With the Author's Compliments

Report on the Terrestrial Mollusca collected by the Percy Sladen Expedition to Lake Titicaca, 1937

BY

G. I. CRAWFORD,
British Museum (Natural History)

[*From the* PROCEEDINGS OF THE MALACOLOGICAL SOCIETY, Vol. XXIII, Part VI, November, 1939.]

[From the Proceedings of the Malacological Society, Vol. XXIII, Pt. 6, pp. 318–332, November, 1939.]

REPORT ON THE TERRESTRIAL MOLLUSCA COLLECTED BY THE PERCY SLADEN EXPEDITION TO LAKE TITICACA, 1937

By G. I. Crawford, British Museum (Natural History)

(*Read* 14 *April* 1939)

[Plates 19, 20]

The localities from which Mollusca were collected by the Titicaca Expedition of 1937 may be classified into two sets; firstly those which lie on the Altiplano or in similar and adjacent areas, and secondly those in the neighbourhood of Cuzco. I found no species common to both sets of localities.

The Altiplano is a high plateau, with a mean width of 50 to 100 miles, extending in a N.W. to S.E. direction from 15 to 22 degrees south. The northern part of the plateau has a considerable rainfall in the months of October to March, and crops can be cultivated, but the climate becomes progressively more arid in the south-easterly parts, some of which are rainless and in all of which mollusca are apparently very rare. The northern part of the plateau is largely occupied by the comparatively deep freshwater lake Titicaca (altitude 12,500 feet), which drains southward into the shallow, brackish Lake Poopó (12,100 feet). Lake Poopó has at present no outlet, but the great saltpans which lie still further to the south presumably formed, until recently, a third lake of the same series.

The Altiplano is bounded by the two main chains of the Andes, many of the peaks of which exceed 20,000 feet in height. The line of permanent snow is at about 17,000 feet, and a number of the passes connecting the plateau with the Pacific and Atlantic drainage areas lie between 14,000 and 15,000 feet, and are always clear of snow. Crucero Alto (14,700 feet) leads to the hot desert country of the Pacific Coast, La Raya (14,100 feet) to the hot, moist Urubamba Valley, and El Alto (14,000 feet) to La Paz and to the southern headwaters of the Amazon; and others again run south-east into the subtropical parts of the Argentine. For further details of this region Gilson (1938) may be consulted.

The limits of temperature at Puno, which stands on the shores of Lake Titicaca at an altitude of 12,500 feet, are approximately 30° F. and 55° F. in July, and 40° F. and 65° F. in January. Frosts are more common in the drier regions to the south, but even near Puno they are severe at altitudes of over 14,000 feet in July.

Both sedimentary and igneous rocks are exposed on the Altiplano, and the hillocks of calcareous sandstone which are frequent round the shores of Lake Titicaca afford the best collecting grounds for mollusca.

The Expedition spent six months (April to September) of the dry season in Peru, with headquarters at Capachica near Puno.

It is on the sandstone hillocks, more or less calcareous, of this neighbourhood that I collected most frequently, but I also secured mollusca at the adjacent villages of Ácora and Samár, and near the railway station at Lagunillas at a height of 13,600 feet. At Pazña, in the arid region near Lake Poopó, on hills of about 12,500 feet, I found only some juvenile and unidentifiable *Bulimulus* of the subgenus *Scutalus*. The only collection of mollusca which I made on the Pacific slopes of the Andes was at San Antonio de Esquilache (14,500 to 15,000 feet). Since the pass separating this village from the Titicaca basin lies only at 15,200 feet, and since there is no sudden change of climate or vegetation experienced in crossing it, the terrestrial fauna of S. Antonio is likely to be similar to that of the Titicaca basin.

The collections from the Altiplano and from S. Antonio contain in all nine species of terrestrial mollusca :—

Succineidae.
Succinea andecola n.sp.
Clausiliidae.
Temesa peruviana (Pfeiffer).
Endodontidae.
Radiodiscus peruvianus n.sp.
Systrophiidae.
Systrophia altivaga n.sp.
Limacidae.
Agriolimax laevis (Müller), subsp. *andecola* (d'Orbigny).
Bulimulidae.
Bulimulus (*Peronaeus*) *hamiltoni* (Reeve).
B. (*Scutalus*) *culmineus* (d'Orbigny).
B. (*S.*) *quechuarum* n.sp.
B. (*Bulimulus*) *nivalis* (d'Orbigny).

Only three other species have been recorded from the Altiplano : *Bulimulus pentlandi* Reeve (1849, No. 614), from " mountains in the vicinity of Lake Titicaca ", *B. exornatus* Reeve (1849, No. 560) and *Temesa magnifica* Sykes (1901). Mr. Tomlin has lent me the unique type of *B. pentlandi*, which is a *Scutalus*, resembling *B. culmineus* in its sculpture, but easily distinguished by its brown epidermis and smaller size. The dimensions of the shell, which appears to be adult, are : height 21 mm., breadth 11 mm., aperture 11 × 7·5 mm. *B. exornatus* was originally collected at Chilón, Bolivia (6,000 feet), and later recorded from E. Peru (Pilsbry 1896, 10, p. 171), from the Andes E. of L. Titicaca (Ancey, 1901, p. 93) and from Chilalaya, on L. Titicaca (Bavay, 1904, p. 152). It seems possible that the two last records refer to *B. hamiltoni*, since the range in altitude from 6,000–13,000 feet is greater than is to be expected in one species, since *B. hamiltoni* is a species likely to

be common in the regions named, and since Ancey mentions that the tip of the spire of his specimens of *B. exornatus* is " rougeâtre ". Unfortunately I have not been able to see these specimens.

