

HAWAIIAN HELICINIDAE

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CONTENTS

| | PAGE |
|------------------------------------|------|
| Introduction | 3 |
| Orobophana | 9 |
| Pleuropoma | 38 |
| Pleuropoma (Sphaeroconia) | 83 |
| Doubtful and excluded species..... | 98 |

ILLUSTRATIONS

| | PAGE |
|---|------|
| FIGURES 1-17.—Orobophana from Kauai | 12 |
| 18-29.—Orobophana uberta and varieties and forms from Waianae Mountains, Oahu | 20 |
| 30-43.—Varieties of Orobophana uberta from Koolau Range, Oahu..... | 28 |
| 44-61.—Pleuropoma laciniosa and varieties from Oahu..... | 41 |
| 62-72.—Varieties of Pleuropoma laciniosa from Kauai and Niihau..... | 66 |
| 73-91.—Varieties and forms of Pleuropoma laciniosa from islands south of Oahu | 71 |
| 92-101.—Three other species of Pleuropoma (sensu stricto)..... | 80 |
| 102-117.—Species and varieties of Pleuropoma (Sphaeroconia)..... | 86 |

Hawaiian Helicinidae

By

MARIE C. NEAL

INTRODUCTION

The family Helicinidae is distributed from America westward to Mauritius and the Seychelles, including the West Indies, Central America, southern North America, northern South America, islands of the Pacific and Indian oceans, Australia, and eastern and southeastern Asia. It is apparently absent from Europe, Africa, New Zealand. According to Wagner,¹ in his work on Helicinidae from all the world, representatives of the family are most abundant in two centers: 1, in the West Indies and Central America; 2, on islands and coasts between the Indian and Pacific oceans. In the Pacific region westward from the Galapagos Islands to Japan and China and from the Taumotus to Australia, continuing westward through the Indian Ocean to Mauritius, Wagner describes species of five genera common to most of that region and locates them as follows:

| TOTAL | APHANOCONIA | OROBOPHANA | PALAEO- HELICINA | STURANYA | SULFURINA |
|--------------------|-------------|------------|---------------------|----------|-----------|
| Species | 78 | 15 | 25 | 20 | 15 |
| Varieties | 28 | 5 | 14 | 3 | 18 |
| NUMBER FROM HAWAII | | | | | |
| Species | 1 | 2 | | 2 | |

The short list of Hawaiian species results from Wagner's omission of names added by Pilsbry and Cooke² in their work in 1908 on Hawaiian Helicinidae, which includes 13 species and 7 varieties grouped under one genus, *Helicina*. Shells and opercula, not radulae or anatomy in general, as has been undertaken by Baker,³ were used by Wagner in classifying. According to Wagner, the genus *Helicina* is confined to America, a conclusion with which Baker agrees. In his original description of the genus in 1799, Lamarck did not refer to any species. In 1801, one species was named—*H. neritella* Lamarck, from Jamaica—which, Sykes says, "may be taken as the type." Besides their study of shells of Hawaiian species of Helicinidae, Pilsbry and Cooke described the radulae of four species and found that the

¹ Wagner, Anton, Die Familie der Helicinidae: Syst. Conch.-Cab. of Martini and Chemnitz, I, 18, 1911.

² Pilsbry, H. A., and Cooke, C. M., Jr., Hawaiian species of Helicina: B. P. Bishop Mus., Occ. Pap., vol. 3, no. 2, pp. 1-14, 1908.

³ Baker, H. B., Notes on the radula of the Helicinidae: Acad. Nat. Sci. Phila., Proc., vol. 74, pp. 29-67, 1922.

teeth of *H. baldwini* and *H. uberta* are similar, that those of *H. laciniosa* are distinct, and that those of *H. rotelloidea* resemble *H. laciniosa* in some details and *H. baldwini* in others. Baker states that "from their studies, it appears that the radula of *Sturanya* . . . (type *H. laciniosa* . . .) is very close to that of *Sphaeroconia* [an eastern and southern Pacific subgenus of *Pleuropoma*], but that the radula of *Orobophana* . . . (type *H. uberta* . . .) is considerably different."

Because of their opercula, which increase concentrically to a more or less central nucleus, rather than on one side only, Wagner considers Helicinas as the oldest land snails, also that the genus *Bourciera* Pfeiffer, which is confined to South America, "is probably the most primitive member of the family, unless the structure of the operculum is secondary." According to Simroth,⁴ Helicinas are represented among fossils since the "Carboniferous" with special development in the "Carboniferous" and Recent times. Many are still living. The largest number of species has been found in the Antilles.

In Hawaii, two genera of Helicinidae and three species of *Georissa* are the only land operculates known, and they have been found only at rather low elevations. In any part of the world, Helicinidae are sensitive to cold and inhabit only tropical or nearly tropical regions. Their habit as a family varies little in Hawaii, most species being consistently terrestrial. *Pleuropoma* (*Sphaeroconia*) *rotelloidea* and a few *P. (S.) hawaiiensis* variety *knudseni* are found on shrubs 2 feet or so above the ground. Most species live in damp places in woods on dead leaves on the ground, some on damp rocks. Many shells are found as fossils, either among sand dunes, or in pockets in the earth, where excavations for roads and buildings reveal them. Some belong to living species and varieties; some are distinct. Unless otherwise stated the shells were taken alive.

In explanation of the age of similar beds in which the larger Achatinellidae are found and in regard to recent climatic change, Pilsbry⁵ writes:

In the Islands the distinction between Pleistocene and Holocene deposits is a real and necessary one, since human occupation brought in factors profoundly affecting the physiography of the whole lower zone, or on some islands the entire area. It would also be inexact to call the Holocene beds "recent," though some of them are apparently of no great antiquity. If the terms are used loosely in this book it is because not enough work has been done to fix the age of the various dune deposits definitely. The Manoa, Kailua, and Kahuku bluff deposits, and the beds of Mana, Hawaii, seem to be undoubtedly Holocene. The dune-covered beds of northwestern Oahu, those of Moomomi, Molokai, and those of the neck of Maui (which I have not seen), are doubtless older than the first group, but may possibly belong also to the early human period. The human remains in the Moomomi dunes, however, are probably intrusive. The land-shell breccia and tuff of

⁴ Simroth, H., Dr. H. G. Bronn's Klassen und Ordnungen des Tier-Reichs, Bd. 3, Mollusca, Abt. 2, 1896-1907.

⁵ Pilsbry, H. A., Achatinellidae: Man. Conch., vol. 22, pp. xlvi-1, 1912-1914.

Diamond Head, and other tuff cones of the Kona side of Oahu, are undoubtedly Pleistocene.

As yet, only the Achatinellidae and Amastridae of all these beds have been thoroughly studied, and these are the groups which everywhere show the greatest local speciation, therefore less useful for comparative studies of the beds than the widely distributed small shells of other families.

The Diamond Head breccia contains a considerable number of extinct species. Dune sand, interbedded with land-shell breccia, where the section has been fully exposed in the sand quarry along the road, contains only recent marine shells. I conclude therefore that the Diamond Head and Punchbowl land-shell deposits are Pleistocene, not Pliocene. A certain proportion of special species would naturally be expected in a region of such intense local endemism as Oahu. They are not of themselves an indication of age.

Whether any fossiliferous deposits older than Pleistocene will be found on Oahu is doubtful. There is a possibility of inland deposits, but if the movement of the island has been mainly downward, as I believe, there is little probability that marine Tertiary beds will be found near the surface.

That there has been a change from more humid to dryer climate in many districts of all the islands, if not known by historic evidences, would be demonstrated by the restriction of most land snails to higher levels than formerly occupied. Sixty years ago the Achatinellas were found in abundance at half the elevations now inhabited by them. Still earlier forest shells lived within a few feet of the present sea level, as the Kailua and Kahuku deposits show. Forest shells, *Amastra* and others, are found in many of the low deposits, and it is obvious that the Pleistocene forests extended nearly or quite to the sea on the northern and western coasts of both Oahu and Molokai. The changes within the last century are held to be due to deforestation by cattle, which by destroying the underbrush cause the dessication of the forest humus, and prevent reproduction of the native trees. In Lanai the wild goats have almost, and in Kahoolawe have totally, completed the destruction of native forests. With loss of the forest there is less precipitation on the heated soil, and what water falls is not conserved. Whether the earlier destruction of low-lying forest was due to human agency is not known, but in the absence of any other known cause that seems likely.

The change from humid to arid conditions in the lower zone seems to have been too rapid to admit of the evolution of many arid-country species. There is one *Succinea* which lives under volcanic rocks in the most arid places; a species of *Bifidaria* is often found in dry country, and a few *Leptachatinas* exist in similar places. In general, however, one finds little or nothing to encourage search on the slopes of the lower zone.

The same tale of increasing aridity is heard from the tuff cones of the Kona coast, where deposits of fossil forest-snails occur on Koko Head, Diamond Head, Punchbowl, and others. . . . Of herbage there is now little, save for a thin line of dusty algarobas (*Prosopis*) bordering the shore and straggling up the gullies, and tufts of dry grass which may harbor the dry-country *Succinea* and *Bifidaria*. In Pleistocene times, between periods of activity and after the eruptions ceased, these cones were heavily wooded, with a copious snail fauna.

Since 1908, when Pilsbry and Cooke published two papers,⁶ some significant contributions on Hawaiian Helicinidae, cited on the following pages with descriptions of the shells studied, have appeared. Many specimens have been collected and cataloged since 1908. The present paper is based on col-

⁶ Pilsbry, H. A., and Cooke, C. M., Jr., Hawaiian species of Helicina: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 1-14, 1908. On the teeth of Hawaiian species of Helicina: Acad. Nat. Sci. Phila., Proc., vol. 60, p. 560, 1908.

lections from eight islands—Kauai, Niihau, Oahu, Molokai, Maui, Lanai, Kahoolawe, Hawaii—and deals with shells and opercula only. The collectors were many, and their specimens are, as a rule, accompanied by valuable details as to habitat. To Dr. C. M. Cooke, Jr., who collected many of the shells and who chiefly inspired the collecting and the keeping of records by others, is due the large and well-kept collection of Helicinidae as well as of all Hawaiian land mollusks in Bernice P. Bishop Museum. Dr. Cooke's guidance in the work of this paper and his criticism of it in all stages of its progress have been exceedingly helpful.

The genus *Helicina* of Pilsbry and Cooke has been split into two genera, one with a subgenus, based on characters of shells and opercula. These genera do not have a uniform distribution in the Hawaiian islands. *Orobophana* is confined to Oahu and Kauai; *Pleuropoma* is found on all the eight main islands, *Pleuropoma (sensu stricto)* being much more common than *Pleuropoma (Sphaeroconia)*, which is lacking on Lanai and Kahoolawe. Six new species, thirty-four new varieties, and twelve new forms were found, the types of which are in Bernice P. Bishop Museum. Table 1 shows their distribution.

Table 1. Distribution of Hawaiian Helicinidae

(* Exclusively fossil; † fossil and living; without symbol, living.)

| | |
|---|--|
| KAUAI | |
| * <i>Orobophana juddii</i> | * <i>Pleuropoma laciniosa</i> variety |
| * <i>Orobophana berniceia</i> | matutina |
| * <i>Orobophana cookei</i> | <i>Pleuropoma laciniosa</i> variety |
| * <i>Orobophana stokesii</i> | canyonensis |
| * <i>Orobophana stokesii</i> variety | † <i>Pleuropoma nonouensis</i> |
| praemagna | <i>Pleuropoma (Sphaeroconia)</i> |
| <i>Orobophana baldwini</i> | hawaiiensis |
| <i>Orobophana baldwini</i> variety | † <i>Pleuropoma (Sphaeroconia) hawaii-</i> |
| lihueensis | ensis variety knudseni |
| <i>Orobophana meineckeii</i> | <i>Pleuropoma (Sphaeroconia) hawaii-</i> |
| <i>Pleuropoma laciniosa</i> variety delta | ensis variety makalii |
| <i>Pleuropoma laciniosa</i> variety | <i>Pleuropoma kauaiensis</i> |
| praeparva | <i>Pleuropoma kauaiensis</i> |
| † <i>Pleuropoma laciniosa</i> variety | variety orientalis |
| globuloidea | |
| NIIHAU | |
| * <i>Pleuropoma laciniosa</i> variety delta | * <i>Pleuropoma (Sphaeroconia)</i> |
| * <i>Pleuropoma laciniosa</i> variety | niihauensis |
| kiekieensis | |

OAHU, WAIANAE MOUNTAINS

- Orobophana uberta
 †Orobophana uberta variety bryani
 *Orobophana uberta variety bryani form a
 †Orobophana uberta variety bryani form b
 Orobophana uberta variety wilderi
 Orobophana uberta variety wilderi form a
 Orobophana uberta variety makuaensis
 †Pleuropoma laciniosa
- †Pleuropoma laciniosa variety ferruginea
 Pleuropoma laciniosa variety spaldingi
 Pleuropoma laciniosa variety laula
 †Pleuropoma laciniosa variety pusilla
 Pleuropoma laciniosa variety gamma
 Pleuropoma oahuensis
 Pleuropoma oahuensis variety gemina
 *Pleuropoma subsculpta
 Pleuropoma (Sphaeroconia) rotelloidea

OAHU, KOOLAU RANGE

- †Orobophana uberta variety magdalena
 *Orobophana uberta variety borealis
 Orobophana uberta variety subtenuis
 Orobophana uberta variety beta
 †Orobophana uberta variety hybrida
 Orobophana uberta variety lymaniana
 Orobophana uberta variety nuuanuensis
 Orobophana uberta variety percitrea
 *Orobophana uberta variety exanima
- *Pleuropoma laciniosa
 Pleuropoma laciniosa variety pusilla
 †Pleuropoma laciniosa variety sandwichiensis
 †Pleuropoma laciniosa variety alpha
 †Pleuropoma laciniosa variety gamma
 †Pleuropoma laciniosa variety signata
 *Pleuropoma laciniosa variety perparva
 †Pleuropoma (Sphaeroconia) rotelloidea

MOLOKAI

- †Pleuropoma laciniosa variety molokaiensis
 †Pleuropoma laciniosa variety molokaiensis form a
- *Pleuropoma laciniosa variety moomomiensis
 †Pleuropoma (Sphaeroconia) rotelloidea variety sola

MAUI

- †Pleuropoma laciniosa variety honokowaiensis
 †Pleuropoma laciniosa variety kulaensis
 Pleuropoma laciniosa variety kulaensis form a
- Pleuropoma laciniosa variety kulaensis form b
 Pleuropoma (Sphaeroconia) rotelloidea variety mauiensis

LANAI

- †Pleuropoma laciniosa variety piliformis
 *Pleuropoma laciniosa variety piliformis form a
- *Pleuropoma laciniosa variety kaaensis
 *Pleuropoma laciniosa variety kaaensis form a

KAHOOLAWE

- *Pleuropoma laciniosa variety kahoolaweensis

HAWAII

- Pleuropoma laciniosa variety konaensis
 *Pleuropoma laciniosa variety konaensis form a
 *Pleuropoma laciniosa variety konaensis form b
- *Pleuropoma laciniosa variety konaensis form c
 *Pleuropoma laciniosa variety konaensis form d
 Pleuropoma (Sphaeroconia) sulculosa

According to Wagner, *Orobophana* is known from New Caledonia to the Marquesas and in Hawaii; *Aphanoconia* is known in all countries inhabited by Helicinidae; *Sturanya* is known from Samoa, Fiji, Tonga, Solomons, Cook Islands, Galapagos, Hawaii, Carolines, probably Norfolk Islands and the New Hebrides. Wagner's generic name, *Orobophana*, is retained for Hawaiian species, as Baker selected *O. uberta* as the type of the genus. The inclusion of Hawaii in the distribution of *Aphanoconia* by Wagner is due to confusion about the location of *A. fulgora*, described in 1847 by Gould as from Samoa, and in 1852 redescribed by Pfeiffer with "Sandwich Islands" added to the location. (See p. 40.) This wrong location eliminates *Aphanoconia* from Hawaii, as Wagner listed only one representative of that genus from there. By mistake he classed *laciniosa*, a typical *Aphanoconia*, with *Sturanya*. Later, Baker chose *S. laciniosa* as the type of the genus. This was in agreement with Wagner, who had, however, described and illustrated Mighels's *Helicina laciniosa* with the characters of *H. hawaiiensis* Pilsbry and Cooke. Later still, Baker (letter, May 10, 1927) called attention to the fact that *Aphanoconia* is preoccupied by *Pleuropoma* Moellendorff. Thus *Sturanya* is eliminated from Hawaii instead of *Aphanoconia*, that is, *Pleuropoma*. Five species are grouped with subgenus *Sphaeroconia* of *Pleuropoma*, the geographical range of which is given by Wagner as Bonin Islands, Loo Choo, Formosa, Hainan, Hongkong, Tonking, Palau Islands, New Guinea, Bismarck Archipelago, Louisiades, York (near Australia), New Hebrides, New Caledonia, Fiji, Tonga, Samoa, Ellice Islands, Tuamotus, their center of distribution being between New Guinea and New Caledonia.

The two genera *Pleuropoma* and *Orobophana* seem to intergrade in characters of both shells and opercula.

A full description of an operculum is given (pp. 87-88) for *Pleuropoma* (*Sphaeroconia*) *hawaiiensis* variety *knudseni*. As other opercula are basically similar, their differences only are described.

A new character was noticed. On the base of many species in the neighborhood of the axis is a formation called here the "umbilical callus." In shape it ranges in different species from a wide to a narrow crescent shape, in size from comparatively large to small. It is bordered by an indented line and is more or less thickened. The term "basal callus" is applied, as is customary, to the thickening on the lower part of the beginning of the last whorl, in front of the aperture.

Ridgway's "Color Standards and Nomenclature" is used for colors.

Key to Genera

Shells round-conoidal; mostly thick-walled; basal callus in some species thick; whorls convex and tightly wound, last one rounded or round-angled; sutures shallow. Opercula half oval, S-ridge very slightly raised, in some species nucleus oblique and near columellar edge. From Kauai and Oahu.....**Orobophana**

Shells lens- to cone-shaped; firm but not thick-walled; basal callus thin; whorls convex to flat, loosely wound, last one sharp-angled; sutures shallow. Opercula semicircular to triangular, S-ridge slightly raised, nucleus less oblique and nearer the center than in *Orobophana*. From Kauai to Hawaii.....**Pleuropoma**

Shells subglobose conoidal; comparatively thin-walled; basal callus thin; whorls convex and loosely wound, last one not angled; sutures deep; aperture large. Opercula as in *Pleuropoma* (*sensu stricto*), but generally with a more prominent S-ridge. From Kauai, Niihau, Oahu, Molokai, Maui, Hawaii.....**Pleuropoma (Sphaeroconia)**

Genus OROBOPHANA Wagner

Orobophana Wagner: Denk. Akad. Wien, Helicinenst., vol. 77, p. 415, 1905; Syst. Conch.-Cab., Helicinidae, I, 18, pp. 223, 224, 1911. Baker: Acad. Nat. Sci. Phila., Proc., vol. 74, p. 43, 1922.

Helicina Lamarck: Soc. Hist. Nat. Paris, Mem., p. 77, 1799: Hist. Nat. des Anim. sans Verte., pp. 153-157, 1838. Pfeiffer: Syst. Conch.-Cab., Helicinaceen, I, 18, 19, pp. 10, 11, 1846-1853. Pilsbry and Cooke: Bernice P. Bishop Mus., Occ. Papers, vol. 3, no. 2, 14 pp., 1908.

Ideas of the relationship of Helicinidae to other shells were confused until the publication of Lamarck's studies, which took into consideration comparison of such features in different genera as shell, operculum, tentacles, eyes, and pulmonary aperture. In early groupings, Helicinas were placed by some with *Trochus*, a marine genus, and by Férussac in one large family with *Cyclostoma*. Among authors who later followed Lamarck in the generic title *Helicina* were Roissy, Férussac, Gray, Blainville, Menke, Cuvier, Deshayes, Anton, and Reeve. Schröter and Mühlfeldt did not distinguish it from *Helix*. Montfort called it *Pitonnullus*, Say called it *Oligyra*, Swainson *Pachystoma*, Gray *Alcadia*. Attempts were made to split the genus, as by the Adamses, who made subgeneric divisions based on shell characters. Not until 1905 and 1911 was the genus split into several genera, by Wagner, on the basis of characters of shells and opercula. Wagner limited the genus *Helicina* Lamarck to a part of the American Helicinas, for which it was originally established. New subfamilies, genera, and *Formenkreise* were created by him, and they have been generally adopted. Wagner's work was based on specimens from many regions of the world where Helicinidae are found. Baker (1922, p. 29) says: "Although a great advance on earlier attempts, his [Wagner's] work is seriously marred by a general disregard

of previous writers on the subject, and of the modern laws of priority." Wagner describes *Orobophana* as follows:

Gehäuse kugelig bis linsenförmig, fest bis dickschalig, mit glänzendem, dicken Basalkallus. Der Mundsaum kurz ausgebreitet oder fast gerade, aber innen lippenartig verdickt; die kurze, dicke Spindel nach aussen gebogen. Das niedrige und abgerundete Gewinde besteht aus 4 bis 5 nahezu flachen, langsam zunehmenden Umgängen. Die schwache Skulptur besteht zumeist nur aus feinen Zuwachsstreifen, daneben sind häufig dichte, feine und sehr hinfallige Spiralfalten der Epidermis vorhanden, selten jedoch feine eingedrückte Spirallinien. Deckel breit halbeiförmig oder abgerundet dreieckig mit geradem oder schwach S-förmig gebogenem Spindelrand. Die zumeist gekörnelte Kalkplatte ist am Spindelrande stärker bis knochenartig verdickt, gegen den Aussenrand zu allmählig dünner bis krustenartig zart; die Oberseite derselben flach konkav mit sehr seichter oder undeutlicher Rinne neben dem Spindelrand. Der Nukleus dem Spindelrande sehr genähert, die Sigmakante schwach gebogen, oft nahezu gestreckt; der untere senkrechte Ast deutlich erhoben und oft durch eine vom Nukleus zum Aussenrand verlaufende Furche begrenzt. Die Spindel-seite der Platte 4 bis 8 mal schmaler wie die Aussenseite.

Verbreitung: die Formen des Genus sind von Neu-Caledonien, den Viti, Samoa, Hervey, Gesellschaftsinseln, den Paumotu, Marquesas und Sandwich-Insel bekannt geworden; diese Inselgruppen stellen ein zusammenhängendes Gebiet dar, welches westlich in Neu-Caledonien seine Grenze findet. Schon auf den Neuen Hebriden ist das Vorkommen hierhergehörender Formen zweifelhaft, auf den Salomonen, Louisiaden und dem Festlande Australiens kommen dieselben bestimmt nicht mehr vor. Die entsprechenden Vorkommnisse der Sandwich-Insel sind derzeit noch isoliert, machen es aber sehr wahrscheinlich, dass Formen des Genus *Orobophana* m. auch auf den zentralpolynesischen Sporaden leben.

Durch Ausscheidung der Formenkreise *Primeana* m., *Sublaevigata* m., *Musiva* m., *Diversicolor* m. und *Pachystoma* m. wurde der Umfang des Genus *Orobophana* m. gegenüber meiner Auffassung desselben im ersten Teil der Helicinenstudien wesentlich eingeeengt. In dem hier angegebenen Umfange stellt das Genus ungezwungen eine natürliche Gruppe dar, welche durch auffallende Merkmale der Schale and des Deckels gut gekennzeichnet erscheint. Eine nahe Verwandtschaft zeigen die Formen dieses Genus besonders zu den Formenkreisen *Musiva* m., *Porphyrstoma* m. und *Inconspicua* m. des Subgenus *Sphaeroconia* m.; dieselben erweisen sich als Uebergangsglieder, indem die Form der Schale für den Anschluss an das Genus *Orobophana* spricht, während der Deckel noch deutlich die Merkmale des Genus *Aphanoconia* m. erkennen lässt. Extrem entwickelte Formen des Genus *Orobophana* m., welche besonders auf den Paumotu und Marquesas auftreten, besitzen einen Deckel mit einem dem Spindelrande sehr genäherten Nukleus und sehr schmaler Spindel-seite der Platte, kommen also Verhältnissen nahe, welche für das Genus *Palaeohelicina* m. charakteristisch sind; die Berücksichtigung der übrigen Verhältnisse, besonders die Beschaffenheit der Schale lässt jedoch über die Zugehörigkeit auch dieser Formen keinen Zweifel aufkommen.

Hawaiian representatives of *Orobophana* fit Wagner's description. Due to the shape of the aperture the opercula tend to be half oval in shape. A low, indistinct S-ridge and a rather oblique nucleus, which is nearest the columellar edge, are the rule.

Key to Species

A. Fossil shells, from Kauai.

1. Lip and basal callus conspicuously joined, shells very thick-walled, callus thick4
- Lip and basal callus not conspicuously joined.....2

2. Shells thick-walled3
 Shells thin-walled, callus thin..... **O. berniceia**
3. Callus thin **O. cookei**
 Callus thick **O. juddii**
4. Shell low-conoidal, aperture moderately oblique and flaring..... **O. stokesii**
 Shell high-conoidal, aperture extremely oblique and not flaring.....
 **O. stokesii** variety **praemagna**
- B. Living shells, two from Kauai; one, *O. uberta*, from Oahu.
1. Low-conoidal, with peripheral angle, callus thin.....2
 Globular, round periphery..... **O. uberta**
2. Rather thick-walled, pinkish beneath epidermis, peripheral whorl distinctly
 biangled **O. meineckeii**
 Rather thin-walled, white beneath epidermis, peripheral angle flat.....3
3. Without rib at base of columella..... **O. baldwini**
 With rib at base of columella..... **O. baldwini** variety **lihueensis**

Orobophana juddii (Pilsbry and Cooke) Caum (figs. 1, 2).

Helicina juddii Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 12,13, fig. 13, 1908.

Orobophana (?) *juddii* (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 7, 1928.

Original description:

The shell is semiglobose, with a flattened base and a rounded periphery, solid, nearly smooth, but under lens fine growth-lines are seen intersected at right angles by fine, close, forwardly descending wrinkles. Spire elevated, with convex outlines. Suture simple, well impressed. Whorls $4\frac{3}{4}$, slightly convex, the last rather abruptly descending in front, rounded at the periphery and above, flattened below. Aperture contracted, semi-circular, very oblique; outer lip thickened within, though thin at the edge, duplicate above the periphery. Callus very thick, smooth. Operculum wanting. Maj. diam. 4.8, total length 4.6 mm.

Kauai: Koloa beach, in a fossil state (Judd).

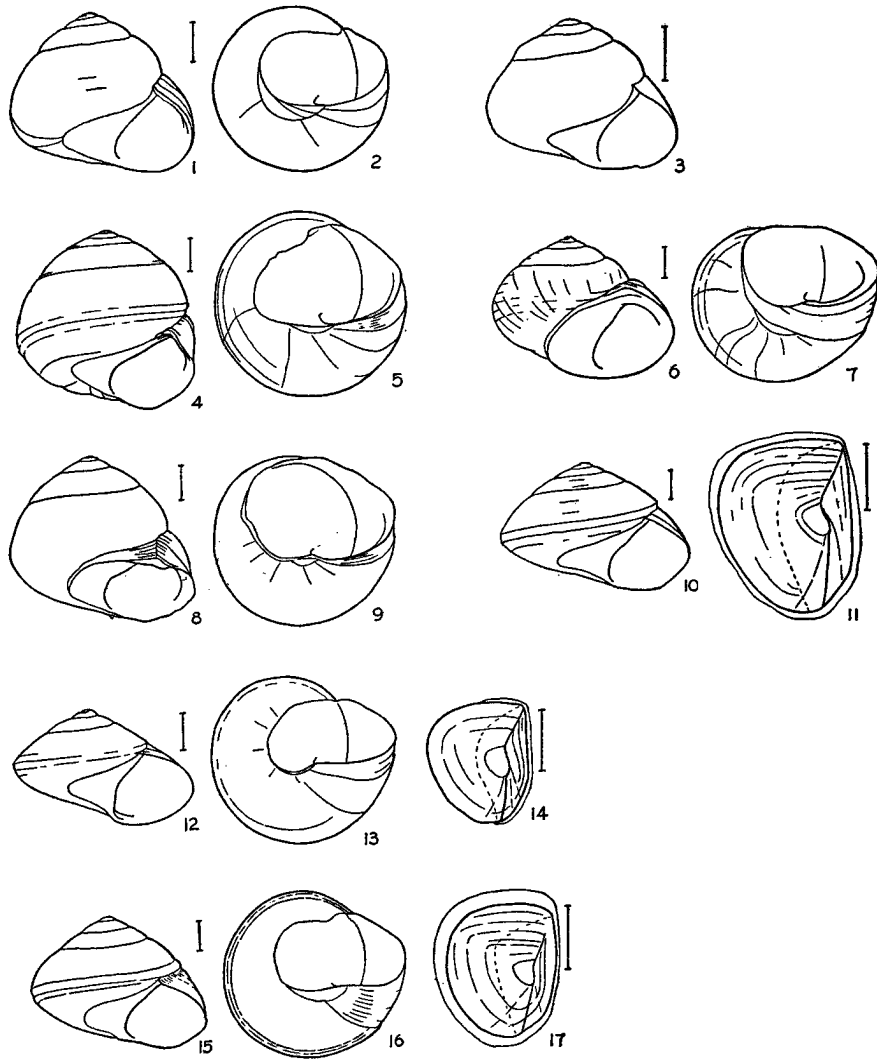
Type No. 14,898, Bishop Museum.

This species is easily recognized by its semiglobose form, flattened base, large size, and by the minute corrugation of its surface. It is only known, at present, from bleached specimens found on the Koloa beach.

So far this is the only representative of the group related to *H. uberta* from the island of Kauai.

Originally five fossil specimens of *O. juddii* were found, by A. F. Judd, on sand dunes west of Keonelo, Koloa, Kauai. Later, J. F. G. Stokes found large quantities under similar conditions in the same general region, at Makahuena Point and at Weliweli.

Some shells are considerably eroded and polished; others have perfect details, even embryonic whorls being distinct. Remeasurement of the type shows the dimensions to be: diameter 4.6, height 4.2 mm., compared with diameter 4.8, height 4.6 given in the original description. Some closely resemble the type; others vary considerably from it, being higher and wider or narrower. In some the aperture is larger and more flaring; in some a broad indentation is present in the middle of the last whorl. Adult shells have fully 5 whorls; the type, which is not quite mature, has $4\frac{3}{4}$. In several specimens



FIGURES 1-17.—*Orobophana* from Kauai: 1, 2, *O. juddii*, type, no. 14898; 3, *O. berniceia*, type, no. 14909; 4, 5, *O. cookei*, cotype (smaller of two), no. 11245; 6, 7, *O. stokesii*, type, no. 11246; 8, 9, *O. stokesii* variety *praemagna*, type, no. 11247; 10, 11, *O. baldwini*, type, no. 19065, shell; no. 16693, operculum; 12-14, *O. baldwini* variety *lihueensis*, type, no. 11243, shell; paratype, no. 80005, operculum; 15-17, *O. meineckeii*, type, no. 11240, shell, no. 86435, operculum. The dull area on opercula is outlined by a broken line. The measure indicates 1 mm.

the growth lines are here and there rather deeply indented, resulting in an irregular surface. In all specimens a crescent-shaped callus is present in the umbilical region. In none are forwardly descending wrinkles present, a character belonging to *O. stokesii*, one specimen of which was mixed with the type lot of *O. juddii*, in the original description of which it was used.

On sand dunes near the shore at Mahaulepu, J. F. G. Stokes and C. M. Cooke, Jr., collected several lots of *O. juddii*, many closely resembling the type, some lower and some narrower (for example, diameter 4, height 5.6 mm). None runs so large as those from Makahuena Point, and none is so conspicuously indented on the last whorl. In some of these specimens, markings on the upper whorls are distinct, appearing on these fossils as alternate opaque and translucent bands.

At Kipukai, 5 miles along the shore east of Makahuena Point, C. M. Cooke, Jr., found in sand dunes several specimens like the type, but a little smaller and thinner.

Orobophana berniceia (Pilsbry and Cooke) Caum (fig. 3).

Helicina berniceia Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 11, fig. 11, 1908.

Orobophana (?) berniceia (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

The shell is globosely depressed, with a rounded periphery, quite thin, smooth, minutely marked with growth-striae. The spire is rather high, with convex outlines and a slightly conoidal summit. Suture simple, slightly impressed. Whorls 4, very slightly convex, regularly increasing, the last rounded, slightly flattened below, hardly descending in front. Aperture oblique, semicircular, not contracted; outer lip thin. Callus thin, smooth. Operculum wanting. Maj. diam. 3.5, total length 3.1 mm.

Kauai: Limahuli, fossil (Judd, Cooke).

Type No. 14,909, Bishop Museum.

This species is somewhat related to *H. laciniosa* Migh., though it lacks the spiral lines and the angular periphery. Its nearest relative appears to be *H. nuuanuensis*, from Oahu. From this species it differs slightly in size, in the convexity of the spire and whorls, and the lack of spiral lines. At present this species is only known in its fossil state.

This species is dedicated to Bernice Pauahi Bishop, in whose memory the Museum, which bears her name, was founded.

On the northern shore of Kauai, at Limahuli, besides the type lot collected by A. F. Judd, other lots of the fossil shell *O. berniceia* were collected by C. M. Cooke, Jr., C. S. Dole, W. H. Meinecke, and T. T. Dranga, and a few are in the D. D. Baldwin collection in Bernice P. Bishop Museum:

The shells resemble the type closely but run larger in size, and some have higher, some lower spires. Fine spiral lines to the number of 15 were found on the last whorl of several specimens, being quite distinct on one of the paratypes. One of the few fresh specimens was noticed to have markings: alternately translucent and opaque on the

penultimate whorl. All have a crescent-shaped callus in the umbilical region, resembling that of *O. meineckei*. In general they look like *O. juddii*, from the southern shore of Kauai, but are thinner and much smaller, and like *O. uberta* variety *lymaniana* from Oahu.

In the next valley to the east, Haena, J. F. G. Stokes, C. M. Cooke, Jr., and W. H. Meinecke found a few specimens like those from Limahuli. Seven miles east of Haena, in a sand bank at Kalihikai, a few specimens were collected by C. M. Cooke, Jr., that resemble those from Haena. By Kalihiwai stream, W. A. Bryan found a few juvenile specimens. In a road cutting at Hanalei, C. M. Cooke, Jr., found a few specimens, which are small like the types. The same is true of a few collected near by, at Waipa, by W. H. Meinecke.

At Wailua, on the western side of Kauai, mostly between 1 and 4 miles south of the river, C. S. Dole and C. M. Cooke, Jr., collected many specimens of a distinct geographical race of *O. berniceia*. Some nearly equal the type in size; most are smaller, averaging about as follows: diameter 3, height 2.7 mm. On some, 7 or 8 fine spiral lines can be discerned. At Waipouli, bordering Wailua on the north, Cooke, Dole, and D. Thaanum found a few shells similar to those from Wailua.

***Orobophana cookei*, new species (figs. 4, 5).**

Fossil. Shell large, low- to high-conical, solid; smooth except for a double ridge around the periphery, two lines faintly suggested above it carried on to upper whorls, and a rounded ridge below causing a flat base; spire elevated, obtuse; whorls 5, flat, the penultimate whorl and one just above bordered on their lower margin by the upper of the 2 double peripheral ridges; aperture not expanded, very oblique, oval; columella simple, producing a rather thin callus; lip as in *O. stokesii*, but not so closely joined to the basal callus; callus in umbilical region a tiny crescent. The cotypes measure: diameter 6, height 5.6 mm; diameter 6.7, height 6.5 mm. Operculum wanting.

Kauai, Kalalau, on cliff on west side of valley, altitude about 200 feet, July 17, 1907, C. M. Cooke, Jr., and A. Knudsen, cotypes no. 11245, paratypes no. 15667.

Fifteen specimens of this remarkably large representative of Hawaiian Helicinidae were collected. It vies with *O. baldwini* in size. The shape varies from high, narrow, conoidal to low and wide. In a general way this shell resembles *O. stokesii* variety *praemagna* from Wailua, but is larger, has a double ridge around the periphery, and has a thin basal callus.

In one locality at Haena, about 7 miles east along the shore from Kalalau, C. M. Cooke, Jr., found several fossil shells resembling *O. cookei* in general appearance. However, they have at most $4\frac{3}{4}$ whorls and are smaller, the measurements ranging somewhere between 5.2 to 4.8 mm in diameter, 4.8 to 4.2 mm in height.

