

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 59, NUMBER 14

REPORT ON LANDSHELLS COLLECTED IN PERU IN 1911
BY THE YALE EXPEDITION UNDER PROFESSOR HIRAM
BINGHAM, WITH DESCRIPTIONS OF A NEW SUBGENUS,
A NEW SPECIES, AND NEW VARIETIES

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(PUBLICATION 2092)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
JUNE 8, 1912

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

REPORT ON LANDSHELLS COLLECTED IN PERU IN 1911
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This expedition under the auspices of the Yale Corporation reached Peru in June, 1911, and proceeded to Cuzco. The collections were made chiefly in the Urubamba Valley, a region which had been visited by Angrand, and perhaps other collectors, but, of which, as regards its molluscan fauna comparatively little was known.

The region seems to possess a fauna of which the species are very wide-spread, and mostly have been described from other localities. A few new varieties and one new species were among the shells collected, and the addition to our knowledge of the distribution of the species is valuable.

But the most interesting result is the discovery of a new and remarkable group among the Bulimulidæ, characterized by a peculiar internal protective armature behind which the animal can retreat when menaced by such enemies as the predaceous millipedes, which are known to feed upon living pulmonate mollusks.

This internal armature has not been previously noted, as the shells are uncommon in collections and this feature can only be observed by opening the whorls of the spire.

Professor H. W. Foote, in charge of the natural history work of the party collected most of the shells here enumerated.

Professor Foote writes in regard to the situs of the shells as follows:

It was the dry season and winter when I was in Peru and it seemed to be a resting period for all the snails we saw. They were not moving and appeared to be glued to their resting places in all cases.

The specimens labelled "near Maras" were all found on bushes, and I think thousands of them could have been obtained in a day. The region where they were was somewhat dry, or at least there is a long dry season, and it was above the tree line.

The shells labelled "Santa Ana" were from the valley of the Urubamba River and were rather hard to find. Most of them were fastened on the under side of shelving rocks. We collected nearly all we saw, but, judging by the number of dead shells, snails must be common there in the wet season. The

region was originally heavily forested, but has been cleared and a second growth of brush has taken the place of the original forest which does not grow again.

It may be added that though some of the *Drymæus* were collected in August, 1911, and were not received by the present writer until March, 1912, a certain number of them were still living at the latter date. All the specimens of *Phenacotaxus* and *Peronæus* had become entirely desiccated.

LIST OF THE SPECIES OBTAINED.

BORUS MATHIUSII Orbigny

Helix mathiusii ORB., Guérin Mag. de Zoöl. 1835, p. 16.

Strophocheilus (Borus) mathiusii PILSBRY, Man. Conch., vol. 10, p. 17, pl. 7, f. 4, 5; pl. 9, f. 45, 1895.

Near Santa Ana, Eastern Peru, at a height of 3500 feet.

The species is finely spirally striated and has a white peristome. U. S. N. Mus., No. 250238.

BORUS CAPILLACEUS Pfeiffer

Bulimus capillaceus PFR., P. Z. S. 1855, p. 93; Hupé, in Castelnau Exp. p. 26, pl. 4, f. 3, 1857.

Strophocheilus (Borus) capillaceus PILSBRY, Man. Conch., vol. 10, p. 31, pl. 14, f. 69, 1895.

Found with the preceding. The shell is of a more whitish color, has no spiral sculpture, and the peristome when fresh is of a deep rose-pink. U. S. N. Mus., No. 250241.

SCUTALUS REVINCTUS Hupé

Bulimus revinctus HUPÉ, in Castelnau Exp. p. 39, pl. 7, f. 2, 1857.

Bulimulus (Scutalus) revinctus PILSBRY, Man. Conch., vol. 11, p. 17, pl. 3, f. 34-40, 1895.

Between Ollantaytambo and Maras, in Eastern Peru, at an elevation of 10,000 to 11,000 feet. Several not quite mature specimens were obtained. U. S. N. Mus., No. 250242.

DRYMÆUS TORALLYI Orbigny

Helix torallyi ORB., Guérin, Mag. de Zoöl. 1835, p. 11.

Drymæus torallyi PILSBRY, Man. Conch., vol. 11, p. 278, pl. 44, f. 97, 98, 99, 1, 2, 3; 1895.