Of the remainder of the species recorded in this paper five were found in the course of a few days in the valley of the Urubamba near Cuzco at about 10,000 or 11,000 feet and one at Arequipa (8,000 feet). The climate at Cuzco is warmer and rather less arid than at Puno, and trees and shrubs are common, though they do not form woods. Below Cuzco the Urubamba falls 7,000 feet in about 100 miles, and enters the hot, moist, forested plain which forms the greater part of the basin of the Amazon. The mollusca of the Urubamba Valley and its vicinity are treated by Morelet (1863) and by Dall (1912) among others, and are far more numerous and varied than those of the Altiplano.

Family SUCCINEIDAE

Succinea andecola n.sp. (Pl. 19, figs. 15, 16)

Capachica, 12,500 feet, under stones near streams and ponds, or under clods in places submerged during the wet season, 44 specimens, 16 to 30 April.

Ayaviri, 12,800 feet, in watercress beds, 12 specimens, 23 June.

Near Cuzco, about 10,500 feet, beside a pond along the Rio Huatanay, one dead shell, 27 June.

Description of holotype, a dead shell from Capachica : length 10·8 mm., breadth 6·7 mm., aperture 8·5 × 5·3 mm. broadly oval ; whorls 2½ to 3, ventricose, with a blunt apex, very short spire and well-marked suture : shell rather solid, with distinct, broad, regular, transverse striae, fainter near the apex : colour brownish straw, becoming gradually reddish straw towards the apex.

This is by far the largest shell. The dimensions of two other specimens from Capachica are : length 8·2 mm., breadth 5·5 mm., aperture 5·7 × 4·0 mm., and length 5·2 mm., breadth 3·3 mm. and aperture 4·0 × 2·7 mm. The corresponding dimensions of the specimen from near Cuzco are 7·0 mm., 4·4 mm., 4·9 mm., and 3·6 mm. The majority of the specimens from Capachica and Ayaviri lie between 4 and 7 mm. in length, and it is possible that in this species only juveniles occur during the dry season (April to October).

The shells of these smaller specimens are not full grown, although Dr. Quick found on dissection that some of the largest were sexually mature. It seems likely that the normal size for adult shells in the wet season is the same as that of the holotype. The paratypes, which were collected alive, show certain features which are missing in the holotype. Those from Capachica are rather less

opaque than it (though their colouring is similar) and the periostracum is marked with faint criss-crossings, only to be seen with a magnification of 100 or so. Those from Ayaviri are amber coloured, with the usual redder apex, and are translucent; the criss-cross markings are far more distinct and, as Dr. Quick has pointed out, the foot and mantle are much more deeply pigmented than in Capachica specimens.

These differences are more likely to be the results of differences in environment than signs of any systematic distinctness. The Capachica shells have a rather impoverished appearance, and in some of them there are pale oval dots arranged in rows along some of the transverse striae.

About thirty species of Succinea have been described from South America or from adjacent islands, but almost all are known only from low-lying ground. The exceptions are *Succinea labiosa* Philippi (1860) from Tilopozo (23° S., 68° W., 9,000 feet); *S. bogotensis* Pfeiffer (1866) from Bogotá (8,000 feet); *S. porrecta* Doering (1873), Sierra de Tucumán (3,400 feet); and *S. burmeisteri* Doering (1873), recorded by Pilsbry (1911) from 2,400 feet in Patagonia. None of these, however, seem from the available figures and descriptions to be the same as the Titicaca specimens; they all have a higher spire, and no mention is made of a red apex. The only species with a low spire and a red apex are *S. patagonica* Smith (1881) from near the Straits of Magellan, and *S. magellanica* Gould (1848) from Tierra del Fuego. Some unnamed specimens in the British Museum from Bogotá show both these features, and it seems probable that a small group of closely-related species extends along the Andes in cool, damp places.

Family CLAUSILIIDAE

Nenia (*Neniatracta*) *balnearum* n. sp. (Pl. 19, fig. 13)

Tambo-Machay, near Cuzco, 11,000 feet, in crevices of limestone near the Inca's Baths: five adult and four juvenile shells, all dead.

Holotype.—Shell conically fusiform, not decollate, length 16·5 mm., breadth 3·6 mm. (at penultimate whorl), whorls nine, scarcely convex, of which apical 1½ smooth, and remainder with close rather regular transverse oblique striae; suture scarcely impressed; neck short, keeled above: aperture quadrate, peristome somewhat expanded; superior lamella and spiral lamella forming a continuous S-curve; inferior lamella strong. Colour faded, apparently fuscous in life.

The dimensions of three other adult shells are 16·5 × 3·5 mm., 15·4 × 3·5 mm. and 15·3 × 3·4 mm.

The short neck, close sculpture, and the nearly conical shape are features also of *N. belahubbardi* Pilsbry from Caspisapo, Rio Huallaga, Peru, a species for which Pilsbry (1926a) established

the subgenus *Neniatracta*. The holotype of *N. belahubbardi* measures 27·8 mm. in length. *N. pampasensis* Dall (1911, p. 182), from Rio Pampas (N.E. Peru) at 6,000 feet resembles *N. balnearum*, but the whorls are more convex. It is possible that *Clausilia andecola* (Morelet, 1863, pp. 214–215, pl. 11, fig. 14) is an earlier name for *N. balnearum* but I am unable to trace authentic specimens and Morelet's figure is insufficient for identification. It was described from near Tarma and Vilcabamba.