Orobophana stokesii, new species (figs. 6, 7).

Fossil. Shell low cone-shaped, with pointed apex, solid, smooth except for growth lines more or less distinct and raised spiral striations, 6 of which are clearly visible on the last whorl, 2 on one or two whorls above. Whorls 5, flat to slightly convex except the last, which is well-rounded. Suture shallow. Aperture prominent and flaring, oblique and semicircular. Lip is wrinkled longitudinally and consists of a thinning of the shell, the translucent inner layer continuing somewhat beyond the chalky outer layer, which ends in a short slope after ascending slightly on the penultimate whorl. The lip joins without interruption a smooth, very thick, large, basal callus, which ends abruptly with a rounded margin in the upper part, in the lower less abruptly. The shell is opaque, on the penultimate whorl having a narrow zigzag pattern, on the last whorl more or less regular furrows from growth lines. A small crescent-shaped callus is visible in the umbilical region. The type measures: diameter 5.5, height 4.4 mm. Operculum wanting.

Kauai, Koloa, Makahuena Point, November 1911, J. F. G. Stokes, type no. 11246, paratypes no. 35829.

In general appearance *O. stokesii* is much like *O. uberta*, but is heavier and has a more widely flaring aperture. It is the heaviest species known in Hawaii. All are fossil, white, and more or less eroded.

The shell was discovered by A. F. Judd, who collected one with the five original specimens of *O. juddii*. It was confused with them and gave rise to an erroneous detail in the description of *O. juddii*—"forwardly descending wrinkles" on the surface, which are absent in *O. juddii*. In many other ways the two species are distinct. Later, a large lot was collected (nearly 2,000 specimens) by J. F. G. Stokes, mixed with *O. juddii* and in about an equal number, at Makahuena Point, Koloa. They are quite uniform in shape, varying most perhaps in amount of convexity of whorls and in height of spire. In size they vary much.

On sand dunes at Mahaulepu, in the southeastern part of the Koloa district, J. F. G. Stokes and C. M. Cooke, Jr., found a few fossil shells similar to those from Makahuena Point that are somewhat smaller than the type. Some have a jutting edge to the margin of the callus, as in *O. stokesii* variety *praemagna*.

In several localities on sand dunes at Kipukai, over the ridge bounding Mahaulepu on the east, C. M. Cooke, Jr., found fossil shells that closely resemble those from Mahaulepu. Some have a suggestion of a keel on the last whorl. Along the shore about 15 miles north of Kipukai, in a sand bank at Kealia (no. 77862), C. M. Cooke, Jr., found fossil shells (one measures: diameter 4.7, height 3.9 mm) much like those from Kipukai. But spiral markings are not so evident, and the aperture is less flaring. In Kapaa, near the Kealia race track, D. Thaanum found a single remarkably large fossil differing from shells from Kealia chiefly in size, being 6.8 mm in diameter and 6.3 mm in height.

On the extreme west side of the island behind the Barking Sands at Mana, C. M. Cooke, Jr., collected four much-worn fossil specimens (no. 37522) much like those from Kealia, but having a thinner callus and a more acutely rounded last whorl. One measures: diameter 4.9, height 4.2 mm. From McInerny the Museum received some fossil shells (no. 23743) probably collected by Whitney near Mana, and they are much like representatives of this species from Mana except in size, being larger (one of the largest: diameter 6.1, height 5 mm), somewhat thicker, with upper whorls more rounded and suture deeper.

In Wailua, Kauai, at the Waipouli race track, C. S. Dole collected some fossil specimens of shells closely resembling those from Kipukai.

Orobophana stokesii variety **praemagna**, new variety (figs. 8, 9).

Fossil. Shell somewhat like that of *O. stokesii*, but blunter-conical, spire higher, aperture not flaring, more oblique. Lip narrower and thinner. Basal callus more distinct and slightly concave, its margin ending sharply and jutting out in an acute angle from the whorl. Whorls $4\frac{3}{4}$. Umbilical callus smaller. The type measures: diameter 5.4, height 5 mm. Operculum wanting.

Kauai, south of Wailua River, half a mile from ocean, altitude 5 to 10 feet, no date, C. S. Dole, type no. 11247, paratypes no. 16061.

Several shells in several lots were collected in a limited area at the type locality, by C. S. Dole, C. M. Cooke, Jr., and D. Thaanum. The spire varies in height.

At Mahaulepu, Stokes and Cooke each found a specimen closely resembling this variety, intermediate between the variety and the species from the same locality. They are slightly smaller than the variety and larger than the species.

Orobophana baldwini (Ancey) Caum (figs. 10, 11).

Helicina baldwini Ancey: Malacol. Soc. London, Proc., vol. 6, pt. 2, pp. 126-127, pl. 7, fig. 24, 1904. Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 13-14, 1908.

Orobophana (?) *baldwini* (Ancey) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

Testa conoideo-lenticularis, solidula, subnitidula, sub epidermide tenui lutescente vel ochracea sordide alba, vertice rubello vel luteo, lineis incrementi tenuibus sub lente sculpta, et stria unica parum impressa supra angulum medianum sita et suturam sequentes exarata. Spira conoideo-depressa, vertice minuto. Anfractus fere 5, planulati, superiores subexserti, ultimus ad peripheriam biangulatus, angulo inferiore altero valde approximato, infra medium sulco exili circumcinctus, basi convexus. Callum basale lividum, intus luteum, granulatum. Apertura obliqua, subtriangularis, angulo extero rotundato. Peristoma simplex, rectum, margine columellari cum basali angulum rotundatum efficiente.

Diam. maj. 6, min. 5.66, alt. 4, alt. apert. (oblique) 3.25 mm.

Hab. Kipu, Kauai (D. D. Baldwin).

The largest species hitherto found in the Sandwich Islands, but of the same general type.

Enlarging and modifying the original description:

Shell low-conoidal, rather thin, slightly shining, nearly smooth, aperture oblique and broadly oval, in color yellowish or reddish. Epidermis thin, chamois to buckthorn-brown, on a few specimens ferruginous, grading toward the tip of most to a reddish orange, which is light in some and as strong as bittersweet-orange in others. Beneath the epidermis the shell is chalky white. The color is solid on most shells, on the last whorl or two of others striped with many inconspicuous alternating white and colored oblique bands or with zigzag bands. These are especially distinct on juvenile specimens. The apertures range from white to wax-yellow or approach ferruginous.

Lines of growth are fine and regular. On $1\frac{1}{2}$ whorls preceding the last whorl, 2 shallow, parallel, impressed lines (in some 1 line) proceed spirally on to the last whorl, where they continue more or less distinctly to the lip, accompanied by a similar line or two below the periphery. In many juvenile shells these lines as well as the two angles of the periphery are raised membranes.

Whorls 5, flattened, slightly convex, in most specimens in its lower part the penultimate whorl protruding above the last whorl. This is due to the presence on the periphery of a flattened angle, which in many specimens is bisected by the last part of the suture of the last whorl. In some it passes above the suture, in others below it. In all adult specimens it becomes well-rounded, with little or no trace of an angle on the last quarter whorl or so.

Columella broadly rounded, rather thick, a thin, finely punctate, tongue-shaped callus extending from it on to the base. Lip not thickened but thinning, on some specimens duplicate, the lower layer extending slightly beyond the upper. Callus in the umbilical region small, like that of *O. meineckei* but about two thirds its length; eroded in the type (no. 19065). Base convex.

My measurements of the type—diameter 6.3, height 4.5 mm—do not agree with Ancey's which are: diameter 6, height 4 mm. The type and the paratypes are not so large and mature-looking as many specimens, some of which are considerably larger, some higher, some lower. The species vies with *O. cookei* in being the largest representative of Hawaiian Helicinidae and probably averages largest.

Operculum thin, grading from thicker columellar edge to thin, transparent palatal edge. S-ridge indefinite, not raised above and fanning out below the nucleus. Outside covered with tiny granulations. In general like that of *O. uberta*, but differing as follows: shape rectangular triangle as compared with the isosceles triangle of *O. uberta*, curve of palatal angle more acute, the ridge on the columellar margin of the outer layer sharp-angled and rising vertically. In color the opercula are amber-yellow and orange-buff, and some have a rufous spot on the columellar edge.

In 1908, Pilsbry and Cooke studied the teeth of four species of Helicinidae. They say: "In *H. baldwini* the denticle formula of the laterals is 6, 5, 4, 5, 0; that is, the innermost lateral tooth has 6 points or denticles on its recurved cusp, the next tooth has 5, and so on. The inner uncini have three or four rather large denticles. Lateral iv has very unequal conic denticles, two of them much larger than the others. *H. uberta* is like *baldwini*, except that the inner lateral has only 4 denticles." For this reason, *Orobophana baldwini* and related species are classified in this paper with *O. uberta*.

At Kipu, this species was discovered by C. M. Cooke, Jr. He sent specimens to D. D. Baldwin, who in turn passed on to Ancey the material, which he named from a type and two paratypes. These three shells are now in Bernice P. Bishop Museum. Later, several specimens were found in valleys

and on low ridges at Kipu by C. S. Dole and Leslie Wishard, one by L. H. McDaniels.

In the adjoining valley, Kipukai, Cooke also collected specimens. They resemble those from Kipu but run somewhat larger, perhaps having lived in a more favorable environment. Possibly more have high spires. On Haupū, a peak in Kipu district, several specimens, large but otherwise typical, were collected by C. M. Cooke, Jr., C. S. Dole, and T. T. Dranga. The opercula are similar to those in shells from Kipu, except two that differ in color, being quite dark, mostly hazel.

Bearing the label "Kauai" only, are five shells collected by C. M. Cooke, Jr., and they have every indication of having come from the same region as the type, though they exceed it in size.

***Orobophana baldwini* variety *lihueensis*, new variety (figs. 12-14).**

Resembling small *O. baldwini*. Though having only 4 whorls the shells seem adult. The largest—the type—measures: diameter 5, height 3.3 mm; they average: diameter 4.6, height 3.2 mm. The flattened angle on the last whorl is well-rounded at the lip and just behind it, as in adult *O. baldwini*, in juvenile specimens of which the angle is still present at the lip. The shells are translucent and thinner than *O. baldwini*, have a glossier surface, and are not so distinctly angled, one specimen (pathologic) having no angle. At the base of the aperture of most shells, a short ridge joins at an angle the base of the columella, as in some *Pleuropoma* (*Sphaeroconia*). In color they are cinnamon-rufous, with more or less distinct zigzag stripes in cream color, the type being the reverse, with the main color cream, the zigzags cinnamon-rufous. Umbilical callus a very narrow crescent, in some shells wider, as in the species. Operculum is like that of *Orobophana baldwini* but smaller, nucleus slightly nearer the center, and S-ridge definite.

Kauai, Lihue district, back of Grove Farm reservoir, July 6, 1925, W. H. Meinecke, type no. 11243, paratypes no. 80005.

Besides the type and four paratypes, one shell belonging to this variety was found by C. M. Cooke, Jr., at Kilohana, Lihue.

***Orobophana meinecke*, new species (figs. 15-17).**

Shell low-conoidal, rather solid, slightly shining, nearly smooth, aperture oblique and broadly oval. Epidermis thin and ephemeral, apricot-buff or lighter. Beneath the epidermis the shell is pale ochraceous salmon with rufous aperture or alizarine-pink with brick-red aperture. On the first half of the last whorl and on the penultimate whorl are fine rufous transverse bands. The apex is cream color. Lines of growth fine and regular. Whorls $4\frac{1}{2}$, flattened, slightly convex, ordinarily the penultimate whorl being margined on its lower edge by a ridge—the upper half of the rounded double angle at the periphery, which is bisected in most at the peristome. In adult specimens the double angle is well-rounded at the peristome. Columella broadly rounded, rather thick, a transparent, thin, finely punctate callus extending from it on to the base. Lip cream color, thinning, and wrinkled for a considerable distance. Callus in umbilical region rather small, much like that of *O. baldwini*, but longer. Base convex. Type measures: diameter 6.2, height 4.6 mm. Operculum similar to that of *O. baldwini* in all ways except in shape, the upper columellar and palatal angles being more rounded. The palatal angle rounds off the acute angle of younger lines of growth.

Kauai, Hanakoa Valley, July 2, 1927, W. H. Meinecke, type no. 11240, paratypes no. 86435.

In Hanakoa Valley, on the north side of Kauai, several specimens besides the type were found by Meinecke. The shell resembles *O. baldwini* in a general way, especially in size and shape, but is distinct in so many details that it seems to deserve specific rather than varietal rank. *O. meinecke* is a heavier shell than *O. baldwini*, the biangled keel on the periphery is more distinct and ordinarily has a furrow down the center, and the shells are different in color, *O. meinecke* having a distinctly reddish cast.

On the northeast side of Kalalau Valley, 2 miles west of Hanakoa, Meinecke found four adult shells that can not be distinguished from small-sized adult shells of *O. meinecke* from Hanakoa. With them were a few juvenile shells, which one each collected by C. S. Dole and C. N. Forbes resemble.

Orobophana uberta (Gould) Wagner (figs. 18-20).

Helicina uberta Gould: Boston Soc. Nat. Hist., Proc., vol. 2, p. 202, 1847;

U. S. Expl. Exped., Mollusca and Shells, pp. 94, 95, 1852, also pl. 7, fig. 114, 1856. Pfeiffer: Mon. Pneum., vol. 1, pp. 367, 368, 1852; in Gray's Cat. Phaner., p. 266, 1852; Mon. Pneum., vol. 2, p. 186, 1858. Adams, H. and A.: Gen. Rec. Mollusca, p. 302, 1858. Sowerby: Thes. 3, p. 293, pl. 276, figs. 396, 397, 1866. Baldwin: Cat. Shells, p. 16, Honolulu, 1893 [not *Orobophana uberta* = *Pleuropoma laciniosa* varieties *honokowaiensis* and *kulaensis*]. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 397, 1900. Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 13, 1908.

Helicina huberti (Gould?) in Mus. Cuming, Pfeiffer: Mon. Pneum., vol. 1, p. 368, 1852.

Orobophana uberta (Gould) Wagner: Syst. Conch.-Cab., Helicinidae, I, 18, p. 236, pl. 46, figs. 9-12, 1911. Caum: B. P. Bishop Mus., Bull. 56, p. 7, 1928.

Original description:

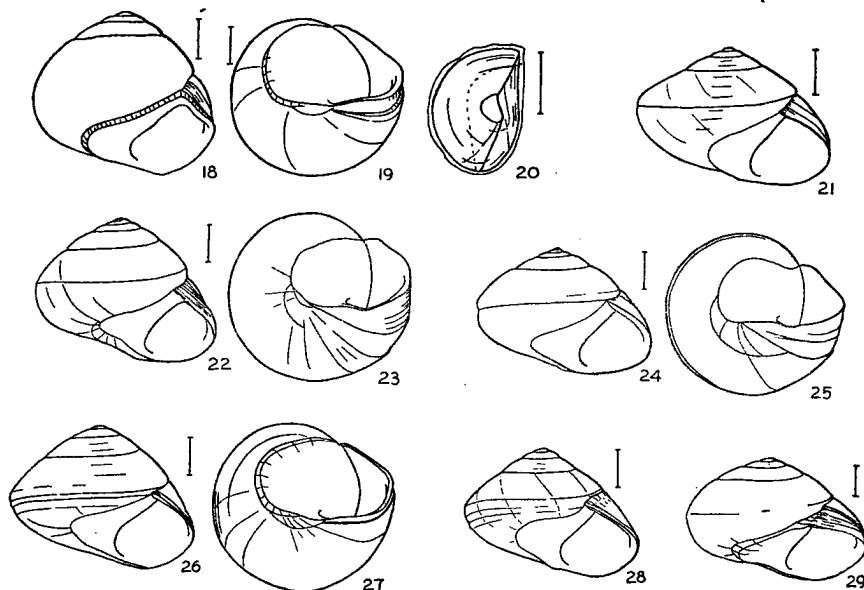
Testa parva, solida, sub-globosa, laevis, dilute citrina; spira anfr. 4; sutura impressa; apertura parva, semilunaris, extrinsecus constricta; peristomate simplici, vix reflexo; columella callo flavo copiosissimo, haud appresso, induta. Lat. 7/40, alt. 3/20 poll. Hab. Maui, and Oahu Mountains.

Very remarkable for the abundant golden yellow callus which forms a tongue-like projection across the base of the shell.

Gould's translation (1852) of his original description and some details added:

A small, solid, smooth, nearly globular, pale greenish-yellow shell, very faintly marked by the lines of growth, having four whorls, the outer one large and well-rounded at the periphery, with a fine but well-impressed suture; but chiefly remarkable for the

quantity of bright yellow callus nearly covering the convex base of the shell in a tongue-shaped mass, not appressed to the shell. The aperture is semilunate, made very small by a deep constriction just behind the lip, which is sharp, and very slightly reflexed, so that the opening seems thrust somewhat across the base of the shell. Axis three twentieths of an inch [3.8 mm]; breadth seven fortieths of an inch [4.7 mm].



FIGURES 18-29.—*Orobophana uberta* and varieties and forms from Waianae Mountains, Oahu: 18-20, *O. uberta*, no. 14897, shell; no. 42251, operculum; 21, *O. uberta* variety *bryani*, type, no. 11262; 22, 23, *O. uberta* variety *bryani* form *a*, type, no. 11263; 24, 25, *O. uberta* variety *bryani* form *b*, type, no. 11264; 26, 27, *O. uberta* variety *wilderi*, type, no. 11261; 28, *O. uberta* variety *wilderi* form *a*, type, no. 33152; 29, *O. uberta* variety *makuaensis*, type, no. 11265. The dull area on operculum is outlined by a broken line. The measure indicates 1 mm.

Shells studied in the collection of Bernice P. Bishop Museum closely fit Gould's description and figures of the type (no. 5516, Smithsonian Institution).

The most striking features of *O. uberta* are solidity of the shell, its roundness, its large, thick, shining callus, its abruptly thinning lip. Gould described the shell as nearly globular, with a convex base; Pfeiffer as semiglobose-conoid, hardly convex at the base; Wagner as globular with a low, rounded, cone-shaped spire. A specimen from Pukalooa, southeast of Puu Kaala, Waianae Mountains, Oahu (Bishop Museum no. 14897), collected by C. M. Cooke, Jr., has been compared by him with the type, which it closely resembles. It is globular, with a low, pointed, cone-shaped spire, and is hardly convex at the base. Extremes from Pukalooa have spires both much elevated, resulting in a conical shape, and hardly elevated, resulting in an oval shape with horizontal diameter greatest. In Waianae Valley, typical and lower forms have been collected.

The measurements given by different authors are about the same: 4.7 by 3.8 mm,

Gould; 5 to 4.5 by 4 mm, Pfeiffer; 4.5 to 4 by 3.5 mm, Wagner. The specimens discussed here are from Pukaloa and are in the collection of Bernice P. Bishop Museum, collected by C. M. Cooke, Jr., D. Thaanum, Alvin Seale, W. A. Bryan, J. S. Emerson, A. Gouveia, I. Spalding, W. D. Wilder, W. H. Meinecke. No. 14897 is 4.6 mm in width, 4.1 in height, being higher than the average, which is close to Gould's measurements. One of the lowest in the same lot, no. 14866, is 4.6 mm in diameter, 3.7 in height. The measurements vary considerably. Height and width are nearly the same in two, no. 35957, being 4.35 mm in diameter, 4.25 in height. Quite the opposite in proportions is one of the largest, no. 36798—5 mm in diameter, 4.1 in height. The smallest, no. 35957, is 4.2 mm in diameter, 3.3 in height. Shells from Waianae Valley collected by C. M. Cooke, Jr., R. A. Cooke, W. D. Wilder, D. D. Baldwin, and O. Oswald have an average size like that of the largest specimen from Pukaloa; one odd specimen measures: diameter 5, height 4.6 mm.

Gould's and Wagner's term "solid" applies to *O. uberta* from all localities represented in the collection of Bernice P. Bishop Museum. Pfeiffer's "rather thin" would seem to indicate that his specimens were young.

Smooth except for fine growth lines and a few spiral lines. In some specimens a few growth lines are more deeply indented than others. On the base of the last whorl of best-preserved specimens are 2 to 5 fine spiral lines, in most of these impressed, in some raised and giving a malleated effect to the surface. In some specimens from Waianae Valley, 5 or 7 impressed or raised lines are present on the last whorl, extending with regular spacing from the base to the suture, and 2 impressed lines are more or less distinct on part of the second and third whorls.

Gould describes the shell as greenish yellow, Pfeiffer as white, Wagner as bright yellow. Shells in Bernice P. Bishop Museum have these approximately and also cream and reddish colors. No. 14897 is opaque, ferruginous, overlain with a more or less continuous film of chalky white down to the last whorl, where it becomes cream color overlain with white, the base bearing patchy remnants of a thin primuline-yellow epidermis. Many shells are like this. Others have white spires and more epidermis on the last whorl, which is mostly Naples-yellow, partly mustard-yellow. Some are entirely dull white with no epidermis. In a few the ferruginous color continues into the beginning of the last whorl, and in a few the epidermis is ferruginous. As the epidermis only is shining, the surface is dull where it is absent.

Patterns of zigzags, ferruginous and white or cream color alternating, are more or less distinct on a few specimens, extending on a half or whole whorl preceding the last half of the last whorl. Callous plate and interior of aperture cream color and shining. Many shells from Waianae Valley have citron-yellow plates, some shading at the outer margin to ochraceous orange. Lip white or cream color.

In 1908, Pilsbry and Cooke published their results of examination of teeth of four species of Helicimidæ. They say: "*H. uberta* is like *baldwini*, except that the inner lateral has only 4 denticles."

Specimens from Waianae Valley have the same range of color as those from Pukaloa, though in some ferruginous is replaced by orange-vinaceous in the spire. Colored spire and zigzag pattern are rare, the general appearance being white and yellow. Specimens from Haleauau, east of Puu Kaala, are white with some primuline-yellow epidermis on the base.

No. 14897 has $4\frac{1}{4}$ whorls. In some specimens the first 3 whorls are slightly convex down to the last one, which is well-rounded. The first 2 whorls increase gradually in size, the last 2 more rapidly. Suture fine, shallow, not margined. The outer layer of the shell ends abruptly just before reaching the lip. The suture rises a little at that point on to the penultimate whorl and descends to position with the thinning of the lip.

Umbilicus absent, but in the umbilical region and attached to the base of the callous plate is a tiny, slightly crescent-shaped elevation or callus.

Other lots from Pukaloa are similar. They have about the same number of whorls. A few of high pyramidal shape have on the last whorl a broad rounded keel, which appears on the penultimate whorl bulging above the suture. Some others not keeled have a decidedly convex penultimate whorl. Specimens from Waianae Valley average $4\frac{1}{2}$ whorls; penultimate whorl of few bulges, and keel is absent.

Aperture oblique, broadly semi-oval, with a thick translucent shining callus, smooth except for many hardly perceptible punctations, forming on the base of the shell continuous with the peristome a semicircular plate, ending abruptly with a slightly raised margin. The plate becomes thin as it extends back into the aperture, making a sharp angle at the columella. Columella short, much-curved, flattened.

Lip thin, narrow, slightly sinuous in outline, and slightly expanded. Gould's impression that the aperture is made small by a deep constriction behind the lip was probably due to the thinning of the shell at the lip, which does not, however, affect the interior size of the aperture. The close fitting of the operculum in different depths of the aperture would seem to bear this out.

Shells that are almost adult, having nearly 4 whorls, differ markedly from adults as follows: brighter yellow or ferruginous and shining, the epidermis being present; thinner, commonly being translucent; pattern of zigzag lines commoner; callous plate not formed; more globular in shape; thin, fragile, unexpanded lip. In younger stages, a rounded angle at the periphery is common; also distinct, raised, spiral lines, 7 being found on the last whorl, with a burr, 2 on the penultimate.

Operculum translucent, shining, Naples-yellow, cream, or pale salmon. Some are apricot-orange at the columellar edge. Broadly half-oval, on columellar edge weakly sinuous, projecting slightly above and curving back decidedly at the base. Very thick close to columellar edge, where a narrow ridge is formed on the outside of the operculum that dips rather suddenly toward the edge, and nearly as suddenly toward the middle, greatly reducing the thickness of the operculum, which continues thin to the outer or palatal edge. The outside or calcareous layer is concave, inclined to be whitish, nearly smooth, covered with tiny low flattened granulations that are greatly reduced in size or absent near the edge. They seem to be concentric, following the lines of growth. On the inside or horny layer, the nucleus, which though much smaller nearly resembles the operculum in shape, is slightly below the middle, nearest the columellar edge, and more oblique than the nucleus in opercula of *Pleuropoma*. S-ridge not prominent, lower part most distinct and with a branch to the columellar edge. The portion between the S-ridge and the columellar edge has a higher elevation than the portion toward the palatal edge, which is a little convex with the nucleus highest. Growth lamellae distinct; dull area large. A narrow margin of the inner filmy layer extends beyond the outer layer.

For the locality of *O. uberta*, Gould gives in his first reference, "Maui, and Oahu Mountains," in his second reference, "mountains of the Sandwich Islands, on Oahu by Pickering and Case, on Maui by Drayton." Pfeiffer gives "Sandwich Islands, Maui, Oahu." Wagner gives "Sandwich Islands." Baldwin gives "Maui." Sykes states: "Maui and Oahu, according to Gould, Oahu, below Kaala, according to Perkins." Pilsbry and Cooke give "Waianae Mts., Oahu." As no *Orobophana* in the collection of Bernice P. Bishop Museum is from Maui and no representatives of that genus in the Koolau Range of Oahu fit the original description of the species, Gould's type evidently came from the Waianae Mountains of Oahu, probably from Waianae Valley, where specimens agreeing best with Gould's description, though

slightly larger, have been obtained. Additional evidence that Waianae Valley is the type locality is furnished by Wilkes's narrative ⁷ of the expedition during which the shells described by Gould were collected:

Dr. Pickering and Mr. Brackenridge made a tour to Waianae, for the purpose of examining more particularly the Kaala Mountains for plants. . . . After stopping a night at Ewa, they took a middle route, and passing through a gap in the mountain, fifteen hundred feet in elevation, reached Waianae in the afternoon, a distance of sixteen miles. . . . While at Waianae, they extended their walks in different directions, along the beach, at the foot and sides of the mountains, meeting with several very interesting plants. . . . They endeavoured to make an ascent on one of the ridges, but found themselves obliged to give it up, when they had reached half the altitude of the mountain. . . . They left Waianae after being two days with the chief.

O. uberta occupies a small area, but it is rather abundant in some favorable localities in this area, as small, damp valleys. It lives on the ground on dead leaves and dead twigs. Bernice P. Bishop Museum has few lots. The typical forms are confined to the central part of the Waianae Mountains, from Haleauau to Kanehoa, on both sides of the range, most specimens coming from the valleys of Pukaloa and Waianae. The altitudinal range is wide, specimens being found living from the lowest forest belt of the valleys to the highest forest belt of the mountains.

Geographical variation is not great. A single specimen from Kanehoa, collected by C. M. Cooke, Jr., and R. von Holt, is in the collection. Its whorls are more convex than those of no. 14897 from Pukaloa, but not more so than other examples from the same locality. It is white with callous plate of cream color and rufous lip, measures 5 mm in diameter and 3.9 mm in height, and the parietal angle of the operculum is rounded. Otherwise it resembles shells from Pukaloa. Kanehoa and Pukaloa are about four miles apart, and as no specimens have been collected between them the presence of this shell in Kanehoa suggests that at an earlier time when valleys were damper and vegetation was continuous the typical form had a wider distribution than today.

Five specimens from Haleauau, collected by C. M. Cooke, Jr., are like those from Pukaloa, an adjoining locality. Specimens from Waianae Valley, which is on the opposite side of the range, resemble those from Pukaloa except in characters noted.

A single nearly adult specimen, dead and bleached, measuring 3.9 mm in diameter, 3 in height, with 4 whorls which are well-rounded as also is the angle on the last whorl, was collected by O. Oswald at Nanakuli, the next valley south of Lualualei. It resembles *O. uberta* as closely as *O. uberta* variety *bryani* form *a*.

⁷ Wilkes, Charles, Narrative of the U. S. Exploring Expedition (1838-1842), vol. 4, pp. 81, 82, Philadelphia, 1845.

Key to Varieties

A. From Waianae Mountains.

- | | |
|---|------------------|
| 1. Whorls slightly convex, sutures shallow..... | 2 |
| Whorls flat, sutures faintly impressed, shell pyramidal, diameter about 5.1 mm | wilderi |
| 2. Diameter about 4.1 mm..... | bryani |
| Diameter about 5.7 mm..... | makuensis |

B. From Koolau Range.

- | | |
|--|--------------------|
| 1. Shells thick, low-conoidal, 4 whorls (a few $4\frac{1}{4}$ to $4\frac{1}{2}$), rounded peripheral keel | 3 |
| Shells not thick, smaller than <i>magdalenae</i> | 2 |
| 2. Shells keeled, low-conoidal..... | 5 |
| Shells rounded, high-conoidal..... | 4 |
| 3. Shells living and fossil, callus orange and thick, lip orange and thin and consisting of inner layer of shell only, diameter about 5 mm..... | magdalenae |
| Shells fossil, without color, lip finely duplicate, diameter about 3.8 mm..... | exanima |
| 4. Whorls increasing rapidly..... | 6 |
| Whorls increasing comparatively gradually, $4\frac{1}{2}$ whorls, shells living, red- dish brown, lip ending abruptly, average diameter about 4.5 mm..... | beta |
| 5. Shells fossil, callus thin, whorls 4..... | borealis |
| Shells living, yellow, callus transparent, whorls $4\frac{1}{2}$ | subtenuis |
| 6. Shells living and fossil, diameter about 3.8 mm, aperture oblique and indented on upper side..... | hibrida |
| Shells living, aperture not indented..... | 7 |
| 7. Diameter about 4.6 mm..... | percitrea |
| Diameter smaller, about 3 mm..... | 8 |
| 8. Periphery rounded | lymaniana |
| Periphery angled | nuuanuensis |

Orobophana uberta variety **bryani**, new variety (fig. 21).

Smaller and thinner than *O. uberta* and having a more cone-shaped spire and an angled last whorl. Quite uniform in size and shape, averaging 4.1 mm in diameter, 3 mm in height. The type measures: diameter 4.1, height 2.9 mm. Striations similar to those of the species, but spiral lines more abundant, on the last whorl several fine impressed ones being discernible, two of which are distinct, in some, even in the second whorl.

In color, a few shells, including the type, have a plain cream-colored epidermis with dull white showing through here and there. Most have a pattern of stripes or zigzag lines, pompeian red or cinnamon-rufous to kaiser-brown alternating with white, extending $1\frac{1}{2}$ or more whorls up from the base, the remainder of the spire in some specimens the solid lighter color, in some the solid darker.

Whorls 4 to $4\frac{1}{2}$ (the type 4), slightly convex; those with nearly flat whorls have less-rounded spires. The increase in the size of the whorl is more gradual than in the species. The last whorl is angled and has a low rounded ridge at the periphery, which in some continues at the lower end of the penultimate whorl as a bulge above the suture. Suture fine, shallow, not margined.

The ending of the last whorl is much like that in the species, but the shell is not so thick, and the outer layer does not end so abruptly. The aperture, lip, and columella are similar to those of the species, the basal callous plate thinner and transparent. The callus in the umbilical region is much like that of variety *hibrida*. Opercula are similar in color and shape to those of the species, though the parietal angle is round-angled as in the Kanehoa shell.

Oahu, Waianae Mountains, Kolekole Pass, February 29, 1920, E. H. Bryan, Jr., type no. 11262, paratypes no. 60038.

Besides several specimens collected by Bryan at Kolekole Pass, C. N. Forbes collected among kukui trees in Waianae Valley three specimens that are not distinguishable from variety *bryani*, except one that is dwarfed; and in Nanakuli Valley Cooke collected a fossil shell, slightly lower, distinctly ridged on the periphery, otherwise typical.

Orobophana uberta variety *bryani* form **a** (figs. 22, 23).

Fossil. Similar to variety *bryani* and similar in thickness and texture to *O. uberta* so far as can be seen in more or less eroded fossil specimens: striations and spiral lines distinct on some; all bleached white, but some with a zigzag pattern extending over $1\frac{1}{2}$ whorls preceding the last whorl; $4\frac{3}{4}$ to 5 whorls, embryonic ones rounded, remainder nearly flat. They increase at about the same rate as in the species. Last whorl distinctly angled and slightly keeled, the angle appearing on part of the penultimate whorl of some specimens as a bulge. Spire cone-shaped, slightly rounded. Sutural line very fine and shallow, not margined. Their measurements average 4.8 mm in diameter, 3.6 in height, the largest 5.1 by 4 mm. The type measures: diameter 5.1, height 3.9 mm; it has 5 whorls. Aperture smaller than that of the species and variety *bryani*, thinning near the lip less abruptly than in the species, lip only slightly expanded. A distinct character in the type is a false umbilicus. Basal callus thinner, smaller, not so distinctly margined as in variety *bryani*. Callus in the umbilical region large, partly eroded in the type. Operculum wanting.

Oahu, Waianae Mountains, Lualualei, plain near aeolian sandstone ridge, April 17, 1914, C. M. Cooke, Jr., and C. N. Forbes, type no. 11263, paratypes no. 40863.

In the same region, specimens were found rather abundantly by Cooke and Forbes. Several fossils like those from Lualualei were collected at Makua by Cooke and Forbes. They are a little smaller, however, and have margined keels.

Orobophana uberta variety *bryani* form **b** (figs. 24, 25).

Fossil. Outline lower and rounder than form *a*. Average size about 4.6 mm in diameter, 3.3 in height. The type measures: diameter 4.8, height 3.3 mm. It has 5 whorls, which are slightly more rounded than in form *a*, especially the last one, and the suture is deeper. It differs from variety *bryani* in size and in having a more distinctly ridged peripheral keel. Operculum wanting.

Oahu, Waianae Mountains, Lualualei, plain near aeolian sandstone ridge, April 17, 1914, C. M. Cooke, Jr., and C. N. Forbes, type no. 11264, paratypes no. 57900.

Mixed with form *a* from the same localities in Lualualei and apparently in similar abundance is this lower form.

In the next valley—Makaha—three living juvenile specimens that are similar were collected by Forbes. They are thinner, however, and have only a minute umbilical callus. They are smooth, slightly shining, and have a uniform reddish color, except one faded to greenish.

Below Sisal, on the Ewa coral plain, J. C. Bridwell, C. N. Forbes, and C. M. Cooke, Jr., collected fossil shells like those from Lualualei, except that they run smaller, lower, thinner.

Orobophana uberta variety **wilderi**, new variety (figs. 26, 27).

More pyramidal in shape than *O. uberta*, resembling the outline of variety *bryani* form *a* above the periphery, but round-angled and not keeled at the periphery, less rounded below (the type bearing a ridge below the periphery), without false umbilicus, larger, averaging 5.1 mm in diameter, 3.8 in height. The type measures: diameter 5.2, height 4 mm. A smooth shell, not so thick as *O. uberta*, with fine striations, 4 or more spiral lines on the last whorl, raised at the periphery and impressed below it, one or two impressed ones on earlier whorls extending up into the second whorl. Mostly covered with a thin, glossy, cream-colored epidermis, dull white where this is absent. Whorls $4\frac{1}{2}$, slightly convex, last one well-rounded with a rounded angle at the periphery. They increase in size more gradually and regularly than in *O. uberta*. Suture fine. Aperture large, approaching the rectangular in shape. Lip thins suddenly, very short, and only slightly expanded, white within, columella well-curved, not flattened, base not protruding as in variety *bryani* form *a*. Callus shiny, smooth, thinner, not so definitely margined as in *O. uberta*, transparent, finely punctate, similar in size to variety *bryani*. Callus in umbilical region white, small, overlapped by the basal plate. No opercula found.

Oahu, Waianae Mountains, Mokuleia, no date, W. D. Wilder, type no. 11261, paratypes no. 51059.

This variety includes but three specimens. They were taken alive.

Orobophana uberta variety **wilderi** form **a** (fig. 28).

Similar to variety *wilderi*, but spire more pointed, size smaller: diameter 4.6, height 3.3 mm. The whorls number $4\frac{1}{4}$, and 2 spiral ridges are present just below the periphery. Operculum dried within the shell, therefore not available for study.

