I., Type 86665 A.N.S.P. Hemphill's assorted lots run by easy stages from 8.5 to 18.3 mm. diameter; whether from one colony is unknown. The smallest are not really distinguishable from *beatula*.

(*Labiosus*, broadlipped.)

Binney (*Terr. Moll.*, 5: 371) mentions "a form [of *rufocincta*] from Santa Barbara Island, with thick shell and closed umbilicus, greater diameter 31 mm."; repeated without name of the island in his *Manual*, 1885. Apparently one or more mistakes are involved.

**Micrarionta gabbi** (Newcomb)

Fig. 104 a.

*Helix gabbi* Newcomb, 1864, Proc. Cal. Acad. Sci., 3: 117. Binney, 1869, L. & Fr. W. Sh. N. A., 1: 175, fig. 304.

*Arionta gabbi* Newc., Binney, 1878, Terr. Moll., 5: 371, fig. 254, pl. 9, fig. p (anatomy).

*Helix rufocincta* var. *gabbi* Hemphill, 1890, Zoe, 1: 332.

*Helix gabbiana* Newc., Von Ihering, 1928, Abh. Archiv Molluskenk., 2: 42.

The shell is depressed with low conoid spire, nearly covered umbilicate; dilute cinnamon-buff fading to buff around the umbilicus, with a narrow

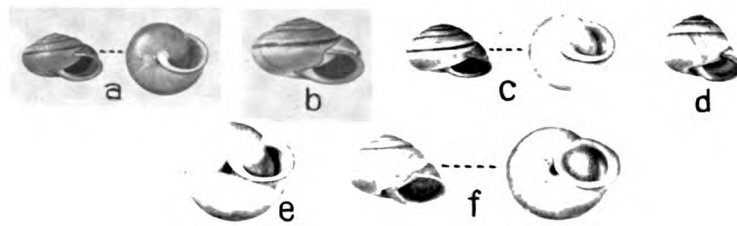


Fig. 104. a. *Micrarionta gabbi*, San Clemente; b. form *maxima*, San Clemente. c. d. *M. facta*, Santa Barbara; e. form *intermedia*, Santa Barbara. f. *M. sodalis* form *micromphala*, San Nicolas.

cinnamon band above the periphery, bordered above and below with whitish bands. Surface glossy, with very light lines of growth and traces of fine spiral lines (from distinct to subobsolete in different specimens). Whorls slowly increasing, moderately convex, the last descending very slightly to the aperture. Peristome white, rather narrowly reflected throughout, not much thickened, dilated over most of the umbilicus, the insertions remote, joined by a thin callus.

Height 5.3 mm., diameter 8.3 mm.;  $4\frac{1}{2}$  whorls.

Height 0.2 inch, diameter 0.4 inch; 5 whorls. Newcomb, type.

Height 6.5 mm., diameter 10.6 mm.; 5 whorls.

Height 9 mm., diameter 15 mm.;  $5\frac{1}{3}$  whorls (form *maxima*.)

CALIFORNIA: San Clemente Island. (Newcomb), Type 1097 California State Museum. Also collected by J. G. Cooper, H. Hemphill and others.

The shell is closely similar to *M. rufocincta beatula*, but the last whorl is less depressed and in a dorsal view is narrower than in Catalina snails. The spiral lines are usually weak or illegible in the small, typical *gabbi*.

A larger form which may be called form *maxima*, new form (Fig. 104 b), 86616 A.N.S.P., is 14 to 15 mm. in diameter, ivory yellow with a narrow dark band (or of the palest cinnamon tint, then faintly showing bordering bands of the light ground tint). Some specimens have spiral lines as distinct as in *M. rufocincta*, but in others they are weak or subobsolete. Umbilicus as in the type, or more reduced but not closed. This is a rather distinct form.

(Named for William M. Gabb, author of "Paleontology of California".)

**Micrarionta facta** (Newcomb)

Fig. 104 c, d.

*Helix facta* Newcomb, 1864, Proc. Cal. Acad. Sci., 3: 118. Binney, 1869, L. & Fr. W. Sh. N. A., 1: 175, figs 306-308; 1876, Ann. Lyc. Nat. Hist. N. Y., 11: 179, pl. 17, figs. 9, 13 (teeth and genitalia); 1878, Terr. Moll., 5: 372, fig. 256, as synonym of *Arionta gabbi*.

*Helix ruficincta* var. *facta* Newc., Hemphill, 1890, Zoe, 1: 332.

*Micrarionta facta* (Newc.), Pilsbry, 1927, Proc. Cal. Acad. Sci., 16: 165, pl. 8, fig. 2 (anatomy).

*Helix facta* Newc. var. *oleata* Ancey, 1890, Le Naturaliste, 1: 334 (2me année).

The shell is depressed subglobose, nearly covered umbilicate, solid, white with a narrow chestnut-brown band above the periphery (or very pale brownish, the base largely white, the dark band bordered with white). Surface glossy, with very fine wrinkles of growth and in places some traces of spiral lines. Whorls slowly increasing, the last moderately descending to the aperture. Peristome rather narrowly reflected and recurved throughout, of a light ochraceous-salmon color (or tints between that and white).

Height 0.22 inch, diameter 0.42 inch; 5 to 5½ whorls. Newcomb, type.

Height 6 mm., diameter 9.4 mm.; 5½ whorls.

Height 7.3 mm., diameter 11.5 mm.; 5½ whorls.

CALIFORNIA: Santa Barbara Island (Newcomb), Type 1099 California State Collection. Also collected by H. Hemphill and others.

A very compact little shell, more solid and opaque than *M. gabbi*, with the suture descending more in front, and the lip more or less deeply colored. Typically the umbilicus is covered except for a narrow crevice, but the degree of covering varies in the living form, and more in fossil shells. One of the Hemphill lots consists of strongly elevated shells, h/d index up to 76 (the usual figure being about 63); one measures 8.7 x 11.4 mm. One of this lot is bandless, a variation occasionally met in this species (Fig. 104 d).

Typical *facta* seems to be abundant as a fossil, but there is also an extinct form which reached a larger size than any recent shells, though the smallest do not excel the largest of the living form. This is form *intermedia* Hemphill (Fig. 104 e). It usually has the umbilicus only half covered. One measures: height 9.5 mm., diameter 14.8 mm.; 6 whorls. Some examples have the lip rather wide.

Ancey described a var. *oleata* as having "the lip a fine white, the rest of the shell is corneous, subdiaphanous and tawny brown, the band on the last whorl always apparent. Found with the type form on Santa Barbara Island." The brownish form fades by insensible degrees into the white, so that a name for it seems superfluous.

(*Factus*, worked smooth.)

**Micrarionta feralis** (Hemphill)

Fig. 105.

*Helix* var. *feralis* Hemphill, 1901, Nautilus, 14: 121; *Helix feralis* Hemphill, on pl. 1, fig. 2 (about ¾ nat. size).

"Shell imperforate, smooth, compact, globose, white (faded), consisting of five convex whorls, the last with an obscure band at the periphery, and

slightly descending at the aperture; spire elevated, somewhat pointed; sutures well impressed; aperture oblique, cramped, not effuse, about as wide as high; peristome reflected, thickened, its face rounded, the basal portion in some of the specimens slightly appressed to the body, its terminations very little approached. Subfossil. Diameter 18, alt. 13 mm.; diameter 16, alt. 11 mm.; diameter 15, alt. 11 mm.; diameter 10, alt. 8 mm." (Hemphill.)

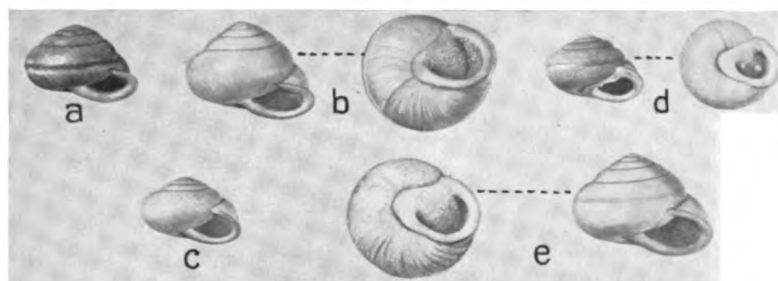


Fig. 105. *Micrarionta feralis*; a, b, c, San Nicolas; d, e, San Clemente.

CALIFORNIA: San Nicolas Island (Henry Hemphill), Type C.A.S. Also San Clemente, only fossil (Hemphill).

The shell is imperforate or nearly so, solid, larger and more elevated than *M. gabbi* and *M. facta*, and a trifle more contracted behind the lip. The peristome usually has a rounded face but is sometimes flattened, the ends remote, not approaching. *M. rufocincta beatula* form *celo* differs by its more depressed last whorl.

Fresh shells, first taken by Hemphill in his visit of 1904, are cinnamon-buff, with a narrow hazel band with wide white border below, a narrow one above; lip faintly brown-tinted. Under the microscope some spiral lines below the suture can be made out on some examples, none in others. One measures: 11.4 x 14.9 mm., 6½ whorls (Fig. 105 a). Fossils seen from San Nicolas run from 9 x 13.3 mm. to 13.3 x 17.2 mm. The surface is often well preserved, glossy, and sometimes shows the band.

I can find no difference between San Nicolas and San Clemente shells. One (Fig. 105 e) from S. Clemente measures: height 12.9 mm., diameter 17.4 mm.; 6 whorls. Other specimens measure: 14 x 18.6 mm., 6 whorls, and 9.8 x 14.2 mm., 5½ whorls. This race, which is known in S. Clemente only as a fossil (? late Pleistocene), was collected by Hemphill in abundance. The location of the fossil bed, probably an old dune, is not known. The brown band is sometimes retained. The large size possibly indicates a period of higher humidity than the present, though some modern shells exceed the smallest fossils. In one of the Hemphill lots the lip is wider and flat, and there are two low callous nodules on the parietal callus (Fig.

105 d), recalling those of *Sonorella dalli* and *Helminthoglypta hannai diodon*. The shell figured measures 9.5 x 13.2 mm.

(*Feralis*, funereal.)

**Micrarionta sodalis** (Hemphill)

Fig. 106

Nearly flat species like a *Polygyra*, J. G. Cooper, 1868, Amer. Journ. Conch., 4: 20.

*Helix sodalis* Hemphill, 1901, Nautilus, 14, pl. 1, fig. 3 (about  $\frac{1}{2}$  nat. size).

*Helix* var. *sodalis* Hemphill, 1901, Nautilus, 14: 122.

The shell is depressed (h/d index about 58 to 61), more openly umbilicate than other species of the group; cartridge-buff or nearly white (fossil);



Fig. 106. *Micrarionta sodalis*, San Nicolas Island.

nearly smooth (but rarely showing weak traces of spiral lines below the suture). Last whorl descending shortly in front (or often very slightly). Aperture nearly as high as wide, rounded; the lip thickened within, rather narrowly reflected, the margins converging, joined by a moderate or thin callus, the columellar margin impinging slightly on the umbilicus.

Height 8 mm., diameter 13.7 mm., aperture 6.4 x 7 mm.; 5 $\frac{1}{2}$  whorls.

Other specimens: 4.6 x 7.5 mm., 4 $\frac{1}{2}$  whorls; 6.4 x 10.5 mm., 5 whorls.

CALIFORNIA: San Nicolas Island, Pleistocene (Henry Hemphill), Type C.A.S.; paratypes 79750 A.N.S.P.

By the size, depressed shape and relatively open umbilicus this species has some resemblance to *M. rufocincta* form *catalinae*, but it differs by the decidedly converging ends of the peristome, the mouth approaching a circular form, while in all other island races, except *M. guadalupiana*, the margins do not converge.

Mr. Hemphill has figured a series showing the variation in size; he gave the range as from 4 x 7 mm. to 8 x 14 mm. In 17 lots sent us from his expeditions of 1900 and 1904 the intermediate and small sizes, diameter 8 to 12.5 mm., are most numerous. The lip is thinner in small specimens.

(*Sodalis*, companion.)

Form *micromphala*, new form. (Fig. 104 f). Higher than *sodalis*, approaching the form of *feralis*, the umbilicus very small, partially covered; shoulder band wanting or very weak; the lip-margins converging somewhat, but less than in *sodalis*. Lip rather narrow, thickened within, ivory-yellow to pinkish buff, with an ochraceous-tawny internal border. 9.7 x 14 mm., 5 $\frac{1}{2}$  whorls; also running down to about 9 mm. diameter. San Nicolas; only fossil specimens. Close to *M. facta* form *intermedia* of Santa Barbara; also to some forms of *feralis* from San Clemente.

## Subgenus PLESARIONTA new subgenus

The shell is about as in *Xerarionta* except that the radial striae of the embryonic whorls are waved. The cavity of the long penis is terminated by a short verge. The penial retractor muscle is very short and broad; flagellum short, its length not much exceeding the diameter of the shell.

TYPE: *Helix stearnsiana* Gabb.

Only one species is now known to have the penial structure described above, but the Lower Californian and some Island species need examination with reference to the presence of a verge.

(Πλησίος, near, + *Arionta*.)

**Micrarionta stearnsiana** (Gabb)

Fig. 107 a-f.

*Helix kelleltii* Forbes, Reeve, 1852 (in part), Conch. Icon. Helix, pl. 115, fig. 665a.—Binney, 1869, L. & Fr. W. Sh. N. A., 1: 176, description; not fig. 309.

*Helix stearnsiana* Gabb, 1867, Amer. Journ. Conch., 3: 235, pl. 16, fig. 1 (San Tomas to a little beyond Rosario, L. Cal.).—Binney, 1869, L. & Fr. W. Sh. N. A., 1: 177, fig. 310.—Fischer & Crosse, Miss. Sci. Mex., Moll., 1: 248, pl. 11, figs. 5, 5a.

*Arionta stearnsiana* Gabb, Binney, 1878, Terr. Moll., 5: 362, fig. 243, pl. 9, fig. 1; pl. 13, fig. B (teeth and genitalia).

*Helix (Arionta) kelleltii* Fbs., Roper, 1889, Nautilus, 3: 35 (Point Loma).

*Epiphragmophora kelleltii* Fbs., Dall, 1900, Proc. Acad. Nat. Sci. Phila., pp. 103-4 (San Diego and Coronado Is.).

*Epiphragmophora stearnsiana* Gabb, Pilsbry, 1898, Proc. Acad. Nat. Sci. Phila., p. 70, pl. 1, figs. 8-10 (genitalia; Coronado Is.).—Dall, 1900, Proc. Acad. Nat. Sci. Phila., p. 101.—Kelsey, 1906, Nautilus, 20: 61 (Pacific Beach).—Clapp, 1906, Nautilus, 20: 13, fig. 2 (apical sculpture).

*Helix stearnsiana* Gabb, Hemphill, 1901, Nautilus, 14: 137-9.—Lowe, 1913, Nautilus, 27: 25 (Point Banda, on bushes; Todos Santos Is. and San Martin, under loose rocks).—Fred Baker, 1902, Nautilus, 16: 42 (San Martin I.).

*Micrarionta stearnsiana* (Gabb), Hanna, 1925, Proc. Cal. Acad. Sci., (4), 14: 247.—Pilsbry, 1927, l. c., 16: 178 (San Quentin Bay, San Martin I.).

*Micrarionta (Xerarionta) stearnsiana* (Gabb), Berry, 1928, Journ. Ent. & Zool. Pomona Coll., 20: 75, pl. 2, figs. 1-9, map on p. 78.

The shell is thin, narrowly perforate, subglobose with conoidal spire, of a warm buff or pinkish-buff to pale brown tint, with some lighter mottling, and copiously mottled and often streaked with avellaneous to dull brown; having a ragged or spotted dark vinaceous brown band above the periphery, often an indistinct pale border below it (or sometimes the whole ground color has a cinnamon or darker suffusion). Surface rather glossy, irregularly sculptured with incremental striae and wrinkles and more or less shallowly pitted, but without distinct spiral impressed lines. 1½ embryonic whorls (Fig. 108: 2) with very dense, fine, obliquely radial lineolation (or in some examples interrupted, partly subgranulose). The whorls are convex, the last descending in front. Aperture fawn color within, the white peristome narrowly expanded, at the columellar insertion dilated and almost covering the umbilicus.

Height 15.5 mm., diameter 20.8 mm.; 5½ whorls. Smallest seen.

Height 18.5 mm., diameter 23.5 mm. S. Coronado I.

Height 21 mm., diameter 25.3 mm. S. Coronado I.

Height 21.5 mm., diameter 26 mm. San Diego.

Height 18 mm., diameter 26.7 mm. Gabb's type of *stearnsiana*.

Height 24.5 mm., diameter 30.7 mm.; 5½ whorls. San Tomas River.

CALIFORNIA: Point Loma; Pacific Beach and Imperial Beach, near San Diego; hill back of Scripps' Institute, near La Jolla (Berry); below Murray dam, near La Mesa, (L. G. Ingles).

LOWER CALIFORNIA: Tia Juana (Rehn & Hebard); rock slide near highway in La Mision Valley (Chace). South Coronado Island; coast and coastal islands south to beyond Rosario.<sup>1</sup>

*M. stearnsiana* is usually found on or under tuna cacti and under stones. On a sand spit at Pacific Beach Kelsey found it under stunted bushes (Fig. 107 d). It has been taken from near sea level up to 1000 feet.

It has been confused with the *Xerarionta* of Santa Catalina Island, but George H. Clapp in 1906 indicated important differences in the embryonic whorls, and the two species are now admitted to be distinct, as there are also important anatomic differences.

The largest examples seen are from near the mouth of San Tomas river. Forbes' type was a small specimen. At Pacific Beach the diameter runs from 21.5 to 26 mm. in the lot at hand. Berry gave some evidence that small shells occur around the limits of its range, but equally small ones are found also in other lots not limited. It is a matter of individual conditions. Gabb selected the most depressed shell of his lot, 10831 A.N.S.P., for the type of *H. stearnsiana*.

(Named for the learned and well beloved Californian conchologist R. E. C. Stearns).

The organs of reproduction (Fig. 102 A) differ remarkably from those of *M. kelletti*. The penis is very long, internally four-ribbed in the anterior part, with more numerous ribs posteriorly. It contains a short, blunt, cylindrical verge (Fig. 102 a), above which the epiphallus is wide with thick walls and a small duct. The retractor muscle is very short (4 to 5 mm.) and thick. Beyond it the epiphallus becomes smaller and thin-walled. The vagina is also very long, thrown into folds above the dart sac. The ascending mucous gland (m. gl.) is applied to the upper part of the vagina, the descending gland to the basal part of the penis. Both of these glands have very extensive, thin, membranous extensions spreading far beyond the thicker parts shown in the figure. This thin extension is omitted in the drawing for the sake of clarity. The spermathecal duct bears a short (2 mm.) diverticulum (but in another opened, this is lacking).

I have dissected several specimens, all from Los Coronados. The large size of the penis and the presence of a verge are its more important differential features, but the relatively short flagellum, very short penial retractor, long vagina and rudimentary branch of the spermathecal duct are other peculiarities.

<sup>1</sup> For details of distribution in Lower California with map, see Berry, 1928. The Cedros Island record (*Nautilus*, 20: 13), seems to be an error.

## Subgenus XERARIONTA Pilsbry

*Xerarionta* Pilsbry, 1913, Proc. Acad. Nat. Sci. Phila., p. 382; type *M. veatchi*.  
*Euparypha* and *Arionta* sp., Binney, 1878, Terr. Moll., 5.

Rather capacious, globose-conic or depressed-globose shells, perforate or closed, copiously variegated or sometimes white; the embryonic  $1\frac{1}{2}$  whorls with radial sculpture or nearly smooth; peristome moderately or scarcely expanded, shortly dilated at the axial insertion. Cavity of the penis is continuous with that of the epiphallus. The flagellum is very long.

A group of conspicuous snails, four species occurring within our limits, six along the Ocean coast and on the islands of Lower California. They are everywhere highly variable shells.

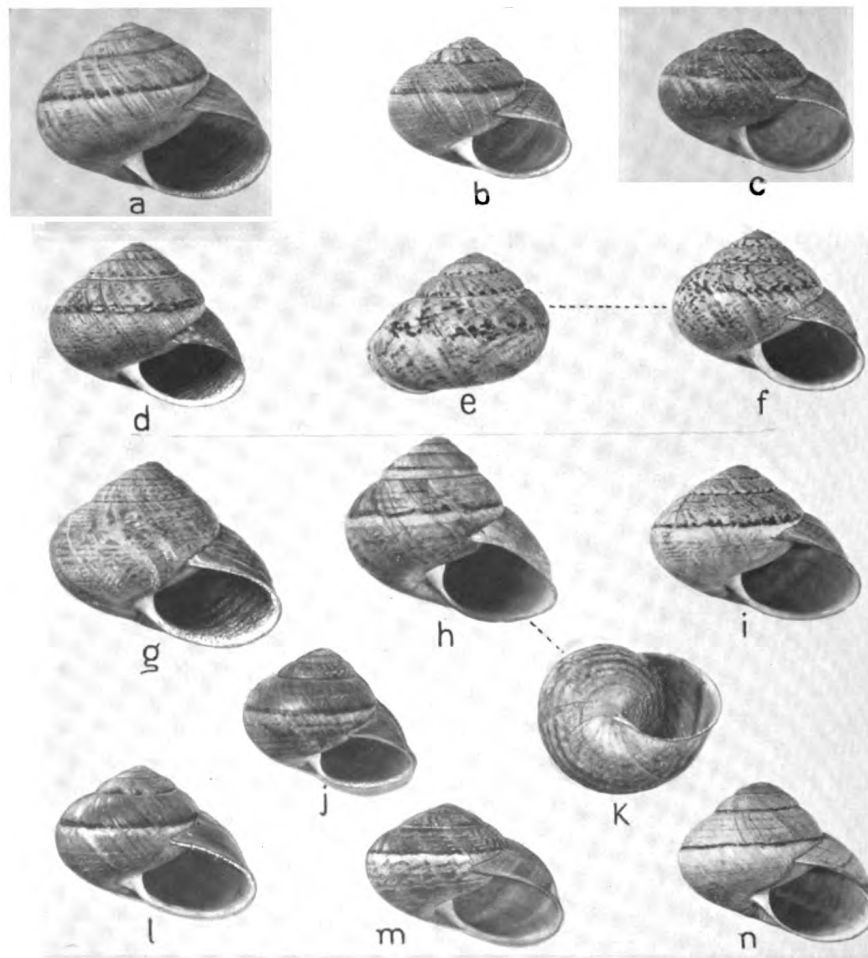


Fig. 107. a-f, *Micrarionta stearnsiana*; a, San Tomas River; b, Tia Juana; c, type of *stearnsiana*; d, Pacific Beach; e, f, South Coronado. g-n, *M. kelletti*; h, j, k, Isthmus; i, Avalon; n, paratype of form *frater*.



(Ξηρός, arid + *Arionta*.)

*Helix damascenus* Gould, 1856, originally stated to be from the "Desert region east of California" was later recognized by Gould to be *Helix pandorae* Forbes, a *Xerarionta* from Los Benitos Islands.

*Key to Species of subgenera Xerarionta and Plesarionta*

1. Surface scored by distinct incised spirals.....2  
Spiral lines weak or wanting.....3
2. Bicolored; clouded and streaked above the periphery, light colored and nearly plain below. Santa Barbara; San Nicolas.....*M. tryoni*  
Not bicolored though often paler below; San Clemente.....*M. intercisa*
3. Surface with minute, forwardly descending lineolation; San Clemente...*M. redimita*  
Minute lineolation indistinct or wanting; shell speckled.....4
4. Embryonic whorls smooth or with simple radial ripples; Catalina Island...*M. kelletti*  
Embryonic whorls with close, irregular or subgranose radial ripples; San Diego district and southward.....*M. stearnsiana*

**Micrarionta kelletti** (Forbes)

Fig. 107 g-n.

*Helix kelletti* Forbes, 1850, Proc. Zool. Soc. Lond., p. 55, pl. 9, fig. 2a, b. — Reeve, 1852, Conch. Icon., *Helix*, pl. 115, fig. 665b.