Near Camana, west coast of Peru, at 2000 feet elevation. The specimens have a wider umbilicus than the typical form. U. S. N. Mus., No. 250243.

DRYMÆUS LONGINQUUS Morelet

Bulimus longinquus MORELET, Ser. Conchyl., vol. 3, p. 195, pl. 11, f. 2; April 1863.

Drymæus longinquus PILSBRY, Man. Conch., vol. 11, p. 293, pl. 50, f. 93, 94, 1898.

?*Bulimus amænus* BONNET, Rev. and Mag. de Zoöl. 1864, p. 70, pl. 6, f. 2; not of Pfeiffer, 1847.

Between Ollantaytambo and Maras, Eastern Peru, at a height of 10,000 to 11,000 feet. U. S. N. Mus. 250244. This species and that of Bonnet are so similar that it seems possible that they are identical, and that Bonnet's locality questioned by Pilsbry is right after all. The *D. corumbaënsis* Pilsbry, from Eastern Brazil is probably distinct.

DRYMÆUS PÆCILUS Orbigny

Helix (Cochlogena) pæcila ORB., Guérin, Mag. de Zoöl., 1835, p. 11.

Bulimus pæcilus ORB., Voy. Am. Mér., p. 268, pl. 31, f. 1-10, 1837.

Bulimus pictus BONNET, Mag. de Zoöl. (2) vol. 16, 1864, p. 69, pl. 5, f. 4-6; pl. 6, f. 1.

Bulimus (Mesembrinus) pæcilus LUBOMIRSKI, Proc. Zoöl. Soc. Lond. for 1879, p. 725 (Chota, Peru).

Eastern Peru, from 3500 to 11,000 feet elevation.

This form is one of the most puzzling and apparently variable that I know of, but the large series collected by the Yale Expedition permits one to come to some conclusions. The possession of specimens of Orbigny's species obtained from him by Dr. Isaac Lea has been of material assistance. I feel some doubt as to the identity of the specimens referred to by Doctor Pilsbry as coming from Matto Grosse, Brazil, with the Yale Peruvian form, and it is possible we have to do with several distinct species which pass through an analogous series of color variations.

Orbigny's variety *major* has a nearly black apex, which is not found in his variety *minor* (so far as our specimens indicate) nor in any of the specimens collected by the Yale Expedition. The specimens noted by Lubomirsky from Chota, Peru, also did not possess this feature.

Orbigny's specimens of both varieties have an imperforate umbilicus; variety *major* has a wide reflection of the pillar lip, with a space behind it, but no perforation, his variety *minor* lacks even this, there being only a very minute chink and narrow reflection. Beside Orbigny's specimens we have others from Venezuela taken in the Sierra Madre Mountains at an altitude of 6000 feet, and some from Corumbá, Brazil, all of the variety *minor*.

Except the pure white form (which may be a distinct species) all the Yale specimens have well developed, or traceable, the following characters: (1) A perforate axis with usually (when fully adult) a wide funicular space behind the reflected lip at the entrance of the perforation; (2) a more or less interrupted brown spiral band in front of the suture; (3) a very marked dark, often black spiral band, which is covered by the advancing lip, immediately under the suture. When nearly all the other brown markings are obsolete this single band is very persistent, and is absent only when all the other spiral dark bands, except the umbilical band, are absent; (4) a broad dark band in the atrium of the umbilicus, the most persistent of all; (5) between the subsutural and preceding antesutural bands on the last whorl are several minor, narrower and less persistent bands, usually more or less broken up into dots or patches. The normal number of these seems to be three, but one is sometimes absent or fused with one of the others. Between the subsutural and umbilical bands there are one usually and sometimes two minor bands of which one is always less strong than the other. All these bands may be absent or feeble, but the umbilical band is usually traceable. The axial brown coloring is present in vertical streaks, when the shell is melanitic the color seems to flow at the intersection of the spiral bands with these streaks leading to an appearance which might be described as "strung triangles." These, in very dark specimens, become more or less nebulous or indistinctly limited. The spirals by themselves may fuse till nearly the whole shell is dark colored. In Orbigny's varieties there is no umbilical dark band and the shell is markedly white under the pattern, while the Yale Expedition specimens tend to creamy or pale buff rather than white. As a majority of the Yale specimens came from the vicinity of Santa Ana, I propose to call this type variety *santanensis* and restrict to Orbigny's form the designation *pæcilus* s. s.