Oahu, Waianae Mountains, Palehuaiki, a little south of Palikea, October 19, 1912, C. M. Cooke, Jr., and R. von Holt, type no. 33152. The type was unaccompanied. At the head of Nanakuli Valley, O. Oswald found a few adult and juvenile shells similar to the type except in being lower. A few are uniform cream color; most are cream color with numerous zigzag lines of apricot-orange. Opercula similar to those of *O. uberta* but smaller. These shells most nearly resemble shells from Mokuleia at the northern end of the mountain range.

Like the shells from Nanakuli are some from Palehua in the mountains at the head of Nanakuli Valley collected by T. T. Dranga and from Palikea by W. H. Meinecke, those from Palikea having similar opercula. At Lualualei, O. Oswald found several specimens, Forbes and Cooke one specimen, related to that from Palehuaiki. Most have a sharper peripheral angle, which is distinctly ridged. They have the same range of colors and patterns as those from Nanakuli. Some lots from a dry, rocky slope consist of thick shells with prominent basal callus and prominent ridges at the periphery and below

it. In a small ravine were found a few low-spired shells. Opercula resemble those in shells from Nanakuli.

Orobophana uberta variety **makuaensis**, new variety (fig. 29).

Differing in size and shape from *O. uberta* but in general having a similar appearance. They are larger, lower, and wider, the spire forming a low cone. Their measurements are quite uniform and average: diameter 5.7, height 4 mm. The type measures: diameter 6, height 4.3 mm. In thickness and texture they resemble *O. uberta*. The epidermis, which has vanished entirely or nearly so at maturity, is mustard-yellow. The remainder of the shell is dull cream or white. No patterns were seen. The $4\frac{1}{4}$ to $4\frac{1}{2}$ whorls (type, $4\frac{1}{2}$) are slightly convex down to the last one, which is well-rounded. Near its beginning the third whorl widens more rapidly than do the preceding ones, and the next whorl so continues. Outer layer is not so thick as that of *O. uberta*, and so the ending at the aperture is less conspicuous. Suture very shallow, not margined. The aperture is larger but similar in shape to that of *O. uberta*; lip short and expanded, cream color like the aperture and callus, or like them mustard-yellow. The callous plate resembles that of *O. uberta* except that it is not so distinctly margined. In the umbilical region, a curved impressed line marks off a small crescent shape, much as in variety *borealis*. The only operculum seen resembles that of *O. uberta* with a rounded parietal angle, a less oblique nucleus, and a less sloping palatal edge.

Oahu, Waianae Mountains, Makua Valley, east side, May 11, 1913, I. Spalding, type no. 11265, paratypes no. 34048.

Eleven paratypes accompanied the type. The younger shells are well-rounded, with spiral lines more distinct.

Orobophana uberta variety **magdalenae** (Ancey) Caum (fig. 30).

Helicina magdalenae Ancey: Soc. Malacol. France, Bull., no. 7, p. 342, 1890. Baldwin: Cat. Shells, p. 16, Honolulu, 1893. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4. Mollusca, p. 396, 1900.

Helicina uberta variety *magdalenae* (Ancey) Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 13, fig. 14, 1908.

Orobophana uberta magdalenae (Ancey) Caum: B. P. Bishop Mus., Bull. 56, p. 7, 1928.

Helicina constricta Pfeiffer variety: Syst. Conch.-Cab., Helicinaceen, I, 18, 19, p. 22, pl. 7, figs. 37-39, 1846-1853.

Helicina constricta Pfeiffer β : Mon. Pneum., vol. 1, p. 350, 1852.

Helicina constricta Pfeiffer β : in Gray's Cat. Phaner., pp. 252, 253, 1852.

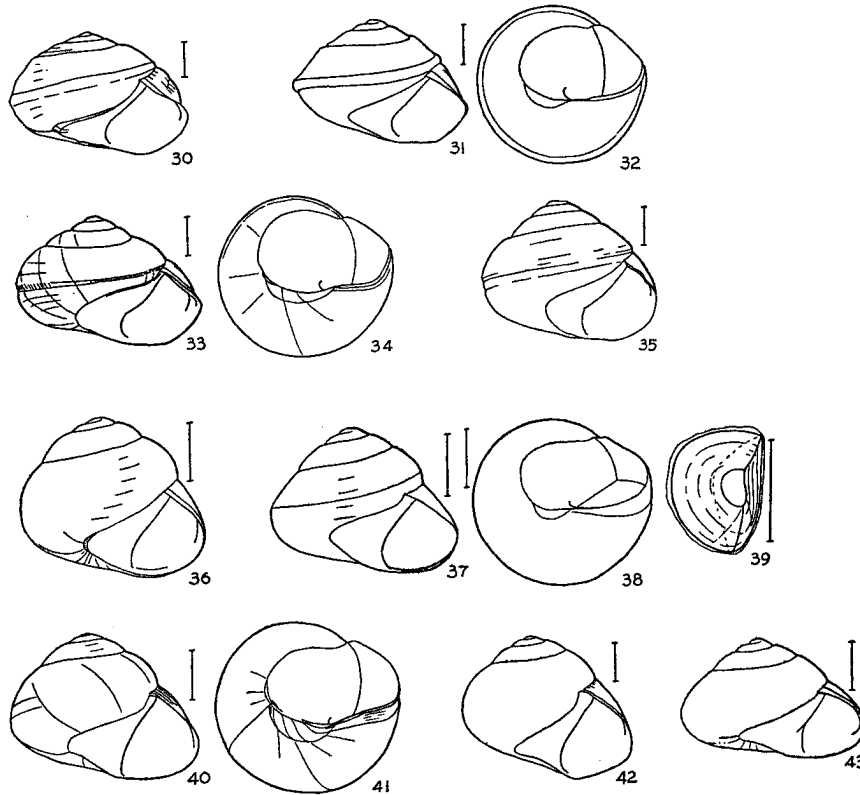
Helicina rhodostoma Mighels: in sched. Cuming not Sowerby, 1852 or before. Manuscript, not Sowerby, see Gray, 1852 or before. Pfeiffer: Malak. Blätter, p. 36, 1857.

Orobophana constricta (Pfeiffer) Wagner: Denk. Akad. Wien, Helicinenst., vol. 77, pl. 9, fig. 9, p. 424, 1905. Wagner: Syst. Conch.-Cab., Helicinidae, I, 18, pp. 236, 237, pl. 46, figs. 13, 14, 1911.

Original description:

Testa solida, lenticularis, angulata, luteo-alba, ad aperturam et callum inferum columellarem coccinea, epidermide lutea plerumque decidua tecta. Spira convexa, apice

subacuto. Anfractus 4, plani, sutura lineari, vestigiis linearum spiraliū interdum impressi; ultimus angulo cinctus, supra convexo-declivis, subtus convexus, callo medio crasso erectoque, circumscripto. Apertura obliqua, subtrigona, extus angulata, margine supero convexo-declivi, basali subconvexo, cum columella brevi angulum obtusum formans. Peristoma simplex, intus, incrassatum. Diam., $5\frac{1}{2}$; min., $4\frac{1}{2}$; alt., $3\frac{1}{3}$ millim. Tantalus, dans l'île d'Oahu (Prof. Lyons).



FIGURES 30-43.—Varieties of *Orobophana uberta* from Koolau Range, Oahu: 30, *O. uberta* variety *magdalena*, type, no. 19067; 31, 32, *O. uberta* variety *borealis*, type, no. 11260; 33, 34, *O. uberta* variety *subtenuis*, type, no. 11258; 35, *O. uberta* variety *beta*, type, no. 14903; 36, *O. uberta* variety *lymaniana*, type, no. 14910; 37-39, *O. uberta* variety *nuuanuensis*, type (operculum in aperture), no. 14908, shell; no. 15351, operculum; 40, 41, *O. uberta* variety *hibrida*, type, no. 11257; 42, *O. uberta* variety *percitrea*, type, no. 11271; 43, *O. uberta* variety *exanima*, type, no. 11250. The dull area on operculum is outlined by a broken line. The measure indicates 1 mm.

Ancey adds:

Cette jolie coquille est peut-être la *rhodostoma* de Mighels, mais comme cette Espèce est imparfaitement décrite et qu'il existe une autre *Helicina* du même nom, dont la publication est antérieure, je crois devoir caractériser de nouveau la forme des îles Sandwich, et je lui donne le nom de ma femme, en témoignage d'affection et pour la remercier du concours qu'elle n'a cessé de me prêter dans mes travaux.

In Pfeiffer's description in the Conchylien-Cabinet *Helicina constricta* is given as from "Otaheite," the variety (now called *Orobophana uberta* variety *magdalenae*), which is stated to differ from the species only in the red callus and red lip, as from "Sandwich Islands." In his original description of the species (Zool. Soc. London, Proc., p. 120, 1848), the variety is not mentioned (the callus is described as white or red), and "Otaheite" and "Sandwich Islands" are given as the habitats. In Monographia Pneumonopomorum viventium and in Gray's Catalogue, Pfeiffer gives the Sandwich Islands for both the species and variety, Tahiti possibly being unintentionally omitted. Finally, Ancey gives the shell a name and a definite locality. Sykes, quoting Ancey, gives the location as Tantalus, Oahu, considering the variety of *O. constricta* from Oahu as a synonym of variety *magdalenae*, but the typical form from Tahiti as belonging to a different species. Pilsbry and Cooke give the location as the Pauoa side of Tantalus. Wagner identifies variety *magdalenae* as *O. constricta* and gives Oahu as the habitat.

Confusion about the habitat of the species and variety arose in Pfeiffer's original description. His later statement that the variety of *O. constricta* came from "Sandwich Islands" still holds, though it is now considered a variety of another species. The identity of *O. constricta* has not been determined. Possibly the reference to Tahiti is wrong and Oahu the only locality, thus making the species and variety the same.

A discussion of identifying *Helicina bronniiana* with variety *magdalenae* is given on page 98.

Ancey's description agrees closely in many respects with shells in Bernice P. Bishop Museum. It seems to be, however, a composite description of the three shells in the type lot, which differ in size, markings, and color. From these, because it is nearest the average size of the variety and is in the best condition, I have chosen for the type the largest, though it lacks the red coloring mentioned in the description and is much more round-angled than the other two shells. The type and two paratypes, no. 19067, in the Ancey collection, found by Baldwin and Lyons on Mount Tantalus and now in Bernice P. Bishop Museum, are the criteria for this variety:

The most striking features of the shell are the heavy keel on the last whorl and the ordinary red-orange callus and lip. The abruptly thinning lip is invariably present. The shell is flatter, larger, and more irregular in outline than *O. uberta*. Wagner's figures and full description of *O. constricta* apply to this shell.

In shape the type is a broad cone, with keeled and swollen last whorl and flattened base. Spire low, pointed, the first $2\frac{1}{2}$ whorls more or less sunken into the following whorl.

The dimensions given by different authors nearly agree: 5 to 6 by 3.5 mm, Pfeiffer; 4.9 to 5.6 by 3.3 to 4 mm, Pilsbry and Cooke; 4.5 to 5.5 by 3.5 mm, Wagner. Specimens in Bernice P. Bishop Museum from Mount Tantalus, collected by D. D. Baldwin, A. B. Lyons, C. M. Cooke, Jr., E. W. Thwing, vary somewhat. The average in no. 15817 is 5.1 mm in diameter, 3.6 in height, extremes, 5 by 4 and 5.3 by 3.4 mm. The type (5.1

by 3.5 mm) and two paratypes (5.1 by 3.3, 4.8 by 3.3 mm) average 5 by 3.4 mm. One of the smallest shells, 4.9 by 3.4 mm, and the highest shell, 4.7 by 4.1 mm, were found in no. 16140; the widest, 5.4 by 3.9 mm, in no. 56308. Some lots, collected by A. F. Judd, D. Thaanum, P. Bartsch, C. M. Cooke, Jr., I. Spalding, E. W. Thwing, and A. B. Lyons, run slightly larger, in no. 14878 the largest being 5.5 by 3.8 mm, one odd one 5.8 by 4 mm; though labeled "Pauoa," the locality is probably not distant from the others, or the habitat was more favorable. Another explanation may be sex, as in Helicinidae the two sexes are said to differ in size.

The shell is thick but not so thick as that of *O. uberta*. It is smooth except for fine growth lines similar to those of *O. uberta* but less regular, and a few spiral lines, 1 to 3 below the keel and 1 to 4 above it. Of the upper spirals, 1 or 2 are visible in many specimens as far as the second whorl.

Soon after maturity is reached, the epidermis, cream color to light orange-yellow, is lost, changing the surface of the shell from shiny opaque to chalky white or white with a yellowish or pinkish cast. A fine zigzag ground pattern of alternating cream and white is visible on the penultimate whorl of a few shells, alternating cream and English red on a few others, in which the zigzags may be present also on the last whorl, covering the base, or may be blended into a more or less solid English red. Callous plate and interior of aperture shining and cream color, white, light orange-yellow, apricot-orange, or English red. The majority of the shells are a solid cream color. Many are dull white with apricot-orange callus and lip. Ordinarily the lip agrees in color with the callus and interior; in a few shells it is lighter. As the widest color variations are present in the same lot of shells, evidently environment is not the reason for such differences.

Most shells have 4 to $4\frac{1}{4}$ whorls, a few $4\frac{1}{2}$. The spire is broadly cone-shaped for the first $2\frac{1}{2}$ whorls, which are nearly flat, and more steeply so for the remaining $1\frac{1}{2}$. The first $2\frac{1}{2}$ whorls are slightly sunken into the following whorl, which in many specimens bulges on upper and lower sides, the last whorl seeming contracted near the aperture. The bulge on the lower side becomes a distinct rounded keel on the last whorl. The last $1\frac{1}{2}$ whorls increase more rapidly than the preceding ones. The suture, narrow and shallow, has a flattened margin only on the first $2\frac{1}{2}$ whorls. As in *O. uberta* the outer layer of the shell ends abruptly just before reaching the lip, where the sutural line dips slightly.

Umbilical region as in *O. uberta*, in some the crescent-shaped callus being less distinct, in type and paratypes absent.

Aperture more oblique than in *O. uberta* but similar in shape, in some shells more rounded than in others. Basal callus also similar though slightly thinner, columella more rounded. Lip of many thinning less abruptly.

Opercula translucent, shining, solid cream color or light orange-yellow, or light orange-yellow with columellar edge of English red. Slightly larger than *O. uberta*. Similar to it in shape, especially in shells with high spires. In shells with low spires more nearly elliptical and corners more rounded, in both kinds slightly less oblique. Dull area on the inside layer not observed.

Young shells differ from adults as follows: 1, ordinarily a continuous shining epidermis; 2, thinner, some partly translucent; 3, callous plate absent; 4, spire lower; 5, peripheral angle sharper; 6, lip thin, fragile, unexpanded.

The distribution is extremely limited. The first definite localities were given by Baldwin as Mount Tantalus and Pauoa. According to Cooke, who has searched thoroughly that region, *Orobophana uberta* variety *magdalenae* inhabits only a small part of the slope on the Pauoa side of Mount Tantalus, near the trail running below the highest peak. It lives on the ground on dead leaves and dead twigs. Not only is the area restricted, but the shells are few. Wide ranges in shape and size are found in the same colony.

One typical specimen, no. 14805, in the Cooke collection, bore "Kauai" on the original label, but Cooke does not remember collecting it there and does not believe the label is correct. One lot collected by R. Lyman, bearing the label "Oahu," obviously came from Pauoa, as the shells are typical. A lot of four shells in the Garrett collection bears the label: "*Helicina uburta* Gould, Oahu, Sandwich Isles." They are like variety *magdalenae* from Pauoa: two are typical forms, two higher-spined.

Several fossil specimens in Bernice P. Bishop Museum were collected in Pleistocene deposits in Manoa Valley in the area between Kamehameha Avenue and Awapuhi Street, Manoa Road and Ferdinand Street, by C. M. Cooke, Jr., W. Mist, F. Girdler, D. Kuhns, and B. C. Olivera. They were found mixed with other genera in pockets as deep as 12 feet in cinder soil. They are apparently small forms of variety *magdalenae* and range in size from 4 mm in width by 3 mm in height to 4.9 by 3.5 mm. The original color is lost, as all are bleached white, but in a few specimens the last two whorls are etched in a zigzag pattern. The basal callus is even more distinct than in living variety *magdalenae*. The few accompanying opercula are so much worn that many definite characteristics are not visible. They seem to have been smaller, some otherwise similar to variety *magdalenae*, some oval rather than elliptical, some with a higher nucleus.

Orobophana uberta variety **borealis**, new variety (figs. 31, 32).

Fossil. Compared with fossil variety *magdalenae* from Manoa Valley they are lower and smaller, have thinner shells and basal callus, and are less rounded at the periphery, where the keel projects prominently. Whorls 4, flattened, suture deep. The type measures: diameter 4.4, height 3.2 mm. Zigzag pattern visible on some. Umbilical callus small and distinct. Operculum wanting.

Oahu, Punaluu, in plowed field, C. M. Cooke, Jr., August, 1917, type no. 11260, paratypes no. 45169.

The many specimens accompanying the type are quite uniform, closely resembling it.

Farther east, O. Oswald found similar fossils in Weliweli, a valley in Kaaawa. In Kaneohe Bay, on Kapapa Island, T. T. Dranga found a fossil shell like those from Kaaawa.

Orobophana uberta variety **subtenuis**, new variety (figs. 33, 34).

Differing somewhat from the typical forms of variety *magdalenae*. They are smaller and thinner and have a lighter, higher keel on the last whorl. The basal callus is thinner and transparent. On some the keel on the last whorl is visible also on the lower part of the penultimate whorl as a rounded ridge. The lines of growth are distinct on most, and the epidermis is well-preserved. In color they are mostly maize-yellow, a few pale orange-yellow, some of the latter with zigzag stripes which in a few are as dark as coral-red. The crescent-shaped callus in the umbilical region is distinct but rather small. The type measures: diameter 4.8, height 3.6 mm. It has 4½ whorls. Opercula similar to those of variety *magdalenae* but antimony-yellow in color; nuclei only slightly oblique.

Oahu, Mount Tantalus, north inner side of crater, C. M. Cooke, Jr., type no. 11258, paratypes no. 15888.

About 40 living specimens were collected by C. M. Cooke, Jr., on the inside and outside of the north side of the Tantalus crater. In shape and size the range is considerable, from low- to high-conoidal and from 4 mm in diameter and 3 mm in height to 4.8 by 3.6, averaging 4.2 by 3.2 mm. Those on the Manoa side are smallest.

Three specimens collected by C. M. Cooke, Jr., and I. Spalding on Pauoa Flats, joining Mount Tantalus on the north, differ from shells on the crater only in having a keel less defined, the last whorl being almost perfectly rounded. On Pacific Heights ridge, west of Pauoa, Podmore collected 10 similar shells, but somewhat thinner and the ridge in some entirely lacking.

Across the valley on two peaks, Puu Lanihuli and Mauna Kope, I. Spalding and A. Gouveia collected a few shells resembling those from Mount Tantalus but smaller and comparatively higher. They also resemble *Pleuropoma lacinoso* variety *alpha*, but aperture and operculum are distinct. Opercula of the specimens from Mauna Kope are smaller and narrower, nuclei more oblique than in the typical specimens, and colored zinc-orange on the columellar edge.

On the windward side of Oahu, in the Kualoa mountains, O. Oswald found a few shells like those from Mauna Kope, but unangled and with smaller opercula. One is cinnamon-rufous in color.

Orobophana uberta variety **beta** (Pilsbry and Cooke) (fig. 35).

Helicina lacinoso variety *beta* Pilsbry and Cooke; B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 6, 7, fig. 4, 1908.

Sturanya lacinoso beta (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 5, 1928.

Original description:

The shell is globose-conic, with the periphery rotundate-angulate, nearly smooth, faintly striate with lines of growth, encircled at and immediately below the periphery with three raised, rounded keels. Color a uniform dull claret, spire slightly eroded. Spire conic, with slightly convex outlines, apex slightly obtuse. Suture faintly impressed, simple, indistinctly margined above on the third whorl. Whorls $4\frac{1}{2}$, slightly convex, the embryonic slightly eroded, the last rotundate-angulate, slightly descending in front. Aperture oblique, nearly semicircular, not contracted; outer lip with a thin edge. Callus thick, minutely punctate. Operculum dull claret, minutely punctate. Maj. diam. 4.5, total length 4.0 mm.

Oahu: Kapalama (Lyman).

Type no. 14903, Bishop Museum.

This variety differs not only in size and in its relative proportions, but also in its dull claret color which has not been observed in any of the other varieties of this species.

Four shells collected in Kapalama by Lyman were named "*Helicina laciniosa* variety *beta*" by Pilsbry and Cooke and described as above. But they have characteristics of the genus *Orobophana* and evidently belong to a variety of *O. uberta*.

Additional to the original description is the following, based on shells from Kalihi.

Resembling *O. uberta* except in the following respects: pyramidal, lower shape, thinner and somewhat translucent shell, keeled last whorl, smaller and less conspicuous callus, thinner lip with outer layer ending as in *O. uberta*, callus at umbilicus larger, similar to that of variety *borealis*. The size of adult shells is quite uniform and averages: diameter 4.5, height 3.5 mm. Most are Hay's russet or cinnamon-rufous, with more or less distinct zigzag patterns in cream color; a few are solid naples-yellow. Most are covered nearly continuously with a shining epidermis, chalky white where this is absent. Opercula shining, naples-yellow or cream, many apricot-orange at the columellar edge. Though in shape nearly oval, otherwise they closely resemble opercula of *O. uberta*.

Several specimens of this smooth, conical shell were collected in Kalihi by J. C. Bridwell, I. Spalding, O. Oswald, and A. Gouveia. Three came from Kamaikai in Kalihi Valley, the rest from one of the lower ridges of the valley. Several shells similar except for their smaller size were collected by Marie Neal on Alewa Heights above the pineapple fields. Two like them were collected by J. C. Bridwell in Rook's Valley, Nuuanu.

A slightly different form was collected by A. Gouveia, 13 specimens in Kamaikai (also 1 juvenile by O. Oswald), 1 at Kanahoe on the ridge between Moanalua and Halawa valleys. They are a little larger and higher than other forms of the variety from Kalihi. The last whorl is rounded and bears an indistinct keel. Operculum wanting. One from the west side of the Pali, Nuuanu Valley, also collected by Gouveia, is similar but smaller and keelless.

From Kapalama 3 specimens—2 from A. B. Lyons and 1 from the Cooke collection—resemble shells from Kalihi.

***Orobophana uberta* variety *lymaniana* (Pilsbry and Cooke) (fig. 36).**

Helicina lymaniana Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 12, fig. 12, 1908.

Orobophana (?) *lymaniana* (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 7, 1928.

Original description:

The shell is semiglobose, with the periphery rounded, quite thin, nearly smooth, not polished, minutely striate with lines of growth and with a few slightly raised longitudinal striae on the last whorl. Color a pale dull red under a yellowish cuticle. Spire very convex. Suture well impressed, simple. Whorls about 4, slightly convex, regularly increasing, the last slowly but rather deeply descending in front, well rounded. Aperture

contracted, very oblique, small, semicircular; outer lip slightly thickened, minutely duplicate above. Callus whitish, reddish towards the outer edge, thick, minutely punctate. Operculum wanting. Maj. diam. 3.0, total length 3.0 mm.

Oahu: Waialua (Lyman).

Type No. 14,910, Bishop Museum.

Another form from Waihiawa [Wahiawa], Oahu, though slightly larger, undoubtedly belongs to this species.

Lymaniana is somewhat related to *H. uberta* Gld. Its smaller size and more globose form easily separate it from Gould's species.

Since the specimens collected by Lyman at Waialua were described, several others have been added to the collection of Bernice P. Bishop Museum by C. M. Cooke, Jr., and C. N. Forbes, from places in the Koolau Range east of the point of discovery—at Kaipapau and Kaliuwaa:

In general appearance these shells more closely resemble Lyman's paratype than type, having a lower spire and a deeper suture. An average of the dimensions of adult shells is: diameter 3, height 2.5 mm, the range of individuals being slight. In most other respects the shells resemble those from Waialua. The spiral lines are distinct, about 8 being visible on the last whorl as impressed lines on some adult shells, on juvenile shells as thin raised ridges. The main color, antimony-yellow, grades into russet, especially on the last whorl and at the apex. Otherwise the color is solid and without pattern. The epidermis has a slight sheen. Umbilical callus small, as in variety *nuuanuensis*. The aperture is more rounded and larger than in the shells from Waialua, not contracted, and having a white callus. The greater prominence of the aperture results in a more concave base. In the aperture of some specimens a line is present on the palatal wall where the edge of the operculum would ordinarily touch when closed upon the living animal. It appears to be a fold or ridge but is not.

Opercula, lacking in the specimens from Waialua, were examined in one lot of shells from Kaliuwaa. Though the inner layer is wanting and most specimens are fragments, the opercula seem to resemble the *Orobophana* type. They are small and have a slightly oblique nucleus. Pale flesh color or white on most of the operculum, on the columellar side of the S-ridge the color is deep chrome.

***Orobophana uberta* variety *nuuanuensis* (Pilsbry and Cooke) (figs. 37-39).**

Helicina nuuanuensis Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 10, 11, fig. 10, 1908.

Aphanocomia nuuanuensis (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

The shell is subglobose conic, slightly angular at the periphery, thin, nearly smooth, minutely transversely striate and with four or five fine raised spiral striae, of which two are above, the rest below, the slightly angular periphery. Color of a uniform greenish yellow or cinnamon brown. Spire conoidal, apex obtuse. Suture simple, well impressed. Whorls $3\frac{3}{4}$, flatly convex, slowly and regularly increasing, the last flattened and sloping above the slightly angular periphery and very convex below it, gradually descending in front. Aperture oblique, semicircular, not contracted; outer lip thin. Callus thick and white near the axis, the rest very thin, of the same color as the shell, minutely punctate. Operculum very thin, of the same color as the shell and minutely punctate. Maj. diam. 2.9, total length 2.5 mm.

Oahu: Nuuanu, upper part (Cooke).

Type no. 14908, Bishop Museum.

Nuuanuensis is easily distinguished from the other Hawaiian species. In size it approaches *H. rotelloidea* Migh., but differs by its higher spire, less convex whorls, the last of which is flattened above the inconspicuous peripheral angle. It is apparently most nearly related to *H. laciniosa* Migh.

Closely resembling specimens of variety *lymaniana* from Kaipapau are a dozen or more lots from Nuuanu collected by C. M. Cooke, Jr., D. Thaanum, C. N. Forbes, and O. Oswald, besides two in the D. D. Baldwin collection:

Many shells are like the type of variety *nuuanuensis*, but some are lower and larger and most have a larger aperture. In size the shells from Nuuanu run slightly larger and some are keeled on the last whorl. Most are cream color, some warm buff, and a few tawny. Though the majority are uniform, a few have a suggestion of mottling on the upper whorls. The umbilical callus in the type is a very small crescent.

Opercula are of the *Orobophana* type, some nearly oval in shape, from widely to narrowly so, a few semicircular. Position of S-ridge is defined by low elevations. The nucleus is slightly oblique if at all. The opercula are translucent and pale-colored, the outer layer being white and creamy, the inner warm buff. Some include also pale ochraceous salmon.

What appears to be a juvenile representative of this variety was collected by Cooke on Mount Tantalus.

At Kuliouou, O. Oswald found a few specimens that closely approach *Pleuropoma* (*Sphaeroconia*) *rotelloidea*, but an angle at the periphery and more oblique aperture seem to indicate closer relationship to *Orobophana uberta* variety *nuuanuensis*. In color they are cinnamon, with spots of Hay's russet on the last whorl. Operculum slightly wider at top and narrower at base, S-ridge more prominent as compared with that of variety *nuuanuensis*; otherwise similar.

***Orobophana uberta* variety *hibrida*, new variety (figs. 40, 41).**

Shell rather thin, smooth, opaque; epidermis where present hardly shining, Hay's russet to hazel, white beneath; spire high-conoidal, obtuse; 4 rounded whorls, the last swollen and not angled, lip duplicate; suture rather shallow, not margined; aperture oblique, nearly oval, slightly flattened or indented on upper side; columellar area white, callus transparent, rather thin, finely punctate; callus in umbilical region large and distinct, a third of a circle in shape. Type measures: diameter 3.8, height 3 mm. Operculum similar to that of variety *magdalanae*, more nearly oval, S-ridge quite indistinct, nucleus perhaps slightly less oblique. Ochraceous orange on columellar side, grading to light ochraceous-salmon on the opposite side.

Oahu, Kawaiiki, October 8, 1914, I. Spalding, type no. 11257, paratypes no. 37338.

Thirteen shells collected in Kawaiiki, Moanalua, and Wahiawa, by W. D. Wilder, I. Spalding, and C. M. Cooke, Jr., resemble considerably the shells of variety *subtenuis* from Pauoa Flats. They have the general shape, including the convex base of variety *lymaniana* and the more flaring aperture of

variety *subtenuis*. Two shells are slightly angled and have zigzag markings. Several geographical races were found:

1. To the east, near a waterfall in Nuuanu Valley, C. M. Cooke, Jr., found several specimens like those from Kawaiiki, but much thinner, somewhat lower, whorls more convex, color with a yellowish cast. Opercula larger, but in shape and sculpturing practically the same.

2. In Waimano, below the bridge of the plantation railroad, C. M. Cooke, Jr., and C. N. Forbes collected five fossil specimens which seem to be intergrades between this variety and the species. The suture is more deeply impressed, and the shells run to larger sizes than variety *lymaniana*. But the spire is lower and the last whorl more rounded than in most specimens of the variety. Callus in the umbilical region small but distinct. The largest specimen measures: diameter 3.7, height 2.9 mm.

3. At Kanahoe, on the ridge between Moanalua and Halawa valleys, A. Gouveia found 11 living specimens similar to the fossils from Waimano. They are, however, slightly larger, have comparatively larger apertures, and have a shining surface. In color they are like variety *percitrea*. In size they average: diameter 3.5, height 3.1 mm. The opercula are translucent, semicircular in shape, have a decidedly oblique nucleus, and otherwise are much like opercula of variety *magdalenae*. But the S-ridge is more distinct. They are zinc-orange on the columellar edge, pale ochraceous buff elsewhere. Three lots from Halawa, one collected by O. Oswald, one by I. Spalding, and one in a collection made by D. D. Baldwin, closely resemble those from Kanahoe.

4. On a ridge in Aiea, I. Spalding and C. M. Cooke, Jr., found several specimens that are not only smaller but some comparatively lower than those from Halawa, approaching variety *nuuanuensis*. Two similar but higher specimens from "Wauala" were in the collection of D. D. Baldwin. Like those from Aiea is one collected by Forbes at Kawailoa but smaller and darker and comparatively higher.

5. A nearly adult specimen from Opaepa collected by I. Spalding and an adult collected by Meinecke are hardly distinguishable from typical variety *hibrida*. Opercula similar to those of variety *magdalenae*, except in color, the columellar edge being lighter—ochraceous orange—the rest maize-yellow.

6. A shell from Poamoho collected by W. D. Wilder resembles the race from Opaepa but has a smaller aperture, more deeply impressed sutures, and lighter color.

7. Nine juvenile specimens were collected by C. M. Cooke, Jr., and C. N. Forbes in Kaipapau. Three nearest the adult stage closely resemble the race from Waimano, but have a slightly higher spire.

8. On Kualoa ridge, O. Oswald collected three lots of shells that appear related to variety *hibrida*. They are small, comparatively thin, low, and

approach variety *lymaniana* in size and shape. The opercula differ from those of the type in being smaller.

Orobophana uberta variety **percitrea**, new variety (fig. 42).

Similar to variety *hibrida* but larger: diameter 4.2 to 4.6, height 3.3 to 3.9 mm; the type: diameter 4.6, height 3.9 mm. Last whorl rounded instead of slightly flattened, aperture more sharply angled at base, and callus in the umbilical region absent. In color uniform ochraceous tawny, except two paratypes, which have lighter mottlings on the last whorl. As in variety *hibrida*, surface smooth, though juvenile and nearly adult shells have about 8 spiral lines visible on the last whorl, 2 on the penultimate. Operculum wanting.

Oahu, top of ridge between Halawa and Aiea valleys, no date, W. D. Wilder, type no. 11271, paratypes no. 51279.

This variety is represented by only one lot of shells—the type and eight paratypes.

Orobophana uberta variety **exanima**, new variety (fig. 43).

Fossil. Shell rather thick, compact, lens-shaped, smooth though having fine growth lines, opaque, shiny white, low conoidal with blunt spire; 4 whorls, slightly rounded, suture shallow, last whorl with well-rounded keel, indented at the base, aperture with a slight flare, lip finely duplicate; aperture oblique, small, nearly triangular; columella rounded and making a simple curve, from it extending a tongue-shaped callus on to the last whorl; callus in the umbilical region large, a third of a circle in shape, resembling that of variety *hibrida*. Measurements are: diameter 3.8, height 2.6 mm. Operculum wanting.

Oahu, Kahuku, coral bluff half a mile west of town, October 2, 1912, C. M. Cooke, Jr., type no. 11250, paratypes no. 33495.

In the northern Koolau region, several fossil specimens of variety *exanima* were collected by Cooke:

These shells approach forms *a* and *b* of variety *bryani* but are smaller, and some have comparatively smaller apertures. In general, also, they are somewhat like variety *lymaniana*, but larger and heavier, comparatively lower and wider.

In the shells is considerable variation. Some have higher spires, keel more or less distinct, larger or smaller aperture, suture more or less impressed. All are dull or shining solid white. The concavity on the base of the last whorl at its joining with the callous plate in some specimens forms a false umbilicus. One unique juvenile specimen has a contracted aperture, above which the penultimate whorl bulges.

From Paumalu is a specimen like the high kind from Kahuku and having a rounded periphery and flaring aperture.

From Waimea, opposite the store, are fossil shells that resemble the type from Kahuku, except that the aperture is larger, the spire is higher, and the penultimate whorl rises higher above the last whorl.

A fossil shell from Pupukea is more typical than those from Waimea but is smaller and has a comparatively large aperture. With it are three small juveniles which have a more distinct peripheral keel.

Genus PLEUROPOMA Moellendorff

- Pleuropoma* Moellendorff: Senckenb. naturf. Gesell., Ber., p. 140, 1893.
Naturf. Gesell. z. Görlitz, Abh., 22, p. 181, 1898. Not *Pleuropoma*
Caziot: Ann. Soc. Linn., Lyon, t. 56, p. 205, 1910.
- Helicina* Lamarck: Soc. Hist. Nat. Paris, Mem., p. 77, 1799; Hist. Nat.
des Anim. sans Vert., pp. 153-157, 1838. Pfeiffer: Syst. Conch.-Cab.,
Helicinaceen, I, 18, 19, pp. 10, 11, 1846-1853. Pilsbry and Cooke:
B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, 14 pp., 1908.
- Aphanoconia* Wagner: Denk. Akad. Wien, Helicinenst., vol. 77, p. 47,
1905; Syst. Conch.-Cab., Helicinidae, I, 18, p. 171, 1911.
- Sturanya* Wagner, Baker: Acad. Nat. Sci. Phila., Proc., vol. 74, p. 43,
1922.

The early classification of Helicinidae is discussed under *Orobophana*. In 1893, Moellendorff selected the species *dichroa* from Cebu, Philippines, as the type of *Helicina* (*Pleuropoma*), and in 1898 in a list of Philippine land shells he again placed *H. dichroa* (with several subspecies and two other species) in the "Section *Pleuropoma* Mlldff." In 1905 Wagner named the genus *Aphanoconia*, and in 1922 Baker selected *Helicina lacimosa* Mighels, a typical *Aphanoconia*, but classed with *Sturanya* by Wagner, as the type of *Sturanya* Wagner. In a letter dated May 10, 1927, to C. M. Cooke, Jr., Baker points out that *Aphanoconia* falls before *Pleuropoma*. For, as pointed out to me by H. A. Pilsbry (letter, July 28, 1930), *Pleuropoma* has precedence over *Aphanoconia* Wagner, 1905, as Wagner admits by citing "*Helicina* (*Pleuropoma*) *dichroa* Möllendorff" in the synonymy, and saying that the operculum has the same structure as that of *Pleuropoma*.

