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NON-MARINE MOLLUSCA OF PATAGONIA

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H. A. PILSBRY
1911



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PART V.
NON-MARINE MOLLUSCA OF PATAGONIA.

BY
HENRY A. PILSBRY,
ACADEMY OF NATURAL SCIENCES, PHILADELPHIA.

This report deals with the non-marine mollusks of Tierra del Fuego and Patagonia as far north as the thirty-ninth parallel, where the Rio Negro Valley forms a transition region, the Patagonian fauna giving place to the La Platan.

The scope of the work has been extended to include some account of all the South American forms of certain little-known families, such as the *Amnicolidæ* and *Sphæriidæ*, and all of the *Chilimidæ* occurring east of the Andes. Finally, the relationships of the South American molluscan fauna with the faunas of other continents are considered.

The collections made by Mr. J. B. Hatcher and placed in my hands by Professor William B. Scott form the basis of this report. The material from the region along the Rio Chico de la Santa Cruz and in the base of the Andes above its head is ample. Elsewhere but few mollusks were collected, and I have used material which I owe to the generosity of Dr. H. von Ihering, Director of the Museu Paulista, Dr. W. H. Rush, U.S.N., and others.

ZONAL DISTRIBUTION OF PATAGONIAN MOLLUSCA.

An inspection of the data existing on Patagonian mollusks shows that several faunas largely distinct in species occupy zones extending from the Atlantic to the Andes and succeeding one another from north to south. So far as aquatic animals are concerned, these zones are determined by the drainage systems, which are separated by poorly watered plains, and flow independently into the Atlantic. The aquatic mollusks known from these several zones are enumerated below.

Chilina, *Lymnæa* and *Pisidium* are the only genera of fresh-water mollusks which extend throughout Patagonia, the first two also in Tierra del

Fuego. The *Unionidæ* and *Mutelidæ*, groups copiously represented in the La Plata, have their southern limit in the Rio Negro, each represented by one species; *Planorbis* has two, *Ancylus* one species, the rest of the fauna being Patagonian. The Rio Negro fauna, including the region of Bahia Blanca, is transitional also in land mollusks, the genera *Bulimulus*, *Odonostomus* and *Strophocheilus* reaching their southern limit in the Sierra Ventana, near Bahia Blanca. In the humid region west of the Cordillera the faunal zones are deflected southward, the transition zone as marked by the southern limit of *Unionidæ* being in the neighborhood of Chiloe Island. That the transverse faunal zones of Patagonia run northward in the Andean region is shown by the occurrence on the upper Rio Chico of several Magellanic forms.

I. LA PLATAN ZONE.¹

Includes the Plata and its tributaries in Argentina, Uruguay, Paraguay, Brazil, and rivers flowing into the Atlantic in the Brazilian states of Sao Paulo and Rio Grande do Sul. Except in *Chilinidæ*, only the genera of this fauna are mentioned below, the species being very numerous.

Chilinidæ: *Chilina fluminea*, *C. f. microdon*, *C. globosa*, *C. rushii*, *C. parva*,
C. portillensis, *C. tehuelcha mendozana*.

Physidæ: *Physa*.

Lymnæidæ: *Lymnæa*, *Planorbis*.

Ancylidæ: *Ancylus*.

Amnicolidæ: *Littoridina*, *Potamopyrgus*, *Potamolithus*.

Ampullariidæ: *Ampullaria*, *Asolene*.

Cyrenidæ: *Corbicula*.

Sphæriidæ: *Musculium*, *Pisidium*.

Unionidæ: *Diplodon*, *Castalia*, *Castalina*.

Mutelidæ: *Anodontites*, *Leila*, etc.

II. PATAGONIAN ZONE.

A. Rio Negro Fauna.²

(All of the known aquatic mollusks of this fauna and those following are enumerated.)

¹ Probably the La Platan fauna is a subdivision of the Amazonian, chiefly characterized by the great development of *Chilinidæ* and *Amnicolidæ*.

² Including also the Rio Colorado, and known solely by the works of d'Orbigny and Doering.

- Chiliniidæ: *Chilina tehuelcha*, *C. puelcha*, *C. parchappii*.
 Lymnæidæ: *Lymnæa viator*, *Planorbis peregrinus*, *P. anatinus*.
 Ancyliidæ: *Ancylus concentricus bonariensis*.
 Amnicolidæ: *Littoridina parchappii*, *L. australis*.
 Sphæriidæ: Not reported, but doubtless present.
 Unionidæ: *Diplodon patagonicus*.
 Mutelidæ: *Anodontites puelchana*.

B. *Rio Chubut Fauna.*

Unknown.

C. *Rio Santa Cruz Fauna.*¹

- Chiliniidæ: *Chilina strebeli*, *C. smithi*, *C. fulgurata*, *C. f. oligoptyx*, *C. f. livida*, *C. f. andicola*, *C. f. hatcheri*, *C. campylaxis*, *C. monticola pilula*, *C. lebruni*, *C. perrieri*.
 Lymnæidæ: *Lymnæa viator*, *L. diaphana*, *L. d. inelegans*, *L. patagonica riochicoensis*, *L. andeana*.
 Amnicolidæ: *Littoridina hatcheri*, *L. simplex*, *L. sublineata*.
 Sphæriidæ: *Musculium patagonicum*, *Pisidium magellanicum*, *P. patagonicum*, *P. observationis*.

D. *Magellanic, Fuegian and Falkland Faunas.*²

- Chiliniidæ: *Chilina patagonica*, *C. amœna*, *C. fuegiensis*, *C. monticola*, *C. fusca*, *C. nervosa*, *C. falklandica*.
 Lymnæidæ: *Lymnæa diaphana*, *L. patagonica*, *L. pictonica*, *L. brunneo-flavida*.
 Sphæriidæ: *Pisidium magellanicum*.

These several faunas may be roughly compared with the life-zones of North America. The La Platan zone is equivalent to the Austral, the Rio Negro fauna to the Transition, and the remainder of the Patagonian zone to the Boreal zone of the northern continent.

The distinctness of the Patagonian faunas A, C, D may be attributed to three main factors: (1) Climate, which imposes limits on the north or south distribution of species. (2) Absence of streams flowing north or south, and the consequent isolation of the river systems, favoring the evo-

¹ Known only from the collections of Mr. J. B. Hatcher.

² From the researches of Captain King, Dr. Copping, the U. S. Exploring Expedition, the French Expedition to Cape Horn, Dr. Michaelson and others.

lution of distinct species. (3) Ignorance of the Patagonian faunas between the Rio Negro and the Rio Santa Cruz system, and along the base of the Andes, where Transition forms and intermingling of the species may occur.

GASTROPODA.

Family *ENDODONTIDÆ*.

Two genera of this family are known from Patagonia: *Stephanoda* and *Radiodiscus*. The relationships of these forms to genera of other regions are unknown, since we have as yet no knowledge of their soft anatomy. *Endodontidæ* were present in the North American Carboniferous, represented by forms resembling the modern *Gonyodiscus* and *Charoſa* in shell characters, and like their descendants, living in and upon decaying stumps. The family is now found all over the world, even on the most remote islands.

RADIODISCUS Pilsbry.

Radiodiscus Pils., Proc. A. N. S. Phila., 1906, p. 154, for *R. millecostatus*.

Minute, discoidal, openly umbilicate Patuloid snails, with the embryonic $1\frac{1}{2}$ whorls minutely engraved spirally, the rest of the shell densely radially costulate. Aperture rotund-lunate, but slightly oblique, and as high as wide. Type *R. millecostatus* Pils. & Ferr.

In the *Endodontidæ*, where small differences in the shell characterize extensive series of species, it seems desirable to recognize as of generic rank such readily definable groups as *Radiodiscus*.

The distribution of this genus is very wide, extending from Tierra del Fuego to the mountain ranges of the southern boundary of Arizona, where it meets the Holarctic *Gonyodiscus* and the Nearctic *Helicodiscus*, both at their southern limits. At present, the known distribution of *Radiodiscus* is markedly discontinuous, one area extending from southern Arizona to central Mexico, the other from southern Brazil to Cape Horn; yet it must be remembered that the Andes and northern South America are unsearched for minute shells. We know very few so small as these (2 to 3 mm. diam.); and some of the species imperfectly described may turn out to belong to *Radiodiscus*. It is likely that the group is an Austral one, which has invaded Mexico from the south.

Some Tasmanian snails have a great resemblance to *Radiodiscus*, in

size, form and sculpture — a resemblance possibly due to convergence, but perhaps indicating affinity. I have not been able to actually compare specimens. On account of their spirally sculptured embryonic shells Hedley has referred them to the subgenus *Allodiscus* of the genus *Flammulina*.¹

RADIODISCUS COPPINGERI (E. A. Smith).

Helix (Patula) coppingeri Smith, P. Z. S., 1881, p. 36, pl. 4, f. 14, 14a.

Patula coppingeri Smith, Strebel, Zool. Jahrb., XXV, 1907, p. 159.

The shell is described as $1 \times 1\frac{1}{3}$ mm., composed of $3\frac{1}{2}$ whorls, the "umbilicus moderately small, equalling about one-sixth of the basal diameter."

It was described from Tom Bay (Dr. Coppinger), found on a rotten tree. This is near Madre de Dios Island, on the west coast. Strebel reports specimens which he identified as *coppingeri* from the west coast of Tierra del Fuego, Ushuaia, and Navarin Island. While this form must stand near *R. patagonicus*, it appears distinct by the much smaller umbilicus, if we may trust the published figures. I have not seen specimens. The apical sculpture has not been described.

RADIODISCUS MAGELLANICUS (E. A. Smith).

Helix (Patula) magellanica E. A. Smith, P. Z. S., 1881, p. 36, pl. 4, figs. 15, 15a.

This species, described from the same place as the preceding, will probably prove to be a *Radiodiscus*, when the embryonic whorls are examined.

RADIODISCUS PATAGONICUS (Suter).

(Plate XLII, Figs. 1, 1a, 1b.)

Pyramidula patagonica Suter, Revista do Museu Paulista, IV, 1900, p. 334, pl. 3, f. 6, 6b.

Stephanoda patagonica Suter, Pilsbry, Proc. A. N. S. Phila., 1900, p. 387, pl. 12, f. 9-11.

The shell is openly umbilicate (the umbilicus about one-fourth the total diameter), of a uniform pale brown tint, discoidal, the spire convex but low, suture deeply impressed. Whorls about $3\frac{1}{2}$, convex, slowly increasing, the embryonic $1\frac{1}{2}$ densely striate spirally, the rest radially costellate,

¹ Cf. *Flammulina (Allodiscus) roblini* Petterd, as figured by Hedley in Records of the Australian Museum, VII, 1909, p. 300.

the riblets about as wide as their intervals, about 25 in 1 mm. on the last half of the last whorl. Under the microscope some very minute striations may be seen upon the ribs, and in places an extremely minute and very faint spiral striation. The rotund-lunate aperture is slightly oblique.

Alt. 0.9, diam. 1.7 mm. (50 miles above Sierra Oveja).

“ 1.2 “ 1.8 mm. (Santa Cruz).

Santa Cruz (v. Ihering, type locality). Near Mt. of Observation. On the Rio Chico 50 miles above Sierra Oveja, on a dry stone near the water. Spring near base of the Andes, 65 miles north of the Rio Chico, elevation 2400 ft. Banks of a small stream 10 miles from Ushe Lake (J. B. Hatcher).

The above description and the figures are from a shell collected alive 50 miles above the Sierra Oveja. The original description, in Portuguese, was based upon fossil specimens, which had lost the color and part of the finer sculpture. The original lot of *patagonicus* was from Santa Cruz, on the coast, in a modern deposit. Part of the original lot is before me. They are a little larger than the living shell described, with the whorls slightly deeper; yet in the series examined from all of the localities yet known, the very slight differences seem to intergrade.

STEPHANODA Albers.

This group comprises Patuloid species in which the embryonic whorl is typically smooth, but in some forms now referred here it is marked with radial striæ, but no spirals. It differs from *Amphidoxa* (with which I formerly united it) by the more numerous, less rapidly widening whorls. Without a knowledge of the soft parts, the relationships of these South American snails to the Austral *Charopa* and *Flammulina*, and to the northern Patuliform genera, cannot be defined. The following species from southern Patagonia belong here:

S. lyrata (Gld.), summit of highest mountain near Orange Harbor, etc.
(*Helix lyrata* Gld.).

S. leptotera (Mab. et Rochebr.), Orange Bay (*Patula leptotera* M. & R.).

S. rigophila (Mab. et Rochebr.), Orange Bay (*Patula r.*, M. & R.).

S. michaelsoni (Strebel), Magellan Strait to Navarin Island (*Patula m.*, Strebel, 1907).

Family ZONITIDÆ.

The small land snails originally described as *Helix saxatilis* Gld. and *H. ordinaria* Smith have all the external characters of the *Hyalinia* group of *Zonitidæ*. *H. saxatilis* has pedal grooves and a mucous pore at the tail. Mabille and Rochebrune have proposed for it the generic term *Payenia*. What status this group will ultimately be given depends wholly upon the internal anatomy, of which we know nothing. It may possibly belong to the *Endodontidæ*.

PAYENIA SAXATILIS (Gld.), U. S. Expl. Exped., Mollusca, p. 42, pl. 3, f. 33. Orange Harbor, under dry stones.

PAYENIA ORDINARIA (E. A. Smith), P. Z. S., 1881, p. 36, pl. 4, f. 16, 16a. Tom Bay, on the west coast, attached to the frond of a fern.

Family LIMACIDÆ.

Except as introduced animals, *Limacidæ* are unknown in South America. A species of *Limax* (probably the European *Agriolimax lævis* or *A. agrestis*) has been reported from the Falkland Islands and from Ushuaia, Tierra del Fuego (Strobel, Wissenschaftliche Ergebnisse der schwedischen Süd Polar-Expedition, die Gastropoden, p. 7, 1908).

Agriolimax lævis under the name *Agriolimax argentinus* Strobel has attained a rather wide distribution in temperate South America. Doering reports it from the Rio Colorado, Rio Negro, and Sierra de Córdoba.

Family SUCCINEIDÆ.

SUCCINEA Drap.

SUCCINEA PATAGONICA E. A. Smith.

S. patagonica Smith, P. Z. S., 1881, p. 37, pl. 4, f. 17, 17a; Proc. Malac. Soc. London, VI, 1905, p. 338.

S. lebruni Mabille et Rochebrune, Miss. Sci. Cap Horn, Moll., p. 14, pl. 6, f. 4a, 4b.

The shell is rather ventricose, greenish-yellow, with the first whorl light scarlet. Length 12.5 mm. Cockle Cove, shores of Trinidad Channel and Puerto Bueno (Dr. Coppinger); Rio McClelland (Capt. Crawshay).

S. lebruni seems to differ only in the smaller size of the type specimens, length 8–9 mm.—a trivial distinction. It was taken at Punta Arenas and Orange Bay.

Two specimens, the largest 10 mm. long, were taken by Mr. Hatcher at Punta Arenas.

SUCCINEA MAGELLANICA Gould.

S. magellanica Gld., U. S. Expl. Exped., Moll., p. 24, pl. 2, f. 22; Strebel, Zool. Jahrb., XXV, 1907, p. 161, Taf. 8, f. 99; ?Doering, Informe Oficial Exped. Rio Negro, 1881, p. 62.

The shell is ventricose, similar to the preceding, except that the apex is not red. Type locality Orange Bay, but reported from numerous localities between Punta Arenas and Navarin Island by Strebel (*l. c.*). It has been recorded also from the region of Sierra Ventana, above Bahia Blanca, by Dr. Adolfo Doering, but there is a possibility that some similar form has been mistaken for *S. magellanica*.

SUCCINEA ORDINARIA E. A. Smith.

S. ordinaria Smith, Proc. Malac. Soc. London, VI, 1905, p. 338, fig. iv.

A species with 3 to 3½ very convex whorls, length 10.25 mm., diam. 6, length of aperture 6 mm. It is "apparently very like *S. lebruni* Mabilie, but without the sanguineous apex and rather more coarsely sculptured." I have not seen this species, which is probably closely related to *S. magellanica*. Admiralty Sound, Tierra del Fuego (Captain Crawshay).

SUCCINEA MERIDIONALIS d'Orbigny.

Succinea meridionalis d'Orbigny, Voyage dans l'Amér. Mérid., pp. 711;

Doering, Informe Oficial Exped. Rio Negro, 1881, p. 62 (var. *cornea*).

Sierra de la Ventana (d'Orbigny). Swamps in the pampa north of the Rio Negro (Doering, for var. *cornea* Doer.).

SUCCINEA BURMEISTERI Doering.

(Plate XLII, Figs. 2-6.)

Succinea burmeisteri Doering, Malakozoologische Blätter für 1873, XXI, p. 59, Taf. 2, f. 15-19 (Rosario am Paraná).

"Gehäuse eiförmig, zugespitzt, etwas bauchig, durchscheinend, gelblich-hornfärbig, stark und oft unregelmässig runzelig gestreift, wenig glänzend. 3½ ziemlich stark convexe und rasch an Weite zunehmende Umgänge; der letzte etwas bauchig. Gewinde zugespitzt. Mündung gerundet-eiförmig, der äussere Rand des ziemlich breiten, obwohl etwas undeutlichen Spindel-Umschlages mit dem Mundsaum zusammenhängend.

"Longit. 12 mm. Lat. 7.3 mm. Apertura 8 mm. longa, $5\frac{1}{3}$ mm. lata."

Dr. Doering's description and figures apply fairly well to a *Succinea* of the *S. avara* group, which is abundant and widely distributed in the territory of Santa Cruz, collected at the following stations:

Near Mt. of Observation (near the coast, south of Santa Cruz River).

Near Pescadores, south side Santa Cruz River, 15 miles above mouth.

Spring on Rio Chico, above mouth of Rio Chalia.

Spring on Rio Chico, north side, near Sierra Ventana.

Spring on Rio Chico, 7 miles above Sierra Ventana.

Spring near Sierra Oveja.

Springs on Rio Chico, 15, 40 and 50 miles above Sierra Oveja, and 25 and 15 miles below confluence of Rio Belgrano.

Stream near mouth of the Rio Belgrano.

Base of Andes, 40 miles north of Rio Chico, 2000 feet elevation.

Base of Andes, 50 miles north of Rio Chico, 1750 feet elevation.

Base of Andes, 65 miles north of Rio Chico, 2400 feet elevation.

Pool near Arroyo Eke, near head of Spring Creek, elevation 1750 feet.

Specimens from a spring 7 miles above the Sierra Ventana, "on horse dung near the water," are figured, Pl. XLII, figs. 4, 5, 6. The color varies from honey-yellow to whitish-yellow, always with the first whorl of a deeper yellow shade. The suture is very deep and the whorls extremely convex. The specimens figured measure:

Length	11	diam.	6	mm.,	length	of	aperture	6.5	mm.;	whorls	$3\frac{1}{2}$.
"	11	"	6.9	"	"	"	"	7.25	"	"	$3\frac{1}{2}$.
"	12.3	"	6.9	"	"	"	"	7	"	"	$3\frac{3}{4}$.

It will be noted that, as compared with Doering's description, these shells have the aperture shorter.

At all other stations the shells are smaller. Two figured from the Rio Chico 50 miles above Sierra Oveja (Pl. XLII, figs. 2, 3) representative of this small form measure:

Length	7.9	diam.	4.9	mm.,	length	of	aperture	5	mm.;	whorls	$3\frac{1}{3}$.
"	7.5	"	4	"	"	"	"	4	"	"	$3\frac{1}{2}$.

In a series of fossil individuals from the banks of a stream 10 miles from Ushe Lake (collected January 14, 1898), there is remarkable variation in contour, though most of the shells are much lengthened.

Length	11,	diam.	6.1,	length of aperture	6.3 mm.;	whorls	3½.
"	9.8	"	5.5	"	5	"	3¾.
"	8.8	"	6	"	5.3	"	3⅓.

Family *LYMNÆIDÆ*.

LYMNÆA Lamarck.

Lymnæa is more widely distributed than any other genus of freshwater mollusks, extending from the shores of the Arctic Ocean to Tasmania and Cape Horn, and in the Pacific reaching the Hawaiian group. The genus in its present limits is a synthetic group, which no doubt will ultimately be divided into several genera.

There are very few species in tropical South America, where the genus seems to be of rare occurrence; but in Patagonia the species are more numerous, individuals are abundant and generally distributed. South American *Lymnæas* fall into three subgenera or sections of the genus. Section I is clearly an intrusive element from North America. Section II may possibly be of North American origin, but its relationships are unknown, as no specimens with the soft parts have been received. Section III is peculiar to Patagonia, and not closely related to any northern forms.

I. Section GALBA Schrank. The marginal teeth of the radula differ from the laterals by being more oblique, but are essentially *tricuspid*. The shell is small, compactly coiled, of very convex whorls, usually umbilicate, the columellar lip broadly revolute, not folded. The type is *L. truncatula* of Europe. South America species, *L. viator*, *L. cousini*.

II. Section ———? Dentition unknown. The shell is lengthened, fragile, *Succinea*-shaped, of few whorls, the last large and elliptical. *L. peregrina*, *L. andeana*.

III. Section PECTINIDENS n. sect. The marginal teeth are broad and short, the cusps split into a comb-like series of many narrow denticles. Type *Lymnæa diaphana* King. There are two groups of species.

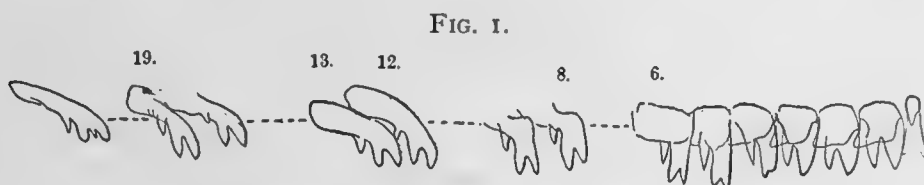
Group of *L. diaphana*. Moderately large, elongated forms, with very convex whorls and a narrow umbilical chink.

Group of *L. patagonica*. Small forms, with very short spire (peculiarly liable to truncation) and few whorls, the last relatively very large and short, rimate or imperforate. *L. patagonica*, *L. p. riochicoensis*, *L. pic-*

tonica. It is possible that the presence of acid in the water, causing erosion of the shell, may also account for the stunted stature of these forms.

DENTITION OF SOUTH AMERICAN LYMNÆAS.

Dentition of L. viator d'Orb.—The radula examined was from one of the specimens taken on the Rio Chico near the Sierra Oveja. The central tooth is narrow and unicuspid as usual. There are three or four lateral teeth, having two long cusps. In the following transition teeth the inner cusp (entocone + mesocone) is long and bifid, ectocone simple. The

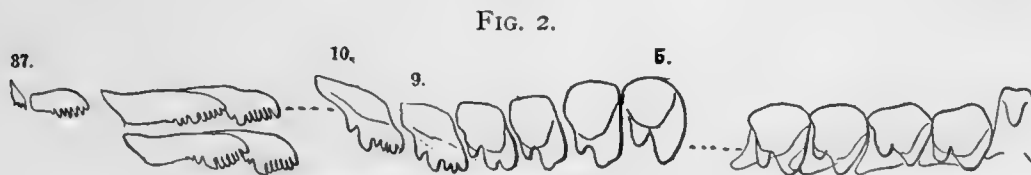


Teeth of *Lymnaea viator* d'Orb. Rio Chico, Patagonia.

marginal teeth are very oblique, with three cusps, entocone, mesocone and ectocone. In some of the outer marginal teeth there may be one or two minute accessory cusps.

The radula of *L. viator* agrees well with that of the European *L. truncatula* as figured by Lehmann. It differs from typical *Lymnaea* by retaining the primitive tricuspid type of teeth in the marginal series, with few small accessory cusps or none. *Lymnaeas* with this type of teeth have a continuous distribution from Patagonia to Alaska and in the Palæarctic region.

Dentition of Lymnaea diaphana King.—These are about 30, 7, 1, 7, 30 teeth. The central tooth is wider than usual in *Lymnaea*, unicuspid. The lateral teeth are bicuspid, the broad inner cusp becoming bifid on the transition teeth. The inner marginals have the mesocone and ento-

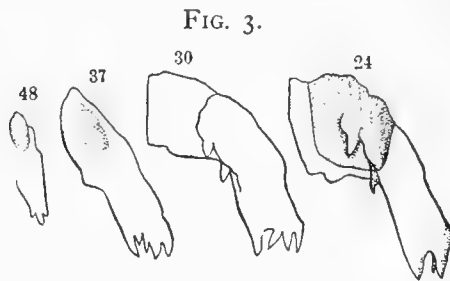


Teeth of *Lymnaea diaphana* King. Rio Chico, Patagonia.

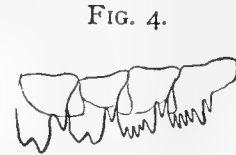
cone split into four to six small cusps, the ectocone remaining simple. Further out the marginals become transversely lengthened, their cusps lie

parallel to the long axis of the tooth, and are split into a comb-like series of denticles.

The marginal teeth of *L. diaphana* differ from those of typical *Lymnæa* by their prostrate position, the cusp of one tooth overlying the basal plate of the succeeding one in the same transverse row, and also by the comb-like cusps. In typical *Lymnæa* (*L. stagnalis*, fig. 3) the cusp stands obliquely erect, its cutting edge transverse to the long axis of the tooth.



Marginal teeth of *Lymnæa stagnalis* L.
(after Dybowski).



Two outer lateral and two inner marginal
teeth of *Lymnæa patagonica riochicoensis* Pils.

Lymnæa patagonica riochicoensis (fig. 4, two outer lateral and two inner marginal teeth) has a radula closely resembling that of *L. diaphana*. There are ten lateral teeth.

No *Lymnæa* of the northern hemisphere, of which the teeth are known, has marginals like those of *L. diaphana*, but I have shown that somewhat similar teeth exist in a Hawaiian species.¹

¹ Figures of Lymnæid teeth may be found in the following works, among others:

Lehmann: Die lebenden Schnecken und Muscheln der Umgegend Stettins und in Pommern, 1873, Taf. 15, 16.

J. Hazay: Malak. Blätter, n. F., VII, Taf. 1 (*Lymnæa auricularia*, *ovata*, *peregra*).

W. Dybowski: Studien über die Zahnplatten der Gattung *Limnæa* Lam., in Bull. Soc. Imp. Naturalistes de Moscou, LX, 1884, pt. 2, pp. 256-262, pl. 5 (*L. stagnalis* var. *vulgaris*). The best figures of *Lymnæa* teeth published. Also, Malak. Blätter, n. F., VIII, p. 124, Taf. 7 (*Amphipeplea glutinosa*).

R. P. Whitfield: Description of *Lymnæa* (*Bulimnæa*) *megasoma* Say, in Bull. Amer. Mus. Nat. Hist., I, 1882, p. 29, pl. 5.

Fischer et Crosse: Mission Scientifique au Mexique, Mollusques, II, pl. 36 (*L. auricularia*).

F. C. Baker: A revision of the *Limnæas* of northern Illinois, in Trans. St. Louis Acad. Sci., XI, 1901, pp. 1-24.

H. A. Pilsbry: Proc. A. N. S. Phila., 1903, p. 790 (*L. hawaiiensis*).

Section GALBA Schrank.

LYMNÆA VIATOR d'Orbigny.

(Plate XLVI, Fig. 8).

Limnæus viator d'Orb., Magazin de Zoologie, 1835, p. 24; Voy. dans l'Amér. Mérid., Moll., p. 340, pl. 43, figs. 1-3.

A species of the group of *L. truncatula*. The shell is small and smoothish, composed of five very convex whorls, joined by a very deep suture; the aperture is oval or nearly round, more than half the length of the shell. The axis is very distinctly umbilicate. Length 8, diam. 4 mm.

d'Orbigny records this species from the banks of the Rio Negro, 41° S. lat., 7 or 8 leagues above the mouth, very abundant. This may be considered the type locality. Afterwards he collected it also at Santiago, Chili, and at Callao and Lima, Peru, in irrigation ditches. The specimens from Peru, he notes, are constantly more elongate than those of Patagonia and Chili, with the whorls more deeply separated. Dr. W. H. Rush collected many specimens in a creek in the Prado, at Montevideo, Uruguay. These specimens, with others from Lima before me, do not seem separable from the Antillean *L. cubensis* Pfr. (1840) by any character in the shells.

Specimens from a pool on the bank of the Rio Chico, a mile west of the Sierra Oveja (Pl. XLVI, fig. 8) are larger than those from Uruguay, the individual figured measuring length 10, diam. 5.1, length of aperture 5 mm., whorls 5½. The spire is longer, and the umbilicus somewhat narrower. The columellar margin is broadly revolute and without fold or perceptible sinuosity. This form differs from that figured by d'Orbigny, and from the Montevideo shells examined, chiefly by having a longer spire and shorter aperture, the latter half as long as the shell; by having more whorls, a smaller umbilicus, and by its somewhat greater size.

Section PECTINIDENS n. sect.

LYMNÆA DIAPHANA King.

(Plate XLVI, Figs. 3, 7, 9).

Lymnæa diaphana King, Zoological Journal, V, p. 344, No. 43, 1830.

Limnæa diaphana King, Sowerby, Conchologia Iconica, XVIII, pl. 5, fig. 30, 1872.

Linnæa diaphana King, Strebel, Zool. Jahrb., XXV, p. 163, Taf. 8, figs. 100a-c, 1907.

Linnæa lebruni Mabilie, Bull. Soc. Philomathique de Paris (7), VIII, p. 44, 1883. Mabilie et Rochebrune, Mission Scientifique du Cap Horn, Mollusques, p. 19, 1889.

Freshwater ponds in the neighborhood of Cape Gregory (Cabo San Gregorio) on the north side of the Straits of Magellan, just west of the 40th meridian (King). Punta Arenas and Gente Grande, Lagune (Strebel). Punta Arenas (Mabilie, for *L. lebruni*).

King's type measured about 17×7.5 mm. ; Strebel's shells were smaller, 10-13 mm. long, and he seems to have entertained some doubt of their identity with King's. *L. lebruni* is described as 16 to 20 mm. long, and agrees well with *L. diaphana* in other respects. It may be noted that Mabilie and Rochebrune do not mention *L. diaphana*, and evidently overlooked it.

On the Rio Chico de la Santa Cruz Mr. Hatcher collected numerous Lymnæas of the *L. diaphana* type, some agreeing with the typical form from the Straits of Magellan, others divergent therefrom.

In what I take to be typical *L. diaphana*, from a spring on the Rio Chico, 15 miles above the Sierra Oveja (Pl. XLVI, figs. 3, 7, 9) the shell is thin, but moderately strong, narrowly rimate, rather long, the last whorl swollen, but *much smaller than in L. d. inelegans*, very evenly rounded, with sculpture of unequal growth-lines, but not malleated, and very glossy. The spire is *long, slender and acuminate*. The shortly ovate aperture is rather small; columella very narrowly revolute, not adnate above, continuing free to the parietal wall above the axial crevice. The color is light brown, or, when the cuticle is worn off, pink, or pinkish white. Specimens measure:

Fig. 3.	Length 17,	diam. 9.4,	length of aperture 8.8 mm.;	whorls $5\frac{1}{2}$.
" 9.	" 14	" 7.25,	" " 6.9	" " $5\frac{1}{3}$.
" 7.	" 6.3 mm.;	whorls 4 (young shell).		
	" 21.2,	diam. 11,	length of aperture 10.8 mm.;	whorls 6.
	" 17	" 9.8	" " 9.4	" " $5\frac{1}{3}$.
	" 17.8	" 10.4	" " 10	" " $5\frac{1}{3}$.

In a small stream, 5 miles above Sierra Oveja, the shells are nearly typical in shape, but small and thin. One measures, length 11.8, diam.

6.7, aperture 6.7 mm.; whorls 5. One from near the Sierra Ventana is similar.

In a pool near the Sierra Oveja the shells are similar, but darker colored, more olive. The apices are eroded.

LYMNÆA DIAPHANA INELEGANS subsp. nov.

(Plate XLVI, Figs. 1, 2, 4-6).

The shell is narrowly rimate, short and wide, the *last whorl disproportionately large*, inflated, with sculpture of rather coarse growth-wrinkles and more or less malleation. The spire is small, shortly conic. *Aperture very ample*. Columella very indistinctly or not folded, narrow, nearly straight in the middle, its edge narrowly reflexed, expanding in the axial region. The specimens figured measure:

Length 16,	diam. 10.5,	length of aperture 10.8 mm.;	whorls 5.
“ 16	“ 9.3	“ “ 9.7	“ “ 4¾.
“ 16	“ 10	“ “ 9.4	“ “ 5.
“ 15	“ 10	“ “ 9.7	“ “ 4¾.
“ 15.3	“ 9	“ “ 9	“ “ 5.

Spring on the Rio Chico, 25 miles above the Sierra Oveja (figs. 1, 2, 4, 6). Small stream, 35 miles above Sierra Oveja (fig. 5).

The specimens from the second locality mentioned are more regular in contour. Up to a length of 15½ to 16 mm. the surface shows no malleation, and at that size the shells of this lot reach maturity. The lip expands slightly and a very thin, white, submarginal callus strengthens it. In one individual growth has proceeded beyond this stage, the part added being strongly malleated. This shell (Pl. XLVI, fig. 5) measures, length 17, diam. 10, length of aperture 9.8 mm.; whorls 5.

In two of the four lots from “springs on the Rio Chico, 25 miles above Sierra Oveja,” there are some dwarf individuals. One measures, length 10, diam. 6, aperture 6.5 mm.; whorls 4¼. In another lot, all the shells are similarly dwarfed.

In the Rio Chico, 50 miles above Sierra Oveja, a similar dwarf shell was taken.

In and near drying pools on a high divide near the base of the Andes, 50 miles north of the Rio Chico, elevation 2400 ft., the shells are very fragile, pale, dull buff, with strongly developed, low, wave-like costation

and more or less malleation. One measures, length 14, diam. 8, length of aperture 8.6 mm.; whorls $4\frac{1}{2}$. Those from the Arroyo Eke, near the head of Spring Creek, are also small.