Temesa peruviana (Pfeiffer) (Pl. 19, fig. 14)

Balea peruviana Pfeiffer 1867, p. 78 (Philippi MS.).
Exbalea peruviana Jousseaume 1900, p. 34, p. 1, f. 13, 14.
Temesa clausilioides Sykes (part), 1901, p. 221.

Capachica, 12,600 feet, about 80 specimens.
Acora, 12,600 feet, a few dead shells.
Saracocha, 13,600 feet, about 40 specimens.
Near Cuzco, about 11,000 feet, 5 specimens.

The type locality of *T. peruviana* is Yanaoca, in the Province of Cuzco.

All these specimens were collected on calcareous rocks either in the cracks in the rock or under the cushions of moss growing upon it. There is little variation in the form of the shell, but the transverse ribs are closer together in the specimens from Saracocha than in the others, as a result perhaps of slower growth in a colder climate.

The dimensions (length and breadth) of the largest specimens from each locality are 12·3 mm., 3·2 mm. (Saracocha) ; 12·5 mm., 3·5 mm. (Capachica) ; 11·4 mm., 3·0 mm. (Cuzco).

Four other species of *Temesa* are known, two of which appear very closely related to *T. peruviana*. *T. clausilioides* (Reeve 1849, "*Bulimulus*," No. 523), from the Andes of Cajamarca, about 600 miles N.W. from Cuzco, was supposed by Sykes (1901) to be synonymous with it, but the shouldered whorls and very close-set transverse sculpture of *T. clausilioides* are sufficient to distinguish it for the present. No specimens have been collected other than the type set of three in the British Museum ; the type measures 14·5 by 3·3 mm. *T. incarum* Pilsbry (1926a, p. 14, pl. 2, fig. 6) closely resembles *T. peruviana*, except that the last four whorls are malleated. This species is known only from the neighbourhood of Lake Junín, about 350 miles N.W. of Cuzco, at an altitude of 13,000 feet. The radula, figured by Pilsbry on p. 13, fig. 1, resembles closely those of three specimens from Capachica mounted by Colonel Peile.

T. magnifica Sykes (1901, p. 221, fig. 3) is a much larger species (length of holotype in B.M. is 28·7 mm.) from Sorato, Bolivia, at 3,600 m. (11,800 feet). Sorato is presumably Sorata in the Titicaca basin. *T. dichroa* (Haas, 1929, p. 10, figs. 4, 5), from Timuxi, Bolivia,

at the same altitude, appears to resemble *T. magnifica* rather than *T. peruviana* in form as well as in size. It is 20 mm. long.

Three specimens in the collection of Mr. Tomlin from Maco, near Tarma, Peru, show a degree of shouldering in the whorls intermediate between that of *T. peruviana* and *T. clausiliides*. Tarma is close to Lake Junín, at about 11,000 feet.

The recorded altitudes at which species of *Temesa* have been found all lie between 11,000 and 14,000 feet, and there is no evidence that these limits are widely transgressed.

Family ENDODONTIDAE

Radiodiscus peruvianus n.sp. (Pl. 20, figs. 23–27 ; fig. 28)

S. Antonio de Esquilache, Peru, in the Pacific drainage area, under moss on rocks near streams, 14,000 up to 15,000 feet, about 40 specimens.

Capachica, Peru, under moss on rocks at 12,600 feet, six specimens.

Description of holotype (from S. Antonio de Esquilache), diam. maj. 2·8 mm., diam. min. 2·6 mm., alt. 1·0 mm., whorls four, first 1½ with close spiral sculpture both above and below, and remainder with close even transverse ribs completely encircling them, every fourth or fifth of which is much stronger than the intermediates ; whorls rounded, sutures impressed, spire very slightly elevated ;

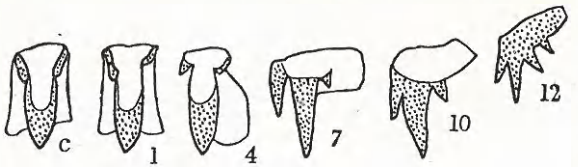


Fig. 28.—Radular teeth of *Radiodiscus peruvianus*, × 1000.

umbilicus wide and rather deep, displaying the sculpture of each whorl, measuring 1·1 × 0·9 mm. ; outer lip an arc of a circle. The characters of the shell described above agree exactly with the original diagnosis of the genus, which was founded on *R. millecostatus* Pilsbry and Ferris, from Arizona and Mexico by Pilsbry in Pilsbry and Ferris (1906, p. 154).

The paratypes are very uniform except in the spacing of the ribs ; in some there are only one or two riblets between each pair of strong ribs, and in others the strong ribs are widely spaced without any visible intermediate riblets. It may be seen from the figures how distinct the close-ribbed specimens appear from those with more widely spaced ribs. I consider that all these specimens belong to a single species first because the size and form is the same, secondly because some intermediates occur, and thirdly because the specimens from under a single stone show much variety in respect of the

closeness of ribbing. The terrestrial mollusca of these elevated regions are so few that it is unlikely that two closely related species of one genus should be found in an identical habitat.