Moellendorff's references are not available, and the following description of Hawaiian *Pleuropoma* is based on Wagner's description of his synonymous genus, *Aphanoconia*, and on my observations:

Shell small, lens- to cone-shaped, with convex base. Whorls $3\frac{1}{2}$ to $4\frac{1}{2}$, slightly convex to flat, the last carinate or distinctly angled, the aperture triangular, only slightly thickened and spreading if at all. The basal callus semicircular, moderately thin. Color ordinarily yellow or red, with a pattern of several to many radial zigzag lines more or less conspicuous, especially on the upper part of the last whorl. Sculpturing consists of fine, uniform lines of growth. The operculum triangular to almost semicircular, with nearly straight or convex or slightly sinuous columellar edge, decreasing to the pointed lower end, which bends backward. The nucleus approaches the columellar edge, but is about equidistant from top and bottom palatal edges, its long axis oblique to the long axis of the operculum. The S-ridge is slightly bent and slightly raised and spreads toward the lower part in a fan shape.

The opercula and shells of some species have characters that seem to grade toward *Orobophana*.

The distribution, according to Wagner, is over all countries inhabited by Helicinidae.

Key to Species

1. Shells fossil, low-conoidal, moderately thick, bearing two heavy spiral ridges, from Waianae Mountains, Oahu.....**P. subsculpta**
Not bearing spiral ridges.....2
2. Peripheral angle present.....3
Peripheral angle rounded, whorls 4, diameter about 3.5, height about 2.3 mm, from Waianae Mountains, Oahu.....**P. laciniosa**
3. Whorls 4½, periphery biangled, medium diameter about 4.3, height 3 mm, from Kauai**P. nonouensis**
Whorls 4, peripheral keel acute, diameter about 5, height 2.7 mm, from Waianae Mountains, Oahu.....**P. oahuensis**

Pleuropoma laciniosa (Mighels) (figs. 44-46).

Helicina laciniosa Mighels: Boston Soc. Nat. Hist., Proc., vol. 2, p. 19, 1845. Pfeiffer: Mon. Pneum., p. 352, 1852; in Gray's Cat. Phaner., pp. 254, 255, 1852. Gould: U. S. Expl. Exped., Mollusca and Shells, p. 99, pl. 7, fig. 108, 1852. Paetel: Cat. d. Conch., Abt. 2, p. 496, 1889. Baldwin: Cat. Shells, p. 16, Honolulu, 1893. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 396, 1900. Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 4, 5, 1908.

Helicina (subgenus *Idesa*) *laciniosa* Mighels, Adams, H. and A.: Gen. Rec. Mollusca, vol. 2, p. 304, 1858.

Aphanoconia fulgora (Gould) Wagner: Syst. Conch.-Cab., Helicinidae, I, 18, p. 163, pl. 32, figs. 12-15, 1911.

Sturanya laciniosa (Mighels) Baker: Acad. Nat. Sci. Phila., Proc., vol. 74, p. 43, 1922. Caum: B. P. Bishop Mus., Bull. 56, p. 5, 1928.

Original description:

Shell orbicular, convex, reddish brown, interspersed with irregular light spots; whorls five, more or less flattened, with two or three raised lines, revolving over the middle of the outer whorl; aperture semilunar; lip simple, acute. Diameter, 3/20 inch. Habitat Oahu.

Pfeiffer published a fuller description in Latin in *Monographia Pneumopomorum Viventium*, and in Gray's Catalogue he published a translation of it, as follows:

Shell subconic, rather thin, faintly striated, scarcely shining, cinnamon-coloured, irregularly striped and spotted with whitish; spire conoidal, rather pointed; whorls 4-4½, scarcely convex, the last marked with 1-3 slightly raised [lines] on the periphery, flattened beneath; columella very short, dilated backward into a diffused, shining callus; aperture oblique, semioval, somewhat triangular; peristome simple, straight, sharp, its basal margin forming with the columella an angle of about 90 degrees. Operculum thin, horn-coloured. Height 2½, greatest breadth 4, least br. 3 1/3 mm.

Habitat Oahu, Sandwich Islands.

The type selected by Mighels was lost, so Gould chose a neotype that answers the original description, which, however, is so meager that it is some-

what ambiguous. As Gould's description is similar and fuller and includes the first figure of the shell, it has been used in selecting typical specimens:

Shell conic-globose, rather solid, of a cinnamon-brown colour, variegated with yellowish zigzag stripes. Spire composed of 5 flattened whorls, the last of which is obtusely angular at periphery, and has 2 or 3 raised revolving lines upon it. The aperture is lunate, the lip acute, expanding in the vicinity of the columella.

Operculum thin, yellowish-brown.

Axis one-tenth of an inch; base three-twentieths of an inch.

Found at Kauai, Sandwich Islands. Couthouy. Waianai, Pickering.

The figure does not agree with the description, the whorls appearing somewhat rounded, the periphery rounded, not angled.

No authors add information until 1900, when Sykes gives other locations besides Oahu and Kauai, namely those listed by Perkins: "Lanai, behind Koele; also Kalamaula, Molokai; Kaala, Oahu; and between Lihue and the sea, Kauai."

Although Pilsbry and Cooke state that Souleyet's description of *H. sandwichiensis* seems to show that it can hardly be separated even as a variety from *H. laciniosa*, further comparison of figures and descriptions is rather convincing that *H. sandwichiensis* is the same as *H. laciniosa* variety *disso-tropis* (Ancey) Pilsbry and Cooke.

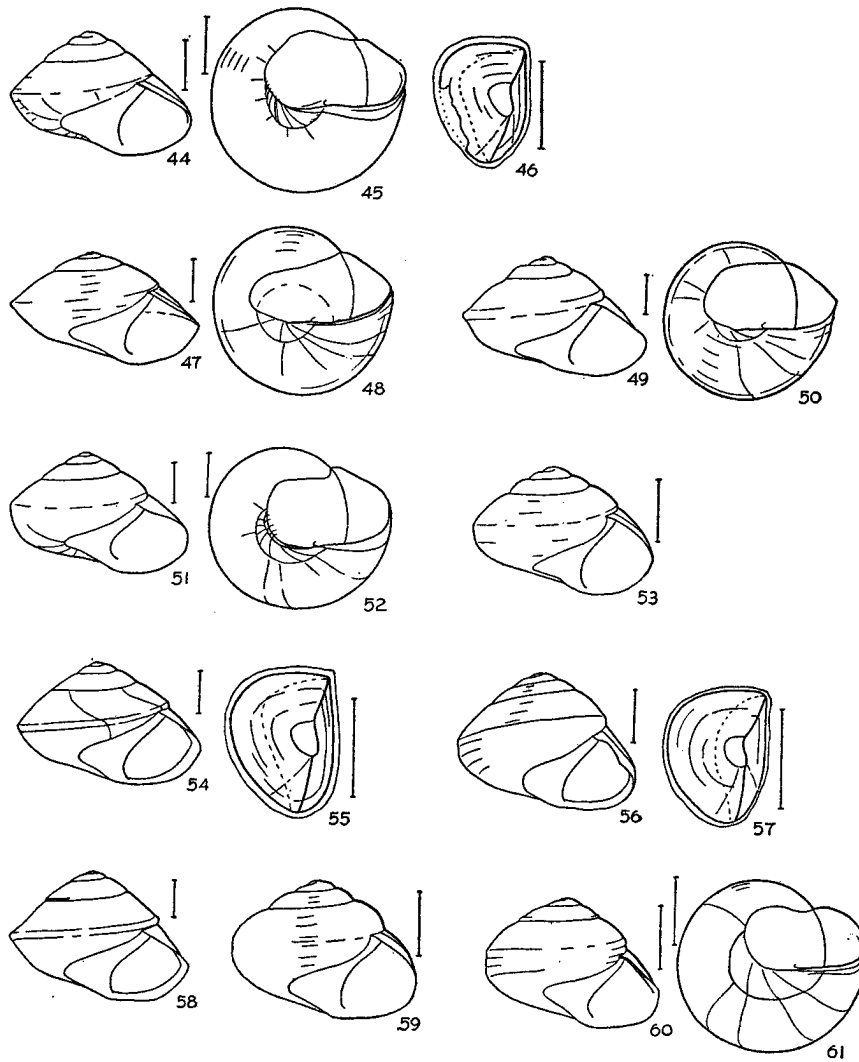
Wagner's *Sturanya laciniosa* is a synonym for *Pleuropoma* (*Sphaeroconia*) *hawaiiensis* variety *knudseni*.

Somewhat resembling this shell is *Aphanoconia fulgora*, about which confusion has arisen. In the original description in 1847, Gould gave the location of this species as Upolu and Manua. In 1852, Pfeiffer redescribed the shell and added to the Samoan localities "Sandwich Islands." Paetel and Wagner gave "Sandwich Islands" only. In 1900, Sykes stated that *H. fulgora* probably does not come from the Hawaiian islands, and as Gould mentioned Samoa only and in his description of *H. fulgora* compares that species with *H. laciniosa*, saying that *H. laciniosa* is smaller, more globular, and without reflexed lip, Sykes's statement seems correct. Examples of the two species in the collection of Bernice P. Bishop Museum can be distinguished easily.

In 1908, Pilsbry and Cooke published the results of their examination of the teeth of four species of Helicinidae. Of *H. laciniosa*—the specimen selected probably being a variety from Oahu—they say: "*H. laciniosa* has the denticle formula 5, 6, 4, 7, 0. The major lateral (iv) has an even series of subequal denticles. The inner uncini have about 7 very minute, subequal denticles."

In 1922, Baker chose *laciniosa* as the type of the genus *Sturanya*.

A typical specimen of *Pleuropoma laciniosa* (no. 11196) was selected to agree with Gould's description. A full description of it follows:



FIGURES 44-61.—*Pleuropoma laciniosa* and varieties from Oahu: 44-46, *P. laciniosa*, neotype, no. 11196, shell; no. 59432, operculum; 47, 48, *P. laciniosa* variety *ferruginea*, type, no. 11216; 49, 50, *P. laciniosa* variety *spaldingi*, type, no. 11217; 51, 52, *P. laciniosa* variety *laula*, type, no. 11254; 53, *P. laciniosa* variety *pusilla*, type, no. 11251; 54, 55, *P. laciniosa* variety *sandwichiensis*, (operculum in aperture) no. 19070, shell; no. 90745, operculum; 56, 57, *P. laciniosa* variety *alpha*, type, no. 14904, shell; no. 16142, operculum; 58, *P. laciniosa* variety *gamma*, type (operculum in aperture), no. 14902; 59, *P. laciniosa* variety *signata*, type, no. 11252; 60, 61, *P. laciniosa* variety *perparva*, type, no. 11253. The dull area on opercula is outlined by a broken line. The measure indicates 1 mm.

Shell broadly cone-shaped; rather thin, shining where small patches of epidermis remain, dull elsewhere; smooth except for minute lines of growth and faint spiral lines, 2 of which are impressed on the upper half of the last whorl, 3 or 4 faintly on the lower half. The color is vinaceous rufous, fading to cream color at the lip, with several flammules of cream color on the last $1\frac{1}{2}$ whorls. The base is cinnamon-rufous with a white area in the center around the columella. Whorls 4, regularly and slowly increasing, upper slightly convex, last flat above the rounded peripheral angle, convex below it. Suture shallow, not margined. Near the lip the last whorl drops slightly and exposes the keel on the penultimate whorl. Aperture nearly oval, with the broad end flattened, not expanded. Lip cream color, thin, the upper shell layer ending abruptly near the aperture. Columella concave on the face, obtusely curved and round-angled on the edge. Basal callus a large transparent film, having many minute punctations. Umbilical callus distinct and elevated, nearly a third of a circle in area. It measures: diameter 3.5, height 2.3 mm.

Operculum translucent, shining, cream color tinted with light ochraceous salmon. Apricot-orange on columellar edge. Oval; columellar edge weakly sinuous, ending above in a right angle and curving back gradually in the lower half. Thick along columellar edge, thin elsewhere. Outside concave, covered with fine, flat granulations that gradually disappear toward the edge. Inside convex and undulating upward at base. Nucleus slightly above middle, near columellar edge and parallel to it. S-ridge low, upper part indistinct, middle and lower part raised and continuing at same elevation to columellar edge, at the base sloping inward in a fan shape. Growth lamellae distinct; dull area large. A narrow margin of the innermost filmy layer encircles the operculum.

Oahu, Waianae Mountains, Kupehau, a small valley half a mile south of Palikea, facing east, August 23, 1922, C. M. Cooke, Jr., and Marie Neal, neotype no. 11196.

With the typical specimen were several similar shells, some with slightly greater dimensions, some darker, and one naples-yellow. On the base of the dark shells the light flammules are present but are interrupted by a wide or narrow spiral band of the base color. One large lot with still wider variation was collected in the same locality. In one odd specimen the penultimate whorl has a keel that is prominent and stands above the lower part of the last whorl. Juvenile specimens are more sharply conical, thinner, and distinctly marked on the last whorl with about 8 raised spiral lines.

At Palikea, C. M. Cooke, Jr., I. Spalding, and W. H. Meinecke collected nearly typical specimens. They are, however, more obtuse at the periphery, though the keel is ordinarily more prominent, being slightly furrowed on each side. Mixed together in some lots are two forms, a high and a low, and the size ranges from larger than the typical specimen to smaller. The flammules are distinct on many, indistinct on others, and some specimens are uniform color with either a reddish or a yellowish cast. Opercula similar to the one described from Kupehau; nuclei of some slightly oblique, and columellar edge of some lighter-colored. Meinecke collected similar juvenile shells. Three shells in a lot labeled "Waianae Mts.," from C. N. Forbes, are like those from Palikea.

At Mauna Kapu, a peak south of Palikea, C. M. Cooke, Jr., and I. Spalding found shells like those from Palikea. The lower half of the last whorl of many is marked more distinctly with spiral lines. Opercula typical.

At Palehua and in its vicinity, C. M. Cooke, Jr., collected many lots, W. H. Meinecke one lot, all of which agree closely with those from Palikea. Some have higher spires. Only one lot had opercula, and those were typical.

One lot collected in Pukaloa by Cooke fits best here, having perhaps slightly lower spires than those from Palehua.

North of Palikea, at Puu Kaua, O. Swezey collected four juvenile shells which are like those from Palikea and have typical opercula.

At Lualualei, in a dry gully below Pohakea Pass, Cooke found two dead shells like those from Palikea.

At Pukaloa, C. M. Cooke, Jr., I. Spalding, and W. H. Meinecke found several specimens that seem to differ from no. 11196 only in being rounder due to a more obtusely angled periphery, the keel on the penultimate whorl distinctly rising above the last third of the last whorl. One odd high specimen was found. Only one operculum was available, and that is typical; nucleus slightly oblique. A similar rounded shell was collected by Meinecke in Haleauau.

Grading from the species to variety *ferruginea* is a lot from Haleauau collected by I. Spalding and one specimen by O. Oswald. The peripheral keel is distinct and the shape typical. Opercula are only tinted with red on the columellar edge, otherwise typical, though some are quite large.

Three lots labeled "Leilehua" (no. 16035, Pukaloa to Kalena Valley; no. 17061, Kalena Valley; no. 14877, ridge south of Kolekole gap), closely resemble shells from Pukaloa but are much more distinctly keeled. One odd specimen is narrow and high. O. Oswald collected some with which nearly typical narrow-keeled specimens are mixed. Opercula are typical or vary only slightly in shape and size from typical.

At Puu Kalena, above Pukaloa, one typical juvenile shell was collected by I. Spalding. High-spired forms were found at many localities in the Waianae Mountains. They vary from narrower to wider than the typical specimen and from prominently to slightly keeled. There are many intergrades between the typical and high forms. One lot collected by I. Spalding at Palikea is high-spired.

On the west side of the range, at Nanakuli, O. Oswald collected many typical specimens, some grading to the high form, some small, approaching variety *pusilla*, one shaped like the type but much larger. Opercula are typical, of the many examined few varying much in size and shape.

In a glen in Lualualei, Oswald found two lots of high, rounded shells, one lot with opercula, which are typical.

On top of the range, at Palehua, C. M. Cooke, Jr., and I. Spalding found several specimens of a moderately narrow form, many with rounded last whorl, upper whorls more convex and with indistinct keel, grading into the typical form. They are marked with 8 spiral lines that are impressed except at the periphery. In one lot, 2 spirals are slightly angled and form a flat or concave band around the periphery. Opercula typical.

Northeastward, at Kunea (east of Puu Kaua), W. D. Wilder collected similar shells, some double-keeled and higher.

At Lihue, the region north of Kunea, Cooke and Spalding collected a few lots, some of which have much higher spires than the typical specimen and a single, obtuse keel. Others grade into the typical form, and many are larger. Opercula typical, but wider at top and narrower at base.

A similar high-spired shell was collected by Meinecke at Haleauau. Operculum resembles those in shells from Lihue.

At Kanehoa, Cooke and Spalding found similar shells. Some are small and almost grade into variety *pusilla*. Their opercula are mostly shorter and rounder.

In the valley to the north—Popouwela—Cooke, Forbes, Spalding, and Pilsbry collected specimens much like those from Lihue. Some are larger and approach variety *ferruginea*; some are quite high and not prominently keeled. The opercula in three lots are typical but large.

In various parts of Lualualei, on the west side of the Waianae Mountains, O. Oswald made a large collection of *P. laciniosa* which resemble those from Popouwela. They vary somewhat in height of spire, prominence of peripheral keel, and color pattern. Their opercula are fairly typical; some variations exist, however, in width, color, size, and prominence of ridge.

Also in Lualualei, in a dry gully below Pohakea Pass, Cooke collected several specimens deviating from the typical form, most being smaller, comparatively higher, rounder whorled, and distinctly keeled, some having a suggestion of a wide double keel. Opercula much like those in shells from Lihue. Two collected by Oswald have flatter whorls—like the type. Fossil shells found by Forbes and Cooke in a coral ridge south of Puuohulu, Lualualei, are similar, though some are rounder, some lower.

In Waianae Valley, C. M. Cooke, Jr., O. Oswald, and J. C. Bridwell found a few high-spired specimens like those from Lihue but with keel more rounded. Opercula typical of the species.

Two mature shells, larger and comparatively higher, with ridged keel, from Kololua Valley in Waianae Valley, should perhaps be classed here. Their epidermis is worn off. Average measurements: diameter 4, height 3 mm.

Cooke and Spalding collected a few shells in Mokuleia, some like those from Lihue, others lower and typical. The only available opercula differed from the type in being wider.

In the next valley—Kawaihapai—fossil shells were found by Cooke, Forbes, and Spalding. Five are nearly typical, and one differs from the typical specimen in several ways, being wider, larger, with rounder spire, smaller aperture, and more distinct keel, approaching variety *ferruginea*. These differences, however, are not varietal, as is proved by several specimens collected by Forbes and Cooke on the other side of the range, at Makua. For though some of these specimens are similar to the wide form from Kawaihapai, others grade to the high-spired form of Lihue, some having $4\frac{1}{2}$ whorls, some being more distinctly keeled than others.

Forbes also found several high-spired shells at Makaha, L. H. MacDaniels two. Similar reddish shells were found by T. T. Dranga on the ridge between Makua and Makaha; opercula typical.

At an elevation of 150 feet in Keawaula, on the northwest end of the range, Forbes found fossil shells like those from Makua, which is not far off. They average smaller in size.

In the Koolau region, near a large fossil deposit of *Orobophana uberta* variety *exanima*, in a coral bluff $1\frac{1}{2}$ miles north of the Kahuku store, Cooke found two fossils resembling living specimens from Popouwela.

Key to Varieties

- A. From Kauai (five) and Niihau (two).
1. Shells about 4 mm in diameter.....2
Shells about 3 mm in diameter.....3
 2. Whorls 4, keel ordinarily biangled.....*canyonensis*
Whorls $4\frac{1}{2}$, keel not biangled, from Kauai and Niihau.....*delta*
 3. Fossil4
Not fossil5
 4. Less than 3 mm in diameter, umbilical callus ordinarily nearly equaling
half a circle.....*matutina*
More than 3 mm in diameter, umbilical callus ordinarily nearly equaling
a third of a circle, from Niihau.....*kiekieensis*
 5. Whorls $3\frac{1}{2}$, umbilical callus lacking or narrow, periphery not biangled.....*praeparva*
Whorls 4, umbilical callus large, periphery of some shells faintly biangled....*globuloidea*
- B. From Oahu.
1. Shells more than 3 mm in diameter.....4
Shells mostly less than 3 mm in diameter.....2
 2. Periphery unangled, in some shells indented.....*signata*
Periphery angled3
 3. From Waianae Mountains, fossil and living, lip not flaring, umbilical callus
a narrow crescent*pusilla*
From Kailua, fossil only, lip flaring, umbilical callus a broad crescent....*perparva*

- | | |
|---|-----------------------|
| 4. Shells about 4 mm in diameter..... | 5 |
| Shells about 5 mm in diameter, narrower than <i>ferruginea</i> | <i>gamma</i> |
| 5. Lower half of last whorl swollen..... | 6 |
| Lower half of last whorl not swollen, keel less distinct than in <i>sandwichiensis</i> , color decidedly reddish..... | <i>ferruginea</i> |
| 6. Shell 4 + mm in diameter, keel distinct..... | 7 |
| Shells about 3 mm in diameter, keel rounded, ordinarily narrower than <i>sandwichiensis</i> | <i>alpha</i> |
| 7. Aperture not flaring, whorls 4 +..... | 8 |
| Aperture flaring, whorls 3½, suture margined on penultimate whorl..... | <i>spaldingi</i> |
| 8. From Koolau Range, peripheral angle projecting above the suture..... | <i>sandwichiensis</i> |
| From Waianae Mountains, suture distinctly indented, not margined by angle | <i>laula</i> |
| C. From islands south of Oahu. | |
| 1. Like typical <i>alpha</i> but lower, diameter about 3.3 mm..... | 2 |
| Much like <i>sandwichiensis</i> but smaller..... | 3 |
| 2. Aperture large, last whorl rounded, from Molokai..... | <i>molokaiensis</i> |
| Aperture average size, last whorl angular, from Maui..... | <i>kulaensis</i> |
| 3. Aperture small, shell rather thick..... | 4 |
| Aperture medium-sized | 5 |
| 4. Aperture comparatively one of smallest of varieties of <i>P. laciniosa</i> , shell higher than <i>molokaiensis</i> ; from Molokai..... | <i>moomomiensis</i> |
| Shell lower than <i>molokaiensis</i> ; from Kahoolawe..... | <i>kahoolaweensis</i> |
| 5. Umbilical callus larger than that of <i>kulaensis</i> , as in <i>P. laciniosa</i> | 6 |
| Umbilical callus either larger or smaller than in <i>P. laciniosa</i> | 7 |
| 6. Type measuring: diameter 3.7, height 2.7 mm, from Maui..... | <i>honokowaiensis</i> |
| Type measuring: diameter 3.1, height 2 mm, from Lanai..... | <i>kaensis</i> |
| 7. Umbilical callus rather small, much as in <i>spaldingi</i> , aperture large and wide, from Lanai | <i>piliformis</i> |
| Umbilical callus much larger, aperture small and narrow; from Hawaii..... | <i>konaensis</i> |

***Pleuropoma laciniosa* variety *ferruginea*, new variety (figs. 47, 48).**

With the paratypes of *P. oahuensis* was mixed a higher, narrower form of shell, smaller, slightly heavier, and with more obtuse spire—closer to *P. laciniosa*, but larger and comparatively lower. It has a decided reddish cast. Besides the color pattern above, white and reddish flammules or dots alternate on the base around the basal callus. Umbilical callus about a third of a circle. The type measures: diameter 4.3, height 2.7 mm.

Oahu, Waianae Mountains, Leilehua, August 22, 1904, C. M. Cooke, Jr., type no. 11216, paratypes no. 11197.

On the peak above Leilehua—Puu Kalena—I. Spalding collected a few similar shells. South, at Palikea, Cooke and Spalding collected similar shells with ordinarily less rounded spire and distinct keel. At least two lots approach the species. Opercula in three lots like those of *P. laciniosa* but larger and comparatively wider.

In Waianae Valley, Cooke found some specimens like those from Palikea, but larger, with more distinct spiral lines, and lower half of last whorl slightly less bulging. Opercula like those of *P. laciniosa*.

In Haleauau, the valley next to the type locality, I. Spalding collected five large shells that resemble closest those from Waianae Valley, the largest measuring: diameter 5.4, height 3.2 mm. Whorls about $3\frac{1}{2}$. Opercula also similar in one lot at least, but much larger (no. 36627). One nearly typical lot was collected in Haleauau by Thaanum; another lot by Meinecke, smaller and with lower spires.

Next to Haleauau, in Pukaloa, Spalding collected several shells also larger than typical specimens. Similar shells but without a pattern were collected by E. W. Thwing at some unknown locality in the Waianae Mountains. Pattern was not visible in a few dead shells collected by O. Oswald in Leilehua.

In all the specimens is some variation in the height of the spire, but none are so high as one collected in Makaleha Valley by A. F. Judd (no. 53710, diameter 5.1, height 3.3 mm) and four similar ones collected in Makaha Valley, just north of Waianae, by C. N. Forbes (no. 17873, the largest: diameter 5, height 3.2 mm), height being accentuated by the large swollen lower half of the last whorl. The range of variation in the angulation of the periphery is considerable. Besides these shells, I. Spalding collected a typical adult and three juveniles in Makaha, the opercula of which are typical, and W. D. Wilder six like some of those from Haleauau, or nearly typical.

Three fossil specimens were collected by Cooke and Forbes at Kawaihapai, which are swollen and more distinctly keeled than the type, otherwise much like it. One specimen collected by Cooke on Makua ridge is narrower and more rounded than the fossils from Kawaihapai.

At Mauna Kapu, Spalding collected two shells showing extremes of variation in form. At Popouwela, shells collected by Spalding, Pilsbry, and Cooke differ a little, are either typical of the variety or comparatively higher and narrower, the spire more conical, the lower half of the last whorl more rounded. Opercula resemble those of *P. laciniosa*, though larger. A lot in the Baldwin collection from Waianae resembles the high form from Popouwela. From Haleauau came a few shells similar to those from Popouwela, some grading to the large form, collected by W. H. Meinecke, W. D. Wilder, C. M. Cooke, Jr., O. Oswald, O. Swezey, and one in the Cooke collection. On the southwestern slope of Palikea, Meinecke collected a large lot of dead shells, which are very large and high-spined.

At Palehua, at the extreme southern end of the Waianae Mountains, Spalding collected several specimens typical of the variety. Only one operculum was available; though worn, it resembled those in shells from Waianae Valley.

Pleuropoma laciniosa variety **spaldingi**, new variety (figs. 49, 50).

Shell thin, hardly opaque, smooth except for many fine growth lines, shining, bluntly conoidal; in color cinnamon-rufous grading to Hay's russet with many interrupted zigzags of cream color. The $3\frac{1}{2}$ whorls are distinctly convex, and the suture is margined on penultimate whorl. A rounded keel follows the periphery, which ends at a large, flaring, squarish, somewhat oblique aperture with a thin, slightly flaring lip. Basal callus white, thin; umbilical callus a white, narrow crescent. Measurements: diameter 4.6, height 3 mm. Opercula of type and paratypes are like those of variety *sandwichiensis*, which are, however, much smaller.

Oahu, Waianae Mountains, Puu Kaala, near spring, elevation about 3,000 feet, May 8, 1923, O. Oswald, type no. 11217, paratypes no. 54199.

In the shells is considerable variation, as in color and shape and size. Most specimens are lighter-colored than the type, one amber-yellow. Those from the top of Puu Kaala are especially high-spined.

This variety might be described as a western form of variety *sandwichiensis*. It includes shells collected on Puu Kaala and in the adjoining valley, Haleauau, by D. Thaanum, O. Oswald, J. C. Bridwell, and I. Spalding, having been discovered by Spalding on top of Puu Kaala. As the form of the average specimen is that of shells collected near the spring on Puu Kaala, one of these is chosen as the type. It resembles especially variety *sandwichiensis* from Mauna Kope at the head of Kalihi Valley (no. 41107), which though smaller and comparatively higher has similar texture, color, periphery, indentation of suture, convexity of whorls, and shape of aperture.

Pleuropoma laciniosa variety **laua**, new variety (figs. 51, 52).

Larger than the species, the type of the variety differing from the type of the species as follows: peripheral keel rounded, lower half of last whorl more swollen, aperture comparatively larger, diameter 4.4, height 2.9 mm. This shell also looks much like *Orobophana uberta* variety *bryani*. But the periphery is sharper-angled and the opercula of the paratypes of *Pleuropoma laciniosa* variety *laua* are typical *Pleuropoma*.

Oahu, Waianae Mountains, Makua, southern slope, November 11, 1913, I. Spalding, type no. 11254, paratypes no. 34844.

Laua is Hawaiian for "broad."

Among the many paratypes the height of the spire varies considerably and also the sharpness of the angle at the periphery. A few are cream color without a pattern. In low-spined shells the aperture is less oblique than in high-spined.

On the southeast side of the same valley, C. M. Cooke, Jr., found many similar shells, and on the east side Spalding found a few nearly adult that are much like them. Far up in the valley of Mokuleia, just over the range from Makua, C. M. Cooke, Jr., I. Spalding, and A. Gouveia collected several specimens of this variety, some of which are like the type, some larger, most with a distinct rounded keel, some with 1 or 2 rounded ridges below the

peripheral keel. Opercula large and broad, except the five nearly typical specimens collected by Spalding, which have typical opercula. One odd juvenile shell collected on Puu Kaala was received from Thwing. Though it is not quite mature, a specimen collected by C. N. Forbes in Waianae Valley seems typical. Zigzag markings are distinct. In the Garrett collection are four shells labeled "*Hel. sandwichensis* Gould, Sandwich Isles," which resemble *Pleuropoma laciniosa* variety *laula* from Mokuleia Valley.

***Pleuropoma laciniosa* variety *pusilla*, new variety (fig. 53).**

A small, round shell, resembling the species except in size, being smaller and comparatively higher (the type measuring: diameter 2.8, height 2 mm), upper whorls more convex, nearly 4 whorls, umbilical callus slightly narrower. Specimens also resemble variety *alpha*, but are lower and sharper-angled. Some specimens are much like *Orobophana uberta* variety *lymaniana*, but ordinarily have a more distinct keel.

Oahu, Waianae Mountains, Palehuaiki, May 30, 1915, A. Gouveia, type no. 11251, paratypes no. 40612.

Found at several points in the Waianae Mountains by several collectors: C. M. Cooke, Jr., H. A. Pilsbry, W. H. Meinecke, A. Gouveia, O. Oswald, I. Spalding, J. C. Bridwell, and C. N. Forbes.

Those from Nanakuli are large, almost equaling the species in size, and they have the most strongly angled keels. Five from Pukaloa are high, rounded, and not prominently keeled; spiral lines visible on some. Two from Haleauau have ridged periphery. Two from Puu Kalena are similar, though sutures are deeper. Those from Kanehoa are pale, yellow-tinted shells. A juvenile angled specimen was collected on the division ridge between Leilehua and Waialua.

Some fossil specimens were found, a few at Kawaihapai, which are typical (though one is odd due to an injury on the penultimate whorl), some with distinct spiral lines; several at Makua, which run larger, some comparatively wider; four at Mokuleia, which though juvenile seem typical; and four at Keawaula.

Some odd, high-spined specimens probably belonging to this variety have been found: one at Pukaloa, one at Popouwela, one at Kupehau near Palikea, two at Palikea.

Opercula of specimens from Kanehoa and Palikea only were available. They are similar and differ from those of the species in being smaller, narrower at the base, less translucent, and in color antimony-yellow on the columellar edge, grading to white on the outer edge. Many mostly whitish.

In the region between the Waianae Mountains and the Koolau Range this variety has representatives. At Haleiwa a high-spined fossil specimen with a round-angled periphery was collected by Cooke. The dimensions are: diameter 2.8, height 2 mm. At Waialua, the same collector found four fossil

specimens with angled periphery, of the size of those from Kawaihapai. At Kawaihoa, an adjoining district to the east, in the Koolau Range, Cooke found several lots of fossils like typical ones from Palehuaiki. They run larger—like those from Waialua—and have more swollen bases. They are distinctly patterned with fine zigzags.

Pleuropoma laciniosa variety **sandwichiensis** (Souleyet) (figs. 54, 55).

Helicina sandwichiensis Souleyet: Voy. Bonite, Zool., t. 2, pp. 529-530, pl. 30, figs. 1-5, 1852. Pfeiffer: Mon. Pneum. Viv., 1st suppl., pp. 190, 191, 1858. Paetel: Cat. d. Conch.-Samml., Abt. 2, p. 500, 1889. Baldwin: Cat. Shells, p. 16, Honolulu, 1893. Crosse: Jour. de Conch., vol. 42, p. 405, 1894. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 397, 1900. Sowerby: Thes. Conch., III, pl. 270, figs. 173, 174, no date.

Helicina dissotropis Ancey: Malacol. Soc. London, Proc., vol. 6, pt. 2, p. 127, pl. 7, figs. 22, 23, 1904.

Oligyra sandwichiensis M. E. Gray: Figs. Molluscos Anim., t. 303, fig. 10 (ex Souleyet), 1857-1859.

Helicina laciniosa variety *dissotropis* (Ancey) Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 5, 1908.

Aphanoconia fulgora (Souleyet) Wagner: Syst. Conch.-Cab., Helicinidae, I, 18, p. 163, pl. 32, figs. 12-15, 1911.

Aphanoconia dissotropis (Ancey) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

Helicina, testa orbiculato-conoidea, carinata, subalbida, flammulis rubicundis et undatis ornata; spira conico-depressa, obtusiuscula; anfractibus quinis, depressiusculis; apertura subtrigona, peristomate acuto, postice incrassato.

Operculum corneum, subovatum, tenue, pellucidum, substriatum.

L'animal a le pied étroit et allongé, les tentacules effilés à leur sommet. Il est d'un brun jaunâtre dans toutes ses parties.

Dimensions de la coquille. Largeur, quatre millimètres; hauteur, trois millimètres. Cette petite *Helicine* habite les îles Sandwich. Elle a d'assez grands rapports avec l'*Hélicine flamée* (*H. flammea*) de MM. Quoy et Gaimard; mais elle en diffère par sa forme plus déprimée, par la carène du dernier tour et par son péristome tranchant et non rebordé.

Ancey's description of *Helicina dissotropis*:

Testa lenticularis, utrinque depresso-convexa, solidula, subnitidula, striis capillaribus incrementi sub lente oblique sculpta, acute carinata, rubella, supra infraque ad callum basalem albo strigata. Spira depressa, late conoidea, apice obtuso. Anfractus 4 plani, superiores exserte carinati, sutura parum profunda; ultimus superne plano-declivis, præter carinam superam altera illae approximata et interdum tertia minus distincta circumdatus. Callum circumscriptum, granulatum, lividulum. Apertura obliqua, supra regulariter declivis, extus angulata, basi subarcuata. Peristoma acutum, basi vix expansiusculum.

Diam. 4.2, alt. 2.25, alt. apert. (oblique) fere 2 mm.

Hab. Oahu (Thaanum).

A distinct species of compressed form and with two or three acute keels on the last whorl. Surely not a variety of *H. Sandwichensis*, Souleyet, of which I have typical specimens from the Waianae Mountains, Oahu (D. D. Baldwin). Some subfossil examples also are in my hands from Waimea, Hawaii (Henshaw).

As the original descriptions of variety *sandwichiensis* and *Pleuropoma laciniosa*, though meager, agree considerably, the shells have been confused by authors and collectors. But as it has been ascertained that the type of variety *sandwichiensis* was collected in Nuuanu Valley in the Koolau Range and the type of *P. laciniosa* in the Waianae Mountains, also as the figures of the types are distinct, these names can not be synonyms. *P. oahuensis* has been confused with variety *sandwichiensis* also. The type of variety *sandwichiensis* is believed to be lost, as vain search by Cooke has been made for it in the French Museum, where Souleyet probably deposited it.

Pfeiffer has a fuller description in Latin than the original, and some statements do not agree, Pfeiffer's description being based on a specimen in the Cuming collection, not the type. Therefore Pfeiffer's description can not be considered. He gives the habitat as Sandwich Islands (Dr. Newcomb). He reports variety β —paler, thinner, with a thinner basal callus—as from "Loyalty Island" (Macgillivray). He observes that variety *sandwichiensis* is similar to *P. laciniosa* but keeled.

Paetel includes *Helicina sandwichiensis* in his list of *Helicina* and gives Jamaica as its home. Baldwin lists the name as *H. sandwichensis* and gives the Waianae Mountains as the habitat.

Sykes says: "Nec? *H. sandwichiensis* Sowerby"; that the variety recorded by Pfeiffer from the Loyalty Islands is probably an error; and that the habitat is Oahu, Waianae Mountains (Baldwin), at and below Kaala (Perkins). According to Pilsbry and Cooke, shells distributed by Baldwin as *H. sandwichiensis* Souleyet are not that species but *H. oahuensis*.