*Helix kelletti* Forbes, Cooper, 1868, Amer. Journ. Conch., 4: 218 (Catalina Island). — Binney, 1869, L. & Fr. W. Sh. N. A., 1: 177, fig. 309, not the description. — Williamson, 1899, Journ. Malacol., 7: 87.

*Arionta kelletti* Forbes, Binney, 1878, Terr. Moll., 5: 361, fig. 242, pl. 9, fig. 1, pl. 13, fig. 10 (teeth and genitalia). Not the description.

*Helix kelletti* Fbs., Hemphill, 1891, Zoe, 1: 333, with varr. *castaneus*, *nitidus*, *multilineatus*, *frater*, *californica*, *forbesi*; p. 334, varr. *bicolor*, *tricolor* and *albida*.

*Helix kelletti* var. *albida* Hemphill, in Binney, 1890, 3rd Suppl., Bull. Mus. Comp. Zool., 19: 220. — *Helix kelletti* var. *castanea* Hemphill, l. c., both from Santa Catalina Island.

*Epiphragmophora kelletti* Fbs., Gaylord, 1901, Nautilus, 15: 72 (Avalon canyon; Isthmus). — Clapp, 1906, Nautilus, 20: 13, fig. 1 (apical sculpture).

*Micrarionta kelletti* Forbes, Field, 1931, Nautilus, 44: 86 (Point Firmin to Portuguese Point and beyond).

The shell is thin, imperforate, subglobose-conic; cartridge-buff shading into vinaceous buff on the upper whorls, the last whorl more or less profusely speckled and mottled with avellaneous to buckthorn-brown (or pale grayish vinaceous in dulled individuals); sometimes speckled with deep brownish drab, these marking tending to form into narrow bands. There is a narrow, irregular band of darker shade above the periphery, and a much wider, pale buff peripheral cincture. The surface is semi-matt, with rather weak wrinkles of growth, some weak malleation, and sometimes traces of engraved spiral lines. On the spire and in places on the last whorl there is often a weak, minute granulation, which trends in a direction at right angles to the incremental lines. The embryonic  $1\frac{1}{2}$  whorls are smooth, with some very low, straight radial ripples in the most perfect specimens (Fig. 108: 1). The large aperture is buff to cameo-brown within. Peristome pale, narrowly expanded, dilated over and wholly (or almost) covering the umbilicus.

Height 20 mm., diameter 27.5 mm.,  $5\frac{1}{2}$  whorls.  
 Height 21.5 mm., diameter 30.7 mm., 5 whorls.  
 Height 21.5 mm., diameter 25.8 mm.,  $5\frac{1}{4}$  whorls.  
 Height 15.1 mm., diameter 20 mm.,  $4\frac{3}{4}$  whorls.

CALIFORNIA: Santa Catalina Island, usually on or under tunas (*Opuntia*); very abundant. Mainland of Los Angeles County, from Point Firmin to Portuguese Point (Field and Chace); Point Vincent (Hemphill).

This snail is similar in appearance to *M. stearnsiana*, but clearly distinct. The apical whorl of *M. kelletti* is larger. Some specimens show a minute sculpture not occurring in *stearnsiana*. The chief differences in the shells were pointed out by G. H. Clapp as follows:

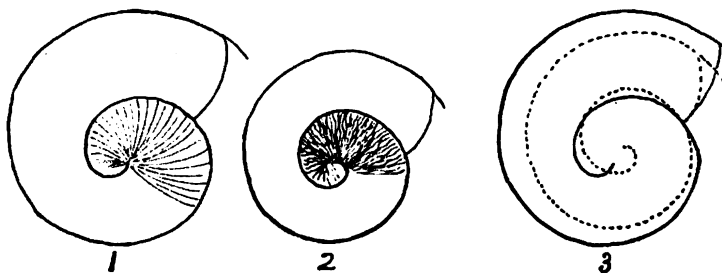


Fig. 108: 1. Embryonic whorls of *M. kelletti*, "The Isthmus," Santa Catalina I.; shell 26 mm. diam. 2. *M. stearnsiana* Gabb, San Diego; shell 26 mm. diam. 3. shows Fig. 1 superposed upon Fig. 2, the latter in stippled line. All figures  $\times 10$ . (After Clapp.)

"The sculpture of the embryonic whorls of the two species also indicates that they are distinct, that of *kelletti* consisting of very weak radial lines, *not wavy*, so that the whorls appear almost *smooth*, while in *stearnsiana* it is a very closely set series of *wavy* lines, generally bifurcate at the suture, giving the surface a *granulated* appearance under low magnification. The accompanying figures show the difference in size of the embryonic shells of the two species, figs. 1, 2, and in fig. 3 the drawings are superimposed to bring out the difference more distinctly."

All of the varietal names given by Hemphill except *frater* were preoccupied in *Helix*, and could not be used even if they stood for valid races. None were localized on the island, and most were evidently selected specimens out of variable colonies. As any study of the variation of the species will have to be carried on from a different standpoint and based on new collections, it is not worth while to occupy space with Hemphill's descriptions.<sup>1</sup>

The variety *frater* Hemphill is buff with sparse or pale markings (Fig. 107 n), being lighter than the ordinary forms of the species. A few very

<sup>1</sup> Besides the names published by Hemphill, he gave several additional names on the labels of material he sent out. There is no point in printing these unless they are shown to have some significance.

dark examples have a warm cinnamon-brown color, fading towards the middle of the base, and with the usual light peripheral band (Fig. 107 l). On Bird Island, off Catalina, Hemphill found a very thin, light colored form. Mainland shells seen do not differ from island specimens. These small colonies seem to be disappearing. The suggestion has been advanced that they were planted there from Catalina.

*M. kelletti* was collected during the voyage of H. M. S. "Herald", and named for Captain Henry Kellett, R.N., in command. A naturalist was included in her staff, and large natural history collections were brought home. The localities of *M. kelletti* and *M. pandorae* were not recorded when collected. Forbes, who described them, thought they were "probably from the same country [neighborhood of the Columbia river], though the box in which they were contained was marked 'Santa Barbara'". The Herald was off "John Begg's reef," northwest of San Nicolas on Sept. 27th, 1846, "surveyed San Nicolas, San Clemente and the Coronado Islands,"<sup>1</sup> anchoring off South Coronado October 2nd, where a party went ashore and to the top, collecting; rattlesnakes and a tarantula are mentioned in the Narrative. At San Diego the Herald lay off shore, sending in the tender "Pandora". No collections reported, and apparently the visit was brief. Santa Catalina Island was not mentioned in the Narrative. From these circumstances I thought South Coronado the most likely locality for *kelletti*. Reeve's figure 665 a is a characteristic Coronado pattern. Forbes' figure could be either a Coronado or a Catalina shell. However, the following report kindly furnished by Lieut.-Col. A. J. Peile indicates Catalina Island as the type locality of *kelletti*. He writes:

"Type set of *H. kelletti*, ex Kellett and Wood, consists of three specimens which I should certainly unite with your Sta. Catalina shells No. 138970. Of the three (which were on one tablet) one was received by the Museum in 1850, two in 1855. One of the shells agrees with Forbes' dimensions as given in P. Z. S. 1850, and agrees with his figure in shape but not in coloration. Either this shell has faded very much, or Forbes' artist got his coloration from other specimens. The apices of all three agree with your Catalina diagram, i.e. almost smooth with no traces of wavy, anastomosing lineolation. The peripheral band is firmer, as in your Catalina shells, than that in your San Diego and Coronado shells, and there is a distinct white band below it merging into the basal bands and blotchings. Altogether a very satisfactory correspondence between the two sets, yours and ours. I should add the locality on the tablet was 'Sta. Barbara'".

"Of the figures in Reeve, 665 b represents *kelletti* with apex plain; 665 a represents shells originally labelled *kelletti*, with apex wavy, now relabelled *stearnsiana* by Gude when he was rearranging the Museum Helicidae. Localities on tablets were Sta. Catalina for (b), Lower California for (a). We have two other lots of *stearnsiana*, all with wavy sculptured apex,

<sup>1</sup> Berthold Seemann, 1853; Narrative of the Voyage of H. M. S. Herald, 1: 118.

including a set from Kellett and Wood labelled 'Sta. Barbara,' no doubt in error. To sum up, I have no hesitation in giving opinion that *kelletti* is the correct name of the Santa Catalina species".

Genitalia (Fig. 102 D).—The atrium is very short. Penis ample, rather thin-walled, tapering posteriorly into the epiphallus, which has rather thick walls and four-ribbed cavity; its junction with penis marked internally by abrupt flattening of the ribs but no papilla or verge. This point is marked by an arrow in the figure. The long penial retractor is inserted on the epiphallus. Flagellum very long. The long vagina bears the dart sac. Two mucous glands enter by slender ducts in the crotch between dart sac and vagina. One gland descends and is spread over the base of the penis, the other over dart sac and the adjacent vagina (not ascending, as in *M. stearnsiana*). The spermathecal duct bears a long diverticulum. Measurements follow:

	<i>M. kelletti</i>	<i>M. redimita</i>	<i>M. stearnsiana</i>
Penis .....	8 mm. }	16 mm.	{ 20 mm.
Epiphallus .....	17 mm. }		{ 15 mm.
Flagellum .....	58 mm.	43 mm.	27 mm.
Vagina .....	7 mm.	..	19 mm.
Spermatheca .....	..	..	27 mm.
Diverticulum .....	32 mm.	..	2 mm.

**Micrarionta redimita** (W. G. Binney)

Fig. 109 a, b, e.

*Helix nickliniana*, part, A. Binney, 1857, Terr. Moll., 3, pl. 6, fig. 1, upper and lower figs.

*Helix redimita* W. G. Binney, 1858, Proc. Acad. Nat. Sci. Phila. for 1857, p. 187; 1859, Terr. Moll., 4: 9 ("redemita"); 1869, L. & Fr. W. Sh. N. A., 1: 167, fig. 289.

*Arionta redimita* W. G. Binney, 1878, Terr. Moll., 5: 359, pl. 9, fig. a (teeth).

*Helix kelletti* var. *redimita* Binn., Hemphill, 1891, Zoe, 1: 334, with varr. *castaneus* and *hybrida*.

*Epiphragmophora* (var.?) *clementina* Dall, 1900, Proc. Acad. Sci. Phila., p. 103.

"Shell imperforate, globose-conic, rather thin, wrinkled, covered with minute and crowded granulations; color reddish-brown; apex free from granules, rather blunt; spire elevated; suture impressed; whorls six,<sup>1</sup> convex, the last quite large and rounded, falling towards the aperture, and banded with reddish-brown above the middle; aperture rather large in proportion to the size of the shell, very oblique, transversely rounded, within showing the band; peristome simple, reddish-ash color, thickened, reflected slightly at the base, ends approached; umbilicus entirely covered with a white callus. Greater diameter 21,<sup>2</sup> lesser 17; height 12 mm." (Binney.)

CALIFORNIA: San Clemente Island.

This species differs from *M. intercosa* in sculpture: spiral lines are only weakly impressed, often wanting, and the surface has a minute lineolation of close, oblique striae nearly at right angles with the lines of growth. This lineolation is more or less interrupted by the incremental wrinkles, and was described by Binney as "minute and crowded granulations". It is most

<sup>1</sup> Evidently an error in counting, as there are scarcely five whorls; Binney's figure, a face view, shows only four.

<sup>2</sup> By error the diameter was given as 31 mm. in Binney's works of 1859, 1869 and 1878, but correctly 21 mm. in his Manual of 1885.

fully developed in the thin, brown typical form of the species, and it sometimes appears only in patches. I have never seen this sculpture in *M. intercisa*, in a large number examined. Binney (1885) considered *redimita* a variety of *intercisa*, and Hemphill thought it a variety of *kelletti*. As material seen does not support either of these views, it is here left as a species.

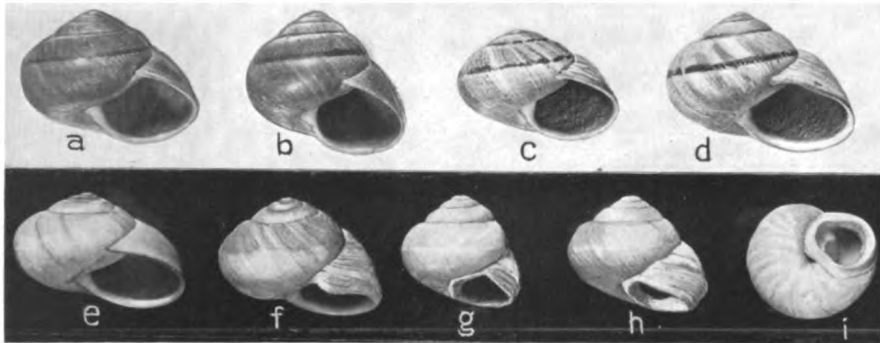


Fig. 109. a, b, e, *Micarionta redimita*; c, d, form *hybrida*; f-i, form *inconstans*, the type at f. Figs. a-e are recent, f-i fossil shells. San Clemente Island.

The typical form varies in color from cinnamon, shading behind the aperture into pecan brown, to chestnut brown or darker (Hemphill's "var. *castanea*"), having more or less profuse whitish speckling on the spire and generally on the last whorl also, the light flecks there arranged in spirals. The embryonic  $1\frac{1}{2}$  whorls are glossy, appearing either almost smooth or with some curved radial ripples and a few more ample waves. The last whorl descends rather deeply in front. The very narrowly expanded peristome has a slightly pinkish tint, whiter at the axial expansion, which may wholly cover the umbilicus, but much more frequently leaves a narrow crevice. Two measure: 16 x 21 mm.,  $4\frac{3}{4}$  whorls; 17.6 x 23 mm.,  $4\frac{3}{4}$  whorls. Hemphill found some bandless, pure white examples also (Fig. 109 e).

(*Redimitus*, wreathed around.)

Form *hybrida* Hemphill. (Fig. 109 c, d.) This is a more solid, opaque form, nearly white, with buff-pink to shell-pink or fawn colored streaks and flecks; or some specimens might be described as fawn colored with white streaks and flecks. The minute sculpture is often much reduced. Both this and the typical form occur also as fossils.

Form *clementina* (Dall). "Shell small, thin, pale translucent brownish in color with obscure, revolving series of very minute yellow or whitish flecks; whorls four, the nucleus wrinkled transversely, reddish, slightly flattened, the succeeding whorls rather convex with a distinct suture; a very narrow dark reddish-brown band, with a hardly visible pale border in front

of it, revolves above the periphery; sculpture of rather well-marked incremental rugæ, cut on the upper part of the last whorl by microscopic spiral striation, to which is added a partly obsolete oblique striation which is visible, under magnification, chiefly in patches; the effect of the whole is to give the surface a very fine shagrination; the last whorl near the aperture descends strongly and the plane of the aperture forms an angle of about  $45^\circ$  with the axis of the shell; base full and rounded, the umbilicus completely covered by a reflection of the pillar lip; aperture rounded, the peristome narrow, whitish, slightly thickened and reflected. Major diameter 15, minor diameter 12, alt. 11 mm.; other specimens are slightly larger. San Clemente Island, Cal., U. S. Fish Com." (Dall.)

The exact locality and the status of this small, delicate race remain to be determined, but it appears close to typical *redimita*, the type, 102324 U.S.N.M., having the same sculpture.

Form *inconstans* Hemphill, new form. (Figs. 109 f, g, h, i.) As a fossil *redimita* is less abundant than *intercisa*. When worn or sand-etched it is often indistinguishable from the latter. The shell in the race *inconstans* is heavier than any living shells seen, sometimes very thick, and variable in degree of elevation. A large proportion show features of senility of the race, by the great variability in shape, the thickened and variously calloused peristome and the irregular sculpture. Hemphill applied many label-names to selected specimens, but there seems no reason for recognizing more than one multiform race at present. Figure 109 f represents the type of *inconstans*, 86761 A.N.S.P.

Genitalia of a San Clemente specimen collected by Cockerell is drawn in Figure 102 c, c'. The penis is much as in *H. kelletti*. Laid open (Fig. 102 c') it shows a thin-walled anterior part, the penis proper, followed by a four or five ribbed epiphallus. Under the microscope the surface is seen to be densely covered with granules in partly transverse, partly oblique series. The foot is plumbeous-black in the example opened, deep gray in another. Mantle very pale gray. Venation of the lung faint.

**Micrarionta tryoni** (Newcomb)

Fig. 110 a-h.

*Helix tryoni* Newcomb, 1864, Proc. Cal. Acad. Sci., 3: 116.—Binney, 1869, L. & Fr. W. Sh. N. A., 1: 173, figs. 312-314.—Lowe, 1903, Nautilus, 17: 68 (conditions of life).

*Euparypfa tryoni* Newc., Binney, 1878, Terr. Moll., 5: 375, figs. 259-261, pl. 10, fig. B, pl. 14, fig. c (anatomy).

*Helix tryonii* Newc., Hemphill, 1891, Zool., 1: 331, with varr. *varius*, *nebulosa*; p. 332, varr. *fasciata*, *californica* and *albida*, all from Santa Barbara.

*Helix tryonii maculata* Hemphill, 1901, Nautilus, 14: 123 (Santa Barbara).

The shell is solid, imperforate (or very nearly so); upper surface of various shades and tints of lavender, vinaceous drab, and slate purple, more or less streaked or mottled, with a dusky band above the periphery, and on the spire with generally dark or white maculation; base ivory-buff, or with a vinaceous tinge, rarely showing some faint spotting. Sculpture of rather weak wrinkles of growth and deeply cut revolving lines on the last  $2\frac{1}{2}$

whorls, which become obsolete in the middle of the base. Embryonic  $1\frac{1}{2}$  whorls, after the initial smooth tip, having close, radiating little ridges, more or less cut into granules. The last whorl descends in front. The aperture is white or tinted within; peristome very slightly expanded, thickened within, the columellar margin wider, with a low, blunt convexity or tooth, often indistinct.

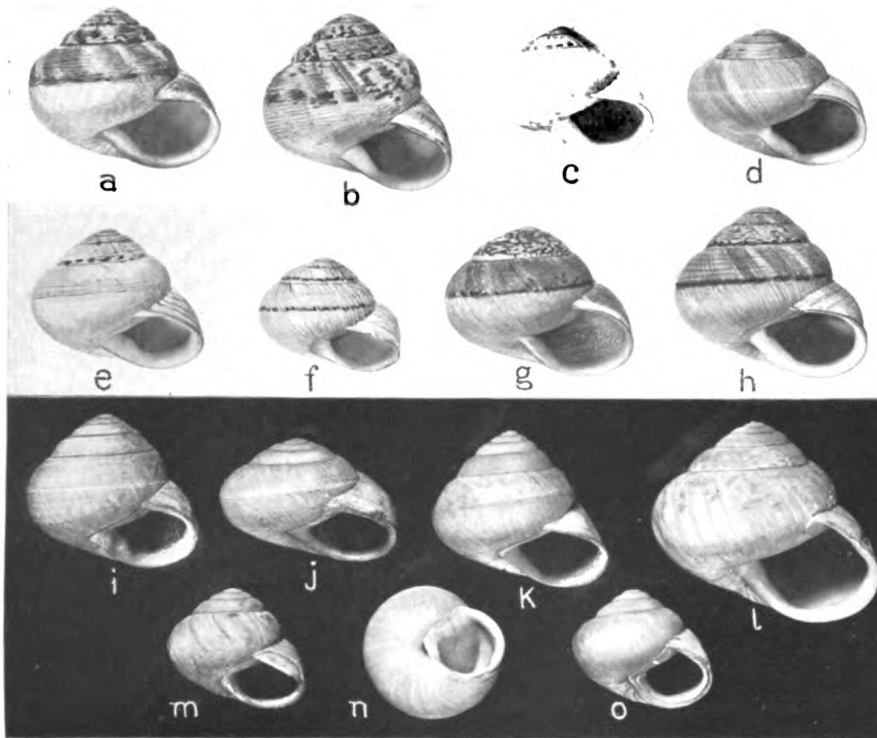


Fig. 110. a-f, *Micrarionta tryoni*, Santa Barbara; g, h, San Nicolas. i, j, *M. tryoni carinata*, Santa Barbara; k-o, San Nicolas.

"Height 0.75 inch, diameter maj. 1, min. 0.88 inch." (Newcomb).

Height 21.2 mm., diameter 25 mm.;  $5\frac{3}{4}$  whorls. Paratype.

Height 21 mm., diameter 22 mm. Santa Barbara.

Height 18.2 mm., diameter 23.5 mm. Santa Barbara.

Height 15.7 mm., diameter 19.5 mm.;  $5\frac{1}{2}$  whorls. Santa Barbara.

Height 22.8 mm., diameter 26.5 mm.; 6 whorls. San Nicolas.

CALIFORNIA: Santa Barbara Island (Newcomb and others), Type in Newcomb Collection, Cornell University. San Nicolas Island (Newcomb, Hemphill, Lowe and others).

It is related to *M. intercosa* by the sculpture, but differs in coloration, the better development of the columellar tooth and the sculpture of the embryonic whorls.

The following "varieties" from Santa Barbara Island are merely selected specimens, and of no taxonomic significance. Except *varius* and *californica*, all of the names are preoccupied in *Helix*.

"Var. *varius*: The upper or dark zone is of a lighter shade of bluish brown or chestnut than the preceding, and is flecked and sprinkled with ashen white; band at the periphery, dirty white beneath. Var. *nebulosa*: Lighter colored above than var. *varius*, marbled and clouded with various patterns of dark brown and dirty white; dirty white beneath. Var. *fasciata*: Uniform light chocolate above and beneath, with a dark band at the periphery. Var. *californica*: Creamy buff color, darker above than below the periphery, very faintly banded. Var. *albida*: Uniform creamy, and sometimes milk white above and beneath, and without band. *Helix tryonii maculata*: Ground color ashy white, lighter beneath than above; the body whorl and spire speckled with darker spots, banded or bandless at the periphery, form variable in size; spire elevated or depressed; diameter 25, alt. 19 mm.; diameter 20, alt. 16½ mm.; diameter 22, alt. 15 mm." (Hemphill.)

Newcomb states that "the animal is of a deep smoky hue, almost black, with *sometimes* the terminal half inch of the foot of a dirty white".

(Named for George W. Tryon, Jr.)

**Micrarionta tryoni carinata** Hemphill new subspecies

Fig. 110 i-o.

*Helix tryonii* var. *subcarinata* Hemphill, 1891, *Zoe*, 1: 332. Not *H. subcarinata* Menke or of Thomae.

*Helix tryonii* var. *major* Hemphill, 1901, *Nautilus*, 14: 123, pl. 1, middle figs. Not *Helix major* Binney.

*Helix tryonii* var. *minor* Hemphill, l. c., pl. 1, outer figs. (preoc.).

The shell is narrowly perforate (or sometimes imperforate), with flatter whorls than *tryoni*, the last carinate (varying to weakly angular) at periphery; surface with the spiral lines rather weak, typically.

Height 16.4 mm., diameter 22.4 mm.; 5½ whorls.

CALIFORNIA: Santa Barbara Island (H. Hemphill), Type 86804 A.N.S.P. San Nicolas Island (Hemphill). Fossil in the sand dunes; very rare in both islands as a living form.

Remarkable for its peripheral angle or low keel. In a few of the larger shells from Santa Barbara this is wanting on the last whorl. In some hundreds seen the angle appears nearly always in the fossil specimens, but its presence is a great rarity in living adult shells. Since Hemphill's published names for the race were all homonyms, I have used one of his label names.

It is variable in size and shape, two from Santa Barbara I. measuring, 13.4 x 18 mm., and 20 x 22.2 mm. The largest seen is 24 mm. in diameter. The peristome is sometimes very thick.



At the west end of San Nicolas Island, according to Lowe, "dead and bleached shells lie by the thousand on the great stretches of drifting white sand. . . . There is no vegetation whatever on that end of the island". Some time in the Pleistocene the climate was doubtless favorable. The fossils of San Nicolas are intermediate between *tryoni* proper and *carinata*. The size varies from 15 x 18 mm., 5 whorls, to 25.6 x 30 mm., 6 whorls. The columellar tooth is sometimes well developed but usually weak or wanting. The peripheral angle is generally weak, never so strong as in some Santa Barbara shells. Spiral striation distinct, when not etched by rolling or by blowing sand. Some shells show traces of color. Hemphill's varieties *major* and *minor*, as well as several other label names, were based upon selected stages in a continuous series of variations of San Nicolas shells. (*Carinatus*, keeled.)