The former has, as has been indicated, a great variety of color mutants, the more conspicuous of which may be enumerated as follows:

1. (variety?) *pærcandidus* Dall, nov. Shell pure white, seven-whorled, perforate, surface somewhat rudely, axially striated, with, on the last whorl, rather distant, somewhat irregular, widely separated, minute axial ridges. Length of shell 32; of aperture, 17; max. diameter of shell, 17 mm.

Above Santa Ana, opposite Chinche, at 3500 feet elevation, and above Ollantaytambo at 10,000 feet elevation. U. S. N. Mus., No. 250245.

2. Mutation *A*. Shell creamy white with faint, axial, gray or pale brownish streaks, and traces of obsolete spirals as grayish bands.
Ollantaytambo, at 10,000 feet elevation. U. S. N. Mus., No. 250247.
3. Mutation *B*. Pale buff with darker axial streaks, apex rosy; no spirals except the conspicuous umbilical band.
Three leagues above Santa Ana, opposite Chinche, 3500 feet elevation. U. S. N. Mus., No. 250248.
4. Mutation *C*. Buff with broken spirals except subsutural and umbilical bands; apex corneous.
Same locality as *B*. U. S. N. Mus., No. 250249.
5. Mutation *D*. Buff with sharply defined subsutural and umbilical spirals, the other spirals absent or barely traceable.
Same locality as *B*. U. S. N. Mus., No. 250250.
6. Mutation *E*. Larger, darker, subsutural band wide and strong, the others mostly broken, the axial streaks dark brown.
Same locality as *B*. U. S. N. Mus., No. 250251.
7. Mutation *F*. Axial streaks dark and strong. All spirals absent or obsolete.
Above Ollantaytambo, 10,000 feet elevation. U. S. N. Mus., No. 250252.
8. Mutation *G*. Spirals chocolate brown, more or less fused; axials strong; with an effect of a peripheral whitish band.
Between Ollantaytambo and Maras, 10,000 to 11,000 feet elevation. U. S. N. Mus., No. 250254.
9. Mutation *H*. Larger, antesutural band much broken, subsutural strong, others mostly broken, but strong.
Same location as *B*. U. S. N. Mus., No. 250253.
10. Mutation *I*. Smaller, spirals dark and close set with "strung triangles" effect over axial streaks.
Same location as *B*. U. S. N. Mus., No. 250255.
11. Mutation *J*. Very dark, all spirals strong and close set, more or less nebulous, apex rosy.
Same location as *B*. U. S. N. Mus., No. 250257.

The *D. humboldti* of Reeve, while belonging to the same general group, seems to be a very distinct form, represented in the U. S. N. Mus. by specimens from Urubamba, Peru (No. 110065).

DRYMÆUS BEYERLEANUS Hupé

Bulimus beyerleanus HUPÉ, in Castelnau, Anim. Nouv. Am. du Sud. p. 50, pl. 6, f. 6, 1857.

Drymæus beyerleanus PILSBRY, Man. Conch., vol. II, p. 197, pl. 38, f. 4, 5, May, 1898.

Under rocks at Lucma, Peru, 7000 feet elevation, also three leagues above Santa Ana, Eastern Peru, Yale Expedition, 3500 feet elevation.

While this may be, as claimed by some naturalists, a mutation of *B. zoögraphicus* Orb., it is the exact type which Hupé named *beyerleanus*. U. S. N. Mus., No. 250258.

D. BEYERLEANUS var. **MITCHELLI** Dall, nov.¹

With the preceding, but, so far as the collections show, without intergradations.

Shell somewhat more slender than *beyerleanus*, with the same number of whorls; the peristome less reflected, the pillar more slender and slightly gyrate. Color of pinkish buff, disposed in alternating darker and paler axial streaks. Interior of the aperture pale lilac. Height, 41.0; aperture, 20.0; maximum diameter, 15.0 mm. U. S. N. Mus., No. 250260.

BULIMULUS TYLERI Dall, n. n.²

Bulimus simplex HUPÉ, Castelnau, Nouv. Anim. Am. du Sud. p. 53, pl. 9, f. 6, 1857, not of Jonas, P. Z. S. 1842, p. 189.