In Swan Lake (about 50 miles north of the Rio Chico) the shells are very delicate, almost like tissue paper, but little malleated or (usually) without malleation, and of a pale olive color. Most of the examples conform nearly to Pl. XLVIa, fig. 2, in shape, but I have also figured the most elongate (fig. 1) and the shortest (fig. 3) shells. Fig. 2 measures, length 19, diam. 11, length of aperture 10.9 mm.; whorls $4\frac{3}{4}$.

Mr. Hatcher in his narrative has alluded to the abundance of shells in this lake (Reports of the Princeton University Expeditions to Patagonia, I, p. 166). The lake basin is composed of igneous rocks dammed by a lava flow. To the absence of calcareous material, the tenuity of the shells is probably due.

Lymnæa brunneoflavida Preston, Annals and Magazine of Natural History (8), V, January, 1910, p. 110, pl. 4, fig. 1, from the Falkland Islands, is described as wider, more opaque and darker than *L. diaphana*, alt. 14, diam. 8, aperture 8.75 mm. It evidently stands close to *L. diaphana*.

LYMNÆA PATAGONICA Strebel.

Lymnæa patagonica Strebel, Zool. Jahrb., XXV, p. 164, Taf. 8, figs. 103a, b, 1907.

Strebel's types are said to differ from the form he describes as *L. diaphana* by being browner, more of a chestnut-brown, the whorls increase more rapidly in width, the apex is commonly broken, with the breach closed by shell-material; the columella stands more nearly vertical, and its reflection is somewhat wider, but leaves an umbilical crevice open. It measures as follows:

Length 14.8, diam. 12.6, aperture 10.7×6.8 mm., $3\frac{1}{2}$ whorls remaining.

“ 10.4, “ 8.1, “ 7.2×4.5 “ 3 “ “

Puerto Bridges, in a fresh-water lake.

LYMNÆA PATAGONICA RIOCHICOENSIS subsp. nov.

(Plate XLVI, Figs. 10, 11.)

The shell resembles *L. patagonica* in shape, being short ovate; the axis is *imperforate*. It is *pale honey-yellow* or *very pale yellowish-brown*. In

an entire specimen (fig. 11) there are $3\frac{1}{4}$ convex and rapidly enlarging whorls, the last inconspicuously marked with rather widely spaced, very low longitudinal wrinkles, and some weak malleation in places. The aperture appears to be less rounded than in *L. patagonica*. The parietal and axial callus is a mere transparent film (not distinct as shown in fig. 11), closely adnate throughout. The columella is white, solid and rounded, nearly straight, and without trace of a fold. The largest specimen (fig. 11) measures:

Length 6.8, diam. 4.8, aperture 4.9×3.1 mm.

Rio Chico, 25 miles below the confluence of the Rio Belgrano, in the river under stones, numerous specimens. Also in a pool near the Sierra Oveja, one characteristic individual.

Most of the adult examples taken are very much eroded, the spire removed, and the last whorl deeply eaten in places, as though by acid. The parietal callus is thick, with the outer edge distinctly raised. The external erosion is compensated by thickening of the shell from the inside. Fig. 10 measures:

Length 5, diam. 4, aperture 4.1×3 mm.; $2\frac{1}{3}$ whorls.

Although the perfect and the deeply eroded shells were in one lot when received, yet I have no doubt that they came from two sources, one of pure water, the other carrying CO_2 , doubtless from leaching through decaying organic matter.

LYMNÆA PICTONICA Rochebrune et Mabille.

Lymnæa pictonica R. et M., Miss. Sci. Cap Horn, p. 21, 1889.

A small, very fragile species, with exserted spire and truncate apex, 2 or 3 convex, rapidly increasing whorls remaining. There is a very narrow perforation.

Length 6, diam. 3 mm.

Picton Island, in the southeastern termination of the Beagle Channel.

This species seems to be decidedly narrower than the preceding. It may be the southern terminal member of the series of short Lymnæas represented in the Magellan district by *L. patagonica* and on the Rio Chico, 400 to 500 miles farther north, by *L. p. riochicoensis*. It is quite possible, however, that these several forms may prove to be independent shortened forms, each directly related to more normal forms.

SECTION UNDETERMINED.

LYMNÆA ANDEANA sp. nov.

(Plate XLVIa, Figs. 4, 4a.)

The shell is acuminate-oblong, imperforate, very thin and fragile, pale yellowish-corneous, translucent. Surface dull, smooth to the eye except on the last part of the last whorl, where it is conspicuously malleated. Under the microscope the dullness is seen to be caused by extremely fine hair-lines, mainly longitudinal in direction, but forming a close mesh over the whole surface. There are also faint growth-lines and weak traces of spiral bands of vertical wrinkles. Whorls barely 4, the first convex, those following only weakly so. The last whorl has the form of a long ellipse. Aperture ovate. Parietal film scarcely perceptible. Columella slender, slightly concave, dilated above, the dilatation thin and adnate.

Length 11.9, diam. 6.3 mm.; aperture 7.3 mm. long.

Near the base of the Andes in drying pools on a high divide, 50 miles north of the Rio Chico.

This species is apparently related to *L. peregrina* Clessin of southern Brazil and Uruguay, but differs conspicuously by the very weak development of spiral sculpture, that species being even more copiously striate spirally than the North American *L. columella*.

A few immature specimens of another thin, fragile species, probably related to *L. andeana*, were taken in small streams on the Rio Chico, 10 and 25 miles above the Sierra Oveja.

PLANORBIS PEREGRINUS d'Orbigny.

Planorbis peregrinus d'Orb., Voy. dans l'Amér. Mérid., p. 348.

Rio Negro, Bahia Blanca, etc. (d'Orbigny); lakes along the Rio Negro (Roca Exped.).

PLANORBIS ANATINUS d'Orbigny.

Planorbis anatinus d'Orb., t. c., p. 351 (Paraná river, Prov. Entrerios, Argentina).

Lakes along the Rio Negro (Roca Exped.).

Family ANCYLIDÆ.

ANCYLUS CONCENTRICUS BONARIENSIS Strobel.

A. c. var. *bonariensis* Strobel, Materiali, etc., p. 51, pl. 2, f. 4 (around Buenos Aires).

A. c. bonariensis Strobel, Doering, Informe Oficial de la Comision científica agregada al estado mayor general de la Expedition al Rio Negro, bajo las órdenes del General D. Julio A. Roca, Zoologia, p. 71, 1881.

Rio Negro near the mouth of the Rio Neuquen (Roca Exped.).

Family *CHILINIDÆ* Dall.

Chiliniidæ Dall, Annals of the Lyceum of Natural History of New York, IX, 1870, p. 357.

CHILINA Gray.

Chilina Gray, Specilegia Zoologica, p. 5, July 1, 1828 (for *Auricula fluctuosa* Gray).

Dombeia d'Orbigny, Voyage dans l'Amérique Méridionale, Mollusques, planche 43 (1843?).

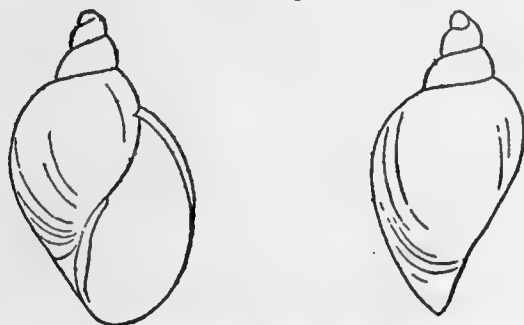
Duplicaria Rafinesque, Atlantic Journal and Friend of Knowledge, No. V, 1833, p. 165 (for *D. bonariensis* Raf. = *Chilina fluminea* Maton).

Pseudochilina Dall, Annals of the Lyceum of Nat. Hist., New York, IX, 1870, p. 357 (for *Pseudochilina limnæformis* Dall).

Acyrogonia Mabille et Rochebrune, Mission Scientifique du Cap Horn, VI, 1889, Mollusques, p. 25.

The apex in *Chilina* differs from that of all Lymnæid snails in the initial half whorl of the embryo, which is tilted up, as shown in fig. 5. Growth of the shell seems to be upward at first, the nucleus lying below the summit. At the end of the third whorl, in *C. fulgurata* and several other

FIG. 5.



Chilina fulgurata Pils. Young specimen 3.8 mm. long, composed of $3\frac{1}{2}$ whorls.

species, the color-pattern begins weakly. Previous to this the shell is uniform corneous-brown. The columellar fold is present at a very early stage, but my material does not show when it first appears.

The growth of the shell in Patagonian species is periodic, growth-arrest periods being marked by streaks interrupting the normal pattern. On resumption of growth, the zigzag pattern is sometimes replaced by irregular streaks; but in a later growth-period the original pattern may be resumed.

The subgenus *Pseudochilina* was based upon a form shaped about like fig. 7 of Plate XLIII. The irregular or fibrous surface, which served to characterize the subgenus, seems to me to be wholly due to erosion, the cuticle or periostracum being lost from the unique type in the National Museum. In other characters the shell is a typical *Chilina*.

Acyrogonia of Mabilie and Rochebrune is a *Chilina* in which the columellar plait is wanting. I have found this plait variable in development in some forms of *Chilina* from the Rio Chico. In *C. fulgurata oligoptyx* it approaches the condition described in *Acyrogonia*.

DISTRIBUTION OF CHILINA.

Chilina occupies the temperate and cold zones of South America from the Tropic of Capricorn to Cape Horn. No member of the group, either living or fossil, has been found outside of these limits.¹ It is noteworthy that no trace of the group has been found in other Austral lands—Tasmania and New Zealand having sufficiently similar climatic conditions to favor the survival of *Chiliniidæ*, if the family ever had a wider range in the Antarctic area.

Within their area, the *Chiliniidæ* are abundant snails in all suitable stations, as *Physidæ* are in the north. They swarm in springs, small streams, lakes, and in some places the margins of rivers. They are most abundant southward, becoming rarer and local toward the northern borders of their range.

The species from west of the Andes are in all cases, so far as we know, distinct from those east of the divide. In the cold temperate and cold zones at least, the widely diverse physical features on opposite sides of the Andes would lead us to expect different snail faunas.

¹ *Chilina olivula* Repelin, Ann. Mus. d'Hist. Nat. de Marseille, VII, p. 69, of the Cenomanian of central France, has no columellar fold, and is clearly a Lymnæid snail with no relations whatever to *Chilina*. *Chilina* in Europe, like *Partula*, *Polygyra*, *Glandina*, etc., is one of those myths of European palæontology which astonish and amuse the investigator using modern methods with Pulmonate snails.

The eastern fauna, with which alone we have now to deal,¹ inhabits a comparatively arid region, poorly watered by roughly parallel streams flowing southeastward into the Atlantic. Each of the principal river systems has its own series of freshwater mollusks, in large part distinct specifically or racially from those of other rivers. The *Chilimida* of the several drainages have been enumerated on pp. 514-5.

CHILINA PATAGONICA Sowerby.

Chilina patagonica Sowb., Conchologia Iconica, XIX, pl. 3, fig. 11 (bad), August 1874; E. A. Smith, Proc. Zool. Soc., London, 1881, p. 845; Strebel, Zool. Jahrb., XXV, 1907, p. 166.

Patagonia (Sowerby). Puerto Bridges, Picton Island and Puerto Montt (Strebel, various forms taken by Michaelson and Lau).

Mr. Smith has given valuable information on this species in his paper of 1881. Strebel includes in it some very diverse forms, the pertinence of which to *patagonica* seems open to doubt.

The specimens figured by Strebel from Gente Grande Bay, under the name "*Chilina fluviatilis* Gray," are obviously not *Chilina fluviatilis* (Maton) of the La Plata drainage. What they are, remains uncertain.

CHILINA AMÆNA E. A. Smith.

Chilina amœna E. A. Smith, P. Z. S., 1881, pp. 37, 846, pl. 4, f. 18, 18a.

"This species is remarkable for its fragility, the slenderness of its form and the vividness of the markings."

Length 26, diam. 11, aperture 14.5 mm.

Tom Bay (Coppinger).

CHILINA FUEGIENSIS E. A. Smith.

Chilina fuegiensis E. A. Smith, Proc. Malac. Soc. London, VI, p. 339, fig. vii, September, 1905.

A very slender species, length 24, diam. 10, aperture 13.5 mm., apparently related to the preceding.

Rio Marazzi, Useless Bay, Tierra del Fuego.

¹ Mr. E. A. Smith has published a catalogue of *Chilina* in Proceedings of the Zoological Society of London, 1881, to which the student is referred for information on the species of Chili.

CHILINA FUSCA Mabilie.

Chilina fusca Jules Mabilie, Bull. Soc. Philomathique de Paris (7), VIII, 1883, p. 45.

Acyrogonia fusca Mabilie et Rochebrune, Miss. Sci. du Cap Horn, VI, 1889, p. 25.

The shell is fragile, brownish-corneous, ornamented with a few brown spots; columella white, somewhat twisted, a little thickened, but without a fold. Length 16 to 17, diameter 8 mm.

Punta Arenas (Lebrun).

This species is the type of the group *Acyrogonia*¹ described as a new genus of *Chiliniidæ*, with the following characters: "Shell thin but quite strong, the general shape acutely oval, spire projecting but not very slender; columella arcuate, twisted but little, without the columellar folds characteristic of *Chilina*, and descending to the base of the aperture."

This group is known only by the original account. Neither of the two species has been figured. I do not think it generically distinct from *Chilina*. In some species of that genus the columellar fold is reduced to an inconspicuous vestige.

CHILINA NERVOSA (Mabilie et Rochebrune).

Acyrogonia nervosa Jules Mabilie et Rochebrune, Mission Scientifique du Cap Horn, VI, Mollusques, Pt. H., p. 26 (1889).

A more compact, ventricose species than *C. fusca*, with the aperture wider, the columella thick, arcuate, impressed in the middle and without a fold. Length 16, diam. 10 mm.

Punta Arenas, in pools (Lebrun).

CHILINA FALKLANDICA Preston.

Chilina falklandica Preston, Annals and Magazine of Natural History (8), V, January, 1910, p. 111, pl. 4, fig. 2.

Near *C. amæna*. Length 15, diam. 8, aperture 9.5 mm.
Falkland Islands.

CHILINA STREBELI sp. nov.

(Plate XLIV, Figs. 24-28.)

The shell is elliptical, with a short, conic and acute spire; rather solid. Sculpture of rather coarse and unequal wrinkles along growth-lines and

¹ *Acyrogonia* Jules Mabilie et Rochebrune, Mission Scientifique du Cap Horn, VI, Mollusques, p. 25, 1889.

minute, indistinct spiral striæ. The ground-color is rather bright yellow on the last whorl, copiously marked with purplish-brown zigzag streaks, each with 4 principal angles projecting forward, and more or less widened at the angles. On the latter part of the whorl the streaks disappear, leaving four bands of spots. The spire is dark blue, with dusky brown zigzag markings on the penultimate and next earlier whorls, those above being uniform purplish-brown or dull blue. Whorls between $5\frac{1}{2}$ and 6, convex, regularly increasing, the last elliptical, widest in the middle. The aperture is nearly vertical, white, rich brown deep in the throat, showing the external markings as purplish-brown spot-bands. Columella rather broad, white, bearing a rather stout oblique fold above, a slight spirally entering prominence below it (in most examples scarcely showing in front view). Parietal callus thin, bearing a low, spirally entering fold at its lower third, usually hardly visible in a front view.

Fig. 24.	Length 25,	diam. 14.2,	length of aperture 18 mm.
" 25.	" 25.2	" 14.5	" 18 "
" 26.	" 23.5	" 13.2	" 16 "
	" 24	" 13	" 16 "

Mount of Observation, 40 miles south of Santa Cruz River.

This fine species was collected in some quantity. It is distinguished from *Chilina puelcha* d'Orb. by the presence of a parietal fold, among other peculiarities. No other species from south of the Rio de La Plata drainage has this fold developed. In the young stages (figs. 27, 28) the color-streaks are less distinctly defined, fading at their edges,¹ and the parietal fold is present only as a very thin whitish callus.

CHILINA SMITHI sp. nov.

(Plate XLIII, Figs. 1-4.)

The shell is oblong-ovate, solid, minutely rimate, rather rudely sculptured, with wrinkles of growth and more or less distinct spiral lines; always more or less deeply eroded in the adult stage. The color of the cuticle is olive, or in the newly-formed band behind the outer lip it is yellow. In adults a large part of the cuticle is wanting, exposing the calcareous layer beneath, which is blue and gray, or when deeply worn (as in figures 3 and 4), it is white. The spire is worn, whorls convex, the last one *distinctly shouldered*, compressed laterally, widest at the middle *or below it*. The

¹They are represented entirely too sharply defined in figures 27 and 28.

aperture is nearly vertical, very dark chestnut-colored within in adults, less dark in younger shells, fleshy-whitish near the lip-edge, which is thin and acute. The columella is not very wide, flat, white or flesh-tinted, more or less concave, and bears a rather small, very oblique fold above. Parietal callus very thin, transparent.

Fig. 1.	Length	41,	diam.	22,	length of aperture	24	mm.
“ 2.	“	30	“	15.3	“	“	19
“ 3.	“	39.5	“	20	“	“	22
“ 4.	“	31.2	“	19	“	“	21.8
		35.2	“	17.2	“	“	21.6

Springs on the Rio Chico, 15–25 miles above the Sierra Oveja.

This is one of the largest species of the genus, remarkable for its solid, inornate shell, shouldered at the last whorl (a feature not very well shown in the figures), and very dark chestnut or purplish-chestnut interior. Typically the spire is well produced, as in figs. 1, 3, but the lot contains also shortened forms, such as fig. 4.

The shouldered last whorl, solidity and color distinguish this species from *C. parchappii* d'Orb. It also attains a larger size. Named in honor of Mr. E. A. Smith, to whom we owe a very useful catalogue of the genus.

Young shells up to 22 mm. long show faint traces of waved longitudinal brown streaks on the last whorl, but in older ones these disappear, though faintly indicated spot-bands may persist up to 30 mm. long in some examples. Figures 8, 9, 10 of Plate XLIII represent young shells 17.2, 16 and 14.5 mm. long respectively. At this stage there are $5\frac{1}{2}$ to 6 whorls. The spire is acuminate and the apex perfect in some individuals. On a yellow ground there are chestnut streaks, which show three (figs. 8, 9) or four (fig. 10) forwardly projecting angles, with a row of spots just below the suture.¹

CHILINA LEBRUNI Mabile.

Chilina lebruni Jules Mabile, Bulletin Soc. Philomathique de Paris, 7 Série, VIII, 1883, p. 45; Mabile et Rochebrune, Mission Scientifique du Cap Horn, VI, Zoologie, Pt. H., Mollusques, p. 22, 1889.

An unfigured form, probably related to *C. fulgurata*. Length 10 to 13 mm., diam. 6 to 9 mm.

Santa Cruz (Lebrun).

¹The pattern is not very well rendered in the drawings, and the outlines of the markings are too definite.

CHILINA FULGURATA sp. nov.

(Plates XLIII, Figs. 11-15; XLIIIa, Fig. 4.)

The shell is imperforate, elliptical, with short, conic spire, thin. Fully grown shells are in large part dull gray from loss of the cuticle on the back, but what remains in front is dull pale yellowish, with numerous dusky brown, angular streaks (fig. 15). Younger shells (fig. 11, length 12 mm., and fig. 12, length 13.2 mm.) are densely marked with reddish-chestnut, zigzag stripes on a whitish or in places yellow ground, the penultimate whorl with a blue ground. In an older stage (figs. 13, 14, length 16 mm.) the ground color on the back and spire is blue, but whitish at the base. The brown stripes have four forwardly projecting angles. The apices are more or less eroded in the type lot, but there are evidently not less than 5 whorls. The aperture shows the external marking on a ground more or less suffused with rich light chestnut in shells not fully adult, but in old shells the markings are not seen, and the throat becomes chestnut, fading to whitish near the lip. The columella is rather narrow, white, straight, or only slightly arcuate, and bears a small and rather thin, very oblique lamella above.¹

Fig. 15. Length 19, diam. 10.7, length of aperture 12.9 mm.
 " 13-14. " 16, " 8.9, " " 10.9 "

Small stream on the Rio Chico, 5 miles above the Sierra Oveja, type locality; also northward to the foothills of the Andes, in various springs and streams.

This species has the elaborate color-pattern of *Chilina puelcha* d'Orbigny, but differs from that by its comparatively narrow contour. The dimensions of the type of *C. puelcha* are, length 20, diam. 15 mm. *C. fulgurata* is probably related more closely to *C. parchappii* d'Orb., a more slender and lengthened species, deficient in color-ornamentation.

The type of *C. fulgurata* is drawn in Plate XLIII, figs. 13, 14, and Plate XLIIIa, fig. 4.

In springs twenty-five miles above the Sierra Oveja, a large, thin form of *fulgurata* was found. The elaborate color-pattern persists through the period of maturity, but fails in the aged or gerontic stage. The surface has minute axial plicæ and distinct spiral lines, giving it a decussate-

¹ This lamella, while correct as to outline in figures 13 and 15, is represented as more massive than it really is.

granular appearance, more or less developed in different examples. The columella is flat, vertical, nearly straight, with a small, compressed and acute fold above. Pl. XLIIIa, figs. 6, 6a, represent an old shell deeply eroded in places. Length 18 (spire largely eroded), diam. 11, length of aperture 13 mm. In this lot the cuticle persists over most of the surface.

At 30 miles above the Sierra Oveja similar large shells were found in a spring. In even the largest, the color-pattern and sculpture persist to the lip-edge. Pl. XLIIIa, fig. 7, represents an area immediately below the termination of the suture. The shell measures, length 20.7, diam. 11, length of aperture 13.4 mm. The apex is eroded.

In a small running stream on the south side of the Rio Chico, 25 miles above Sierra Oveja, two forms of *Chilina* were found: numerous small *C. fulgurata*, the largest 10 to 11 mm. long, and probably not fully adult; and three examples of a very elongate form, one of them figured in Pl. XLIV, fig. 23. In this shell the waved streaks appear only on the last half of the last whorl, being preceded by two bands of small spots.¹ The columella is Lymnæid. Sculpture as in the large decussate *C. fulgurata*. Axis rimate. Length 17, diam. 8, length of aperture 10 mm. The significance of these examples is doubtful.

Small specimens which seem to be *C. fulgurata* were taken in a spring on the south side of the Rio Chico, seven miles above the Sierra Ventana.

CHILINA FULGURATA OLIGOPTYX subsp. nov.

(Plate XLIV, Figs. 18, 18a, 20-22a.)

The shell is oval, inflated, with short but acuminate spire of between 5 and 6 whorls. The cuticle is extremely thin and deciduous, but more or less usually remains on the face and behind the outer lip. It is corneous, or slightly yellowish (somewhat too yellow in figs. 20, 21, 22), with faint reddish-brown streaks. Where the epidermis is removed, the shell is ash colored, or livid purplish or fleshy, sometimes showing traces of the waved color-markings, the spire often dark purple (as in fig. 22a). The columella is only moderately arched, and either has no fold (fig. 18) or a small fold may be seen above, in an oblique view, sometimes somewhat stronger than in fig. 22. The outer lip is somewhat thickened within, in adult shells.

¹ The scattered dots shown in fig. 23 are ferrous deposits, foreign to the shell.

Fig. 18.	Length 15,	diam. 8,	length of aperture 10	mm.
" 21, 22.	" 12	" 7	" 8.8	"
" 22a.	" 12.5	" 7	" 9	"
	" 12	" 7.1	" 8.6	"
	" 13.5	" 7.3	" 9	"
	" 12.2	" 7.9	" 9.5	"

Spring on the north side of the Rio Chico near the Sierra Ventana. Types No. 88,686 A. N. S. P. Also taken in springs 20 and 25 miles below the Sierra Ventana.

By its shorter form, weak or wanting columellar fold, and the less developed color-pattern, this race differs from *C. fulgurata*. Some examples from 25 miles below the Sierra Ventana are more fully colored, resembling *C. fulgurata* in this respect; and it may be said that dead shells which retain the cuticle also show the color-pattern more distinctly than living shells.

CHILINA FULGURATA LIVIDA subsp. nov.

(Plates XLIII, Figs. 5-7; XLIV, Figs. 16, 17, 19.)

The spire is *longer* than in *fulgurata*, acuminate, and consisting of fully $6\frac{1}{2}$ whorls; spiral striæ distinct. In the adult stage the surface, where unworn, is *livid purplish* on the back, and color-streaks are wanting or very weak, though one to three faint spot-bands are generally retained. The eroded spots have the appearance of mould, the edges under a hand-lens, appearing fuzzy or fibrous. The columellar fold is usually well developed, though often appearing weak or blunt in a face view. The interior is dark purplish-brown.

Fig. 5. Length 20.5, diam. 10.25, length of aperture 12.1 mm.

" 6.	" 20	" 10	" 12	"
" 7.	" 16	" 8	" 9.8 ¹	"
	" 23.8	" 12.9	" 15.4	"

Spring 15 miles above the Sierra Oveja. Types no. 88,662 A. N. S. P.

The young stage down to 14 mm. long, is colored like fig. 7, but occasional specimens of larger size show some faint, waved color-streaks.

Another lot which I refer to *livida* (Pl. XLIV, figs. 16, 17, 19) was taken in a small stream 5 miles above the Sierra Oveja. The half grown stage (Pl. XLIV, fig. 19) is elaborately zigzag-striped with reddish-brown

¹ Immature.

on a buff ground. In older shells (figs. 16, 17) the pattern is very indistinct or lost by erosion.

Fig. 16.	Length	21.8,	diam.	10,	length of aperture	12	mm.
" 17.	"	18	"	9	"	10.9	"
" 19.	"	13.1	"	6.9	"	8	"

CHILINA FULGURATA ANDICOLA subsp. nov.

(Plate XLIIIa, Figs. 5, 5a.)

A series of three quite young shells from under stones along a small running stream near the mouth of the Rio Belgrano, and a single shell, perhaps adult, from a spring 50 miles north of the Rio Chico, at an elevation of 1750 ft., indicate that a special race inhabits the Andean foothills, though the material at hand is hardly sufficient for its full characterization. The cuticle is rather bright yellow, with a full development of the *fulgurata* pattern in young shells. This pattern begins about the middle of the third whorl.

In the larger shell (Pl. XLIIIa, figs. 5, 5a), from the second locality, the ground is olive or greenish-yellow. The first half of the last whorl has the usual *fulgurata* streaks, but the last half (following a growth-arrest period) has the streaks broken, leaving four spot-bands. The yellow ground also has many fine olive lines. The aperture is like that of *fulgurata*. The apex is eroded. Length 8.5, diam. 5, length of aperture 6.8 mm.

CHILINA FULGURATA HATCHERI subsp. nov.

(Plate XLIIIa, Figs. 3, 3a.)

The shell is *thin*, of a dilute dull red color, variegated with four bands of spots, more or less indistinct, often hardly noticeable. There are also some obscure red-brown longitudinal streaks. The spire is darker, acuminate above, its surface more or less eroded. There would be over 5 whorls if the apex were perfect. Surface glossy, with fine growth-lines and very delicate spiral striæ, much as in *C. fulgurata* from 30 miles above Sierra Oveja, but much more delicate. Columella straight and flattened below, acutely folded above, similar to large forms of *C. fulgurata*.

Fig. 3.	Length	19,	diam.	10,	length of aperture	13.4	mm.
" 3a.	"	17.5	"	8.8	"	11.5	"

Arroyo Eke, near the headwaters of Spring Creek (north of the Rio Belgrano), April 10, 1898.

Except on the spire, the cuticle is generally well preserved. When worn on the last whorl, it is deciduous along the spiral striæ, which otherwise are hardly noticeable. These shells are readily distinguishable from any taken at lower levels, along the Rio Chico.

CHILINA CAMPYLAXIS sp. nov.

(Plate XLIIIa, Figs. 1-2a.)

The shell is oval, much inflated, thin. Dead individuals, but evidently almost or wholly unchanged in color, are light reddish-brown, with rather faint streaks of chestnut, which are angular and dilated to form three bands of sagittiform spots besides a row of small spots below the suture. These markings are often less fully developed than in the figured specimens, and they are generally removed in part by the erosion of the surface. Where the cuticle is retained behind the outer lip, it is yellow. The surface shows spiral striæ more distinct than usual. The aperture is light brown or fulvous inside. The outer lip does not seem to be thickened within, as it is in *C. f. oligoptyx*. The *columella* is narrow, deeply concave, and has a small but distinct fold above (rarely subobsolete.)

Figs. 1, 1a.	Length 19,	diam. 11.2,	length of aperture 13	mm.
" 2, 2a.	" 18.2	" 11	" 12	"
	" 18	" 11	" 12.25	"
	" 17	" 10.8	" 12.8	"
	" 17	" 11	" 13	"
	" 17.2	" 11	" 13	"
	" 17	" 10.2	" 12	"

The numerous specimens vary but slightly in size or other features. They have some resemblance to the Magellanic *C. patagonica*, which however is figured as having a straight columella and a stronger columellar fold.

All of the specimens are "dead" shells. At this spring *C. fulgurata oligoptyx* was also found, both alive and among the dead shells which were preserved separately; the larger individuals have the outer lip noticeably thickened. The shells of *C. campylaxis* differ constantly from the associated *oligoptyx* in various structural features, and must, I think, be regarded as specifically diverse.

CHILINA PERRIERI Mabile.

Chilina perrieri Jules Mabile, Bull. Soc. Philomathique de Paris (7), VIII, 1883, p. 46; Mabile et Rochebrune, Miss. Sci. du Cap Horn, VI, Pt. H., Mollusques, p. 24, 1889.

A short, oval, solid form, apparently near *C. monticola*. Length 12, diam. 8 mm. It has not been figured.

Santa Cruz (Lebrun).

CHILINA MONTICOLA Strebel.

Chilina monticola Strebel, Zool. Jahrb., XXV, 1907, p. 169, Taf. 8, fig. 101.

The shell is thin but rather strong, translucent chestnut, with separated, dilute, waved streaks, or spot bands also, mostly indistinct; comparatively broad, with short, acute spire of about 5 whorls. Columella has a very weak fold, not visible in front view.

Length 9.8, diam. 6.9, aperture 8.4×3.9 mm.

“ 8.5 “ 6.8 “ 7.5×3.2 “

Punta Arenas, in a large mountain lake at an elevation of about 300 meters.

Strebel seems to entertain some doubt as to whether this may not be an immature stage of *C. ovalis* Sowerby. I have not seen specimens.

CHILINA MONTICOLA PILULA subsp. nov.

(Plate XLIV, Figs. 29, 30, 30a.)

The shell is very small, shortly oval, with a very short conic spire; thin; glossy when unworn, sculptured with fine growth-striæ and indistinct, minute spiral lines. Adult shells are generally dull ashy- or brownish-white from loss of the cuticle, but where preserved, it is yellow or dusky reddish, closely marked with indistinct reddish-brown streaks, upon which there are spots at intervals, forming five spiral bands, one just below the suture, the others at subequal intervals on the last whorl. The longitudinal streaks are scarcely visible on some examples, and the spot-bands are often very faint or reduced to three. The very short spire is eroded in all the specimens seen, the number of whorls being therefore uncertain. The aperture is quite ample and shows the external color through the thin outer lip. The columella is white, rather narrow and weakly

arcuate, having a very small and low fold close to the upper end, and hardly noticeable in most specimens.

Length 5.1, diam. 3.8, length of aperture 4.3 mm.

Springs on the Rio Chico, 25 miles below the Sierra Ventana, Feb. 15, 1899.

This species is known from 40 specimens in two lots, taken the same day in the same neighborhood, but apparently from two springs, the station numbers being different and the condition of the specimens as regards erosion slightly diverse. There is also another individual from a different station, "freshwater spring on the Rio Chico," date and locality not given. They range in size from young shells less than 3 mm. long to slightly over 5 mm. In a shell of 3 mm. there are fully three whorls. All the adults have the spire worn, so that the number of whorls is uncertain, but there are evidently four or more.

The very globose shape of these shells shows that they are not young or dwarf individuals of the larger species of the same region. Moreover, the larger ones have the eroded and old appearance of adult snails. Whether the species attains greater size in the streams running from the springs which they inhabit remains uncertain. I know of several instances of dwarf snails inhabiting springs, having put at least one such case on record.¹ It is evident that the usual explanations of dwarfing in small quantities of water are not pertinent, since in flowing springs there is no lack of aëration and no accumulation of the toxins of metabolism. It seems likely that the dwarfing of snails in springs may be due to the purity of the water, which affords an insufficient supply of diatoms, other algæ and vegetable food.

This form is, for the time being, ranked as a subspecies of *Chilina monticola* from Punta Arenas, but I suspect that it is related rather to *C. fulgurata*. Apparently adult shells are only about half the size of *monticola*.

CHILINA TEHUELCHA d'Orbigny.

Chilina tehuelcha d'Orb., Voy. dans l'Amér. Mérid., p. 336, pl. 43, figs. 6, 7; Strobel, Mat. Malac. Argent., p. 43, with var. *mendozaana*, p. 43, pl. 2, fig. 4.

A very obese, solid species with short spire and very large aperture. Length 35, diam. 25 mm.

¹ Cf. *Goniobasis comalensis fontinalis*, Proc. A. N. S. Phila., 1906, p. 169.

Rio Negro, thirteen leagues above its mouth, in the channels formed by the river between the numerous wooded islands of the place called San Xavier, in sandy places (d'Orbigny).

The var. *mendozaana* Strobel is "smaller, the maximum length 18, diam. 10 mm., six-banded." It is from San Carlos, province of Mendoza.

CHILINA PUELCHA d'Orbigny.

Chilina puelcha d'Orb., Voy. dans l'Amér. Mérid., p. 336, pl. 43, figs. 8-12;
Strobel, Mat. Malac. Argent., p. 45.

The shell is oval, thick, yellowish-green, very rarely uniform, but generally marked with wavy longitudinal streaks, widened at their forward angles to form three spiral spot-bands. Columella thick, having a very strong fold. Length 20, diam. 15 mm.

Rio Negro, 6 or 7 leagues above its mouth, on stones on the shores, very abundant (d'Orbigny).

CHILINA PARCHAPPII (d'Orbigny).

Limneus parchappii d'Orb., Magazin de Zoologie, 1835, p. 25.

Chilina parchappii d'Orb., Voyage dans l'Amérique Mérid., p. 338, pl. 43,
figs. 4, 5.