The following observations on the mouth-parts are based on preparations made by Colonel Peile from three specimens from Capachica. Jaw very delicate and transparent, composed of about 16 narrow rectangular plates which lie parallel to one another and slightly overlapping. Radula, formula 14.1.14, with six or seven tricuspid laterals, and seven or eight marginals: the inner marginals with three cones, and the outer with four or five.

Family SYSTROPHIIDAE

Systrophia incarum n.sp. (Pl. 20, figs. 20–22)

Pisacc, in the Urubamba Valley, on hill-sides at about 10,500 feet, five dead shells.

Diam. maj. 4·7 mm., diam. min. 4·4 mm., alt. 2·0 mm. Whorls six, regularly expanding, first two smooth, remainder with faint irregular transverse growth-lines and faint spiral lines; spire distinctly elevated, whorls rounded, sutures impressed; umbilicus deep and (for this genus) narrow, measuring 2·0 × 1·8 mm. at the last whorl: shell transparent, pale horn-coloured.

The largest specimen measures 5·0 × 4·7 × 2·2 mm., and has six whorls.

In the tightness of its coiling this species resembles *S. tortilis* (Morelet 1863, p. 165, pl. 7, fig. 2) from the neighbouring town of Urubamba, but *S. tortilis* is much larger, its spire is absolutely flat, and its umbilicus much wider and shallower.

Systrophia altivaga n.sp. (Pl. 20, figs. 17–19)

Capachica, under stones on calcareous hills, 12,600 feet, three freshly-dead shells.

Isla Campanaria de Ccotos, near Capachica, on limestone, 12,600 feet, one dead shell.

Description of holotype (from Capachica); diam. maj. 9·0 mm., diam. min. 8·0 mm., alt. 2·9 mm., whorls $4\frac{1}{2}$, increasing regularly, apical $1\frac{3}{4}$ whorls with very faint spiral lines, remainder with faint irregular puckered transverse lines of growth, and very faint spiral lines; spire practically flat, suture impressed; umbilicus wide and shallow; shell transparent, straw-coloured.

The specimen from Isla Campanaria de Ccotos measures 10·0 × 8·9 × 3·6 mm., and has five completed whorls.

S. altivaga somewhat resembles *S. gyrella* Morelet (1863, p. 165, pl. 7, fig. 8), from Urubamba, the type of which is in the British Museum, but *S. gyrella* has a wider and shallower umbilicus, much stronger and more regular transverse ribs, and no spiral striation at all.

Systrophia sp.

Two large specimens (15–16 mm. in diameter), under stones on hill-side at Pisacc, about 10,500 feet; in too poor condition for identification.

Family LIMACIDAE

In the vicinity of Lake Titicaca, and even in rather drier regions, slugs of the genus *Agriolimax* were common in damp localities. I sent all my specimens to be examined to Mr. Hugh Watson, of Cambridge, and I am indebted to him for the dissections and notes on which the following account is based.

Agriolimax laevis (Müller 1774), subsp. *andecola* (d'Orbigny 1837)

Arequipa (8,000 feet), Capachica (12,500 feet), Ayaviri (12,800 feet), Ancoraimes (12,500 feet), and Calacoto near La Paz (11,200 feet); 28 specimens in all, among damp vegetation or in damp ground under stones.

This subspecies was first collected by d'Orbigny in the neighbourhood of La Paz, and described as a new species, *Limax andecola* (d'Orbigny 1834–1847, vol. 5, p. 222). He gave no illustrations, and no specimens now exist. My specimens agree closely with his description, and the localities from which they were collected are so similar to the original locality that there can be little doubt of their identity.

Watson calls my attention to the fact that in all the specimens which he dissected the ♂ organs are vestigial though the ♀ ducts are fully developed. These specimens were collected between mid-April and mid-July, that is during the first half of the dry season.

Agriolimax reticulatus (Müller 1774)

Arequipa (8,000 feet), two specimens in a damp spot.

Watson writes: "The two smaller specimens from Arequipa are, in my opinion, small and slightly immature examples of *Agriolimax reticulatus* (Müller)."

Family Bulimulidae

Bulimulus (*Ataxellus*) *spiculatus* Morelet

B. spiculatus Morelet 1863, pp. 203–4, pl. 11, fig. 3.
B. spiculatus Pilsbry 1896, 10, p. 144, pl. 45, fig. 29.

Pisacc, valley of Urubamba, Peru, 11 specimens under stones on dry hill-sides above the town, 10,000 to 11,000 feet.

These specimens are smaller than Morelet's types in the British Museum, the mouth is less elongate, and the transverse ridges are more widely spaced. The type locality, Ollantaytambo, is about 20 miles below Pisacc in the same valley.

B. spiculatus var. *pectinatus* Dall (1912) differs from the type and from my specimens in the presence of marked spiral sculpture. The subgenus *Ataxellus* is distinguished by an expanded plica on the columella.

Bulimulus (*Peronaeus*) *hamiltoni* (Reeve) (fig. 29)

Bulimus hamiltoni Reeve 1849, No. 610 (fig.).
Bulimus hamiltoni Hupé 1857, p. 49, pl. 9, fig. 5.
Bulimus hamiltoni Morelet 1863, p. 201.
Bulimulus (*Peronaeus*) *hamiltoni* Pilsbry 1896, 10, p. 149, pl. 46, fig. 51 (after Reeve).