Above Santa Ana, opposite Chinche, Peru, at 3500 feet elevation. U. S. N. Mus., No. 250261.

Two specimens agreeing with Hupé's figure and description were collected as above, thus confirming the habitat given by him, which had been questioned.

Subgenus ATAXUS Albers

Ataxus ALBERS, Die Heliceen, p. 164, 1850. Type *Bulimus umbilicaris* Souleyet.

Owing to the kindness of Dr. H. A. Pilsbry of the Academy of Natural Sciences, Philadelphia, I have been able to examine a specimen of the type of the subgenus, which is notable for its deep tubular umbilicus extending to the apical part of the shell and bordered by a blunt carina on the base of the shell. On opening the specimen so as to expose the interior of the whorls, the axis is seen to be very

¹ Named in honor of Alfreda Mitchell at the request of Dr. Bingham.

² Named in honor of Mr. Victor Tyler at the request of Dr. Bingham.

simple, without irregularities or laminæ on any part of the interior surface. U. S. N. Mus., No. 214369.

There are a number of species which have been referred to this group which do not agree with *Ataxus* except in external characters. They have developed an elaborate system of lamination within the whorl, but so far back from the aperture that only by opening the shell can it be observed, somewhat as in *Holospira*.

The species I have been able to examine are *scalaricosta* Morelet, *infundibulum* Pfeiffer, *umbilicatellus* Pilsbry, *tubulatus* Morelet, and *spiculatus* Morelet, which last from its want of the wide umbilicus had been referred to *Peronæus*.

It is evident that a new name is required for the forms with an internal armature, for which I propose the name *Phenacotaxus* and divide this into two sections, *Phenacotaxus* s. s. and *Ataxellus*; as follows:

Subgenus PHENACOTAXUS Dall, nov.

Type *Bulimulus (Ataxus) umbilicatellus* Pilsbry.

Shell elongate or fusiform, slender, axially sculptured, the pillar with a plication beginning in the posterior half of the last whorl and extending nearly to the apex, the plica at intervals widely expanding laterally into the lumen of the whorl.

Section *Phenacotaxus* s. s.

Shell with a funicular wide umbilicus extending to the apex, narrowing the whorl and aperture, and making the axis tubular.

Section *Ataxellus* Dall, nov.

Shell very elongate, imperforate, the axis thread-like, gyrate. Type (*Bulimus spiculatus* Morelet, var.?) *A. pectinatus* Dall, n. sp.?

PHENACOTAXUS SCALARICOSTA Morelet

Bulimus scalaricosta MOR., Journ. de Conchyl., vol. 8, 1860, p. 375; Sér. Conchyl. vol. 3, p. 205, pl. 11, f. 8, Apr. 1863. (Plateau of Andamarca, province of Cuzco, Peru.)

Between Ollantaytambo and Maras, Peru, at 10,000 to 11,000 feet elevation. U. S. N. Mus., No. 250262.

This species has a narrow holostomate aperture almost separated from the preceding whorl.

The axial plica is invisible from the aperture and begins in the first half of the last whorl near the base, where it forms a broad, strong lamella curving distally toward the base of the whorl, and about half

as wide as the lumen of the whorl. As it recedes toward the apex of the spire it becomes narrower and also ascends more rapidly than the coil of the whorl, so that when it has completed one turn it appears midway between the roof and base of the whorl and is also much reduced in width; at the completion of the second turn it is close to the roof of the whorl and exhibits a short, broad subtriangular horizontal expansion; in the next turn it has become again a simple thread-like, low plica which is at the junction of the roof of the whorl and the axial wall, and so continues up the spire.

PHENACOTAXUS INFUNDIBULUM Pfeiffer

Bulimus infundibulum PFR., Proc. Zoöl. Soc. Lond. for 1851, p. 255.

Bulimulus (Ataxus) infundibulum PILSBRY, Man. Conch. 10, p. 131, pl. 44, f. 89-92, Mar. 1896.

Right bank of the Rio Pampas, on road from Bombon to Pajonal, Peru. Dr. H. Bingham.¹ U. S. N. Mus., No. 209266. Province of Ayachuco, Peru, Pfeiffer.