An elongate, thin species, brownish, with four spot-bands, the spire conic and acute, whorls 5; columella typically having a small fold. Length 33, diam. 15 mm.

Pampas between 38° and 39° S. lat., the typical form from the "Arroyo Salado" on the slopes of the Sierra de la Ventana, near Bahia Blanca. In the "Arroyo de las Achiras" in the same region a very thin variety of uniform color and without a columellar fold was taken by M. Parchappe.

CHILINA FLUMINEA (Maton).

(Plate XLV, Figs. 35-39.)

Voluta fluminea Maton, Trans. Linnean Soc., 1809, X, p. 330, pl. 24,
figs. 14, 15.

Voluta fluviatilis Maton, l. c., fig. 13.

Chilina fluminea Gray, Spicil. Zool., p. 5; d'Orbigny, Voyage dans l'Amér. Mérid., p. 337, pl. 43, figs. 19, 20; E. A. Smith, Proc. Zool. Soc. Lond., 1881, p. 843.

Duplicaria bonariensis Rafinesque, Atlantic Journal and Friend of Knowledge, No. V, 1833, p. 165; Binney and Tryon's reprint, p. 93.

A short-oval, inflated shell, with usually olive ground-color, but sometimes olive-yellow or bright green, and either unicolored or marked with one to five spiral bands of dark chestnut spots, alternating with spots paler than the ground-color. The upper bands are more persistent than those below. Very rarely the pattern is of irregularly zigzag streaks flowing from the suture down, not quite reaching the base (fig. 38). The ample aperture is blue-white within, and usually shows the external markings through. The columellar lamella is very strong, and a long entering callous ridge stands on the parietal wall, and is always well developed in adult snails. The specimens figured from San Gabriel's Island, opposite Colonia, Uruguay, measure:

Fig. 35.	Length 11,	diam. 7.9,	length of aperture 8.9	mm.
" 36.	" 10.25,	" 7	" "	8.25 "
" 37.	" 12	" 8.5	" "	9.9 "
" 38.	" 10.8	" 7.5	" "	9 "
" 39.	" 7.8	" 5.6	" "	6.8 "

Some examples from Buenos Aires are larger, 13.25 mm. long. All adult shells seen have the spire eroded.

Fig. 36 has the pattern of the type of *C. fluminea*. Fig. 35 is the color-form which Maton called *fluviatilis*, but it has no racial characters.¹ Figures 38 and 39 are color-forms hitherto unrecorded. The spots composing the bands vary in size, and are sometimes reduced to mere dots.

Very young shells, 2.25 mm. long, are plain colored, have no parietal fold, and only a very small columellar fold. With growth, the band at the shoulder appears first. No streaked stage precedes the bands.

La Plata (Maton); Buenos Aires (Phila. Acad. coll.); San Gabriel's Island (Dr. W. H. Rush); Rio Colorado (Roca Exped.).

CHILINA FLUMINEA MICRODON subsp. nov.

(Plate XLV, Figs. 40-44.)

Chilina fluminea d'Orb., Heynemann, Malak. Blätter, XV, 1868, p. 112, Taf. 5, fig. 11 (teeth).

Chilina fluminea Maton, Martens, t. c., p. 184.

¹The name *Voluta fluviatilis* has precedence on Maton's page, but subsequent authors have preferred that of *fluminea*.

Shell similar to *fluminea*, but differing by having the parietal lamella very small and deeply placed; columellar fold smaller than in *fluminea*. The color is bright greenish-yellow, uniform or marked with 5 or fewer spot-bands; rarely it is brown or olive-brown.

Fig. 40.	Length 10,	diam. 7.4,	length of aperture 9	mm.
" 41.	" 8.3,	" 6.1	" "	7.5 "
" 42.	" 12.1	" 7.7	" "	10 "
" 43.	" 11	" 7.1	" "	8.9 "
" 44.	" 11	" 7.7	" "	9.5 "

Province of Rio Grande do Sul, Brazil: Guatzbu (H. von Ihering, type loc.); Guahyba at Porto Alegre, common on stones (Dr. Hensel).

Professor von Martens has already referred to the differential features of this race, which inhabits the Jacuhy river system.

As in *C. fluminea*, there is wide variation in the size and prominence of the spire, which may be either very short, as in figs. 40, 41, or wider and much more produced, figs. 42, 43. The tip of the spire is worn away in all the examples seen.

CHILINA GLOBOSA Frauenfeld.

(Plate XLV, Fig. 45.)

C. globosa Ffd., Zoologische Miscellen, in Verhandlung der k. k. zoologisch-botanischen Gesellschaft in Wien, 1866, p. 13.

According to Frauenfeld, this is a round-oval, brownish yellow shell, with three hardly noticeable spot-bands on the last whorl. Columellar lip very thick, covered with a white callus to the upper end, two-toothed. Length 13.8, diam. 10.2 mm.

The example figured is larger, length 16, diam. 12.5, aperture 13.9 mm. long. It is straw yellow, with traces of a spot-band upon a low spiral angle, which crowns the last whorl. It is also stained with iron oxide in front and under the parietal callus. The very heavy columellar callus continues upon the parietal wall, bearing thick, obtuse, parietal and columellar lamellæ.

This species is chiefly distinguished from *C. fluminea* by its very heavy parietal callus.

La Plata States (Ffd.); La Plata (coll. A. N. S. P.).

CHILINA RUSHII Pilsbry.

(Plate XLV, Figs. 31-34.)

Chilina rushii Pils., Proc. A. N. S. Phila., 1896, p. 561, pl. 26, figs. 6, 7.

This species is closely related to *C. fluminea*, but differs by the acute keel at the shoulder. This keel arises rather abruptly at the end of the second whorl; and either runs to the end, or after continuing for several whorls, gradually dies out, leaving the last whorl rounded, as in fig. 33. In a young shell 4.3 mm. long, with $3\frac{1}{3}$ whorls, the last whorl only is acutely carinate.

Fig. 31.	Length	14.3,	diam.	9.5,	length of aperture	11	mm.
" 32.	"	15.25	"	11	"	12.3	"
" 33.	"	11.5	"	7.8	"	9	"
" 34.	"	14.5	"	9	"	11.3	"
	"	22.5	"	13.5	"	16	" ¹

Uruguay River at Fray Bentos, Uruguay (Dr. Wm. H. Rush, U.S.N.).

CHILINA PARVA von Martens.

Chilina parva v. Marts., Malakozoologische Blätter, XV, 1868, p. 185.

A small, rather thin, globose form with flat spire; brown, obsoletely lightning-streaked; columella having a distinct columellar tooth and a low dentiform swelling below, the parietal callus distinct.

Length $5\frac{1}{2}$ -6, diam. $4\frac{1}{2}$ -5 mm.; aperture $4\frac{1}{2}$ mm. long.

Province of Rio Grande do Sul, Brazil, at Rödgersberg, in small brooks in the forest (Dr. Hensel).

An unfigured species known by the original description only.

CHILINA PORTILLENIS Hidalgo.

Chilina portillensis Hidalgo, Journal de Conchyliologie, 1880, p. 322, pl. 11, fig. 1.

An ovate, rather solid olive-green shell, marked with darker spiral bands and lines. It has columellar and parietal folds, and evidently is rather closely related to *C. fluminea*. Length 12, diam. 9 mm., length of aperture 9 mm.

Western Argentina at Portillo, 4000 meters elevation.

¹ Rush collection.

Family *AMNICOLIDÆ* Tryon.

Amnicolidæ Tryon, Proc. Acad. Nat. Sciences of Philadelphia, 1862, p. 147; Gill, Proc. A. N. S. Phila., 1863, pp. 33, 35.

Hydrobiinæ Stimpson, Researches upon the Hydrobiinæ and Allied Genera, 1865, p. 4.

Hydrobiidæ Fischer, Manuel de Conchyliologie, 1885, p. 723.

This family of minute river-snails has been but little studied or collected in South America. We have some knowledge of the species of the Rio de La Plata system though the work of d'Orbigny, Doering and Strobel and collections made by Dr. W. H. Rush, U.S.N. In southern Brazil Dr. von Ihering has done good work, though hampered by the want of La Platan material for comparison. In Ecuador K. Miller has described a few forms collected by Wolf and others. In the north, Dr. von Martens has recorded a few Venezuelan species. None are known from the Orinoco or Amazon systems. Through the collections of Mr. Hatcher we are now enabled to add several forms from Patagonia. The opportunity has also been taken fully to describe and figure the known species of *Potamolithus*, part of them new forms, most of the rest hitherto defined only by a brief "key" published in 1892. Only six of the thirty species now known have hitherto been figured.

All of the South American genera and species of *Amnicolidæ* are described or referred to below.

The following genera of this family are represented in South America:

<i>Amnicola</i> Gould and Haldeman,	<i>Idiopyrgus</i> Pilsbry,
<i>Littoridina</i> Souleyet,	<i>Potamolithus</i> Pilsbry,
<i>Potamopyrgus</i> Stimpson,	<i>Lithococcus</i> Pilsbry.

Of these genera, *Amnicola* has been found only in the extreme north. *A. ernesti* (Martens) of Lake Valencia, Venezuela, is closely related to *A. panamensis* Tryon and several Mexican species, and is undoubtedly of North American origin.¹

Potamopyrgus is the dominant genus of *Amnicolidæ* in New Zealand and Tasmania. It is unknown in the Oriental region. In America it extends from Argentina to Venezuela, through Mexico to central Texas and throughout the West Indies. This distribution is explicable on the

¹ *Hydrobia* (*Amnicola*) *ernesti* Martens, Die Binnenmollusken Venezuelas, 1873, p. 209, Taf. 2, fig. 12.

supposition that the genus had its origin in Antarctica, or one of the Austral lands once connected therewith.

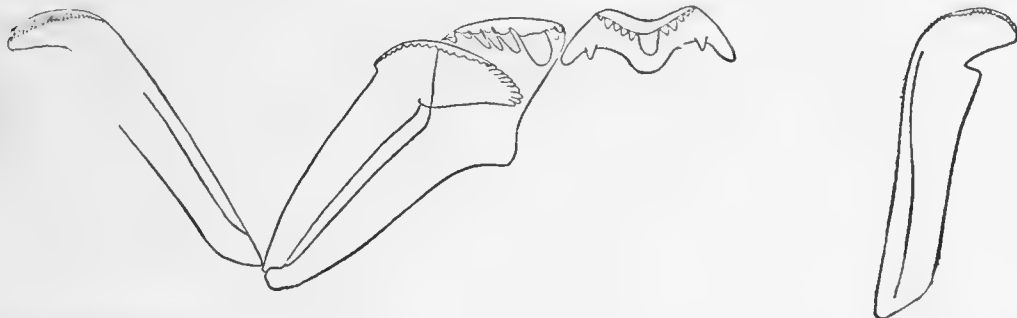
Littoridina resembles the Holarctic *Paludestrina* and the genus *Fluviopupa*¹ of Australia and the Melanesian Plateau, but until the external genitalia of all can be compared, no well-founded opinion of the affinities of these genera can be formed.

Idiopyrgus is an Archhelenic genus, if my estimate of its affinities is correct.

The affinities of *Lithococcus* are uncertain.

Potamolithus, in the form of the shell, closely resembles the genera assembled by Tryon in the subfamily *Lithoglyphinae*: *Fluminicola* of western North America, *Lithoglyphus* of eastern Europe, *Pachydrobia*, *Lacunopsis* and *Fullienia* of Indo-China. All of these genera differ from *Potamolithus* by the small number and large size of the cusps of the outer marginal teeth.² *Fluminicola* has male genitalia of widely different form. The genus *Petterdiana* of Tasmania and Australia has a strong globular

FIG. 6.



Petterdiana tasmanica (Tenison-Woods), half row of teeth and an isolated outer marginal tooth.

shell, with wide columella, similar to the primitive species of *Potamolithus*. The radula, hitherto undescribed, has the formula $\frac{5, 1, 5}{1-1}$. 2, 1, 5. 20. 25 (Fig. 6, teeth of a half row, and a detached outer marginal tooth). This

¹ *Fluviopupa* n. gen., type *F. pupoidea* (Mousson) of Fiji. The teeth are of the usual shape in *Amnicolinæ*, central with the cusp formula $\frac{6, 1, 5}{4-4}$, admedian with 10 subequal cusps, marginals with about 30, those of the outer marginal very minute. Shell pupiform, with obtuse summit and convex sides, the aperture ovate, vertical or sloping forward below, the long parietal margin straightened. Operculum thin, with nucleus near the base. Penis unknown. *Hydrobia petterdi* E. A. Smith seems to be congeneric, judging from specimens sent from Manaro, N. S. Wales, by Dr. J. C. Cox. These shells have the appearance of the European *Bythinellæ*, but differ from them in dentition.

² See J. Poirer, *Journal de Conchyliologie*, XXIX, 1881, pp. 1-19.

radula resembles that of *Potamolithus* in the important character of having many minute cusps on the marginal teeth, more than double the number of those on the admedian tooth. It differs from *Potamolithus* by having a single basal cusp or denticle on each side of the central tooth, *Potamolithus* having two or more. I have found the number of basal cusps so variable in many genera that I do not attach much importance to this character. Of all known genera, *Petterdiana* is, in my opinion, the most closely related to *Potamolithus*.

Marginal teeth with a small number of cusps characterize the subfamily *Lithoglyphinae*. The Austral genera *Potamolithus* and *Petterdiana* cannot be included in this subfamily. They may for the present be placed in the *Annicolinae*.

LITTORIDINA Souleyet.

Littoridina Souleyet, Voyage autour du Monde exécuté pendant les années 1836 et 1837 sur la corvette La Bonite, Zoologie, II, p. 565 (1852).
Monotypic: type *L. gaudichaudii* Soul.

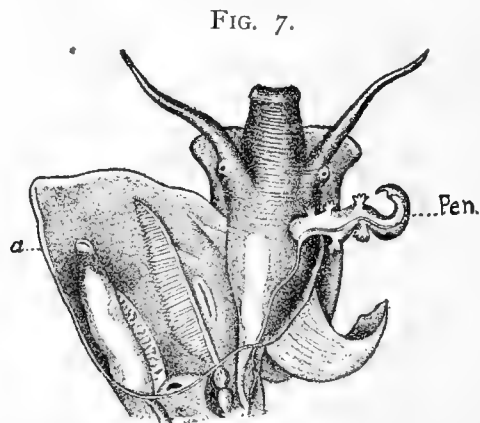
"*Littorinida* Eydoux et Souleyet" Stimpson, Researches upon the Hydrobiinæ, etc., 1865, p. 43; Fischer, Manuel de Conchyliologie, 1885, p. 730.

Paludestrina in part, d'Orbigny, 1839; Stimpson, 1865.

Heleobia Stimpson, Researches upon the Hydrobiinæ, etc., 1865, p. 47.
Monotypic: type *P. culminea*.

Hydrobia and *Paludina* of some authors.

The shell is small, very narrowly rimate, acutely ovate, thin, smooth or rarely striated spirally, of olive or pale corneous color; whorls usually



Littoridina gaudichaudii, anterior part of the body, the pallial cavity opened and spread to the left. *a*, anus; *Pen.*, penis. (After Souleyet.)

but slightly convex, rarely carinate; aperture ovate, not very oblique, less than half as long as the shell; peristome thin and simple, continuous or interrupted. The operculum is thin, ovate, paucispiral, the nucleus below the lower third and near the columellar margin. The long penis has several digitate lateral papillæ or simple warts, and is curved at the end. The central tooth of the radula has one to four basal denticles on each side. The marginal teeth have very numerous denticles, more than twice as many as the admedian tooth. The animal is oviparous.

DENTITION OF LITTORIDINA.

Littoridina guadichaudii, the type of the genus, has several, probably four, basal denticles on each side of the central tooth. Souleyet's figure shows five, but allowance must be made for the difficulty of the object and the date, 1852.

Dr. von Ihering found two basal denticles on each side in *L. australis*. For *L. picium* he gives the number $\frac{9}{4-4}$ and *L. charruana* $\frac{11}{1-1}$.

L. simplex of the Rio Chico (fig. 8) has a central tooth with the cusp-

FIG. 8.



Central tooth of *Littoridina simplex* Pils.

formula $\frac{5-1-5}{3-3}$. The admedian tooth has 6, 1, 6 cusps, the two marginal teeth many, about 30, cusps.

L. hatcheri, Rio Chico, has the cusp formula $\frac{9}{2-2}$. 8. 25. 30. The cusps of the marginal teeth are so excessively small that their exact number is not certain (fig. 9).

FIG. 9.



Teeth of *Littoridina hatcheri* Pils.

Littoridina was based upon a snail from the river of Guayaquil, having

a shell resembling *Paludestrina* or *Bythinella*, but differing by the penis, which is not bifid, and has several lateral papillæ or warts.

We owe to Souleyet an excellent account of the anatomy of *L. guadi-chaudii*, and Dr. von Ihering has published valuable notes on that of several species of southern Brazil. Many other species are referred to *Littoridina* from the resemblance of the shells and their distribution alone. Most of them have been described under genera based upon European types, such as *Paludestrina* and *Hydrobia*, which, so far as we know, differ anatomically from the type of *Littoridina*. Provisionally, therefore, we refer to *Littoridina* all of the smooth, slender and thin oviparous Amnicolinæ of South America, having the lip simple.

Most of the species are fresh-water forms, but a few live as well in the brackish water of estuaries, or even in the salt water of sheltered bays. They are known to extend from below the mouth of Santa Cruz River in Patagonia north to Ecuador in the west, and to the state of Rio Janeiro, Brazil, in the east.

Many species of *Littoridina* have been described from the La Plata system and the Sierras of western Argentina (Provinces of Córdoba and Mendoza) by d'Orbigny,¹ Strobel² and Doering,³ but none have heretofore been reported from the southern territories. Mr. Hatcher's collections extend the range of the genus south to the Mount of Observation, below the mouth of the Santa Cruz River.

Several species of *Littoridina* have both slender and stouter forms, with others of intermediate shape, in any large lot. These differences may be sexual, but no observations bearing on the point have been made. In some other species the contour is nearly uniform.

Various authors having referred the Littoridinæ to d'Orbigny's *Paludestrina*, it may be well to give some account of that genus.

Paludestrina was proposed by A. d'Orbigny in 1839⁴ for *Paludina acuta* of France and the South American rissoids of fresh and brackish water, having the operculum spiral, such as *P. lapidum*, *P. peristomata* and *P. australis*. Various subsequent authors have mentioned or discussed

¹ Alcide d'Orbigny, Voyage dans l'Amérique Méridionale, Mollusques, 1839.

² Pellegrino Strobel, Materiali per una Malacostatica di terra e di acqua dolce dell'Argentina Meridionale. Pisa, 1874.

³ Adolfo Doering, Apuntes sobre la fauna de moluscos de la República Argentina, in Boletín de la Academia Nacional de Ciencias en Córdoba, VII, 1884, pp. 465-474 ("*Hydrobia*").

⁴ Voyage dans l'Amérique Méridionale, Mollusques, p. 381.

the group, but no type species seems to have been selected until William Stimpson, in 1865, selected *P. auferiana* d'Orb. as type.¹ Bourguignat in January, 1887, named *P. acuta* Drap. as type of the genus.² In 1895 Dr. von Ihering proposed to restrict *Paludestrina* to the group now called *Potamolithus*, with *P. peristomata* as type.³ This course cannot be followed because of Bourguignat's earlier selection. *P. acuta* (Drap.) must stand as the type of *Paludestrina*.

The following names will fall as synonyms of *Paludestrina*: *Littorinella* Braun, 1846, type *L. acuta* (Drap.). *Ecrobia* Stimpson, 1865, type *Turbo minutus* Totten. The preceding live in brackish water, or in sheltered bays or estuaries, or sometimes where the water is fresh. The exclusively fresh-water groups *Bythinella* Moq., 1851, type *B. viridis* Moq., and *Stimpsonia* Clessin, 1878,⁴ type *B. nickliniana* (Lea), are indistinguishable from *Paludestrina* in shell, operculum and dentition, but according to Moquin-Tandon the penis of *B. ferrusina* is bifid, while that of *P. minuta* (Totten) was found to be simple by Stimpson. Until the types of these proposed genera are studied and the forms of their penes ascertained, there seems to be little reason for recognizing more than one genus of these slender Amnicoloid snails in North America and Europe, although it is likely that several may ultimately be defined.

In *Paludestrina* (including *Bythinella*) the central tooth has a single well-developed basal denticle on each side, but often a second one is weakly developed.

LITTORIDINA HATCHERI sp. nov.

(Plate XLII, Figs. 7, 7a, 8, 11-13.)

The shell is minute, imperforate (though slightly rimate), rather solid, olivaceous brown, smooth; in shape ovate or somewhat pupiform. The outlines of the spire are convex; the summit minute, a little obtuse, though the apex is not depressed. Whorls 4, convex, at first slowly, then rapidly widening, the suture therefore descends more rapidly and obliquely in its last volution, and it is also deeper than in those preceding.

¹ Recherches upon the Hydrobiinæ and allied forms, Smiths. Misc. Coll., No. 201, pp. 45, 46. This selection was not valid for the reason that *auferiana* was not one of the species included in *Paludestrina* in d'Orbigny's original publication, but was added some years later.

² Étude sur les noms génériques des petites Paludinéés à opercule spirescent, pp. 9, 10.

³ Die Gattung *Paludestrina*, in Nachrichtenblatt d. d. Malak. Gesellschaft, XXVII, 1895, pp. 122-128.

⁴ Malak. Blätter, XXV, 1878, p. 151.

The last whorl is rounded and expands towards the aperture, at the upper angle of which it descends slightly. The aperture is subvertical, symmetrically ovate, narrower but not angular above. The peristome is continuous, of a deep reddish brown color, almost black at the edge. The outer margin is slightly thickened and obtuse; the inner margin is rather heavily calloused, forming a raised ledge across the preceding whorl, from which it is slightly detached above and below.

Length 2.25, diam. 1.2 mm.; length of aperture 1.1 mm. (Pl. XLII, figs. 7, 7a).

Rio Chico de la Sta. Cruz, Territory of Santa Cruz, Argentina, from below the mouth of the Rio Chalia to the mouth of the Rio Belgrano; and northward along the eastern slope of the Andes 65 miles, in springs and small streams. Specimens were taken at the following localities: Spring on the Rio Chico below the mouth of the Rio Chalia (2: 12: '99); spring on Rio Chico, 25 miles below Sierra Ventana (type locality); twenty miles below Sierra Ventana, in a spring; north side of Rio Chico near Sierra Ventana; Rio Chico, 40 miles above Sierra Ventana; small stream 5 miles above Sierra Oveja; small stream on south side of Rio Chico, 50 miles above Sierra Oveja; near the mouth of Rio Belgrano; Rio Blanco, base of the Andes; spring 50 miles north of Rio Chico, elevation 1750 ft.; spring near base of the Andes, 65 miles north of the Rio Chico, elevation 2400 ft. Also several lots from springs on the Rio Chico without exact location.

This small snail is evidently abundant in springs and small streams along the whole course of the Rio Chico de la Sta. Cruz. It is apparently related to *L. kuesteri* and especially to *L. k. cordilleræ* (Strobel),¹ from the Province of Mendoza, but differs from these by its wider, convexly conic spire, the shape of *L. hatcheri* being rather pupiform, whereas the spire is strictly conic in *L. kuesteri* and *cordilleræ*.

L. hatcheri varies within wide limits in nearly all of the colonies collected. This variation is chiefly (1) in size, nearly every lot consisting of both large and small individuals, the difference being greater than I have ever observed in North American *Annicolidæ*; and (2) in the degree of descent, lateral deviation or uncoiling of the last whorl. As type I have selected a shell nearly normal in shape, Pl. XLII, figs. 7, 7a, 2.25

¹*Hydrobia kuesteri* and var. *cordilleræ* Strobel, *Materiali per una Malacostatica di Terra e di Acqua dolce dell'Argentina Meridionale*, p. 61. Pisa, 1874.

mm. long. Some others in the same lot are smaller and more pupiform, with the parietal callus barely free from the preceding whorl, as in fig. 8, length 1.7 mm. The entire lot from the type locality consists of shells which do not depart much from the normal *Littoridina* contour.

At two stations, 40 and 50 miles above the Sierra Oveja, a considerable proportion of the shells have the last whorl deeply descending to the aperture and becoming free, or partially free near the termination. A series from 40 miles above Sierra Oveja is figured, Pl. XLII, figs. 11, 11*a*, 12, 13. Fig. 12 represents a nearly normal shell; figs. 11, 11*a* and 13, those with the last whorl loosening its coil; all are fully mature, but not old snails. The individuals figured measure:

Fig. 11. Length 3.3, diam. 1.7, length of aperture 1.2 mm.; whorls $4\frac{3}{4}$.
 " 12. " 2.7 " 1.6 " " 1.25 " " $4\frac{1}{2}$.
 " 13. " 2.1 " 1.3 " " 1 " " $4\frac{1}{3}$.

The same tendency is well-marked in a lot from far down the river, below the mouth of the Rio Chalia. The other lots of the species resemble the type lot, having the shape nearly normal, but with a variable proportion of individuals in which the peristome is partly or for a short distance free.

L. hatcheri is thus a species distinctly aged or gerontic, with this feature much more strongly emphasized in certain colonies.

LITTORIDINA SIMPLEX sp. nov.

(Plate XLII, Figs. 9, 10.)

The shell is minutely rimate but scarcely perforate, rather thin, ovate-conic, of a very pale olivaceous-yellowish tint, the apex and first whorl reddish in the type lot, smoothish, but lightly marked with growth-lines. The spire is straightly conic, the apex minute and very slightly obtuse. Whorls $4\frac{1}{2}$, all rather strongly convex, regularly enlarging, and joined by an impressed suture, which on the last whorl or two shows a narrow faint margination below caused by transparence. The aperture is ovate, subvertical. Peristome continuous, its edge delicately marked with a brownish line. The outer lip curves forward a little in the middle, and has a very delicate whitish thickening within. Inner margin thickened a little, continuous, in contact with the preceding whorl.

Fig. 9. Length 3, diam. 1.8 mm., length of aperture 1.3 mm.
 " 10. " 3 " 2 " " " 1.5 "

Springs along the Rio Chico de la Sta. Cruz, at the following places: About 15–20 miles above the mouth of the Rio Chalia; springs 20 and 25 miles below the Sierra Ventana; spring near the Sierra Ventana (type locality); 25 and 50 miles above the Sierra Oveja. Also near Mt. of Observation, on the coast, below the mouth of the Santa Cruz River. Also at the foot of the Andes, 50 miles north of the Rio Chico.

This species resembles several forms of the Rio de La Plata system, but is distinguished by the combination of quite strongly convex whorls and a continuous peristome; its inner margin, though not much thickened, yet forms a distinct ledge across the preceding whorl. The striation is exaggerated in fig. 9, and the umbilical chink is represented too wide and prominent in both figures. The apex is reddish in the type lot, but not in others. *L. simplex* occurs in the same springs with *L. hatcheri* along the Rio Chico, but it is apparently less abundant and it does not seem to ascend the river so far.

LITTORIDINA SUBLINEATA sp. nov.

(Plate XLVIa, Figs. 5, 5a.)

The shell is imperforate, ovate-pyramidal, thin, light brown. Surface faintly marked with growth-lines, and on the last half of the last whorl there are several (four or five in the type specimen) very low spiral cords, grouped in the peripheral region. The spire is rather straightly conic, the summit a little obtuse, the apex rising but little above the level of the first whorl. Whorls 5, convex, the last very indistinctly angular below the periphery, causing the base to appear slightly flattened. The aperture is ovate, very slightly oblique; peristome thin and acute, the outer margin not darkened or thickened. Columella concave, slightly thickened, continued in a thin adnate callus across the parietal wall.

Length 3.6, diam. 2.2 mm., length of aperture 1.5 mm.

Small stream on the Rio Chico, 35 miles above the Sierra Oveja (type locality); also in a spring 25 miles above the Sierra Oveja, and in a "big spring on the Rio Chico," the exact location of which was not noted on the collector's label.

It sometimes attains a larger size than the type, a shell from the second lot noted above being 5.4 mm. long with $5\frac{1}{2}$ whorls. This species differs from *L. simplex* by its weakly subangular periphery, marked with a few spiral lines, the less prominent parietal callus and fragile outer lip.

LITTORIDINA AUSTRALIS (d'Orbigny).

(Plate XLIc, Figs. 3-8.)

Paludina australis d'Orb., Mag. de Zool., 1830, p. 30.*Paludestrina australis* d'Orb., Voyage, p. 384, pl. 48, figs. 4-6 (Bahia Blanca and Bahia de San Blas, Patagonia, on water plants and mud covered by each tide; also at Montevideo); von Ihering, Nachrichtenblatt, XXVII, 1895, p. 123, anatomy (Rio Grande do Sul and Sao Paulo); von-Martens, Malak. Blätter, XV, 1868, p. 192 (Porto Alegre).*Melania dubiosa* Clessin.

d'Orbigny gives the dimensions, length 6, diam. 3 mm., whorls 7. Fig. 7, drawn from a specimen from Bahia Blanca, the type locality, is of this size. Some examples are narrower (fig. 6), and others much larger, length 8.5 mm. (fig. 5). The whorls are almost flat except in the largest shells, where the last whorl is convex. Under a strong lens very faint spiral striæ may be seen on most examples. Figures 5-7 represent bleached shells from Bahia Blanca, the type locality, received from Dr. von Ihering.

At Montevideo, in a creek in the Prado, the shells taken by Dr. Rush are large, olivaceous, with noticeably more convex whorls. They measure :

Length	8.3,	diam.	4,	length of aperture	3.5 mm.;	whorls	8.
"	8.2	"	3.9	"	"	3.2	" " 7½.
"	8.4	"	3.9	"	"	3.3	" " 8¼.

In a small spring back of the Cerro, Montevideo, the shells are similar but smaller, about 5 mm. long with 6½ whorls.

Shells from Rio Grande do Sul, sent by Dr. von Ihering, are about 6 mm. long, 2.3 to 2.9 mm. in diameter. The more slender shells are less numerous than the stouter ones, and some are transitional in shape. The color varies from dark to pale olive (Plate XLIc, figs. 3, 4, 8). A small form has been sent also from Ilha Comprida, near Iguape, on the Sao Paulo littoral.

Melania dubiosa Clessin, judging from specimens sent from S. Leopoldo, State of Rio Grande do Sul, by Dr. von Ihering, is identical with the large form of *L. australis* noticed above from Montevideo.

LITTORIDINA CHARRUANA (d'Orbigny).

(Plate XLIc, Figs. 1, 2.)

Paludestrina charruana d'Orb., Voy., p. 384, pl. 75, figs. 1, 2 (at the embouchure of a stream into the sea north of Montevideo); von Ihering, Nachrbl., 1895, p. 123, anatomy (Iguape, Sao Paulo).

A shorter, stouter snail than *L. australis*, the cuticle olive, with black growth-arrest lines in old shells. It varies widely in shape, as may be seen by figs. 1, 2, which represent average, stout and slender shells from the Rio Cubatao, near Santos, State of Sao Paulo. They measure:

Length	5.8,	diam.	3.5,	aperture	2.6 mm.;	whorls	6.
"	5.7	"	3.1	"	2.5	"	7.
"	5	"	2.7	"	2.2	"	

It has also been sent by Dr. von Ihering from the Ribeira at Iguape and from Guatzbu, State of Rio Grande do Sul, where the shells are more slender.

d'Orbigny's type measured, length 5, diam. 3 mm., whorls 6.

LITTORIDINA PICIUM (d'Orbigny).

(Plate XLIc, Fig. 13.)

Paludina picium d'Orb., Mag. de Zool., 1835, p. 30.

Paludestrina picium d'Orb., Voyage, p. 383, pl. 47, figs. 17-21 (Rio de La Plata at Buenos Aires, etc., under stones); von Ihering, Nachrbl., 1895, p. 123, anatomy (Rio Grande do Sul); von Martens, Malak. Blätter, XV, 1868, p. 192 (Rödersberg).

This is smaller and thinner than *L. charruana*, less opaque, of a paler greenish yellow or olive-corneous tint. The whorls are rather strongly convex, the suture well-impressed, having a grayish border below. d'Orbigny gives the size as length 3, diam. 2 mm., whorls 5. Two from San Gabriel's Island, in the Rio de La Plata off Colonia, Uruguay, measure:

Length	4,	diam.	2.2,	aperture	1.8 mm.;	whorls	6.
Fig. 13.	" 4	"	2.4	"	1.8	"	5¾.

Specimens are before me also from the type locality, Buenos Aires, agreeing fully with those figured.

Littoridina glabra (Tryon) from Bolivia resembles *L. picium*, but it is somewhat more slender, thinner, the columella less calloused.

LITTORIDINA BERTONIANA sp. nov.

(Plate XLIc, Fig. 9.)

The shell is barely perforate, oblong-turrite, pale olivaceous, the length about double the greatest diameter, and two and one-half times the length of the aperture. Spire rather straightly conic, the apex obtuse. Whorls $5\frac{1}{3}$, moderately convex, the last well rounded. Surface delicately marked with very fine spiral striæ, usually strongest on the penultimate whorl. The aperture is ovate, angular above. Peristome thin and simple, continuous, the columellar margin narrowly expanded.

Length 3.6, diam. 1.7, length of aperture 1.4 mm.

Puerto Bertoni, Paraguay. Types No. 103,045, A. N. S. Phila., from No. 244 of the Museu Paulista, collected by A. de W. Bertoni.

This species differs from *Potamopyrgus peteningensis* (Gld.) by its much less convex whorls, smaller size and minute spiral striæ. *Potamopyrgus scottii* has far more convex whorls and coarser sculpture.

In some specimens from the type locality the spiral striæ are extremely minute and weak, yet visible under the compound microscope. These were sent under No. 190 Museu Paulista.

A few other species at present referred to *Littoridina*, such as *L. pedrina* Miller, have spiral sculpture; yet the presence of this unusual feature raises some doubt as to the genus, which can be definitely determined only by examination of the genitalia. *L. bertoniana* may prove to belong to *Potamopyrgus*.