**Micrarionta intercesa** (W. G. Binney)

Figs. 111 d, e, f, g, m.

*Helix nickliniana* var., A. Binney, 1851, Terr. Moll., 2: 120; 1857, 3, pl. 6, fig. 1, middle fig.

*Helix intercesa* W. G. Binney, 1857, Proc. Acad. Nat. Sci. Phila., p. 18; Proc. Boston Soc. Nat. Hist., 6: 156; 1859, Terr. Moll., 4: 8; 1869, L. & Fr. W. Sh. N. A., 1: 167, fig. 290. — Hemphill, 1891, Zool., 1: 330, with var. *minor*, *elegans*, *nepos* and *albida*.

*Arianta intercesa* Binney, 1878, Terr. Moll., 5: 360, pl. 6, fig. 1, middle; 1883, 1st Suppl., Bull. Mus. Comp. Zool., 11: 158, pl. 1, fig. 1 (teeth); 1885, Man. Amer. L. Sh., p. 137, fig. 114.

*Helix crebri-striata* Newcomb, 1864, Proc. Cal. Acad. Sci., 3: 116.

*Epiphragmophora intercesa* (W. G. B.), Pilsbry, 1897, Nautilus, 11: 60, with var. *callojunctis*, undescribed.

"Shell globose-conic, with 5 slightly rounded whorls; spire little elevated; suture distinct; upon the body-whorl a dark revolving band, hardly discernible; aperture very oblique, shape of a horseshoe; peristome thickened, heavy, dirty white, slightly reflected at the umbilicus, which it entirely conceals, near its junction with the columella furnished with a tooth-like process, the extremities connected by a heavy ash-colored callus, which is spread more lightly over the whole parietal wall; epidermis grayish-yellow, apex rufous; the striae of growth are very numerous and distinct, crossed by numerous, regular, revolving lines, so deeply impressed as to entirely separate them into small sections; thus the whole surface of the shell is divided into minute, raised parallelograms, separated by the deep longitudinal and horizontal furrows. Greatest diameter 22, lesser 19 mm.; height, 15 mm." (Binney.)

CALIFORNIA: San Clemente Island.

Binney's figure of the type is copied in Figure 111 m. It is a form with very thick peristome and distinct columellar tooth, structures which can be matched in fossil shells but not closely in living ones I have seen. Probably

the type was from some colony not yet found by modern collectors, though the shells represented in Figures 111 d, e are not far from typical. The umbilicus is generally not quite closed. The shell is solid, opaque and rather cretaceous, varying from nearly white to vinaceous-buff, the base generally paler, early whorls buff-pink; but the tints vary individually.

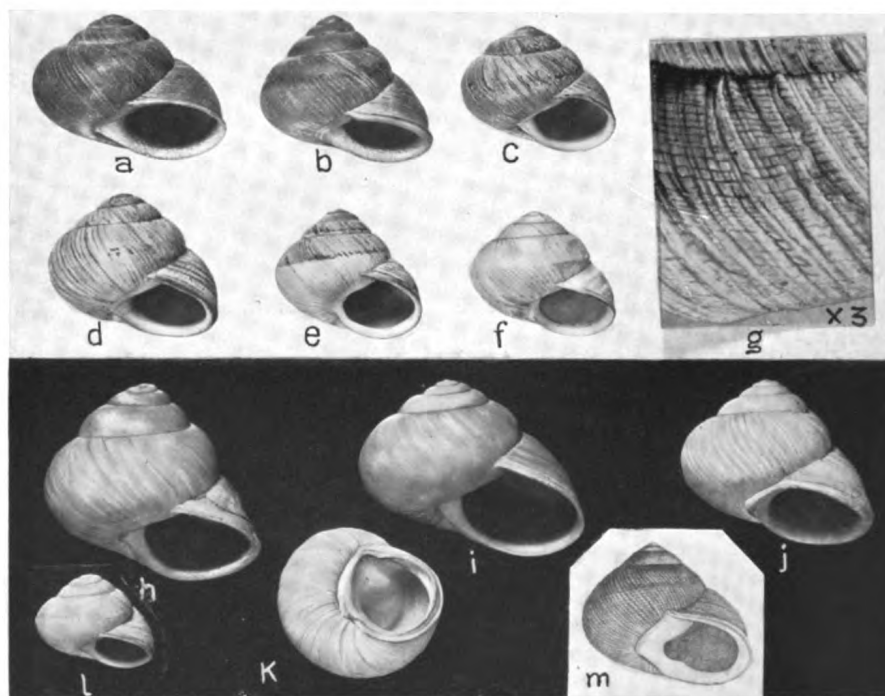


Fig. 111. a-c, *Micrarionta intercesa* form *crebristriata*. d, e, f, g, m, *M. intercesa*. h-i, form *ductor*; j, k, form *callojunctis*; l, form *puer*. m, *M. intercesa*, copy of Binney's type figure.

The band above periphery is only weakly developed. Sculpture of coarse, unequal wrinkles of growth and strongly incised spiral lines; both widely variable. The embryonic whorls have weak (to subobsolete), curved radial ripples, usually worn from adult shells. The peristome is slightly or scarcely expanded, strongly thickened within, pale buff. Parietal callus from moderate to heavy. The size runs from 15 x 19.3 mm.,  $4\frac{3}{4}$  whorls, to 20 x 24 mm., 5 whorls.

In one lot of pure white shells the periphery is strongly angular (Fig. 111 f). It is labelled var. *albida* Hemph. In others similarly labelled no

angle is present. Hemphill defined it as "uniform milk-white, sometimes with a faint band at periphery; sculpture nearly obsolete".

The following three "varieties" are simply selected examples of the subtypical form described above, and I think, synonyms of that.

"Var. *minor*: Smallest specimen, greatest diameter 18 mm., altitude, 11 mm.; uniform light-yellowish chestnut color, with and without a band, and varies very much in form and elevation or depression of spire. Var. *elegans*: Uniform ashy-buff color, faintly banded and variable in form. Var. *nepos*: Uniform ashen-white; spire horn color, variable in form and sculpturing." (Hemphill.)

(*Intercisus*, cut through.)

Form *crebristriata* (Newcomb). (Figures 111 a, b, c.) The shell is thinner, generally larger, between cinnamon and snuff-brown, or varying to dilute fawn color, the band ill-defined or sometimes wanting. Peristome narrowly expanded, thinner than in *intercisa* proper, having but little thickening within, the columella concave or slightly straightened, not toothed. Umbilicus nearly covered.

"Alt. 0.55 inch, maj. diameter 0.92 inch." (Newcomb.)

Other specimens from 20.5 x 26.3 mm., 5½ whorls, to 20 x 23 mm., 5½ whorls.

This form is restricted to narrow-lipped shells, thinner and darker colored than the type form, which were first sent out by Newcomb (10809 A.N.S.P.) and figured by Binney (Terr. Moll. 5: 361, fig. 241). It is fairly recognizable, though transitions to the thicker form exist.

*Fossil forms.*—*M. intercisa* is an extremely abundant fossil of the sand dunes.<sup>1</sup> While many specimens correspond fairly well to the typical recent shell, others are more solid, and variation of size and contour is much greater. The spiral sculpture is frequently weak or almost illegible, but how much of it has been etched away by the blowing sand is not easy to determine. Many years ago I named one of the forms, and later (1904) Hemphill issued sets bearing some 14 varietal names, none of which have been published. These are merely selected forms out of the series. It may be convenient to have names for three conspicuous aspects of variation.

Form *callojunctis* Pilsbry, new form. (Figures 111 j, k.) Peristome thickened strongly, continuous in a raised ledge across the parietal wall (10806 A.N.S.P.).

Form *ductor* Hemphill, new form. (Figures 111 h, i.) Lip and parietal callus moderately thick, the latter adnate; size large, 25.5 x 29 mm., 5½ whorls; 22.8 x 29.7 mm., and 24.5 x 30 mm., 5 whorls (86747 A.N.S.P., etc.).

Form *puer* Hemphill, new form. (Figure 111 l.) Small, diameter 15 to 20 mm., often angular at periphery (86720 A.N.S.P.).

<sup>1</sup> See Holder, 1910, The Channel Islands of California, plate facing p. 227.

## Subgenus EREMARIONTA Pilsbry

*Eremarionta* Pilsbry, 1913, Proc. Acad. Nat. Sci. Phila., p. 382, for *Micrarionta desertorum* P. & F.

The umbilicate or perforate shell is depressed, whorls rounded, nearly smooth or minutely papillose, plain colored, usually with a band; lip from scarcely to distinctly expanded; embryonic whorls papillose in spiral and oblique series, the papillae lengthened (Fig. 112); sometimes united into short threads or partly netted together.

Genitalia similar to *Micrarionta* s. s. by the short flagellum, the rather capacious penis and the dart apparatus except that both mucous glands descend. In *M. wolcottiana*, *M. indioensis xerophila* and *M. aquaealbae* they partially envelop the base of the penis (Fig. 113 a) or the atrium (Fig. 113 b). In *M. rowelli hutsoni* and *M. r. desertorum* both glands descend and are less extensively spread (Fig. 115). The spermathecal duct is typically simple, but it is branched in *M. wolcottiana*.

(*Ερημία*, desert, + *Arionta*.)



Fig. 112. Apical whorls of *Micrarionta rowelli desertorum*; termination of embryonic stage at the top.

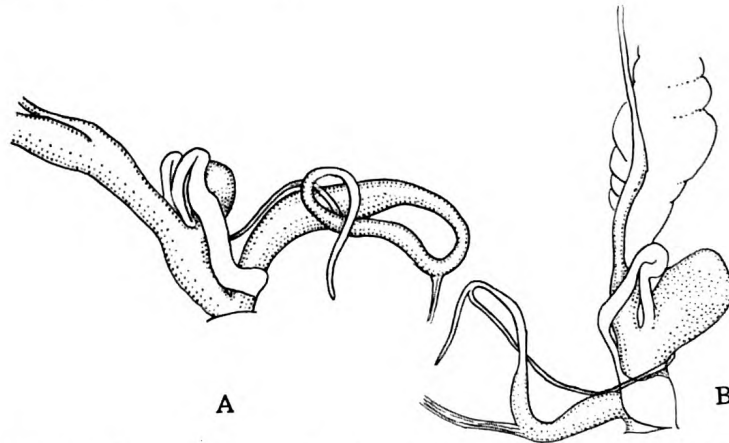


Fig. 113. Anterior parts of genitalia of: a, *Micrarionta indioensis xerophila*. b, *M. aquaealbae*.

*Distribution.*— Hills and mountains of the Death Valley region, the Mohave and Colorado Deserts and bordering mountains, California; Yuma County, Arizona; northwestern Sonora. Eastern known limit is marked in Fig. 142.

These snails live among rocks, often in places where there is little vegetation and no shade. Granite, gneiss or other impervious rock is favored. Like *Sonorella* they conserve water during the resting time of dry seasons by sealing the rim of the aperture to the stone, thus forming similar white rings on the latter. They do not penetrate so deeply in the rock slides as many *Sonorellas*.

The desert tract inhabited by *Eremarionta* is about 600 miles long and in places perhaps 200 wide. In Arizona the eastern limit of the *Eremariontas* has not been defined; their low desert is continuous with that rising eastward, which is inhabited by *Sonorella*, but the latter has not been found as far west as Ajo, nor *Eremarionta* so far east. It is a region of excessive summer heat and low rainfall, averaging about 3 or 4 inches over much of the area.

As in *Sonorella*, the colonies are generally small and the herds isolated by desert; but there is nothing corresponding to the strongly differentiated and strictly local high mountain herds of *Sonorella*. The type of distribution in *Eremarionta* is like that of the dry mountain and foothill *Sonorellas*, such as *hachitana*, *huachucana*, *tumamocensis* and *ambigua*, in which species range rather widely though discontinuously, often with numerous ill-defined or incipient local races. The extreme aridity which now limits the dispersal of these snails is a relatively recent condition. The presence of old lake beds shows that sometime in the Pleistocene there was far more precipitation,<sup>1</sup> and it was doubtless at such a time that *M. rowelli* and others spread from range to range. The present separation of snail colonies by miles of desert naturally has led to the description of feebly characterized local races as "species". The Colorado River does not seem to have been a barrier to the spread of these snails; its lower course is known to have shifted during the Pleistocene. The presence of only a single well marked species in Arizona appears to indicate relatively recent spread east of the Colorado River.

My field experience is limited to the single species of Palm Springs. Though many of the described forms are represented in our series, most lots are small and mainly of dead specimens. The following account is in large part quoted from the writings of S. S. Berry and George Willett. Berry has supplied numerous paratypes of his species. To Willett, who has personally collected most of the species, I am deeply indebted for specimens, for advice on synonymy and other information.

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<sup>1</sup> Thompson, D. G., U. S. Geol. Surv. Water Supply Paper 578, pp. 108-112. etc.

GROUP OF *M. ROWELLI****Micrarionta rowelli* (Newcomb)**

Fig. 114.

*Helix rowelli* Newcomb, 1865, Proc. Cal. Acad. Sci., 3: 181.—Binney & Bland, L. & Fr. W. Sh. N. A., 1: 185, upper fig. 326; not the description or lower figure.

*Sonorella rowelli* (Newc.), in part, Bartsch, 1904, Smiths. Misc. Coll., 47: 199.

*Micrarionta rowelli* (Newc.), Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75: 99, pl. 3, figs. 6, 7.

“Shell with open umbilicus, orbicular, depressed, opaque white, polished, very finely obliquely striate; whorls  $4\frac{1}{2}$ , convex, the last large, anteriorly descending; spire but little elevated, at the apex projecting like a nipple; suture moderately marked; aperture truly circular; lip thin, slightly reflected, margins continued, adhering to the last whorl. Alt. .4 pol., diameter maj. .6 pol., min. .5 pol.” (Newcomb.)

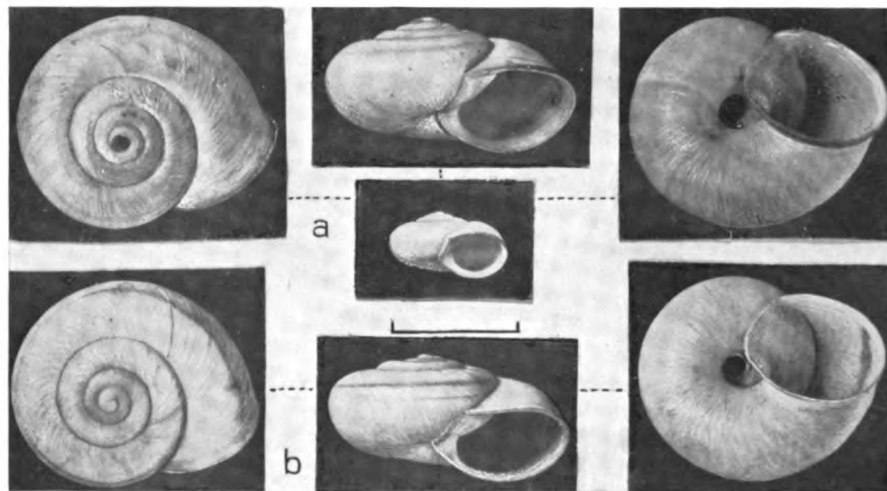


Fig. 114. *Micrarionta rowelli*; a, type; b, Tinajas Altas specimen. (Middle figure natural size, the rest enlarged.)

The type-specimen of *M. rowelli* is represented in Figure 114 a. It is bleached white, but shows a narrow gray band above the periphery. The surface is glossy, finely, weakly striate. On the antepenult whorl the striæ are slightly irregular, indistinctly broken into long granules. The apex is broken, but the last part of the embryonic shell remaining shows a sculpture entirely similar to that of *M. wolcottiana*, *M. hutsoni* and others,—granules lengthened in a spiral direction. The whorls are rather strongly convex, the last one very wide, and descending rather deeply in front. Aperture is very shortly oval, nearly as high as wide, the peristome expanded, a little thickened within, the margins connected by a strong parietal callus.

Height 8.8 mm., diameter 16 mm.; diameter umbilicus 2.8 mm. Aperture 8 mm. high, 9 mm. wide.

ARIZONA: (Frick), Type 27517 Newcomb Collection, Cornell University. Tinajas Altas, east base of the Gila Mountains (Maj. E. A. Mearns), 187478 U.S.N.M. East side Gila Mountains, 8 miles north of Tinajas Altas, Yuma County (E. C. Jaeger).

In the U. S. National Museum there are two examples (one much broken) of a *Micrarionta* collected at Tinajas Altas by Maj. E. A. Mearns, Feb. 21, 1894. The better example measures: height 8.2 mm., diameter 15.5 mm., aperture 7.7 x 8.7 mm., umbilicus contained 6.2 times in diameter; 4½ whorls. It is illustrated in Figure 114 b. The parietal callus is not so heavy as in Newcomb's type, which is evidently an old shell. These shells agree so completely with the type of *M. rowelli* that the habitat of that species can now be fixed with a high degree of probability. Mearns was in camp at Tinajas Altas, at the east base of the Gila Mountains, from February 14 to 23, 1894, and made a careful exploration.<sup>1</sup> These famous natural rock tanks, which furnish an almost unfailing supply of good water, were an important camping place on the old Yuma Trail to California,<sup>2</sup> and probably are where Frick obtained the type of *Helix rowelli*. In the absence of other information, we propose that Tinajas Altas be considered the type locality.

A specimen collected by Jaeger 8 miles north of Tinajas Altas measures 8.4 x 15 mm.

*M. rowelli* stands close to *M. hutsoni*, but the aperture is slightly more rounded, less oval, its length being about 87 percent of the width, while in the figured cotype of *hutsoni* it is about 83 percent. The differences are very small, and in 1934 I proposed to consider *hutsoni* and its immediate relatives as subspecies of *rowelli*.

*M. rowelli* was, it is believed, the first land snail described from Arizona. Newcomb's type came from Frick, or at least he is given as authority for the locality "Arizona." Whether Frick was a fortyminer who reached California by the Old Yuma Trail through Mexico and Arizona we have no direct information. He lived in Oahu for some years and collected shells there; but no other details of his life have been obtained.

Binney (1869, p. 185, fig. 326) confused Newcomb's species with *Helix lohrii* Gabb, a very different shell. His description appears to be composite, and only his upper figure is certainly identifiable as *rowelli*. The lower figure differs in lacking the parietal callus and in being larger. Fischer and Crosse followed Binney in this mistake.

In 1882 Henry Prime reported "*Ampelita rowelli*" from the Salt River Mountains, 7 miles south of Phoenix, Arizona, "determined by Dr. Newcomb." I have seen some of these shells, which have a general resemblance

<sup>1</sup> Mammals of the Mexican Boundary of the United States, Bull. 56 U. S. N. M., 1907, pp. 21, 122, pl. 13, fig. 1.

<sup>2</sup> "The Old Yuma Trail." National Geographic Magazine, 1901, 12: 129-143, map on p. 132.

to *M. rowelli*, but are really bleached *Sonorella* "bones" of an undescribed species. In 1905 I thought to recognize Newcomb's species in certain small sonorellas from foothills of the Patagonia Mountains, Arizona. On comparison with the type specimen it was seen that these shells are different, and the name *Sonorella tryoniana* was proposed for them.

In addition to the following subspecies of *rowelli* there is a bandless race, *M. r. mexicana* Pilsbry & Lowe (1934, *Nautilus*, 48: 67), from mountains about 12 miles south of Sonoyta, Sonora, and a smaller form which sometimes shows a weak, narrow band, from rocky hills at Punta Libertad, on the Gulf of California, all collected by H. N. Lowe.

(Dedicated to the Rev. J. Rowell, of San Francisco.)

***Micrarionta rowelli hutsoni* (Clapp)**

Fig. 115 A-6a.

*Epiphragmophora (Micrarionta) hutsoni* G. H. Clapp, 1907, *Nautilus*, 20: 136, pl. 9, figs. 1-4.—Pilsbry, 1907, *Nautilus*, 20: 138, pl. 9, figs. 5-8.

*Micrarionta hutsoni hutsoni* (Clapp), Willett, 1930, *Nautilus*, 44: 5.

"Shell openly umbilicate; rather thin but strong, smooth and shining when fresh; reddish-horn color on the upper surface, much paler to creamy-white below, with a rather narrow brown band, about 1 mm. wide, above the periphery, visible only on the last  $1\frac{1}{2}$  whorls, the band margined above and below by wider white bands, the lower shading off into the light-colored base. Whorls about  $4\frac{1}{3}$ , the inner ones convex, the last somewhat flattened above, well rounded below and at the periphery. The embryonic shell consists of  $1\frac{2}{3}$  whorls, terminating with an inconspicuous whitish line; the first  $\frac{1}{3}$  whorl is depressed and highly polished; the remaining embryonic whorls are evenly and densely covered with elongate-oval papillae arranged in spiral lines. In the following  $1\frac{1}{2}$ –2 whorls, beginning the neanic stage, the epiconch bears *exceedingly delicate*, very short hairs arranged in obliquely descending series, but less regular than the papillae of the embryonic whorls. These are entirely lost in mature shells, although the hair-scars are generally visible on fresh specimens. The body-whorl shows the usual slight growth-lines, but is otherwise smooth except for varical impressions showing resting periods, of which there are usually 2 on the body-whorl and others clear up to the nuclear whorls. The body-whorl enlarges rapidly, and is suddenly deflected and expanded at the aperture, which is large, almost round, oblique, with a slightly reflected and thickened margin; lips widely expanded at the columella and partly reflected over the umbilicus. Ends of lip converging, forming about four-fifths of a circle. Gr. diameter  $14\frac{1}{2}$ , lesser  $11\frac{1}{2}$ , alt. 8 mm. Aperture 7 mm. high, 7 mm. wide. Umbilicus  $2\frac{1}{2}$  mm." (Clapp.)

The figured specimen (93285) measures height 7.4 mm., diameter 14.2 mm.; aperture 6.9 x 8.2 mm.; umbilicus contained 6.2 times in diameter;  $4\frac{1}{3}$  whorls. The largest and smallest shells seen measure 15 and  $12\frac{1}{2}$  mm. diameter respectively.

ARIZONA: About 20 miles south of Quartzsite, 12 miles north of Kofa. Yuma County in foothills of the Short Horn Range, at an alt. of about 1600 feet, (Geo. G. Hutson).<sup>1</sup>

Types 5659 Carnegie Museum; co-types 93285 A.N.S.P.

<sup>1</sup> After publication of Dr. Clapp's description the locality given by him was corrected by Mr. Hutson as above. It is in the north end of the Eagle Tail Mountains.