Pilsbry and Cooke describe *Helicina laciniosa* variety *dissotropis* as having a flatter shell and a more angulated periphery than typical *H. laciniosa*.

Wagner lists *Helicina sandwichensis* as a synonym of *H. fulgora* Gould, which he believes to be from Hawaii. As Gould mentions only Samoa as the habitat of *H. fulgora*, Hawaii is apparently wrongly given by Wagner and Pfeiffer. Sykes thinks that *H. fulgora* is erroneously noted from Hawaii. Therefore *H. samoana* is thrown out—a name given by Wagner to what is actually the Samoan *H. fulgora*. Following is a translation of Wagner's statements:

This form [*H. samoana*] is at present commonly designated as *Helicina fulgora*. According to the account of the author, however, this similar form lives on the Sandwich Islands and has received the name *Helicina sandwichensis* Souleyet, while the older name [*fulgora*] was used by Mousson and others on its similar occurrence in Samoa, Fiji, and

Tonga Islands. The original description fits the two forms so closely that the place of discovery must be used to decide the matter.

As Ancey's type of *H. dissotropis* (no. 19066, Bishop Museum) is immature, it is not representative, having such juvenile characters as thin shell, flattened spire, few whorls, fresh and intact epidermis. The original material from which Ancey chose the type is in all probability a lot consisting of 12 shells (no. 19070, Bishop Museum) collected by D. Thaenum in Nuuanu Valley. These range in size from smaller than the type to larger, and none except the type has a two-angled keel. From these shells two adult ones were selected by C. M. Cooke, Jr., as more representative of the species than the type. Another lot of six shells (no. 14880), collected by Thaenum at Nuuanu Pali, is paratype material, as Thaenum sent it to Cooke from the same lot as that from which he sent the type material to Ancey. Both lots sent by Thaenum (nos. 19070 and 14880) are probably mixtures of *Helicina laciniosa* variety *dissotropis* and what Ancey called variety *sandwichiensis*, which with its much rounder base was considered distinct. As the original description of variety *sandwichiensis* does not differ greatly from that of variety *dissotropis*, the two have been confused. But the original figures are quite distinct, even after making allowances for the immaturity of the type of variety *dissotropis*. Neither figure is typical, that of variety *dissotropis* resembling *Orobophana uberta* variety *magdaleneae*, that of variety *sandwichiensis* an extreme form of variety *magdaleneae* with well-rounded base. Ancey stated that *dissotropis* is "surely not a variety of *H. Sandwichensis*," of which he said he had "typical specimens from the Waianae Mountains" from D. D. Baldwin. As already noted (p. 51), Baldwin distributed *Pleuropoma oahuensis* as *Helicina sandwichiensis* Souleyet. As specimens grade from having extremely convex to slightly convex bases—apparently their only difference—many are impossible to distinguish, and so the name *H. laciniosa* variety *dissotropis* is dropped, and *Pleuropoma laciniosa* variety *sandwichiensis* only is recognized.

The shells are much like *P. laciniosa* variety *ferruginea*. But typical forms of variety *sandwichiensis* are comparatively higher, have a more oblique aperture, a more rounded lower half to the last whorl, a more conoidal spire, and a more distinct keel on the peripheral angle. Typical specimens of variety *sandwichiensis* and variety *alpha* are quite distinct, variety *alpha* being smaller, rounder-angled, and comparatively higher. But large specimens of variety *alpha* and small ones of variety *sandwichiensis* approach each other in size and appearance so closely that they are difficult to distinguish.

Souleyet's description of the lost type needs to be modified when applied to the paratypes of Ancey's *Helicina dissotropis*, now called *Pleuropoma laciniosa* variety *sandwichiensis*, as follows:

Whorls 4+, slightly convex, suture shallow, the suture of the second half of the penultimate whorl margined with a projecting keel, which continues on the last whorl around the peripheral angle and is visible as far up as the second whorl; umbilical callus distinct, crescent-shaped, about a quarter of a circle in size, much like that of *P. laciniosa* variety *spaldingi*. The larger (fig. 54) of the two "neotypes" (no. 19070), selected from Ancey's paratypes of *Helicina dissotropis*, measures, diameter 4.2, height 3 mm; the smaller, diameter 3.9, height 2.9 mm. Red and white flammules are not present on all specimens, one "neotype" being nearly uniform pinkish buff with faint flammules, the other "neotype" and the paratypes having more or less distinct flammules of alternating Hay's russet or vinaceous rufous and cream color.

Many shells do not have the keel visible beyond the penultimate whorl, and some have faint indications of spiral lines, ordinarily 2 above and 2 to 3 below the keel. Operculum similar to that of the species; nucleus ranges from very oblique to parallel with the columellar edge, varying in size and width.

The geographical range of variety *sandwichiensis* is wide—from Punaluu across to Kalaikoa, east to Kuliouou.

At Nuuanu Pali and in Nuuanu Valley, C. N. Forbes and I. Spalding collected several shells, some nearly typical, some high-spired and with the last whorl having a well-rounded base. On a ridge east of the forester's house, C. M. Cooke, Jr., collected one lot.

On the west side of the Pali, A. Gouveia collected 6 shells, 3 of which are nearly typical. Three are like these but are larger and uniform cream color, on the largest—diameter 4.5, height 3.2 mm—flammules being present in a faint shade of orange. The environment of these shells was evidently different, the large shells perhaps coming from a more favorable locality than the small ones; or perhaps they differ in sex.

A. Gouveia also collected a large lot in Nuuanu Valley. They are like the so-called "neotypes" of *Helicina dissotropis*, with a noticeable range in the height of the spire, a few being lower, a few higher. The color pattern is typical, except two uniformly cream-colored specimens. In the D. D. Baldwin collection is a large lot from the ridge between Glen Ada and Glen Elm, resembling Forbes' shells from the Pali (no. 52190). On the ridge above Lulumahu, Cooke collected a typical shell. Four small, low shells were collected by W. D. Wilder in Nuuanu.

On "west ridge 2," close to Nuuanu Pali, C. M. Cooke, Jr., collected a high-spired, narrow-keeled shell with $4\frac{1}{2}$ whorls. Similar ones with spires of varying height and keels of varying width, Forbes collected nearby. Some of these correspond with the original drawing of *H. sandwichiensis*, but are somewhat higher; others, with the low *H. dissotropis*. In eastern Nuuanu, Cooke collected similar shells. A single example of a more rounded form with a high spire, narrow keel, large aperture, and a more convex base was found by Cooke near Puu Lanihuli, on the prominent cliff with a waterfall.

On Puu Lanihuli, I. Spalding collected three lots, W. D. Wilder one lot, all consisting of shells with rounded apices and convex bases, some with

depressed apices, convex whorls, large apertures. Otherwise, the shells are typical. Opercula large, with nuclei parallel to columellar edge or quite oblique; many not orange on the columellar edge.

On the "west ridge below Dickey's camp," between Kapalama and Nuuanu, Cooke found two specimens somewhat like those from Puu Lanihuli but smaller, and, still smaller, some from the south inner side of Tantalus crater, some from the outer Pauoa side (one with raised spiral lines), opercula small, nuclei upright. On left and right sides of Pauoa Valley, small shells resembling some from Nuuanu Valley were collected by C. M. Cooke, Jr., I. Spalding, A. Gouveia, and E. W. Thwing. A few like them were collected by Cooke and Spalding in Makiki. Opercula—one lot from each valley—are typical in shape, are nearly transparent, and have a uniform yellowish tint.

Fossil shells similar to those from Puu Lanihuli were collected on the outer slopes of Punchbowl by C. M. Cooke, Jr., W. A. Bryan, and W. D. Wilder. They are, however, thicker; some have 2 or 3 raised spiral lines below the periphery and 1 above, and their umbilical callus is larger. "Near Honolulu," A. B. Lyons found similar fossil shells.

On the western slope of Manoa Valley, in excavations for houses and roads, several deposits of fossil shells were found by Cooke, Pierce, F. Girdler, and D. Kuhns. They resemble those from Honolulu collected by Lyons and are smaller than those from Punchbowl, which they approach in shape. The spire varies considerably in height. On the Manoa slope of Round Top, in a road cutting, Cooke found a few fossil shells slightly larger than those from Manoa. In deposits near rocks on Rocky Hill, Cooke also found fossil shells, which resemble those from Manoa, but run larger. In sculpturing they resemble the fossil shells from Punchbowl. Some have a secondary keel or angle below the prominent peripheral keel or one or more raised spiral lines. Some have deep sutures and very convex whorls.

Similar to fossil shells from Punchbowl are several fossils in a lot collected by C. M. Cooke, Jr., in Moanalua near Puuloa in a road cutting and in another lot collected by Forbes and Cooke in Waimano. Those from Moanalua bear two or more raised spiral lines just below the periphery, a character belonging also to some fossils—differing in being somewhat rounder and lower and convex whorled—found in the region of Diamond Head by Cooke, Pilsbry, and Mant. The shells from Diamond Head grade toward *Pleuropoma laciniosa* variety *signata*.

Resembling some shells from Mount Tantalus are a few rather small ones grading to variety *alpha*, collected at Waimanalo as fossils by J. F. G. Stokes and C. M. Cooke, Jr. Most bear raised spiral lines. One is only slightly angled at the periphery.

On the ridge trail at the head of Manoa, Cooke collected three nearly typical shells but a little closer to those from Puu Lanihuli and light yellow in color, a fourth rounded one, red with light flammules.

Light- and typical-colored shells were collected in the adjoining eastern valley, Palolo, by Cooke, Spalding, A. Gouveia, and C. F. Mant. Some are from the backbone of the main range at the head of the valley and are much like those from Puu Lanihuli. Others at lower elevations grade into more rounded forms, with slightly keeled periphery; a few are albino. They vary considerably in size and height of spire.

Farther east, in Niu, I. Spalding collected one small, well-rounded, nearly adult shell with slightly keeled periphery similar to some from low parts of Palolo. On the backbone of the Koolau Range, at the head of Wailupe Valley, A. Gouveia collected a few light-colored shells much like those from the heights at the head of Palolo Valley and smaller than those from Puu Lanihuli. The opercula are more pointed at the base than is typical, and most are apricot-yellow on the columellar edge. In Kuliouou, I. Spalding collected several small thin-shelled specimens with well-rounded bases, which range from having a sharp angle or slight keel at the periphery to a rounded periphery.

At Niniko, below Waipakiki Glen, C. M. Cooke, Jr., collected a few fossils, which vary in shape somewhat, most resembling the rather low form in Hillebrands Glen and nearly agreeing with the original drawing of *Helicina sandwichiensis*. In the D. D. Baldwin collection is a similar lot of shells from a gulch opposite the dam.

In Rooks or Waolani Valley, over the ridge from Niniko, J. C. Bridwell collected several specimens like those from Niniko. Like them, all do not have a distinct pattern, on some the flammules being most inconspicuous at the keel. Opercula in one lot are available, and they are like those of the species. Three juvenile shells collected by I. Spalding and R. von Holt should be grouped with these. They have raised spiral lines.

On the east side of Nuuanu Valley, opposite the forester's house, near a waterfall, Cooke found three small specimens. On the east side, also, in Glen Ada, Cooke and Forbes collected several lots of specimens, many of which are smaller and more rounded than the type. From between the first two waterfalls and at the entrance to the glen came several small-sized specimens grading somewhat toward *Pleuropoma laciniosa* variety *alpha*, at a waterfall one young shell, at the head of the glen and at the fork in the glen a few nearly typical specimens. Raised spiral lines and a double ridge at the periphery are present on some. A few opercula were examined and found to resemble those of the type. Juvenile specimens have thin raised spiral lines.

At Luakaha, both R. A. Cooke and C. M. Cooke, Jr., collected a few lots

of shells, three resembling the high, rounded, double or single-angled form from Glen Ada, one lot a low, sharp-angled form.

In Glen Elm, just above Glen Ada, Cooke collected four shells like those from Glen Ada.

In the valley adjoining Nuuanu, Kalihi, shells were collected resembling in shape those from Puu Lanihuli but running smaller and grading into the higher, smaller form from Hillebrands Glen. One to several raised spiral lines are evident on some below the periphery. They were collected by J. S. Emerson, M. Clough, O. Oswald, and C. F. Mant. Opercula were seen in one lot only, and they were rather large and narrow at the base, with nuclei parallel to the columellar edge.

The Lanihuli type was found in Kahauiki, the valley adjoining Kalihi on the west, by C. F. Mant and I. Spalding. Operculum well rounded and nearly straight across the top or upper palatal edge. One odd specimen has a very high spire.

On the ridge dividing Kahauiki from Moanalua, J. S. Emerson found on ti leaves on the ground several shells like those in Kahauiki. They have distinct flammules, the basal half of the last whorl is strongly convex, and on it spiral lines are evident. An average shell measures: diameter 3.9, height 2.5 mm.

On top of Mauna Kope, A. Gouveia found three specimens closely resembling those from Puu Lanihuli.

A much commoner form of *P. laciniosa* variety *sandwichiensis* than the type has a very convex base. Some lots of shells can be separated easily. The more convex kind has a rounder outline, the last whorl being strongly convex below, the peripheral keel less prominent, and the aperture more rounded. It tends to be higher and narrower, and many shells have a white basal callus. In other respects the typical and rounded forms are alike, and in many lots they intergrade. Most specimens came from Nuuanu Valley, possibly because collecting has been more intensive in that valley. The geographical range is from Nuuanu-Kalihi ridge to Pauoa. Many lots were collected in Hillebrands Glen, several by Cooke, one each by Forbes, A. Gouveia, and J. S. Emerson. A. Gouveia collected two closely related shells bearing the label "Nuuanu."

The shells vary considerably in size, height of spire, prominence of keel, convexity of whorls, some grading toward typical variety *sandwichiensis*, the juveniles toward variety *alpha*. The pattern of flammules is ordinarily present.

In Hillebrands Glen and on Mount Independence, at the head of the Glen, Cooke found rounded specimens, running small, mostly juvenile. Opercula, present in three lots, are like those of the species.

Just below Hillebrands Glen, J. S. Emerson collected a lot with some shells grading toward variety *alpha*. The opercula are like those of shells from Puu Lanihuli and run large. A shell without a label appears to be from Hillebrands Glen, as it closely resembles specimens collected there.

Above the high waterfall near Puu Lanihuli, Cooke collected several nearly adult shells, which are rather low and quite thin and transparent. At the foot of the cliff he collected well-rounded specimens.

In Waolani Valley, A. Gouveia found similar shells, as also did Cooke on trees on a ridge in a small valley above the head of Waolani Valley. Two opercula were found with them, and they are typical of the species.

Below "Dickey's camp," on the ridge above Waipakiki, Cooke collected a broad, moderately high specimen and above the camp two smaller ones.

In the center of Nuuanu Valley, a quarter of a mile south of the Pali, were collected high, well-rounded shells in the D. D. Baldwin collection, and at the reservoir a juvenile. Opposite the dam, I. Spalding collected several high-spined shells; on the ridge above Lulumahu, Cooke collected three.

Cooke also found in other parts of eastern Nuuanu juvenile small shells, on Mount Tantalus, on the northern and southeastern sides of the bowl, adult rounded ones, two with triply ridged periphery, and on the Pauoa side of Mount Tantalus two high ones with well-rounded bases.

In the first valley west of Nuuanu, Kapalama, some shells resembling those from near-by Mount Independence were found by O. Oswald and A. Gouveia. Only one operculum was found, and that was like those of the species.

Similar to these are several from Kamanaiki, the valley adjoining Kapalama on the west, collected by A. Gouveia, Mrs. E. H. Bryan, J. S. Emerson, and I. Spalding. Among them are a few narrow, high-spined shells, extreme variations of the high form. Opercula are like those of the species, most with nearly vertical nuclei, some with nearly flat inner side.

On the northwestern side of Kalihi Valley, O. Oswald collected three small, high-spined shells with typical opercula.

On Puu Konahuanui, the peak east of the Pali, several lots of shells were collected by C. M. Cooke, Jr., I. Spalding, C. N. Forbes, and E. Knudsen. They resemble shells collected on the peak across the valley, Puu Lanihuli, but run larger. The basal callus is thick and conspicuous. Some are typical of the species in appearance. Two or three lots include specimens that are lower and wider, and one lot includes three remarkably large shells, the largest measuring: diameter 4.7, height 3.5 mm. The opercula in one lot only are available.

On the ridge extending from Puu Konahuanui to Nuuanu Pali, near the two cuts in the ridge and half-way up, C. N. Forbes collected several rather

small, nearly typical shells, with well-rounded bases. In the valleys below "ridge 7" and at its head, on the eastern side of Nuuanu, he and Cooke collected some larger, quite similar shells. These are, however, thinner and have a prominently rounded base, large aperture, and high spire. The operculum is large and broad and the nucleus decidedly oblique. One similar lot of smaller shells came from an undesignated locality in Nuuanu Valley. One large fossil specimen was collected by Cooke in a road cutting on Ferdinand Street.

Other large shells were found in other parts of Nuuanu. At the entrance to the valley below the waterfall, near Puu Lanihuli, Cooke found a few, the largest measuring: diameter 4.6, height 3.3 mm. Somewhere in the valley, W. D. Wilder collected some large high shells with well-rounded bases, and on the western side of the Pali, A. Gouveia collected some larger and wider. Similar shells were collected by Forbes and Spalding and Gouveia farther to the west, in Waiau Valley, two with more conical spires and prominent keels in Kahauiki. The opercula belonging to one lot of shells from Waiau are large, long, reddish (especially on the columellar edge); they have slanting nuclei and an elevated area between nucleus and columellar edge. Opercula of the shells from Kahauiki are broad, thin, nearly flat, and tinged with red.

On Mount Tantalus, on the northern outer edge, Cooke also collected a large shell. At the head of Pauoa and Nuuanu valleys, Spalding found one large shell. Similar but flatter in the umbilical region are three collected by Forbes half-way up the eastern side of the Pali. In upper Lulumahu, Forbes collected two large, otherwise nearly typical specimens.

In localities on the east side of Nuuanu a few specimens of variety *sandwichiensis* were found by Cooke, several on Mount Tantalus, three at the base of Manoa Valley. One lot on the northern side of Tantalus crater resembles the neotypes; but they are sharper-keeled, slightly lower and wider, and have a whitish callus. Like these are four from southeastern and eastern sides of the crater, two from a small valley behind the crater, and also those from the mountains at the head of Manoa Valley taken on the fourth subridge from Puu Konahuanui on the trail to Mount Olympus.

Some juvenile fossils were collected by Cooke near Manoa Road with very low, flattened spires and sharply angled peripheries. They suggest *P. oahuensis* from the Waianae Mountains, but are higher and have more convex whorls.

Shells resembling some of those from Mount Tantalus are from O. Oswald, who found them on the slope between Nuuanu Pali and Puu Konahuanui.

Modified forms of shells from Puu Lanihuli were collected by A. Gouveia on the ridge separating Hillebrands Glen and Kapalama. They are smaller

and distinctly keeled, and some have the flattened base of typical variety *sandwichiensis*. In the Cooke and D. D. Baldwin collections also are four flattish ones but with periphery unkeeled.

Farther west, specimens approaching the typical were found. In Aiea, Cooke collected two specimens, an adult and a juvenile, which are nearly typical, possibly slightly narrower.

At Waimalu, A. Gouveia collected several large, strikingly typical specimens but with periphery bearing prominent keel.

In a lot collected by Baldwin from "Oahu" are 6 shells, 3 larger—approaching variety *gamma*—and 3 smaller than typical, which resemble specimens from this part of the island.

Still farther west, at Waimano, W. D. Wilder and I. Spalding collected shells that tend to have higher spires, more convex base, heavier shells, and thicker basal callus. A single incomplete operculum seems like those in shells from Manana.

In the adjoining valley on the west, Spalding collected somewhat rounder shells, with keel less prominently angled. The opercula are typical except in size, being rather larger than ordinary.

What appears to be a juvenile specimen of variety *sandwichiensis* was collected by Gulick several valleys farther westward, at Kalaikoa.

Northwestward, in Kaipapau Valley, Cooke collected fossil shells that differ from the type in being smaller and comparatively lower.

On a ridge at Kaaawa, A. Gouveia collected a living specimen that seems closest related to shells from Nuuanu and Mount Tantalus, though the peripheral angle is well-rounded. It has 4 whorls, a few impressed spiral lines, and is a uniform cinnamon-buff in color. It measures: diameter 3.1, height 2.1 mm. Operculum not removed from shell.

A dead shell collected in Kaneohe Bay on Kapapa Island by T. T. Dranga is much like the live one from Kaaawa. Both shells approach variety *signata*.

Pleuropoma laciniosa variety **alpha** (Pilsbry and Cooke) (figs. 56, 57).

Helicina laciniosa variety *alpha* Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 7, 1908.

Sturanya laciniosa alpha (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 5, 1928.

Original description:

The shell is globose-conic, with the periphery strongly angular, quite smooth, striate with lines of growth and encircled with 5-7 impressed spiral lines, the two most prominent being just above and below the peripheral keel. Color a nearly uniform light cinnamon red with a slight suffusion or spotting from incipient surface decay, sometimes broken by very indistinct lighter flammules. Spire straightly conic, apex rather acute. Suture scarcely impressed, indistinctly margined. Whorls nearly 4, almost flat, the

embryonic very minutely transversely striate, the last nearly flat above the strongly angular periphery, very convex below it, slightly descending in front. Aperture oblique, subtriangular, not contracted; outer lip thin. Callus quite thick, whitish about the axis, the rest nearly transparent, minutely punctate. Operculum reddish corneous, thin, very minutely punctate. Maj. diam. 3.2, total length 2.6 mm.

Oahu: Mt. Tantalus (Cooke).

Type No. 14,904, Bishop Museum.

This variety comes nearer the true *H. laciniosa* in form and sculpture than any of the other varieties of this species mentioned herein. It differs in its higher spire and smaller size. It is intermediate between *H. laciniosa* Migh. and *H. sulculosa* Ancey.

The types were collected by C. M. Cooke, Jr., on a ridge in the Tantalus region at the source of Makiki Valley. They vary in shape somewhat, especially in height and in angulation of the peripheral keel, extremes being well-rounded and distinctly ridged. Some have well-rounded upper whorls due to a deeper suture than in the type. The descending of the last whorl near the aperture causes the peripheral keel to pass through a little below the middle of the penultimate whorl at that point in the type, in other specimens similarly or nearer the suture of the last whorl. Paratypes are smaller than the type. The umbilical callus runs slightly smaller than that of variety *ferruginea* but is similar to it.

P. laciniosa variety *alpha* grades into variety *sandwichiensis*, though for the most part specimens of variety *alpha* have a more rounded periphery with a less distinct angle and a comparatively higher spire.

In a small valley behind Tantalus crater, Cooke found nearly typical shells, running slightly lower and more distinctly keeled than the type. Inside the crater he found several that range from distinctly to indistinctly keeled. On the Tantalus side of Pauoa Valley and in Nuuanu, a few lower or smaller than the type—like some of the paratypes—were collected by Cooke, one by A. Gouveia and two in the Cooke collection, and in another lot several nearly typical but smaller and comparatively wider.

Several shells collected by D. Thaanum, bearing the label "Oahu," resemble the paratypes. Most have a ridged peripheral keel and are lower. Opercula are nearly like those of the species but smaller, plain yellow, and upper palatal edge inclined to slope downwards to a more rounded angle.

Typical to low specimens with rather large apertures, grading toward variety *sandwichiensis*, were collected in Waialaeiki Valley by J. C. Bridwell, in Waialae by A. B. Lyons and in the Cooke collection, in Niu Valley by W. D. Wilder, on the main Koolau Range, Wailupe, by A. Gouveia. A single operculum in a shell from Niu resembles those in the shells labeled "Oahu," as also do two in shells from Wailupe.

In Palolo, shells collected by Cooke and Spalding differ from the paratypes chiefly in having a distinct keel on the peripheral angle. Most also

have deeper sutures and more rounded upper whorls and tend to be greater in width.

An indistinct keel and rounded outline are the outstanding characters of two shells collected by A. Gouveia on the eastern side of Maunalua. Otherwise they closely resemble the paratypes.

On the Pauoa slope of Mount Tantalus, just below the middle of the saddle, Cooke collected a large lot of specimens running larger and either higher or wider than the type, most with distinctly ridged keel, a few with a tendency toward a double keel. In Pauoa, D. Thaanum collected a few like them. Opercula are similar to those in shells labeled "Oahu," though slightly larger and some with reddish columellar edge.

In Nuuanu, shells similar to those from the Pauoa slope of Mount Tantalus were collected by C. M. Cooke, Jr., and C. N. Forbes, including two peculiar high ones, from Hillebrands Glen, which have the peripheral angle rising above the whorl below, in all but the first whorl. In the Cooke collection is one specimen labeled "Nuuanu?" that fits well here.

Two lots from Glen Ada collected by Cooke include some high specimens. Six in a lot in the Garrett Collection resemble those from Glen Ada. The lot bears the label "*Helicina laciniosa* Mighels, Hawaii, Sandwich Isles." The few opercula available are mostly like those in shells from Pauoa slope of Mount Tantalus; some have more oblique nuclei.

On the western slope of Manoa Valley, in cuttings along Manoa Road and near it, C. M. Cooke, Jr., found deposits of fossil shells that are evidently variety *alpha*. They are similar to the paratypes from Mount Tantalus, but run smaller and lower. Two specimens are accompanied by opercula which though worn appear to be typical. Similar fossils were found by Cooke on Rocky Hill. A few dead typical shells were found by O. Oswald two thirds of the way up the western side of Manoa Valley under kukui trees. Over the ridge in sand dunes at Waimanalo, J. F. G. Stokes found a fossil specimen like some in Manoa, having an angled periphery and shallow sutures.

Other similar fossils, some much worn, were collected east of Manoa. Some in a road cutting at Kahala were found by C. M. Cooke, Jr., some in the region of Koko Head by C. N. Forbes and Elizabeth Shepard, others on Wailupe flats by A. Gouveia. Among them are shells patterned with fine zigzag lines and shells with a more definite peripheral angle than others. They approach in appearance variety *pusilla*, but have a more rounded outline.

Pleuropoma laciniosa* variety *gamma (Pilsbry and Cooke) (fig. 58).

Helicina laciniosa variety *gamma* Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 6, fig. 3, 1908.

Sturanya laciniosa gamma (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

The shell is biconic, acutely carinate at the periphery, nearly smooth, finely striate with lines of growth, without spiral lines, but distinctly impressed just above and below the peripheral keel. Color light cinnamon, nearly uniform, overlaid with a thin yellowish cuticle. Spire depressed-conic, apex subacute. Suture simple. Whorls 4, nearly flat, the embryonic nearly smooth, the second and third slightly convex, the last flat above the carinate periphery, convex below, descending slightly in front. Aperture oblique, subtriangular, not contracted; outer lip with a thin edge. Callus thick and whitish about the axis, the rest very thin and transparent, minutely punctate. Maj. diam. 5.0, total length 3.5 mm.

Oahu: Ewa (Cooke), Wahiawa (Lyman, Cooke).

Type No. 14,902, Bishop Museum.

This is one of the most distinct of the varietal forms of *laciniosa*. The relatively high spire and pronounced carination easily distinguish it from the other varieties.

This is a form of *Pleuropoma laciniosa* found in several parts of Koolau Range, mostly near the central part. It is a Koolau representative of variety *ferruginea*, and it is ordinarily comparatively higher and narrower than that variety. In some specimens the keel tends to curve upwards, a characteristic of *P. oahuensis*. In color a dark reddish is common, and flammules are conspicuous. The umbilical callus is small, as in variety *spaldingi*. The paratypes are either lower-spired or smaller than the type. Opercula of two lots were examined and found to resemble those of the species. Most are very large, have rather slanting nuclei, and on the inner side are slightly elevated between the nucleus and columellar edge.

Type and paratypes are from Aiea, in the Cooke collection. Other specimens from Aiea vary considerably in height, from as high as the type to lower than variety *ferruginea*. Collectors were C. M. Cooke, Jr., I. Spalding, and A. Gouveia.

In the next valley to the northwest—Kalauao—W. D. Wilder collected typical shells, and in Waipio Valley Forbes collected a similar one. In adjoining Waimano Valley, Forbes and Cooke collected several fossil shells, which are rather low, sharply keeled, slightly double-keeled. The keel curves upward, and the upper part of the last whorl is somewhat concave. The earlier whorls are flat. Otherwise the shells resemble low forms of this variety. At Wahiawa were found three small high shells, which came from the Cooke collection. Farther northwestward, I. Spalding collected two specimens resembling the fossil ones from Waimano in having a double keel, which is, however, less prominent. Also the shells are higher spired.

A small juvenile specimen like the double-keeled ones from Ahonui was collected in the gulch east of Opaepa by I. Spalding. Nearby, at Poamoho, W. D. Wilder collected three sharp-angled specimens, which do not have

distinct keels. Their shells are rather thick and bear below the periphery 3 raised spiral lines. They have 4 to 4½ whorls. Otherwise they resemble the paratypes of variety *gamma*. Like the shells from Poamoho, though thinner, are three collected in Waialua by Lyman.

East of Aiea some specimens of variety *gamma* were collected at Halawa by D. Thaanum and W. D. Wilder, thicker walled and larger than the type, some comparatively wider. Father east, at the summit of Mauna Kope, A. Gouveia collected a specimen that is nearly typical, though lower than the type. The operculum is like those in specimens from Aiea.

In Nuuanu, C. N. Forbes collected some variety *gamma*, one with convex whorls, several others (taken on the eastern side of the Pali near the two cuts in the ridge) like the paratypes. From the shells resembling the paratypes opercula were removed and found to be like those belonging to shells from Aiea.

On Mount Tantalus, Cooke found two juvenile specimens that are nearly flat on top, above the periphery forming a very broad, low cone with slightly convex whorls, like *P. oahuensis*, having a typical base below the periphery. Their opercula are flat across the broad top part, are large, and have somewhat slanting nuclei near the center. Two more immature specimens found on the Tantalus side of Pauoa by Cooke resemble those from Mount Tantalus, combining characters of *P. oahuensis* and *P. laciniosa* variety *gamma*.

At the head of Wailupe, on the backbone of the Koolau Range, A. Gouveia collected two adult shells with rather convex whorls and two juvenile shells with comparatively lower spires and quite prominent keels, the last like a juvenile found in the central division ridge in Wailupe by Spalding. The only available operculum is flat across the broad upper palatal edge and has a slanting nucleus near the center.

In the Waianae Mountains, in Ewa and Haleauau, and on top of Puu Kaala, a few specimens were collected by I. Spalding and E. Lyman that are obviously variety *gamma*. They have considerable range in height and size, and those from Ewa are rather thin.

***Pleuropoma laciniosa* variety *signata*, new variety (fig. 59).**

Fossil. Similar to varieties *pusilla* and *alpha*, except that the periphery is rounded and unangled, the upper whorls are very convex, the flammules are distinct, and spiral lines are evident on some. Superficially they look like intergrades between *Orobophana uberta* variety *lymaniana* and *Pleuropoma (Sphaeroconia) rotelloidea*, but differ from those species in having flammules in a zigzag pattern, 4 whorls, which increase more slowly, flatter base, umbilical callus much like that of *P. laciniosa* variety *ferruginea*, wider columellar fold. A very slight, dimple-like indentation is visible around the periphery of many. One of the largest shells measures: diameter 3.1, height 2.2 mm. They vary considerably in size and in height of spire. The type measures: diameter 2.8, height 2.1 mm. Operculum wanting.

Oahu, Malaekahana, April 6, 1917, C. M. Cooke, Jr., type no. 11252, paratypes no. 44789. Several lots were collected by Cooke at Malaekahana. Included with some lots is a small form with low spire, tighter whorls (especially the last), finer flammules. They differ from variety *perparva* in being smaller, lower-spired, smoother, unangled. Two fossil lots of these, mixed with the larger form, were found by Cooke at Laie. One of the largest specimens measures: diameter 2.7, height 2 mm.

With specimens of *Orobophana uberta* variety *exanima* from Kahuku, found as fossils in a coral hill, Cooke collected a large lot of shells like the larger size of *Pleuropoma laciniosa* variety *signata* from Malaekahana. A few are extraordinarily large and have spiral lines evident on the last whorl. The largest measures: diameter 4, height 2.6 mm. Not running quite so large are a few from Paumalu. In Waialae Valley, Cooke found a smaller, slightly angled specimen with distinct spiral lines; it measures: diameter 3, height 2 mm.

At Punaluu and Kaipapau, Cooke found deposits containing shells resembling those from Laie and Malaekahana. More rounded and higher-spired are two shells collected alive by O. Oswald in Kahana Valley. About 6 impressed spiral lines are visible on the last whorl. The periphery has a slight angle, which continues on the penultimate whorl a short way, rising above the last whorl. The aperture is very oblique and rather small. The color is uniform cinnamon rufous. In other ways the shells resemble fossils from Punaluu.

In Kaaawa, Oswald found a few dead and living shells—most wider and with larger apertures, approaching *P. (Sphaeroconia) rotelloidea*, some with zigzag patterns, some with flatter whorls. In one lot the shells are extraordinarily large. In Kualoa mountains, Oswald found shells like those from Kaaawa. Opercula accompany the shells from Kaaawa and Kualoa mountains, and they are like those of the species but smaller.

***Pleuropoma laciniosa* variety *perparva*, new variety (figs. 60, 61).**

Small fossil shells. The type measures: diameter 2.8, height 2 mm. Whorls 4; upper slightly convex, suture shallow; last whorl swollen and rounded, peripheral angle high, rising above the penultimate whorl, round-ridged, succeeded below by two similar spiral ridges. Growth striae distinct and regular. Flammules rather fine, visible on last 2 whorls. Basal callus distinct, small; umbilical callus large, semicircular. Variations from these characters are considerable. Ridges range from 1 to 5, sutures vary in depth, and spires vary in height. In a sandstone bluff a quarter of a mile back of Kailua beach, the shells have spires consistently higher. Operculum wanting.

Oahu, Kawailoa (Kailua), April 20, 1912, J. F. G. Stokes, type no. 11253, paratypes no. 77635.

In several localities in Kailua large series of this small fossil shell were found by J. F. G. Stokes, C. M. Cooke, Jr., I. Spalding, and H. A. Pilsbry.

Though similar in size to variety *signata*, they differ in some other characters, having an angled periphery and spiral lines around the periphery. They seem most nearly related to representatives of variety *alpha* from Nuuanu and the surrounding region and are sculptured like fossils of variety *sandwichiensis* from Punchbowl. They are smaller and lower than variety *alpha*.

Pleuropoma laciniosa Mighels variety **delta** (Pilsbry and Cooke) (figs. 62, 63).

Helicina laciniosa Mighels variety *delta* Pilsbry and Cooke: Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 5, 6, fig. 2, 1908.

Sturanya laciniosa delta (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

The shell is somewhat lenticular, carinate at the periphery, striate with lines of growth, with 4-6 low and not very conspicuous spiral ridges grouped above and below the peripheral keel. Bright red, distinctly and closely marked with numerous zigzag yellowish-white flammules. Spire depressed conic, apex subacute. Suture lightly impressed, margined above. Whorls $4\frac{1}{2}$, nearly flat, the embryonic smooth, the penultimate slightly projecting, the last flat above the carinate periphery, slightly convex below, not descending in front. Aperture oblique, semicircular-triangular, not contracted; outer lip with a thin edge. Callus thin, whitish about the axis, the rest transparent, minutely punctate. Operculum corneous, thin, minutely punctate.

Maj. diam. 4.4, total length 2.9 mm.

Kauai: Ekaula, below Puukapele.

Type No. 14,901, Bishop Museum.

This variety somewhat approaches *H. oahuensis*. It is, however, quite closely related to *H. laciniosa*. This is the nearest relative to *laciniosa* so far reported from the island of Kauai.

Besides type and paratypes collected at Ekaula, Kauai, C. M. Cooke, Jr., also collected 3 similar specimens about 2 miles to the east, at Puu Ka Pele, where later Marie Neal found 2 more. Thus, aside from the type and 12 hardly adult paratypes, few specimens have been taken near the type locality.