OTHER SPECIES OF LITTORIDINA DESCRIBED FROM SOUTH AMERICA,
SOUTH OF THE EQUATOR.¹

LITTORIDINA ISABELLEANA (d'Orbigny). *Paludestrina isabelleana* d'Orb., Voy., p. 385, pl. 75, figs. 4-6. 3×1 mm., whorls 6, flat. In a stream near Montevideo and in the Bay of Montevideo at the contact of fresh and salt water.

LITTORIDINA PARCHAPPII (d'Orbigny). *Paludina parchappii* d'Orb., t. c., p. 30; *Paludestrina parchappii* d'Orb., Voy., p. 383, pl. 48, figs. 1-3. 6.5×3 mm. with 7 very convex whorls; whitish, aperture not angu-

¹ This list is believed to be a complete catalogue of the genus up to the end of 1909. *Paludina brunnea* and *P. conica* Anton, Verzeichniss, 1839, p. 52, South America, and *Bulinus paludinoïdes*, Ibid., p. 42, are probably Littoridinæ, but the descriptions are totally inadequate and the names should be deleted from the list of species.

lar posteriorly. Streams in the pampas south of Buenos Aires as far as Bahia Blanca, especially in the Rio Salado and Arroyo Salado in 30° S. lat. *Hydrobia parchappii* Doering, Bol. Acad. Cienc. Córdoba, VII, 472.

LITTORIDINA KUESTERI (Strobel). *Hydrobia küsteri* Strobel, Mater. Malac. Argent., 1874, p. 61, pl. 2, fig. 6. 4×2.5 mm., 5 whorls, to $3.5 \times 2-2.5$ mm. San Carlos ed Aguanda, province of Mendoza, in stagnant water. *Hydrobia küsteri* var. *cordillerae* Strobel, t. c., p. 61, pl. 2, fig. 7. $3 \times 1.5-2.5 \times 1.33$ mm., $4\frac{1}{2}$ whorls. Sierra de Mendoza.

LITTORIDINA AMEGHINI (Doering). *Hydrobia ameghini* Doering, Bol. Acad. Cienc. Córdoba, VII, pp. 466, 469. $7-9 \times 3.5-4$ mm., whorls $7\frac{1}{2}$. Pampean formation, Lujan, Argentina.

LITTORIDINA OCCIDENTALIS (Doering). *Hydrobia occidentalis* Doering, t. c., pp. 466, 471. 6×2.7 mm., whorls 6. San Luis, Mendoza, San Juan, Santiago, Argentina.

LITTORIDINA MONTANA (Doering). *Hydrobia montana* Doering, t. c., pp. 467, 473. 4.5×2 mm., whorls 6. Sierras de Córdoba and S. Luis, Argentina.

LITTORIDINA GLABRA (Tryon). *Hydrobia glabra* Tryon, American Journal of Conchology, I, p. 222, pl. 22, f. 12. Bolivia.

LITTORIDINA CUMINGII (d'Orbigny). *Paludina cumingii* d'Orb., Mag. de Zool., 1835, p. 30. *Paludestrina cumingii* d'Orb., Voy., p. 385, pl. 47, figs. 14-16. 6×2 mm., whorls 6. In fresh-water streams near Callao and at Valparaiso.

LITTORIDINA ATACAMENSIS (Philippi). *Paludina atacamensis* Philippi, Reise durch die Wüste Atacama, 1860, p. 185, Taf. 7, fig. 15. Length $1\frac{1}{8}$ lines, whorls 5. Tilopozo, Chili, in about 23°, 20' S. lat.

LITTORIDINA POPOENSIS (Bavay). *Paludestrina popoensis* Bavay, Bull. Soc. Zool. France, 1904, p. 154, fig. 5. Conic, $5 \times 2.5-3.5$ mm., with 6 to 7 rounded whorls. Lake Popo, Bolivia.

LITTORIDINA CUZCOENSIS n. sp. (figs. 10, 11). The shell is minutely perforate or rimate, thin, corneous-white, smooth and glossy. Spire straightly conic, whorls 6, moderately convex, the last evenly rounded. Aperture ovate, slightly oblique. Peristome thin and simple.

Fig. 10. Length 4.9, diam. 2.5, length of aperture 1.8 mm. (typical).

“ 11. “ 4.8 “ 2.2 “ “ 1.6 “ (slender phase).

Cuzco, Peru (H. von Ihering).

This species evidently stands close to *L. popoensis* Bavay, of the saline Bolivian Lake Popo; but the spire seems to be of a more turrete shape,



FIG. 10.



FIG. 11.

the last whorl comparatively shorter in *L. popoensis*, which moreover belongs to a different drainage.

Compared with *L. culminea* of Lake Titicaca, this species differs by the less attenuate spire and fewer whorls. *L. cuzcoensis* is not very closely related to the Titicaca species.

LITTORIDINA NEVENI (Bavay). *Pyrgula neveni* Bavay, Bull. Soc. Zool. France, 1904, p. 155, fig. 6. Last three whorls strongly carinate. 5×3 mm. with $6\frac{1}{2}$ whorls. Lake Titicaca.

LITTORIDINA ANDICOLA (d'Orbigny). *Paludina andicola* d'Orb., t. c., p. 29. *Paludestrina andicola* d'Orb., Voy., p. 385, pl. 47, fig. 13. Bavay, Bull. Soc. Zool. France, 1904, p. 153, fig. 2. 8×3 mm. with 8 flat whorls, the last acutely carinate. Lake Titicaca.

Littoridina andicola, ecarinate form: *Paludestrina culminea* d'Orb., Voy., p. 386, pl. 47, figs. 10-12. 6×3 mm., whorls 7, somewhat convex. Lake Titicaca.

Some specimens of the *L. culminea* type, collected by A. Agassiz in Lake Titicaca, are subangular at the periphery, and therefore somewhat intermediate between *L. culminea* and *L. andicola*. Bavay has figured a series of shells showing the intergradation of these supposed species.

LITTORIDINA GUADICHAUDII Souleyet, Voyage la Bonite, Zoologie, II, p. 565, pl. 31, figs. 31-33 (living animal, shell and operculum), pl. 32, figs. 9-19 (soft anatomy). 5×3 mm., 6 whorls. River of Guayaquil, Ecuador.

LITTORIDINA ECUADORIANA (Miller). *Paludestrina ecuadoriana* Miller,

Malak. Blätter, n. F., I, 1879, p. 153, Taf. 8, f. 3. $7 \times 3-4$ mm., whorls 6. Guayaquil River, Guayaquil, Ecuador.

LITTORIDINA BOETZKESI (Miller). *Paludestrina boetzkesi* Miller, t. c., p. 155, Taf. 8, fig. 4. 4.5×2.4 mm., whorls $6\frac{1}{2}$. S. Domingo and Guayaquil River, Ecuador. Cf. *L. guadichaudii*.

LITTORIDINA (?) PEDRINA (Miller). *Hydrobia pedrina* Miller, t. c., p. 155, Taf. 6, f. 7. 3.5×1.5 to 4×1.8 mm., $5\frac{1}{2}$ to $5\frac{3}{4}$ whorls. Microscopically granulose. Rio Pedro in the Chillo valley, Ecuador.

POTAMOPYRGUS Stimpson.

Potamopyrgus Stimpson, American Journal of Conchology, I, 1865, p. 53; Researches upon the Hydrobiinæ, Smiths. Misc. Coll. No. 201, p. 49. Monotypic; type, *Melania corolla* Gld.

Lyrodes Doering, Bol. Acad. Nac. Ciencias Córdoba, VII, 1884, p. 461. Type *L. guaranítica*.

Pyrgophorus Ancey, Bulletin de la Société Malacologique de France, V, 1888, p. 192. Type, *Pyrgulopsis spinosa* C. & P.

Huttonia Johnson, Proc. Royal Society of Tasmania for 1890, p. 90 (1891). Type, *Potamopyrgus corolla*.

Amnicolinæ with rather slender, thin, rimate shells of ovate-conic or turritid contour, often armed with a row of spines on a delicate keel at the shoulder of the last whorl or two. They differ from other American genera in being viviparous.

Besides the following species, *P. coronatus* Pfr. is known from Baranquilla, Colombia, and Lake Valencia, Venezuela. It has a wide range in Mexico and the West Indies. Professor von Martens has figured the shell, teeth and embryonic young. (Die Binnenmollusken Venezuelas, p. 208, Taf. 2, figs. 13a-h.)

POTAMOPYRGUS GUARANITICUS (Doering).

Lyrodes guaranítica Doering, Boletín de la Academia Nacional de Ciencias en Córdoba (República Argentina), VII, 1884, pp. 461-463, fig. 2.

Length 3.5, diam. 1.9 mm., whorls $5\frac{1}{2}$, the last encircled by a slender keel at the shoulder, and several spiral striæ on the base.

Rio Barrancas, Corrientes.

POTAMOPYRGUS SCOTTII sp. nov.

(Plate XLIc, Figs. 10, 11.)

The shell is very minutely perforate, turrite, the length about double the greatest diameter and nearly three times the length of the aperture. The spire has straight outlines and an obtuse apex. Whorls $6\frac{1}{2}$, very convex, parted by a deep suture. The first two whorls are smooth; then fine, narrow, thread-like, spiral striæ appear, 6 to 8 in number on the visible part of each whorl, one at the upper third sometimes being more prominent. There are also numerous ripples in an axial direction, on the last two whorls. The last whorl is well rounded and nearly smooth on the base. The aperture is ovate, peristome simple and thin, continuous, the columellar margin concave, narrowly reflexed.

Fig. 10. Length 5, diam. 2.6, length of aperture 1.7 mm.

" 11. " 3.8 " 1.9 " 1.4 "

Buenos Aires. Types No. 10,153 A. N. S. P.

This is a very much lengthened form, larger and longer than *P. guaraniticus* (Doer.), and differs in sculpture. It is closely related to *P. peteningensis* (Gld.) which, however, has a smooth surface. The specimens are bleached and apparently fossil, being filled with sandy mud. A minute embryonic shell was obtained from the matrix washed out of one of the specimens figured. This confirms the generic reference to some extent, as all *Potamopyrgus* species are viviparous.

Named for Professor W. B. Scott, whose work has thrown a flood of light on Patagonian vertebrate palæontology.

POTAMOPYRGUS PETENINGENSIS (Gould).

(Plate XLIc, Fig. 12.)

Cingula peteningensis Gould, U. S. Expl. Exped., Mollusca, p. 130, pl. 9, figs. 152, a, b.

Lagoa de Peteninga, near the entrance of Rio Janeiro harbor, in brackish water.

The shell of this species resembles *Paludestrina attenuata* of the eastern United States by its extremely convex whorls parted by deep sutures. The type, from the Lagoa de Peteninga, was described as smooth, about 8.5 mm. long, 2.5 wide, with 6 whorls. One of the original lot is figured

(fig. 12). It measures 5.4 mm. long, 2.4 wide, the aperture 1.8 mm. long, and is composed of $6\frac{1}{3}$ whorls. The apex is very obtuse. Another lot, received from G. von Frauenfeld, contains shells slightly more slender than that figured. In one of them I found two minute embryonic shells.

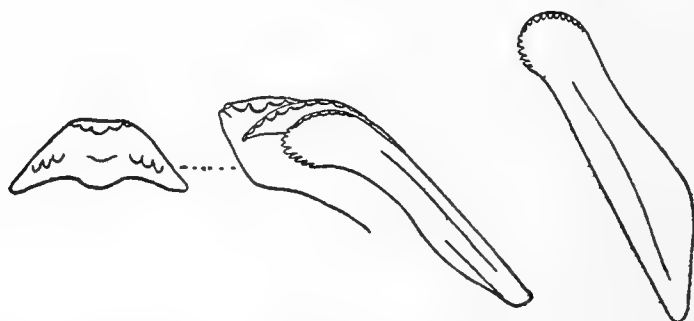
IDIOPYRGUS gen. nov.

The shell is perforate, solid, turrite, with long spire of very convex whorls; aperture diagonal, oval, its plane sloping forward below, posterior end rounded, sinused; a small sinus at junction of the outer lip with the basal margin. Lip slightly expanded, thickened within. Operculum paucispiral, with the nucleus at the lower fourth, near the columellar margin. Radula having the formula $\frac{5}{3-3}$. 7. 9. 16.

Type, *I. souleyetianus*.

The snail for which this genus is proposed differs from all known species of *Littoridina* by its internally thickened, somewhat expanded and bisinuate peristome, the diagonal aperture, and by having fewer cusps on the upper reflection of the central teeth, as well as on the marginal teeth. The scoop-like shape of the outer marginal tooth is also rather peculiar.

FIG. 12.



Idiopyrgus souleyetianus, half row of teeth and an isolated marginal tooth.

Idiopyrgus has some resemblance to the Dalmatian genus *Lanzaia* Brusina, and to the Mexican *Pterides* Pilsbry. In all of them the long axis of the aperture stands strongly diagonal to that of the shell, the posterior end of the aperture is rounded, effuse or sinused, the lip expands more or less, and the whorls of the tapering spire are strongly convex. These apertural characters are so unusual in *Annicolidæ*, that I am disposed to view them as indications of real relationship between the three genera, rather than convergent structures in snails otherwise diverse.

Unfortunately *Lanzaia* and *Pterides* are known by dead and bleached shells only, so that the relationship suggested remains hypothetical. It affords no safe basis for deductions concerning the antecedents of the three groups, each known from a single spot, and separated from its supposed relatives by thousands of miles.

The genera are characterized as follows :

Common characters:—Shell turrite, composed of very convex whorls; aperture strongly diagonal to the axis of the shell, oval, the posterior end rounded, spreading or sinused, the basal margin also retracted or effuse; peristome continuous, more or less expanding, running forward below.

- a. Shell openly umbilicate, thin, *sculptured with sinuous longitudinal ribs and fine spiral striæ*, minute (2 to 3 mm. long, with 6 whorls); the aperture elliptical, lip broadly flaring. Dalmatia. *Lanzaia* Brusina.
- b. Shell rimate, thin, *smooth*, minute (2.5 to 3 mm. long, with 7 to 10 whorls); the aperture ovate; lip sinused or spreading above, broadly retracted or spreading at the base. Mexico. *Pterides* Pilsbry.
- c. Shell perforate, solid, smooth, of about $7\frac{1}{2}$ whorls; the aperture oval, small, the lip having a rounded sinus above and a smaller one at junction of outer and basal margins, which expand but little. Southeastern Brazil. *Idiopyrgus* Pilsbry.

IDIOPYRGUS SOULEYETIANUS sp. nov.

(Plate XLIc, Figs. 14, 14a.)

The shell is perforate, solid, turritid, greenish-yellow, opaque. The surface is smooth and glossy, growth-lines very faint. The spire tapers regularly to a small but obtuse apex. Whorls $7\frac{1}{2}$, all strongly convex, joined by deep sutures. The aperture is oval, oblique, the *basal margin being advanced*, the outer lip retracting upward. The peristome is continuous, the outer lip expanded, somewhat thickened within. It has a rounded sinus just below the upper insertion, and a small sinus at the junction of the outer and basal margins. The continuous columellar and parietal margins are arcuate, forming a raised ledge across the parietal wall.

Length 5.3, diam. 2.1 mm., length of aperture with peristome 1.9 mm.

Rio Doçe, State of Espírito Santo, Brazil. Types No. 100,534, A. N. S. Phila., from No. 127 Museu Paulista.

In old individuals the spire becomes more or less shortened by erosion of the early whorls. This form differs from the Littoridinas by its peculiar peristome. It is probably a straggler from the fauna of eastern Brazil, of which little is yet known.

POTAMOLITHUS Pilsbry.

Paludestrina in part, d'Orbigny, Voyage dans l'Amérique Méridionale, Mollusques, p. 381.

Lithoglyphus sp., of some authors.

Potamolithus Pils., Nautilus, X, Nov., 1896, p. 80.

Amnicolidæ with the shell imperforate, solid, ovate or globose, smooth or 1-3 carinate, covered with a thick cuticle, which is usually green or olive; aperture ovate or rounded, the peristome continuous; columella concave, more or less heavily calloused.

Operculum lodging some distance within the aperture, corneous, oval, reddish-brown, opaque, with a thinner, yellowish border along the basal, outer and upper margins. It is composed of about 2 whorls, the nucleus near the lower third, and nearer the columellar side. The outer face is slightly concave and rather strongly striate. Inner face is glossy except for a long dull scar of attachment near the columellar margin (*P. rushii*).

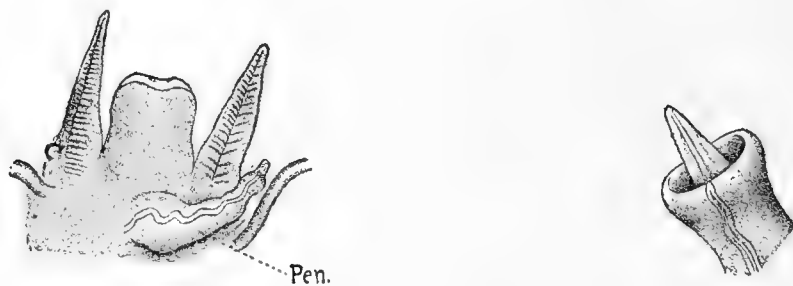
Penis simple, terminating in a small glans surrounded by a fleshy preputial ring.

The radula has teeth of the form usual in *Amnicolidæ*, central tooth with 2 to 4 basal cusps on each side, admedian tooth armed with 8 to 10, marginal teeth having many cusps, 17 to over 30.

Type *P. rushii* Pilsbry.

Distribution, La Plata drainage and faunally similar streams draining into the Atlantic in Sao Paulo and Rio Grande do Sul, Brazil.

FIG. 13.



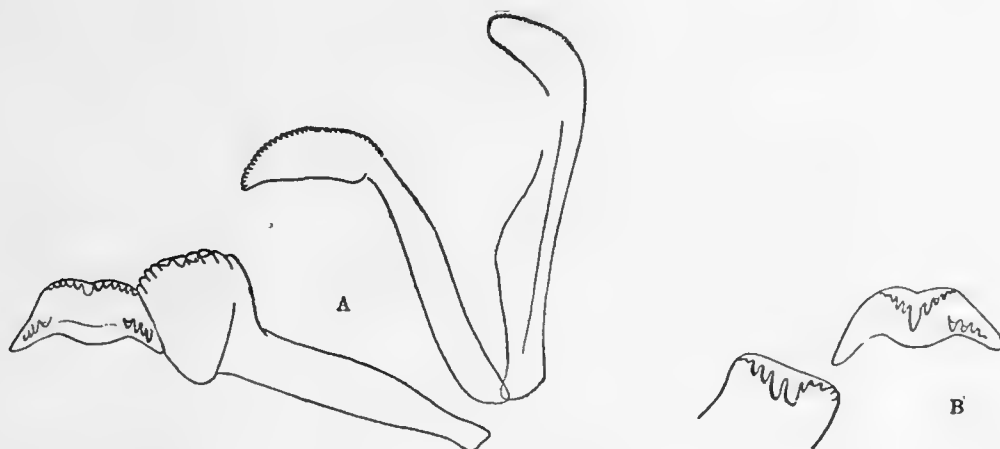
Head, showing tentacles and penis, and end of the penis of *Potamolithus*. (After von Ihering.)

The soft anatomy is known from A. d'Orbigny's figures of living *P. lapidum* and H. von Ihering's description and figures of a form from near the mouth of the Santa Maria River, of the Rio dos Sinos drainage, identi-

fied as *P. lapidum*.¹ In this form "the penis is inserted nearly on the median line of the back of the neck (fig. 13). It was not found for a long time, because the number of females far exceeded the males among the animals examined. It is very broad at the base, provided with an obtuse hump and runs somewhat coiled towards the right side, where its summit lies near the base of the tentacle. It is perforated throughout by the vas deferens, and terminates in a slender conical point, which is encircled by a sort of prepuce."

Dentition of Potamolithus.—I have examined the teeth of *P. rushii* and *P. lapidum supersulcatus*. The former (fig. 14) has teeth with the formula $\frac{6, 2, 6}{4-4}$. 10. 33. 40. The middle cusp of the central tooth is long but rather

FIG. 14.



Potamolithus rushii, A, the teeth of a half row, somewhat pressed backward, foreshortening the cusps, especially of the marginal teeth. B, central and cusp of the admedian teeth, in their normal positions.

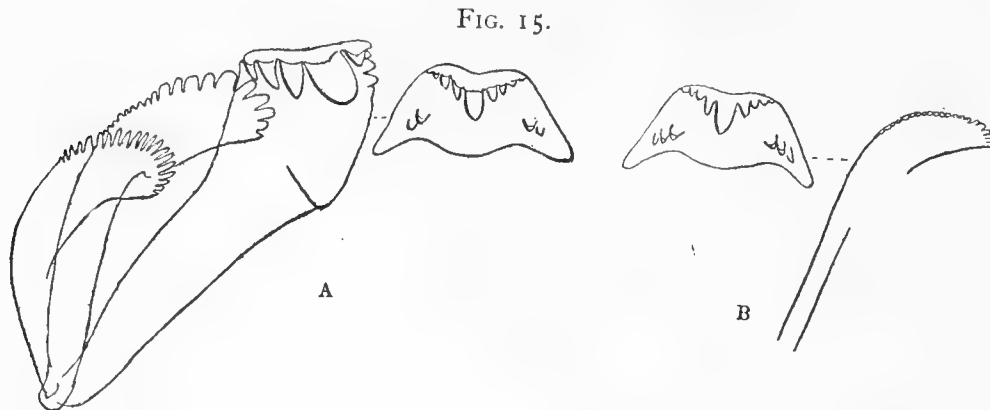
narrow, and the side cusps are small. The cusps of the admedian tooth are of about equal width, but are longer in the middle, as shown in fig. 14, B. On the inner marginal tooth the cusps are extremely small and numerous, and on the outer they are still more numerous.

In *P. lapidum supersulcatus* from Fray Bentos on the Uruguay River (fig. 15) the formula is $\frac{5, 2, 5}{2-2}$. 8 (4, 1, 3.) 17. 18, or in another radula, the central tooth has the cusp-formula $\frac{5, 2, 5}{3-3}$. All of the teeth have much larger cusps than in *P. rushii*, and on the admedian tooth the median cusp is much longer than its fellows. All of the teeth have the same general shape as

¹ Malakozoologische Blätter, n. F., VII, 1885, pp. 96-99.

those of *P. rushii*, the difference in the figures being chiefly due to the side teeth being shown in their natural positions, while in *P. rushii* they are drawn from a frayed radula, as is usually done in allied genera.

The teeth of a form from the Santa Maria River, a tributary of the Sinos, identified as *P. lapidum* (probably not that but an allied species) have been figured by Dr. H. von Ihering, as having two basal teeth on



Potamolithus lapidum supersulcatus, A, the teeth of a half-row in their normal positions. B, central and outer marginal teeth of another individual.

each side. The figure is somewhat diagrammatic, but shows teeth resembling *P. l. supersulcatus*.

The eggs are deposited in plano-convex chitinous capsules about .6 or .7 mm. in diameter, adhering to shells and probably stones. The embryonic shell is smooth, Naticoid or globular in probably all of the species. So far as I can see, it is quite continuous with the neanic stage. In all of the species studied, the earlier portion of the neanic stage is also Naticoid. In some forms this shape persists to maturity, but in others angles or carinæ set in, their appearance dividing the period of youth into two or three substages; so that a highly specialized form may pass successively through rounded, singly carinate, bicarinate, tricarinate, and finally varicose stages. The degrees to which these sculpture-conditions are accelerated and the stage finally reached, allow us to fix the relationships and evolutionary grade of the several forms with some degree of accuracy, in species where the young stages are accessible.

These little river snails live on and under stones, at and below low-water mark, often in copious numbers. Up to this time, they have been collected at comparatively few places, yet the range of the genus probably

embraces the whole La Plata drainage, together with some rivers flowing directly into the Atlantic, but having their rise adjacent to or interposed between the head streams of the Uruguay and Paraná Rivers. Many new forms doubtless remain to be found, since only an inconsiderable part of the waters of the Plata system have been explored for mollusks.

To what extent the specific characters of the forms vary from place to place, we cannot say, since most of them are known from a single locality. *P. lapidum*, which has been assigned a wide range, seems to vary with locality, and probably several species will eventually be recognized in what is now considered *lapidum*. Of most of the forms, many specimens have been studied, some of them by hundreds, and I have been astonished at the absence of intermediate or ambiguous individuals, such as one finds in the fresh-water *Pleuroceratidæ* or *Melaniidæ*. It is however well known to those who have studied large quantities of fresh-water snails, that the *Annicolidæ* are generally conservative; the specific features are crystallized, while in the Melanians they are fluid.

SIGNIFICANCE OF THE CHARACTERS OF POTAMOLITHUS.

In the *Annicolidæ*, as in the *Viviparidæ*, the prevalent genera almost everywhere are smooth-shelled forms with rounded or convex whorls. Such forms have prevailed since the first appearance of these families. In those *Annicolidæ* which are sculptured in the adult stage, the early (embryonic and early neanic) stages are smooth or nearly so. These facts apparently point to the conclusion that smooth, rounded shells are primitive and sculptured shells derivative in these families.

Throughout Neocene time, carinate, varicose or otherwise strongly sculptured species or genera of these families have frequently appeared, but their distribution has been local and their duration brief. In some cases the genesis of these sculptured or distorted forms from smooth and normal types has been traced, as in the case of *Viviparus hoernesii* of the Pliocene of southeastern Europe, and *Viviparus altior* and *limnothauma* of the Floridian Pleistocene. At the present time, sculptured *Viviparidæ* and *Annicolidæ* are comparatively rare and confined to small areas. *Margarya* in Lake Tali, *Tulotoma* in the Coosa River, *Pyrgulopsis* in Pyramid Lake, Nevada, and *Tryonia* in a very restricted area in the Southwest, are familiar examples. To these may be added the group of carinate species of *Potamolithus* in the Uruguay River. In all of these

cases, the distribution of the forms is very restricted, often to a single lake, or a few springs; and in some cases, as *Pyrgulopsis* and *Tryonia*, we have evidence that the species had a wider range in the Pleistocene and are now apparently approaching extinction.

The facts indicate that in *Annicolidæ* and *Viviparidæ*, shell-sculpture is a phylogerontic character, showing the approach of senility of the race; strongly developed sculpture in a species signalizes its last incarnation.

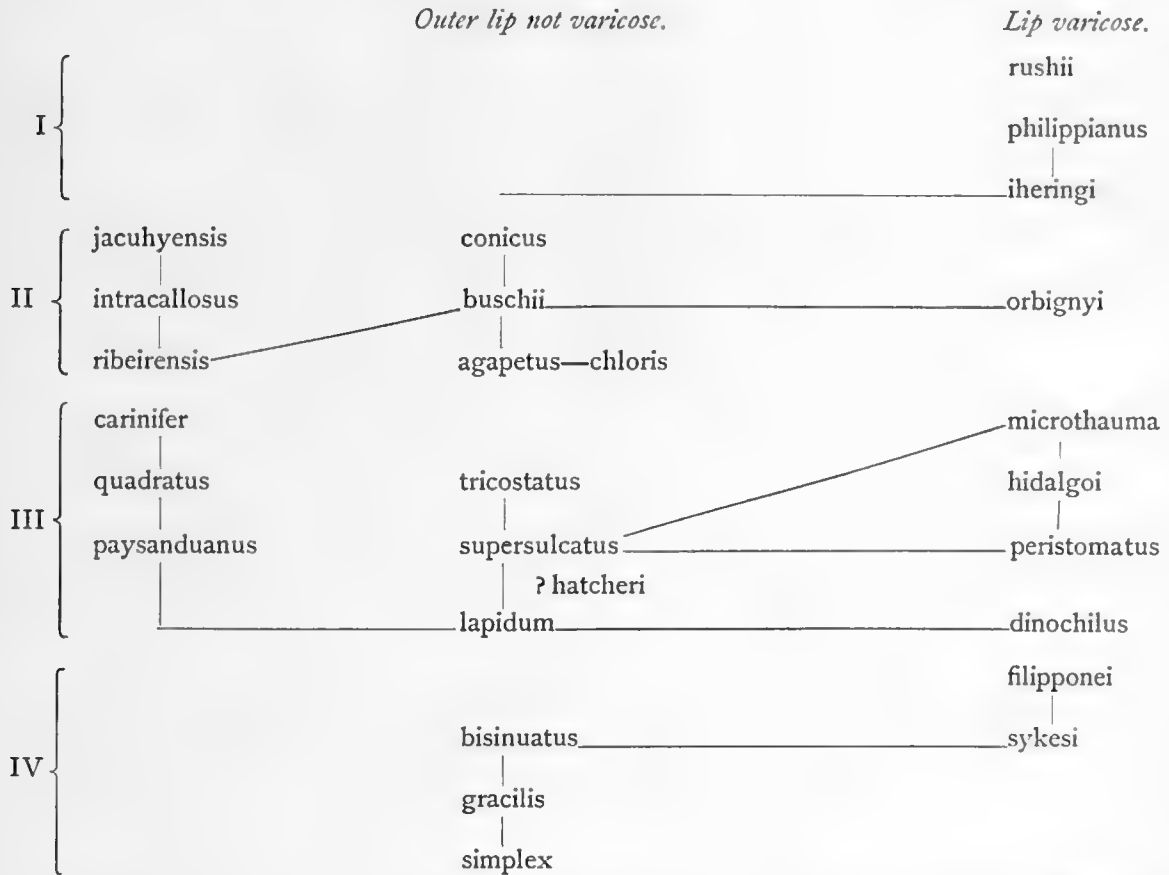
The considerations advanced above go to show that the present *Potamolithus* fauna consists in large part of species which in an evolutionary sense are aged, are more or less distinctly gerontic or senile. Over 80 per cent. of the species have characteristics which indicate, as experience has shown, that they represent side lines of evolution, impotent to continue the phylum, or to give birth to new phyla. There remains also a small group of unspecialized species represented by *P. lapidum* of the Paraná and its allies in southern Brazil.

I have been unable to find a shred of evidence to connect the development of sculpture in these fresh-water snails with the concentration or increased alkaline content of waters they inhabit, as some conchologists have assumed. It is doubtful whether any such modified forms inhabit alkaline or saline waters, while it is positively known that most of them do not. *Annicolidæ* which live in brackish or sea water are not strongly sculptured, but as smooth as their congeners in fresh water. Examples of this are found in certain species of *Paludestrina* (*P. minuta* (Tott.), *P. acuta* (Drap.), *P. salsa* Pils.) and *Littoridina* (*L. australis* (d'Orb.), etc.). It is extremely likely that these are forms of fresh-water origin, which have become adapted secondarily to more or less saline waters. Part of them live also in perfectly fresh water.

INTERRELATIONS OF THE SPECIES OF POTAMOLITHUS.

The species now known belong to four collateral phyla, each comprising forms in several very diverse stages of specialization. The less differentiated species in each phylum retain in adults a globular or Naticoid shell without keels or angles, and in three of the groups have the lip simple and unspecialized. This type of shell is common to other genera of the subfamily. In all of the phyla some species have developed orthogenetically a varix or crest at the lip; the shape of the shell is profoundly altered by spiral keels in some species. These modifications are more or

less exactly parallel in the several series. I have attempted to express the above ideas graphically in the following diagram, in which the least evolved species of each group are placed below, while the carinate forms are placed above in each group.



[In these diagrams the most primitive, Naticoid species of each group are below ; those modified by the development of carinæ above ; and the right-hand column contains derivative species having the outer lip varicose. The connecting lines indicate the chief affinities of the forms.]

While the above diagrams are not intended for phylogenetic trees, all the species being contemporaneous, yet it is likely that the ancestral forms in groups II, III and IV did not differ materially from the least differentiated of the recent species. It is significant that the only form known to have a wide distribution, *P. lapidum*, is one of the least specialized of the genus.

The evolution of carinæ and varices in the several groups seems to have been homoplastic. It will be shown below that the keels are superposed

upon the Naticoid form much earlier in some species than in others; and judging from these various degrees of acceleration, it would seem that the specialized species are of unequal antiquity.

KEY TO SPECIES AND SUBSPECIES OF POTAMOLITHUS.