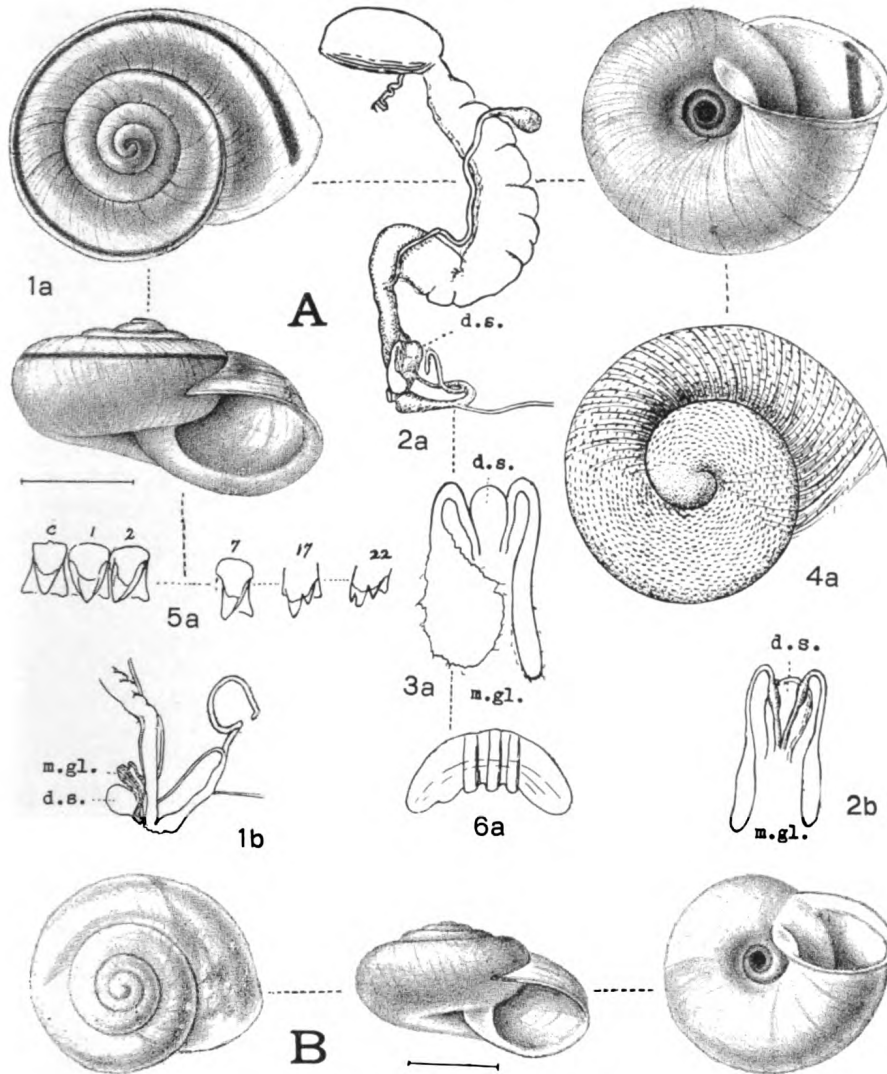


Fig. 115. A, *Micrarionta rowelli hutsoni*. 2a, genitalia; 3a, dart sac and mucous glands; 4a, embryonic and half of a neanic whorl; 5a, teeth; 6a, jaw. B, *M. r. desertorum*. 1b, genitalia; 2b, dart sac and mucous glands. (Actual size indicated by lines below figures A and B.)

A lot of shells obtained by Ferriss in the Dome Rock range, about four miles west of Quartzite, are apparently identical with specimens from the type lot. Though the diameter of the largest specimen of the type lot is given as 15 mm., one specimen in our lot measures 16.5 mm. In typical *hutsoni* the white zone above the narrow peripheral band is abruptly bordered by another brown band that extends to the suture. This is lighter

in color, consequently less conspicuous, than the band above the periphery, and about twice as wide. It is particularly apparent inside the aperture and gives the shell the appearance of being doubly banded.

The animal is purplish-black, with gray mantle-edge. The surface is finely and evenly granulose. There is a weak impressed line on the ridge of the tail, and a pair of contiguous dorsal grooves, scarcely noticeable except between the tentacles. Foot-margin very narrow, hardly differentiated. The sole is conspicuously tripartite in color, the sides being purplish or slaty-black, while the middle field is of a much paler gray tint. The pale area is somewhat wider than the dark sides.

The genitalia, (Fig. 115: 2a, 3a), show a very short penis, swollen basally, an epiphallus of about the same length or somewhat longer, and a flagellum longer than either. The long retractor muscle is inserted on the epiphallus, and distally on the lung floor. At the base of the vagina a well-developed dart sack (d. s.) is inserted; on each side of its base enter the ducts of the mucous glands, which ascend as high as the dart sack and then descend, their flattened, glandular portions being bound to the vagina and atrium. The general relations of the dart sack and mucous glands are shown diagrammatically in Figure 115: 3a. As usual, the two glands are unequal. The spermatheca is ovate, on a long, slender duct. Length of penis 2 mm.; of epiphallus 2.8; flagellum 4 mm.; length of spermatheca and duct 16.5 mm.

The right ocular retractor passes between penis and vagina.

The general features of the alimentary tract are as usual in the helices. The crop is long, the salivary glands equally lengthened, lying on the upper side of the crop, and conerescent throughout their length.

The jaw is of the usual arcuate shape, with only three ribs, grouped in the median third (fig. 6a).

The radula has 17,10,1,10,17 teeth (Fig. 115: 5a). The central and lateral teeth have simply mesocones without side cusps. The marginal teeth have the ectocones developed, and in the outer ones the larger cusp is bifid. I noticed no teeth with the ectocone bifid. The transition from lateral to marginal teeth is quite gradual.

The venation of the lung is faintly outlined with gray pigment. The kidney is about half as long as the lung, and nearly twice the length of the pericardium.

**Micrarionta rowelli desertorum** Pilsbry & Ferriss

Fig. 115 B-2b.

*Micrarionta desertorum* Pilsbry & Ferriss, 1908, Nautilus, 21: 134, pl. 11, figs. 6-10.

*Micrarionta hutsoni desertorum* (P. & F.), Willett, 1930, Nautilus, 44: 5.

The shell is small, depressed, openly umbilicate, the width of umbilicus contained  $5\frac{1}{2}$  times in that of the shell, glossy, opaque, pinkish-white with some oblique streaks of flesh-color, and usually a few corneous dots; the inner  $2\frac{1}{2}$  whorls fleshy-corneous. The spire is convex but low, whorls about  $4\frac{1}{3}$ , the inner ones rather slowly increasing, the last much wider, about double the width of the preceding. The embryonic shell consists of  $1\frac{1}{2}$  whorls, the first fourth of a whorl smooth, the rest with close, even sculpture of minute papillae, which are lengthened in a direction parallel to the sutures, and form a regular pattern of oblique, forwardly descending and ascending rows.

The post-embryonic whorls have fine, irregular, somewhat wavy striae in the direction of growth-lines, and papillae like those of the embryonic whorls but much more sparsely placed, and disappearing near the end of the penultimate whorl. The last whorl has weak growth-lines only. It is rounded peripherally and descends slowly to the aperture. The suture is deeply impressed, especially at the last whorl. The aperture is oblique, rounded-oval. Peristome slightly expanded, with a narrow, rusty edge; upper and outer margins very slightly expanded; basal margin more expanded; columellar margin rather broadly dilated. The ends converge and are joined by a short glossy callus.

Height 7.25 mm., diameter 12.9 mm., aperture alt. 5.9, width 6.7 mm.  
Type.

Height 6.5 mm., diameter 12.8 mm.

Height 6.7 mm., diameter 11.1 mm.

ARIZONA: Small range of mountains 12 miles south from Parker, Yuma County (W. J. Gilchrist), Lectotype and paratype 94783 A.N.S.P.

The whole upper surface, head and tentacles, are blackish-slate color, finely irregularly granulose. There are no distinct dorsal or genital furrows. The sole is tripartite, the areas separated by indistinct longitudinal impressed lines, in drowned alcoholic examples. The middle area is twice as wide as the others, slaty-white; side areas darker slate color. The mantle is whitish, the venation of the lung outlined delicately with gray.

The genital system (Fig. 115: 1b, 2b) resembles that of *M. hutsoni*. The penis is swollen near the base, and has a slender retractor muscle and a moderately long flagellum. The vagina is very short, the spermatheca globular, its duct very long, and inserted unusually low, much farther down than in *M. hutsoni*. The dart sack (d. s.) is large, and near its base, on the side facing the vagina, the two mucus glands (m. gl.) are inserted close together (as shown in Fig. 2 b, diagram of dart sack and mucous glands viewed from the side towards the vagina, showing the contiguous insertions). The mucus glands descend and their enlarged ends lie near the base of the dart sack. The measurements are: length of penis (to insertion of retractor), 3 mm.; length of epiphallus, 1.8 mm.; length of flagellum, 4 mm.; length of vagina, 1.8 mm. The jaw has about 6 unequal ribs, grouped in its median part.

This form stands close to *M. hutsoni*, but most specimens lack the band, the umbilicus is slightly larger and aperture smaller relative to the diameter. Some minor differences in the mucous glands, and the contiguous insertions of their ducts, may prove significant, and the jaw has more ribs; but only one has been dissected.

Willett, who visited the type locality, concluded that *desertorum* is not specifically separable from *hutsoni*; he writes: "The northern extremity of the Dome Rock Mountains, the habitat of *hutsoni*, is only about fifteen miles from the small, unnamed mountain that is the type locality of *desertorum*. Though the shell of *desertorum* is said to be unbanded, eighteen specimens out of our series of eighty show traces of bands: furthermore, an albinistic specimen of *hutsoni*, taken alive together with normal specimens,

is indistinguishable from *desertorum*. That these two forms intergrade geographically is doubtful, as several miles of desert intervene between their mountain habitats, but that they do intergrade by individual variation is clearly shown in our series. Our largest specimen of *desertorum* has a maximum diameter of 14.4 mm."

Ferriss also found weakly banded shells with the bandless ones when he was at the same mountain in 1922. He gave the distance from Parker as 10 miles.

(*Desertorum*, of deserts.)

***Micrarionta rowelli acus***, new subspecies

Fig. 116 a.

The shell is slightly less depressed than *M. r. hutsoni*, the base and borders of the band whiter; the carob brown band and the zone below the suture are darker, both very distinct inside; there are often a few dusky dots on the latter part of the body-whorl. The papillation of the embryonic

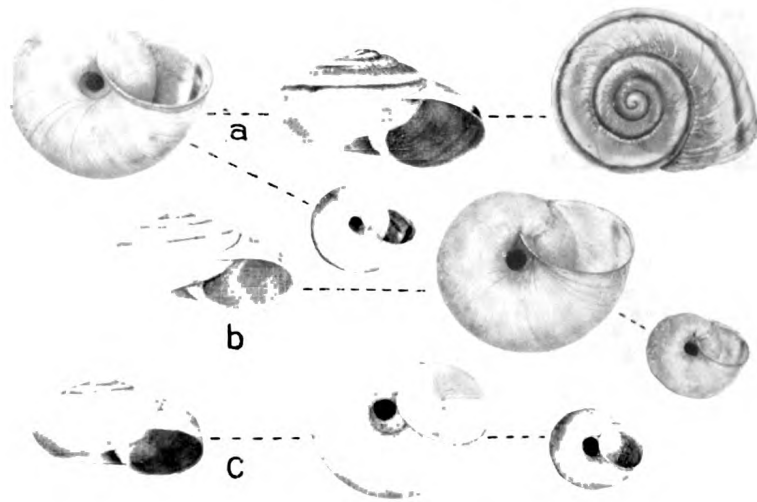


Fig. 116. a, *Micrarionta rowelli acus*. b, *M. rowelli unifasciata*. c, *M. rowelli mccoiana*. (Natural size and  $\times 2$ .)

whorls is coarser, not so clear-cut as in *hutsoni*, radial wrinkles of the ground between them being more distinct. Sparse papillae extend as far as the middle of the penult whorl. The umbilicus is narrower than in *hutsoni*, contained slightly more than 7 times in the diameter (5.7 times in the figured cotype of *hutsoni*).

Height 7.4 mm., diameter 13.7 mm., aperture 6.6 x 8 mm.;  $4\frac{1}{2}$  whorls.

ARIZONA: Needles Peaks near Topock (J. H. Ferriss), Type and 6 paratypes 168516 A.N.S.P.

CALIFORNIA: Mohave Mountains, opposite Topock; mountains north-east of Essex (J. H. Ferriss).

The Californian specimens are not typical *acus*. They vary from the form of *acus* towards that of *hutsoni*, but usually the umbilicus is noticeably narrower than in the latter; the color is lighter than *acus*, but they were collected dead. The size varies from that of *acus* to 11.4 mm. in diameter. However, in a few bones taken in the mountains north of Java, the depressed form and the umbilicus, 5.7 times in diameter, agree with *hutsoni*. Possibly the Californian specimens are a transitional race, not directly connected with the Needles form. I have no good fresh shells.

(*Acus*, a needle.)

***Micrarionta rowelli unifasciata* Willett**

Fig. 116 b.

*Micrarionta hutsoni unifasciata* Willett, 1930 (July), Nautilus, 44: 6; 1935, Bull. So. Cal. Acad. Sci., 34: 1.

*Micrarionta hutsoni hilli* Willett, 1930 (July), Nautilus, 44: 6.

"Similar to *M. hutsoni hutsoni*, but smaller, somewhat more depressed, and with only the narrow peripheral band showing on the last whorl and within the aperture. The white zone above the peripheral band merges gradually into the horn-color of the upper part of the shell, not abruptly as in the typical form." (Willett.)

Max. diameter 13.5, min. diameter 10.9, alt. 6.1, umbil. 1.3 mm.; 4½ whorls. Type.

Max. diameter 13.5, min. diameter 11, alt. 6.2, umbil. 1.3 mm.; 4½ whorls. Paratype.

CALIFORNIA: Newberry Springs, north end of Kane Mountains, San Bernardino County (G. Willett), Type 1023 coll. Los Angeles Museum; paratypes in Willett Collection. Also southern end of the Coxcomb Range, Riverside County (Willett).

"Though the type localities of *M. hutsoni hutsoni* and *M. hutsoni unifasciata* are 150 miles apart, and separated by desert, several mountain ranges and the Colorado River, the two forms are so nearly alike that it seems best to consider the differences only subspecific.

"The shell taken in the Coxcombs, near the southern end of the range, is so nearly identical with *Micrarionta rowelli unifasciata* Willett, that it seems advisable to refer it to that form." (Willett.)

*M. hilli* is now considered by Mr. Willett to be synonymous with *M. r. unifasciata*. The description follows:

"Similar to *M. hutsoni hutsoni*, but differing in smaller size, more depressed form, and in relatively larger umbilicus; also in lack of any perceptible band between the upper white zone and the suture. Differs from *M. h. unifasciata* in slightly more depressed form and larger umbilicus. Max. diameter 13.8, min. diameter 10.5, alt. 5.3, umbilicus 2 mm., 4½ whorls, type; 12.8, 10.4, 5.6, 2 mm., 4½ whorls, paratype." (Willett.)

CALIFORNIA: Sheep Hole Mountains, San Bernardino County, on the road leading from Amboy to Twenty-nine Palms (G. Willett), Type 1024 collection Los Angeles Museum; paratypes in Willett Collection.

“The type locality of this form lies about seventy-five miles southeast of the type locality of *M. h. unifasciata*. Between these two localities are three mountain ranges, the Bessemers, an un-named range and the Bullions. Visits to these ranges at several different points have resulted in no traces of shells being found. I take pleasure in naming this shell in honor of Mr. Howard R. Hill, conchologist at the Los Angeles Museum.” (Willett.)

***Micrarionta rowelli mccoiana* Willett**

Fig. 116 c.

*Micrarionta mccoiana* G. Willett, 1935 (May 15), Bull. So. Cal. Acad. Sci., 34: 2.

“Shell small, fragile, depressed; aperture nearly circular, the inner lip encroaching slightly on the umbilicus; papillation on early whorls as in *M. rowelli*. Early whorls light brown in color; last whorl white, irregularly clouded with light amber; most specimens show an extremely narrow, light brown band on the periphery, but this is absent in a few examples. Measurements of type: Diameter, 12.8 mm.; alt., 7 mm.; number of whorls,  $4\frac{3}{8}$ .” (Willett.)

CALIFORNIA: McCoy Well, McCoy Mountains, Riverside County (G. Willett), Type 1044 Los Angeles Museum.

“Similar in size and shape to *M. r. unifasciata*, but more depressed, with more descending last whorl, and much lighter in color. In color much like *M. r. desertorum* Pilsbry and Ferriss, but smaller, more fragile, and lacking the heavily reflected lip of that form; also most specimens of *mccoiana* show the thin peripheral brown line which is absent in the majority of *desertorum*.

“The type and one immature specimen were living when found, the others dead and more or less faded.

“The Coxcomb and McCoy Mountains are volcanic ranges, their slopes covered with lava rock in which no snails were found. In both regions, however, heavy rains have torn gullies through the surface lava and into granite and sandstone, and in rock slides along the sides of these gullies specimens were secured.” (Willett.)

***Micrarionta rowelli bakerensis* Pilsbry & Lowe**

Fig. 117.

*Micrarionta rowelli bakerensis* Pilsbry & Lowe, 1934 (Oct.), Nautilus, 48: 68.

The shell is less depressed than *M. rowelli*, opaque pale ochraceous-buff with light pinkish cinnamon spire, a chestnut-brown band above the periphery and an ill-defined avellaneous band below the suture on the last whorl; also some fine, oblique, protractive dusky lines and scattered dots in the peripheral region and base (sometimes absent). The embryonic whorl projects somewhat, with sculpture of fine, close-set elongate papillae as in *M. rowelli*; smaller papillae are sparsely developed on later whorls but disappear on the latter part of the penult and the last whorl, which are polished, with faint lines of growth only. The low-conoid spire is rather small, of slowly increasing whorls, the last whorl wide, descending rather deeply to the aperture. Umbilicus contained 8 times in diameter. Aperture

shortly oval, about as in *M. rowelli*, the outer and basal margins expanded, columellar dilation impinging little on umbilicus; parietal callus thin.

Height 10.1 mm., diameter 16.9 mm., aperture 8.4 x 9.7 mm.; 4½ whorls.

A paratype measures 8.5 x 14.8 mm.; the smallest, not absolutely adult, 13.7 mm. diameter.



Fig. 117. *Micrarionta rowelli bakcrensis*.

**CALIFORNIA:** North slope of a small range of limestone hills west of the highway, about half a mile south of Baker, San Bernardino County (H. N. Lowe), Type and paratypes 162958 A.N.S.P.; other paratypes in Lowe Collection.

It is less depressed than *M. r. hutsoni*, with rounder aperture and decidedly smaller umbilicus. It is more elevated and more narrowly umbilicate than *M. r. amboiana* Willett. It appears more distinct than other forms herein considered subspecies of *rowelli*, but the ultimate rank of this and many other eremariontas is uncertain until the country is more fully explored for these snails.

Mr. Lowe found the shells about halfway up the hill, just under a high cliff, mostly buried under a few inches of soil and small bits of rock. There was no protecting vegetation of any kind. Several were still attached to stones, but none alive.

***Micrarionta rowelli amboiana* Willett**

Fig. 118.

*Micrarionta hutsoni amboiana* Willett, 1931 (Apr.), Nautilus, 44: 123, pl. 7, fig. 4.

“Similar in shape and size to *Micrarionta hutsoni hilli* Willett from the Sheep Hole Mountains, about thirty miles to the southward. Differs from *hilli* in somewhat smaller umbilicus, lighter coloration, and narrower and less sharply defined peripheral band. In coloration most like *M. hutsoni desertorum* Pilsbry and Ferriss, but differs from that form in proportionately larger umbilicus and banded periphery. Differs from *M. hutsoni unifasciata* Willett, from Newberry Springs, in lighter coloration, narrower band, and smaller umbilicus. The color of *amboiana* is a very light horn—almost white—with a very narrow, brown band at the periphery of the last whorl: color of animal black, with the exception of the middle part of the last whorl, which is smoky gray. Dead, faded specimens of *unifasciata* are very close to living *amboiana* in coloration, but living specimens of the former are much darker, with wider and more pronounced band. Max. diameter, 12 mm.; min. diameter, 10.3; alt., 6.3; umbilicus, 1.7; number of whorls, 4½. The largest specimen found (a dead one) has a maximum diameter of 13 mm., and minimum diameter of 10.6.” (Willett.)

CALIFORNIA: Among rocks on a small hill about six miles northwest of Amboy, San Bernardino County (G. Willett), Type 1029 Los Angeles Museum; paratypes in Willett Collection. The type, two other living specimens and four dead ones taken.



Fig. 118. *Micrarionta rowelli amboiana*, type. ( $\times 2$ .)

“The type locality is about one mile north of the highway running from Amboy to Needles, and is separated from the ranges of all other known *Micrariontas* by several miles of desert floor.” (Willett.)

***Micrarionta rowelli granitensis* Willett**

*Micrarionta granitensis* Willett, 1935 (May 15), Bull. So. Cal. Acad. Sci., 34: 1.

“Shell almost circular, rather small; aperture slightly wider than high; pillar of inner lip encroaching somewhat on the umbilicus; papillation on nuclear whorls as in *M. rowelli*. Color light horn, with narrow chestnut band on the periphery of the last whorl. Measurements of type: diameter, 14.8 mm.; alt., 8.5 mm.; number of whorls,  $4\frac{1}{2}$ .” Willett.)

CALIFORNIA: Northwest end of the Granite Mountains, Riverside County (Ora A. Willett), Type 1043 Los Angeles Museum. This locality is about one mile southeast of the road running from Desert Center to Rice.

“From *M. rowelli unifasciata*, its nearest neighbor on the west, this form differs principally in larger size and rounder outline. In these characters is similar to *M. rowelli bakerensis* Pilsbry and Lowe, but differs from that form in narrower chestnut band, thinner lip, rounder (higher) aperture, and smaller umbilicus.

“In the Granite Range, which, as the name indicates, is made up mostly of granite, snails were taken in the usual locality, rock slides on the mountain slopes.” (Willett.)

***Micrarionta rowelli chuckwallana* Willett**

*Micrarionta chuckwallana* Willett, 1935 (July), Nautilus, 49: 15.

“Easily distinguishable from *mille-palmarum* and *brunnea* by larger size, larger aperture, and heavier shell. Superficially very similar to *M. bakerensis* Pilsbry and Lowe, though there can hardly be very close genetic relationship between the two. From this form it differs somewhat in darker coloration, larger (higher) aperture and thinner lip. From *M. rixfordi*, of the Eagle Mountains, the closest known form on the north, *chuckwallana* is specifically distinct, as is shown in the different arrangement of the



papillae on the nuclear whorls. Measurements of type in millimeters: diameter, 16.8; alt., 10.4; no. of whorls,  $4\frac{1}{2}$ ." (Willett.)

CALIFORNIA: About one mile south of Corn Springs, Chuckawalla Mountains, Riverside County (G. Willett), Type 1040 Los Angeles Museum. Twelve additional specimens secured at the same time and place, all dead, but several in a good state of preservation.

**Micrarionta rowelli chocolata** Willett

*Micrarionta chocolata* Willett, 1935 (July), Nautilus, 49: 15.

"Similar to *M. chuckwallana*, but differing in larger umbilicus, lighter coloration, and much narrower brown band on the body whorl. Measurements of type in millimeters: diameter, 16.7; alt., 10.3; whorls,  $4\frac{1}{2}$ ." (Willett.)

CALIFORNIA: Near Beal's Well, Chocolate Mountains, Imperial County (Ora A. Willett), Type 1041 Los Angeles Museum.

**Micrarionta newcombi** Pilsbry & Ferriss

Fig. 119.

*Micrarionta newcombi* Pilsbry & Ferriss, 1923, Proc. Acad. Nat. Sci. Phila., 75: 101, pl. 3, fig. 8.

The shell is strongly depressed, openly umbilicate (the umbilicus contained 5 times in the diameter), thin, whitish (dead), with a narrow brown band above the periphery. Surface smoothish, with faint growth striae only. Embryonic whorls showing no sculpture (somewhat worn). Whorls convex, rather slowly increasing. Aperture rounded-lunate. Peristome sharp, the specimen not fully mature.

Height 8 mm., diameter 15.5 mm.;  $4\frac{1}{2}$  whorls.

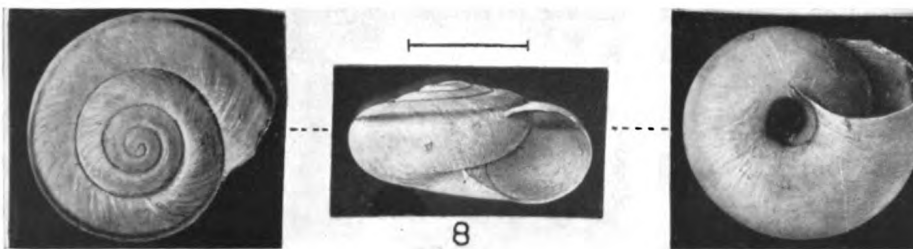


Fig. 119. *Micrarionta newcombi*, type. ( $\times 2$ .)

ARIZONA: Type in the collection of Cornell University.

A single example of this species was in the Newcomb collection with the type of *M. rowelli*; presumably from the same locality. It is not fully mature, yet should be easily recognized by the strongly depressed shape and large umbilicus, unlike any other known species of the region. It is more depressed and more openly umbilicate than *M. rixfordi*.

**Micrarionta immaculata** Willett

Figs. 120, 121.