In this species the internal lamella begins abruptly in the inner half of the last whorl as a strong, stout plate with a much thickened distal edge which nearly reaches the opposite (outer) wall of the whorl, and has its margin recurved toward the base of the whorl. The part joining the pillar wall is thin, and (in the specimen examined) has a rather large perforation. The plate curves round the inner wall of the whorl, ascending in one turn from the middle of that wall nearly to the angle of that wall with the roof of the next whorl, and at the same time diminishes in size and strength to a low, sharp, simple lamella. This is traceable as a mere thread in the two preceding whorls.

PHENACOTAXUS UMBILICATELLUS Pilsbry

Bulimulus (Bostryx, Ataxus) infundibulum var. *umbilicatellus* PILSBRY, Man. Conch., vol. 10, p. 131, pl. 44, f. 93, 94, March 1896.

Bulimulus (Bostryx) umbilicatellus DALL, Proc. U. S. N. Mus., vol. 38, No. 1736, p. 179, June 1910.

Rio Pampas, with the last species, Dr. Bingham. U. S. N. Mus., No. 161618.

Externally this species differs chiefly from *A. infundibulum* by being more slender, so that Dr. Pilsbry regarded it as only a variety of the latter; and this opinion was justified by the appearance of the

¹ These specimens were obtained by Dr. Bingham on a previous journey, the mollusks of which are described in the Proceedings of the U. S. Nat. Museum, number 1736, pp. 177-182, June, 1910.

shells. By breaking or grinding away the outer wall of the later whorls and revealing the hidden lamination, it is seen to be quite different in the two forms. As often happens in *Holospira* a similar exterior masks two very unlike interior arrangements.

In the present species instead of beginning abruptly and reaching its greatest extension in the first half of the last whorl as in *infundibulum*, the lamina begins gradually near the base of the pillar wall and rises for a third of a whorl before beginning its strongest development, when it forms a remarkably stout horizontal lamina with a broad, flat edge almost touching the outer wall, and, rising ob-



FIG. 1



FIG. 2

FIG. 1.—*Ataxus umbilicatellus*, part of front wall removed showing hidden lamina. 3/I.

FIG. 2.—*Ataxus umbilicatellus*, part of shell removed showing opposite view of lamina. 3/I.

liquely in the lumen of the penultimate whorl, continues in the angle between the axial wall and the roof of the whorl. Then it suddenly becomes thin, and immediately low, and continues in the antepenultimate whorl as little more than a sharp raised thread.

The peculiarities of this spiral lamina as observed in the several species, include its beginning so far back from the aperture, its near occlusion of the passage when at its strongest, the enlargement or recurvation of the distal edge, the curious oblique course not parallel with the gyre of the whorls, and, in the more elongated forms, of the duplication or repetition of the expansion at different points in the spire. Its function is probably protective, as it almost closes the aperture, and the animal can retreat behind the most obstructive portion.

PHENACOTAXUS TUBULATUS Morelet

Bulimus tubulatus MORELET, Journ. de Conchyl., vol. 8, 1860, p. 375; Sér. Conch., vol. 3, p. 204, pl. 11, f. 4, 1863.

Bulimulus (Bostryx, Ataxus) tubulatus PILSBRY, Man. Conch., vol. 10, p. 132, pl. 44, f. 95, 96. Mar. 1896.

Valley of Andahuaylas, Peru (Angrand); Urubamba Valley, at 9000 feet elevation (Rolle).

In this species the lamella begins gradually and reaches laterally only about half way across the whorl. It is more slender and less thickened at the distal margin than in *P. infundibulum* and the undulations in the width as it ascends are less marked, though quite evident. It does not ascend the axis as rapidly as in the preceding species. Beginning below the middle of the axial wall, in the next preceding whorl it is very slightly above the middle and becomes obsolete in the next preceding whorl. There is, however, some difference between the development of the lamina in different specimens. U. S. N. Mus., No. 110072.

PHENACOTAXUS (ATAXELLUS) SPICULATUS Mor. var. **PECTINATUS** Dall, nov.

Bulimus spiculatus MORELET, Journ. de Conchyl. 1860, p. 375; Sér. Conchyl., vol. 3, p. 203, pl. 11, f. 3, 1863.

Bulimulus (Bostryx, Peronæus) spiculatus PILSBRY, Man. Conch., vol. 10, p. 144, pl. 45, f. 29, 1896.