- I. Columella wide, having a longitudinal furrow excavated in its face. Latter part of the suture not more rapidly descending; outer lip strengthened by a strong varix.
- a.* Last whorl dominated by a very strong peripheral keel. *P. rushii.*
 - a*¹. Last whorl flattened peripherally, without carina. *P. philippianus.*
 - a*². Last whorl rounded, conspicuously banded with green. *P. iheringi.*
- II. No longitudinal groove in the face of the columella.
- a.* Outer lip well expanded or with a prominent varix; not notched or sinuous.
 - b.* Periphery strongly keeled, the keel visible on part of the penultimate whorl.
 - c.* Three keels on the last whorl. *P. microthauma.*
 - c*¹. Last whorl flattened above and below the peripheral keel. *P. hidalgoi.*
 - c*². Last whorl globose, convex above and below the peripheral keel. *P. peristomatus.*
 - b*¹. Periphery obtuse or rounded.
 - c.* Lip-varix very strong; periphery hardly angular, base convex; back with a spiral rib below the suture; no columellar area. *P. dinochilus.*
 - c*¹. Lip-varix narrow; last whorl without keels, except that around the columellar area. *I. orbigny.*
 - a*¹. Outer lip simple or slightly contracted, without an external varix, the edge not sinuous.
 - b.* Last whorl sculptured with spiral keels or angles.
 - c.* With a single keel or angle at the basal periphery, none above it.
 - d.* High-trochiform, flattened above and below the strong carina, much higher than wide; columella narrow. *P. conicus.*
 - d*¹. Obliquely trochiform, convex above the peripheral angle, about as wide as high; columella wide. *P. buschii.*
 - c*¹. Trochiform, with a carina at the basal periphery and two contiguous keels on the back above. *P. tricostatus.*
 - c*². Trochiform, with a strong carina at the median periphery, the slope above it flat, with a small carina at the upper third; no distinct umbilical area. *P. carinifer.*
 - c*³. Stout keels at both periphery and shoulder, giving the last whorl a squarish contour; umbilical area ample; spire very short. *P. quadratus.*
 - c*⁴. Base and periphery rounded, a shallow sulcus or two low ridges on the back above. *P. lapidum supersulcatus.*
 - c*⁵. Back of last whorl with two contiguous angles, the upper one stronger, base rounded, spire rather slender and high. *P. hatcheri.*
 - b*¹. Last whorl rounded, without keels, angles or sulci.
 - c.* Shape approaching globular, the spire short or very short, conic.
 - d.* Columella narrow; last whorl evenly rounded.
 - e.* Green or olivaceous; alt. 5, diam. 4 mm. *P. lapidum.*
 - e*¹. Yellow, alt. 3.3, diam. 3 mm. *P. paranensis.*

- c*². Three-banded with reddish; alt. 4, diam. 3 mm. Paraná River.
P. petitianus.
- d*¹. Columella and especially the parietal wall thick, forming a blackish ledge; spire very short.
e. Last whorl swollen below the suture; olivaceous, about 5 × 4 mm.
P. paysanduanus.
- e*¹. Last whorl evenly rounded; olive with black markings, alt. and diam. 7 mm.
P. doeringi.
- d*². Columella wide, flat and white; last whorl evenly rounded.
e. Pale green, diameter nearly equal to the alt., 3 × 2.8 mm. *P. agapetus*.
*e*¹. Pale green, higher than wide, alt. 3, diam. 2.5 mm. *P. chloris*.
*e*². Olivaceous, perforate, alt. 5.7, diam. 4.3 mm. *P. catharinæ*.
*e*³. Reddish brown, alt. 3.5, diam. 3.4 mm. *P. ribeirensis*.
*e*⁴. Naticoid, but with an obtuse prominence on the columella far within.
P. intracallosus.
- d*³. Last whorl noticeably flattened peripherally; solid, brown, becoming green at the base and behind the lip; 6 × 5.6 mm. *P. jaculhyensis*.
- c*². Acutely long-ovate in shape, smooth, the ovate aperture not much exceeding half the total length; 4.3 × 3 mm. *P. simplex*.
- a*². Outer lip sinuous, nicked or notched.
b. Trochiform, the periphery very strongly carinate, aperture squarish, umbilical area large. *P. filipponei*.
- b*¹. Shell nearly globular, the diameter about equal to the alt., smooth, swollen below the suture, lip with a sinus above. *P. paysanduanus simulabris*.
- b*². Shell globose-conic.
c. Outer lip strongly expanded, with swollen, thickened and three-notched face. *P. sykesi*.
- c*¹. The outer lip thin, with deep subsutural and basal sinuses; 4.8 × 3.3 to 5 × 3.9 mm. *P. bisinuatus*.
- c*². Similar, but with the sinuses shallower, the upper one often inconspicuous. *P. bisinuatus obsoletus*.
- b*³. Shell acutely ovate-conic, about 4.3 × 2.7 mm., the outer lip thin, sinuated, especially at the base. *P. gracilis*.

GROUP OF *P. BISINUATUS*.

Smooth, globose-conic or ovate-conic species, with no trace of spiral angles or sulci, except in *P. filipponei*; the outer lip usually sinuous. The spire is longer than in other groups of the genus.

POTAMOLITHUS FILIPPONEI von Ihering.

(Plate XLIa, Figs. 8, 8a.)

Potamolithus filipponei von Ihering, Nautilus, XXIV, June, 1910, p. 15.

The shell is imperforate, pyramidal, olive colored, with a weak reddish-brown spiral band in the middle of the penultimate whorl. Surface

smoothish, weakly marked with lines of growth. Whorls 5, the first very minute and dark, following whorls strongly convex, the last whorl strongly carinate, concave above and below the carina, convex on the upper surface. The base is excavated or concave between the peripheral keel and a second prominent keel which bounds a large, funnel-shaped umbilical area. The aperture is very oblique. Peristome continuous, the outer lip thin, unexpanded, having small rounded sinuses below the suture, below the peripheral angle, and at the base of the columella. The columella is narrow, very little thickened, straight, much longer than the short, thick parietal margin.

Length 4.4, diam. 4 mm.

Montevideo, Uruguay, type in the Museu Paulista, collected by Dr. Florentino Filippone.

This species has some resemblance to *P. hidalgoi*, from which it differs by the entirely different shape of the aperture, the swelling between keel and suture, etc. The bisinuate outer lip, the texture and color-pattern of the shell, etc., show it to be a carinate member of the group of *P. bisinuatus*. Described and figured from the type specimen.

POTAMOLITHUS SYKESI Pilsbry.

(Plate XLI, Figs. 1-2a.)

Potamolithus sykesi Pilsbry, Nautilus, X, p. 88, Dec., 1896.

The shell is imperforate, globose-conic, rather solid, yellowish olive, smooth and glossy, faintly marked with growth lines. The spire is conic, truncate at the summit in adult shells of the type lot, about $3\frac{1}{2}$ moderately convex whorls remaining. The last whorl is evenly convex, smooth, and expands strongly at the lip. There is a narrow umbilical crescent. The aperture is very oblique and subcircular. The outer lip is strongly expanded, built forward and convex beyond the expansion, and then contracted, with three deep notches in its margin, one near the upper insertion, another median, the third wider and basal in position. The columella and parietal wall are moderately calloused, and the whole peristome is dusky or blackish.

Length 4.9, diam. 3.9 mm.

“ 4 “ 3.5 “

Uruguay River at Paysandú.

Development.—The neanic stage in this species is like that of *P. bisinuatus*. The ephebic stage is described above. A single gerontic individual before me has built the median region of the outer lip forward, obliterating the median notch of the lip (Pl. XLI, figs. 2, 2a).

This remarkable form is the most advanced of the *bisinuatus* phylum known. It resembles *P. bisinuatus* in contour, and neanic shells of the two species are distinguishable only by the bands of the latter, when these are developed. The ephebic stage differs widely by the strong expansion of the outer lip, its thickened and thrice notched face.

What relation *P. bisinuatus* and *P. sykesi* bear towards *P. petitianus* (d'Orb.) of the Paraná River is unknown, pending the discovery of the adult stage of the latter, the specimen described and figured by d'Orbigny being supposed to be immature. It is likely that *petitianus* will prove to be different from either of the other species.

POTAMOLITHUS PETITIANUS (d'Orbigny).

Paludestrina petitiana d'Orb., Voyage dans l'Amérique Méridionale, Mollusques, p. 487, pl. 75, f. 19-21 (1839).

Shell short, ovate-inflated, thin, smooth, not umbilicate; spire short, eroded, with obtuse summit, composed of five convex, narrow whorls, parted by a suture which is not very deep. Aperture oval with simple margins. Color green, with three reddish bands, one on the convexity of the spire, the others at the suture and anterior. Alt. 4, diam. 3 mm. (*d'Orbigny*).

Paraná River at San Pedro, Argentina, collector unknown.

This may be the neanic stage of a species allied to *P. bisinuatus*; but in this group of forms (*bisinuatus* and *sykesi*) the neanic stage shows no specific differentiation, the specific characters appearing only in the final stage of development. Until the adult form of *P. petitianus* is collected at the type locality, San Pedro on the Paraná, no good purpose will be served by uniting either of the other species to *petitianus* as its hypothetical adult. There remains also the possibility that *P. petitianus* is a permanently undeveloped form, not passing beyond the neanic stage of the bisinuate species, and therefore falling more properly in the *lapidum* group. Compare also *P. paranensis*, p. 589.

POTAMOLITHUS BISINUATUS Pilsbry.

(Plate XLI, Figs. 6-7a.)

Potamolithus bisinuatus Pilsbry, Nautilus, X, p. 88, Dec., 1896.

The shell is imperforate, globose-conic, moderately solid, green or pale yellowish-green, sometimes one-colored, but usually begirt with three narrow reddish-brown bands, one bordering the suture, another above the periphery, and on the penultimate whorl visible above the suture, and the third band below the periphery. The nearly smooth surface is weakly marked with lines of growth. The spire is conic and rather high, truncated at the summit in all adult shells seen, by the erosion of the early whorls, about $3\frac{1}{2}$ remaining. These are strongly convex, the last one globose, without keels or angles of any kind, and with no expansion or varix behind the outer lip. There is a distinct and concave but quite small columellar area. The aperture is moderately oblique, round-ovate, white or brownish inside. Its posterior angle is more or less filled with a callous deposit. The peristome is edged with a black line. The thin outer lip has a deep rounded sinus near its posterior insertion, and there is a second sinus, wider and not so deep, at the base, the lip projecting as a broad truncated lobe between the two embayments. The columella is concave, narrowly calloused and the parietal callus is rather thick.

Length 5, diam. 3.9, length of aperture 2.8 mm.

“ 4.8 “ 3.3 “ “ 2.9 “

Uruguay River at Paysandú. Types collected by Dr. W. H. Rush, U.S.N., May 7, 1892.

Development.—The shell is of the ordinary simple Naticoid shape throughout the neanic stage, differing from *P. lapidum* only in having a longer spire. The peculiar Pleurotomoid sinuosities of the peristome have their origin and development wholly in the ephebic stage. In this respect, *P. bisinuatus* is like *Pachycheilus dalli* Pils., and differs widely from *Gyrotoma* and *Pleurotoma*, in which the anal notch appears very early.

This species is related to *P. sykesi*, from which, however, it differs totally in characters of the ephebic stage.

POTAMOLITHUS BISINUATUS OBSOLETUS Pilsbry.

(Plate XLI, Figs. 3-5.)

Potamolithus bisinuatus obsoletus Pilsbry, Nautilus, X, p. 88, Dec., 1896.

The shell is more slender than *P. bisinuatus*, acutely ovate-conic, green, without color bands. The outer and basal margins of the peristome have only shallow sinuses in place of the deep ones of *P. bisinuatus*; the upper one is often hardly perceptible, and, when developed, is nearer the upper insertion of the lip than in *bisinuatus*. The inner margin of the peristome is less heavily calloused, and the columellar area is excessively narrow, hardly noticeable. The apices are perfect in the type lot, the shell consisting of $5\frac{1}{2}$ whorls.

Length 4.9, diam. 3.5 mm.; aperture 2.8 mm. long.

" 4.6 " 3.1 "

Rio de La Plata, at San Gabriel's Island, near Colonia, Uruguay. Also Uruguay River, at Fray Bentos, Uruguay.

A large series from the first locality shows this form to be constantly unlike *P. bisinuatus*. It has the characters of an immature stage of the latter.

POTAMOLITHUS GRACILIS Pilsbry.

(Plate XLI, Figs. 8, 8a.)

Potamolithus gracilis Pilsbry, Nautilus, X, p. 88, Dec., 1896.

The shell is imperforate, acutely ovate-conic, solid but not thick, olive-yellow, becoming reddish-brown on the spire, or dull green; smooth and glossy. The spire is straightly conic, rather acute. Whorls $5\frac{1}{2}$, moderately convex, the last symmetrically rounded. The aperture is ovate, subvertical. The outer lip is not expanded, acute, the edge sinuous, being retracted slightly at the suture, a trifle sinuated in the middle, and having a distinct rounded sinus at the base. The columella is concave and narrow, the parietal callus thin. There is no differentiated umbilical area.

Length 4.3, diam. 2.7, length of aperture 2.25 mm.

Uruguay River at Paysandú. Types collected by W. H. Rush, U.S.N., July 18, 1892.

This species is related to *P. bisinuatus*, but it is unlike that species in its narrower contour. A long series has been examined. The green specimens predominate.

POTAMOLITHUS GRACILIS VIRIDIS Pilsbry.

(Plate XLI, Figs. 9, 9a.)

Potamolithus gracilis viridis Pilsbry, Nautilus, X, p. 89, Dec., 1896.

This form is similar to *gracilis* in contour, etc., but there is a deeper sinus near the upper termination of the lip, and the basal sinus is well developed. The color is green. The dark maculæ shown in the figure are due to the dried soft parts.

Rio de La Plata, at San Gabriel's Island, near Colonia, Uruguay.

POTAMOLITHUS SIMPLEX sp. nov.

(Plate XXXIX, Figs. 6, 6a.)

The shell is acutely ovate-conic, thin, but rather solid, pale greenish-yellow; the surface glossy, faintly marked with growth-lines. The spire is straightly conic, apex rather acute. Whorls $5\frac{1}{2}$, convex, the last evenly globose, not expanded at the lip. There is a distinct and rather wide flat axial area, bounded by a delicate keel. The suture is deep and descends briefly and rather abruptly close to the aperture. The aperture is oblique and acutely ovate. Peristome simple, thin, black-edged and continuous, its edge even, not in the least sinuous or notched. The columella is very narrow and concave.

Length 4.3, diam. 3, length of aperture 2.25 mm.

Uruguay River at Paysandú.

The slender ovate contour and smooth surface ally this species to *P. gracilis*, but the total absence of any sinus or notch in the lip, the anterior descent of the suture and the well developed axial or umbilical area are features unlike *P. gracilis*. No young individuals have been identified, but they probably could not be distinguished from *P. gracilis*. *P. simplex* approaches *Littoridina* in contour, but the anteriorly descending suture and the axial crescentic area are unlike that genus.

GROUP OF *P. BUSCHII*.

POTAMOLITHUS AGAPETUS sp. nov.

(Plate XL, Figs. 10, 10a.)

The shell is imperforate, globular-conic, of a rather light green color. The surface is smoothish, faintly marked with growth-lines. Spire short

and conic, the apex obtuse. Whorls 4, convex, the last evenly rounded, without keels or angles, the suture shortly deflexed at the aperture. There is a moderate or narrow and usually rather conspicuous columellar area. The aperture is oblique, rather broadly ovate. The peristome is thickened within, the basal and outer margins are evenly and strongly arcuate, the outer becoming straightened near the upper angle of the aperture. The inner lip is heavily calloused; columella rather wide and flattened.

Length 3, diam. 2.8 mm.

Rio de La Plata, at San Gabriel's Island, near Colonia, province of Colonia, Uruguay. Types, 69,683, A. N. S. P.

Development.—The young of about three whorls and 2 mm. diameter are essentially similar to the adult stage in shape. The columella is somewhat wider in proportion.

This is the smallest *Potamolithus* now known. It has the globular shape of *P. lapidum*, but the wide columella of the neanic stage shows that *P. agapetus* is related to *P. buschii*. It differs from *P. buschii* by the evenly rounded shape of the last whorl, the diminutive size and clear green color, as well as by the total absence of a peripheral angle or keel; but the young stages of *P. buschii* are not always readily distinguishable from immature *P. agapetus*.

In some shells the aperture is smaller than in that figured, by reason of a greater descent of the last whorl immediately behind the lip. The columellar crescent varies from quite narrow, almost linear, to quite wide and concave.

POTAMOLITHUS CHLORIS sp. nov.

(Plate XLIIb, Figs. ⁷8, ⁷8a.)

The shell is imperforate, rather solid, ovate conic, light green, the spire paler, summit corneous. The spire is straightly conic, apex minute, slightly obtuse. Whorls 4½, convex, the last evenly rounded throughout, expanding near the aperture. The aperture is very oblique, shortly oval. The peristome is slightly expanded, obtuse. Columella and parietal wall heavily calloused, the former flattened, rather wide.

Length 3, diam. 2.5 mm., length of aperture 1.8 mm.

Salto das Cruzes, Rio Tiete, State of Sao Paulo, Brazil. Type, No. 103,046, A. N. S. P. from No. 106 Museu Paulista. Collected by Hase-
mann, 1908.

This snail has the texture, color and size of *P. agapetus*, from which it differs by the longer, *Amnicola*-like shape and the small aperture. There is no differentiated umbilical area.

POTAMOLITHUS BUSCHII (Ffd.).

(Plates XL, Figs. 11-14; XLIb, Fig. 3.)

Lithoglyphus buschii Dunker, Frauenfeld, Zoologische Miscellen, V, in Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien, 1865, XV, p. 530, Taf. 11, first two figures.

The shell is obliquely trochiform, being flattened below, semiglobose above; moderately solid; green or olive-green with irregular buff flecks or zigzag streaks, and usually a dusky-brown band midway between the periphery and suture. Surface with faint growth-lines and indistinct spiral striæ. Spire very short, the apex usually reddish. Whorls $4\frac{1}{2}$, convex, the first one or two usually eroded in adult shells. The last whorl is carinate, strongly angular, or with a rounded angle at the basal periphery, very convex above the keel, and usually having a low ridge on the back a short distance below the suture; there is also, sometimes, a second obtuse ridge below the upper one (fig. 13), much as in *P. lapidum supersulcatus*. Base flattened, but slightly convex. There is a well developed concave columellar area bounded by an acute ridge. The aperture is very oblique, ovate, the outer lip without a varix, but built downward somewhat near and at the upper angle, contracting the aperture. The columellar and parietal margins are heavily calloused; columella rather wide, concave and flattened.

Length 4.7, diam. 4.6 mm.

“ 4.3 “ 4 “

Mouth of the Arroyo San Juan, where it empties into the La Plata, Province of Colonia, Uruguay (type locality); San Gabriel's Island in the La Plata, near Colonia, in the same Province, and Fray Bentos on the Uruguay River (Wm. H. Rush).

Development.—At the end of the second whorl the periphery begins to be weakly angular, the shell being about 2 mm. in diameter. Before that stage the shape is globose-depressed, with a rounded periphery. At the end of the third whorl the angle is strong. The columella is very broad,

its face concave, throughout the neanic stage. Figs. 11, 11*a* represent a young shell 3.3 mm. in diameter.

P. buschii is related to *P. agapetus*, but it attains a larger size, and differs in the coloration and angular periphery; yet there are some immature specimens in the lot from San Gabriel's Island, which approach very near to *P. agapetus*. It differs from *P. lapidum* and *P. tricostatus* by its wide columella at all stages of growth. It is a very abundant snail at San Gabriel's Island, on the northern shore of the Rio de La Plata.

The figures on Plate XL represent the least angular forms of the species from San Gabriel's Island. The type was a carinate shell, such as that represented in Plate XLI*b*, fig. 3, from Fray Bentos, on the Uruguay River. The ridge below the suture on the back is usually inconspicuous. Most of the specimens from San Gabriel's Island are similar to those figured on Plate XL, or somewhat more angular, but less so than shells from the mainland. They also have the ridges or sulcus on the back more strongly developed in some examples.

POTAMOLITHUS CONICUS (Brot).

(Plate XL, Figs. 8, 9, 9*a*.)

Lithoglyphus conicus Brot, Journal de Conchyliologie, XV, 1867, p. 69, pl. 1, fig. 5 (Uruguay River in the Province of Entrerios).

The shell is high-trochiform, rather straightly conic, solid, green or brownish-olive, variegated with pale green or yellow zigzag streaks. The smoothish surface is rather glossy, with the usual fine growth-lines. The conic spire is longer than in related species, and often eroded at the apex. Whorls nearly $4\frac{1}{2}$, convex. The last whorl slopes steeply and with little convexity to the carinate periphery, which is basal in position. On the back there is sometimes a very weak ridge below the suture and parallel to it, but this is usually wanting. The base is flat, and there is a rather wide crescentic, concave columellar area defined by a sharp angle. There is no varix at the lip. The aperture is very oblique, symmetrically ovate, in fully adult shells is contracted somewhat, being filled in above; with a continuous, black-edged peristome. The columella is concave and narrow.

Length 4.7, diam. 3.7 mm.

“ 3.9 “ 3.3 “

Uruguay River at Paysandú, Uruguay, under stones at extreme low water.

Development.—The youngest shells at hand lack about one whorl of completion. At this stage the shape is practically that of adults, except that there is no columellar crescent and the columella is wide and flat. The weak subsutural ridge, when developed at all, appears on the back of the last whorl only. The most fully developed shells therefore have the characters of the four-whorled stage in *P. tricostatus*, while most shells, wanting the upper keel, are like *tricostatus* at the three-whorled stage.

P. conicus differs from *P. tricostatus* by its smaller size, more highly conic shape, and the less developed sculpture of the last whorl. It is more closely related to *P. buschii*, both having the columella wide during the neanic stage; but in the adult stage *P. buschii* is depressed and *P. conicus* elevated in shape.

The color in life is probably always more or less green. The rich brown tint of those figured may be due to change in alcohol, though I am not sure that this is the case, as the shells were dry when they came into my possession. A lot of *P. buschii* which had been in alcohol have changed to brown, while all of those dried fresh are green.

POTAMOLITHUS ORBIGNYI Pilsbry.

(Plate XL, Figs. 1-5.)

Potamolithus orbignyi Pilsbry, Nautilus, X, p. 88, Dec., 1896.

The shell is imperforate, globose, solid and strong. Uniform olive colored, or with brown bands below the suture and in the middle of the last whorl, on an olive or green ground. Surface smoothish, with faint growth-lines and fine, very indistinct spiral striæ. The spire is very short and conic. Whorls nearly $4\frac{1}{2}$, strongly convex, the later third of the last whorl descending more rapidly. The last whorl is squarish, obtusely biangular, being shouldered above, flattened in the middle, and more or less angular at the basal periphery. The ample crescentic columellar area is concave and bounded by an angle. The lip is strengthened by a narrow varix, which is blackish and bevelled to the lip-edge. The aperture is very oblique, and rounded-ovate. The outer lip is thickened within, the inner lip heavily calloused. The columella is broad and flattened.

Length 5, diam. 4.8 mm.

“ 4.5 “ 4.5 “

Uruguay River, at Paysandú, Uruguay. Types, No. 69,696, A. N. S. P.

In the typical form of the species the flattening of the last whorl is nearly vertical below the shoulder. In other examples (Pl. XL, figs. 2, 3) the flattened surface slopes steeply, and the periphery is somewhat more angular, though still rounded off. Young shells (Pl. XL, figs. 4, 4a) with $3\frac{1}{2}$ whorls, having a diameter of 2.5 mm., have a distinct flattening above the periphery, though less marked than in adults. This was not seen by my artist, who drew the peripheral region of fig. 4 much too regularly rounded. Fig. 5 represents a slightly larger shell, diam. 2.8 mm., the basal aspect drawn to show the very broad, flat, columellar callus. In contour it resembles fig. 2.

P. orbigny is somewhat related to *P. dinochilus*, but differs in the lower varix, absence of a spiral ridge below the suture, the larger columellar area, broader columella, etc. It is similar to *P. philippianus* in shape, but lacks the columellar furrow of that species.

POTAMOLITHUS JACUHYENSIS Pilsbry.

(Plate XXXIX, Figs. 3, 3a.)

Potamolithus jacuhyensis Pilsbry, Nautilus, XII, p. 113, Feb., 1899.

The shell is globose, solid and strong, smoothish, with the usual slight growth lines and scarcely visible spirals; covered with a strong, rich brown cuticle, becoming more reddish towards the apex, and dark green below the last turn of the suture, behind the lip, and at the base. Spire short and conic. Whorls $4\frac{1}{2}$, those of the spire convex, the last very obtusely biangular, being flattened peripherally, subangular at the shoulder, flattened and sloping above it, and tapering basally. There is in some specimens a well-developed flattened columellar crescent, but in other individuals it is reduced and inconspicuous. The aperture is large and somewhat spreading, moderately oblique and irregularly semicircular. The outer lip is sharp, with a dark line at the edge, not expanded, and not in the slightest degree varicose or contracted. The inner lip is heavily calloused.

Length 6, diam. 5.6 mm.

Jacuhy River, Rio Grande do Sul, Brazil. Types, 61,820, A. N. S. P., collected by Dr. H. von Ihering.

No immature stages are represented in the series before me. The species belongs to the more primitive or youthful group, by its simplicity of form, the absence of varices, and the want of contraction at the mouth. It is not closely related to any of the La Plata drainage forms, but has some resemblance to *P. lapidum*, from which it differs by the obtusely biangular shape, the much larger aperture, and the heavily calloused columella, which allies it to species of the Uruguay system, and those following.

POTAMOLITHUS INTRACALLOSUS sp. nov.

(Plate XLIIb, Figs. ^{8, 8a} 9, 9a.)

The shell is imperforate, solid, globose with short, conic spire, olive-green, blackish in the axial region. Surface very lightly marked with growth lines. Whorls $4\frac{1}{2}$, convex, the last strongly convex below the suture and at the periphery, which is below the middle, somewhat flattened above the periphery; base convex; an acute keel divides off a crescentic umbilical area. The suture descends slightly near the aperture. The aperture is ample, oblique, very shortly oval. The peristome is black-edged, not expanded. The continuous columellar and parietal margins are very heavily calloused, the columella broad and flattened. In oblique view in the aperture, a broadly rounded prominence is seen in the middle of the columella.

Length 3.7, diam. 3.5 mm., length of aperture 2.7 mm.

Hiririca, Rio Ribeira, State of Sao Paulo, Brazil. Type, No. 103,047, A. N. S. P., from No. 2037 of the Museu Paulista. H. von Ihering.

This small species of the *P. buschii* group is notable for its very broad columella, with an internal node or rounded prominence. This last feature differentiates it from *P. ribeirensis*, which closely resembles *intracallosus* in shape.

POTAMOLITHUS RIBEIRENSIS sp. nov.

(Plate XLIIb, Figs. ⁵ 6, 7.)

The shell is imperforate, rather solid, globose, red-brown, with a faint olivaceous tint near the outer lip; sculpture of indistinct growth-lines only. Spire short, conic. Whorls $3\frac{1}{2}$, convex, the last globose, most convex at the periphery and just below the suture, the intervening surface somewhat flattened in some examples, but strongly convex in others. The periphery is very indistinctly subangular in front, but in fully adult

shells this is often scarcely noticeable. The base tapers and is not very convex. The suture descends very slightly in front. There is an extremely narrow umbilical area. The aperture is oblique and ample, angular above. The outer lip is thin and acute, and forms a half-circle. The columella is very heavily calloused, its face flat or excavated, with a longitudinal depression. Parietal callus heavy within, thin and adnate at the edge.

Length 3.5, diam. 3.4 mm.; length of aperture 2.7 mm.

Rio Ribeira, Yporanga, State of Sao Paulo, Brazil. Types collected by R. von Ihering, 1908.

This form resembles *P. lapidum* (d'Orb.) in shape, but differs by its very broad columella and diminutive size. It is rather closely related to *P. buschii*, though differing by the rounded periphery, which even in immature shells shows the hardly noticeable trace of an angle. *P. intracallosus* is an allied species.

A series of eight shells from Hiririca, Rio Ribeira, State of Sao Paulo, collected dead, but not bleached, has been submitted by Dr. von Ihering. The cuticle is olive-green or clear green. The shape is about as in *ribeirensis*. In several shells there is a very narrow umbilical area, defined by a raised line. In the youngest shells, diam. 2 mm., the columella is very wide, as in *ribeirensis*, but in the largest shells, length 5.2, diam. 4.2 mm., it is quite noticeably narrower. In one shell of this lot (Plate XLIb, fig. 3A) there is a wide, lunate, concave umbilical area, defined by an acute black keel, the columella being wide, as in *P. ribeirensis*. It measures, length 4.2, diam. 4 mm. Further material is needed to show the status of this form, which for the present may be considered a race of *P. ribeirensis*.

POTAMOLITHUS CATHARINÆ sp. nov.

The shell is perforate, acutely ovate, solid but strong, covered with an olive-green cuticle. The spire is conic, its lateral outlines straight, the apex small, but somewhat obtuse, entire in adult shells. Whorls $5\frac{1}{2}$, evenly convex, parted by an impressed suture, which descends very briefly at the aperture. The last whorl is strongly convex throughout; near the aperture it dilates a little. The aperture is slightly oblique, ovate, fleshy-gray within, blue-white near the lip. The outer lip is thin and black at the edge, and with the basal lip forms a half-circle; in profile its edge is even. The columella is heavily calloused, the callus extending across the parietal wall, where it is less thickened. There is a distinct umbilical

perforation and a feebly differentiated axial or columellar area, linear in the adult stage, but becoming wider in old shells.

Length 5.7, diam. 4.3, length of aperture 3.8 mm.

Colony of Hammonia, State of Santa Catharina, Brazil. Types, No. 103,048, A. N. S. Phila., from No. 163 of the Museu Paulista.

This is a much more robust species than *P. simplex*. It differs from *P. lapidum* by the produced spire and heavier columella. It is unlike all

(Fig. 16.)

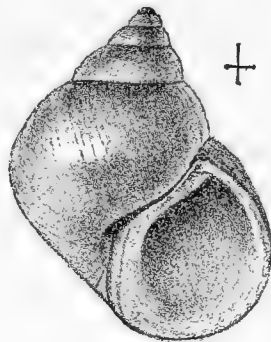


FIG. 16. *Potamolithus catharinæ*.

described forms in having a distinct umbilical perforation. The apex is perfect in all of the shells received, although the oldest of them has the last whorl deeply eroded.

GROUP OF *P. LAPIDUM*.

POTAMOLITHUS LAPIDUM (d'Orbigny).

Paludina lapidum d'Orbigny, *Magazin de Zoologie*, p. 29 (1835).

Paludestrina lapidum d'Orbigny, *Voyage dans l'Amér. Mérid.*, *Mollusques*, p. 382, pl. 47, f. 4-9.

Hydrobia lapidum Strobel, *Materiali per una Malacostatica di terra e di acqua dolce dell' Argentina Meridionale*, 1874, p. 59, with var. *dunkeri*, t. c., p. 59, pl. 2, f. 5.

?*Hydrobia lapidum* d'Orb., E. von Martens, *Malakozologische Blätter*, XV, 1868, p. 192 (Guahyba River at Porto Alegre; near Rödersberg; in the forest region and Cima da Serra at the *Estancia* of Christian Horn, on the plateau, 3-4000 ft. elevation; collected by Dr. Hensel).

?*Lithoglyphus lapidum* d'Orb., von Ihering, *Malakozologische Blätter* (neue Folge), VII, 1885, pp. 96-99, figs. 1-3 (dentition, head and

penis of specimens from the Santa Maria River, near its confluence with the Rio dos Sinos).

?*Lithoglyphus lapidum* d'Orb., Clessin, Malak. Blätter, n. F., X, p. 170 (Guahyba débris; Santa Maria River).

"Shell inflated-conic, short, thick, smooth, spire conic, acute at the summit; whorls 5, convex, the last whorl usually depressed, all being parted by a deep suture. Aperture round, ample, with thick borders, not reflexed. The columella is calloused. Color uniform green. Operculum corneous, flexible, spiral.

"Alt. 5, diam. 4 mm.

"This species is closely related to the preceding (*P. peristomatus*) by its short shape; it differs constantly by wanting a carina, and by the non-reflexed peristome" (d'Orbigny).

"*P. lapidum* inhabits the whole course of the Paraná and La Plata, from well above Corrientes to Buenos Aires, or from 27° to 34° S. lat.; on stones, clinging in great numbers to the under side, at extreme low water. It moves quite actively" (d'Orbigny).

The typical form of *P. lapidum*, figured by d'Orbigny, has an evenly rounded last whorl, though his phrase, "le dernier [tour] est souvent comme déprimé," indicates that the Paraná shells are frequently compressed around the upper part of the last whorl. Mr. E. R. Sykes, who kindly examined the types of the species for me, states that one specimen is so characterized. The aperture is ample, the lip not in the least contracted and not thickened, the columella only moderately thickened.

The variety *dunkeri* of Strobel, from the Rio de La Plata at Olivos, near Buenos Aires, seems to differ from *P. lapidum* only by its small size; length 4, diam. 3.5 mm., with 4 whorls. It was described from a single individual, and probably has no racial significance.

I have not seen typical *P. lapidum* from the Uruguay River.

In the State of Sao Paulo *P. lapidum* has been reported by several authors from streams flowing into the Atlantic, as quoted in the references above, which I am unable to control; but I doubt whether the true *P. lapidum* is found in those waters.

A form of *P. lapidum* having the spire rather longer than d'Orbigny's type figures is drawn in figs. 4, 5, 5a of Plate XXXIX. It is from the Uruguay River, exact locality not noted.

At Paysandú, Uruguay a race occurs differing somewhat from typical

P. lapidum (Plate XLIb, fig. 5). The shell is solid, globose, with conic spire longer than in *P. lapidum*, though the apex is eroded in all specimens seen. Aperture smaller than in *lapidum*, somewhat contracted by an internal thickening and contraction of the lip above. Columella narrow. A very narrow umbilical area is defined by an angle, which runs very close to the columellar lip. This race may be called var. *elatior*.

Length 4.5, diam. 3.5 mm.

The long spire separates this form at once from *P. paysanduannus*, which moreover differs in the shape of the last whorl. In old examples the aperture is more contracted than in that figured, and the spire is more worn.

POTAMOLITHUS LAPIDUM SUPERSULCATUS Pilsbry.

(Plates XXXIX, Figs. 7, 7a; XLIa, Fig. 7.)

Potamolithus lapidum supersulcatus, Pilsbry, Nautilus, X, p. 88, Dec., 1896.

The shell is like *P. lapidum* in its globular shape. It is dark green, usually with pale, irregular zigzag markings, sometimes confined to the spire, and there is usually an indistinct brownish band above the periphery. On the last whorl an obtuse ridge revolves not far below the suture, most prominent on the back; this is followed by a concavity, below which there may be a second obtuse angle. The base is quite full and rounded. The suture descends suddenly to the aperture, which is therefore a little contracted, oblique and ovate. The peristome is acute, dark-edged, continuous, without trace of a varix. The columella is narrow and concave, and the parietal wall is only moderately thickened. Whorls $4\frac{1}{2}$.

Length 5.3, diam. 4.7 mm.

“ 4.3 “ 4 “

Rio de La Plata, at San Gabriel's Island, near Colonia, Uruguay. Also Uruguay River at Fray Bentos, and Paysandú, Uruguay.

Development. — The spiral ridges appear only on the last whorl, and usually only on its last half. Up to that time the whorls are rounded and the shape Naticoid. At all stages of growth the columella is quite narrow.

Potamolithus l. supersulcatus is quite closely related to *P. tricostatus* (Brot), from which it differs chiefly by the weaker spiral ridges, which are only one or two in number, not three, as in *P. tricostatus*. These ridges are not only less emphatic in *supersulcatus*, but they do not appear so

early in the development of the individual. The narrow columella is similar in the two species.

The specimens from Fray Bentos and Paysandú (where only a few were taken), have no second angle below the upper spiral ridge on the back. It is a very abundant snail at San Gabriel's Island. Specimens preserved in alcohol become brown when dried; and this is also true of most, probably all, of the dark green species.

The figures by von Itersen, on Plate XXXIX, represent a very dark green specimen. They are not so characteristic as that on Plate XLI α , which shows the back of an example with the color-pattern fully developed.

POTAMOLITHUS PARANENSIS sp. nov.