*Micrarionta immaculata* Willett, 1937 (May), Bull. So. Cal. Acad. Sci., 36: 6, pl. 1, figs. a-c.

"Shell small, depressed, umbilicated. Color white, with brownish apex; unbanded. Nuclear whorls papillated in diagonal rows, as in the *M. rowelli* group, these papillations gradually becoming less distinct and showing mostly on growth lines, practically disappearing on last whorl and base. Aperture oblique, almost circular. Outer lip descending at insertion; inner lip encroaching slightly on the open umbilicus. Measurements of type: diameter 12.3, alt. 7.2 mm. The largest specimen (dead) measures 13 x 7.3 mm. Two juvenile examples show faint traces of a very narrow brown band; the others of the series are immaculate. One living specimen lacks the brownish apex, being white throughout." (Willett.)

CALIFORNIA: East slope of Riverside Mountains, Riverside County, 7 miles south of the town of Vidal, San Bernardino County (George & Ora Willett), Type 1051 Los Angeles Museum; paratypes 168619 A.N.S.P., and in Willett Collection.

"Of the known races of the genus, *immaculata* appears nearest to *M. mccoiana* Willett, but it differs from that shell in its pure white coloration and lack of color band. It is smaller and much whiter than *M. rowelli desertorum* Pilsbry and Ferriss, from near Parker, Ariz." (Willett.)

(*Immaculatus*, spotless.)



Fig. 120.  
(After Willett.)



Fig. 121. *Micrarionta immaculata*, paratype. ( $\times 2$  and actual size.)

**Micrarionta millepalmarum** Berry

Fig. 122.

*Micrarionta (Ercmarionta) mille-palmarum* Berry, 1930 (May), Ann. Mag. Nat. Hist., (10), 5: 543.

"Shell helicoid, small, thin, depressed-conic; whorls averaging about  $4\frac{1}{2}$ , strongly convex, the last descending parietally. Aperture rounded-oval, oblique. Peristome hardly thickened, and expanded little or not at all except at the umbilicus; the latter wide, contained 6 to  $7\frac{1}{2}$  times in the

diameter of the shell. Embryonic whorls somewhat swollen, ornamented with numerous clean-cut and regularly arranged microscopic papillae, replaced on the subsequent turns by smaller, rounder, and more distant papillations which are obsolete on the body-whorl. Periostracum thin and polished, vinaceous-buff, paling below, and with a narrow supraperipheral band of prout's brown, bordered lighter. Max. diameter 12.1, alt. 7.3, diameter umbilicus 1.9 mm." (Berry.)

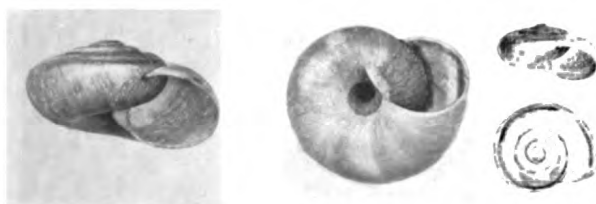


Fig. 122. *Micrarionta millepalmarum*, paratypes. (Enlarged and actual size.)

CALIFORNIA: Thousand Palms, Riverside County (S. S. Berry & L. G. Ingles), Type 6502, S. S. Berry Collection; paratypes in the collections of Mr. Allyn G. Smith, the San Diego Museum, and the Academy of Natural Sciences of Philadelphia (152596).

"This, the smallest helicoid of the Coachella Valley district so far to be described, curiously recalls the Arizonan *M. hutsoni* Clapp, but the shell-texture and the strong convexity of the early whorls serve to distinguish it, while of course the habitat is widely removed." (Berry.)

"Specimens from Mecca Hills, near Shaver's Well, and from the northern Orocochia Mountains, are somewhat intermediate between *millepalmarum* and *brunnea*." (Willett.)

***Micrarionta brunnea* Willett**

*Micrarionta brunnea* Willett, 1935 (July), Nautilus, 49: 15.

"Shell small and fragile, like *M. millepalmarum*, but browner in coloration; light color above band on body whorl either absent or very inconspicuous. Measurements of type, diameter, 13.5 mm., alt., 7.9 mm.; whorls, 4 $\frac{1}{3}$ ." (Willett.)

CALIFORNIA: Near Chuckawalla Spring, Little Chuckawalla Mountains, Riverside County (G. and Ora A. Willett), February 21, 1935. Type 1042, Los Angeles Museum, and about fifty additional specimens, mostly dead.

"The only land shell previously recorded from this region is *Micrarionta millepalmarum* Berry, from Thousand Palms Canyon, Indio Hills. The three forms [*brunnea*, *chuckwallana* and *chocolata*] are of the same general group as the Thousand Palms species, the first of them, however, being much more closely related to it than the other two. They all, including *millepalmarum*, have the arrangement of papillation on the nuclear whorls as in

forms of *M. rowelli*, and may be races of that species, but complete intergradation with it is yet to be shown.

(*Brunneus*, brown.)

**Micrarionta orocopia** Willett

Fig. 122 A.

*Micrarionta orocopia* Willett, 1939, Bull. So. Cal. Acad. Sci. 38: 15, pl. 15, figs. a-c.

“About the same size as *M. millepalmarum*, but with heavier shell, much darker coloration, and wider brown band at the shoulder. Color nearly like that of *M. chuckwallana*, but differs from that species in much smaller size and less rounded body whorl. Papillae on early whorls in diagonal rows, as in the *M. rowelli* group.

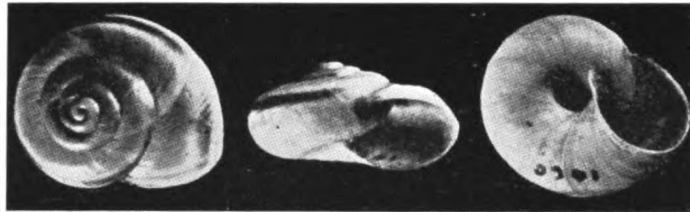


Fig. 122 A. *Micrarionta orocopia*. (After Willett.)

“Measurements of type: Max. diameter 14; min. diameter 11.5; alt. 8.2 mm. The largest specimen taken (defective) measures: Max. diameter 15.3; min. diameter 12.4; alt. 8.2 mm.” (Willett.)

CALIFORNIA: Rock slide on south side of canyon on south slope of Orocopia Mountains, about two and one-half miles north of Dos Palmas Spring, Riverside County (G. & Ora Willett). Type 1060 Los Angeles Museum, Paratypes 174071 A.N.S.P., and California Academy of Sciences.

“Near the northeastern extremity of the Orocopia Range, at a point about twenty miles distant from the type locality, eight rather poor specimens were taken that appear referable to this species.” (Willett.)

**Micrarionta melanopylon** Berry

Fig. 123.

*Micrarionta (Eremarionta) melanopylon* Berry, 1930 (Aug.), Ann. Mag. Nat. Hist., (10), 6: 187, figs. 1, 2.

“Shell rather thin, of moderate size, depressed, the spire low-conic; whorls  $4\frac{1}{2}$  to  $4\frac{3}{4}$ , convex, regularly expanding; suture well marked; last whorl descending parietally. Aperture rounded, oblique, its deflection from the vertical varying between  $40^\circ$  and  $50^\circ$  in the specimens measured. Peristome slightly thickened; little expanded parietally, but more distinctly so below and with a weak columellar reflection. Umbilicus funicular, permeable to the apex, and moderately wide, being contained from 6 to  $6\frac{2}{3}$  (usually a trifle over 6) times in the diameter of the shell. Spiral sculpture wanting, the body of the shell smooth save for the numerous growth-lines and the papillation forthwith to be described. Embryonic shell at first

nearly smooth, very weak concentric wrinklins appearing on the latter part of the first fraction of a whorl, this state abruptly giving way for another full whorl to a heavy sculpturing of coarse, rather crowded, hyphen-shaped papillae, as a rule distinct, separate, and showing arrangement in the usual obliquely descending series, but in some specimens at first showing a tendency to coalesce or even slightly to anastomose. On the latter whorls



Fig. 123. *Micrarionta melanopylon*, paratypes. ( $\times 2$  and actual size.)

the papillae are smaller, more distant, more rounded, and eventually become weaker and weaker, although they or their traces may sometimes be detected even on the upper surface of the body-whorl. Lower surface of body-whorl practically smooth. Periostracum thin and with a somewhat waxy lustre in fresh specimens, the color apparently much as has been described for related species, and with the usual spiral band of bistre above the shoulder about 1 mm. wide, flanked on each side by a slightly narrower pale area. Max. diameter 14.6 mm., min. diameter 12.3 mm., alt. 8 mm.; umbilicus 2.2 mm.;  $4\frac{3}{4}$  whorls." (Berry.)

Paratypes from 7.4 x 14.4 mm. to 8.4 x 16 mm.

CALIFORNIA: Black Rock Hills, west side of Black Canyon near mouth, 9 miles north of Hinkley, San Bernardino County (Edmund C. Jaeger); 8 mature and 12 immature shells, all dead and for the most part well bleached, taken among black basalt rocks on the mountain-side. Type 7073 Berry Collection; paratypes 7074 of the same collection; others deposited in the collections of Mr. Allyn G. Smith, the San Diego Museum of Natural History, and the Academy of Natural Sciences of Philadelphia (152597).

"In general aspect it most resembles *M. rixfordi* Pilsbry and *M. aetotis* Berry, but the umbilicus widens more rapidly than in the former and it differs from both in lacking the peculiar retiform embryonic sculpturing peculiar to that group. *M. argus* (Edson) is geographically a nearer neighbor, but has a more capacious aperture, and is a materially smaller species.

"The specific name chosen is derived from μέλας, black, and πύλη, gateway, and finds its significance in the name of the canyon and mountain range which the species inhabits." (Berry.)

**Micrarionta argus** (Edson)

Fig. 124.

*Sonorella argus* Edson, 1912 (Aug.), Nautilus, 26: 37.

"Shell small, depressed, flesh-colored, with a narrow brown band encircling the whorls a little above the periphery. This shell approaches very nearly *S. fisheri* Bartsch but differs in color, size, and in having a wider umbilicus. The type measures: maj. lat. 11.3 mm., min. lat. 9.5 mm., alt. 5.7 mm., aperture: maj. lat. 6 mm., alt. 5.3 mm., umbilicus, 2 mm." (Edson.)

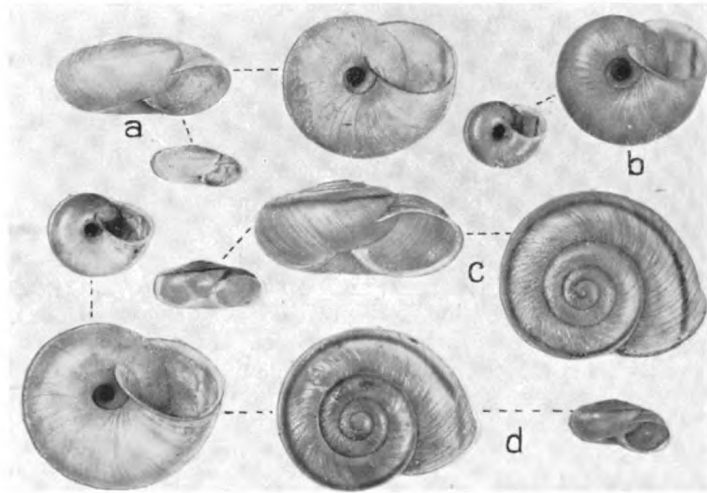


Fig. 124. *Micrarionta argus*; a, type; b, Layton Canyon; c, Indian Joe Canyon; d, Hennepin Canyon, Panamint Range. ( $\times 2$  and actual size.)

A thin, depressed shell with wide last whorl, a noticeably projecting apex and moderately open umbilicus contained about  $5\frac{1}{2}$  times in the diameter. The inner whorls increase rather slowly but the last is unusually wide; it descends rather deeply to the aperture. Color, various tints around olive-buff, often with one or two whitish radial streaks on the base, the upper surface dilute avellaneous, with a cinnamon-brown band above the periphery bordered above with a pale band. The embryonic shell of  $1\frac{1}{2}$  whorls has the initial half whorl smooth, with some radial ripples near the upper suture, the next whorl very convex, closely set with granules lengthened in a spiral direction and more or less regularly disposed in forwardly descending trends. Subsequent whorls with close, fine and irregular wrinkles of growth, and very minute, weak, sparsely scattered papillae. These continue upon the base in front of the aperture but disappear later on the body-whorl. The aperture is shortly oval with margins converging to the short parietal callus; the outer and basal margins narrowly expanded, columellar margin dilated, impinging but little on the umbilicus.

Height 5.3 mm., diameter 10.6 mm., aperture 5 x 5.7 mm.;  $3\frac{3}{4}$  whorls. Iron Cap mine.

Height 7.9 mm., diameter 15 mm., aperture 7.1 x 8 mm.; umbilicus 5.8 times in diameter;  $4\frac{1}{3}$  whorls. Indian Joe Canyon.

Height 5.5 mm., diameter 11.3 mm.; umbilicus  $5\frac{1}{2}$  times in diameter; 4 whorls. Lectotype.<sup>1</sup>

CALIFORNIA: Argus Range. Inyo County: Iron Cap copper mine (A. M. Strong), Cotypes in the geological museum of Stanford University and Academy of Natural Sciences of Philadelphia (no. 102457, Lectotype). North and middle forks of Shepherd canyon; Great Falls, Argo Canyon; Indian Joe Canyon; Graham Jones' mine, Homewood Canyon; Iron Cap copper mine; west side of canyon northward from Trona. Slate Range: at Stockwell mine; Andres Canyon; Tank Canyon; Layton Canyon; San Francisco Canyon; January Jones Canyon, 2000-2200 feet; Surprise Valley. In the Panamint Range at Goler Canyon and Broken-leg Canyon. Avawatz Mountains, east side, at Silver Lake, San Bernardino County. Red Pass, 10 miles west of Silver Lake; Jim Hyten's Mt., 10 miles south of Silver Lake (J. H. Ferriss, 1922).

Edson's material (Fig. 124 a) was dead. It appears to be a common snail in the desert mountains west and south of Death Valley. The depressed shape and very wide last whorl are its more prominent features. The papillae of the embryonic whorls show no tendency to become confluent. There is variation in their size and spacing, but with intermediate grades; so that an attempt to divide our series by that character failed. The papillae of the post-embryonic whorls are often hard to see on the upper surface; a few can generally be detected on the base in front of the aperture.

The size varies individually as usual, the smallest seen measure: diameter 10.1 mm., from the type locality, and 10.2 mm. from the Layton Canyon. In January Jones Canyon the diameter runs from 10.6 to 12.5 mm. In Indian Joe Canyon from 12 to 15 mm.,—the largest seen. Specimens from the Avawatz Mountains have close, fine nuclear papillae, measure 11.5 to 13.2 mm., and the shells are whiter than in other localities.

There is an extremely faint band between the suture and the light upper border of the shoulder band in some topotypes and other lots, rather distinct in a few, but in most shells this band is not perceptible.

In Johnson Canyon, Broken-leg Canyon (between Quail and Chuckawalla Canyons) and Hennepin Canyon, all in the Panamint Mountains, a slightly less depressed form was taken by Ferriss, the brownish zone below the suture distinct, and the umbilicus smaller. One from Hennepin Canyon (Fig. 124 d) measures: height 7 mm., diameter 13 mm., umbilicus  $6\frac{1}{2}$  times in diameter;  $4\frac{1}{2}$  whorls. One of the lot from Broken-leg Canyon has an asymmetrically projecting apex, as in *M. avawatzica*. A series from the Owl Head Mountains, between the Panamints and Avawatz ranges, is also characterized by a well-marked band between the shoulder band and suture.

<sup>1</sup> Edson's measurement of height of the same specimen exceeds mine by .2 mm., a trifling discrepancy such as one often encounters.

GROUP OF *M. INDIOENSIS****Micrarionta indioensis*** (Yates)

Fig. 125 c. f.

*Helix (Arionta) carpenteri* Newc. variety *indioensis* L. G. Yates, 1890, Nautilus, 4: 63; see also pp. 51, 52.

*Sonorella indioensis* (Yates), Bartsch, 1904, Smiths. Misc. Coll., 47: 189, pl. 33, fig. 1.

*Micrarionta indioensis* (Yates), Berry, 1922, Proc. Acad. Nat. Sci. Philad., 74: 93.

*Micrarionta indioensis indioensis* (Yates), Willett, 1930 (Apr.), Nautilus, 43: 115.

*Micrarionta (Eremarionta) callinepius* Berry, 1930 (May), Ann. Mag. Nat. Hist., (10), 5: 544.

“Shell umbilicated, rounded conical, apex obtuse, obscurely marked with one brown band, lines of growth well defined; whorls 5, rounded, suture well marked; aperture circular, entire; peristome slightly expanded except at the columella, where it is broadly expanded in a line nearly parallel with the vertical axis. Greater diameter 18 mm., height 12 mm.” (Yates.)

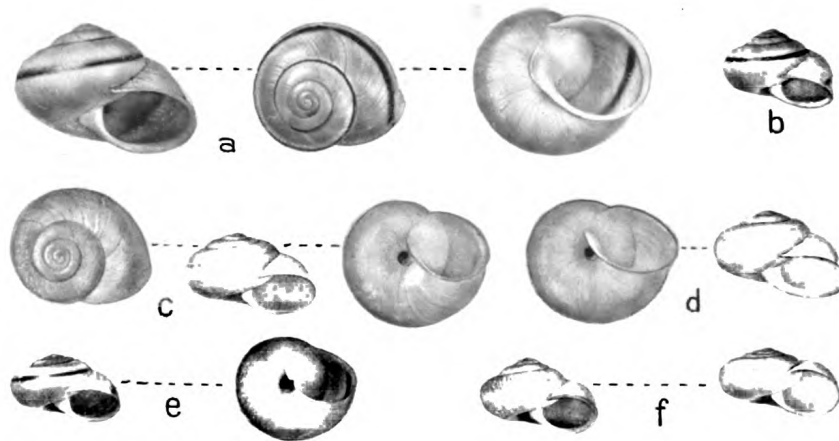


Fig. 125. a, b, *Micrarionta indioensis wolcottiana*, topotypes. c, *M. indioensis*, topotypes. d, *M. indioensis* (paratype of *callinepius*). e, *M. indioensis xerophila*. f, *M. indioensis*.

The embryonic whorls are typical of the subgenus, there being  $1\frac{1}{2}$ , the tip smooth, followed by a few radial ripples, then regular, spirally lengthened granules. The first post-embryonic whorl has minute papillae which become sparser and then disappear on the penult whorl, leaving only weak, fine growth wrinkles on the last whorl. The base is very convex. Umbilicus contained  $8\frac{1}{3}$  times in the diameter, in the type specimen (7 times in a smaller one). The aperture is nearly circular, the upper margin strongly arched, parietal callus rather short. The type measures: height 11 mm., diameter 17.8 mm.; aperture 9 x 10.2 mm.; barely  $4\frac{1}{2}$  whorls. Others run from 10 x 16 mm. to 12.5 x 8.8 mm., the last from the original lot; from another “Indio” lot smaller ones only, diameter 16 to 17 mm. So far as I know, only bleached “bones” have been found.



CALIFORNIA: Indio, Riverside County, on the south side of the valley among granite talus (Dr. Stephen Bowers), Type 62145 A.N.S.P. Cove back of Indian Wells (S. S. Berry). Occurs in its typical form from near Indian Wells, Riverside County, an undetermined distance southward. Specimens are at hand from La Quinta; Coral Reef, west of Thermal; one and one-half miles south of Coral Reef, and Fish Traps, west of Mecca. (Willett.)

Dr. Berry gives the dimensions of the largest specimen he had seen as alt. 10.5 mm., diameter 18.6 mm., diameter of umbilicus 2 mm.,  $4\frac{3}{4}$  whorls. "Examples from the immediate vicinity of Indian Wells seem variously intermediate between typical *indioensis* and the next form [*xerophila*]." (Willett.)

In *M. wolcottiana* the umbilicus is nearly covered by the broad reflection of the columellar lip. *M. callinepius* appears to me practically identical with *indioensis*; the only difference noted is that its umbilicus is a trifle narrower. The description is reprinted below, and a paratype is figured.

*Micrarionta (Eremarionta) callinepius* Berry. (Fig. 125 d.) "Shell helicoid, of moderate size and thickness low-conic; the whorls about  $4\frac{1}{2}$ , convex, increasing rapidly in size; the body-whorl ample, inflated, strongly descending parietally. Aperture large, rounded to rounded-ovate, oblique. Peristome well expanded, especially at the umbilicus; the latter of but moderate width, being contained on the average about 8.6 times in the diameter of the shell. Embryonic whorls slightly swollen and ornamented with exceedingly numerous and in good specimens very clear-cut and regularly arranged papillae; later whorls at first with a few more distant, minute, rounded papillations which soon become obsolete. Color of fresh specimens whitish below, above clouded with the usual light brownish fawn, and with a conspicuous brown spiral band shaded lighter. Max. diameter 20.0, alt. 12.3, diameter umbilicus 2.4 mm." (Berry.)

CALIFORNIA: South slope of Santa Rosa Mountains, east of mouth of Rockhouse Canyon, San Diego County (E. C. Jaeger). Type 7053 of the author's collection; paratypes to be deposited in the collections of Mr. Allyn G. Smith, the San Diego Museum, and the Academy of Natural Sciences of Philadelphia (152599).

"Characters to be noted in this species are the size, open umbilicus, tumidity of the body-whorl, large aperture, and the abundance and beautiful regularity of the embryonic sculpture which has suggested the specific name. It admittedly appears to stand rather near to the still poorly understood *indioensis* (Yates), and may eventually be connected therewith as the intermediate area is more thoroughly explored. On the other hand, it is strikingly distinct from its more immediate neighbor, the larger and more discoid *M. borregoensis* Berry." (S. S. Berry.)

**Micrarionta indioensis wolcottiana** (Bartsch)

Fig. 125 a, b.

*Helix traskii*, form, Orcutt, 1890, *Nautilus*, 4: 67.*Sonorella wolcottiana* Bartsch, 1903, *Proc. Biol. Soc. Wash.*, 16: 103.*Sonorella wolcottiana* Bartsch, 1904, *Proc. Biol. Soc. Wash.*, 17: 101; *Smiths. Misc. Coll.*, 47: 187, 188, pl. 28, pl. 31, fig. 4.*Micrarionta wolcottiana* Pilsbry, 1918, *Proc. Acad. Nat. Sci. Phila.*, p. 139, fig. 16 (anatomy); 1921, *Nautilus*, 35: 48.—Berry, 1922, *Proc. Acad. Nat. Sci. Phila.*, 74: 89, pl. 8, fig. 3 (habitat).*Micrarionta indioensis wolcottiana* (Bartsch), Willett, 1930, *Nautilus*, 43: 116.

“Shell moderately elevated, rather thin, polished, of light isabelline color, with a moderately broad dark chestnut band encircling the whorls somewhat posterior to the periphery. This band is bordered on each side by a narrow zone a trifle lighter than the general color of the shell and is usually almost completely covered in all the whorls except part of the penultimate and the last volution. Nuclear whorls one and one-half, marked by many microscopic, subspirally arranged, elongate-oval papillae. Post-nuclear whorls four and one-half, well rounded, somewhat inflated, marked by fine irregular lines of growth and a few minute scattered papillae. Sutures very distinct. Last whorl strongly deflected, the summit falling halfway between the dark spiral band and the base of the columella; slightly constricted behind the fairly well developed and somewhat reflected peristome. Columella obliquely curved, much expanded and decidedly reflected at the base where it almost conceals the umbilicus. Aperture large, oblique, rounded. Maj. lat. 23.5; min. lat. 18.5; alt. 15.5; aperture maj. lat. 14; min. lat. 12.7 mm.” (Bartsch.)