Near Capachica and Ácora (20 miles S.E. of Puno), aestivating in great numbers under stones at about 12,600 feet. Unlike *B. culmineus* this species was only present where the rock was highly calcareous.

This species was first collected by Pentland, who is responsible for a manuscript note in the British Museum register : " This small species abounds in every part of the Andes of Peru and Bolivia. I have found it to nearly the snowline. It is perhaps the terrestrial mollusc that reaches the greatest elevation."

Morelet records that M. Angrand found this species in a number of localities in the valleys of the Urubamba and Abancay. The most northerly and least elevated of these is Andahuaylas, at about 10,000 feet, and 13° 35′ south latitude. Morelet gives no figures, and his specimens cannot be traced.

The radulae of specimens from Capachica contain from 20 to 25 laterals + marginals. The secondary cutting point is single in all the teeth.

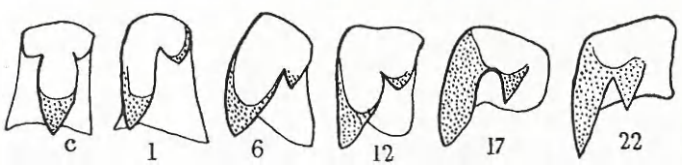


Fig. 29.—Radular teeth of *Bulimulus* (*Peronaeus*) *hamiltoni*, × 300.

A set of five cotypes is in the British Museum. Reeve's figure, and Pilsbry's, are not recognizable ; Hupé's figures, however, are good, though the apex is redder, and the other whorls more chalky white than he has shown them.

Bulimulus (*Scutalus*) *culmineus* (d'Orb.) (Pl. 19, figs. 1–8)

Helix culmineus d'Orbigny 1835, p. 13, No. 72.
Bulimus culmineus d'Orbigny 1834–1847, p. 288, pl. 33, figs. 8, 9.
Bulimus culmineus Reeve 1849, No. 360.

Bulimus confusus Reeve 1849, No. 316.
Bulimus culmineus Hupé 1857, p. 48, pl. 8, fig. 4. Probably not *Bulimus culmineus* Morelet 1863, p. 178, pl. 8, fig. 4.
Bulimulus (*Scutalus*) *culmineus* Pilsbry 1897, 11, p. 25, pl. 5, figs. 74–78 ; pl. 8, figs. 30–32. (After d'Orbigny, Morelet and original.)
B. edwardsi Binney 1876, p. 191 ; 1884, p. 124, pl. 11, f.k.
B. edwardsi Pilsbry (part) 1897, 11, p. 27 (no figs.).

Very common on rocky ground (limestone or sandstone) at Capachica (12,500–13,000 feet), Acora (12,600 feet), Puente Samán (12,500 feet), and Saracocha (13,600 feet), either under stones, or sheltering between the stems of shrubby *Eupatorium* and the rock faces against which these grow.

Collections made on an area of a few acres on a limestone hill near Camjata Hacienda, Capachica, contain 80 adult specimens, the study of which makes it possible to distinguish the specific characters of the shell from those which are merely individual.

The following characters are subject to little variation. Whorls, six, rapidly increasing, rounded ; upper 2 or $2\frac{1}{4}$ sculptured with very fine wavy transverse wrinkles, which frequently anastomose to form a network ; remaining whorls with close-set, strong, irregular growth-ridges, and less developed, more regular spiral ridges—the apices of the irregular rectangles into which the surface of the shell is divided by these ridges are usually worn flat and coloured white ; aperture ovate, outer lip simple, curved, columella shining white, reflexed over the umbilicus, which it nearly covers.

The chief characters in which much variation occur are (i) size and form, (ii) colour and banding.

The set of eight figured on Pl. 19, figs. 1–8, shows the limits in size and form of adults in these 80 specimens. The height and major diameter of these specimens in order are : 34·0, 15·5 ; 30·5, 15·5 ; 33·5, 15·0 ; 33·0, 14·0 ; 27·0, 11·5 ; 32·0, 15·0 ; 29·0, 13·0 ; 26·0, 13·5 mm. The most usual size and form is near to that of fig. 1, and this size is seldom exceeded by this species.

The ground colour varies from very pale straw or pinkish buff to a dull yellowish-brown, usually with a number of narrow darker transverse streaks. Spiral bands are either entirely absent or present to the full number of five, of which three only are visible on the upper whorls. The bands are dark brown, often tinged with purple, and are visible from the inside of the aperture. The uppermost is very close to the suture and is the narrowest ; the others, especially the central one, are rather broad.

Colonel Peile has prepared slides of the radulae of three specimens from Capachica, one of which contains numerous malformed teeth. Neither in this nor in the others are there any lateral or marginal teeth with a bicuspid cutting point, as is figured by Binney (1876,

1884) : in all of them the main cutting point is single, and there is a secondary cutting point which is indifferently single, double or triple. Binney's specimen had 44 laterals and marginals : in mine this number ranges from 30 to 37

I have compared the shells from Lake Titicaca and d'Orbigny's specimens of *B. culmineus* with as many type specimens as possible. The conclusions which I have reached about the identity of various species of *Scutalus* are given below.

B. confusus (Reeve) (1849, no. 316), type set of three in B.M. ; type locality unknown. These are unbanded *B. culmineus*, with the ground colour pale pinkish buff.