(Plate XLI β , Figs. 10, 11.)

The shell is globose, with conic spire, olive-yellowish, smooth except for fine growth-lines and very fine, indistinct spiral striæ. Whorls strongly convex, the last swollen below the suture, in its latter part flattened below the swelling, rounded at the periphery and base. The aperture is very oblique, ovate, outer lip thin and sharp. Columella moderately calloused.

Fig. 11. Alt. 3.3, diam. 3 mm.; 3 whorls remaining, the apex eroded.

" 10. " 2.4, " 2.3 " 4 whorls, the apex perfect.

Rio Paraná at Puerto Bertoni, Paraguay, collected by A. de W. Bertoni, No. 103,049, A. N. S. Phila., from No. 189, coll. Museu Paulista.

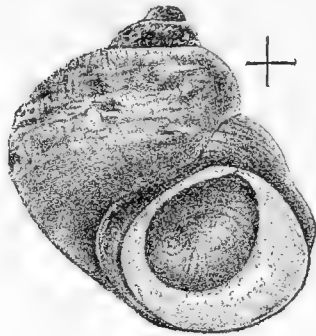
From the sharpness of the outer lip, I am disposed to think that none of the specimens is fully mature, though the largest one must be nearly so, as it is eroded like an old shell. It differs from *P. lapidum* by the longer spire, small size and pale color. There are two specimens in the collection of the Academy of Natural Sciences of Philadelphia, three in that of the Museu Paulista.

POTAMOLITHUS DOERINGI sp. nov.

The shell is subglobular with a short conic spire, solid and strong, olive-colored, more or less streaked or mottled with black. The surface is dull, lightly marked with fine lines of growth and extremely weak, coarse spirals; $3\frac{1}{2}$ whorls of the spire remain, the apex being eroded in adult shells. The whorls are strongly convex, parted by a deep suture, which descends briefly at the aperture. The last whorl is convex through-

out. Aperture quite oblique, large, white within. Peristome black, a little contracted, more so above, black. Columella and parietal wall

(Fig. 17.)

FIG. 17. *Potamolithus doeringi*.

moderately calloused, the edge black, continuous. There is a concave, crescent-shaped umbilical area defined by an angular ridge.

Length 7, diam. 7 mm.; length of aperture with peristome 5.7 mm.

Salto do Yguassú, Province of Misiones, Argentina, collected by Dr. H. von Ihering, June, 1910.

This is a larger species than *P. lapidum* (d'Orb.), with the last whorl decidedly more dilated, the aperture more oblique, and a crescentic umbilical area developed. When collected, the shells were heavily coated with black ferrous material and most of them bear egg-capsules on the shell.

POTAMOLITHUS PAYSANDUANUS von Ihering.

(Plate XLIa, Figs. 1, 1a.)

Potamolithus paysanduanus v. Ihering, Nautilus, XXIV, 1910, p. 15, with forms *sinulabris* and *impressus*.

The shell is imperforate, solid, subglobular, olive-colored, smooth except for weak growth-lines, shining. The spire is very low, conic, the apical whorls eroded in all the individuals seen; three whorls remaining are strongly convex. The last whorl is *swollen below the suture*, then somewhat flattened, rounded at the periphery and base. The suture descends abruptly to the aperture in fully adult shells. The aperture is somewhat oblique, ovate. The peristome is black, with obtuse, flat edge; the outer and basal margins are narrow; the upper part of the outer lip and the upper angle are wide, and the *columellar and parietal margins are very wide and flat, black*, contracting the aperture.

Length 4.8, diam. 3.9 mm.

Paysandú, Uruguay. Dr. Florentino Filippone. Types, No. 103,070, A. N. S. P.

This form differs from *P. lapidum* by its contracted aperture, the inner and upper margins of the peristome being heavily thickened within, the thickening covered with a blackish cuticle. In *P. lapidum* the aperture is ample, with no such heavy thickening. In the stage immediately preceding maturity the columella has a moderate white callus within, and the parietal callus is quite thin. The type specimen is figured. Six others I have seen show no significant variation.

With these specimens two other forms were sent which seem to be phases or varieties of the same species, but not intergrading in the material examined. Whether they occurred in the same or in separate colonies is not known.

Form SINULABRIS (Plate XLIIa, figs. 2, 3). The shell differs from typical *P. paysanduanus* by having a low rounded ridge behind the outer lip, which is black, contracted, and has a rounded sinus above. The basal lip is narrow and a little retracted. The columellar and parietal margins are not so broad as in *paysanduanus*. There is an excavated umbilical area, but it is generally not distinctly defined by an angle. The shape is otherwise as in *P. paysanduanus*.

Length 4.5, diam. 4.9 mm.

“ 4 “ 4 “

Form IMPRESSUS (Pl. XLIIa, figs. 4, 4a). The shell resembles typical *paysanduanus* as far as the middle of the last whorl, after which it has an impressed, concave zone a short distance below the suture, and usually a sinus in the upper part of the lip. The outer lip is thin and sharp, with no external varix or swelling. The shell, under the cuticle, is light yellow.

Length 5, diam. 4.8 mm.

Up to the time of reaching the size of adult *P. paysanduanus*, this form grows normally. After that, instead of forming a contracted aperture, it adds a half whorl, which is distorted by a superior concave zone and finally terminates with a thin outer lip. The specimens were sent with typical *paysanduanus*.

POTAMOLITHUS QUADRATUS Pilsbry & von Ihering, sp. nov.

(Plate XLIa, Figs. 6, 6a.)

The shell is solid, imperforate, light olivaceous-brown, lightly marked with growth-lines, shining. The spire is very short, $3\frac{1}{2}$ whorls remaining, the apex being eroded. The penultimate whorl has a strong angle at its upper third, is flat and horizontal above the angle, flat and sloping below it. The last whorl is bicarinate, the peripheral and shoulder carinæ being about equally strong, giving it a square appearance. The base tapers to a rather high ridge, which bounds a wide, excavated, umbilical area. The peripheral angle becomes obsolete just behind the outer lip, and it is visible only on the last whorl. The aperture is very oblique, ovate, white within. Peristome a little contracted, its face flat and thickened within, at and above the periphery and in the upper angle; below the periphery it is thin and a little retracted. The columella and parietal wall are moderately calloused, a groove in the face running parallel to their outer margin.

Length 3.9, diam. 4 mm.

Paysandú, Uruguay. Dr. Fl. Filippone.

This snail differs from *P. carinifer* in the shape of the last whorl, the much stronger upper keel (which is developed earlier) and in having a large umbilical area. It lacks the median keel and variegated coloration of *P. tricostatus*.

A young shell 2.4 mm. diam. consists of $2\frac{1}{2}$ whorls, the first $1\frac{1}{2}$ are rounded; the keel at the shoulder then begins, rapidly becoming strong. The columella is very wide, its face excavated.

POTAMOLITHUS CARINIFER sp. nov.

(Plate XLIa, Figs. 5, 5a.)

The shell is imperforate, trochiform, solid, blackish-brown in old individuals, the shell of a brick-red tint below the cuticle. Surface lightly marked with growth-lines. The spire is very short, conoidal. Whorls about 4, the earlier ones convex. The first half of the penultimate whorl is convex; then a small carina gradually arises a short distance below the suture, the surface flat and sloping below it; a little later a strongly projecting keel appears just above the lower suture, being uncovered by the descent of the last whorl. The last whorl has a strongly projecting

peripheral keel and a small keel near the suture, the surface flat between the keels. The base is a little convex. The umbilical area is slightly excavated, but not bounded by a ridge or keel. The suture descends slowly in its last third of a whorl, and then rapidly at the aperture. The aperture is very oblique, shortly ovate, flesh-tinted inside. Peristome blunt, not expanded. Columella concave, rather narrow, its face slightly grooved. Parietal wall rather heavy-calloused.

Length 4.2, diam. 4.1 mm.

Paysandú, Uruguay. Dr. Florentino Filippone.

This species closely resembles *P. microthauma*, from which it differs by the entire absence of a varix behind the outer lip; the coloration is also different, but the type is probably abnormally dark, being an old shell which has lost part of the cuticle.

POTAMOLITHUS TRICOSTATUS (Brot).

(Plate XL, Figs. 6, 6a, 6b, 7.)

Lithoglyphus tricostatus Brot, Journal de Conchyl., XV, 1867, p. 68, pl. 1, fig. 4 (Uruguay River, Province of Entrerios).

The shell is trochiform, solid and strong; olive-colored, profusely marked with irregular or zigzag buff spots. The surface is glossy when clean, with the usual weak growth-lines and minute spiral striæ. Spire short, convexly conoidal. Whorls $4\frac{1}{2}$, the first three convex. A ridge then gradually appears below the suture, increasing to a strong carina on the back of the last whorl. The last whorl has also a thick, strong keel defining the base, and a short keel, chiefly dorsal, above the middle of the slightly convex surface between the two keels. The base is flattened, but a little convex; a small columellar area is usually distinctly differentiated. The last whorl expands slightly at its termination, and then contracts. The aperture is very oblique, rounded-ovate, bluish-white within. The peristome is continuous, black-edged. The columella is narrow and concave; and, with the parietal wall, is moderately calloused.

Length 5, diam. 5 mm.

“ 5.3 “ 4.8 “

“ 4.7 “ 3.9 “

Uruguay River, at Paysandú, Uruguay.

Development.—The youngest shells seen have nearly 4 whorls. The

upper and lower keels are already strongly developed near the lip, but there is no trace of the intermediate keel, which in adults is less than one whorl long. The two keels present are very weak at the beginning of the fourth whorl, the basal one stronger there than the upper, so that apparently at $2\frac{1}{2}$ whorls the form must be Naticoid, like *P. lapidum*. The next stage, at about 3 whorls, would have a basal angle only, like *P. buschii*. The columella is narrow, as in *P. lapidum*, throughout the neanic stage. The ephebic stage is marked by a slight expansion, forming a narrow and low varix. Fully adult shells are markedly gerontic by reason of the strong post-variceal contraction.

The figures of this species given by Brot are unsatisfactory from being too small properly to show its characters. The median keel is shown too low in position. The original locality was indefinite, but comprised an area including the river in the neighborhood of Paysandú. Three specimens of the original lot, received from Dr. Brot, agree with those collected by Dr. Rush at Paysandú.

POTAMOLITHUS HATCHERI sp. nov.

(Plate XXXVIII, Figs. 6, 6a.)

The shell is imperforate, turbinate, solid and strong, pale yellowish-green, becoming darker and narrowly streaked with dark green on the later half of the last whorl; on the penultimate whorl the color changes to rich reddish-brown, becoming darker towards the summit. Surface glossy, with faint growth-lines and fine, indistinct spiral striæ. Spire conic, high and rather slender, the apex lost in the type, a pit in its place. Three whorls remain, the first two of them evenly convex. The last fourth of the penultimate whorl is very obscurely biangular, the lower angle more distinct than the other. These angles are more pronounced on the face of the last whorl, and on its later half the upper angle rises into a strong keel, the surface above it concave; at the same time, the lower angle loses in prominence, and is quite lost behind the lip. An extremely weak spiral ridge is developed on the back below the suture. The base is rounded. The last third of a volution of the suture descends more rapidly. There is no trace of a varix at the lip. The aperture is quite oblique, as wide as high, almost circular, but slightly angular above. The lip is obtuse, thickened within, with a continuous blackish marginal line. The columella is

very concave, and not wider than the outer lip, and is bounded outside by a linear, hardly noticeable columellar area.

Length 5.5, diam. 4.9 mm.

Uruguay River, at Paysandú, Uruguay. Type, No. 90,218, A. N. S. P.

This species is based upon a single specimen, quite adult and to all appearance perfectly normal, yet so unlike other known species that its relationships are doubtful. The prominent characters of *P. hatcheri* are the elevated and tapering spire and the approximation of the two angles of the last whorl, the upper one finally dominating, while the lower becomes obsolete on the last half of the last whorl. The absence of a lip-varix and of a noticeable columellar area, as well as the rather narrow columella, are features like the *P. lapidum* group. The young shell, up to the middle of the penultimate whorl, must be ovate, without angles; but in the absence of immature specimens, not much can be said of the development of the species.

It is named to honor Mr. J. B. Hatcher.

POTAMOLITHUS DINOCHILUS Pilsbry.

(Plate XXXVIII, Figs. 5, 7, 7a, 7b, 8.)

Potamolithus dinochilus Pilsbry, Nautilus, X, p. 87, Dec., 1896.

The shell is globosely trochoidal, imperforate, very solid and thick; green, profusely marked with irregular, zigzag buff streaks. The surface is smoothish, with the usual faint growth-lines and indistinct fine spiral striæ. The spire is conic, rather high when preserved entire (fig. 8), but worn to a blunt summit in all adult shells seen. There are $4\frac{1}{2}$ whorls, but only $2\frac{1}{2}$ to 3 remain in adults. The earlier whorls are rounded, but at the beginning of the last a small ridge arises a short distance below the suture. The last whorl is somewhat flattened and slopes steeply to the basal periphery, which is full and narrowly rounded or subangular. The ridge below the suture is narrow, but well developed on the back. The columellar area is ill-defined and very narrow. The lip is strengthened by a varix, which above the periphery is very high, massive and recurved, but becomes weak at the base. The aperture is very oblique, contracted, irregularly rounded, with the margins built out beyond the varix, continuous around the mouth, thick and obtuse. The columella is strongly concave, and moderately calloused, not more than the lip generally.

Length 4.9, diam. 5.2 mm.

“ 4.5 “ 5 “

Uruguay River, at Paysandú, Uruguay. Types, No. 69,695, A. N. S. P.

Development.—The series at hand contains no young shells, one only (Pl. 38, fig. 8) has not yet formed the post-variceal contraction. It appears however that, until the last whorl is reached, the shell has the primitive Naticoid shape. The last whorl represents morphologically the second neanic substage of such accelerated forms as *P. microthauma*. The strong post-variceal contraction and heavy thickening of the inner margin of the peristome declare that the last stage is distinctly gerontic.

P. dinochilus differs conspicuously from *P. microthauma*, *hidalgoi* and *peristomatus* by the absence of a peripheral keel, and from *P. orbignyi* by the shape of the last whorl and the ill-developed columellar area. It has perhaps more in common with the *P. lapidum* group, especially in the coloration and the persistence of the Naticoid form to the beginning of the last whorl; but the very high, massive lip-varix of *P. dinochilus* is a feature unlike any of the *lapidum* group.

POTAMOLITHUS PERISTOMATUS (d'Orbigny).

Paludina peristomata, d'Orbigny, Magazin de Zoologie, p. 29, 1835.

Paludestrina peristomata, d'Orb., Voy. dans l'Amér. Mérid., Moll., p. 382, pl. 47, f. 1-3.

"The shell is short, trochoidal, thick, smooth, carinate in front, the carina projecting. Spire conic, short, obtuse at the summit, composed of 5 convex whorls, of which the last is keeled in front, the carina forming a border above the suture between the other whorls. Aperture round, much expanded, with thick, reflexed borders; the columella wide and flat. Operculum corneous, spiral. Color uniform greenish, paler in front of the mouth.

"Alt. 5, diam. 5 mm." (d'Orbigny).

Parduá River, above its confluence with the Paraguay River, at the villages of Itaty and Iribucua, Province of Corrientes, Argentina, at extreme low water, under stones where the current is strong; living in numerous families (d'Orbigny).

In general shape this species resembles *P. buschii* and *P. conicus*, but it differs from both by the well-expanded peristome. It is known by the original lot only.

POTAMOLITHUS HIDALGOI Pilsbry.

(Plate XXXIX, Figs. 1, 1a, 1b.)

Potamolithus hidalgoi Pilsbry, Nautilus, X, p. 87, Dec., 1896.

The shell is imperforate, trochoidal, with flattened base and conic spire; moderately solid. The type specimen is dull reddish-brown, somewhat olive-tinted at the base, and olivaceous blackish on the lip-varix; but some immature shells of the original lot are dull olive-colored, darker on the keel. The surface is slightly marked with growth-lines. The spire is conic. There are $4\frac{1}{2}$ whorls, the first $2\frac{1}{2}$ convex; then a keel appears, immediately above and filling the suture. The last two-thirds of the last whorl descends slowly, the peripheral keel projecting above the suture. The last whorl is flat and slopes steeply above the peripheral keel, and is slightly convex below it. A very narrowly crescentic columellar area is defined by an inconspicuous, but acute angle. The outer lip is strengthened by a moderately strong varix, not continued below the termination of the peripheral keel. The aperture is extremely oblique, rounded-ovate, angular above and indistinctly so outwardly, at the termination of the keel. The columella is arcuate and moderately calloused.

Length 5.2, diam. 5 mm.

Uruguay River, at Paysandú, Uruguay. Types, No. 69,687, A. N. S. P.

A very weak ridge below and near the suture may be seen in two immature shells of the type-lot, but this is not developed in the others. The early neanic substage is Naticoid, like the corresponding age in *P. microthauma*. The rest of the neanic stage is the equivalent of substage 2 in *P. microthauma*. The deep descent of the last whorl gives a markedly gerontic character to the adult stage. *P. hidalgoi* is therefore less evolved sculpturally in wanting the third neanic substage, senile characteristics supervening earlier.

The species is named in honor of Dr. J. G. Hidalgo of Madrid, author of a beautiful work on the mollusks of the Spanish Commission to South America, among many other important labors.

POTAMOLITHUS MICROTHAUMA Pilsbry.

(Plate XXXVIII, Figs. 2, 2a, 2b, 3.)

Potamolithus microthauma Pilsbry, Nautilus, X, p. 87, Dec., 1896.

The shell is imperforate, biconic, very solid and strong. The last whorl is olive-green, rather profusely marked with irregular buff maculæ, which

are sometimes absent on the base. The lip-varix is bright green. On the penultimate whorl the ground-color changes to purple-brown and the markings disappear, the earlier whorls being uniform dark purple-brown. The surface shows delicate growth-striæ and a very minute, almost effaced spiral striation. The spire is conic, with straight outlines, the apex entire and obtuse, though small. Whorls 5, the early ones convex, the first $2\frac{3}{4}$ being rounded, without trace of keels. A peripheral keel then begins, strong from the beginning, and projecting flange-like above the suture. The last whorl descends slowly from about its last third and much more rapidly near the aperture. The peripheral keel projects very strongly and is slightly undulating; and a small keel arises below the suture, becomes stronger on the back, then gradually decreases. On the base, midway between the periphery and center, a low keel revolves, the area within it being nearly flat. There is a very narrow crescentic columellar area. The outer lip is strengthened by a very high and massive varix, which is recurved above, with a rib on its face running to the lip-edge, and below passes into the basal keel. The aperture is very oblique, ovate; the outer lip thin at the edge. The columella is narrowly calloused and regularly concave.

Length 5.5, diam. 6 mm.

“ 4.6 “ 4.7 “

Uruguay River, at Paysandú, Uruguay, under stones at low water, Types, No. 60,689, A. N. S. P.

Development.—The neanic stage is sharply divided into

(1) A *lapidum* substage, in which the shell is rounded, without keels, comprising the first $2\frac{3}{4}$ whorls.

(2) A carinate substage, initiated by the almost abrupt rise of the peripheral carina. From a half whorl to a whorl this is the only keel developed. This stage corresponds to the adult *P. hidalgoi*, and is of brief duration.

(3) The basal and the subsutural carinæ begin, weak at first, becoming stronger near the end of the substage.

The ephobic stage is announced by the expansion to form the varix, which, however, is not terminal, the whorl continuing and contracting beyond it, thus assuming gerontic characteristics.

P. microthauma is related to *P. hidalgoi* and *P. peristomatus*, but it is a much more evolved form than either, structures added in the second

and third neanic substages of *microthauma* being superposed upon the adult structure of *P. hidalgoi*.

GROUP OF *P. IHERINGI*.

POTAMOLITHUS RUSHII Pilsbry.

(Plate XXXVIII, Figs. 1, 1a, 1b, 4.)

Potamolithus rushii Pilsbry, Nautilus, X, p. 89, Dec., 1896.

The shell is imperforate, wider than high, biconvex, very solid and strong; light green, the last half of the last whorl dusky green, the keels rather bright green; the early whorls being dark reddish-brown. The surface is somewhat glossy, with faint, fine growth-lines and barely perceptible spiral lines. The spire is convex, the apex obtuse. Whorls 4, but the first is eroded, leaving a pit, in all the adult shells seen. The whorls are convex, with seam-like sutures. In the latter part of the penultimate whorl the peripheral keel is usually visible at the suture. The last whorl has a very strong peripheral keel, the surface being concave above and below it. Above the concavity the upper surface is convex, the convexity rising into a hump on the back, then disappearing, the last fourth of the whorl being flat. The base has a thick and prominent keel, defining a concave yellowish columellar area. The outer lip has a high, narrow varix at the edge. The aperture is very oblique, short-ovate, nearly circular, with a continuous, black-edged margin. The oblique columella is very broad, with a gutter or concavity near to and parallel with the inner margin.

Length 4.3, diam. 6.3 mm.

“ 5.1 “ 6.3 “

Uruguay River, at Paysandú, Uruguay. Types, No. 69,686, A. N. S. P.

Development.—The youngest specimens seen have three whorls and a diameter of 3 mm. They have the depressed contour of adults and are strongly carinate peripherally, but the carina is distinctly weaker in front of the mouth, apparently indicating that it begins when the shell has nearly two whorls and a diameter of about a millimeter. At the 3 mm. stage the columella is very broad, semicircular, with a deep excavation and rod-like inner border (Pl. XXXVIII, fig. 4). Very late in the neanic stage the basal keel appears, the shell then being about 5 mm. in diameter; the columellar area being very narrow, at first linear. The rib or convexity

of the upper surface is also of late appearance, these structures belonging to the third neanic substage, the second, or unicarinate, substage thus occupying the greater part of the neanic stage. The discontinuation of the upper ridge or hump initiates the ephebic substage. The marginal varix and the absence of any tendency of the last whorl to descend or loosen its coil anteriorly, show that this species is at its acme. It has none of the stigmata of senility which are so manifest in *P. microthauma*, *P. hidalgoi*, etc.

There is some variation in the degree of depression of the whole shell, the amplitude of the columellar area and in the prominence of the hump on the back, which is sometimes almost suppressed. The size also varies, one specimen before me with the varix nearly complete measuring only 5 mm. in diameter.

The relationship between *P. rushii* and *P. iheringi* is exceedingly interesting. The two species are similar in general color-scheme, in the varix, absence of more rapid descent of the suture towards the mouth, etc., but are totally diverse in contour, the one being carinate, the other smooth and Naticoid. Yet it is significant that while *P. iheringi* has no trace of a peripheral keel, the green band occupies the same position as that coloring the keel in *P. rushii*.

POTAMOLITHUS IHERINGI Pilsbry.

(Plate XXXIX, Figs. 2, 2a.)

Potamolithus iheringi Pilsbry, Nautilus, X, p. 87, Dec., 1896.

The imperforate or rimate shell is globular-conic, very solid and strong, pale olive-yellow, with a sharply defined, bright green band bordering the suture below and another immediately above the periphery, visible as a narrow border on the penultimate whorl above the suture; the columellar area being also dull green. Very faint growth-lines and an almost effaced spiral striation are visible under the lens. The spire is low conoidal, the suture clearly incised but not impressed. Whorls $4\frac{1}{2}$, the first half whorl usually lost in adult shells; the rest are slightly convex, the last whorl being globular, at first regularly rounded, but its last third descends slowly, and is perceptibly flattened obliquely in the peripheral region, being more full and convex below. The base is convex, but there is a concave crescentic columellar area defined by an inconspicuous angle. The outer lip is strengthened by a moderately strong varix, bevelled to the lip-edge,

and weak at the base. The aperture is quite oblique, ovate, subangular above. The outer lip is thick within. The columellar margin is somewhat straightened, the columella very wide, flattened and excavated, a rather deep furrow running parallel with and near to the inner edge.

Length 5, diam. 4.9 mm.

“ 4.9 “ 4.6 “

Uruguay River, at Paysandú, Uruguay. Types, No. 69,698, A. N. S. P.

Development.—The youngest individuals seen have $3\frac{1}{2}$ whorls, with a length of 2.3 and diam. of 2.8 mm. They are therefore more depressed than the adult stage, and have both green bands well developed. The subsutural green band begins at the end of the second or beginning of the third whorl. The axis is wholly imperforate. The columella is very broad, half-round, with the excavation in its face deeper than in adults. At no stage are there any traces of carinæ or protuberances.

I have seen a long series of this species. The characters described above are very uniform, and it is readily known by the Naticoid shape, grooved columella and green bands. Named in honor of Dr. H. von Ihering.

POTAMOLITHUS PHILIPPIANUS sp. nov.

(Plate XLIIb, Figs. 1, 1a, 2.)

The shell is globose, solid and strong, light greenish yellow, with a narrow dark green border below the suture, the apex pinkish. The surface is nearly smooth, showing faint growth-lines and fine, very indistinct spiral striæ. Spire low, conic, the apex minute, entire. Whorls $4\frac{1}{2}$, convex, the last not more rapidly descending, distinctly flattened peripherally, shouldered above the flattened zone, very obtusely subangular below it, the base convex, with a rather wide, concave and crescentic columellar area, the lower portion of which is bounded by an angle. The outer lip is strengthened by a moderately high varix near the margin, much lower at the base, and continuous with the angle bounding the columellar area. The aperture is very oblique and semicircular, the outer margin being deeply arcuate, the inner somewhat straightened. The columella is rather broad, with a shallow furrow on its face; and the outer edge is somewhat elevated near the insertion, leaving, in the type specimen, a shallow crevice behind it, not visible in younger shells.

Length 5.7, diam. 5.7 mm.

Uruguay River, at Paysandú, Uruguay. Types, No. 103,050, A. N. S. P.

Development.—The smallest specimens seen measure 3 mm. diam., 2.8 high. The peripheral flattening is already weakly perceptible. There is no trace of a basal angle or columellar area, but the columella is very wide, almost semicircular, with a deep excavation in its face. The angle bounding the columellar area is developed very late, appearing only on the last whorl.

This species is described from four specimens, none of them perhaps completely mature. The shell figured is almost mature, but lacks the post-variceal contraction of the lip, which would probably be acquired. Two of the shells have a peripheral brown band, fading out at the edges, and one has a second fainter band on the outer part of the base.

Compared with *P. iheringi*, this species differs by its somewhat biangular shape, the lower varix and the coloration. *P. paysanduanus* differs more radically by its columella.

LITHOCOCCUS gen. nov.

Shell globose, thick, sculptured with strongly developed spiral ribs, the upper ones spinose; composed of 4 to 5 convex whorls. Operculum corneous, subcircular, composed of 3 or 4 whorls, the nucleus near the center. Dentition Amnicoloid; central tooth with 5 to 7 denticles on the cusp and 3 basal denticles on each side. Inner lateral tooth with 13–14, next with about 16 denticles. Type *L. multicarinatus*.

This genus differs from the *Lithoglyphinæ* and *Potamolithus* by the operculum. The penis has not been examined.

LITHOCOCCUS MULTICARINATUS (Miller). *Lithoglyphus multicarinatus* Miller, Malakozoologische Blätter, n. F., I, p. 157, Taf. 15, f. 4. Rio Cayapas, Ecuador, abundant on rocks.

PELECYPODA.

Family SPHÆRIIDÆ Dall.

The family *Sphæriidæ* is represented in South America by four genera: *Sphærium*, *Musculium*, *Eupera* and *Pisidium*. Doubtless the last two genera will prove to be generally distributed and numerous in forms, *Eupera* in tropical, *Pisidium* in temperate and cold regions; but up to this time only a few have been described. The list of species described from

south of the Equator, compiled in the course of work on Patagonian forms, is here given for the convenience of those who have occasion to study the group.

LIST OF SOUTH AMERICAN SPHÆRIIDÆ.

SPHÆRIUM ÆQUATORIALE Clessin, Malakozoologische Blätter, n. F., I, 1879, p. 176, Taf. 11, figs. 4-6.

Rio Pedro, Val de Chillo, Ecuador. Length 9, alt. 6, diam. 3.5 mm.

Referred by Clessin to the group *Corneola*.

MUSCULIUM ARGENTINUM (d'Orbigny). See below.

MUSCULIUM PATAGONICUM Pils. See below.

EUPERA BAHIENSIS (Spix), Testacea Brasil., 1827, p. 32, pl. 25, figs. 5, 6.

Sphærium bahiense Spix, Prime, Monograph of American Corbiculidæ, 1865, p. 53, fig. 52.

Bahia, Brazil.

EUPERA MODIOLIFORMIS (Anton). *Sphærium modioliforme* Anton, Prime, Monograph American Corbiculidæ, 1865, p. 54. *Pisidium moquini-anum* Bgt., 1855. *Pisidium diaphanum* Hald., 1841.

Venezuela, Brazil.

EUPERA TUMIDA (Clessin). *Limosina tumida* Clessin, Syst. Conchylien Cabinet, Cycladeen, p. 246, pl. 46, figs. 5-8.

Bahia, Brazil.

PISIDIUM MAGELLANICUM (Dall). *Corneocyclas magellanicus* Dall, Bull. Mus. Comp. Zool., vol. 43, October, 1908, p. 411.

Magellan Straits, in 61 fathoms; Rio Chico to base of the Andes.

PISIDIUM OBSERVATIONIS Pils. See below.

PISIDIUM PATAGONICUM Pils. See below.

PISIDIUM STERKIANUM Pils., Proc. Acad. Nat. Sci. Phila., 1897, p. 291, pl. 6, figs. 1-4.

Montevideo, Uruguay. Length 6, alt. 5, diam. 3.8 mm.

PISIDIUM DORBIGNYI Clessin, Conchylien Cabinet von Martini und Chemnitz, 2te Aufl., Cycladeen, 1879?, p. 62 (new name for *Cyclas pulchella* d'Orbigny, Voy. dans l'Amér. Mérid., Moll., p. 568, pl. 83, f. 8-10, not of Jenyns).

Maldonado, Uruguay. Length 3 mm.

PISIDIUM VILE Pilsbry, Proc. Acad. Nat. Sci. Phila., 1897, p. 292, pl. 6, figs. 17-20.

Montevideo, Uruguay. Length 2.6, alt. 2.4, diam. 2 mm. Near the following species, but shorter.

PISIDIUM GLOBULUS Clessin, Malakozoologische Blätter, n. F., X, 1888, p. 173.

Taguara, State of Rio Grande do Sul, Brazil. Length 3, alt. 2.5, diam. 2 mm.

PISIDIUM CHILIENSE (d'Orbigny). *Cyclas chiliensis* d'Orb., Voy. dans l'Amér. Mérid., Moll., p. 568, pl. 83, figs. 11-13.

Concepcion, Chili. Length 5 mm.

PISIDIUM FORBESII (Philippi). *Cyclas forbesii* Phil., Malakozoologische Blätter, XVI, 1869, p. 41. Pfeiffer, Novitates Conchologicae, III, p. 489, pl. 105, figs. 15-17.

Bolivia alta (Forbes); Lake Titicaca (Raimondi). Length 7.5, alt. 6.5, diam. 4 mm.

PISIDIUM BOLIVIENSE Sturany, Nachrichtenblatt d. deutschen Malakozoologischen Gesellschaft, 1900, pp. 56, 57, Taf. 1, figs. 1-7.

Bolivia, at Machacamac, between Chililaya and La Paz (Countess von Bayern).

Length 7.8, alt. 6.4, diam. 3.6 mm.

" 6.7 " 5.5 " 3.2 "

" 5.7 " 4.7 " 2.7 "

Near *P. forbesii*, but lower, more oval, with less projecting beak.

PISIDIUM LAURICOCHÆ (Philippi). *Cyclas lauricochæ* Phil., Malak. Blätter, XVI, 1869, p. 41. Pfeiffer, Novitates Conchologicae, III, p. 489, pl. 105, figs. 12-14.

Lake Lauricocha, at head of the Marañon River. Length 7, alt. 6, diam. 4 mm.

PISIDIUM WOLFFII Clessin. *P. wolffi* Clessin in Miller, Malak. Blätter, n. F., I, 1879, p. 178, Taf. 11, figs. 7-9. Clessin, Conchylien Cabinet, Cycladeen, p. 268.

Rio Pedro, Val de Chillo, Ecuador. Length 5, alt. 4, diam. 2.5 mm. Very inequilateral.

PISIDIUM DAVISI (Bartsch). *Corneocyclas davisi* Bartsch, Proc. U. S. Nat. Mus., XXXIII, 1908, p. 681.

Chanchan River, Ecuador. Length 5, alt. 4, diam. 2.7 mm.

MUSCULIUM PATAGONICUM sp. nov.

(Plates XLVIa, Fig. 8; XLVII, Figs. 1-7.)

The shell is thin, nearly equilateral, pale straw-yellow, glossy, finely striate. The beaks are low and broad, the embryonic stage marked off by a contraction or gutter. Anterior end almost symmetrically rounded; posterior end slightly flattened or subtruncate. Hinge-line arched. Cardinal teeth very minute, double in the right, single in the left valve. Lateral teeth very short, triangular, single in the left, double in the right valve.

Figs. 6, 6a. Length 8, alt. 6.6, diam. 4.3 mm. 35 miles above Sierra Oveja.

"	4.5	"	8.8	"	6.8	"	4.5	"	25	"	"	"	"
"		"	9	"	7.2	"	5	"	50	"	"	"	"

Springs and small streams along the Rio Chico de la Santa Cruz, from 15 to 50 miles above the Sierra Oveja. Types from 50 miles above the Sierra Oveja (Pl. XLVIa, fig. 8).

This species is closely related to *Musculium argentinum* (d'Orbigny), but constantly differs from that by having the posterior end less abruptly truncated, and the beaks flatter, not so full. Figs. 2, 3, 5 are not very good. Figs. 6, 6a and 7 show the shape better. Fig. 1 well shows the teeth as seen in a partly open shell. Eight lots are before me, from as many springs and streams, at distances of 15, 25, 30, 35 and 50 miles above the Sierra Oveja. The examples from farther up are the largest and are remarkably well developed in every way (Pl. XLVIa, fig. 8).

MUSCULIUM ARGENTINUM (d'Orbigny).

(Plate XLVIa, Figs. 6, 7, 7a.)