CALIFORNIA, San Jacinto Mountains: Palm Springs (Mrs. H. H. T. Wolcott),<sup>1</sup> Type 170007 U.S.N.M. Palm Canyon about 6 miles south of Palm Springs at about 1000 feet (C. M. Cooke, Jr., Pilsbry and others); Tahquitz Creek (J. A. G. Rehn, J. H. Ferriss); Chino Canyon, 2700 feet (K. R. Coolidge); Murray Canyon, 2000 feet (Berry); base of mountains west of Snow Canyon; “occurs in its typical form along the San Jacinto Range from Palm Canyon to Snow Creek. Southward from Palm Canyon it intergrades with *cathedralis*.” (Willett.)

This fine and abundant race is characterized by the nearly covered umbilicus and large aperture. The largest seen, 16.5 x 24.2 mm., is from Tahquitz Creek, the smallest, 11.2 x 15.6 mm., from Palm Canyon, under cacti. In the canyon back of Palm Springs it was found most abundant under slabs of much weathered gneiss.

*Genitalia*.—On each side of the base of the dart sack, the duct of a mucous gland arises. Each duct ascends and expands into a bulb, then is contracted, recurved upon itself, descending, becoming flattened in form of a long, thin-walled gland adhering to the vagina. As usual in the genus, one of the mucous glands rises high over the dart sack, the other being lower. The spermatheca has an extremely long, thin duct, which bears a long, slender diverticulum. Length of penis 6.5 mm., epiphallus 5 mm., flagellum 7 mm., dart sac 3 mm., vagina 7 mm.

<sup>1</sup> *Nautilus*, 17: 83.

**Micrarionta indioensis cathedralis** Willett

*Micrarionta indioensis cathedralis* Willett, 1930 (Apr.), Nautilus, 43: 115.

"Shell of about five whorls, moderately elevated, umbilicated: tan-colored, with dark brown stripe, from one-half to three-fourths of a millimeter in width, on shoulder of the last one and one-fourth whorls, a more or less indistinct lighter zone on either side of the brown band. Early whorls thickly papillated in diagonal rows, these papillations becoming less conspicuous and more scattered on the later whorls and apparently absent on the last half of the last whorl and on the base, the latter being marked only with irregular growth lines. Aperture oval, oblique, strongly and rather abruptly descending: outer lip and columella well reflected, the reflection of the latter covering about one-half of the umbilicus. The type, which is the largest of the series, measures as follows: max. diameter, 20 mm.; min. diameter, 16 mm.; height, 13 mm.; whorls five." (Willett.)

CALIFORNIA: In rock slides at the head of Cathedral Canyon, Riverside County (George and Ora Willett), Type 1022 Los Angeles Museum; paratypes are in the Willett Collection.

"This form is admittedly an intergrade between *M. indioensis* (Yates), and *M. wolcottiana* (Bartsch), being approximately half way between the two in size, as well as in the reflection of the columellar lip. . . . The intergradation between *cathedralis* and *xerophila* takes place along the south side of Cathedral Canyon; and along the north side of the same canyon, towards Palm Springs, it gradually merges into the next form [*wolcottiana*]" (Willett).

Doubtfully separable from *indioensis*.

**Micrarionta indioensis xerophila** Berry

Figs. 125 e, 126.

*Micrarionta xerophila* Berry, 1922, Proc. Acad. Nat. Sci. Phila., 74: 92, pl. 10, figs. 1-4.

*Micrarionta indioensis xerophila* Berry, Willett, 1930, Nautilus, 43: 115.

"Shell strongly depressed, of moderate weight; whorls convex; sutures distinct; last whorl strongly descending behind peristome. Umbilicus of moderate width, being contained about seven times in the diameter of the shell, funicular permeable. Aperture strongly oblique, its deflection about 45°. Peristome distinctly thickened, its margin somewhat reflected, especially near the umbilicus, the circular outline of which, however, is scarcely affected. Nuclear whorls heavily covered with elongate, moderately crowded papillae, more or less distinctly ranked in oblique, forward slanting lines; subsequent whorls showing gradually smaller, more granular and less crowded papillae, which finally become practically obsolete on the body whorl both above and below. Spiral structure wanting. Periostracum, except for the papillae and numerous fine lines of growth, smooth, thin, lustrous. Shell moderately to conspicuously encircled by a narrow band, 0.5-1.0 mm. wide, varying in color from deep brownish vinaceous in light toned shells, to liver brown in darker ones, this band bordered above and below by very light bands about twice as wide, which vary from white to light ivory yellow; base of shell pale grayish vinaceous to avellaneous; region below suture pale grayish vinaceous to deep brownish vinaceous;

shell on living animals pale olive buff, passing to cinnamon drab near suture, often much mottled or clouded. Body of animal varying from slate black to black, shading slightly lighter toward margin; mantle neutral gray to slate gray, without conspicuous pigment patches; sole of foot deep neutral gray, shading rather abruptly to blackish slate at margin. Max. diameter 16.7 mm., min. diameter 13.5 mm., alt. 9.2 mm., diameter umbilicus 2.3 mm.;  $4\frac{1}{2}$  whorls." (Berry.)

Paratypes measure from 8.2 x 14 mm. to 10.1 x 17 mm.

CALIFORNIA: Five miles west of Indian Well, Riverside County, at 4-600 feet, in crevices and under stones on slope on Ocean-to-Ocean Highway (George Willett), Type 4888 Berry Collection; paratype 130809 A.N.S.P.

Living shells "could be obtained only by digging out the loose detritus in the lee of large rocks, following up crevices or turning stones. They were generally within a few inches of the surface; and whenever deeper digging was attempted we met with no success." (Berry.)

"This rather slightly differentiated form occurs from a short distance north of Indian Wells to the southern side of Cathedral Canyon, specimens having been taken from a number of different localities within this range. It differs from typical *indioensis* principally in being slightly more depressed; also, it may average somewhat smaller." (Willett.)

The genitalia are illustrated in Fig. 113 a.

(Ξηρός, arid, φίλος, lover.)

***Micrarionta indioensis remota* Willett**

*Micrarionta indioensis remota* Willett, 1937 (Apr.), *Nautilus*, 50: 124.

"Shell small, thin, umbilicated. Color light horn, with narrow brown band; upper part of last whorl, between band and suture, clouded with grayish. First one and one-half whorls with elongated papillae in diagonal rows, as in *indioensis* group; followed by wider spaced, irregularly shaped papillae, which gradually become fainter, being almost imperceptible on



Fig. 126. *Micrarionta i. zerophila*, type  $\times 2$ . (After Berry.)

the latter part of the last whorl and on the base. Diameter 13.3, alt. 8 mm.;  $4\frac{1}{2}$  whorls. The largest specimen in the type lot measures 14.5 x 9.1 mm." (Willett.)

CALIFORNIA: Borego Mountain, San Diego County (George and Ora Willett), Type 1050 Los Angeles Museum. The type and eight additional (mostly dead) were collected February 14, 1937.

"Nearest to *M. i. xerophila* Berry, but differs from that form in smaller size, duller coloration, narrower brown band, and lack of contrast in color between band and rest of whorl.

"Borego Mountain is an isolated hill just north of the Julian-Kane Springs highway, about seven miles east of San Felipe Narrows, and completely surrounded by the desert floor. It lies between the Vallecitos and the Santa Rosas, being about four miles from the former mountains and nine miles from the latter. The snail, however, is definitely related to the forms inhabiting the Santa Rosas. Although, as previously stated, this shell is very similar in outward appearance to *xerophila*, the genetic relationship of the two races can hardly be very close, as their ranges are forty miles apart, on different drainages, and another race, *indioensis*, occupies intervening territory." (Willett.)

(*Remotus*, distant.)

**Micrarionta ora** Willett

Fig. 127 a.

*Micrarionta ora* Willett, 1929 (Oct. 20), Bull. So. Cal. Acad. Sci., 28: 17, fig. on p. 19.

"Shell depressed, whorls convex, sutures distinct; last whorl strongly descending behind peristome. Umbilicus wide and deep, contained about five and one-half times in diameter of shell. Aperture strongly oblique; peristome somewhat thickened, rounded, encroaching slightly on the umbilicus. Nephronic stage covered with irregularly shaped papillae, some of which are more or less rounded and others oblong, the axes of the elongated papillae being almost at right angles to the suture. At the beginning of the neanic stage, which embraces about one and one-fourth turns, the papillae become more elongated and regular, being in alternate rows, with their axes parallel to the suture. In the type specimen these papillae are regular and distinct and show little indication of fusion, as in *M. harperi* Bryant. On the subsequent whorls the papillae are much smaller, more rounded and more widely scattered, and are apparently absent on the last third of the last whorl. Base free from papillae, excepting in the aperture and in the umbilicus. Color of shell white or ivory yellow, passing into brownish on spire; a narrow brown band about .6 mm. wide encircling the shoulder." (Willett.)

Max. diameter 18.4 mm., min. diameter 15.4 mm., alt. 10.9 mm., umbilicus 3.4 mm.; 5 whorls. Type.

Max. diameter 16.9 mm., min. diameter 14.2 mm., alt. 9.5 mm., umbilicus 2.9 mm.;  $4\frac{1}{2}$  whorls. Paratype.

Max. diameter 18.1 mm., min. diameter 15.4 mm., alt. 10.8 mm., umbilicus 3.0 mm.;  $4\frac{1}{2}$  whorls. Yaqui Wells.

CALIFORNIA: Vallecito (including Fish Creek) Mountains, north to San Felipe Narrows, Sentenac Canyon (both sides), and head of Blair Valley, and northeast side of Laguna Mountains (Agua Caliente Springs). The type found in rock slides near the north end of Fish Mountains, Imperial County, about three miles from the settlement of San Felipe (George Willett), Type 1018 Los Angeles Museum; paratypes in Willett Collection.

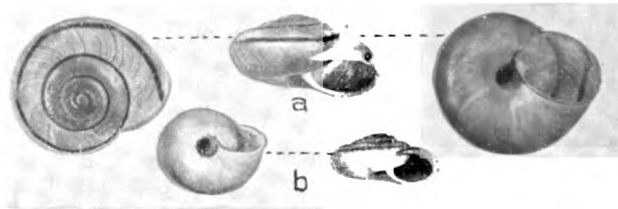


Fig. 127. a, *Micrarionta ora*. b, *M. ora carrizoensis*, paratypes.

“The material at hand at this time shows *M. ora* to differ strongly from typical *orcutti* in much smaller umbilicus, and from *harperi* in much lighter papillation and in lack of same on base of shell and on the last third of the last whorl. Furthermore, if recorded specimens of *orcutti* and *harperi* are adult shells, *ora* is considerably larger than either of them [up to diameter 21.5 mm.; averaging considerably darker in color; papillation, in most specimens, only prominent on upper part of early whorls].

“Recent descriptions of species of this group of micrariontas have almost invariably placed great importance upon the differences in the scheme of papillation of the nuclear whorls. In fact, the reader of these descriptions would receive the impression that there was little variation in this regard within the species, and that such variations might be regarded as specific characters. A study of the nuclear characters of *M. ora* would seem to point to the conclusion that the importance of differences of papillation may have been over-emphasized, possibly due largely to scanty material. The arrangement of papillae described in the type of *M. ora* seems to be the usual one in the species, but there is considerable variation in the type series. In some specimens the papillae merge into slender lines, some of which lines run diagonally to the suture and others parallel with it. In others some of the papillae merge in such a way as to form more or less rectangular, shallow pits.

“The writer names this species in honor of his wife, Ora A. Willett, who assisted in collecting the type series and who, for several years past, has rendered valuable aid in the field.” (Willett.)

**Micrarionta ora carrizoensis** Willett

Fig. 127 b.

*Micrarionta harperi carrizoensis* Willett, 1937 (Apr.), *Nautilus*, 50: 123.

"Resembles *M. ora* in general sculpture (lacking strong papillation on later whorls), but much smaller (max. diameter, 14 mm.), flatter and lighter color. Max. diameter, 14; min. diameter, 11.6; alt. 7.7 mm.; 4 $\frac{3}{4}$  whorls." (Willett.)

CALIFORNIA: Hills above Painted Gorge, Carrizo Mountain, Imperial County, Type 1049 Los Angeles Museum (George and Ora Willett), paratypes 168617 A.N.S.P. and in Willett Collection.

**Micrarionta harperi** (Bryant)

Figs. 128, 129.

*Epiphragmophora harperi* Byrant, 1900 (Apr.), *Nautilus*, 13: 143.*Micrarionta harperi* (Bryant), Berry, 1922, *Proc. Acad. Nat. Sci. Phila.*, 74: 94, pl. 10, figs. 5-8.

"Shell umbilicate, translucent, white; suture well defined; spire a depressed cone composed of five regularly increasing convex whorls, the first three smooth, the remainder marked by obscure, closely-crowded, oblique lines of growth; base convex; aperture nearly circular, oblique; peristome thin, broadly expanded, and reflexed at lower third of baso-columellar portion, its extremities joined by an elevated ridge, bordering which is a somewhat triangular callus bounded on the inner side by a ridge extending from the middle of the base of the reflected portion of the peristome obliquely to the upper part of the basal whorl; width of umbilicus about one-fifth greater diameter of shell. Numerous dark microscopical lines extend from the peristome over the body whorl nearly perpendicular to the lines of growth. Greatest diameter 17, least diameter 14, alt. 9 mm." (Bryant.)

"Shell strongly depressed, of moderate weight; whorls convex; sutures distinct; last whorl strongly descending behind peristome. Umbilicus wide and deep, contained about six times in the diameter of the shell, funicular, permeable, all the whorls easily visible to the apex. Aperture strongly oblique, its deflexion about 45°-50°. Peristome but little thickened, hardly reflexed except slightly at the umbilicus, which it barely indents. Nuclear whorls heavily covered with narrow, elongate papillae, ranked in oblique, forward slanting lines so close together as to be almost or quite confluent, the lines thus being transformed practically into low lirae; papillae on subsequent whorls less crowded and always smaller and rounder than the foregoing, being very obscure on the upper surface of the last turn, minute, well spaced, and granular on almost the whole of the basal surface. Spiral sculpture wanting. Periostracum, except for the papillae and numerous fine lines of growth, smooth, thin, and lustrous. Shell white or very light ivory yellow, passing to avellaneous on the spire; a narrow fawn band, about 0.7 mm. wide encircling the shoulder, flanked both above and below by an obscure whitish band of approximately the same width. Max. diameter 15.5 mm., alt. 8.5 mm., diameter umbil. 2.5 mm.; 4 $\frac{3}{4}$  whorls." (Berry.)

CALIFORNIA: "San Jacinto Mountains" (Bryant). "Warner Hot Springs, San Diego County" (Bryant, label in California Academy of Sciences collection, 8676A, see page 254).

I have not seen this species. Specimens from F. W. Bryant are in the collection of the California Academy, obtained through Hemphill, and were described by S. S. Berry whose account is quoted above. The identity of *M. harperi* with *M. ora* affirmed by Willett (*Nautilus*, 50: 122) is now considered inadmissible by him.



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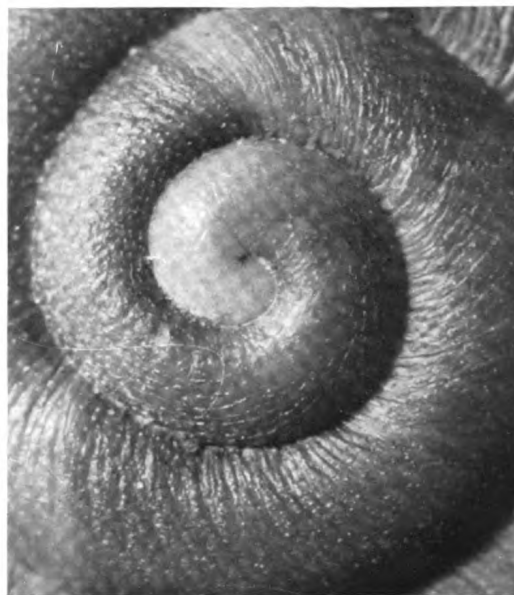


Fig. 128: 5, 6, 7. *Micrarionta harperi*. ( $\times 2$ .)

Fig. 129. Apical whorls of same, much enlarged. (After Berry.)

Distinct granulation extends over the last whorl in *harperi* and *orcuttiana*, but not in *ora* and *carrizoensis*.

Concerning the locality Willett wrote as follows: "That Bryant's specimens came from either the San Jacinto Mountains, as now restricted, or Warner Springs, as believed by Berry, appears doubtful. No *Micrarionta* has since been found at Warner Springs, though diligently searched for by numerous conchologists. Furthermore, the type of terrain immediately contiguous to Warner Springs is not characteristic *Micrarionta* territory, and is occupied by *Helminthoglypta*. . . . Apparently many early collectors failed to realize the importance of exact localities, and specimens from a



considerable area might be recorded as from the place where the collector was making his headquarters. It is probable that this method was followed by Bryant." It is at present a lost species.

**Micrarionta harperi orcuttiana** Bartsch

Fig. 130.

*Sonorella baileyi orcutti* Bartsch, 1904 (Oct.), *Smiths. Misc. Coll.*, 47: 196, pl. 33, fig. 5. Not *Epiphragmophora orcutti* Dall, 1900, also a *Micrarionta* (*Xerarionta*).

*Micrarionta orcutti* (Beh.) Berry, 1922, *Proc. Acad. Nat. Sci. Phila.*, 74: 96.

*Micrarionta harperi orcutti* (Beh.), Willett, 1937 (Apr.), *Nautilus*, 50: 123.

*Micrarionta harperi orcuttiana* Bartsch, 1937 (July), *Nautilus*, 51: 33.

"A lot of specimens collected by Mr. Orcutt in the Colorado desert agree in nuclear character and in many other respects with *S. baileyi*, but differ in the deflection of the aperture which is greater, and in its shape which is more oval; the umbilicus is also larger. This variety may be called *Sonorella baileyi orcutti*. The type (No. 175,082, U. S. Nat. Museum) measures: maj. lat. 16 mm., min. lat. 13.7 mm., alt. 9.1 mm.; aperture: maj. lat. 7 mm.; alt. 6.8 mm.; umbilicus about 3.5 mm." (Bartsch.)



Fig. 130. *Micrarionta harperi orcuttiana*. ( $\times 2$  and actual size.)

The embryonic shell of about  $1\frac{1}{2}$  whorls is densely covered with hyphen-shaped papillae in spiral trends, in places running together to form irregular lines, or sometimes protractive, decurrent lines. Some scattered papillae are seen on later whorls as far as the end of the penult, in the type, which is an old, wholly bleached shell. Other fresh specimens from Mountain Springs are distinctly papillose on the last whorl also, both above and on the base.

CALIFORNIA: South end of Laguna Mountains, in both San Diego and Imperial Counties, from one mile west of Mountain Springs to three miles east of that point (Willett).

"Differs from the preceding races [*ora*, *carrizoensis*] in rougher surface, and in being strongly papillated, above and below, on all the whorls. Maximum diameter 16 mm., hence considerably smaller than [*ora*] and slightly larger than *carrizoensis*. Varies somewhat in shape, but very little in sculpture. About fifty specimens (mostly dead) have been examined. An unusual feature of this shell is that it occurs, not only among rocks, but also under mats of dead agave plants. This is the only instance of an *Ere-marionta* being found in such a situation that has come to the attention of the writer." (Willett.)

Dr. Berry states that when asked about the locality of this snail, Mr. Orcutt was no longer certain, but believed the specimens described came from near Mountain Springs, Imperial County. This has been confirmed by Willett, who collected specimens at Mountain Springs which I find indistinguishable from the type specimen, when in the same state of preservation.

(Named in honor of the Californian naturalist C. R. Orcutt.)

**Micrarionta morongoana** Berry

Fig. 131.

*Micrarionta (Eremarionta) morongoana* Berry, 1929 (Oct.), Nautilus, 43: 39.

"Shell helicoid, of moderate size and thickness, depressed-conic; the whorls usually  $4\frac{1}{2}$  or  $4\frac{3}{4}$ , rapidly enlarging, the last tumid and descending parietally. Aperture large, oval, oblique, the peristome distinctly thickened and everted, especially at the columella. Umbilicus moderate, its diameter



Fig. 131. *Micrarionta morongoana*.

contained usually about 9 or 10 times in that of the shell. Embryonic shell studded with numerous strong hyphen-shaped papillae arranged in forward-slanting lines, this ornamentation giving way on subsequent whorls to a more minute and less definite papillation which becomes wholly obsolete before the formation of the body-whorl. Periostracum thin and polished, the coloration generally similar to that of other species of the group and with a conspicuous brown band bordered by lighter areas, but the interior is more or less ochraceous. Max. diameter 20.1, alt. 11.1, diameter umbilicus 2.5 mm." (Berry.)

CALIFORNIA: Gulch on north side of Morongo Pass, 2 miles below the Morongo Inn, Colorado Desert (E. P. & E. M. Chace). Type 6500 Berry Collection.

"This interesting and very distinct species shows some affinity with the *indioensis-wolcottiana* group of the genus, but differs in its tumid body-whorl, expanded aperture and ochraceous interior." (Berry.)

**Micrarionta borregoensis** Berry

Fig. 132.

*Micrarionta (Eremarionta) borregoensis* Berry, 1929 (Oct. 17), Nautilus, 43: 39.

*Micrarionta reedi* Willett, 1929 (Oct. 20), Bull. So. Cal. Acad. Sci., 28: 17, 19, pl. 6, lower figs.

"Shell helicoid, large for the group and fairly thick, [spire] depressed-conic; whorls about 5, convex, with the last moderately descending parietally. Aperture rounded, oblique. Peristome little thickened and but slightly everted except at the umbilicus; the latter wide, a little less than  $\frac{1}{2}$  the diameter of the shell. Embryonic whorls microscopically heavily papillose, the periostracum otherwise devoid of sculpturing. Color of shell light brownish fawn, with a conspicuous brown spiral band margined lighter. Max. diameter 22.0, alt. 11.8, diameter umbilicus 2.5 mm." (Berry.)



Fig. 132. *Micrarionta borregoensis*.

CALIFORNIA: Palm Canyon, west side of Borrego Valley, San Ysidro Mountains, San Diego County (F. M. Reed, J. M. Klauber, also G. Willett). Type 6913 Berry Collection.

Mr. Willett described *M. reedi* from the same place, in part from the same lot, discovering too late for withdrawal that his description had been anticipated. I have confirmed the identity by examination of paratypes from both authors. Willett's description follows:

"Shell large for the group, whorls convex, sutures distinct; last whorl strongly descending behind peristome. Umbilicus wide and deep, contained about six times in diameter of shell. Aperture strongly oblique; peristome thickened, expanded, encroaching somewhat on the umbilicus. Embryonic whorls covered with irregular, elongate papillae, some of which have their long axes parallel to the suture and others at various angles to it. Later whorls smooth, except for lines of growth. Color of living specimens light brown, encircled at the shoulder by a very dark brown (almost black) band, about one millimeter wide, with indefinitely defined lighter zones above and below. Max. diameter 21.7 mm., min. 18.3 mm., alt. 12.3 mm., umbilicus 3.6 mm.; 5 whorls, type."

A paratype measures: 13.4 x 23.5 mm., umbilicus 3.9 mm., 5 $\frac{1}{4}$  whorls.

"This is the largest of the known Californian eremariontas with the exception of *M. wolcottiana* Beh., from which it is distinguishable at sight by its open umbilicus and more depressed form." By the irregularity of the papillae on the nuclear whorls it has some resemblance to *M. rixfordi*, differing from the more regular papillation of the *indioensis* group.

GROUP OF *M. RIXFORDI****Micrarionta rixfordi*** Pilsbry

Fig. 133.

*Micrarionta rixfordi* Pilsbry, 1919 (Oct.), Nautilus, 33: 53.—Willett, 1930, Bull. So. Cal. Acad. Sci., 29: 17; 37: 15.

*Micrarionta (Eremarionta) aetotis* Berry, 1928 (May), Ann. Mag. Nat. Hist., (10), 1: 619, figs. 1, 2.

*Micrarionta (Eremarionta) depressispira* Berry, Ann. Mag. Nat. Hist., (10), 1: 621, figs. 3-5.