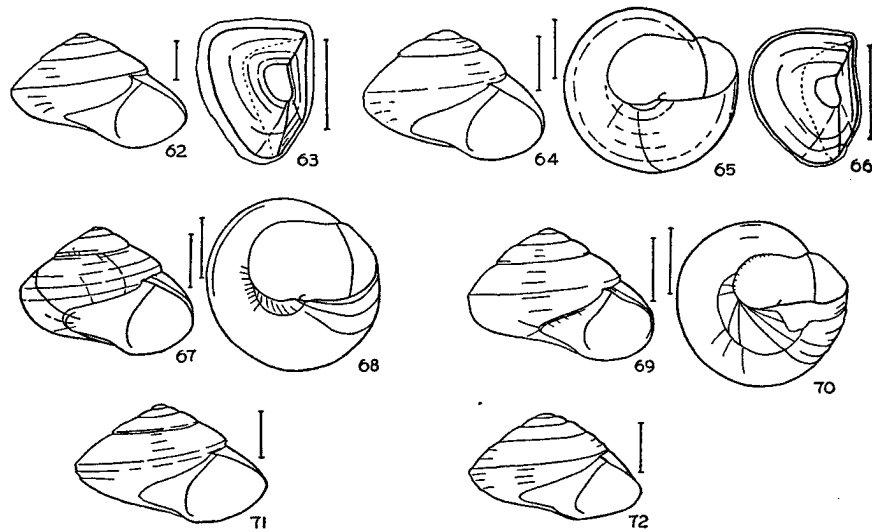
The shells are fairly uniform in size and appearance, though two have well-rounded keels. The spiral ridges are not evident on some and do not exceed 2 or 3 above the peripheral keel. In color they range from cinnamon-rufous to vinaceous rufous, solid in the first whorl or two and marked with many cream-colored zigzags down to about the last quarter whorl, where cream color predominates. Umbilical callus medium-sized, much as in *P. laciniosa*. Operculum wanting.

Several specimens were found on the northern side of Kauai. A description of one lot collected by W. H. Meinecke in Hoolulu follows:

Shells much like variety *canyonensis*. The periphery more sharply angled and not biangled, and the penultimate whorl inclined to blouse distinctly above the last whorl. They are a little smaller, an average one measuring: diameter 4.2, height 2.8 mm. The impressed spiral lines resemble those of *Orobophana baldwini*, 2 or 3 being present both above and below the periphery. The color is vinaceous rufous, in some grading to salmon

color; zigzag bands are distinct and are fine or broad and blended; some shells are cream color.

Opercula are like those of typical *P. laciniosa* but with a deep indentation at the base and a sharper palatal angle; the nucleus is higher; the red area on the columellar side ordinarily wider. The operculum illustrated (fig. 63) is from a shell from Hoolulu.



FIGURES 62-72.—Varieties of *Pleuropoma laciniosa* from Kauai and Niihau: 62, 63, *P. laciniosa* variety *delta*, type, no. 14901, shell; no. 86509, operculum; 64-66, *P. laciniosa* variety *praeparva*, type, no. 11244, shell, front view; paratype, no. 81256, shell, bottom view; no. 11176, operculum; 67, 68, *P. laciniosa* variety *globuloidea*, type, no. 11214; 69, 70, *P. laciniosa* variety *matutina*, type, no. 11215; 71, *P. laciniosa* variety *canyonensis*, type, no. 11212; 72, *P. laciniosa* variety *kiekieensis*, type, no. 11235. The dull area on opercula is outlined by a broken line. The measure indicates 1 mm.

Besides a few specimens from Hoolulu, one similar shell was collected near Halulu Falls, Hanakoa, first valley to the west, by Eric Knudsen and W. F. Frear. At the first valley to the east of Hoolulu, Hanakapiai, P. G. H. Deverill, Eric Knudsen, and W. F. Frear found 18 shells much like the type, but thinner and with a yellowish cast.

In Haena, another valley to the east, C. M. Cooke, Jr., found shells like those from Hanakoa but with more compact whorls and slightly smaller. Between Haena and Hanakapiai he also collected two shells closer to those from Hanakapiai than those from Haena. Operculum typical of the species. At Kalihikai, Cooke also found one fossil juvenile specimen much like specimens from Haena; Meinecke, one juvenile.

Mixed with specimens of *P. (Sphaeroconia) hawaiiensis* in the Garrett collection are three closely resembling specimens of *P. laciniosa* variety *delta*

from northern Kauai. The shells bear the label "*Helicina rotelloides* Mighels, Kauai, Sandwich Isles." At Limahuli, C. M. Cooke, Jr. and C. S. Dole each found a shell resembling variety *delta* but somewhat larger, average measurements being: diameter 4.5, height 3 mm. They seem to have but a single ridge on the periphery. But as the shells are fossil and the color and finer sculpturing are lost, the exact appearance of the shells is not known. At Waiahuakua, Hoolulu, and Haena, three shells were collected by W. H. Meinecke and T. T. Dranga that are of the same kind, one having a distinct double peripheral ridge. These shells include some that seem to grade toward *Orobophana meineckeii*, which are much larger.

Among a meager collection of land shells from Niihau are two fossils collected by J. F. G. Stokes, at Kiekie, on the southwestern shore. They are in one lot (no. 37756) and are like *Pleuropoma laciniosa* variety *delta* from Kauai, one having a rather large aperture; the other, an immature specimen, having a small aperture and low spire. Though both are bleached, the typical zigzag markings show distinctly.

***Pleuropoma laciniosa* variety *praeparva*, new variety (figs. 64-66).**

Differing from variety *delta* in size, being considerably smaller, and in shape, being comparatively higher and rounder. The type measures: diameter 3.2, height 2.2 mm. All the whorls are more convex—a peripheral angle is slight—and the shells are so thin as to require much care in handling. Six or more spiral lines are visible on the last whorl, as is also a fine zigzag pattern of alternating cream color and cinnamon-rufous. Whorls $3\frac{1}{2}$. Umbilical callus lacking or very narrow. Opercula are like those of typical *P. laciniosa* from the Waianae Mountains, Oahu, though the columellar edge is more sinuous. They are smaller than opercula of variety *delta* and more nearly oval.

Kauai, Wailua River, near north fork, October 27, 1925, C. M. Cooke, Jr., and T. T. Dranga, type no. 11244, paratypes no. 81256.

Only a few specimens of this variety were found. Compared with variety *globuloidea*, the shells are similar in size but less compact, the apertures larger. Compared with *P. (Sphaeroconia) kauaiensis*, the whorls are much flatter.

***Pleuropoma laciniosa* variety *globuloidea*, new variety (figs. 67, 68).**

Shells small, high, and rounded, having an indistinctly rounded keel and flattened whorls, in some angled just above the suture. The type measures: diameter 3.2, height 2.2 mm. The surface is smooth and shining. The color is ochraceous tawny, on the last 1 or $1\frac{1}{2}$ whorls kaiser-brown, with several zigzag lines in cream color. About 4 impressed spiral lines are visible at the angle and upper half of the last whorl. Whorls 4, gradually increasing, seemingly angled due to peripheral angle's being visible on two or three of the lower whorls. The suture is shallow. Peripheral angle not distinct, in some specimens faintly biangled. The aperture is small, oval, slightly oblique, thin-lipped due to the outer layer ending shortly before reaching the lip. Basal callus thin, finely punctate. Umbilical callus distinct and rather small.

Operculum like those of typical *laciniosa* but a little smaller; also like variety *delta* from northern Kauai, but smaller, upper palatal angle more rounded, and base not in-

dented. Red area wide on columellar edge. Nucleus near the center, inner surface nearly flat, S-ridge only faintly indicated, even in lower half.

Kauai, Nonou mountains, southwest side, October 21, 1925, C. M. Cooke, Jr., and T. T. Dranga, type no. 11214, paratypes no. 80897.

Several shells of this species were collected in the Nonou mountains, in general appearance resembling *P. (Sphaeroconia) kauaiensis*, but with shallower sutures. This species has affinities with *P. laciniosa* variety *delta*.

At Papaa, about 10 miles north of the Nonou mountains, D. Thaanum found one specimen much like those from the Nonou mountains but slightly larger (diameter 3.4, height 2.3 mm). In Waipa, W. H. Meinecke found three fossil specimens resembling live shells from the Nonou mountains. They have a more rounded and flaring aperture and slightly higher spire. They are well bleached, and no pattern is visible.

***Pleuropoma laciniosa* variety *matutina*, new variety (figs. 69, 70).**

Fossil. Shells high pyramidal, rounded. The type measures: diameter 2.8, height 2 mm. They are of medium thickness and are smooth except for 2 or 3 narrow spiral ridges running both above and below the periphery, those above being visible also on the penultimate whorl of some shells. As they are fossils, the color is not known, but the last 2 whorls have a pattern of fine zigzag lines. Whorls 4, slightly convex, slowly increasing, the ridgelike keel on the last whorl rising on many above the sutural margin of the penultimate whorl. Suture rather shallow. Aperture flaring, oval; lip thin, not expanded, wrinkled on top. Callus at aperture transparent and finely punctate in freshest specimens; umbilical callus a broad, large crescent, in the type nearly equalling half a circle. Operculum wanting.

Kauai, Koloa, Mahaulepu, dune near Kapunakea Pond, January 30, 1916, J. F. G. Stokes, type no. 11215, paratypes no. 52121.

In sand dunes at Mahaulepu, J. F. G. Stokes first found this small species of fossil shells, and later in near-by localities C. M. Cooke, Jr., found several more. They resemble variety *globuloidea* but are smaller and have not only distinct keel at the periphery but also distinct, raised spiral lines. The shells do not vary much in size and shape.

***Pleuropoma laciniosa* variety *canyonensis*, new variety (fig. 71).**

Resembling variety *delta* in many features. A biangled keel at the periphery is evident in most specimens on all the whorls, raising each whorl above the following one. The type measures: diameter 4.1, height 2.6 mm. It has 4 whorls. Basal callus thin, umbilical callus short and narrow, as in variety *praeparva*. Operculum wanting.

Kauai, Olokele Canyon, September 18, 1921, Marie Neal, type no. 11212, paratypes no. 58622. In Olokele Canyon 14 specimens were collected.

Between Lihue and Koloa, W. H. Meinecke found a single nearly adult shell with a somewhat rounded keel, whorls lying nearly in the same plane, and having broad zigzag markings; but resembling in other features the shells

from Olokele. The operculum resembles those of variety *delta* from northern Kauai.

At Kilohana, Lihue, C. M. Cooke, Jr., collected one specimen very similar to that found between Lihue and Koloa, but larger, fully adult, and with a yellow cast.

Pleuropoma laciniosa variety **kiekieensis**, new variety (fig. 72).

Fossil. Low cone-shaped, 4 slightly convex whorls, slightly indented suture, small and very oblique aperture, flattened base, umbilical callus about equal to a quarter of a circle, like that of variety *globuloidea*, from Nonou mountains, Kauai. The peripheral angle is sharp and keeled. Though bleached the surface bears zigzag markings, transparent and opaque white areas alternating at the suture of the last two or three whorls. The type measures: diameter 3.4, height 2.1 mm. Operculum wanting.

Niihau, southwestern shore, at Kiekie, January, 1912, J. F. G. Stokes, type no. 11235, paratypes no. 37753.

Compared with specimens of *P. laciniosa* selected as typical, this variety is lower-spined, has a smaller aperture, and has about the same thickness of shell walls. It seems to be a depauperate form of *P. laciniosa*. The paratypes vary in size and in height of spire. Most are smaller than the type, some comparatively higher. In another lot from the same locality are a typical adult shell and a juvenile. All specimens were collected by Stokes except a single low-spined juvenile from Halehaa, collector unknown.

Pleuropoma laciniosa variety **molokaiensis**, new variety (fig. 73).

The type has a low cone-shaped, rather thin shell, rounded apex, shallow suture, rounded last whorl, and slightly convex upper whorls, which number $3\frac{3}{4}$. The peripheral angle is emphasized by a rounded keel. Four shallowly impressed spiral lines are faintly visible on the base of the last whorl. Continuously, from the apex down near the aperture, 2 impressed spiral lines are visible. The color pattern consists of broad zigzag bands of kaiser-brown on a background of cinnamon-buff. The pattern is clearest on the last whorl, fading near the aperture to the lighter color. The aperture is large, oblique, oval. The umbilical callus is a narrow, white crescent equal to about a quarter of a circle, quite like that of variety *spaldingi*. The shell measures: diameter 3.4, height 2.3 mm. Opercula of paratypes resemble those of the species.

Molokai, east-central mountains, Waikolu Valley, above Kaluahauoni, January 3, 1910, C. M. Cooke, Jr., type no. 11231, paratypes no. 20409.

Much like variety *piliformis*—the dominant form of Helicinidae on Lanai—and variety *honokowaiensis*—dominant on west Maui—are a number of lots of shells on Molokai. Lower-spined than the type of variety *piliformis* and with a longer and comparatively larger aperture. With the neotype of *P. laciniosa* from the Waianae Mountains, Oahu, they agree closely in size and general appearance except that they have a rounder periphery and a longer and more nearly oval aperture. They approach even nearer forms of variety *alpha* from eastern Oahu, especially forms with a large aperture. Characters

differing from the type of variety *konaensis*, from the island of Hawaii, are like those which distinguish variety *molokaiensis* from typical *P. laciniosa*.

Most specimens were collected by C. M. Cooke, Jr., a few by D. Thaanum, A. F. Judd, C. N. Forbes, H. A. Pilsbry, and A. M. Adamson.

The paratypes and other specimens from Waikolu differ somewhat from the type in distinctness of color pattern, height of spire, and size. Some shells have less oblique, more rounded or flaring aperture, more distinct spiral lines. One lot collected in a valley in Kamalo consists of shells slightly smaller and comparatively higher than the type and with more pointed apices. At Waihii, near the edge of the ridge looking down into Waihanau, west of Waikolu, were collected typical specimens. Just east of Waihii, on the ridge at Waileia, a uniformly colored shell with flaring lip was collected. Shells like that from Waileia but smaller were collected near Waikolu, at Kamoku. What seems to be a juvenile specimen of this variety was collected at Ohialele.

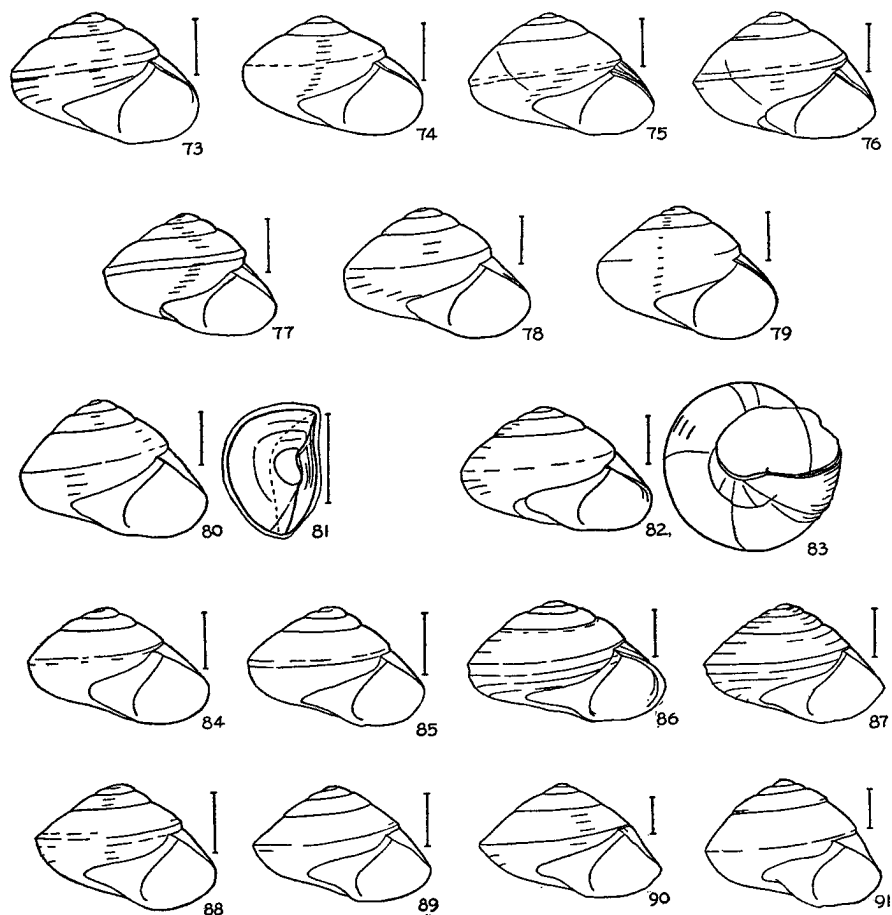
A few small shells with flaring aperture were collected between Waihii and Kamoku, at Maunahui. At Waihanau two shells slightly smaller than typical were collected. At Poholua were collected low, wide shells. Much like them are some immature brick-red specimens from Kaunakakai. At Kaluaaha, on the southeast end of Molokai, six typical shells were collected. In the collection from D. D. Baldwin are three specimens labeled "Molokai" only, which are typical. At the extreme eastern end of Molokai, in Halawa Valley, shells were found varying from the type in size, being much smaller. Both living and fossil shells of this kind were taken.

The opercula show considerable variation. Some have a rounder outline on the palatal edge than others; some are uniform in color and more or less transparent; some are comparatively short and wide. Most nuclei are parallel with the columellar edge or only slightly oblique to it. In color, opercula and shells harmonize, dark shells having dark opercula, light shells light opercula.

Farther west, at Iliilika, a local variation is seen in shells with aperture more flaring and last whorl less rounded than is typical. Similar specimens were collected in the valley to the south, Kalamaula, a few from an elevation of 2,200 feet being exceptionally large. Over the ridge at Kalaupapa, near the bottom of the trail, fossil juvenile shells were collected with characters similar to those of shells from Iliilika. In the eastern half of Molokai, in Makolelau Valley, fossil shells were found that resemble those from Kalamaula but have a smaller aperture, some only a slightly angled periphery.

***Pleuropoma laciniosa* variety *molokaiensis* form a (fig. 74).**

Similar in most ways to variety *molokaiensis*, but smaller and with periphery less distinctly keeled than the type of the variety. The type measures: diameter 3, height 2.1



FIGURES 73-91.—Varieties and forms of *Pleuropoma laciniosa* from islands south of Oahu: 73, *P. laciniosa* variety *molokaiensis*, type, no. 11231; 74, *P. laciniosa* variety *molokaiensis* form *a*, type, no. 11232; 75, *P. laciniosa* variety *moomomiensis*, type, no. 11233; 76, *P. laciniosa* variety *honokowaiensis*, type, no. 11219; 77, *P. laciniosa* variety *kulaensis* type, no. 11220; 78, *P. laciniosa* variety *kulaensis* form *a*, type, no. 21437; 79, *P. laciniosa* variety *kulaensis* form *b*, cotype (larger of two), no. 56319; 80, 81, *P. laciniosa* variety *piliformis*, type, no. 11222, shell; no. 34300, operculum; 82, 83, *P. laciniosa* variety *piliformis* form *a*, type, no. 11223; 84, *P. laciniosa* variety *kaaensis*, type, no. 11224; 85, *P. laciniosa* variety *kaaensis* form *a*, type, no. 11225; 86, *P. laciniosa* variety *kahoolaweensis*, type, no. 11239; 87, *P. laciniosa* variety *konaensis*, type, no. 11226; 88, *P. laciniosa* variety *konaensis* form *a*, type, no. 11227; 89, *P. laciniosa* variety *konaensis* form *b*, type, no. 11228; 90, *P. laciniosa* variety *konaensis* form *c*, type, no. 11229; 91, *P. laciniosa* variety *konaensis* form *d*, type, no. 11230. The dull area on operculum is outlined by a broken line. The measure indicates 1 mm.

mm. The opercula of the paratypes are smaller and comparatively narrower than those of variety *molokaiensis*.

Molokai, Kawela Valley, August 6, 1912, C. M. Cooke, Jr., type no. 11232, paratypes no. 24486. Most shells were collected by C. M. Cooke, Jr. Some are lower and smaller than the type. Nearly typical of the form are some from Waihii, in the mountains northwest of Kawela. Near the head of Kawela Valley, at Hanalilolilo, three specimens with higher spires were collected. At Kamiloloa, a few valleys west of Kawela, A. F. Judd collected shells with higher spires, more pointed apices, and deeper sutures. In general they have a more angular appearance. Somewhat similar to those from Kamiloloa are a few from Puu Kolekole, a point east of Kawela. Also similar is a fossil from near sea level at Kaluaaha, a valley to the east of Puu Kolekole. Opercula are like those of the variety, though smaller.

***Pleuropoma laciniosa* variety *moomomiensis*, new variety (fig. 75).**

Fossil. The type has a little more than 4 whorls, which are nearly flat and are separated by a suture that is only slightly impressed. It is thoroughly bleached and does not show evidence of a pattern. On the lower half of the last whorl, below the peripheral angle with its rounded keel, 4 or 5 impressed spiral lines are faintly discernible. Comparatively, the aperture is among the smallest in any variety of *P. laciniosa*. The umbilical callus is about equal to a third of a circle, like that of *P. laciniosa*. The shell measures: diameter 3.8, height 2.5 mm. Operculum wanting.

Molokai, Moomomi, sand dunes, January 30, 1913, C. M. Cooke, Jr., and H. A. Pilsbry, type no 11233, paratypes no. 37406.

In general appearance this variety is closest to variety *sandwichiensis*—especially fossils from Punchbowl, Oahu. They differ from variety *molokaiensis* in several ways. They are larger and thicker-shelled, have more oblique and comparatively smaller apertures, and have a lower peripheral angle above which rise the upper whorls in a higher cone shape. The umbilical callus runs larger.

The shells are from western Molokai and include several lots, most of which were collected by Cooke and Pilsbry, a few by C. N. Forbes and A. F. Judd.

The paratypes vary considerably in size and in height of spire, somewhat in depth of suture and in size of umbilical callus, and also in amount of sculpturing—some bearing raised spiral lines on the lower half of the last whorl. The typical form grades into a comparatively wide form with normal-sized aperture and distinct though shallow suture.

A few other specimens collected in Moomomi are within the range of characters of the paratypes. Other specimens from the extreme western end of Molokai—Kalaeokailio—resemble those from Moomomi and are in a some-

what better state of preservation; fine zigzag markings are visible on many. At "Shifting Sands," shells were collected similar to those from Moomomi, also one at Hinanaula.

At Kalainawawae, forms were collected that are like those of variety *moomomiensis* but smaller and thinner. At Mauna Loa similar shells were found, including a large lot of juveniles. Other small shells were found at Kalehu, Kawahuna, and Puu Ka Pele.

Pleuropoma laciniosa variety **honokowaiensis**, new variety (fig. 76).

Resembling variety *kulaensis*, from east Maui, but slightly larger and comparatively higher than the type of that variety. Both living and fossil. Living specimens distinctly marked with zigzag lines on the last 2 whorls, which disappear toward the aperture and are absent on the apex or base, cream color on a background of kaiser-brown in the type. Some shells are lighter. The type measures: diameter 3.7, height 2.7 mm. The umbilical callus is like that of *P. laciniosa*, a crescent about the size of a quarter circle, twice as large as that of variety *kulaensis*. The spiral lines are indistinct. Operculum wanting.

West Maui, Honokowai, no date, D. Thaanum, type no. 11219, paratypes no. 14816.

In several localities on west Maui, specimens were collected by D. Thaanum, C. M. Cooke, Jr., J. F. G. Stokes, C. N. Forbes, O. Swezey, and D. T. Fleming. Some are from the Baldwin collection. Aside from exceptions noted, the two varieties of *P. laciniosa* from east and west Maui are much alike. Form *a* of variety *kulaensis* is larger. The specimens of variety *honokowaiensis* vary in height of spire, in color, in depth of suture and consequent amount of convexity of whorls, in size, and in size of aperture. Some, therefore, closely approach in appearance variety *kulaensis*.

Shells from Maunahooma, just south of Honokowai, have a flaring aperture. They are living specimens, as also are some from the adjoining valleys, Hahakea and Honakaoo, which are nearly typical. From the near-by valley, Mahinahina, come three juvenile flat-whorled, fossil shells. A small, rounded form is labeled "W. Maui." A similar shell labeled "Makawao, E. Maui," in the Baldwin collection, may be from the same locality. Lighter, thinner, smaller shells with flattened whorls are from Lahaina. Two fossils from Olowalu, southeast of Lahaina, are larger and comparatively wider than the type.

On the other side of west Maui, at Waihee, fossil shells were collected that resemble, somewhat, live shells from Lahaina but are wider and lower. The periphery is angled, slightly keeled or not keeled. The whorls are only slightly convex. At near-by Waiehu a living shell was collected that is narrower. At Waikapu, inland to the south, were collected three living shells much like that from Waiehu and much like the type but with smaller aperture.

Pleuropoma laciniosa variety *kulaensis*, new variety (fig. 77).

Fossil and a few living. Much like variety *alpha*, from Oahu, differing from the paratypes of variety *alpha* in having slightly more angular contour and comparatively greater width. But the shells vary considerably, and some closely approach variety *alpha*. The penultimate whorl of many specimens of variety *kulaensis* bulges above the last third or half of the last whorl with a keeled angle that continues around the periphery. They differ somewhat more from variety *konaensis*, from Hawaii, being less angular and comparatively higher. On the last whorl of many specimens 7 to 9 spiral lines are distinct, and on some a fine zigzag pattern is still visible. Umbilical callus crescent-shaped, much like that of variety *globuloidea*. The type measures: diameter 3.3, height 2.3 mm. It has nearly 4 whorls. Operculum wanting.

East Maui, Keokea, September 1, 1922, C. M. Cooke, Jr., type no. 11220 (fossil), paratypes no. 52926.

The few living specimens do not seem to differ from the fossils. All specimens were collected in the Kula district and near it by C. M. Cooke, Jr., D. T. Fleming, G. P. Wilder, C. N. Forbes, and E. H. Bryan, Jr. One lot in the Baldwin collection is included.

Pleuropoma laciniosa variety *kulaensis* form a (fig. 78).

Living shell, larger than the variety, umbilical callus smaller. The peripheral angle is rounded. The type has 4 whorls. Diameter 3.9, height 2.9 mm. Operculum wanting.

East Maui, Ukulele, lower ditch, July, 1910, C. N. Forbes, type no. 21437. The type is the only representative of this form.

A shell in the Baldwin collection, no. 11199, with a sharp peripheral angle bears the label "Makawao, E. Maui." But it is doubtfully from Maui, more closely resembling a variety of *laciniosa* from Oahu.

Pleuropoma laciniosa variety *kulaensis* form b (fig. 79).

Two shells closely related to variety *kulaensis* form a. The larger of the two—diameter 3.7, height 2.7 mm—nearly equals it in size and is without pattern but has a more rounded peripheral angle. The smaller, an imperfect juvenile with 3 whorls (diameter 2.7, height 1.9 mm), bears zigzag lines. Both have a rounded peripheral angle and no keel. Operculum wanting.

West Maui, Puu Kukui, no date, D. D. Baldwin collection, cotypes no. 56319.

Pleuropoma laciniosa variety *piliformis*, new variety (figs. 80, 81).

Resembling closely two forms from Maui—variety *kulaensis* form b from Puu Kukui, west Maui, and variety *kulaensis* form a from Ukulele, east Maui. They are a little smaller, have an angled periphery or a rounded peripheral keel, and are uniformly colored or marked with a zigzag pattern. They are also much like variety *alpha*, Oahu, but are larger and have a comparatively larger aperture. The umbilical callus is a short, narrow arc, much like that of variety *spaldingi* from Oahu. Both living and fossil. The type has 4 whorls and in color is nearly uniform tawny with a suggestion of a pattern of lighter zigzag streaks. The periphery bears a round angle, which can be seen continuing on the last quarter of the penultimate whorl rising above the last whorl. The suture is shallower and the aperture less flaring than those of the specimen from east Maui. Spiral

lines on the last whorl—five or more—are indistinct. The type measures: diameter 3.5, height 2.6 mm. The opercula of the paratypes differ from those of the species in being slightly larger and in having a well-rounded outline on the palatal side and a strongly sinuous columellar edge.

Lanai, Mahana District, September 25, 1909, I. Spalding, type no. 11222 (living), paratypes no. 20071.

Several lots were collected by D. Thaanum, I. Spalding, C. N. Forbes, R. C. L. Perkins, G. C. Munro, K. P. Emory, and W. D. Wilder.

In the Mahana District the shells vary considerably in height of spire and in conspicuousness of pattern and of spiral lines. The periphery varies from round to sharp-angled, biangled, keeled. In color most are of an orange cast, rarely yellow. At Kaiholena, 2 or 3 miles south of Mahana and on the other side of the ridge, lower and comparatively wider shells than those from Mahana were collected—almost identical with the shells from Ukulele, east Maui, already referred to. Near by, at Koele and Lanaihale, broad to high forms were taken, and at intervening Waiapaa a high and a low shell like those from Mahana. In one lot from Koele three very small shells are included, probably stunted. Several lots labeled "east end" resemble shells both from Kaiholena and Mahana, some being low, some high, a few smaller. In one lot opercula are available, and they resemble those of the paratypes. One lot of live shells collected in Maunalei consists of shells like those from the adjoining district of Mahana. A few lots labeled "top of mt. (Capt. Soules)" include both low-spired and moderately high-spired shells. Some lots with the only designation "Lanai" include shells like those from the eastern end of the island. Most have opercula with a well-rounded palatal angle similar to the species, due to the less-sloping aperture.

On the ridge between Maunalei and Hauola, at an elevation of 2,000 feet, G. C. Munro found a deposit of fossil shells, including many Helicinidae in a good state of preservation, ranging from very young to adult. Though bleached, the surface of most bears distinct zigzag markings. These shells are like those from Mahana, the district adjoining on the west. They are evidently very young fossils. A nearly adult fossil found west of Hauola Gulch is of the same type, as are also two from Maunalei Gulch.

***Pleuropoma lacinoso* variety *piliformis* form a (figs. 82, 83).**

Fossil. Differing from the variety in being larger, lower, and comparatively broader. They resemble closest the specimens from Kaiholena. Though all are thoroughly bleached, on a few a zigzag pattern is still visible; on all are 3 or 4 raised spiral lines on the last whorl below the peripheral angle. The umbilical callus is large, about a third of a circle. The type has 4 whorls and measures: diameter 4, height 2.6 mm. Operculum wanting.

Lanai, Maunalei Gulch, September 1917, C. N. Forbes, type no. 11223, paratypes no. 45572.

The shells vary somewhat, especially in height of spire and in size of aperture, and one large shell has $4\frac{1}{2}$ whorls.

***Pleuropoma laciniosa* variety *kaaensis*, new variety (fig. 84).**

Fossil. Shells smaller and comparatively lower than variety *piliformis*, from the central and southeastern parts. Otherwise, except for a larger umbilical callus, which resembles that of *P. laciniosa*, they are much like variety *piliformis*. Owing to their fossil state they are, however, bleached and therefore can not be compared exactly with living forms. Zigzag markings are visible on many. The type has nearly 4 whorls and measures: diameter 3.1, height 2 mm. Operculum wanting.

Lanai, western end, no date, C. N. Forbes, type no. 11224, paratypes no. 34739.

In size and shape there is little variation. It seems a depauperate variety of *P. laciniosa*, possibly caused by its dry habitat at the dry western end of Lanai. The collectors were Mr. and Mrs. C. N. Forbes.

***Pleuropoma laciniosa* variety *kaaensis* form a (fig. 85).**

Fossil. Narrower, sharper peripheral angle and smaller aperture than the variety. Distinctly marked with a fine zigzag pattern. The type has nearly 4 whorls and measures: diameter 2.9, height 2 mm. Operculum wanting.

Lanai, western end, dry forest, September, 1917, C. N. Forbes, type no. 11225, paratypes no. 45558.

Besides type and paratypes, other similar fossils were collected by G. C. Munro above Kaena Point at an elevation of 1,520 feet.

***Pleuropoma laciniosa* variety *kahoolaweensis*, new variety (fig. 86).**

Fossil. Much like variety *kulaensis* form a, from east Maui, and variety *piliformis* form a, from Lanai. They differ most noticeably in having a small aperture. Though the surface is well-bleached, a fine zigzag pattern is distinct on many specimens, beginning near the first whorl. The umbilical callus is large—about a third of a circle—and much like that of variety *piliformis* form a. The type has a low cone shape, a moderate-sized aperture, thick walls, zigzag markings up into the second whorl, a shallow suture. It measures: diameter 4, height 2.4 mm.

Kahoolawe, Hakioawa, February 27, 1913, C. M. Cooke, Jr., and H. A. Pilsbry, type no. 11239, paratypes no. 36024.

Variations even in one lot are considerable, especially in size, height of spire, amount of angulation on penultimate whorl visible above last whorl, visibility of spiral lines on lower part of last whorl, depth of suture, and prominence of peripheral angle. Besides those collected by Cooke and Pilsbry, specimens were collected by C. N. Forbes, J. F. G. Stokes, T. T. Dranga, and G. C. Munro.

In a gully, in sand dunes, and near the beach at Kanapou Bay, just below Hakioawa Bay, on the eastern end of the island, typical shells were found with great range in shape and size. They run smaller than many of those from Hakioawa, and some are thinner-shelled.

At Ahupuiki, on the northwestern shore, were found a few fossil specimens that differ from those on the eastern shore in having thinner shells and sharper-pointed apices. One operculum was found—smaller than typical of the species but similar in shape and in appearance, as far as can be seen in a fossil operculum.

At Hakioawa and Kanapou and at the highest point of the island, three lots of small specimens were collected. As they grade toward small sizes in many lots of larger shells they are not separated as a form of this variety. One operculum was found, and it resembles opercula of shells from Ahupuiki.

Pleuropoma laciniosa variety **konaensis**, new variety (fig. 87).

Closely resembling variety *sandwichiensis* of eastern Oahu, but differing from neotypes of variety *sandwichiensis* in several details: variety *konaensis* is smaller, thinner, translucent; its aperture is more oblique and comparatively smaller and narrower; its peripheral angle is distinct but not keeled. Compared with the neotype of *P. laciniosa*, it has few obvious differences, agreeing in size and shape. But its aperture is longer and more flaring. Whorls 4. In color it has a distinct zigzag pattern of alternating cinnamon-rufous and cream color, grading to uniform cream color at the apex. The basal callus is thin, transparent to white. The umbilical callus is a distinct, rather large crescent. On the last whorl, 8 raised, parallel spiral lines are equidistant from suture to base, on the upper whorls 2. The type measures: diameter 3.6, height 2.5 mm. Opercula from the types resemble those of variety *sandwichiensis*. The S-ridge is only slightly raised. The shells are cream color grading toward pink on the columellar edge or have a pinkish tint all over.

Hawaii, Puuwaawaa, Mawai, near Puu Henahena, December 4, 1922, A. Gouveia, type no. 11226, paratypes no. 53671.

The type is not quite mature, judging from the unfinished lip and the raised spiral lines. But it is older than the paratypes and in a good state of preservation. Only one lot of this variety was found.

Pleuropoma laciniosa variety **konaensis** form a (fig. 88).

Fossil. Resembling the variety except in size and a tendency to a flaring aperture. Also the umbilical callus of the type is smaller, like that of variety *spaldingi*. Though the color is bleached, the pattern visible on some is like that of the variety. The shape varies considerably due to differences in height of spire and in diameter. In many shells the peripheral angle, which varies in prominence, makes its appearance in the last half of the penultimate whorl, where it rises above the last whorl. The angle of many is keeled. Commonly, 2 or 3 raised spiral lines are obvious just below the periphery. Some have deeper sutures than others. The type has 4 whorls and measures: diameter 3, height 2 mm. Operculum wanting.

Hawaii, Puuwaawaa, July 13, 1919, A. Gouveia, type no. 11227, paratypes no. 49901.

The state of preservation of the shells is more or less imperfect, for owing to their thinness many are broken. Several fossil lots, including numerous specimens, were collected in different localities in Puuwaawaa by F. J. and A. Gouveia. A few other lots of similar fossils were collected by D.

Thaanum, L. A. Thurston, and T. T. Dranga in parts of North and South Kona and in Waimea.

Pleuropoma laciniosa variety **konaensis** form **b** (fig. 89).

Fossil. Averaging distinctly larger than form *a* and slightly smaller than variety *konaensis*. In other features they resemble form *a*. The type has 4 whorls and measures: diameter 3.3, height 2.3 mm. Operculum wanting.

Hawaii, Puuwaawaa, Waihou, July 11, 1919, A. Gouveia, type no. 11228, paratypes no. 49765.

Several lots from Puuwaawaa and its vicinity in North Kona were collected by A. Gouveia. Other lots of similar fossils were collected by E. W. Thwing, H. W. Henshaw, W. H. Meinecke, and two lots in the Ancey collection, in parts of North and South Kona, in Waimea, Mana, and Kau. A few grade toward form *c*.