B. culminans (Reeve) (1849, no. 98) is certainly a mistranscription of *B. culmineus*, see Reeve's remarks under No. 360. There is no specimen so labelled in the British Museum, and it is uncertain if the figure refers to *B. culmineus* or *B. lithoicus* (see below).

B. nemorensis Pfeiffer 1867, p. 78 ; Pfeiffer 1867–9, p. 345, pl. 81, figs. 15, 16 ; Pilsbry 1897, 11, p. 22, pl. 4, figs. 52, 53 (after Pfeiffer 1867–9). I have been unable to trace Pfeiffer's specimens, but I think it likely from Pfeiffer's figures that *B. nemorensis* = *B. culmineus*. The locality is between " Ayapata and Ollachea ", that is to say only just out of the Titicaca basin on the N. corner, among the mountains of the Amazon basin.

B. lithoicus (d'Orbigny) 1835, p. 13, no. 73 ; d'Orbigny 1834–1847, p. 288, pl. 33, figs. 10, 11. d'Orbigny's types are in the B.M. They are just distinguishable from *B. culmineus* by their slightly less rounded whorls, and their bright strawy colour. They may later be shown to be a local form of that species, but at present evidence of this identity is lacking. The locality is La Paz (12,000 feet), distant only a few miles from El Alto (14,000 feet) on the eastern edge of the Altiplano. Other specimens in the B.M. come from Umapusa and Illimani (Bolivia) : 99.3.8.2–6.

B. jussieui Pfeiffer (1846, p. 33), figured Reeve (1849, no. 242). The type and a paratype are in the B.M. Cuming received them from the Paris Museum, where the name *jussieui* had already been applied in MS. by Valenciennes. The locality is " Cusco ", transcribed " Cusoo " by Pfeiffer and Reeve.

The type measures 31·5 by 15·5 mm. and is of a greyish straw colour ; the paratype is bright straw : and of five specimens from the Paris Museum two are uniform dull brown and three have 5 brown bands on a pale ground. All seven specimens seem to be co-specific with one another, and possibly distinct from *B. culmineus*, from which they differ only in colour, and in being on the average more stout. Pfeiffer (1853, p. 432) reduced *B. jussieui* to a variety of *B. culmineus*, and Pilsbry (1897, 11, pp. 26–7, pl. 5, figs. 59, 60), accepting Pfeiffer's conclusions, established the name *B. subjussieui* for a specimen collected near Cuzco, and figured by Hupé as *B. jussieui* (1857, pp. 48–9, pl. 7, fig. 4) from which

species Pfeiffer (1868, p. 128) considered it distinct. The dimensions of this specimen (Paris Museum) are 27·5 and 15·5 mm., in agreement with Hupé's figure, though not with his text. It is a five-banded specimen, closely resembling the stoutest of Valencienne's *B. jussieui* and to my mind not distinct from them.

Bulimulus edwardsi Morelet (1863), pp. 182-4, pl. 9, fig. 1. The typical form of this species was described from specimens from Huancabelica (12° 40′ S., 75° 6′ W., 12,000 feet), and seems, to judge from its shape and the variety of its colour-pattern, to be *B. culmineus*. The specimens from Puno collected by Agassiz and referred to as *B. edwardsi* by Pilsbry (1897, 11, p. 27), and by Binney (1876, p. 191, and 1884, p. 124) are certainly *B. culmineus*. Through the kindness of Dr. Pilsbry I have examined two specimens myself (No. 25558). I can trace none of Morelet's specimens. Morelet's var. *β* was described from specimens from Huanta (8,000 feet) and two specimens are in the B.M. They are a small five-banded *Scutalus* resembling *S. bicolor* Sowerby, but stouter, and measure 25 × 13 mm., and 25·5 × 13 mm.

It appears that there is no reliable record of *B. culmineus* having been collected outside the Altiplano, though the adjacent regions to the north and the south are populated by *B. jussieui* and *B. lithoicus*, species so closely related to *B. culmineus* that they may well be shown, with fuller information, to be geographical races of that species. Morelet (1863) records *B. culmineus* from a number of localities in the Amazon basin, at altitudes of 7,000 feet and over; but it is doubtful from his figures if he was dealing with this species, and no specimens are available for study. It is possible that the specimens of *B. edwardsi* from Huancabelica figured by Morelet are true *B. culmineus*, but they cannot be traced.

Bulimulus filaris Pfeiffer (1853, p. 50). The type in the British Museum belongs to the subgenus *Scutalus*: it seems to be an abnormal shell.

B. weddellii Hupé (1857, pp. 45–6, pl. 7, fig. 5). The only specimen extant is a juvenile in the Paris Museum (33 mm. by 16 mm), which is not the specimen figured by Hupé. It is easily distinguished from *B. culmineus* by the much heavier shell, stronger transverse ribs, and less convex whorls. It is labelled "Cusco" in the handwriting of the collector (Weddell). The specimen described and figured by Hupé measures 40 mm. by 17 mm., and is recorded from "environs du Lac de Titicaca". I think this is an error, and Cuzco is the true locality. The figures of *B. weddellii* published in Morelet (1863, pp. 179–180, pl. 10, fig. 2), do not seem to refer to this species. I cannot trace Morelet's specimens.

B. prometlius Crosse (1869, p. 423), type in Paris Museum, hab. "Peru". This species belongs to the subgenus *Scutalus* and is very close to *B. weddellii*.