The shell is strongly depressed, umbilicate, the diameter of umbilicus contained about 6.2 times in that of the shell. Embryonic shell of  $1\frac{1}{2}$  whorls has an extremely small smooth area at the tip, followed by an irregular raised reticulation; on the last embryonic half whorl this becomes broken into hyphen-shaped granules, partly separate, partly concretescent into short, irregular, obliquely spiral wrinkles. Some small papillae in forwardly descending trends are seen on the third whorl. Subsequent whorls are delicately marked with growth lines only, moderately convex, the last slowly and rather deeply descending to the aperture, rounded peripherally, and encircled with a brown band above the periphery. The aperture is strongly oblique, irregularly oval. The peristome is thin, basal margin narrowly expanded, columellar margin somewhat dilated, but covering only a very small part of the umbilicus. The parietal callus is very thin.

Height 9.5, diameter 16.7 mm.; umbilicus 3.1 mm.;  $4\frac{2}{3}$  whorls.



Fig. 133. *Micrarionta rixfordi*, type and paratype.

CALIFORNIA: Foot of the mountains on the southern edge of the Mohave Desert about 10 miles west of Twenty-nine Palms, Riverside County, among rocks (Dr. Emmet Rixford), Type and two other specimens 129781 A.N.S.P. Also Eagle Mountains and northeast end of the Orocochia Range (Willett).

Rixford's desert snail is characterized by the compactly coiled shell of nearly five whorls, and the partial transformation of the granules of the embryonic shell into an irregular network or reticulation, following which the usual spirally lengthened granules are seen, part of them united to form short ridgelets, oblique or spiral. The smooth area at the tip is of very small extent. The specimens are practically alike in these features.

Twenty-nine Palms is in San Bernardino County, but the road westward dips into Riverside County; I am not sure which county can claim *M. rixfordi*. The original specimens were picked up dead and except for the shoulder band, show no color.

Mr. George Willett writes: "During the past two years the writer has collected about a dozen mature specimens of *M. rixfordi* at, or very near, the type locality, which is given as 'ten miles west of Twenty-nine Palms,' and as many more in Forty-nine Palms Canyon, three or four miles from the type locality, in the same range of hills.

"The type of *M. rixfordi*, according to Dr. Pilsbry, has a maximum diameter of 16.6 millimeters, umbilicus of 3.1 millimeters, and four and two-thirds whorls. The largest specimen in our series has four and seven-eighths whorls and a maximum diameter of 17.6 millimeters.

"Twenty shells from the Eagle Mountains, about thirty-five miles south-easterly from the type locality of *rixfordi*, and the type locality of Dr. Berry's *Micrarionta aetotis* appear indistinguishable from *M. rixfordi*, as do, also, twenty-two specimens from the type locality of *M. depressispira*.

"The high spire and compact coiling given as the differentiating characters of *aetotis*, are both variable features, extremes of which may be found throughout the series examined, regardless of locality.

"The larger size and wider umbilicus claimed for *M. depressispira* are not apparent when a sufficient series of specimens is studied. Neither does the spire in our specimens average any more depressed than in our series of typical *rixfordi*. True, the type of *depressispira* is six-tenths of a millimeter larger than any other specimen yet examined. However, it has also an additional eighth of a whorl, which would indicate that the slightly larger size of this specimen is a result of natural growth. As to the wider umbilicus attributed to *depressispira*, our series does not show any such character. Furthermore, eliminating our series entirely and considering only the specimens used in the descriptions of *rixfordi* and *depressispira*, we find that the type of the latter, while possessing a third of a whorl more than the type of the former and one and one-fourth millimeters greater diameter, has an umbilicus only one-tenth of a millimeter greater. Also, the third specimen of *depressispira* cited by Dr. Berry, with a diameter only one-tenth of a millimeter less than the type of *rixfordi*, has an umbilicus four-tenths of a millimeter smaller.

"The color of the shells seems identical throughout the series, when results of fading in dead specimens are considered. The general coloration of living specimens is dark horn-color, with band of mummy-brown, and a rather indefinite lighter zone on either side of the band.

"After consideration of the above, the writer believes that both *Micrarionta aetotis* and *M. depressispira* should be considered synonyms of *Micrarionta rixfordi*, and that the range of the latter, as now known, is from a point ten miles west of Twenty-nine Palms, to, and including, the Eagle Mountains."

The type of *M. aetotis* measures: "Max. diameter 16.2 mm., min. diameter 14.1 mm., alt. 9.3 mm., diameter umbilicus 2.5 mm.; 5½ whorls." Paratypes measure from 8.2 x 14.5 mm., umbilicus 2.4 mm., 4¾ whorls, to 8 x 15.5 mm., umbilicus 2.5 mm. It was from the northwest promontory of Eagle Mountains among granitic rocks on the slope; also taken near the forks, west side of Palm Canyon, Eagle Mts., Edmund C. Jaeger. Type 6442 Berry Collection, paratypes 146095 A.N.S.P.

*M. depressispira* measures: "Max. diameter 18.2 mm., min. diameter 15.4 mm., alt. 9.2 mm., umbilicus 3.2 mm.; 5 whorls; type. Max. diameter 16.1 mm., min. diameter 13.5 mm., alt. 8.2 mm., umbilicus 3.0 mm.; 4¾ whorls; paratype." It came from an isolated northwestern outlier of the Eagle Mountains, just west of the road leading south from Pinto Basin, Riverside County; Type 6445 Berry Collection.

**Micrarionta avawatzica** Berry

Fig. 134.

*Micrarionta (Eremarionta) avawatzica* Berry, 1930 (Aug.), Ann. Mag. Nat. Hist., (10), 6: 190, figs. 5-8.

"Shell of moderate size and thickness; low-conic in outline; whorls 4½ to 4¾, strongly convex, high-shouldered, with well-grooved suture; last whorl strongly descending parietally. Aperture rounded or sometimes almost

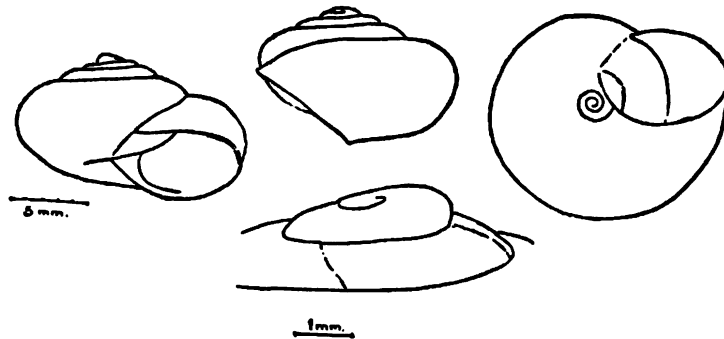


Fig. 134. *Micrarionta avawatzica*, type  $\times 2$ , and slightly oblique view of apex  $\times 7.5$  (after Berry).

subtriangular, due both to the shouldering and to a certain squaring below the columella, strongly oblique, the deflection usually  $50^\circ$  or more. Peristome hardly at all thickened or expanded, save for a moderate flare at the umbilicus, which does not greatly affect the circular outline of the latter. Umbilicus of moderate width, funicular, narrowly permeable to the apex. Its diameter contained in that of the shell about 6½ to 7 times. Spiral sculpture wanting; embryonic shell with first half-whorl initially smooth and vitreous, then incompletely concentrically wrinkled, the wrinkles breaking up on the succeeding full whorl into coarse pustulations which at first show some evidence of arrangement in forward-slanting lines, but are soon more irregular with such degree of confluence and anastomosis as to give

the effect of an irregular and incomplete reticulum rather than true papillation. The principal whorls subsequent to this have the appearance of being covered with low scattered papillae superimposed on a minutely wrinkly-papillose surface, the whole pattern becoming nearly obsolete on the body-whorl both above and below. Lines of growth numerous and very strong on the post-embryonic whorls, more notably on the earlier ones. Embryonic shell after the first half-turn remarkable for being strongly inflated, particularly on one side (cf. Fig. 134), so that it appears to be set into the subsequent coil somewhat obliquely. Periostracum in fresh shells with a peculiar satiny or waxy lustre, most evident on the upper surface and along the sutures, where the surface has an aspect under the microscope almost as if wet: ground-color of base and peripheral part of body-whorl cartridge-buff to tulleul-buff, deepening on the upper part of the whorl and the spire to vinaceous-buff, with a conspicuous supraperipheral band of chestnut about 1 mm. wide, bordered by a very pale area just above and below. Max. diameter 15.4 mm., min. diameter 13 mm., alt. 8.5 mm., diameter umbilicus 2.4 mm.;  $4\frac{1}{2}$  whorls." (Berry.)

A paratype measures 8.6 x 15.1 mm., umbilicus 2.1 mm.,  $4\frac{1}{2}$  whorls; specimens from the second station have diameters from 15 to 17.3 mm.

CALIFORNIA: Station II, rocky point west of road in pass at junction of Barstow and Silver Lake roads, 5 miles south of Cave Spring, Avawatz Mountains, San Bernardino County (S. S. Berry, W. H. Ott, and C. B. Cherry); living ones in a small rock-slide just north of the point, many dead shells scattered about on the surface. Type 6884 Berry Collection; paratypes 6885 in the same collection; others to be deposited in the collections of Mr. Allyn G. Smith, the Academy of Natural Sciences of Philadelphia (152598), the San Diego Museum of Natural History, and the British Museum (Natural History). Also in a rock-slide at base of hill to east of road nearly opposite type Station, Avawatz Mountains (S. S. Berry, A. H. Bliss and others).

"This very distinctive and pretty species seems closely allied to none of its fellows hitherto described. Distinctive characters to note are the peculiar satiny sheen, the very oblique aperture, the shouldering, and especially the peculiar eccentric swelling of the embryonic shell." (Berry.)

It is very closely related to *M. rixfordi*, but differs by the projecting apex and slightly smaller umbilicus.

***Micrarionta avawatzica eremita* new subspecies**

Fig. 135.

The shell is less depressed than *M. argus*, cinnamon-brown above, a more dilute tint of the same at base, fading towards the umbilicus, with a chestnut-brown band about .7 mm. wide above the periphery, bordered with white bands of about the same width above and below it. Embryonic whorls with the papillae largely confluent into irregular threads which spirally ascend slowly, or in places anastomose into a loose net-work. Subsequent whorls have sparse minute papillae, which do not reach to the

last whorl. The whorls increase slowly, the spire being wider than in *M. argus*; apex not mucronate; last whorl descending in front. Aperture rounded. Umbilicus contained 7 times in the diameter.

Height 7.5 mm., diameter 14 mm., aperture 6.5 x 7 mm.;  $4\frac{1}{2}$  whorls.

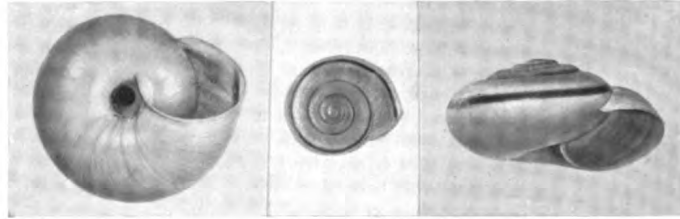


Fig. 135. *Micrarionta avawatzica eremita*, type. ( $\times 2$  and actual size.)

CALIFORNIA: Gunsight Mountains, 3 miles south of Resting Springs, Inyo County (J. H. Ferriss), Type 130901 A.N.S.P.

The spire is less elevated than in *M. avawatzica*, the first whorl not projecting as in that species, and the embryonic sculpture is less irregular. The value of these characters is uncertain; I have noticed an asymmetrically elevated apical whorl in rare individuals of *argus* and other species. A few shells taken by Ferriss 12 miles south of Zabriskie and in the Granite Mts. 5 miles west of Leach's Spring, resemble *eremita* except that the long papillae of the embryonic whorl are not confluent. Without large series, no opinion of value can be formed.

(Ἐρημίτης, hermit.)

***Micrarionta baileyi*** (Bartsch)

Fig. 136.

*Epiphragmophora magdalensis* (in part), Dall, 1897, Proc. U.S. Nat. Mus., 19: 339.  
*Sonorella baileyi* Bartsch, 1904 (Oct.), Smiths. Misc. Coll., 47: 195, pl. 33, fig. 4.



Fig. 136. *Micrarionta baileyi* (after Bartsch).

“Shell rather depressed; general coloration light flesh color with a moderately broad pale brown band encircling the whorls a little above the periphery. This band is only partly visible above the suture, above the last volution. The nepionic stage is rather small, embracing only about one-fourth of a turn; it is sparingly marked with transverse wrinkles. The neanic portion consists of one and one-half volutions, which are ornamented by incremental lines upon which are placed the characteristic sculpture of



the section, the lines seeming to consist of fused attenuated papillae. This species therefore shows a tendency toward the group of *S. wolcottiana*. Ephebic whorls a little more than three, moderately rounded, less so between the sutures than on the base, marked by many incremental lines, and somewhat distant regularly disposed rows of small oval papillae which have an arrangement similar to that found on the neanic portion of the *S. wolcottiana* group, i. e., alternate series fall in the same spiral plane and this lends the whorl the appearance of being crossed by interrupted curved lines of papillae passing from the summit of the whorls very obliquely forward and downward to the suture. The papillae are best developed between the sutures on the early whorls; they appear to become gradually lost on the last half of the last whorl. The last whorl is moderately deflected at the aperture, which is of medium size, very oblique, almost circular and scarcely expanded. Columella only slightly expanded at base; parietal wall covered by a thin callus; umbilicus moderately wide and open at the apex. The type measures: maj. lat. 15.1 mm., min. lat. 13.2 mm., alt. 7.5 mm.; aperture: maj. lat. 6.6 mm., alt. 7.2 mm.; umbilicus about 2 mm." (Bartsch.)

CALIFORNIA: Resting Springs, Inyo County, among rocks on a dry hill 900 feet above the spring (Vernon Bailey, Death Valley Expedition), Type 123,907 U.S.N.M.

The type of this species, which I have examined, has apical sculpture entirely like that of *M. rixfordi*. It is more depressed than *M. avawatzica*, the embryonic whorl not tilted up. It is slightly more depressed than *M. avawatzica eremita*; but all of these forms are very much alike, and further collections in the vicinity of Resting Springs may perhaps show that our distinctions are rather fine-drawn.

#### GROUP OF *M. MICROMETALLEUS*

##### *Micrarionta micrometalleus* Berry

Fig. 137.

*Micrarionta (Eremarionta) micrometalleus* Berry, 1930 (Aug.), Ann. Mag. Nat. Hist., (10), 6: 189, figs. 3, 4.

"Shell small, thin, fragile, very low-conic to sub-discoid; whorls usually 4½, quite strongly convex, only moderately widening as they progress, the suture strongly marked; last whorl somewhat shouldered and moderately descending parietally. Aperture rounded, moderately to rather strongly oblique, its deflection from the vertical about 40. Peristome barely thickened and hardly expanded even at the columella. Umbilicus wide and well-like, its diameter on the average about ½ that of the shell. Spiral sculpture wanting; embryonic shell smooth and hyaline for the first fraction of a turn, then suddenly covered, as far as the first major resting-stage, by numerous small, rather elongate, pointed papillae arranged in forward-slanting lines, but so close together (on the later portions even more or less confluent) that the effect under low magnification is sometimes almost like minute scales; remainder of shell everywhere covered above and below by a minute granular papillation, rendered to a large degree irregular and indistinct by

the numerous heavy and rather uneven lines of growth, which become especially coarse and prominent just back of the aperture. Periostracum of fresh shells thin, pale wood-brown above, a lighter avellaneous on base, only weakly lustrous, with a narrow, indistinct, more or less interrupted, buffy-brown band above the periphery; texture horny rather than porcellaneous. Animal hair-brown, deepening on tentacles, back of the head and sole-margin to cheatura black. Max. diameter 9.6, min. 8.2, alt. 4.6 mm.; umbilicus 1.7 mm.;  $4\frac{1}{4}$  whorls." (Berry.)

Paratypes measure from 4.3 x 9 mm. to 5.4 x 10.2 mm.



Fig. 137. *Micrarionta micrometalleus*. ( $\times 2$  and actual size.)

CALIFORNIA: Base of granite rock-slide in the El Paso Range,  $3\frac{1}{2}$  miles south of Petrified Forest, Kern County; many bleached dead shells in slide, with 3 mature and 1 immature living snails found in aestivation sealed to rocks over 2 feet down; no moisture evident (L. G. Ingles), Type 7071 Berry Collection; paratypes No. 7072 of the same collection; others to be deposited in the collections of Mr. Allyn G. Smith, the Academy of Natural Sciences of Philadelphia (152601), and the British Museum (Natural History).

"This, the smallest Mohavean helicoid thus far described, is further characterized by the much-depressed, almost discoid form, the comparatively slowly enlarging whorls, the well-like umbilicus, the obscure banding, the papillose surface, and the coarse growth-striae, which give a rough crude appearance to the upper surface of the shell. It is a very distinct and characteristic species, apparently not closely allied to any other we know. From the extreme western part of the Desert, it is likewise the first of its genus to be discovered in Kern County. The specific name is derived from *μικρος*, small, and *μεταλλεύς*, miner, and has reference to the minute size of the species and its delving habit." (Berry.)

#### GROUP OF *M. AQUAEALBAE* (Section *Chamaearionta* Berry)

*Chamaearionta* was proposed as a subgenus by Berry (1930, *Nautilus*, 43: 75) characterized by "small size, thin lip, heavy papillation of the entire surface, rough brownish periostracum, brownish maculations on animal." Genitalia (Fig. 113 b) as in *Eremarionta*.

**Micrarionta aquaealbae** Berry

Figs. 138, 139.

*Micrarionta aquae-albae* Berry, 1922 (Aug. 18), Proc. Acad. Nat. Sci. Phila., 74: 87, pl. 8, fig. 2; pl. 9, figs. 2-6.

"Shell small, thin, depressed-conic, umbilicate, the umbilicus deeply permeable, its diameter contained about six times in that of the shell. Whorls four, convex, subcarinate, with deeply channeled sutures, the last whorl only slightly descending in front. Aperture ample, obscurely angulate at the periphery, strongly oblique, its deflection about 40°. Peristome thin, sharp, not reflected except slightly at the umbilicus, its edges strongly con-

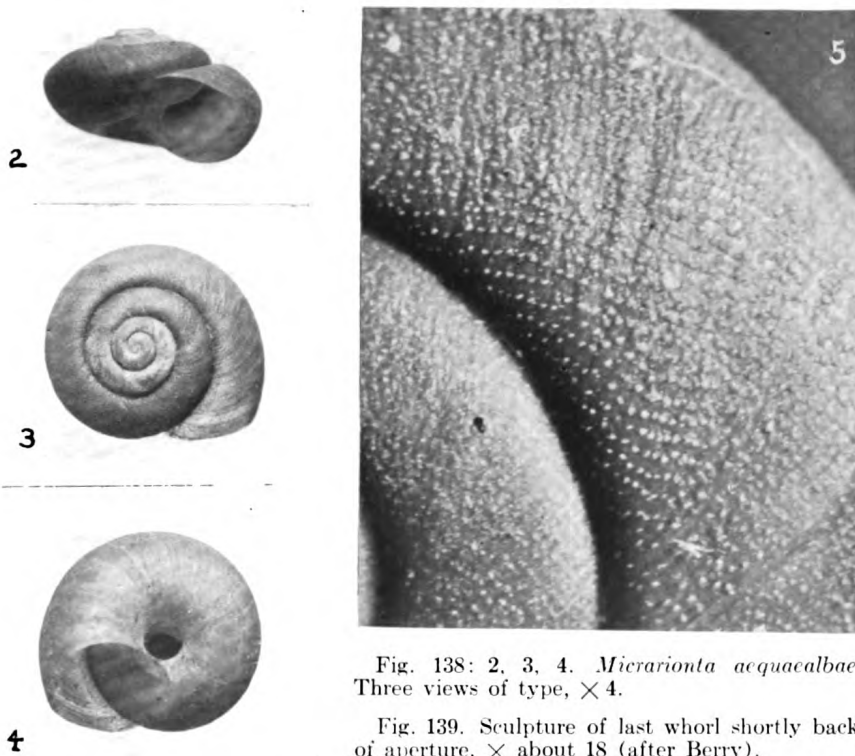


Fig. 138: 2, 3, 4. *Micrarionta aquaealbae*. Three views of type,  $\times 4$ .

Fig. 139. Sculpture of last whorl shortly back of aperture,  $\times$  about 18 (after Berry).

verging and connected by a thin parietal callus. Periostracum slightly deliscent, rather harsh and coarse for the size of the shell, being roughened not only by the lines of growth, but by a very close, fine, everywhere persistent, radial wrinkling, and by an overlying system of small papillae, which are elongate and so crowded as to be almost anastomosing on the first whorl, subsequently becoming more distinct, granular in appearance, and evidently ranked in fairly well defined, forward slanting lines. Papillae on body whorl show a progressively less regular arrangement until on the base they become smaller and more crowded and their linear arrangement is no longer evident. Color of dry shell near Saccardo's umber of Ridgway, slightly lighter below, with a narrow, very obscure sepia band just above

the periphery. Body whorl of shell on living animal snuff brown, with sepia spots where mantle pigment shows through. Color of animal,—upper portion of body slate, the margins neutral gray; mantle a little lighter than 'pale grayish vinaceous,' conspicuously maculated or spotted with slate on surface next shell; sole of foot light mouse gray, shading at edge to neutral gray. Max. diameter 7.7 mm., min. 6.6 mm., alt. 4.5 mm., diameter umbilicus 1.2 mm.; 4 whorls." (Berry.)

A paratype measures: 6.5, 5.4, 3.5, 1.2 mm., 3 $\frac{3}{4}$  whorls. (Berry.)

CALIFORNIA: San Bernardino Mountains among loose leaves and mould under a small tree (probably *Rhus* sp.), in gulch on east side of Whitewater Canyon, near first bend to west, alt. ca. 1800 feet (S. S. Berry), Type 4890 Berry Collection; paratypes in A.N.S.P. (130810), California Academy of Sciences and Allyn G. Smith. Also talus on west side of Whitewater Canyon about 1 mile above mouth, at about 1700 feet (Berry). Near Cabezon, north side of San Jacinto Mountains (Willett).

"Close inspection reveals this little snail as very distinct from all described American species. Its harshly shagreened periostracum, though furnishing almost its only striking specific character, is unlike that of any other snail I have noticed. This feature is evidently but an elaboration of the type of sculpture so characteristic of the earlier whorls in such species as *hutsoni*, *wolcottiana*. Hence it seems appropriate to refer the species, at least until its anatomy can be investigated, to *Eremarionta*. All its other features, coarse periostracum, texture of shell, and particularly the conspicuously spotted mantle, must be confessed to resemble those of no other *Eremarionta* which has been described, being more like those of some of the species of the *Helminthoglypta* group." (Berry.)

#### SPECIES OF UNKNOWN GENERIC POSITION

##### "*Epiphragmophora* " *bowersi* Bryant

*Epiphragmophora bowersi* F. W. Bryant, 1900 (March), *Nautilus*, 13: 122. Cf. Willett, 1937, *Nautilus*, 50: 123.

"Shell umbilicated, convex; epidermis olivaceous; spire slightly elevated; whorls between 4 and 5, convex, gradually increasing; suture well defined; aperture transverse, nearly circular; peristome whitish, thin, very slightly expanded at the basal portion, at the columella broadly reflected, yet leaving the umbilicus entirely open, showing within the whorls at the apex; base convex. A well-defined, moderately broad, light-chestnut band revolves above the centre of the body whorl, and is visible above the suture on the whorl preceding the last; lines of growth close and distinctly marked. Greater diameter 13, lesser 10, height 6 mm." (Bryant.)

CALIFORNIA: San Jacinto Mountains, Riverside County (Bryant).

In a letter (1900) to the author, Bryant stated that he had no duplicates of this species, and that it and *harperi* (a *Micrarionta*) were from the same locality. In correspondence with Dr. Dall in 1908 he informed me that

“the types [of *bowersi* and *harperi*] were in the California Academy and doubtless destroyed in the earthquake and fire”. The size and the shape of aperture suggest that it is an *Eremarionta*, but the “olivaceous” epidermis and the locality assigned indicate *Helminthoglypta*, as Willett has noted. It was named for Dr. Stephen Bowers of Ventura, California. A lost species.