Pleuropoma laciniosa variety **konaensis** form **c** (fig. 90).

Fossil. Shells distinctly larger than the variety. They are comparatively wider and lower. Their sharp-angled periphery is keeled, their aperture is expanded, and their whorls are flat. Otherwise they are similar to the variety and its forms, so far as can be seen in the fossil state. Whorls $4\frac{1}{2}$. The type measures: diameter 4.7, height 3 mm. Opercula few and imperfect but apparently like those of *P. laciniosa*.

Hawaii, Mana, October, 1911, D. Thaanum, type no. 11229, paratypes no. 36740.

The paratypes number more than 900. In the same lots are two much larger specimens, which are oddly formed, possibly due to injury to the shell. Near the aperture the last whorl is drawn in and contracted so that for a short distance the continuation of the peripheral angle on the penultimate whorl is visible, rising above the last whorl. The aperture is comparatively small.

At the opposite end of the island, in Oloo, Thaanum found some juvenile and nearly mature living specimens. They are much like the fossil type from Mana in shape and sculpturing but run smaller. Their pattern and colors resemble those of variety *konaensis*. The few opercula are like those of *P. laciniosa*.

Above Hilo in a forest surrounded by a lava flow (1855), C. N. Forbes collected two high-spined, thin-shelled specimens of form *c*.

Pleuropoma laciniosa variety **konaensis** form **d** (fig. 91).

Fossil. Shells smooth, high-pyramidal, with convexly sloping sides, small oblique aperture, and round-angled periphery. The columella is nearer the vertical than in form *c* and protrudes farther below the base. The whorls number $4\frac{1}{2}$. Otherwise much like form *c*. Zigzag markings are evident on one from the second to the last whorl. Diameter 4.3, height 3.3 mm. Operculum wanting.

Hawaii, Mana, no data, H. W. Henshaw, type no. 11230, paratypes no. 14818.

The paratypes number two. In the Ancey collection are two shells from Mana that are slightly lower-spined and have less oblique aperture and straighter sides. They have 4 whorls. Near Mana, at Palihoukapapa, D. Thaanum collected a similar shell with $4\frac{1}{2}$ whorls and the sculpture of form *c*. From Kona are two fossil shells in the Ancey collection that look like miniature representatives of form *d*. Except for size they are quite like the type. One measures: diameter 3.5, height 2.6 mm.

Pleuropoma nonouensis, new species (figs. 92-94).

Spire depressed-conic, biangled at periphery. The type measures: diameter 4.3, height 3 mm. Rather thin, smooth, 2 or 3 impressed spiral lines both above and below the periphery. Darkest shells Hay's russet with fine zigzag lines on last $1\frac{1}{2}$ whorls; lip plain. Lightest shells (among which is the type) pinkish buff on upper whorls and at lip, zigzag lines on last $1\frac{1}{2}$ whorls alternating cinnamon-rufous and cream. Whorls $4\frac{1}{2}$. Above the biangled periphery the outline of the whorls from first to last is almost straight, the indentation at the suture ordinarily being slight, except in the penultimate whorl, which generally rises above the last. Aperture very oblique, broadly oval; lip thin, slightly flaring, wrinkled on top; columella curving, especially near base. Basal callus wide, transparent, minutely punctate. Umbilical callus white, long, narrow, curved, in type absent. Opercula are similar to those of *P. oahuensis*, Waianae Mountains, Oahu, in color, transparency, size. The shape is slightly different, the base being broader. Many have a rufous spot on the columellar edge.

Kauai, Nonou mountains, northeast side, October 23, 1925, C. M. Cooke, Jr., and T. T. Dranga, type no. 11213, paratypes no. 81121.

In the Nonou mountains, a fairly large series of this species—lower, smaller, and more distinctly angled than *Orobophana baldwini*, larger and in general appearance like *Pleuropoma laciniosa* variety *delta*, also suggesting the lower-spined shell from Oahu, *P. oahuensis* variety *gemina*—have been collected at different times by C. M. Cooke, Jr., T. T. Dranga, and D. Thaanum. Some of the shells are localized in different parts of the Nonou mountains; and they vary, but not uniformly, in size and shape, from comparatively high and narrow to low and wide, intergrading, one of the extremes measuring: diameter 5.2, height 3.2 mm.

At Waipouli, C. M. Cooke, Jr., found several bleached and eroded fossil specimens like the high, narrow type from the Nonou mountains just to the south. They are slightly smaller, and the lower half of the biangle is less distinct and somewhat rounded. At Haena, Cooke also collected a few juvenile fossil specimens like those from the Nonou mountains. But as they are young and bleached they are imperfect.

Pleuropoma oahuensis (Pilsbry and Cooke) (figs. 95, 96).

Helicina oahuensis Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 3, 4, fig. 1, 1908.

Aphanocomia oahuensis (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

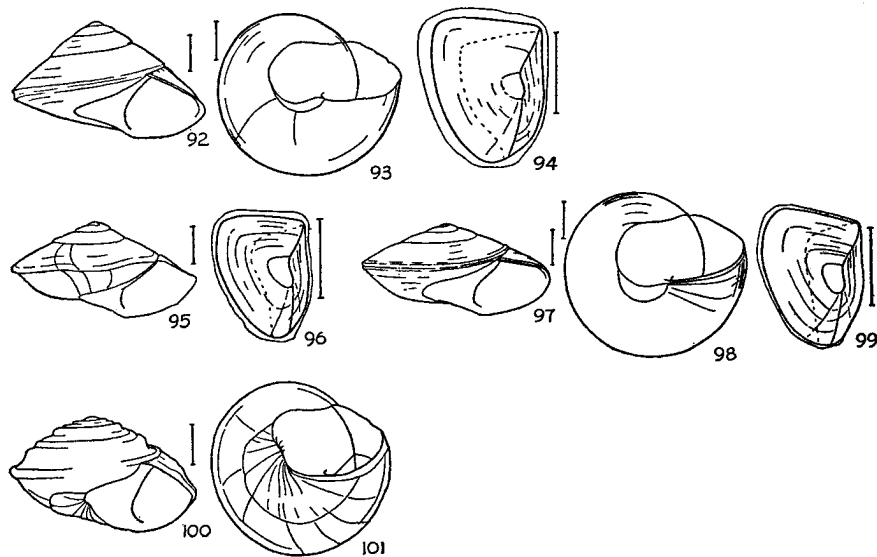
Original description:

The shell is lenticular, with the periphery acutely carinate, slightly sinuous and minutely crenulated by the growth-striae, thin, slightly diaphanous, striate with lines of growth, with two or three faint impressed spiral lines on the upper portion of the whorls and strongly impressed just above and below the peripheral keel. Color reddish alternating with somewhat zigzag light flammules, which are almost white at the periphery, base brownish, except around the callus where there are traces of reddish flammules. Spire low-conical, apex acute. Suture lightly impressed, margined above. Whorls nearly four, almost flat, the last two slightly projecting at the periphery; the embryonic nearly smooth; the last flat above the carinate periphery, slightly convex below, not descending in front. Aperture nearly triangular; outer lip thin, forming a straight line above the periphery, arcuate below. Callus whitish about the axis, the rest very thin, transparent and minutely punctate. Operculum wanting. Maj. diam. 5.0, total length 2.7 mm.

Oahu: Waianae Mountains and Mt. Tantalus (Cooke). The locality of the type specimen is, back of the Leilehua Ranchhouse, Waianae Mountains.

Type No. 14,911, Bishop Museum.

This shell has been referred to *H. sandwichiensis* Soul., by various authors and collectors. Its nearest relative is *H. laciniosa* Migh. variety *delta* P. and C., from which it is easily distinguished by its much more depressed contour.



FIGURES 92-101.—Three other species of *Pleuropoma* (*sensu stricto*): 92-94, *P. nonouensis*, type, no. 11213, shell, front view; paratype, no. 81121, shell, bottom view; no. 47791, operculum; 95, 96, *P. oahuensis*, type, no. 14911, shell; no. 91707, operculum; 97-99, *P. oahuensis* variety *gemina*, type, no. 11218, shell; paratype, no. 17177, operculum; 100, 101, *P. subsculpta*, type, no. 11256. The dull area on opercula is outlined by a broken line. The measure indicates 1 mm.

The type and paratypes do not seem quite adult, the lip being hardly finished, and sculpturing on embryonic whorls not worn. The color is cream with white and cinamon-rufous flammules distinct on the last $1\frac{1}{2}$ whorls.

The basal callus is as distinct as in *P. laciniosa*. The umbilical callus is much like that of *P. laciniosa* variety *laua*.

Operculum in many ways like that of *P. laciniosa*, because of the shape of the aperture differing as follows: larger; angle on upper columellar edge slightly obtuse, slanting back and slightly upward in a nearly straight line to the palatal angle, a broadly acute or rectangular rounded angle. Only imperfect specimens were available from the paratypes.

In the locality where C. M. Cooke, Jr., found the types, I. Spalding also found a few similar specimens, W. H. Meinecke one. In the adjoining valley to the north, Haleauau, Spalding found three typical though extra large specimens—one measures; diameter 5.1, height 2.7 mm—with apparently typical opercula. Over the range in Waianae Valley, in a talus slope on a coffee plantation, J. C. Bridwell collected four more. In a glen in the same valley, O. Oswald collected five more; opercula like those in shells from Haleauau but smaller and narrower. At Kololua and Honua, in the same valley, Cooke collected several specimens, those from Honua varying little in height, some slightly biangled, approaching *P. oahuensis* variety *gemina*. One juvenile specimen was collected by O. Oswald on the eastern ridge of Puu Kaala at an elevation of 3,100 feet.

Very few typical *P. oahuensis* have been found. The locality, Mount Tantalus, given in the original description, seems incorrect, the reference probably being to a low form of *P. laciniosa* variety *sandwichiensis*.

***Pleuropoma oahuensis* variety *gemina*, new variety (figs. 97-99).**

Differing from the species chiefly in the keel, which is biangular. Also, this variety is larger; the spire is more broadly cone-shaped and lower; the lower half of the last whorl is swollen; spiral lines are distinct on all the whorls, on the last whorl 1 to 3 ordinarily being visible above the keel, about 8 below, 1 or 2 below as ridges, in some examples one ridge seeming to make a triple keel; aperture of most less expanded. Whorls 4. The type measures: diameter 5, height 2.5 mm, being considerably wider than *P. laciniosa* variety *ferruginea*.

Oahu, Waianae Mountains, Mokuleia, ridge west of Makaleha Valley, September 3, 1908, C. M. Cooke, Jr., type no. 11218, paratypes no. 17177.

In the northern half of the Waianae Mountains several lots of this variety were collected. Other specimens from Mokuleia besides the type vary in size and height, some being larger and higher. They were collected by C. M. Cooke, Jr., I. Spalding, A. Gouveia, E. H. Bryan, Jr., and Marie Neal. From near the top of Puu Kaala, at the head of Makua Valley, is a large lot of shells collected by Cooke, exceeding in size those from Mokuleia. At Waianae, W. D. Wilder collected six shells, which are about the size of the species and apparently intergrade between species and variety. Like the variety they have a more obtuse apex and a double keel, the lower angle merely indicated

in some, as one of two or three spirals. Though a little narrower, a specimen from the Baldwin collection is nearly typical of the variety. In Makaha, the valley beside Waianae, C. N. Forbes, W. D. Wilder, and I. Spalding collected specimens, some slightly higher and narrower, and some with lower angle indicated by a raised spiral line. In the Garrett collection is a shell labeled "*Hel. sandwichensis* Gould, Sandwich Isles," in a lot with four identified as *P. laciniosa* variety *laula*, apparently from Mokuleia. This shell resembles *P. oahuensis* variety *gemina*, also from Mokuleia.

The opercula of all these specimens resemble those of the species, with slight variations in size, width, and slope of upper palatal edge.

In the Koolau Range, in Kawaiiki, a gulch north of Opaepa, I. Spalding found an odd specimen that was injured when it had nearly reached the third whorl. This probably caused the succeeding whorls to fall below the periphery, which is strongly biangled. The shell is flatter than biangled specimens of *P. laciniosa* variety *gamma*, and though the only eastern Oahu representative of *P. oahuensis* variety *gemina* it was not found far from the center of distribution of that variety—just across the way in the Waianae Mountains. The operculum, too, is similar to that of some specimens from Makaleha.

***Pleuropoma subsculpta*, new species (figs. 100, 101).**

Fossil. A distinct, highly sculptured species. The type, representing the average in size and shape, resembles *P. laciniosa* variety *ferruginea* except in having spiral ridges. It is rather low conoidal, moderately thick, and measures: diameter 4.5, height 2.9 mm. It is smooth except for two ridges that begin on the second whorl and continue as prominent spirals to near the aperture, where they begin to flatten, and are hardly visible at the lip. The color, of course, is bleached out, but white zigzags on a background of cream color suggest that the pattern was similar to that of *P. laciniosa* variety *ferruginea*. Whorls about $4\frac{1}{2}$, wavy with ridges, slightly convexly sloping to apex, gradually increasing in size, lower half of last whorl smooth and shining, periphery prominently keeled. Suture indicated by a line following the last whorl, on other whorls a little more distinctly indented, margin a ridge. Aperture small, narrowly oval, thin, not expanded. Columella rounded, curving outward. Basal callus large, smooth, distinct. Umbilical callus a large semicircle. Umbilicus present, appearing as a shallow dimple. Operculum wanting.

Oahu, Waianae Mountains, Makua, January 25, 1916, C. M. Cooke, Jr., and C. N. Forbes, type no. 11256, paratypes no. 42968.

The shells vary considerably in height and size. In most, the umbilical callus is a large crescent but not so large as in the type. Juvenile shells are thinner, and the upper part of the lip has a wavy margin. Several fossil specimens were collected by Cooke and Forbes.

Subgenus SPHAEROCONIA Wagner

Sphaeroconia Wagner: Syst. Conch.-Cab., Helicinidae, I, 18, p. 189, 1911.

Baker: Acad. Nat. Sci. Phila., Proc., vol. 74, p. 43, 1922.

Wagner describes *Sphaeroconia* as follows:

Gehäuse kegelförmig mit gewölbter Basis bis kugelig; das mehr minder konvexe bis abgerundete Gewinde besteht aus $3\frac{1}{2}$ bis $4\frac{1}{2}$ langsam zunehmenden Umgängen, der letzte ist kantig oder gerundet; der Mundsaum gleichmässig, auch entsprechend dem Oberrande ausgebreitet.

Deckel dreieckig bis halbeiförmig mit häufig abgerundetem, weniger nach hinten gebogenem Spindelwinkel. Die Kalkplatte flachkonkav mit seichter Furche neben der wallartigen Verdickung des Spindelrandes. Die Sigmakante gleichmässig S-förmig gebogen, häufig auch im oberen Aste deutlich erhoben und dem Spindelrande mehr genähert; der Spindelteil dementsprechend schmaler, oft nur $\frac{1}{4}$ von der Breite der Platte betragend.

Das Verbreitungsgebiet dieser Gruppe erstreckt sich über die Bonin-Inseln, Liu Kiu, Formosa, Hainan, Hongkong, Tonking, die Palau Inseln, Neu-Guinea mit dem Bismark-Archipel und den Lousiaden, die York-Halbinsel vom Festlande Australiens, ferner die neuen Hebriden, Neu Caledonien, die Fiji, Tonga, Samoa, Elice und Paumotu Inseln.

Die Mittelpunkt dieses Verbreitungsgebietes liegt anscheinend auf den Inselgruppen zwischen Neu-Guinea und Neu-Caledonien, wo die Gruppe in zahlreichen und gut gekennzeichneten Formen auftritt.

Während die oben beschriebenen Formen des Genus *Aphanoconia* s. str. noch deutlich einzelne Merkmale des Genus *Geophorus* Fischer aufweisen, wie das flache und gekielte Gehäuse, den geraden Oberrand der Mündung und auch mit Rücksicht auf die Beschaffenheit des Deckels eine grosse Uebereinstimmung mit diesem Genus erkennen lassen, erscheinen diese Merkmale bei den hier zusammengefassten Formen sehr abgeschwächt und vielfach geschwunden. Das Gewinde ist mehr erhoben und abgerundet, die langsam zunehmenden Umgänge kantig bis gerundet, der Mundsaum gleichmässig ausgebreitet. Am Deckel erscheint die Biegung des Spindelwinkels nach hinten oft sehr schwach, die Sigmakante ist gleichmässiger, in beiden Aesten gebogen und dem Spindelrande oft sehr genähert, so dass ein allmählicher Uebergang zu den Formen des Genus *Palaeohelicina* (mit randständigem Nukleus des Deckels) bemerkbar wird. So ist auch hier eine scharfe Trennung der Gruppen, sowie eine ausreichende Kennzeichnung derselben durch konstante Merkmale nur unvollkommen durchführbar. Um so wichtiger erscheint es mir die anscheinend nahe verwandten Formen in Formenkreise zusammenfassen, da hiezu schon die Untersuchung der Hartteile genügende Anhaltspunkte bietet. Oft sind es sonst untergeordnete Merkmale, wie Färbung und Skulptur, welche durch ihr charakteristisches Auftreten auf eine nahe Verwandtschaft hinweisen.

Hawaiian representatives of this subgenus fit Wagner's description except in having more rapidly increasing whorls, rather thin shells, and at the aperture an unexpanded lip. As a rule the opercula have a more prominent S-ridge than those of *Pleuropoma sensu stricto*. In 1922, Baker chose *Helicina verecunda* Gould (1859), from Loochoo Islands, as the type of the subgenus *Sphaeroconia*.

The species most closely related to each other in appearance are *Pleuropoma (Sphaeroconia) rotelloidea* of Oahu and *Sturanya parvula* (Wagner's classification) of Atiu, Cook Islands, *S. parvula* differing chiefly in having an aperture that approaches the quadrangular.

Key to Species and Varieties

1. All shells fossil, diameter about 2.7 mm; from Niihau.....**P. (S.) niihauensis**
Most shells living, diameter more than 2.7 mm.....2
2. Peripheral angle slight, rib at base of columella absent, eight spiral lines on last whorl, measurements about: diameter 3.3, height 2.3 mm; from Hawaii.....
.....**P. (S.) sulculosa**
Peripheral angle absent—except *P. (S.) rotelloidea* variety *mauiensis*—and rib at base of columella present—except *P. (S.) rotelloidea* varieties *sola* and *mauiensis*.....3
3. Shells large, diameter about 5.5 mm; from Kauai.....**P. (S.) hawaiiensis**
Shells smaller; from Kauai.....4
4. Whorls rather tightly wound, diameter about 3.2 mm, color orange-red with light yellow flammules; from western Kauai.....**P. (S.) kauaiensis**
Whorls not tightly wound.....5
5. Diameter about 4.9 mm.....**P. (S.) hawaiiensis** variety **knudseni**
Diameter much less than 4.9 mm.....6
6. Much like *P. (S.) hawaiiensis* variety *knudseni* but smaller, diameter about 3.3 mm.....**P. (S.) hawaiiensis** variety **makalii**
Much like *P. (S.) kauaiensis*.....7
7. Smaller than *P. (S.) kauaiensis*, diameter about 2.9 mm, cinnamon-colored grading to vinaceous rufous or lighter; from eastern Kauai.....
.....**P. (S.) kauaiensis** variety **orientalis**
Slightly larger, not from Kauai.....8
8. From Molokai, higher than *P. (S.) rotelloidea* (type: diameter 3, height 2.3 mm).....**P. (S.) rotelloidea** variety **sola**
From Oahu and Maui.....9
9. Periphery well-rounded, last whorls increasing rapidly (type: diameter 3, height 2 mm); from Oahu.....**P. (S.) rotelloidea**
Peripheral angle faint; from Maui.....**P. (S.) rotelloidea** variety **mauiensis**

Pleuropoma (Sphaeroconia) hawaiiensis (Pilsbry and Cooke) (figs. 102, 103).

Helicina hawaiiensis Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 8, fig. 6, 1908.

Aphanoconia hawaiiensis (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Sturanya laciniosa Mighels: Wagner, Syst. Conch.-Cab., Helicinidae, I, 18, pp. 43, 44, pl. 6, figs. 30-33, 1911.

Original description:

The shell is depressed with a conical spire, periphery rounded, quite thin, nearly smooth, under a strong lens minutely striate with lines of growth and, in type specimen, with five fine raised spiral striae, two above, one encircling and two below the periphery. Color a dull yellowish green interspersed with a few irregular light reddish flammules above. Apex somewhat acute. Suture simple, well impressed. Whorls $3 \frac{2}{3}$, convex, the embryonic minutely striate, the last rounded with the base somewhat flattened, slightly descending in front. Aperture elongate-semicircular, not contracted; outer lip thin. Callus small, thin, transparent, minutely granulose. Operculum whitish, thin, granulose. Maj. diameter 5.5, total length 3.7 mm.

Oahu.

Type No. 58,384, Phil. Ac. Nat. Sci.

This species approaches *H. knudseni* in form. Its larger size, the absence of for-

wardly descending wrinkles and the presence of raised spiral lines enable it to be easily distinguished from the Kauaian species. Its closest relative is *H. rotelloidea* Migh. The two differ considerably in size, color pattern, etc.

Wagner's description and figures of *Sturanya laciniosa* from Kauai do not agree with those of *Helicina laciniosa* from Oahu of other authors: Mighels, Pfeiffer, Gould, and Pilsbry and Cooke. But they do agree with those of *Helicina hawaiiensis* Pilsbry and Cooke, from Kauai. The size given by Wagner ("D = 6.5, d = 6, H = 4 mm.") is greater than that of the type but similar to that of some geographical races.

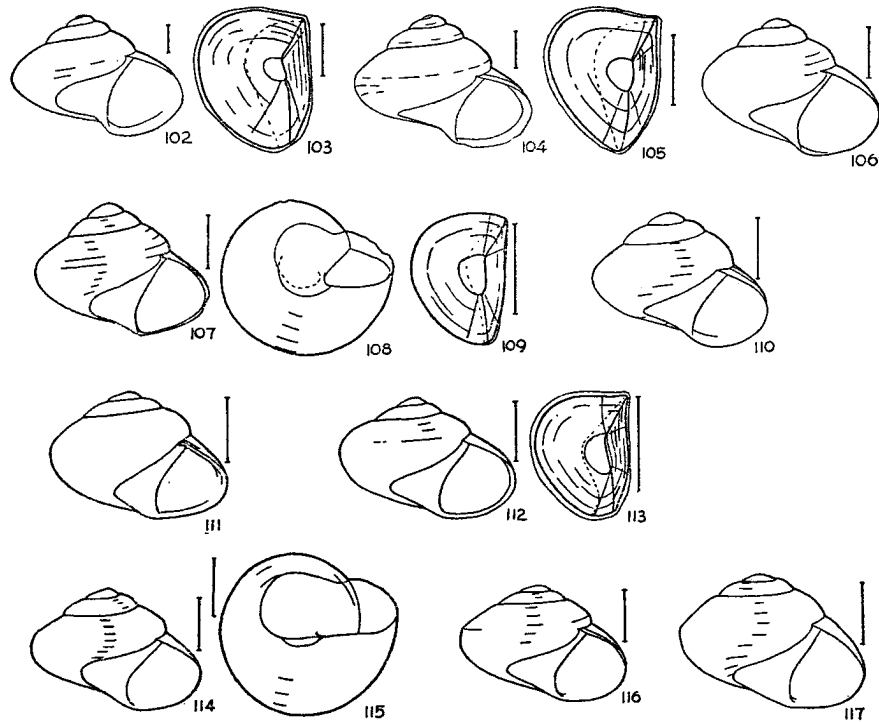
Several specimens resembling the description by Pilsbry and Cooke of *Helicina hawaiiensis*, of which only one specimen had heretofore been known, the type at the Academy of Natural Sciences of Philadelphia, were found by Marie Neal at Kawaikoi, Kauai, above the head of Waimea Canyon:

Except in size the species is not much different from variety *knudseni*, described at the same time as a separate species; the whorls increase more rapidly, the aperture is comparatively larger. In a general way *P. hawaiiensis* resembles *P. rotelloidea*, though much larger and not so compact, and it may represent the shell described by Mighels as a large size of *P. rotelloidea*, for which he gave the measurements "2.5-5.8 mm." One of the largest of the shells from Kawaikoi (no. 58588) measures: diameter 5.8, height 4.3 mm. It has 4 rapidly increasing whorls. The abrupt ending of the columella and the rib continuing from it in the aperture, a character of variety *knudseni*, is even more prominent in *P. hawaiiensis*. On the last whorl of some, more than 5 spiral striae are present. In color, one of the darkest is cinnamon-rufous with flammules of cream color, grading toward the lip to straw-yellow. Some have more yellow color, some no flammules. Umbilical callus is absent. Operculum has nucleus nearly central, similar to opercula of shells from Waipahi.

Oahu as the habitat of the type of *P. hawaiiensis* is apparently erroneous, as Cooke has suggested. Shells agreeing with the original description and figure have been found in several parts of Kauai, possibly arboreal and in wet places, for when details of habitat were preserved this was so.

At Waiakoali, C. M. Cooke, Jr., found one juvenile specimen much like shells from Kawaikoi, which is an adjoining region; and at the head of Wainiha Valley, on shrubs, he found two shells like those from Kawaikoi. In upper Kaapoko, Hanalei, altitude 1,300 feet, Dranga collected a few specimens resembling those from Wainiha Valley. The one operculum available is like those of shells from Kawaikoi. At Waioli, W. H. Meinecke collected a shell approaching in size those from Kawaikoi, but comparatively narrower and with flatter whorls. In an exceedingly wet gulch at Kapaa, D. Thaanum collected a shell like the large ones from Kawaikoi. In several localities at Waipahi, C. M. Cooke, Jr., and T. T. Dranga made a large collection of shells, which include some like those from Kawaikoi, possibly slightly thicker. Opercula are like those of variety *knudseni* from Waipahi (no. 80320), but larger and with top edge more rounded. In the Garrett collection are three specimens that closely resemble one from Hanalei. The label they bear is

"*Hel. rotelloides* Mighels, Kauai, Sandwich Isles." Mixed with them are three *Pleuropoma laciniosa* variety *delta*, which also resemble shells from northern Kauai.



FIGURES 102-117.—Species and varieties of *Pleuropoma* (*Sphaeroconia*): 102, 103, *P. (Sphaeroconia) hawaiiensis*, no. 58588, shell; no. 80492, operculum; 104, 105, *P. (Sphaeroconia) hawaiiensis* variety *knudseni*, type, no. 14905, shell; no. 58623, operculum; 106, *P. (Sphaeroconia) hawaiiensis* variety *makalii*, type, no. 11241; 107-109, *P. (Sphaeroconia) kauaiensis*, type, no. 14906, shell (operculum in aperture); bottom view showing absence of umbilical callus; paratype, no. 14802, operculum; 110, *P. (Sphaeroconia) kauaiensis* variety *orientalis*, type, no. 11242; 111, *P. (Sphaeroconia) niuhauensis*, type, no. 11237; 112, 113, *P. (Sphaeroconia) rotelloidea*, neotype, no. 14907, shell (operculum in aperture); no. 41090, operculum; 114, 115, *P. (Sphaeroconia) rotelloidea* variety *sola*, type, no. 11234; 116, *P. (Sphaeroconia) rotelloidea* variety *mauiensis*, type, no. 11221; 117, *P. (Sphaeroconia) sulculosa*, type, no. 19068. The dull area on opercula is outlined by a broken line. The measure indicates 1 mm.

***Pleuropoma (Sphaeroconia) hawaiiensis* variety *knudseni* (Pilsbry and Cooke) (figs. 104, 105).**

Helicina knudseni Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, pp. 8, 9, fig. 7, 1908.

Aphanocoma knudseni (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

The shell is depressed with a conic spire, the periphery rounded, quite thin, nearly smooth, minutely striate with lines of growth, under a strong lens these are intersected, almost at right angles, by very fine, close, forwardly descending wrinkles. Color light brownish-red, darker on the spire, interspersed with irregular, zigzag yellowish white flammules forming spots on the periphery, and absent on the base except close to the callus. Apex somewhat obtuse. Suture simple, well impressed. Whorls about $3\frac{3}{4}$, quite convex, slightly projecting above the suture, the embryonic nearly smooth, the last somewhat flattened above and below the rounded periphery, not descending in front. Aperture nearly semicircular; outer lip thin. Callus whitish about the axis, the rest transparent, thin, granular. Operculum punctate, of a light cinnamon color. Maj. diam. 4.9, total length 3.6 mm.

Kauai: Olokele (type loc.), Waiakoali (Cooke).

Type No. 14,905, Bishop Museum.

This species has nearly the same form as *H. rotelloidea* Migh. It is easily distinguished by its larger size, the absence of spiral striae, and the peculiar sculpture of the forwardly descending wrinkles over the growth lines.

Besides the type collected by C. M. Cooke, Jr., only eight other specimens have been collected in Olokele Canyon: by T. T. Dranga, W. H. Meinecke, and Marie Neal. They are like the type.

In both juvenile and adult shells, the columella ends abruptly at the base on the edge of the lip and inside joins at an angle a short rib parallel to growth lines. Besides many wrinkles, mentioned in the description, 4 or more spiral lines can be distinguished near the periphery, in some specimens 12 or so altogether. The type is faded, and one of the darkest shells is cinnamon-rufous with a few cream-colored flammules. The area beneath the basal callus is white. Umbilical callus is lacking.

The operculum is rounded-triangular, the outline being as follows: upper edge slightly concave to straight, largely rounded outer or palatal corner, straight to slightly convex oblique line to base, sharply convex base with short oblique line (in some indented a little) to the columellar edge. This edge is straight or slightly convex or sinuous to the upper end, where a slight concavity is present. With the upper, palatal edge it forms a right angle, the point of which is prominent and blunted.

Mostly thin, transparent or translucent. Pale yellow to flesh to pink-colored, some with gradations of all colors, red shells having opercula with any of these colors, yellow shells—as far as noticed—only yellow ones. Thickness uniform, possibly very slightly greater on the columellar edge in some adults.

Opercula have two layers. The outer, Wagner's *Kalkplatte*, is horny to calcareous and is covered with incrustations. The inner, Wagner's *Hornplatte*, is horny. The surface of the outer layer is finely granulated, shining, uneven, concave, with lowest point in center. The highest part or rim is continuous down to the base, where it becomes lower, and below which the base ends after bending slightly backwards, some specimens bearing a slight indentation on the columellar side. This rim is formed by an abrupt rounding off at the edge, which terminates the even and gradual rise of the surface from the center, less abrupt on the lower half of the columellar edge.

A few opercula are made partially opaque by a thin film of white on part of the surface or on all of it, on the area between the little bumps of granulation. These bumps are finest near and on the rim. Most are so transparent that the formations on the inner surface are visible also—the nucleus, the lines of growth, and the ridges.

The surface of the inner layer is smooth, except for striations of lines of growth; shining, except for a broad dull band extending from the upper pointed corner obliquely down, covering the nucleus, and following the S-ridge to the base. Except for the ridges the contour is the reverse of that of the outer surface. The edge is bordered with a narrow membranous layer, the new growth.

Nucleus nearer columellar edge than center and about equally distant from upper and lower corners. Its longitudinal axis is practically parallel to that of the operculum. It is in shape like the operculum, and concentric lines of growth repeat the shape at regular intervals to the edge, the zones being narrowest on the columellar side, widest on the opposite or palatal side.

Baker says: "The embryonic operculum of the Helicinidae is spiral and its spiral nucleus is evident in the adults. The adult operculum may perhaps be regarded as potentially spiral, with the rotation arrested by the shape of the aperture."

A distinct rounded ridge, approaching a long S-shape, extends from the upper pointed corner to the nucleus, the columellar edge of which it follows as a more or less distinct line, becoming a definite ridge again below and spreading out fan-shaped. On some juvenile and some adult opercula an extra spreading ridge or two extend obliquely from the base of the nucleus to the columellar edge.

Individual variations in opercula are chiefly in shape of the outline, the extremes of which are roughly longitudinally half oval and diametrically half oval, in amount of prominence of the S-ridge, and in the number of side ridges formed toward the base.

At the foot of Kalihi (Hii Ridge), in Koloa district, C. N. Forbes found several typical specimens of variety *knudseni*. In color most are cinnamon-rufous with cream-colored flammules, 1 without flammules, 2 mustard-yellow (1 with cream-colored flammules) and 2 with a broad amber-yellow spiral band at the periphery crossing the flammules.

In northwestern Kauai, on the edge of the cliff above Kalalau Valley and on the northeastern side of the valley, four shells were collected by M. Barton and W. H. Meinecke which are typical though slightly larger and lower than those from Olokele. The nucleus of one operculum is almost central. In Hanakoa, Meinecke collected a large specimen with distinct pattern of flammules and typical operculum. Along the shore farther east, at Hanakapiai, thin shells with a yellowish cast and indistinct zigzag flammules, if any, in adults, were collected by C. N. Forbes, C. M. Cooke, Jr., W. F. Frear, Eric Knudsen, and P. G. H. Deverill. They are nearly typical in shape, but are higher and have more convex whorls. A few do not even have these differences, and at least one has a low spire. One measures: diameter 4.5, height 3.7 mm. On some young shells the flammules are distinct. Opercula are translucent and colorless except for a yellowish cast.

Eastward, in the upper part of Haena Valley, C. M. Cooke, Jr., found several shells like those from Hanakapiai but slightly smaller—diameter 4.2, height 3.2 mm. Some are uniformly cream-colored, others have a reddish cast and flammules in the upper whorls, and one cinnamon-rufous with flammules of cream color. Opercula narrower.

Shells similar to those from Haena were collected near the power house at Wainiha, the next valley to the east, by C. M. Cooke, Jr., but they run slightly larger and heavier and have a reddish cast. At Waipa, W. H. Meinecke found a juvenile and a nearly adult shell in a fossil state resembling those from the lower part of Wainiha Valley. In Hanalei, adjoining Waioli

on the east, C. M. Cooke, Jr., and T. T. Dranga found 2 shells, 1 with a reddish and 1 with a yellowish cast, that resemble closest those from Haena, but are larger, heavier, comparatively higher, measuring: diameter 4.9, height 3.9 mm. Operculum like no. 81343 from Wailua; tinted with mustard-yellow, on the columellar edge with ochraceous salmon. Several shells collected by Dranga in upper Hanalei are closest in size to shells from Haena, but opaque, mostly orange-cinnamon in color, few with flammules. Opercula more nearly oval than the rather triangular opercula of shells from Olokele Canyon.

Shells from Wailua are similar to the type from Olokele Canyon but slightly higher and with slightly more convex whorls. They are cinnamon-rufous to Hay's russet with cream-colored or yellowish flammules or uniform cinnamon-rufous, rarely mustard-yellow with rufous and cream-colored flammules or with cream color only on the last whorls. An average specimen measures: diameter 4.7, height 3.7 mm. They were collected by C. M. Cooke, Jr., T. T. Dranga, and W. H. Meinecke. Operculum has nearly central nucleus, tinted with salmon color, which grades to rufous at the margins.

Among them and varying in height and color are several lots of shells that do not, however, differ enough to be called varieties. A small race comes from localities along the north fork of the Wailua River, which tend to be comparatively higher than the type. Opercula are long-oval, narrower than those of shells from Waipahi (no. 80320), nucleus nearly central.

Nearest to these shells from Wailua is one with the label "*Sturanya laciniosa* Mighels, Hawaiian Islands," identified by A. Wagner, belonging to paratype material received from the Senckenbergisches Museum, Frankfurt, Germany (see p. 40). The shell is immature, having hardly more than 3 whorls. It is comparatively low-spined, measuring: diameter 3.6, height 2.8 mm.

On the west side of the Nonou mountains, C. M. Cooke, Jr., and T. T. Dranga collected several specimens similar to those from Wailua. Differences are as follows: 4 whorls, which are less convex, smaller aperture; operculum narrower, with wider membranous edge, and nucleus possibly more oblique. A typical shell measures: diameter 4.3, height 3.5 mm.

At Kukaua, Kilohana, Lihue, C. M. Cooke, Jr., found two shells, back of Kilohana one shell, slightly wider and with a larger aperture than the type, approaching *P. harwainensis*. Behind Grove Farm, Lihue, W. H. Meinecke found one similar shell not fully developed. Farther south in Lihue, at Koloa Gap, C. N. Forbes found a shell like the few others from Lihue.