B. polymorphus (d'Orbigny) (1835, p. 20, No. 107; 1834–1847,

p. 289, pl. 41, figs. 1–5). Types in B.M., "côtes du Perou." The type is identical with *B. bicolor* Sowerby from "Peru" (1834, p. 141), and the other specimen, as Pilsbry (1897, 11, p. 28) has already remarked, is very close to *B. badius* Sowerby (1834) from "Prov. Xagua, Peru". Perhaps Xagua (a name which I cannot trace) is an error for Jauja. The types of both these species are in the B.M. and prove on examination to belong to the subgenus *Scutalus*.

Bulimulus (*Scutalus*) *quechuarum* n.sp. (Pl. 19, figs. 11, 12)

Capachica, on limestone hills, 12,600 feet, two specimens (one dead).

Saracocha, on limestone hills, 13,600 feet, two dead shells.

Lake Junín, Peru, 13,000 feet, Godman Thomas Expedition, 1925. Five specimens (three dead).

Junín lies at 11° 5′ S., 75° 56′ W., about 500 miles N.W. of the other two localities.

Description of holotype from Capachica: length 21·5 mm., breadth 9·0 mm., aperture 10·0 × 6·0 mm., whorls 5–5½, apical two purplish-brown with fine wavy transverse furrows, anastomosing in places, remainder heavily calcified with coarse irregular widely-spaced transverse ribs, without spiral sculpture and coloured dead-white, with numerous irregular transverse streaks of deep violet; suture impressed and lower whorls slightly shouldered; outer lip simple, arcuate; columella orange-brown reflexed over the umbilicus, which is chink-like, interior of aperture pale shining orange-brown, dotted with violet.

The largest of the specimens from Lake Junin, Pl. 19, fig. 12, which appears to have been collected alive, measures 21·0 × 9·0 mm., with an aperture of 9·0 × 6·0 mm. The violet tinge is very faint, and all the shells from Junin are nearly dead white.

Bulimulus nivalis (d'Orbigny) (Pl. 19, figs. 9, 10; fig. 30)

Helix nivalis d'Orbigny 1835, p. 12, No. 67.
Bulimus nivalis d'Orbigny 1847, p. 287, pl. 32, figs. 8, 9.
Bulimulus nivalis Pilsbry 1897, 11, p. 72, pl. 11, figs. 35, 36.

San Antonio de Esquilache, Prov. Puno, Peru, 30.6.37, 13 specimens. Under moss on rock faces near the stream which flows through the village, 14,000 to 15,000 feet.

This species was first collected by d'Orbigny in 1833 near Potosí at an altitude estimated to be 5,000 metres (16,400 feet). It has not been found since. Potosí is about 400 miles from S. Antonio in the south-east corner of the Titicaca basin.

The type of this species in the British Museum was the only specimen known to exist. d'Orbigny's figures, and Pilsbry's, which

are copied from his, show the apex too sharp, but otherwise are good.

My specimens differ from the type in being slenderer and blunter, but they vary greatly in these respects and the similarity in form and in the characteristic texture of the shell prevents me from considering them specifically distinct.

Description of the largest specimen collected alive. Height 18 mm., width 10 mm., height and width of aperture 10·5 × 6·5 mm., apex intorted, whorls five, rapidly increasing, upper two with distinct closely-set wavy transverse furrows, anastomosing in places, remainder with slight irregular raised growth-lines; shell very thin, translucent, bright chestnut with yellow striations descending the lines of growth from the suture, epidermis easily separated from shell; lip simple, columella reflected so as nearly to cover umbilicus, columellar callus present but faint (Pl. 19, fig. 9).

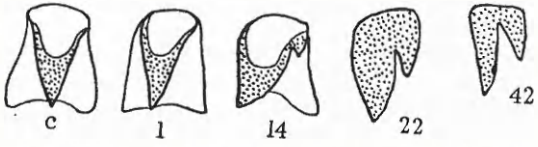


Fig. 30.—Radular teeth of *Bulimulus* (*Scutalus*) *nivalis*, × 300.

The largest specimen is a dead shell of length 21 mm., width 12 mm., and aperture 11·5 × 7·5 mm. (Pl. 19, fig. 10).

The radula of one adult and one juvenile have been mounted. There are 45 laterals + marginals in the adult radula, which on the whole closely resemble those of *B. culmineus*. The chief difference is the relatively large size of the secondary cutting point in the marginals of *B. nivalis*: in both the radulae examined this point is always single (fig. 30).