#### Subfamily SONORELLINAE

The single genus is characterized by having the accessory organs of the genitalia reduced or absent; there is no dart sac or mucous glands. The penis has an epiphallus and a well developed verge, but the flagellum is excessively short, rarely wanting. The spermathecal duct is long, without a branch. The short, simple talon is buried in the albumen gland. Tail rounded above. The depressed, umbilicate shell is rather thin, light colored with a dark band above the periphery, similar to that of *Eremarionta* in the Helminthoglyptinae.

Although the genitalia have partly the technical characters of Camaenidae, *Sonorella* is retained in the Helminthoglyptidae mainly on account of the character of the shell and of the talon, the kidney and the jaw, all of which agree with our genera of Helminthoglyptidae, and are quite unlike our Camaenidae. It appears to be a secondarily simplified member of such a belogonous stock as the Helminthoglyptinae.

#### SONORELLA Pilsbry

*Sonorella* Pilsbry, 1900, Proc. Acad. Nat. Sci. Phila., p. 556, type *S. hachitana* (Dall).

The shell is umbilicate or perforate, depressed heliciform, thin, nearly smooth, light colored with a brown band above the periphery; the whorls are rounded peripherally at all stages of growth; aperture wide, toothless; peristome scarcely thickened, weakly expanded, dilated at the columellar insertion. Embryonic shell of  $1\frac{1}{2}$  whorls, with minute sculpture of radial impressions and usually forwardly descending threads or spirally lengthened granules.

Genitalia: The penis contains a verge; epiphallus is rather long, terminating in a minute flagellum which is sometimes obsolete; penial retractor inserted on the epiphallus or at its base and reaching the apex of penis. ♀ side with no accessory appendages; spermatheca small, on a long, unbranched duct; talon very short, simple, buried in the albumen gland.

The lung has moderately developed venation. Kidney is about half as long as the lung and between two and three times the length of the pericardium. Gut ureter closed.

Free muscles: The right ocular band lies between penis and vagina, and is free from the other bands to its posterior insertion; left ocular band unites with the pharyngeal muscle.

The jaw is ribbed, usually with 4 to 8 ribs (Fig. 140). Radula with unicuspid central and lateral teeth, the marginals with an ectocone, both cusps usually bifid on the outer teeth.

*Distribution.*—Arizona, southern New Mexico and western Texas, southward in northwestern Chihuahua and northeastern Sonora.

The generic name refers to its occurrence in the Sonoran life zone, now usually called Lower Austral.



Fig. 140. Jaws of: left, *Sonorella hachitana flora*; upper middle, *S. hachitana orientis*; lower middle, *S. granulatissima*; upper right, *S. tryoniana*; lower right, *S. virilis*.

*Sonorella* is almost everywhere a rock snail, usually in volcanic rock, rarely in limestone, as in the Big Hachet mountains. Rocky outcrops, taluses or "slides" of coarse broken rock are its usual stations. In the shelter of scattered bushes at the sides, or growing among the stones of a slide, are favorable places for opening a "quarry," the leaves falling among



Fig. 141. Stone bearing resting rings of *Sonorella baboquivariensis*.

the rocks probably affording cryptogamic food plants. The snails are generally in crevices from a foot to several feet below the surface, sealed to stones by their calcareous mucus, which forms white rings as in fig. 141.

They apparently have a homing habit, as several rings of the same size are frequently found superposed or in close proximity. Occasionally several snails are found sealed to a single stone.

Such rock slides, or often mere outcrops of stone sufficiently broken to afford refuge, are the usual habitations of *Sonorella*, from the arid foothills up into the wooded canyons. At upper levels of the higher ranges, such as the Chiricahuas at 9 to 10,000 feet, or the Santa Catalinas at 8 to 9000 feet, there is a heavy stand of coniferous trees, fir, spruce and pine, with patches of aspen showing light green on the mountain slopes, and near the lower border of the forest occasional glades with alder, maple and other deciduous trees. The forest floor is deep and humid. A few of the sonorellas, such as *S. odorata*, are found in such forests under cover of spruce bark and aspen poles, or crawling about in the open in the manner of *Triodopsis* or *Mesodon* in wooded places in the Eastern states.

In the more arid ranges the work of digging out sonorellas is often strenuous. Sometimes only two or three living snails reward a day of hard work; a dozen or twenty is counted a good bag. Most of the species have never been found alive in abundance. Dead and bleached shells are usually abundant; in this arid country the shells disintegrate slowly.

Owing doubtless to their subterranean lives, in sunless places, sonorellas have none of the appearance of desert snails which live exposed to insolation, such as the *Xerarionta* group. The shells are very similar in appearance to micrariontas of the subgenus *Eremarionta*, which have the same petricolous habits.

*Sonorella* can live in much dryer country than *Ashmunella*, and in ranges where both occur it extends to lower and dryer levels.

We have at present no paleontologic data, but the strong differentiation of species of the high sierras indicates dispersal of the genus over them in Tertiary times, with interruption of interrange communication for forest snails not later than Pliocene. Species of the group of *S. hachitana*, and others living in arid mountains and the semi-desert foothills, were doubtless able to spread long after increasing dessication had isolated the humid forest areas. Such species as *S. hachitana*, *huachucana*, *sabinoensis*, *arida*, *ambigua* and others, appear to have become locally isolated in relatively recent times (Pleistocene); the species are uniform over large though usually discontinuous areas, or are broken into weakly characterized local races, now separated by stretches of desert. Thus the strict endemism of sonorellas of the high ranges, and the wide distribution of those of the foothills become explicable.

The shells of *Sonorella* are so weakly differentiated that usually no definite conceptions of the relationships of species can be inferred from

them. The male genitalia have been much more modified, and the classification of the genus is therefore based upon these organs. It is an ill service to science to describe species of *Sonorella* without reference to the anatomy, unless the shell characters are strongly marked. As yet there has been no sufficient study of the radulae.

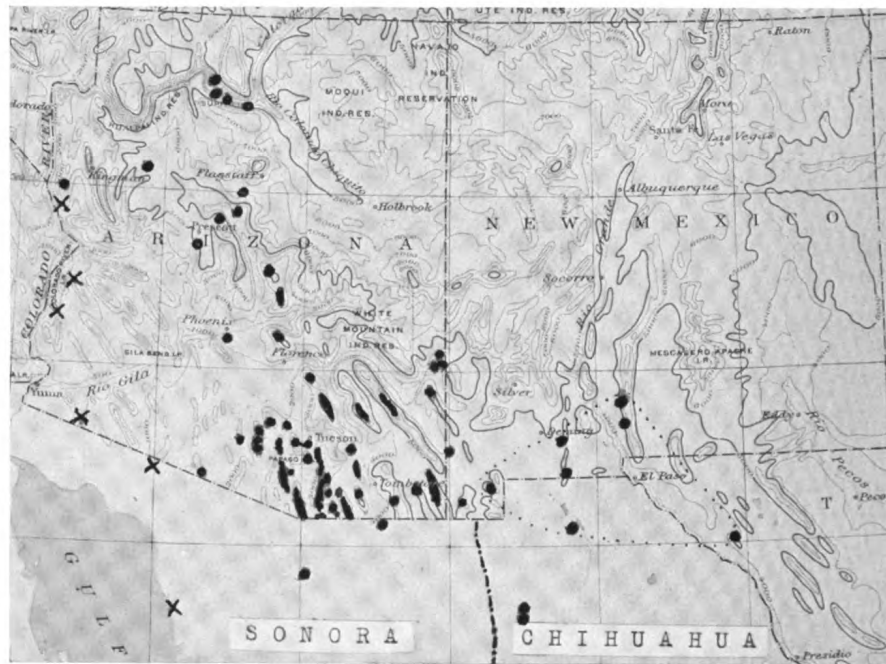


Fig. 142. Distribution of *Sonorella*; showing also the eastern limit of *Eremarionta*, indicated by crosses (X). The heavy contour line is at 5000 feet. A dotted line encloses the races of *S. hachitana*.

In some species the wrinkling or other sculpture of the verge has been described. This is artificial in so far as it is a result of contraction in preservation; but its presence and pattern are ultimately dependent upon structure, hence to be taken into account. That there is variation with different conditions of preservation is to be expected, as in *S. ambigua* (Fig. 227).

The sculpture of the embryonic whorls of the shell is considerably varied and is often useful in the discrimination of species, though the several patterns are connected by transitional forms. It is readily lost, usually imperfect or effaced in adult shells, rarely visible in "dead" ones. Some of the young should always be collected. Good photographs of the embryos are needed, but my trials have not been successful.



Southeastern Arizona is the region of most intense specific differentiation. Of the Mexican sonorellas, *S. nelsoni* and *S. goldmani* Bartsch, from mountains near Lake Santa Maria, Chihuahua, about forty miles south of the Arizona boundary, appear to be members of the *S. hachitana* "Formenkreis" of weakly differentiated races scattered over southern New Mexico and western Texas. *S. mearnsi* Bartsch, from San José Mountain, four miles south of the international boundary east of San Pedro River, should belong, by its sculpture, to the *granulatissima* group. *S. magdalenensis* (Stearns), from Magdalena, Sonora, belongs by its embryonic sculpture and other shell characters to the group of *Sonorella tumamocensis*. *S. pennelli* and *S. mormonum* Pils., from the Sierra Madre of Chihuahua, do not fall into any of the Arizona groups. Various Lower Californian species described as *Sonorella* are now referred to *Micrarionta* and *Helminthoglypta*.

So many of the shells are closely similar that identification of specimens is difficult. No practical key to species can be constructed without the use of anatomic characters. However, as few mountain ranges have more than three to six species, the descriptions to be compared in any case in hand are not numerous. Of course nobody would waste time over unlocalized shells of this genus. For convenient reference the Sonorellas are here grouped geographically.

## New Mexico and western Texas

- |   |                                     |
|---|-------------------------------------|
| <i>S. hachitana</i> , Big Hachets         | <i>S. h. orientis</i> , Organ Mts.; |
| <i>S. h. flora</i> , Florida Mts.         | western Texas                       |
| <i>S. h. peloncillensis</i> , Peloncillos | <i>S. animasensis</i> , Animas Mts. |

## Arizona: Chiricahua Mountains

- |                     |                      |
|---------------------|----------------------|
| <i>S. bicipitis</i> | <i>S. virilis</i>    |
| <i>S. optata</i>    | <i>S. v. leucura</i> |
| <i>S. bowiensis</i> | <i>S. micra</i>      |

*S. binneyi*

## Dragoon and Mule Mountains

- |                        |                    |
|------------------------|--------------------|
| <i>S. dragoonensis</i> | <i>S. ferrissi</i> |
| <i>S. apache</i>       | <i>S. bartschi</i> |

## Empire, Whetstone and Mustang Ranges

- |                              |                            |
|------------------------------|----------------------------|
| <i>S. imperatrix</i>         | <i>S. huachucana cotis</i> |
| <i>S. binneyi imperialis</i> | <i>S. h. mustang</i>       |

*S. insignis*

## Huachuca Mountains

- |                             |                     |
|-----------------------------|---------------------|
| <i>S. huachucana</i>        | <i>S. g. latior</i> |
| <i>S. sitiens montezuma</i> | <i>S. danielsi</i>  |
| <i>S. granulatissima</i>    | <i>S. parva</i>     |

*S. dalli*

## Patagonia Mountains, Canelo Hills

*S. huachucana* *S. h. elizabethae*  
*S. tryoniana*

## Santa Rita Mountains

*S. huachucana aguacalientensis* *S. clappi*  
*S. walkeri* *S. clappi occidentalis*  
*S. rosemontensis* *S. santaritana*  
*S. tumamocensis linearis*

## Tucson Range and Tumamoc Hills

*S. sabinoensis tucsonica* *S. tumamocensis*  
*S. baboquivariensis depressa* *S. arizonensis*

## Ranges and hills south of the Tucson Range to the Mexican boundary

*S. papagorum* *S. sitiens*  
*S. eremita* *S. walkeri*  
*S. arida*

## Baboquivari Mountains

*S. baboquivariensis* *S. b. depressa*  
*S. vespertina*

## Silverbell, Roskrige and Coyote Mountains and westward

*S. baboquivariensis berryi* *S. xanthenes*  
*S. ambigua* *S. sitiens*  
*S. tumamocensis* *S. ashmuni capax*

## Tortillita, Santa Catalina and Rincon Mountains

*S. marmorarius* *S. sabinoensis*  
*S. m. limifontis* *S. s. buehmanensis*  
*S. tortillita* *S. s. occidentalis*  
*S. odorata* *S. s. hesterna*  
*S. o. marmoris* *S. rinconensis*

## Galiuro and Pinaleno Ranges

*S. galiurensis* *S. grahamensis*  
*S. g. superioris* *S. praesidii*

## Region of the Blue and San Francisco Rivers

*S. caerulifluminis* *S. delicata*  
*S. binneyi franciscana*

## Middle and Northern Arizona

*S. micromphala* *S. ashmuni*  
*S. rooseveltiana* *S. compar*  
*S. fragilis* *S. coltoniana*  
*S. verdensis* *S. coloradoensis*  
*S. superstitionis*

*Key to the subgenera of Sonorella*

Penis with thin walls and a cavity of normal size.

Length of penis decidedly less than the diameter of the shell.....*Sonorella* s. str.

Length of penis about equalling or much exceeding the diameter of the shell.

Verge long, with a minute duct.....*Masculus*

Verge short, thin-walled, the duct a minute tube.....*Sonoranax*

Penis with very thick walls and a minute cavity.....*Myotophallus*

Subgenus SONORELLA s. str.

## SONORELLA HACHITANA GROUP

The shell has forwardly descending threads on part of the embryonic whorls; later whorls nearly smooth. The penis is small, with a slender, tapering verge (typically), the penial retractor inserted on the apex of penis and base of epiphallus. Desert snails, inhabiting hills and arid mountains.

In this, the most numerous and difficult group, differential characters are often feebly developed and specific limits uncertain. Some of the species are widely though discontinuously distributed. A few forms, such as *S. verdensis* and *S. bicipitis*, do not agree well with the characters given above, but have been included here to avoid making more ill-defined groups.

***Sonorella hachitana*** (Dall)

Fig. 143.

*Epiphragmophora hachitana* Dall, 1895, Proc. U. S. Nat. Mus., 18: 2; 19: 338-9, in part (not pl. 31, fig. 7, 10 = *S. dalli* Bartsch).

*Sonorella hachitana* (Dall), Pilsbry, 1901, Proc. Acad. Nat. Sci. Phila. for 1900, p. 556; 1905, Proc. Acad. Nat. Sci. Phila., p. 257, in part.—Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 327, pl. 5, figs. 4-4b, text-fig. 2; 1923, p. 65.—Bartsch, 1904, Smithson. Misc. Coll., 47: 190, pl. 31, fig. 2 (shell of type), pl. 29 (apex).



Fig. 143. *Sonorella hachitana*, topotypes.

“Shell large, depressed, polished, sculptured with irregularly prominent, incremental lines, but without spiral striation or surface granulation; whorls four and a half, rounded; suture distinct; last whorl depressed near the peristome; aperture oblique, with a thickened and somewhat dilated but not reflected lip; pillar lip broad near the body; umbilicus moderate, deep, exhibiting nearly two whorls; the fresh shell livid, waxy or pale reddish-purple, with a single darker band, bordered by paler color, above the periphery.” (Dall.)

<sup>1</sup> Dall's measurements “Major diameter, 26.5; minor diameter, 21; height, 12 mm.” were from a specimen of the species subsequently described as *Sonorella dalli* Bartsch.

"Height 13.4 mm., diameters 23.7 and 19.5 mm., umbilicus about 4 mm. Type." (Bartsch.)

NEW MEXICO: Big Hatchet Mountains, Hidalgo County, the type from Big Hatchet Peak at 8271 feet (Maj. E. A. Mearns, U. S. A.), Type 130004 U.S.N.M. In several places between a small peak  $1\frac{1}{2}$  miles south southwest, and the ridge about a mile northeast of Big Hatchet Peak, 7300 to 8366 feet, and subfossil from "Daniels Peak", about 2 miles southeast from Big Hatchet Peak (Pilsbry and Daniels). Carrizalillo Mts. (E. A. Mearns).

The color is cinnamon to cinnamon-buff, fading to white on the base, and with white bands above and below the cinnamon-brown band above the periphery. The last whorl descends in front more deeply than in most related species, though variable in this respect. The aperture is rather small, its greatest width 50 to 54 per cent of the diameter. Umbilicus contained about  $5\frac{1}{2}$  times in diameter of shell. 21 adult shells from our Station 7 measure (to nearest half mm.):

Diameter in mm. . . . .	21.5	22	22.5	23	23.5	24
Number of shells . . . . .	2	8	2	7	1	1

The largest shell, from the eastern flank of Hacheta Grande Peak, has a diameter of 25.5 mm.

It was found most abundant at our station 7, on a hill about  $1\frac{1}{2}$  miles south southeast of Big Hatchet Peak, where there is some shade in the largest group of pinyon pines in the mountains, under large stones on the steep slope near the summit, at about 7400 to 7500 feet.

The genitalia are remarkable for the small size of the male organs. The penis is very slender, diameter 1 mm., tapering downward, and encircled at the base by a short sheath. The verge is very slender, gradually tapering, and annulate. The retractor muscle is terminal, long and slender. Epiphallus a little shorter than the penis. The vagina is slightly longer than the penis. Other organs as usual. Measurements of the organs of two individuals are given in the following table, with those of allied forms for comparison.

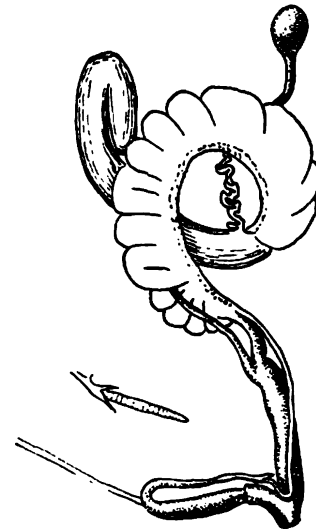


Fig. 144. Genitalia of *S. hachitana*, with detail of verge.

	Penis	Verge	Epiphallus	Flagellum	Vagina	Spermatheca and duct	Penis retractor	Museum No.
<i>S. hachitana</i> .....	6.25	4	4.2	1.25	7.5	19	....	103,098
" .....	6.5	4.6	5.2	1.1	9.7	....	....	103,098
<i>S. h. flora</i> .....	10	4.3	6.2	1.0	12.3	36	....	94,329
" .....	....	5.5	5	1.0	....	....	....	94,329
" .....	9	4	6.5	0.5	10.5	29	....	86,496
<i>S. h. peloncillensis</i> .....	11	6	6.2	1.3	10.3	29	9.5	94,513
" .....	10	6.2	7	1.25	9	....	....	94,513
<i>S. h. orientis</i> .....	7	6	7	1.5	9	....	12	.....

The well-arched jaw has 7 or 8 ribs. The radula has about 22, 16, 1, 16, 22 teeth, both cusps becoming split on the marginal teeth.

Whether the typical form of *S. hachitana* occurs outside of the Big Hatchet range and the arid Carrizalillo Mountains is doubtful. Peloncillo range *Sonorella* (*S. h. peloncillensis*) is not easily distinguishable by the shell alone, but the proportions of the genitalia differ.

On the Carrizalillo Mountains, top of two peaks near the Mexican boundary line, numerous "bones" were collected by Dr. Mearns (126,596, U.S.N.M.). They agree with *S. hachitana* in the rather wide umbilicus, small aperture and deeply descending last whorl, but the average size is smaller from height 10.8, diameter 19.3 mm., to height 12.4, diameter 21.4 mm. The locality is about 30 miles east of Big Hatchet Peak.

The races of *S. hachitana* (except *S. h. peloncillensis*) are enclosed in a dotted line in the map (Fig. 142).

***Sonorella hachitana flora* Pilsbry & Ferriss**

Figs. 145: 3-3 c.

*Sonorella hachitana* . . . Florida Mountains, Pilsbry, 1905, Proc. Acad. Nat. Sci. Phila., p. 257, pl. 17, figs. 1-6 (shell), pl. 20, fig. 12 (genitalia), pl. 23, fig. 20 (jaw).

*Sonorella hachitana flora* Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 347, pl. 5, figs. 3-3c; Text-figs. F, G (genitalia).

The shell is in the average larger than *S. hachitana*, with less distinct white borders along the shoulder band. Umbilicus contained about 8 times in diameter.

Height 16 mm., diameter 27 mm.; umbilicus 4 mm.

Penis decidedly and constantly longer than in *hachitana*, as are also the vagina and spermathecal duct. The verge and epiphallus are only slightly or not longer than in *hachitana*. Verge is indistinctly annulate and tapers slowly to the apex. The penial retractor is long and slender, attached to the apex of the penis, and enveloping the base of the epiphallus. Measurements of the organs are given above. Fig. 146 F, G.

The pallial organs are much as in *Sonorella optata*, but there is no white thread defining the secondary ureter. The sole, in alcoholic examples, is ochraceous in the middle, pale gray at the sides. Back and flanks dark slate-gray, the tail fleshy-gray above, having an indistinct median line.

The jaw (Fig. 140, left) has eight ribs.

The radula is somewhat unlike other *Sonorellas* examined in the central tooth, which is narrower than the adjacent laterals. There are 55.155 teeth, an ectocone appearing on the fifteenth. Both cusps are bifid on most of the marginal teeth, the mesocone + entocone being very oblique and unusually long in the inner marginals.

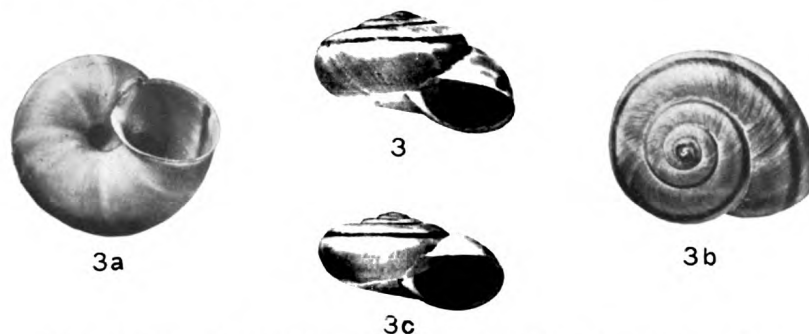


Fig. 145. *Sonorella hachitana flora*: the type, 3, 3a, 3b; topotype, 3c.

NEW MEXICO: Florida Mountains, Luna County, on the west side at "Spring Canyon", at about 6000 to 6500 feet (Ferriss and Pilsbry), Type 112087 A.N.S.P. Also on the north end of the mountain (Ferriss).

120 specimens measure as follows, the upper line being diameters in mm., the lower line the number of specimens of each size:

22.7	23.7	24	24.5	25	25.5	26	26.5	27	27.5	28	28.5	29	29.7
1	1	10	11	18	12	17	16	13	7	3	7	3	1

***Sonorella hachitana peloncillensis* Pilsbry & Ferriss**

Figs. 146 A-E.

*Sonorella hachitana peloncillensis* Pilsbry & Ferriss, 1915, Proc. Acad. Nat. Sci. Phila., p. 349, figs. 6A-E (genitalia).

The shell is a little less depressed than *hachitana*, with the last whorl not so deeply descending, the aperture not so oblique and a trifle larger. Umbilicus contained  $6\frac{3}{4}$  to 7 times in diameter.

Height 13.3 mm., diameter 23.7, umbilicus 3.5 mm. Type.

Height 12.5 mm., diameter 22.8 mm., umbilicus 3.5 mm.

Height 11.7 mm., diameter 19.6 mm.

NEW MEXICO: Skull Canyon, Peloncillo Mountains, Hidalgo County (J. H. Ferriss), Type 94513 A.N.S.P.

The genitalia (Figs. 146 A to E) resemble the same organs in *S. flora*. The penis is encircled by a sheath which reaches nearly to the middle. The verge is slender, tapering, and subannulate to rather strongly annulate. Epiphallus and flagellum as usual in the group of *hachitana*. It differs from *S. hachitana* by the decidedly longer penis, which has a much longer basal sheath. The vagina is slightly shorter than the penis, while in *S. hachitana* and *flora* it is slightly longer. Measurements are given on page 275.

The sole is fleshy-buff, of nearly uniform tint, the side areas not distinct. Back ashy; sides and tail flesh-tinted.