At Huleia, Kipu, C. M. Cooke, Jr., found three shells like those from Wailua but smaller, thinner, and with rounder, smaller aperture; operculum broadly oval, nucleus near center. He also found others like them in the first valley south of the gap at Kipu. They have 4 whorls and measure: diameter

3.6, height 2.8 mm. Operculum is rather narrow, nucleus vertical. In the Kipu range, in the valley below the peak, Dranga collected a similar specimen. On the Kipu side of Haupu, C. M. Cooke, Jr., and C. S. Dole found four specimens like Kipu shells but a little smaller. On Haupu, also, Leslie Wishard collected one somewhat lower-spined shell, which a juvenile collected by T. T. Dranga on a cliff face resembles.

In Ohia Valley, in the Anahola watershed, C. M. Cooke, Jr., and T. T. Dranga found shells indistinguishable from those from Wailua. Opercula also are alike. Among them are three small shells, adult or nearly so, similar except in size, that may be said to belong to a small race.

In several localities at Waipahi, Cooke and Dranga made a large collection of shells, which include some like those from Wailua. They vary in shape from medium to greater height, and in size, some being smaller. Operculum is like that of Wailua shells.

Pleuropoma (Sphaeroconia) hawaiiensis variety **makalii**, new variety (fig. 106).

Almost grading into the small race of variety *knudseni* are still smaller shells. They have only $3\frac{1}{2}$ whorls, and some have the juvenile character of spiral lines raised and distinct. But they seem nearly or quite mature. Umbilical callus is wanting. The type measures: diameter 3.3, height 2.4 mm.

Kauai, Wailua, north fork of Wailua River, October 27, 1925, C. M. Cooke, Jr., and T. T. Dranga, type no. 11241, paratypes no. 81221.

All the specimens closely resemble the type in general appearance. Compared with *P. kauaiensis* they are more loosely whorled. The rib continuing in the aperture from the base of the columella is distinct. Opercula are the same kind as those of variety *knudseni*. The shells—14 in all, in 3 lots—were collected by C. M. Cooke, Jr., and T. T. Dranga, in Wailua.

Makalii is Hawaiian for "very small."

Pleuropoma (Sphaeroconia) kauaiensis (Pilsbry and Cooke) (figs. 107-109).

Helicina kauaiensis Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 9, fig. 8, 1908.

Aphanocoma kauaiensis (Pilsbry and Cooke) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

The shell is subglobose-conic, with the periphery well rounded, quite thin, nearly smooth, under a lens minutely striate with lines of growth, with several (in the type specimen about eight) widely spaced, thin, raised spiral cuticular striae, three above, one on, and the rest below the periphery, the upper striae extended on the spire nearly to the embryonic whorls. Color orange-red, with distinct light-yellow flammules at and above the periphery. Spire convexly conical, with the apex slightly acute. Suture simple, well impressed. Whorls $3\frac{3}{4}$, distinctly convex, under a lens the embryonic whorls are transversely striate, the last rounded, not descending in front. Aperture slightly oblique, semi-

circular, not contracted; outer lip thin. Callus slightly whitish about the axis, the rest very thin, transparent, very minutely punctate. Maj. diam. 3.2, total length 2.4 mm.

Kauai: The upper part of Milolii (Cooke).

Type No. 14,906, Bishop Museum.

This species recalls *H. rotelloidea* Migh., in form. It is slightly larger, darker-colored, with more distinct flammules, higher spire, and is also distinctly marked with spiral cuticular striae.

At an altitude of about 3,000 feet in Milolii, Kauai, C. M. Cooke, Jr., collected four shells, the type and paratypes of *P. kauaiensis*, and no other representatives of that species have been found in that region.

In the aperture a feature not mentioned in the description was noted—a short palatal fold or ridge extending from the base of the columella across the base of the aperture. The presence of the operculum in the type prevented it from being seen. The ridge is present also in juvenile shells. The umbilical callus is lacking.

Opercula are much like those of *P. rotelloidea*, but thicker, especially along the columellar edge, upper edge rounded, nucleus vertical. They are cream-colored, on the outside tinted with ferruginous along the columellar margin, in the paratypes nearly opaque.

Pleuropoma (Sphaeroconia) kauaiensis variety orientalis, new variety (fig. 110).

Closely resembling *P. kauaiensis*. Except in color, all differences are slight. The aperture is more oblique, and the surface is smooth except for a malleated effect caused by flattening between the eight or so spiral lines; the umbilical callus is lacking; in size the shells are smaller. The type measures: diameter 2.9, height 2.2 mm. The color is uniform—cinnamon grading to vinaceous rufous at the apex, or lighter. Opercula similar to those of the species but thinner.

Kauai, Nonou mountains, west side, October 22, 1925, C. M. Cooke, Jr., and T. T. Dranga, type no. 11242, paratypes no. 80987. Several shells strangely like *P. kauaiensis*, which is from the extreme opposite side of the island, were found with the type of the variety. A few specimens collected by C. N. Forbes (no. 42336) and D. Thaanum (no. 47792) in the Nonou mountains, though smaller, resemble these shells so closely that they also probably came from the west side of the mountains.

On the northeast side of the Nonou mountains a few shells collected by Cooke and Dranga are slightly larger (nearly equaling the type of the species), as is also one collected by C. S. Dole from the "Nonou Mts."

Compared with *P. laciniosa* variety *globuloidea*, this variety of *P. kauaiensis* is comparatively higher and narrower, has deeper sutures, rounder periphery, and smaller aperture—is a different type of shell.

Pleuropoma (Sphaeroconia) niuhauensis, new species (fig. 111).

Fossil. Like *P. kauaiensis* variety *orientalis*, from eastern Kauai, differing chiefly in being smaller and thicker-shelled and in lacking a ridge at the base of the columella. Whorls $3\frac{1}{2}$, very convex; suture deep, aperture small and oblique, basal callus thin.

Umbilical callus not discernible in type, as base is somewhat eroded, in paratypes a long narrow crescent, much as in *Orobophana uberta* variety *subtenuis*. Though thoroughly bleached, the surface bears white flammules on the last whorl and a half. The type measures: diameter 2.7, height 2 mm. Operculum wanting.

Niihau, southwestern shore, at Kiekie, January 1912, J. F. G. Stokes, type no. 11237, paratypes no. 37753.

The paratypes vary somewhat in size, in distinctness of flammules, and in size of aperture. Another shell from the same locality and collector is typical.

Pleuropoma (Sphaeroconia) rotelloidea (Mighels) (figs. 112, 113).

Helicina rotelloidea Mighels: Boston Soc. Nat. Hist., Proc., vol. 2, p. 19, 1845. Not Pfeiffer: Syst. Conch.-Cab., Helicinaceen, I, 18, 19, p. 23, pl. 3, figs. 40-43, 1846-1853. Not Pfeiffer: Mon. Pneum., p. 352, 1852. Not Pfeiffer in Gray's Cat. Phaner., p. 254, 1852. Baldwin: Cat. Shells, pp. 16, 24, Honolulu, 1893. Sykes: Fauna Hawaiiensis, vol. 2, part 4, Mollusca, p. 397, 1900. Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 10, fig. 9, 1908.

Helicina (subgenus *Idesa*) *rotelloidea* Mighels, Adams, H. and A.: Gen. Rec. Mollusca, vol. 2, p. 304, 1858.

Not *Helicina bronniiana* Philippi: Zeitschr. Malakozool., p. 124, 1847.

Sturanya rotelloidea (Mighels) Wagner: Syst. Conch.-Cab., Helicinidae, I, 18, p. 44, 1911. Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

Shell orbicular, low-conical, convex at the base, sometimes reddish brown, sometimes greenish, with obscure light spots, surface smooth; whorls about $3\frac{1}{2}$, convex; aperture semilunate; lip simple, acute. Diameter, from $\frac{1}{10}$ to $\frac{8}{35}$ inch. Hab., Oahu.

A fuller description of the species was given by Pilsbry and Cooke:

The shell is depressed, with a low conoidal spire and a well-rounded periphery, thin, nearly smooth, dull, under a lens showing minute lines of growth and two or three faint spiral lines above the periphery. Color a uniform dull cinnamon more reddish on the spire (sometimes of a uniform light greenish yellow). Spire convexly conoidal, apex subacute. Suture simple, well impressed. Whorls $3\frac{2}{3}$, distinctly convex, at first slowly and regularly, then rapidly increasing, the last wide, well-rounded, convex below the periphery, hardly descending in front. Aperture quite oblique, semicircular, not contracted; outer lip thin. Callus thin, becoming thick and whitish about the axis, the outer portion transparent, of the color of the shell, very minutely punctate. Operculum very thin, whitish, minutely punctate. Maj. diam. 3.0, total length 2.0 mm.

Oahu: Nuuanu (Cooke). This species is sometimes terrestrial in habitat. It is usually found on growing plants 2 or 3 feet above the ground.

Type of the above description, No. 14,907, Bishop Museum.

Mighels' type is probably lost. Unfortunately the species is insufficiently described and there are no figures of authentic specimens of this species. Pfeiffer's figures (Conch. Cab., Helicina, pl. iii, figs. 40-43) undoubtedly refer to *H. bronniiana* Phil. [probably a variety of *Orobophana uberta*]. Mighels' measurements (2.5-5.8 mm) include at least two species, the smaller of which has been chosen to represent the species.

The specimen selected differs from his description in the absence of "obscure light spots." These are, however, found in other specimens from another part of Nuuanu Valley.

H. rotelloidea is characterized by its small size, convex whorls, and rounded periphery.

Mighels' largest measurements probably belong to *Pleuropoma* (*S.*) *hawaiiensis* from Kauai, which in a general way resembles *P. rotelloidea*.

The rib crossing the base of the aperture parallel to the lip is a continuation of the columella, as in *P. hawaiiensis*. Umbilical callus absent, or a very narrow minute one (no. 57902).

Operculum much like that of *P. hawaiiensis* variety *knudseni* on Kauai, but smaller. If adult it has a prominent raised S-ridge, between which and the columellar edge is a rather narrow margin. This edge, on the outside, forms a more or less abrupt but rounded ridge with the surface. If the horny layer is present, the color has a yellowish cast.

In 1908, Pilsbry and Cooke published the results of their examination of the teeth of four species of Helicinidae. Of *Helicina rotelloidea* they say: "The radula of *H. rotelloidea* resembles that of *H. laciniosa*, the major lateral having 6 subequal denticles, but the inner uncini are more like the *H. baldwini* type, having about 4 large denticles."

The specimen selected by Pilsbry and Cooke as the neotype was one of several collected at "ridge 7-E," Nuuanu Valley (about a third of a mile from the Pali, on the east side) and, judging by comparison with other lots, unique. For others found in different parts of the valley vary, some even in one colony, having more oblique aperture, higher spire, several smaller size, a few larger, some more convex whorls. The differences are almost as wide for the valley as for the island. The large forms possibly were arboreal.

Collectors in Nuuanu were C. M. Cooke, Jr., O. Oswald, C. N. Forbes, D. Thaanum, W. D. Wilder, A. Gouveia, W. H. Meinecke, W. G. Marshall. Some specimens are in the Baldwin collection.

On Puu Lanihuli, J. C. Bridwell and I. Spalding found three specimens like the neotype but slightly larger, higher, thinner. On the top of Puu Konahuanui, Cooke, I. Spalding, and Eric Knudsen found a few like the neotype, and the opercula of one lot at least are similar but narrower. On the Pauoa slope of Mount Tantalus, Cooke also found a single shell—large, high, with a low aperture, and with a ridge faintly indicated above the periphery. The operculum is broader than those in shells from Nuuanu. Some other lots were nearly typical though mostly high-spined. In and near the crater of Mount Tantalus, Cooke collected a few specimens slightly to considerably smaller. Not much different were four collected by A. Gouveia on the northwest side of Pauoa Valley. In Makiki Valley, half-way or more up the west valley, Cooke found a few specimens of the small, high type, and above a waterfall near by two somewhat larger.

At Kapalama, C. N. Forbes found two *Pleuropoma rotelloidea* of the small type, and similar ones were found by I. Spalding and J. S. Emerson in

Kahauiki and on the ridge between Moanalua and Kahauiki. Two opercula examined were like those in shells from Nuuanu, one narrow, another broad with a very oblique nucleus. On the northwestern side of Kalihi Valley, O. Oswald found a few shells like those from Kahauiki but reddish in color. The opercula are similar also. At Kamanaiki, both large and small high forms with sutures deeply indented, like some in Nuuanu Valley, were collected by A. Gouveia, J. S. Emerson, and Mrs. E. H. Bryan. On Mauna Kope, at the western head of Kalihi, A. Gouveia collected a juvenile specimen with rather shallow sutures.

A single eroded fossil shell, small and high, with deeply indented suture, was collected by W. D. Wilder and bears the label "Halawa?". It closely resembles a living specimen collected by O. Oswald in the same valley, which is like those from Kalihi. Several valleys northwestward, at Waimano, A. Gouveia collected five shells like a common form in Nuuanu Valley—high-spined, shallow-sutured.

On the windward side of Oahu, a few *P. rotelloidea* have been collected. Near Kaneohe Bay, on the ridge between Kahaluu and Ahuimanu, A. Gouveia and I. Spalding found several specimens, which resemble the high-spined shells with deep sutures from Nuuanu Valley. The aperture is larger and more flaring, the spire is higher, and the shell is thicker. Many fine spiral lines are prominent in young specimens. Opercula typical, in no. 41090 being almost transparent, with a slightly pinkish tinge.

Twelve miles to the northwest, in Kaipapau and the adjoining Kaliuwaa Valley, C. N. Forbes and C. M. Cooke, Jr., collected specimens. Some are remarkably transparent and thin, but otherwise in shape and size resemble forms in Nuuanu Valley, with slightly to very convex upper whorls, and with low to high spires. The operculum of one from Kaliuwaa seems typical, though the horny layer is lacking. Farther east, in a few localities in Kahana Valley, O. Oswald found similar shells, mostly juvenile, mostly reddish-colored, and mostly high-spined. Opercula are typical. Oswald found similar high juvenile shells in Kaaawa and Hakiuu, adjoining valleys, and one mature yellowish and two juvenile reddish shells in the Kualoa mountains.

At the extreme southeastern end of the island, at Keawaawa, a few shells were collected by Gouveia, resembling the small, high form in Nuuanu Valley. On the second main ridge to the west—Kuliouou-Niu—L. L. Loofbourrow found a similar shell, and O. Oswald found two juveniles. In Niu Valley, I. Spalding found one with a slightly lower spire.

In the Waianae Mountains, *P. rotelloidea* is present in a slightly different form. Only a small collection of them has been made. All were collected by C. M. Cooke, Jr., except a few by O. Oswald, E. H. Bryan, Jr., W. H. Meinecke, C. N. Forbes, and I. Spalding. On Palikea they resemble the moderately low type from Nuuanu Valley, but are a little larger and have

more convex whorls. Some from the lower part of Mokuleia are similar, running larger and higher. On the main range between Makua and Mokuleia are two small ones, and they are like one in northeastern Makua Valley—a form with higher spire. In Waianae Valley, shells similar to that from Makua were found, some with flatter whorls, some with spires a little higher. Five from Pukaloa with considerable variability in height of spire resemble specimens from Waianae Valley, as does also one from the intervening height, Puu Kalena, the operculum of which is typical, except for slightly sloping upper palatal edge. Some from the edge of the main stream are large and have large apertures.

Northward, in Haleauau, high and low, large and small shells were taken, 3 yellowish-colored, the others reddish. From Lualualei come 3 high-spined shells, 2 cream-colored with cinnamon-rufous apices, 1 mustard-yellow. Three specimens from near the top of Puu Kaala are very small and high-spined. A shell from Makaha, a large, remarkably high one, is odd owing to an injury on the penultimate whorl.

Opercula in shells from Palikea, Waianae Valley, Haleauau and neighborhood, and Puu Kaala were examined and found to be typical, though most were larger than those in shells from Nuuanu Valley.

Pleuropoma (Sphaeroconia) rotelloidea variety *sola*, new variety (figs. 114, 115).

The type is larger than the type of *P. rotelloidea*. It resembles in size and appearance the type of variety *mauiensis* but is a little higher and has deeper sutures. The calluses, the spiral lines, the faint peripheral angle are similar. Whorls $3\frac{1}{2}$. The color on the last whorl is uniform cinnamon-buff, grading to cream color on the apex. Lacking ridge at base of columella. A small umbilical callus is present. Measurements are: diameter 3, height 2.3 mm. Opercula of paratypes like those of *P. rotelloidea* from Nuuanu Valley, Oahu, but running larger and having a rather low S-ridge.

Molokai, Kaunakakai district, Kalihi Valley, January 26, 1913, C. M. Cooke, Jr., and H. A. Pilsbry, type no. 11234, paratypes no. 33638. Specimens of this variety were also collected by A. M. Adamson, A. F. Judd, C. N. Forbes.

In the paratypes is slight variation in size and in height of spire. Some shells have a darker, reddish color, and some are less distinctly angled. On fresh dark-colored specimens a faint pattern is present, cream-colored light areas or flammules running down from the suture of the last whorl and a half. On immature specimens, spiral lines are thin, conspicuous eminences.

Other lots of shells from Kalihi resemble the paratypes, as do also a few lots from Puunaea to the north, one lot from Puu Kaeo and another from Maunahui to the east, and two lots from near-by Waihi. Shells with wide range in height and size and color were collected just west of Kalihi, in Kalamaula Valley. At Poholua, near the head of Kalihi Valley, a few low-spined specimens were collected. From Waileia a shell with more flaring aperture

than typical was collected. On the ridge above Waikolu Valley a few lots were collected, all of which resemble the paratypes. Some are excellent fresh specimens, kaiser-brown in color, with flammules of cream color more distinct than in the paratypes.

Two small, high, reddish specimens were collected at Kamalo, several valleys east of Kaunakakai, also at Kamoku, northwest of Kamalo, and at Kamiloloa (one immature specimen). Small specimens were also found at Ioli, on the ridge above Kalaupapa, with rather small apertures. Southeast of Kalaupapa, near the head of Waihanau Valley, very small immature shells were collected. In the valley east of Waikolu—Pelekunu—were collected specimens differing from the type in having smaller, more flaring apertures. They are light-colored, tending to pinkish or yellowish, some being maize-yellow with alternating cream-colored and tawny flammules. At the top of Wailau Pali, the valley adjoining Pelekunu on the east, some large, well-rounded specimens with rounded, flaring apertures and angled periphery were collected. High on the ridge of Kaluaaha Valley smaller, lower-spined specimens were collected.

Over the ridge, near the bottom of the trail at Kalaupapa, fossil shells were collected with both low and high spires.

The opercula are similar to those of the paratypes, in small shells running smaller. Most are translucent, light, uniform-colored (those that still have the inner layer, which owing to the thinness and fragility of the opercula of *P. rotelloidea* has not been preserved in many). In two lots from Waikolu that have dark red shells the opercula are similarly colored, at least on the columellar edge.

***Pleuropoma (Sphaeroconia) rotelloidea* variety *mauiensis*, new variety (fig. 116).**

Larger and comparatively higher than *P. rotelloidea*; otherwise with only slight differences. Lacking ridge at base of columella. A peripheral angle is faintly indicated. In the type the umbilical callus is a little smaller than that of variety *sola*. The type measures: diameter 3.2, height 2.2 mm. Opercula like those of the species.

West Maui, Maunahooma, February 3, 1904, C. M. Cooke, Jr., type no. 11221, paratype no. 14813.

At Maunahooma, C. M. Cooke, Jr., and C. N. Forbes collected several similar specimens, also a few smaller, juvenile specimens with considerable variation in the height of the spire. One shell bearing the label "W. Maui," from Forbes, is typical of the variety.

***Pleuropoma (Sphaeroconia) sulculosa* Ancey (fig. 117).**

Helicina sulculosa Ancey: Malacol. Soc. London, Proc., vol. 6, p. 127, pl. 7, fig. 25, 1904. Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 8, 1908.

Aphanconia sulculosa (Ancey) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

Original description:

Testa parva, subgloboso-conoidea, solidiuscula, subnitens, lineis incrementi obsoletis, prope aperturam perspicuis oblique notata, praeterea sulcis linearibus distantibus 5-8 circumdata (duobus superioribus anfractus superiores quoque cingentibus), rubella, concolor vel prope suturam pallido maculata. Spira conoidea, acutiuscula. Anfractus 4, inferiores convexiusculi, sutura parum profunda; ultimus supra convexo-declivis, basi convexus, haud carinatus, ad peripheriam initio vix angulatus. Callum basale circumscriptum, elevatum, tenuiter granulatum, lividum, breve. Apertura obliqua, subtriangularis, extus angulatum rotundata. Peristoma simplex, vix basi expansiusculum. Operculum testaceum, lividum, crassiusculum, ad partem sinistram anguste rubro-marginatum.

Diam. 3.33, alt. 2.5, alt. apert. 1.5 mm.

Hab., Oloa, Hawaii (Thaanum).

Pilsbry and Cooke consider that this species is closely related to *Pleuropoma laciniosa* variety *alpha*, though the spire of *P. (S.) sulculosa* "is more depressed, the whorls are slightly more convex, and the aperture is more rounded." Their only other remark is, "This is the only species so far reported from the island of Hawaii."

In some ways the shells seem closely related to *Orobophana uberta* variety *muuanuensis*.

As Ancey's type of *P. sulculosa* (no. 19068) is not mature, it is not representative:

The type is smaller than two of the paratypes and has a lower spire. Today the colors may be described as: ochraceous tawny with alternate spots of kaiser-brown and cream color following the suture of the last whorl. The spiral lines are narrow, shallow indentations, numbering 8 on the last whorl, 2 on the upper whorls. Though the apex is eroded, the number of whorls seems to me $3\frac{1}{2}$ instead of Ancey's 4. The slight peripheral angle noted by Ancey is decidedly inconspicuous and is not present at the aperture. The basal callus is noticeable more for its whitish color than for its elevation, which is slight. The umbilical callus is whitish also, and it is a small crescent, slightly larger than that of *Orobophana uberta* variety *muuanuensis*. Operculum wanting. My measurements, smaller than Ancey's, are: diameter 3.1, height 2.3 mm.

Besides the type, three paratypes are in Bernice P. Bishop Museum, one of which (no. 19077) was sent with the type to Ancey. The paratypes differ from the type in several ways:

They are larger, the larger of two in no. 14899 having the same measurements as Ancey has given for the type: diameter 3.3, height 2.5 mm. They are higher-spined, have a well-rounded angle only faintly indicated, and have light and dark zigzag streaks instead of spots alternating downward from the suture of the last whorl. The spiral lines die out before reaching the aperture, and the lowest one is not evident. Operculum wanting. A juvenile shell with distinct spiral lines and zigzag markings accompanies the adult one. The other paratype (no. 19077) is uniform in color and has more convex whorls, but is similar in other ways. Opercula are attached or lacking, and so the inner side can not be seen. The outer side of only one can be seen clearly, and in shape it resembles that of *P. rotelloidea*. It has a reddish tint along the columellar edge.

Besides type and paratypes collected by D. Thaanum, few specimens of *P. sulculosa* have come to the Bishop Museum—only one from Kapua, South

Kona, received through A. Gouveia. It is like the paratypes, but slightly larger and comparatively lower and wider. The whorls are quite convex, the color nearly uniform.

DOUBTFUL AND EXCLUDED SPECIES

***Helicina antoni* Pfeiffer.**

Helicina antoni Pfeiffer: Zeitschr. f. Malakozool., p. 88, 1848. Pfeiffer: Mon. Pneum., vol. 1, pp. 377, 378, 1852. Pfeiffer: in Gray's Cat. Phaner., pp. 273, 274, 1852. Pfeiffer: Syst. Conch.-Cab. of Martini and Chemnitz, Helicinaceen, I, 18, 19, p. 44, pl. 5, figs. 35-38, 1846-1853. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 397, 1900.
Helicina (subgenus *Oligyra*) *Antoni* Pfeiffer, Adams, H. and A.: Gen. Rec. Mollusca, vol. 2, p. 302, 1858.

In the original description of the species, Pfeiffer does not give the location; in two later references he gives Honduras; and in the Conchylien-Cabinet he gives "Sandwich" and "Gambier" islands. Sykes states: "It really appears to come from Honduras, and the Hawaiian habitat is probably erroneous, these supposed Hawaiian specimens belonging, as undoubtedly the Gambier Island shells do, to *H. pazi* Crosse."

The species is not mentioned by Wagner in his studies of the family Helicinidae (1911) nor by Gould in Mollusca of the Wilkes Exploring Expedition. It is probably due to an error that Pfeiffer once listed this species from Hawaii.

***Helicina bronniana* Philippi.**

Helicina bronniana Philippi: Zeitschr. f. Malakozool., p. 124, 1847. Pfeiffer: Mon. Pneum., vol. 1, p. 352, 1852. Pfeiffer: Syst. Conch.-Cab. of Martini and Chemnitz, Helicinaceen, I, 18, 19, p. 23, 1846-1853. Paetel, Cat. Conch.-Samml., Abt. 2, p. 492, 1889. Baldwin: Cat. Shells, p. 24, Honolulu, 1893. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 397, 1900.

Helicina laciniosa variety *bronniana* (Philippi) Pilsbry and Cooke: B. P. Bishop Mus., Occ. Papers, vol. 3, no. 2, p. 5, 1908.

Sturanya laciniosa bronniana (Philippi) Caum: B. P. Bishop Mus., Bull. 56, p. 6, 1928.

In all references except the original description and Pilsbry and Cooke's, *Helicina bronniana* is said to be a synonym of *H. rotelloidea*. This hardly seems correct, as the original descriptions of the two do not agree, *H. bronniana* being larger and provided with a rounded angle on the last whorl. Instead, *H. bronniana* is perhaps related to *Pleuropoma laciniosa*, as Pilsbry and Cooke state, or even more probably to *Orobophana uberta* variety *magda-*

lenae. In color, form, and size, the description suggests a juvenile stage of that variety.

***Helicina crassilabris* Philippi.**

Helicina crassilabris Philippi: Zeitschr. f. Malakozool., pp. 125, 126, 1847. Pfeiffer: in Gray's Cat. Phaner., p. 252, 1852. Pfeiffer: Syst. Conch.-Cab., Helicinaceen, I, 18, 19, pp. 20, 21, pl. 2, figs. 33-36, 1846-1853. Pfeiffer: Mon. Pneum., vol. 1, p. 349, 1852. Adams, H. and A.: Gen. Rec. Mollusca, vol. 2, p. 304, 1858. Paetel: Cat. d. Conch.-Samml., Abt. 2, p. 493, 1889. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 397, 1900. Caum: B. P. Bishop Mus., Bull. 56, p. 7, 1928.

"Sandwich Islands" is given as the location of this species in the original description, which, however, does not fit any known Hawaiian shell. Pfeiffer cites the same location in one reference. In two other references he questions "Sandwich Islands" and adds Venezuela, once with a question mark. H. and A. Adams do not give a location. Paetel gives "Sandwich Islands." Wagner does not list the species. Sykes and Caum agree that the species is erroneously reported from Hawaii, Sykes saying: "It really comes from Venezuela or the Caribbean region."

***Helicina pisum* Hombron and Jacquinot.**

Helicina pisum Hombron and Jacquinot: Voyage au Pole Sud, Zool., vol. 5, p. 44, pl. 11, figs. 18-22, 1854. Pfeiffer: Mon. Pneum., 1st suppl., p. 185, 1858. Pease: Jour. de Conch., vol. 18, p. 398, 1870. Paetel: Cat. d. Conch.-Samml., Abt. 2, p. 499, 1889. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 397, 1900.

This is not a Hawaiian species. In the references listed above, the locality is given as Tahiti. Pease and Sykes state that it is a synonym of *H. tahitensis* Pease.

***Helicina pisum* Philippi.**

Helicina pisum Philippi: Zeitschr. f. Malakozool., pp. 124, 125, 1847. Pfeiffer: in Gray's Cat. Phaner., p. 250, 1852. Pfeiffer: Mon. Pneum., vol. 1, p. 347, 1852. Pfeiffer: Syst. Conch.-Cab., Helicinaceen, I, 18, 19, p. 19, pl. 2, figs. 30-32, and pl. 8, figs. 7, 8, 1846-1853. Paetel: Cat. d. Conch.-Samml., Abt. 2, p. 499, 1889. Sykes: Fauna Hawaiiensis, vol. 2, pt. 4, Mollusca, p. 397, 1900. Caum: B. P. Bishop Mus., Bull. 56, p. 7, 1928.

Helicina (subgenus *Emoda*) *pisum* Philippi, Adams, H. and A.: Gen. Rec. Mollusca, vol. 2, p. 304, 1858.

In the original description of this species, Philippi states: "Patria: Insulae Sandwich, communicavit cl. Largilliert." Pfeiffer and Paetel also give "Sandwich Islands" as the home. The Adamses do not include a locality. Sykes

thinks Vate or Sandwich Island may have been meant, or possibly Savage Island, "from which specimens, inseparable from this, undoubtedly do come." Wagner (1911) does not list it. Caum states that it is erroneously reported from the Hawaiian islands. The original description does not agree with that of any Hawaiian species. It comes nearest to *Orobophana uberta*, which is, however, proportionately higher and has a sharp and thin rather than a thickened lip and a half-oval rather than a triangular aperture. A variety added by Pfeiffer—larger and with two fine white bands—has not been found in Hawaii. Neither do figures published by Pfeiffer agree with any Hawaiian species.

***Helicina fulgora* Gould.**

See *Pleuropoma laciniosa*.

***Helicina constricta* Pfeiffer.**

See *Orobophana uberta* variety *magdalanae*.

INDEX

| | PAGE | | PAGE |
|---|---------|--|--------|
| Aphanoconia | 38 | Orobophana cookei | 14 |
| Aphanoconia dissotropis | 50 | Orobophana juddii | 11 |
| Aphanoconia fulgora..... | 39, 50 | Orobophana lymaniana | 33 |
| Aphanoconia hawaiiensis | 84 | Orobophana meineckeii | 18 |
| Aphanoconia kauaiensis | 90 | Orobophana stokesii | 15 |
| Aphanoconia knudseni | 86 | Orobophana stokesii variety praemagna | 16 |
| Aphanoconia nuuanuensis | 34 | Orobophana uberta | 19 |
| Aphanoconia oahuensis | 79 | Orobophana uberta variety beta..... | 32 |
| Aphanoconia sulculosa | 97 | Orobophana uberta variety borealis.... | 31 |
| | | Orobophana uberta variety bryani..... | 24 |
| Helicina | 9, 38 | Orobophana uberta variety bryani | |
| Helicina antoni | 98 | form a | 25 |
| Helicina baldwini | 16 | Orobophana uberta variety bryani | |
| Helicina berniceia | 13 | form b | 25 |
| Helicina bronniiana | 92, 98 | Orobophana uberta variety exanima.. | 37 |
| Helicina constricta β | 27 | Orobophana uberta variety hybrida.... | 35 |
| Helicina constricta | 27, 100 | Orobophana uberta variety lymaniana | 33 |
| Helicina constricta β | 27 | Orobophana uberta variety magdalenae | 27 |
| Helicina crassilabris | 99 | Orobophana uberta variety makuuensis | 27 |
| Helicina dissotropis | 50 | Orobophana uberta variety nuuanuensis | 34 |
| Helicina fulgora | 100 | Orobophana uberta variety percitrea | 37 |
| Helicina hawaiiensis | 84 | Orobophana uberta variety subtenuis | 31 |
| Helicina huberti | 19 | Orobophana uberta variety wilderi.... | 26 |
| Helicina juddii | 11 | Orobophana uberta variety wilderi | |
| Helicina kauaiensis | 90 | form a | 26 |
| Helicina knudseni | 86 | | |
| Helicina laciniosa | 39 | Pleuropoma | 38 |
| Helicina laciniosa variety alpha..... | 59 | Pleuropoma laciniosa | 39 |
| Helicina laciniosa variety beta..... | 32 | Pleuropoma laciniosa variety alpha.... | 59 |
| Helicina laciniosa variety bronniiana.. | 98 | Pleuropoma laciniosa variety can- | |
| Helicina laciniosa variety delta..... | 65 | yonensis | 68 |
| Helicina laciniosa variety dissotropis | 50 | Pleuropoma laciniosa variety delta.... | 65 |
| Helicina laciniosa variety gamma..... | 61 | Pleuropoma laciniosa variety ferru- | |
| Helicina lymaniana | 33 | ginea | 46 |
| Helicina magdalenae | 27 | Pleuropoma laciniosa variety gamma | 61 |
| Helicina nuuanuensis | 34 | Pleuropoma laciniosa variety glo- | |
| Helicina oahuensis | 79 | buloidea | 67 |
| Helicina pisum | 99 | Pleuropoma laciniosa variety hono- | |
| Helicina rhodostoma | 27 | kawaiensis | 19, 73 |
| Helicina rotelloidea..... | 92 | Pleuropoma laciniosa variety kaaensis | 76 |
| Helicina sandwichiensis | 50 | Pleuropoma laciniosa variety kaaensis | |
| Helicina sulculosa | 96 | form a | 76 |
| Helicina uberta | 19 | Pleuropoma laciniosa variety ka- | |
| Helicina uberta variety magdalenae.... | 27 | hoolaweensis | 76 |
| | | Pleuropoma laciniosa variety kie- | |
| Oligyra sandwichiensis | 50 | kieensis | 69 |
| Orobophana | 9 | Pleuropoma laciniosa variety konaensis | 77 |
| Orobophana baldwini | 16 | Pleuropoma laciniosa variety ko- | |
| Orobophana baldwini variety lihueensis | 18 | naensis form a..... | 77 |
| Orobophana berniceia | 13 | Pleuropoma laciniosa variety ko- | |
| Orobophana constricta | 27 | naensis form b..... | 78 |

| | PAGE | | PAGE |
|--|--------|---------------------------------------|--------|
| Pleuropoma laciniosa variety ko- | | Pleuropoma oahuensis | 79 |
| naensis form c..... | 78 | Pleuropoma oahuensis variety gemina | 81 |
| Pleuropoma laciniosa variety ko- | | Pleuropoma (Sphaeroconia) ha- | |
| naensis form d..... | 78 | waiiensis | 84 |
| Pleuropoma laciniosa variety ku- | | Pleuropoma (Sphaeroconia) hawai- | |
| laensis | 19, 74 | iensis variety knudseni | 86 |
| Pleuropoma laciniosa variety ku- | | Pleuropoma (Sphaeroconia) hawai- | |
| laensis form a | 74 | iensis variety makalii | 90 |
| Pleuropoma laciniosa variety ku- | | Pleuropoma (Sphaeroconia) kau- | |
| laensis form b..... | 74 | aiensis | 90 |
| Pleuropoma laciniosa variety laula.... | 48 | Pleuropoma (Sphaeroconia) kau- | |
| Pleuropoma laciniosa variety matutina | 68 | aiensis variety orientalis..... | 91 |
| Pleuropoma laciniosa variety molo- | | Pleuropoma (Sphaeroconia) nii- | |
| kaiensis | 69 | hauensis | 91 |
| Pleuropoma laciniosa variety molo- | | Pleuropoma (Sphaeroconia) rotel- | |
| kaiensis form a | 70 | loidea | 92 |
| Pleuropoma laciniosa variety moo- | | Pleuropoma (Sphaeroconia) rotel- | |
| miensis | 72 | loidea variety mauiensis | 96 |
| Pleuropoma laciniosa variety per- | | Pleuropoma (Sphaeroconia) rotel- | |
| parva | 64 | loidea variety sola | 95 |
| Pleuropoma laciniosa variety pili- | | Pleuropoma (Sphaeroconia) sulculosa | 96 |
| formis | 74 | Pleuropoma subsculpta | 82 |
| Pleuropoma laciniosa variety pili- | | Sphaeroconia | 83 |
| formis form a..... | 75 | Sturanya | 38 |
| Pleuropoma laciniosa variety prae- | | Sturanya laciniosa | 39, 84 |
| parva | 67 | Sturanya laciniosa variety alpha..... | 59 |
| Pleuropoma laciniosa variety pusilla.. | 49 | Sturanya laciniosa variety beta..... | 32 |
| Pleuropoma laciniosa variety sand- | | Sturanya laciniosa variety bronniana | 98 |
| wichiensis | 50 | Sturanya laciniosa variety delta..... | 65 |
| Pleuropoma laciniosa variety signata | 63 | Sturanya laciniosa variety gamma..... | 62 |
| Pleuropoma laciniosa variety spal- | | Sturanya rotelloidea | 92 |
| dingi | 48 | | |
| Pleuropoma nonouensis | 79 | | |