Cyclas argentina d'Orbigny, Mag. de Zool., 1835, p. 44; Voy. dans l'Amér.

Mérid., Mollusques, p. 568, pl. 83, figs. 5-7 (Montevideo).

Sphærium argentinum d'Orb., Strobel, Mat. Malacostat. Argent., p. 77.

Not *Pisidium argentinum* Clessin, Conchyl. Cab., p. 63, fig. 2a.

D'Orbigny's figures of this species are very unsatisfactory. Clessin has, I believe, entirely misunderstood them. His *Pisidium argentinum* may possibly be *P. sterkiannum* Pils. For the purpose of affording a basis for comparison with Argentine and Patagonian species, I figure two topotypes, an adult and a half-grown shell, collected by Dr. W. H. Rush, U.S.N., from a creek in the Prado, Montevideo.

The shell is fragile, olive-gray when full-grown, the young ones grayish, with a yellow zone at the basal edge. The ends are more abrupt than in *M. patagonicum*, and the beaks fuller. The teeth are decidedly more delicate and compressed than in *M. patagonicum*.

Pl. XLVIA, fig. 7, 7a. Length 9, alt. 7.8, diam. 5 mm.

“ XLVIA, “ 6. “ 5.3 “ 4.2 “ 2.9 “ (immature).

Strobel reports this species from San Carlos, Province of Mendoza, Bahia Blanca and Carmen de los Patagones. He gives the measurements, length 9, alt. 7.5, diam. 6 mm., for an example from the last named locality.

From the Rio Camaguan, Rio Grande do Sul, Dr. von Ihering sent a single specimen similar to *M. argentinum*, except in being shorter and more globose; length 7.9, alt. 7, diam. 5.2 mm. If such proportions characterize a race in that river, it will probably be considered as specifically distinct.

PISIDIUM MAGELLANICUM (Dall).

(Plate XLVII, Figs. 12-16.)

Corneocyclas magellanica Dall, Bulletin of the Museum of Comparative Zoology, Vol. 43, October, 1908, p. 411.

“Shell small, whitish, with an olivaceous smooth periostracum, low, wide beaks and polished surface, with faint concentric indications of three or four resting stages; form inequilateral, anterior end shorter, bluntly subtruncate; base evenly rounded; posterior end slightly attenuated and rounded; external sculpture of faint incremental lines, chiefly obsolete between resting stages; interior smooth, white; hinge of right valve with a single feeble horizontal tooth directly under the beak, and two well-developed lateral teeth rather distant from the beak, the posterior lateral stronger. Length of shell 3.5, of posterior end of shell 1.8; height 2.5; diameter (of both valves) 2 mm.” (Dall).

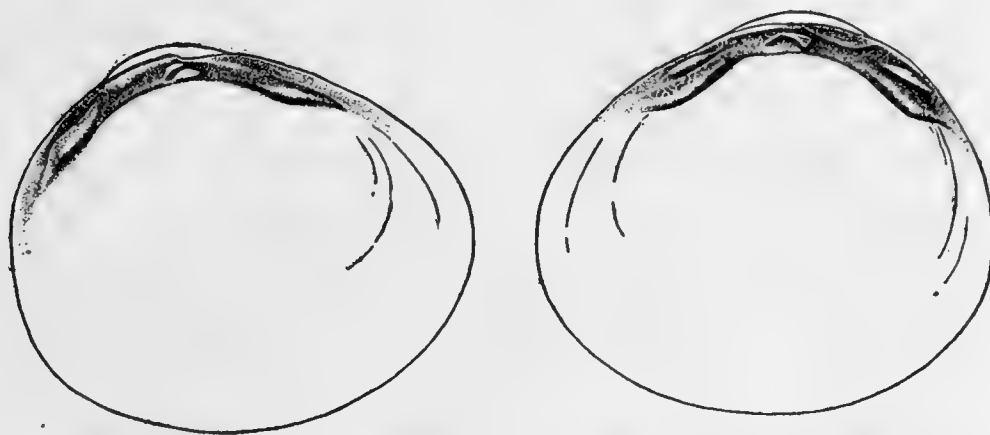
Magellan Straits in 61 fathoms, “Albatross” Station 2778. “A single right valve, evidently washed into the sea from some stream” (Dall).

Springs on the Rio Chico de Santa Cruz, fifteen (Pl. XLVII, figs. 15, 16) and twenty-five miles above the Sierra Oveja; Rio Blanco, at base of the Andes; springs near base of the Andes, 65 miles north of the Rio Chico, 2400 ft. elevation (Pl. XLVII, figs. 12-14).

Dr. Dall, who kindly compared specimens from the last locality mentioned above with the type of *P. magellanicum*, states that they agree almost exactly and, in his judgment, are the same species.

In the fresh specimens from 65 miles north of the Rio Chico the right valve has below the beak a horizontal arcuate tooth, with a straight oblique tooth above it nearer the anterior (short) end. The laterals appear to be smooth. The left valve has a rather long slender tooth, lower and angulated in the middle, the anterior ramus stouter and longer than the posterior. The lateral teeth arise under the visible part of the umbones (while in *P. patagonicum* they arise beyond it). They are high and triangular in profile (fig. 16). The shells are light olive externally, with

FIG. 18.



P. magellanicum, 65 miles above Rio Chico. Interior of right and left valves.

several darker concentric streaks. The largest shells measure, length 4.9, alt. 4, diam. 2.7 mm.

Specimen from a spring 25 miles above the Sierra Oveja are similar, except that the lower cardinal tooth of the right valve is stouter. One opened contained eleven young ones about 1.6 mm. long, almost filling the cavity.

The teeth are practically identical in specimens from six lots examined.

PISIDIUM PATAGONICUM sp. nov.

(Plate XLVII, Figs. 8-10.)

The shell is pale buff, glossy, very finely striate, with low, wide, smooth and glossy beaks; strongly inequilateral, the anterior end very short and rounded, base evenly convex, posterior end narrow and somewhat produced. Interior white. Cardinal teeth are excessively weak and low, nearly effaced. There is a very low, horizontal, rudimentary tooth in the

right valve, a low short one in the left, with the scarcely discernible trace of another anterior to it. These teeth, especially the anterior one, are too distinctly defined in fig. 10. Lateral teeth very short and moderately strong, distant from the beaks.

Length 4.9, alt. 4.3, diam. 3 mm.

Springs on the Rio Chico, fifteen miles (type loc.) and thirty miles above the Sierra Oveja; twenty-five miles below the Rio Belgrano; and in the Arroyo Eke, near the head waters of Spring Creek, 2400 ft. elevation.

This clam differs from *P. magellanicum* by the shorter anterior end, short lateral teeth remote from the cardinals, the anterior laterals standing at an angle approaching 100° with the posterior laterals, on account of the curvature of the anterior margin. In *P. magellanicum* the angle of divergence of the teeth is decidedly greater, and they are longer. The cardinal teeth are almost obsolete in *P. patagonicum*, not projecting above the level of the hinge.

In the type lot, as well as in all the specimens from springs recorded above, the surface is straw-yellow and the striation fine and even, without periodic lines indicating growth-arrest. In specimens from small streams in the same region the shell attains a greater size, up to length 6.9, alt. 5.8 mm., and is marked externally with several darker concentric streaks, indicating periods of growth-arrest; the color is generally paler. This form, which may be called var. *zonifer*, is figured on Plate XLVIa, fig. 9. It is from small streams on the Rio Chico fifteen and twenty-five miles above the Sierra Oveja.

PISIDIUM OBSERVATIONIS sp. nov.

(Text fig. 19.)

The shell is inequilateral, the beaks low and wide, anterior end very short, broadly rounded, posterior end narrow, rounded. Surface glossy, olive, drab or yellowish, marked with several impressed and darker resting periods. Interior bluish-white. Cardinal teeth: in the right valve there are two narrow teeth, parallel, oblique and contiguous. In the left valve there is one nearly straight horizontal tooth, lower and thinner near the middle. The lateral teeth are rather long and not remote from the beaks, single in the right, double in the left valve. The interlocking surfaces of these teeth are more or less granulous.

Length 4.8, alt. 4, diam. 3 mm.; sometimes larger, length 5.1 mm.

Near the Mount of Observation (below the mouth of Santa Cruz River).
This species is chiefly distinguished by its cardinal teeth, which differ constantly from those of the other Patagonian *Pisidia*.

FIG. 19.



Pisidium observationis. Interior of right and left valves.

Family *MUTELIDÆ*.

Genus ANODONTITES Bruguière.

Anodontites Brug., Journ. d'Hist. Nat. Paris, I, 1792, p. 131 (for *A. crispatus* Brug.).

Patularia Swainson, Malacology, 1840, pp. 287, 381 (for *P. ovata* Swains. = *trapesialis* Lam. and *P. rotundatus* Swains. =? *Anodonta woodiana* Lea).

Glabaris Gray, Proc. Zool. Soc. Lond., 1847, p. 197 (for *Anodonta exotica* Lam.).

Glabaris Simpson, Synopsis of the Naiades, p. 916.

Patularia Dall, Nautilus, XX, 1906, p. 39 (type *P. ovata* Swains. implied).

ANODONTITES PUELCHANUS (d'Orbigny).

Anodonta puelchana d'Orb., Mag. de Zool., 1835, p. 40; Voy. dans l'Amér. Mérid., Moll., p. 620, pl. 79, figs. 7-9. Doering, Informe Oficial de la Comision Científica de la Expedition al Rio Negro (Patagonia), 1881, Zoologia, p. 74.

Rio Negro: Marsh of San Xavier (d'Orbigny); 12 leagues from Chichinal (Roca Exped.).

Genus DIPLODON Spix.

DIPLODON PATAGONICUS (d'Orbigny).

Unio patagonica d'Orb., Voyage dans l'Amér. Mérid., p. 610, pl. 70, figs. 1-4.

Rio Negro.

DIPLODON FRENZELLII (Ihering).

Unio frenzellii v. Iher., Archiv für Naturgeschichte, 1893, p. 3, pl. 4, fig. 12.
Rio Negro.

It may be well here to correct the nomenclature of an allied genus of the La Plata and Amazon basins, formerly known as *Castalia* Lam., 1819. This name was believed to be preoccupied by Savigny, in *Vermes*, and *Tetraplodon* Spix, 1827, has been substituted for it.

The late Professor Eduard von Martens wrote to me under date of 18 Oct., 1893, as follows: "Concerning *Castalia*, the date of Savigny's genus of Annelids is given as 1817 in Agassiz's 'Nomenclator,' it is true, but I am not sure that this is correct. I find Savigny's genus first in his System of Annelids, which is said to have been published in 1820, whereas *Castalia* Lamarck was published in 1819, vol. V, part I, of Lamarck's first edition [of the *Animaux sans Vertébres*].

"P. S. I have consulted in these days the original edition of L. Agassiz's Nomenclator and I find concerning *Castalia* the note:

"*Castalia* Sav., Syst. annélid., 1817. Savigny Système des Annelides, présenté à l'Acad. des Sci. en 1817, publié en 1826.'

"It is true that there is also an edition of the same work, in folio, which makes part of the large 'Description de l'Égypte,' and to which in Engelmann's Bibliotheca Zoologica, vol. I, p. 581, the date 1820 is given. By general consense the date of publication and not the date of finishing a manuscript and presenting it to a learned body is accepted as fixing the priority. I come to the conclusion that *Castalia* Lam., 1819 can stand for the shell, and *Castalia* Sav. among the Annelids is to be changed."

II.

NOTES UPON THE CHARACTERISTICS AND ORIGIN OF
THE NON-MARINE MOLLUSCAN FAUNA OF
SOUTH AMERICA.¹

In the following synopsis I have limited myself to a brief consideration of data derived solely from mollusks. This course is not due to any underestimation of the value of other groups in biogeographic work ; but rather because conclusions drawn from a group known to me at first hand have a certain value which would not attach to borrowed data. The classification used herein is that of the Manual of Conchology so far as the groups have been considered in that work.²

It must constantly be borne in mind by those comparing the distribution of non-marine mollusks with that of vertebrate groups, that not only has evolution proceeded more slowly in the former, but migrations have been slower. Thus, when a Pliocene communication was established between North and South America, there was a rapid and extensive invasion of both areas by mammals ; but the molluscan invasion was very much slower and never extended nearly so far. Land and fresh-water mollusks are restrained by conditions which affect mammals and birds far less, such as areas with little forest, unsuitable or very scanty rock on the surface, or short river systems, not well connected.

Any inquiry into the antecedents of a fauna leads to the question of where its component groups had their rise. The rarity of land and fresh-water shells as fossils, and the great antiquity of the family groups, renders this question very intricate. The origin of many groups is still quite unknown ; yet most of the larger families of land-snails, and a few of the fresh-water groups may be traced back with considerable certainty, if not to definite centers, at least to extensive areas of evolution.

The several origins of air-breathing gastropods from marine groups— from the Opisthobranch stock, the Rhipidoglossa and the Tænioglossa

¹ For bibliography see H. von Ihering, *Archhelenis und Archinotis*, Leipzig, 1907. A. Ortman, *Princeton University Expeditions to Patagonia*, IV. T. Arldt, *Die Entwicklung der Kontinente*, Leipzig, 1907 ; bibliography on pp. 622–631.

² The family groups of land snails almost all differ widely in contents and limits from those of Fischer's *Manuel* and other systematic works ; a fact of first importance in dealing with the distribution of the groups, and the relationships of faunas.

—reach far back in Palæozoic time. We have no data bearing upon either the time or place of these events.

I. We have first to do with a fauna composed mainly of the Orthurethrous land-snails¹—forms which are structurally but a step removed from the aquatic pulmonates, and now forming an insignificant element in continental faunas, though still dominant in the islands of the central Pacific. The families *Valloniidæ*, *Enidæ*, *Pupillidæ*, *Partulidæ*, *Ferussacidæ*, *Amastriidæ*, *Achatinellidæ* and *Tornatellinidæ* are remnants of this fauna, which was doubtless once nearly or quite world wide, and probably attained its acme in Palæozoic time. The Heterurethra (*Succineidæ*, etc.) doubtless existed in this early fauna, as well as the Aulacopoda (*Endodontidæ* are known from the Carboniferous), and the *Helicinidæ*. Of the fresh-water forms probably represented in this fauna, we may mention the ancestral stock of fresh-water pearly mussels, the *Cyrenacea*, the ancestral *Melanopsidæ* and *Melaniidæ*, and the *Lymnæidæ*. With the rise of the Sigmurethrous snails, the land-snails of this primitive fauna declined in all continental areas.

One of the most remarkable features of the South American fauna is the extreme scarcity of these primitive Orthurethrous land-snails. This group is represented only by a few *Pupillidæ* and *Ferussacidæ*, probably derived from Middle America in the Tertiary, and closely related to Antillean and Mexican species.

The origin and early differentiation of the Sigmurethrous land-snails is unknown. At the time of their appearance as fossils, in the late Cretaceous and Eocene, the modern families were already more or less clearly blocked out, so far as they are represented by known fossils. From the evidence at hand, derived from the distribution of the groups in the recent fauna, and as Cretaceous and Tertiary fossils, it appears that the evolution of these families had proceeded during Mesozoic time in two chief areas, for which we may use terms proposed in another connection by Dr. Theodore Gill.

II. *Cænogæic or northern fauna*, occupying old land areas in North America, Asia and Europe,—what is now the Holarctic and part of the Oriental realm, with part of the Neotropical (the Antillean-Central American continent). Leading families evolved on this area or areas follow;²

¹ See Manual of Conchology, XX, Introduction.

² The groups of low type continued or derived from the preceding fauna are not included.

those which appear to have radiated from the Antillean Continent are indicated by the letter A.

<i>Unionidæ,</i>	<i>Megaspiridæ,</i>
<i>Pleuroceratidæ,</i>	<i>Urocoptidæ A,</i>
<i>Viviparidæ,</i>	<i>Testacellidæ,</i>
<i>Diplommatinidæ,</i>	<i>Zonitidæ,¹</i>
<i>Cyclostomatidæ A,</i>	<i>Limacidæ,</i>
<i>Proserpinidæ A,</i>	<i>Arionidæ,</i>
<i>Lymnæinæ,</i>	<i>Philomycidæ,</i>
<i>Helicidæ,</i>	<i>Oleacinidæ A.</i>
<i>Clausiliidæ,</i>	

III. *Eogæic or Southern fauna*, which occupied chiefly the Gondwana continent, including a large part of South America, tropical and south Africa, and stretching in a great arch, possibly at no time perfect, to peninsular India and Australia. Here were evolved the families :

<i>Mutelidæ.</i>	<i>Achatinidæ.</i>
<i>Etheriidæ.</i>	<i>Aperidæ.</i>
<i>Ampullariidæ.</i>	<i>Rhytididæ.</i>
<i>Chilinidæ.</i>	<i>Streptaxidæ.</i>
<i>Acavidæ.</i>	<i>Circinariidæ.</i>
<i>Strophocheilidæ.</i>	<i>Veronicellidæ.</i>
<i>Bulinulidæ.</i>	

The South American fauna is largely made up of groups of typically Eogæic or Southern origin, but there are also northern forms, derived from Middle America ("Antillia"), and a few groups of ancient and unknown origin. These several elements are as follows.

I. PRIMITIVE GROUP.

Families of very Ancient and Unknown Origin and World-wide Distribution, and Isolated Autochthonous Families of Eogæic Origin.

Circinariidæ. Northern South America and temperate North America.

Bulinulidæ. Autochthonous; formerly spread to Australasia and now invading North America.

Strophocheilidæ. Autochthonous.

Endodontidæ. World-wide, on all continents and islands.

¹ Primitive *Zonitidæ* were probably evolved at a very early time, but the group attained its main development in the Cænogæic faunas.

Succineidæ. World-wide, on all continents and islands.

Chilinidæ. Autochthonous.

Amnicolidæ. On all continents.

The ancestral stocks of these families probably formed the earliest fauna of non-marine mollusks in South America. Some of the families are known, in other regions, to have been established in Palæozoic times; and it is likely that as early as that they were already found in South America. All of them are sharply isolated groups.

The *Circinariidæ* seem to have remote affinity to *Rhytididæ* and *Strep-taxidæ*—both of which evolved in the southern hemisphere of the Old World. In North America this family is probably intrusive, being represented by a single genus also found in South America.

The *Strophocheilidæ* have relations—though not close—with a series of genera (*Acavidæ*) now found in south Africa, Madagascar, the Seychelles, Ceylon, Moluccas, Australia and Tasmania. The radiation of this scattered group from the Palæozoic Gondwana continent of Neumayr seems a reasonable, in fact the only tenable, hypothesis.

The *Bulinulidæ* have descended from the Holopod stock, probably also of Gondwana Land, since we have no evidence of any other ancestry.

Endodontidæ and *Succineidæ* are world-wide groups, even on the most remote islands. Their early presence in South America is therefore likely.

The *Chilinidæ* represent an isolated branch of the primitive Basommatophora. No scrap of evidence has been brought to light to show that they ever existed elsewhere than in South America; and at present we have every reason to believe that there they invaded fresh water from the sea.

The *Pectinidens* group of *Lymnæidæ* and the *Ancylidæ* are evidently traceable to some very early radiation. Adequate data upon the soft anatomy and relationships of the forms of the southern hemisphere do not now exist.

II. THE ARCHHELENIC GROUP.

*Families which for the Greater Part are Represented in the
Tropical African Fauna by a far Greater Diversity of
Forms than in the South American.*

The hypothesis of an Africo-Brazilian continent of Palæozoic and Mesozoic times, first sketched out on purely palæontological grounds, and ably

advocated by Dr. von Ihering from the evidence of the fresh-water fauna, is essential to any rational explanation of the distribution of land and fresh-water mollusks.

The following South American groups are common to the tropical African radiation center. Terrestrial groups are marked with an asterisk (*).

* *Streptaxidæ* (fig. 21).

* *Achatinidæ* (fig. 20).

* *Veronicellidæ*.

Planorbinae (South American *Planorbis* and *Plesiophysa* close to African *Planorbis* and *Isidora*).

Ampullariidæ (genera with corneous opercula, fig. 22).

Melaniidæ (nearest to African forms).

Mutelidæ (fig. 23).

Etheriidæ (fig. 24).

Sphæriidæ, of the genus *Eupera*.

Such of these groups as are represented in the West Indies and subtropical North America, have evidently, from their distribution, relationships and the greatly diminished number of genera and species, been derived from South America, rather than from some common source, such as Archhelenis. None of them are present as Mesozoic or Tertiary fossils in North America,¹ and nearly all of them are likewise absent from European deposits.

There is a good deal of evidence that most of the above groups arose in the eastern hemisphere and migrated westward, and little evidence or none that any of them moved in the opposite direction.

The *Streptaxidæ*, *Achatinidæ*, *Ampullariidæ*, *Melaniidæ* and *Mutelidæ* are far more diversified in Africa than in South America. It seems that several Gondwana subfamilies were not present in the fauna of Archhelenis, or at least did not extend so far west as to reach South America, though they must date back at least as far as some other subfamilies which are represented both in South America and Africa.

The primitive stock of fresh-water mussels seems to have early split into two phyla: the one, *Mutelidæ*, evolving in the south, on the Gondwana-Archhelenis continent, the other, *Unionidæ*, in the north, in North America

¹The *Planorbinae* are found on all continents, but those of South America are obviously most closely related to the African forms.

and Asia. The occurrence of both families in the same waters is evidently due to migrations, which ensued after the families had become differentiated. The *Mutelidæ* attain their northernmost point in the Panuco River, in northeastern Mexico, where the family is represented by one species of the South American genus *Anodontites*.

Simpson and Germain refer a few African forms to the South American genus *Diplodon*, and Germain has called attention to the similarity of the African *Pseudavicula* to the South American *Prisodon* or *Hyria*. If the resemblance of the shells proves to be supported by the soft anatomy, then this family at least will be evidence of an eastward migration in Archhelenis. At present the evidence is insufficient. The possibility of convergence in shell-form must be taken into account. Most if not all African *Unionidæ*, like the African *Cyclostomatidæ*, *Zonitidæ*, etc., are clearly of Oriental derivation. These are northern Cænogaëic families which have invaded Africa during the Tertiary.

The maps following illustrate the distribution of part of the Archhelenic groups.

FIG. 20.



Distribution of the land-snail family *Achatinidæ*. The numerals represent the number of genera in each area.

The autochthonous families, together with the Archhelenic group, make up the mollusk fauna of the Brazilian plateau; but the more isolated and peculiar, presumably older, genera have outlying forms in the Guiana-Colombian center, indicating a former unity of the northern and southern

massifs. This connection of the Brazilian and Guiana-Colombian areas must have persisted long after the Archhelenic period, for distinctively

FIG. 21.

Distribution of the land-snail family *Streptaxidae*.

FIG. 22.

Distribution of fresh-water snails of the family *Ampullariidae*, having the operculum wholly corneous.

American genera had been differentiated. It was interrupted prior to the union with the Antillean-Mexican continent, since the genera of that area

FIG. 23.

Distribution of the bivalve family *Mutelidæ*.

FIG. 24.

Distribution of the bivalve family *Etheriidae*. 1, *Mülleria*; 2, *Bartlettia*; 3, *Etheria*; 4, *Pseudomülleria*.

did not gain access to the eastern Brazilian plateau. If the conclusion that the Amazon valley was a Cretaceous bay or strait connecting the Atlantic and Pacific be well-founded, then the common dispersion center of this old fauna may have been in land now lost under the Atlantic. The facts

FIG. 25.



Distribution of *Tomigerus*, *Anostoma* and *Auris*, three old genera common to the Brazilian and Guiana-Colombian centers (probably all are more widely distributed inland).

FIG. 26.



Distribution of *Odontostomus*.

FIG. 27.



Distribution of (1) *Macrodonates*, (2) *Anctus*, (3) *Hyperaulax* and *Bonnanus*.

of molluscan distribution favor the view that in Archhellenic times the Amazon valley formed a gulf opening westward, wherein Cretaceous deposits were laid down; eastern Brazil north to Guiana bounding this gulf on the east, until the depression of the Atlantic basin marked the close of Mesozoic

time. Such a hypothesis finds support in the presence of genera of the old Brazilian type on the island of Fernando Noronha. Numerous very peculiar land-shell genera, such as those tabulated in fig. 25, have a distribution not readily explicable on any other hypothesis; while in still other cases, allied but generically distinct groups are similarly distributed. It may be noted that Bates has remarked that the Para insect fauna is essentially Guianian.¹

Figs. 26, 27 show the distribution of several old land-snail genera of the Brazilian center. Fig. 25 that of several genera common to the Brazilian and Guianian centers.

That the Amazonian valley ever formed an upper Cretaceous strait connecting the south Atlantic and Pacific, as claimed by Dr. Ortmann,² seems rather improbable.

The Guiana-Colombian elevation has been a secondary radiation center for a number of genera of autochthonous South American families, chiefly the *Bulinulidæ*. The arboreal groups *Oxystyla* and *Corona* have spread south of the Amazon into eastern Brazil (fig. 28), while numerous other genera from this center are restricted to the north and west as in fig. 29. The Guiana-Colombian area also served as a secondary center for Antillean and Mexican groups, entering by way of the Caribbean elevation and that in the Panamic region. These groups have spread southward as in figs. 30-34.

A hypothesis has been advanced by Dr. Ortmann³ that Archhelenis of the Lower Cretaceous was succeeded in the Upper Cretaceous by a land bridge from tropical Africa to an area covering Guiana, the Caribbean Sea and the Mexico-Antillean region (the so-called Mesozonia), separated from the Brazilian island. By this hypothesis, Antillia should be as rich in African or Archhelenic types as Brazil, and in fact should show a closer resemblance to the African fauna due to the later connection. This is

¹ Naturalist on the Amazons, I, p. 109.

² Proc. Amer. Philos. Soc., XLI, p. 381, and in later articles. Dr. Ortmann's palæogeographic maps incline strongly towards what Fiske would call the "wet theory." It is not likely that all beds reported as Upper Cretaceous were below the sea at any one time. To map an Upper Cretaceous epicontinental sea to include all the exposures of a formation which included so long a period of time is not warranted by our present slight knowledge of the stages of the South American Cretaceous.

³ The Geographic Distribution of Freshwater Decapods and its Bearing upon Ancient Geography. Proc. American Philosophical Society, 1902, pp. 380, 381.

exactly contrary to the actual facts of molluscan distribution. All African or Archhelenic forms which exist in the Antilles are unequivocally of the South American type, and certainly indicate that there was no later migration or communication from Africa in the north. There seems little evidence

FIG. 28.



Distribution of *Orthalicinæ*. *Oxystyla* spreads throughout the black area except in the Antilles. Number of genera in each district indicated by numerals.

FIG. 29.



Distribution of *Plekocheilus*, a genus of Guiana-Colombian origin, spreading southward in the late Tertiary.

for the Upper Cretaceous "Mesozonia," mapped by Dr. Ortmann, and there are very strong reasons for holding that no such land existed.

Dr. von Ihering¹ holds that the subsidence of the Brazil-Ethiopian continent began in the north during the Cretaceous.

¹ Archhelenis und Archinotis, p. 337.

III.

Middle American (Mexico-Antillean) Forms, of Later Date in South America than the Archhelenic Group, in Some Cases Generically Differentiated from their Northern Ancestors, but more often Belonging to the Same Genera; Therefore Doubtless Traceable to both Earlier and Later Migrations Southward.

*Helicidæ*¹ (figs. 31, 32).

Urocoptidæ (fig. 33).

Oleacinidæ (fig. 30).

Pupillidæ.

Ferussacidæ.

Lymnæidæ (of the *Galba* group).

Physidæ.

Cyclophoridæ (fig. 34).

Cyclostomatidæ.

Proserpinidæ.

Helicinidæ.

These intrusive forms from middle America are characteristic of the Guiana-Andean region, though a few have attained a wider distribution. Streams of migration from and to the Antilles are indicated by the way of

¹The belogonous and epiphallogonous *Helicidæ* of South America are clearly of northern origin. Whether such extremely peculiar genera as *Solaropsis*, *Psadara* and *Macrocyclis* also belong in the same category, seems somewhat uncertain, although such competent malacologists as von Ihering and Fritz Wiegmann place these genera in the *Epiphalloгона*.

The heavy, large Helices of the Eocene of southern Europe, such as *Deutello-caracolus*, *Prothelidomus*, *Galactochelitus* and *Fridolinia*, may perhaps belong to the group Epiphalloгона of my arrangement, rather than to the Helicinæ where I formerly placed them; yet if so, I think the supposed relationship to West Indian forms is not especially close. Like the American and European species of *Adelopoma*, the Epiphalloгона probably reached both Europe and America from eastern Asia, and from opposite directions.

Dr. von Ihering (Verhandlungen k. k. zoologisch-botanischen Gesellschaft in Wien, LIX, 1909, pp. 420-428) has recently referred the belogonous Helices (*Epiphragmophora*) of Argentina and southern Brazil to the European genus *Helicigona* (*Campylæa* auct.); but I do not believe that this classification can be sustained. So far as I know, the South American Epiphragmophoras have the spermathecal duct very short, whereas *Helicigona*, like all other European Belogona, has a *very long duct*, bearing a long diverticulum, which is bound by a membrane to the oviduct. These are important differences, quite sufficient to show that *Epiphragmophora* is not at all closely related to *Helicigona*, aside from the different shape of the mucous glands, and their removal in *Epiphragmophora* from the vagina, upon which they are invariably inserted in all European Belogonous *Helicidæ*.

By its short spermatheca, *Epiphragmophora* differs strongly from all other known belogonous *Helicidæ*. In other features it stands nearer to Antillean and North American forms than to European. My former treatment of the genus was too inclusive. I would now restrict *Epiphragmophora* to forms having the spermatheca short, removing all of the Mexican and North American species (which have a long spermathecal duct) from the genus.

the Caribbean Islands on the east, and on the west the region of the Isthmus of Panama, where the interchange of forms has continued to the present time. That the middle American elements are far younger in South America than the Archhelenic, is shown by their close relationships to Antillean and Mexican forms, very few special genera having evolved. In

FIG. 30.



Distribution of the *Oleacinidae*. The dotted area stands for the genus *Englandina* only, which also occupies Mexico and Central America. Vertical shading in Europe for Tertiary, black for recent species of *Poiretia*.

most of the families only one or very few genera have invaded South America out of a large number in the parent lands. Moreover, it is notable that they have not extended far south in the east, where the Amazon valley has proved a barrier to land-snails. Their distribution has been along the Andes, spreading eastward in Bolivia and southern Brazil.

Figures 30 to 34 illustrate the distribution of middle American groups of land-snails incursive in South America.

In molluscan distribution, there is strong evidence against the view of Ortmann (1902, p. 347) that the northern margin of South America formed part of the Antillean continent. Schuchert's representation of the Caribbean Sea as an old permanent basin seems preferable; but his representation of the total submergence of the Antilles in the Middle Cretaceous

FIG. 31.



Distribution of *Helicidae* of the group *Belogona Euadenia* (one species extends westward to eastern Europe).

and again in the Upper Oligocene¹ cannot, I think, be sustained. The rich Oligocene beds of Jamaica (Bowden) and Santo Domingo, carrying a marine fauna of littoral type, occur at very low levels; and no deposits actually known to be Oligocene are found on the higher mountains, which I believe were islands in both Cretaceous and Oligocene times.

The primary region of radiation of the middle American families named above is a subject too large for adequate discussion in this place. So much is clear: the fauna contains three groups of diverse genesis. The

¹ Bull. Geol. Soc. Amer., XX, Pl. 95, 97, 1910.

autochthonous group, such as *Oleacinidæ*, *Urocoptidæ*, *Cerionidæ*, *Sagdinae*, *Cyclostomatidæ*, *Helicinidæ*, contains many phylogerontic lines, signalized by shells with more or less detached or uncoiled later whorls, sculptured embryonic whorls, highly developed, often spinose sculpture, complicated internal armature, and the like. These first families of Antillia, now in their old age, are related to the families of the northern or Cænogæic area of land-mollusk evolution. Some of them, and the ancestors of all, doubtless had a much wider range in Mesozoic times. A few, such as the *Oleacin-*

FIG. 32.



Distribution of Epiphallagonous *Helices* in America (exclusive of *Solaropsis* and *Macrocyclus*).

FIG. 33.



Distribution of *Urocoptidæ*. Shaded area *Eucalodiinae* and *Holospirinae*; black area *Urocoptinae*.

FIG. 34.



Distribution of *Cyclophoridæ* in America.

idæ and *Cyclostomatidæ*, were abundantly developed in Europe as late as the Miocene, or even linger in a few forms in the recent fauna. These European forms cannot, in my opinion, be looked upon as ancestral to the Antillean, but rather as parallel descendants of a common stock derived from the north, where the old Scandinavian and North American land areas were, at least from time to time, united.

A second element of the Mid-American lands consists of groups derived from the Chinese or east-Asiatic center. Prominent members are the dart-bearing and the Epiphallagonous *Helicidæ*, the *Cyclophoridæ*, *Dip-*

lommatinidæ (*Adelopoma*), *Clausiliidæ*, etc. These forms never have the old-age stigmata of the preceding group. They are developed in wonderful abundance and virility. Being known in characteristic genera of American type (*Pleurodonte*, *Cepolis*) in the Floridian Oligocene island, the advent of the group in middle America must have been much earlier. It could hardly have been later than the beginning of the Eocene, and probably was not later than the Upper Cretaceous.¹

Finally, we have as the latest faunal element in the Antillean-Mexican area, a series of South American forms — *Achatinidæ*, *Bulimulidæ*, *Ampullariidæ*, *Melaniidæ*, *Mutelidæ* and some North American forms, *Unionidæ*, *Pupillidæ*, *Zonitidæ*, *Polygyrinæ*, etc. These are, with very few exceptions, unchanged generically, and some are specifically identical with existing South or North American forms. It is very evident that such Archhellenic forms as exist in the Antilles and Mexico were not derived directly from the Archhellenic area; they migrated in the later Tertiary and Pleistocene from the Guiana-Colombian center.

Antillia has not been an evolution center for fresh-water mollusks or fishes, evidently because it has never been a very large area, and has been an unstable one, at one time in form of a continent, again an archipelago, hence without river systems of great extent or duration, such as are essential to the evolution of a fresh-water fauna.