Above Ollantaytambo, Peru, at 10,000 feet elevation, Yale Expedition. Valley of Ollantaytambo, Angrand, in Morelet. U. S. N. Mus., No. 250263.

The shell externally agrees in form and character of sculpture in the main with Morelet's figure. Dr. Bingham's specimens differ by being perfectly white instead of brown streaked, and, while *B. spiculatus* is stated to be without spiral sculpture, the present variety is sharply, spirally striated, through the striæ are not equally visible over the whole shell. The dimensions are: Height, 21.5; length of aperture, 5.0; max. diameter, 4.0 mm. The axis of the shell is entirely imperforate; within the first half of the last whorl it becomes very slender, thread-like, and slightly gyrate. The lamina begins as a short, subtriangular, flexuous, and recurved plate; ascending the axis as a low lamina, has a small triangular expansion in the second preceding whorl, and becomes obsolescent in the whorl above. It also approaches nearer to the roof of the whorl as it ascends.

The next species, though having a close general resemblance to *spiculatus* except in its smoother surface, has the axis quite simple and normal, with no laminose developments whatever.

BOSTRYX (PERONÆUS) ACROMELAS Morelet .

Bulimus acromelas MORELET, Sér. Conchyl., vol. 3, p. 202, pl. 11, f. 1, 1863.

Bulimulus (Bostryx, Peronæus) acromelas PILSBRY, Man. Conch., vol. 10, p. 144, pl. 45, f. 31, 1896.

Valleys of Ayacucho and Urubamba, Peru (Angrand). Between Ollantaytambo and Maras, at an elevation of 10,000 to 11,000 feet, Yale Expedition. U. S. N. Mus., No. 250264.

Very similar to the last, but smoother, with no spiral striation, and with a conspicuous purple-black apex of three or four whorls.

EPIPHRAGMOPHORA CLAROMPHALOS Deville & Hupé

Lysinoë claromphalos D. and H., Guérin's Mag. de Zoöl. 1850, pl. 14, f. 1.

Epiphragmophora claromphalos PILSBRY, Man. Conch., vol. 9, 1894, p. 198; vol. 4, p. 80, pl. 18, f. 55, 56.

Near Santa Ana, at 3500 feet; and above Ollantaytambo, Eastern Peru, at 10,000 feet, Yale Expedition. U. S. N. Mus., No. 250265.

This species closely resembles in its general features the larger Californian species of the group of *E. mormonum*.

DREPANOSTOMELLA AMMONIFORMIS Orbigny

Helix ammoniformis ORB., Guérin, Mag. de Zoöl. 1835, p. 5; Voy. Am. Mér. p. 248, pl. 26, f. 10-13, 1837.

Streptaxis ammoniformis TRYON, Man. Conch., vol. 1, p. 65, pl. 13, f. 43-45, 1885.

Drepanostomella ammoniformis BGT., Moll. de l'Afrique Equatoriale, p. 42, 1889.

Above Ollantaytambo, Eastern Peru, at 10,000 feet elevation. Province of Yungas, Bolivia, Orbigny. U. S. N. Mus., No. 250269.

A single not quite mature specimen was taken by the Yale Expedition.

HAPPIA FOOTEI Dall, sp. nov.

Above Santa Ana, opposite Chinche, at about 3500 feet elevation, Yale Expedition.

Shell of a light yellowish or corneous color, depressed, brilliantly polished, with five and a half whorls; spire almost flat, with a strongly marked suture; outer whorl slightly obliquely flattened above; sculpture of faint incremental lines; aperture hardly descending, oblique, the peristome sharp, simple, not continuous over the body; base more rounded than the summit, with a broad, scalar umbilicus, revealing all the whorls; height, 4.0; max. diameter, 12.0; min. diameter, 9.6 mm. Type U. S. N. Mus., No. 250268.

This belongs in the same group with Preston's *Polita peruviana*, but is considerably larger, with a relatively much larger umbilicus, and has a slight flattening of the body whorl which makes the section of the whorl less rounded above than in Preston's species, of which the National Museum possesses the type specimen. The species is named in honor of Professor H. W. Foote of the expedition.

A small slug was obtained at Cuzco in some numbers, but arrived in such poor preservation that it could afford little or no information on dissection.