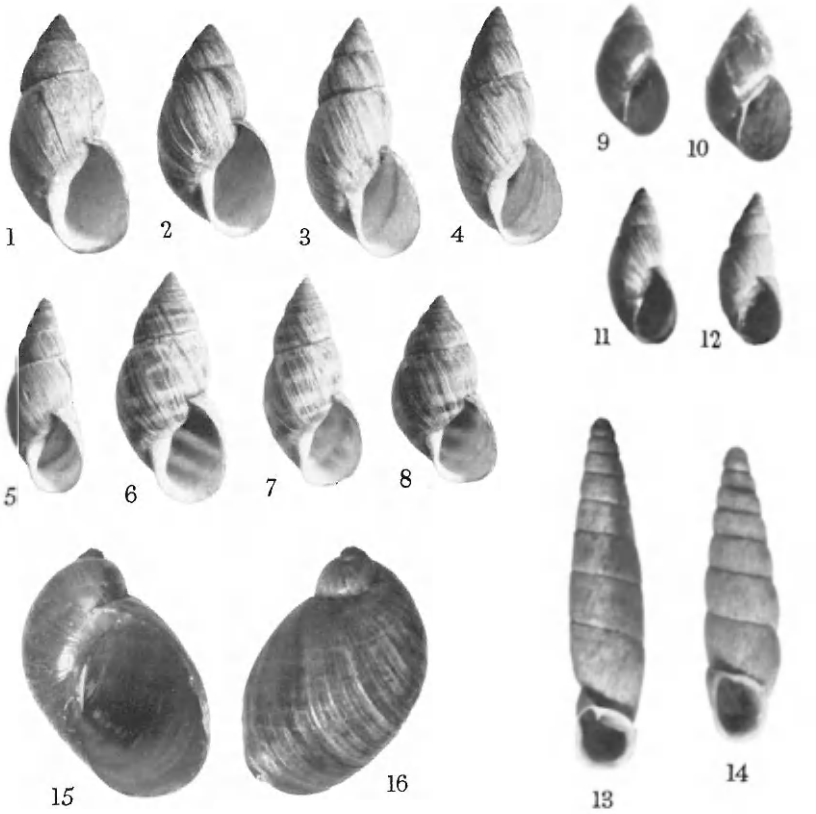
Drymaeus longinquus Morelet

Morelet 1863, p. 195, pl. 11, fig. 2.

Pilsbry 1897, 11, pp. 293-4, pl. 50, figs. 93, 94 (copied from Morelet).

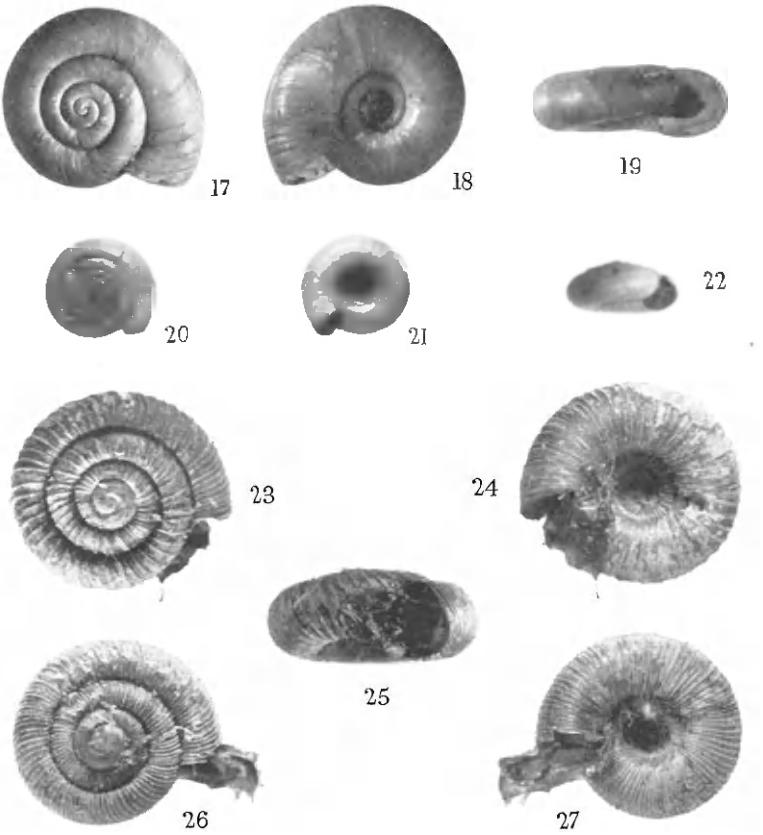
Pisacc, valley of Urubamba, Peru, four dead shells on dry hillside above the town, 10,000 to 11,000 feet.

The largest of these specimens is 27·5 by 14·5 mm. Morelet's type, which is in the British Museum, is slightly more slender; it measures 30·5 by 14·5 mm. In his description Morelet gives these dimensions as 31 and 12 mm., and this error is repeated by Pilsbry. The outer lip of the type is much more arcuate than is shown in the illustrations.



FIGS. 1–8.—*Bulimulus* (*Scutalus*) *culmineus* (d'Orb.), × 1. Eight specimens from a small area at Capachica selected to show the extent of variation.
FIGS. 9, 10.—*B.* (*Scutalus*) *nivalis* (d'Orb.), × 1, San Antonio de Esquilache.
FIG. 11.—*B.* (*Scutalus*) *quechuarum* n.sp., × 1, holotype from Capachica.
FIG. 12.—*B.* (*Scutalus*) *quechuarum* n.sp., × 1, paratype from Lake Junín.
FIG. 13.—*Nenia* (*Neniatracta*) *balneearum* n.sp., × 3, holotype from Tambo-Machay.
FIG. 14.—*Temesa peruviana* (Pfr.), × 3, Capachica.
FIGS. 15, 16.—*Succinea andecola* n.sp., × 3, holotype from Capachica.

[*Facing p.* 332.



Figs. 17–19.—*Systrophia altivaga* n.sp., × 3, holotype from Capachica.
Figs. 20–22.—*S. incarum* n.sp., × 3, holotype from Pisacc.
Figs. 23–27.—*Radiodiscus peruvianus* n.sp., × 10, holotype (1–3) and paratype (4, 5) from Capachica.