There is absolutely nothing in the distribution of mollusks suggesting that either South or North America was at any time connected with the supposed South Pacific continent, or the Hawaiian group. Even Juan Fernandez has a land-snail fauna of Pacific and not South American type. The Hawaiian and Polynesian connections with America mapped by Arldt (1907) seem quite impossible.

¹The American *Clausiliidæ* are thought by Professor Boettger to be related to the European Miocene and recent Pyrenean group *Laminifera*, but they seem to me even closer to the genus *Garnieria*, of the Indo-Chinese center. The *Helicinidæ* may have arisen in Middle America from an aquatic rhipidoglossate stock, but the very wide distribution of the group in Polynesia and eastern Asia suggests that it is a very old one, which probably appeared among the first land-snails.

The Belogonous *Helices* still exist in high latitudes on both sides of the Pacific, being known from Sitka on the American and the Kuril Islands on the Asiatic side.

ARCHIPLATA AS AN EVOLUTION-CENTER.

Wallace in 1876¹ showed that the South American fauna is divisible into two subregions which he called the *Tropical* or *Brazilian* and the *South Temperate* or *Chilian*. He calls attention to the affinities of the Chilian diurnal Lepidoptera and the Carabidæ to North Temperate forms.² Dr. H. von Ihering in numerous papers³ has recognized the two subregions of Wallace as distinct evolution centers. He concludes that these centers, Archiplata (that is, Patagonia, southern Brazil, Chili and western Peru) and Archibrazil, were long isolated from one another by an arm of the sea. As primitive elements of the Archiplatan fauna he mentions the fresh-water crab *Æglea*, the genus *Parastacus*, and the mollusks *Diplodon* and *Chilina*. Negative characteristics are found in the absence of the dominant Amazonian genera of mussels and *Ampullariidæ* (which seem to have invaded the La Plata drainage area comparatively lately, probably in the Pliocene) to which many groups of land-snails might be added.

The geology of the regions involved is so imperfectly known that we have no positive data for or against the hypothesis that an arm of the Cretaceous sea extended across the continent, as von Ihering claims. This is a question only to be settled by geological exploration of the region, which may perhaps show a Cretaceous transgression similar to that which involved eastern Mexico and the region northward in the middle Cretaceous. Yet the fact remains that, so far as molluscan groups are concerned, there is but little evidence of such an isolation of the Archiplatan area. The barriers to migration imposed by climate have not been taken into account. The *Ampullariidæ* are snails that have never, in any region, been able to extend beyond a subtropical climate. The *Chilinidæ* (fig. 36) are apparently, like the large *Lymnæas* in North America, snails which cannot exist in a subtropical or even a warm temperate environment, however favorable may be the conditions of migration. It is instructive, in this connection, to compare the *Lymnæid* faunas of Minnesota and Arkansas, which show great

¹ Geographical Distribution of Animals, II, frontispiece and Chapter XIV.

² Dr. Scharff has suggested an explanation of this peculiarity (*American Naturalist*, September, 1909, p. 513), but his hypothesis explains only a few facts. It would involve us in problems more intricate than those which it solves. Possibly the systematic relations of the insects in question have not been rightly estimated.

³ The more important of these articles have been reprinted in his "Archhelenis und Archinotis," Leipzig, 1907.

diversity, although favorably situated for migration.¹ Another group which is widely distributed in the Archiplatan area, though not confined to it, is the Amnicolid genus *Littoridina* (fig. 35). The absence of Amnicolidæ in the Amazon system is probably apparent rather than real, since practically no collecting of small or minute mollusks of any kind has been done in that vast area. It is likely that Amnicolidæ will be found there

FIG. 35.



Known distribution of *Littoridina*, a genus of fresh-water snails.

FIG. 36.



Known distribution of Chiliniidæ, a family of fresh-water snails.

in abundance. *Diplodon*, another genus which Dr. von Ihering considers Archiplatan, is found almost all over the continent, and cannot fairly be claimed as of Archiplatan origin. It no doubt arose from the same Brazilian (and ultimately Archhellenic) stock as *Hyria*, etc.; but like *Unio* in the northern hemisphere, it is a hardy stock not highly evolved in its phylum, hence probably old. Compare in this connection the Unionid and Pleuroceratid fauna of Alabama with that of Georgia and the Carolinas. In these adjacent areas, which have been continuous land since very early times, we have as much difference in the fresh-water faunas as has been shown to exist between Archibrazil and Archiplata. Rich faunas of fresh-water mussels and gastropods are rarely found in regions like

¹ At Davenport, Iowa, I have found *Lymnæa stagnalis* on logs rafted down the river from Minnesota, but the species has not been able to gain a place in this fauna there or farther south; nor have many of the other northern Lymnæidæ, which must yearly be brought down on drift wood during the spring floods.

southern South America, drained by numerous short, independent rivers, owing to the difficulty of migration and the relative impermanence of the individual streams.

The presence of peculiar and strongly individualized land snails of Brazilian type (*Scalarinella*, *Plagiodontes*, etc.) in the Sierras of western Argentina and the now isolated Sierra Ventana, shows that long ago the Brazilian fauna extended at least as far south as Bahia Blanca, where a fragment has persisted, isolated since the Pliocene at least.¹

Taking into consideration the climate, the rarity of large forest areas, the aridity of large tracts, and the short, unconnected rivers, we are not inclined to give much weight to Dr. von Ihering's contention that many Brazilian groups are wanting in "Archiplata." So far as mollusks are concerned, that area has very slight claims to rank as an evolution center. I regard the Chilian and Patagonian fauna as an impoverished and slightly modified extension of the fauna of the old Brazilian continent. The evidence for an Archiplatan center may be stronger in the case of Crustacea, Oligochæta, plants and insects; but I prefer to leave the discussion of these groups to those having first-hand knowledge of them.

Connected with the Archiplata hypothesis is that of Antarctica, which may here be examined briefly.

AUSTRAL ELEMENTS IN THE SOUTH AMERICAN FAUNA.

The Austral or Antarctic relationships of the South American fauna have been somewhat fully discussed in other volumes of this series, and a map illustrating the Antarctic continent and its hypothetical former extensions may be found in volume IV. I have to deal here with the *evidence afforded by the non-marine mollusks, which, taken by itself*, leads to the following conclusions: (1) There is no evidence that Antarctica was ever an evolution or radiation center for non-marine mollusks, though there is some evidence showing that it served as a highway for migration. (2) There is some evidence of migration from South America to Australasia, but at present no evidence of a counter movement to South America. (3) Nothing in the distribution of mollusks would lead to the hypothesis

¹Dr. Ortmann agrees with von Ihering in isolating a Chilian and southern Patagonian land mass of Cretaceous age, but he views it as an extension of Antarctica. The difference is rather one of names than of things. Proc. Amer. Philos. Soc., 1902, pp. 379, 381.

that South Africa has ever been connected with Antarctica and thereby indirectly with southern South America.

Non-marine mollusks having an Antarctic distribution belong to three families. The evidence in each case is briefly as follows:

1. The *Bulimulidæ*, land snails of South American origin, of which one genus (*Bothriembrion*) is found in Tasmania and southwestern Australia, another (*Placostylus*) in New Zealand, New Caledonia, the islands of Melanesia and as far east as Fiji. Both of these genera are distinct from South American forms, but they are undoubtedly related to the more generalized of the South American genera.

FIG. 37.



Distribution of the land snail family *Bulimulidæ*. The number of genera in each area is indicated by figures.

The presence of *Bulimulidæ* in Australia and Melanesia proves that the part of South America connecting with Antarctica was, or had been, connected with the old Brazilian evolution center.

2. The *Amnicolidæ*, a family of fresh-water snails, has one genus, *Potamopyrgus*, in New Zealand, Tasmania and South America. Another South American genus, *Potamolithus*, has its nearest ally in the genus *Petterdiana* of Tasmania and Australia. Both of these genera are exclusively fresh-water groups. See pp. 548-550 of this report.

3. The Naiades or fresh-water mussels found in all of the continents, are represented in Australia, Tasmania and New Zealand only by species which have been referred to the genus *Diplodon*. This genus is widely distributed in South America, especially southward. It is a relatively primitive genus and probably arose in South America, which, from the number of autochthonous genera, was evidently an old evolution center of Naiades. *Diplodon* is unknown in the northern continents. Whether the relationship with South American forms claimed for the Australia-New Zealand group is well-founded, remains to be confirmed by careful comparison of the soft anatomy.

The family *Endodontidæ*, and *Gundlachia* of the *Ancylidæ*, have been considered "Antarctic" groups, but on evidence of slight value. The *Endodontidæ* are an ancient group, world-wide in distribution. No close relationship has been shown to exist between the South American and the Australian genera. The former are unknown anatomically, and the relations of Australian and New Zealand forms, so far as positively made out, are with the groups of Polynesia and Micronesia (*Charopa*, *Thaumatomodon*, etc.). Certain Tasmanian species may prove to belong to the American genus *Radiodiscus* Pils. See p. 516.

Gundlachia is found in Australasia, South America, the Antilles, Mexico, temperate North America and also the Miocene of central Europe. This wide distribution suggests that the genus may have reached the southern lands from the north. In the United States it has been found in California, Illinois, Ohio, New York, etc., but only at remote intervals and in very narrowly restricted areas. It is likely that it will turn up sooner or later in the Oriental region and Africa. I hesitate to claim *Gundlachia* as an inhabitant of Antarctica.

Pond snails of the family *Lymnæidæ* also occur in all the Austral lands, but South American forms do not seem especially related to Australasian. While *Endodontidæ*, *Gundlachia* and *Lymnæa* may have inhabited Antarctica, no data upon them now in our possession goes far towards proving that they did.

I can find no evidence to support Hedley's contention that the Macrogonia (*Acavidæ*) of Tasmania and Australia, and the *Rhytididæ* of the same regions, New Zealand, New Caledonia, etc., are "of Antarctic origin."¹ These groups must have attained their distribution from South Africa to

¹ Hedley, Proc. Linn. Soc. N. S. Wales, 1899, pp. 396, 398.

Australia by way of the Gondwana continent, leaving isolated genera by the way in Madagascar, the Seychelles, Ceylon and the Moluccas. To this Palæozoic and early Mesozoic land the South African *Endodontidæ*, *Peripatus*, etc., may also belong. The evidence for an isthmus connecting South Africa and Antarctica, as sketched by Forbes, Ortmann and some other palæogeographers, seems unsubstantial. Nothing in the distribution of non-marine mollusks lends it support.

FIG. 38.



Showing sources of the South and Middle American mollusk faunas. Early Mesozoic and earlier migrations in heavy lines, late Mesozoic lighter lines, Tertiary and later migrations in dotted lines.

The rather large size of the fresh-water mussels and *Bulimulidæ* precludes the idea of their distribution as adult organisms except by actual land connection. Some embryonic *Unionidæ* are probably carried by water birds, but we do not know that this is the case with *Diplodon*; moreover only short distances can be so traversed, since unionid embryos are known to die quickly out of water. It is hardly conceivable that *Bulimulid* eggs, which are smooth and not viscid, should be so carried. The same is true

of the egg-capsules of *Amnicolida*. It would be absurd to suppose that they could ever be spread by aquatic birds.

Such evidence as we have favors the view that the connection of South America with Antarctica was transitory, hence taken advantage of by but few genera of mollusks, all belonging to families richly developed in the South American center. So far as non-marine mollusks show, the migration from South America of a few species belonging to three families will account for all the common elements in the austral lands of the two hemispheres. The strong generic differentiation of all the common austral groups, with the exception of *Potamopyrgus* and probably *Diplodon*, indicates that the connection was of considerable antiquity, probably, as Dr. Ortmann holds, not later than Eocene.

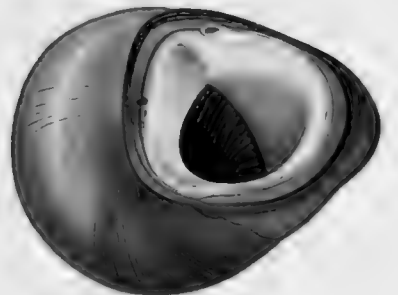
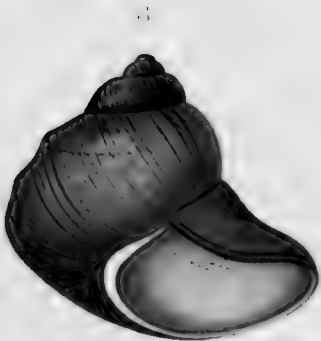
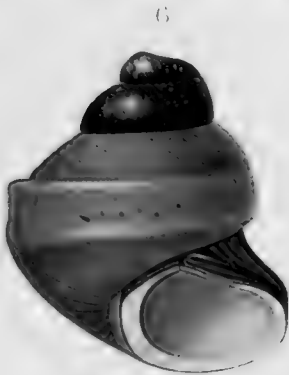
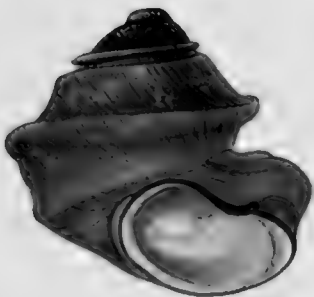
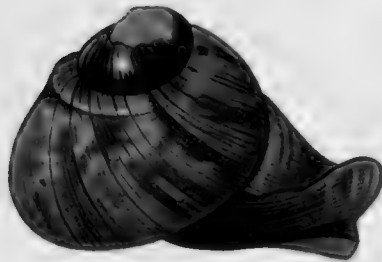
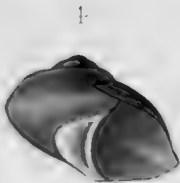
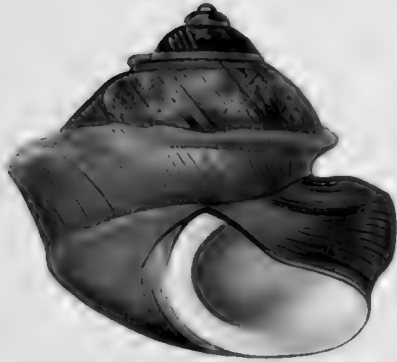
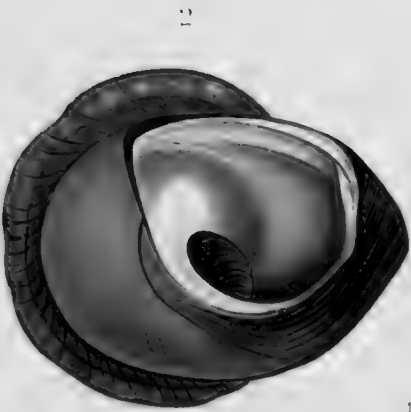
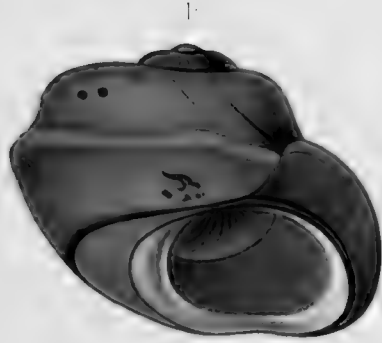
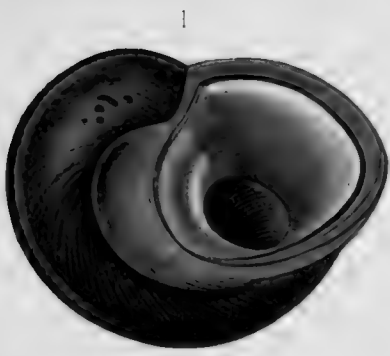
Summary.—The South American molluscan fauna is traceable to two sources: an ancient southern continent lying across the south Atlantic and enduring from at least Palæozoic to near the end of Cretaceous time, and to Miocene and Pliocene to recent connections with the middle American area. Antarctica was not an evolution center for mollusks, but there is strong evidence that a few groups passed by the Antarctic route to Australasia. "Archiplata," owing to its physical diversity from the Brazilian and Colombian areas, has become a Tertiary evolution center for a few groups of Brazilian origin.

Middle America (Antilles + Central America and part of Mexico) has the characteristics of an old evolution center of the northern faunal group, its primitive fauna coming from the north, and now showing phylogenetic features; a later (probably late Cretaceous) element was derived from the East Asiatic fauna. Both elements contributed, during the last half of the Tertiary, to the South American fauna, and received immigrants in return.

The "Nearctic Realm," so far as the genesis of its faunas is concerned, is composite.

EXPLANATION OF PLATE XXXVIII.

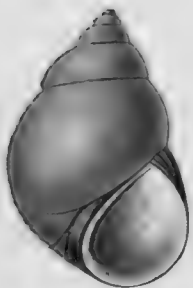
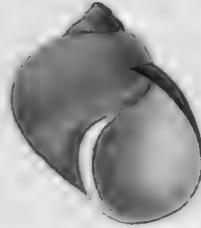
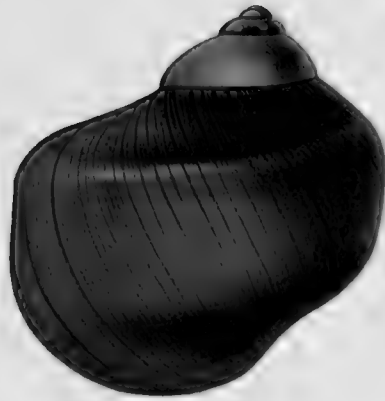
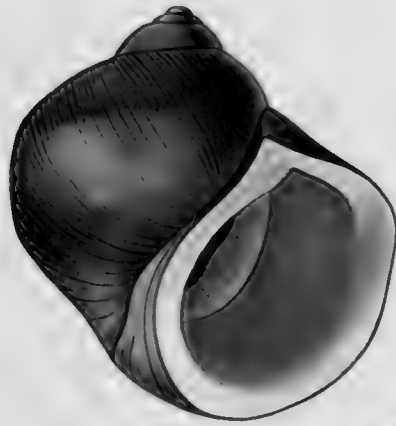
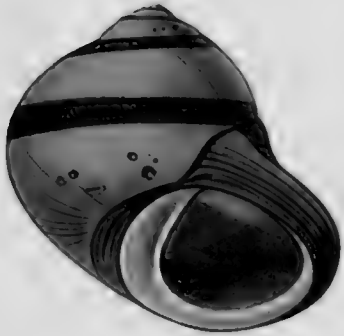
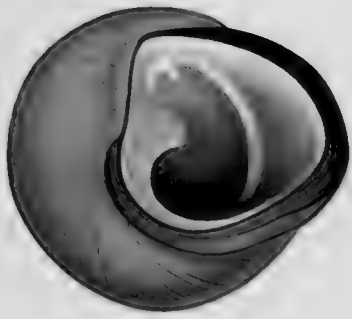
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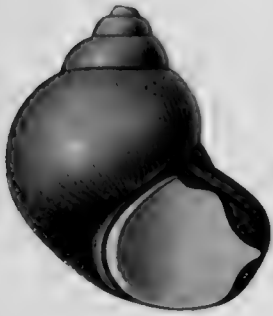


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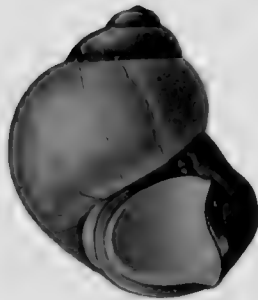
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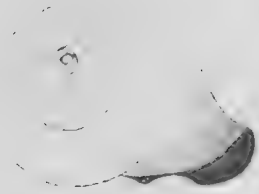
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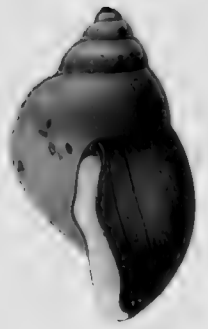
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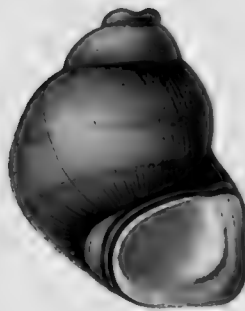
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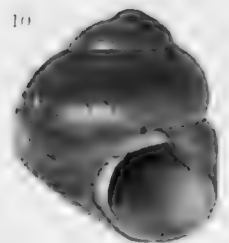
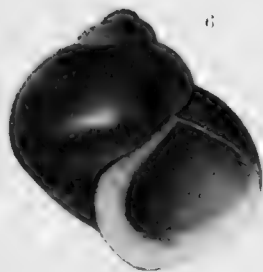
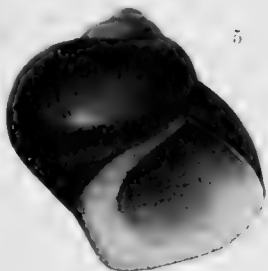
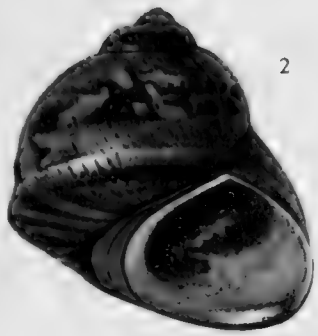
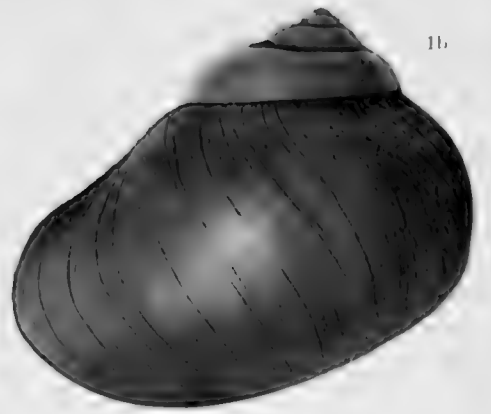
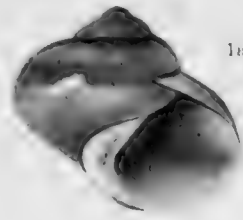
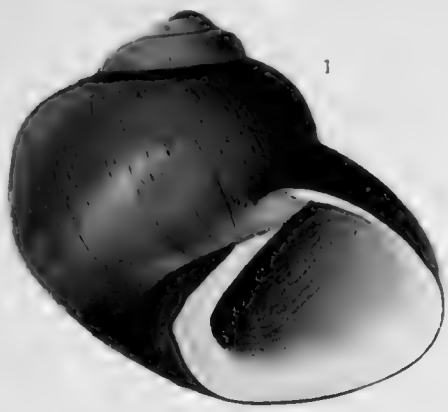
Helen W. Chester del. et pinxit

C. W. Kirtland sculp.

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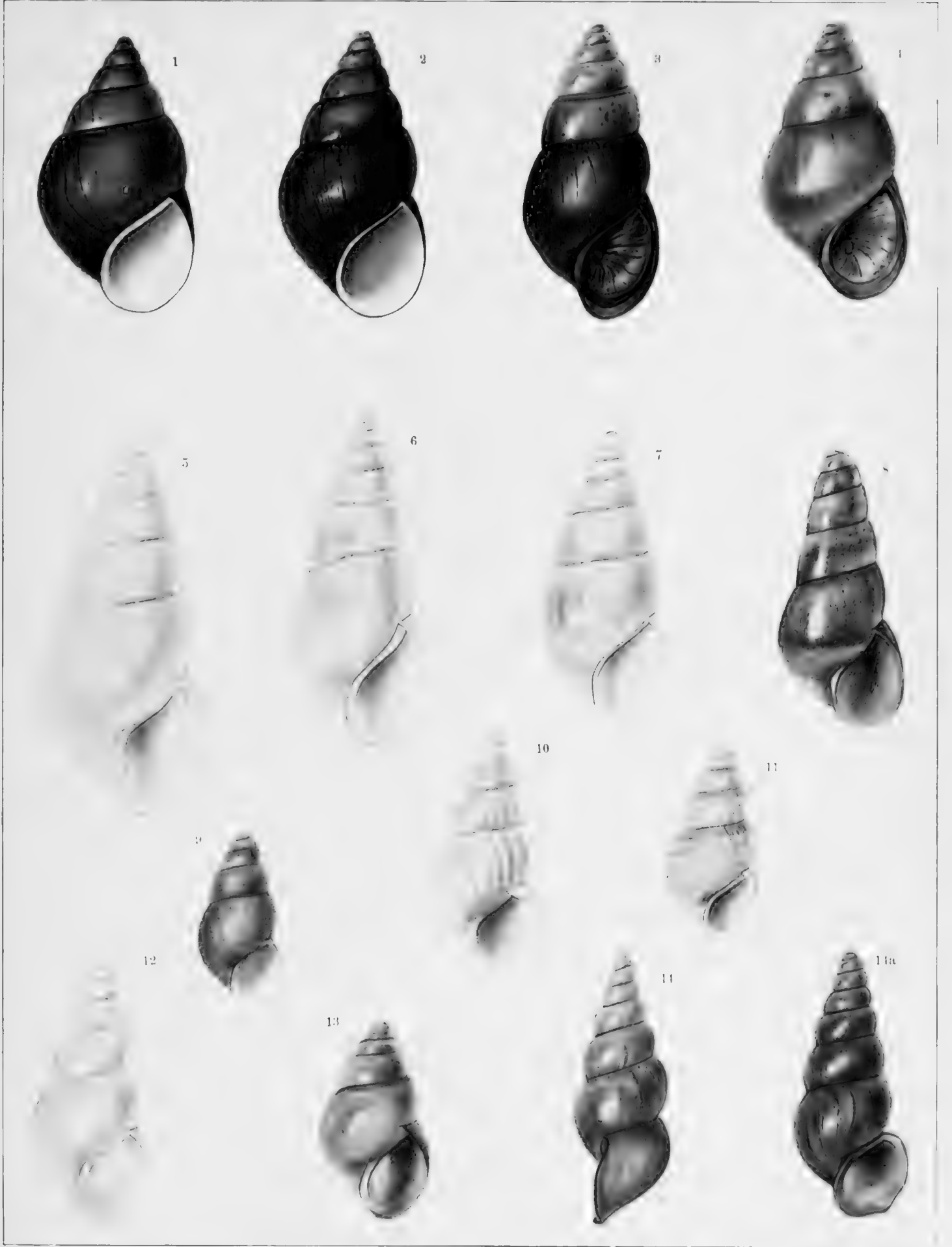
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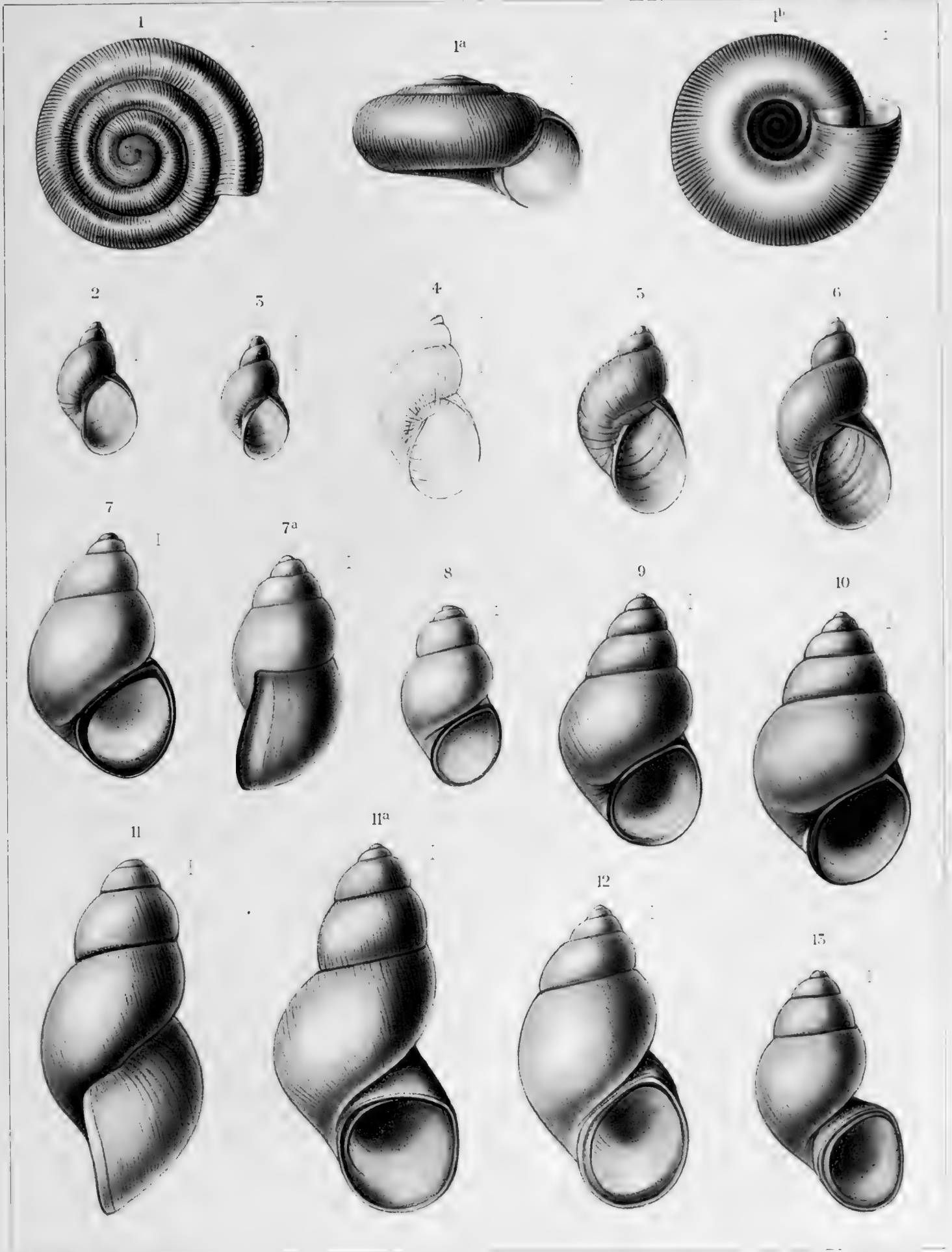


Fig. 101-115

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Cockayne. Reston

CHILINA.

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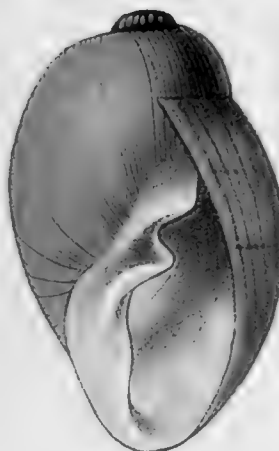
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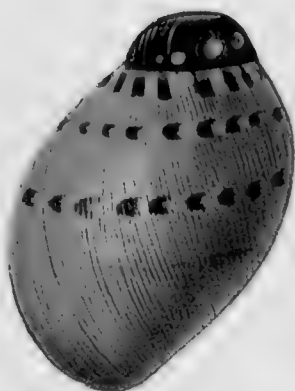
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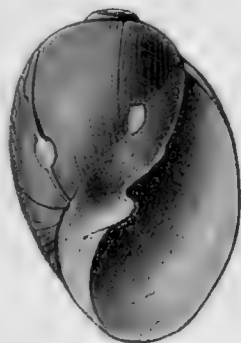
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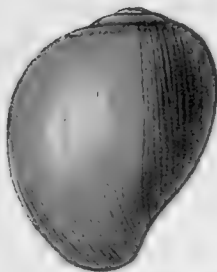
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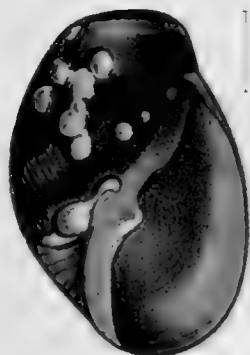
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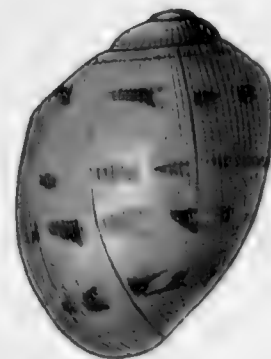
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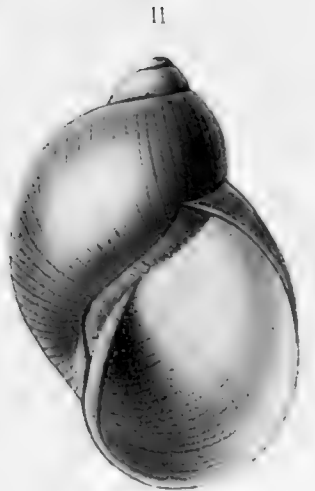
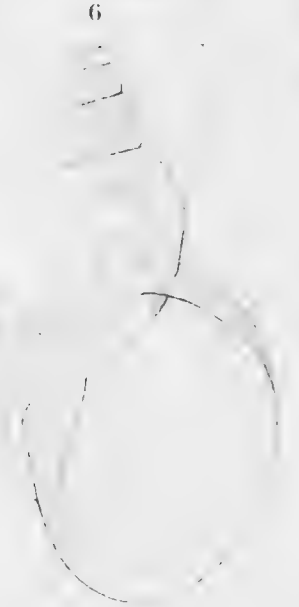
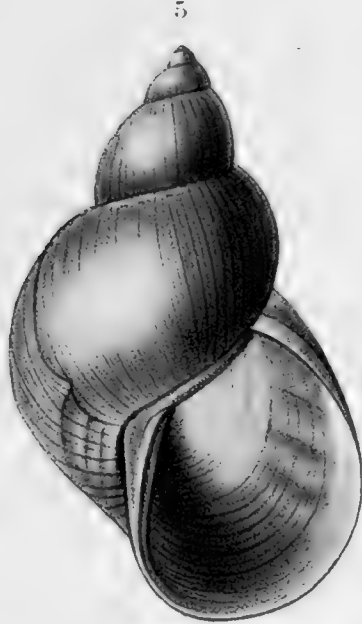
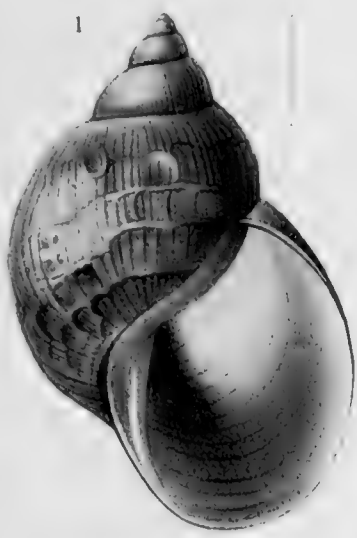
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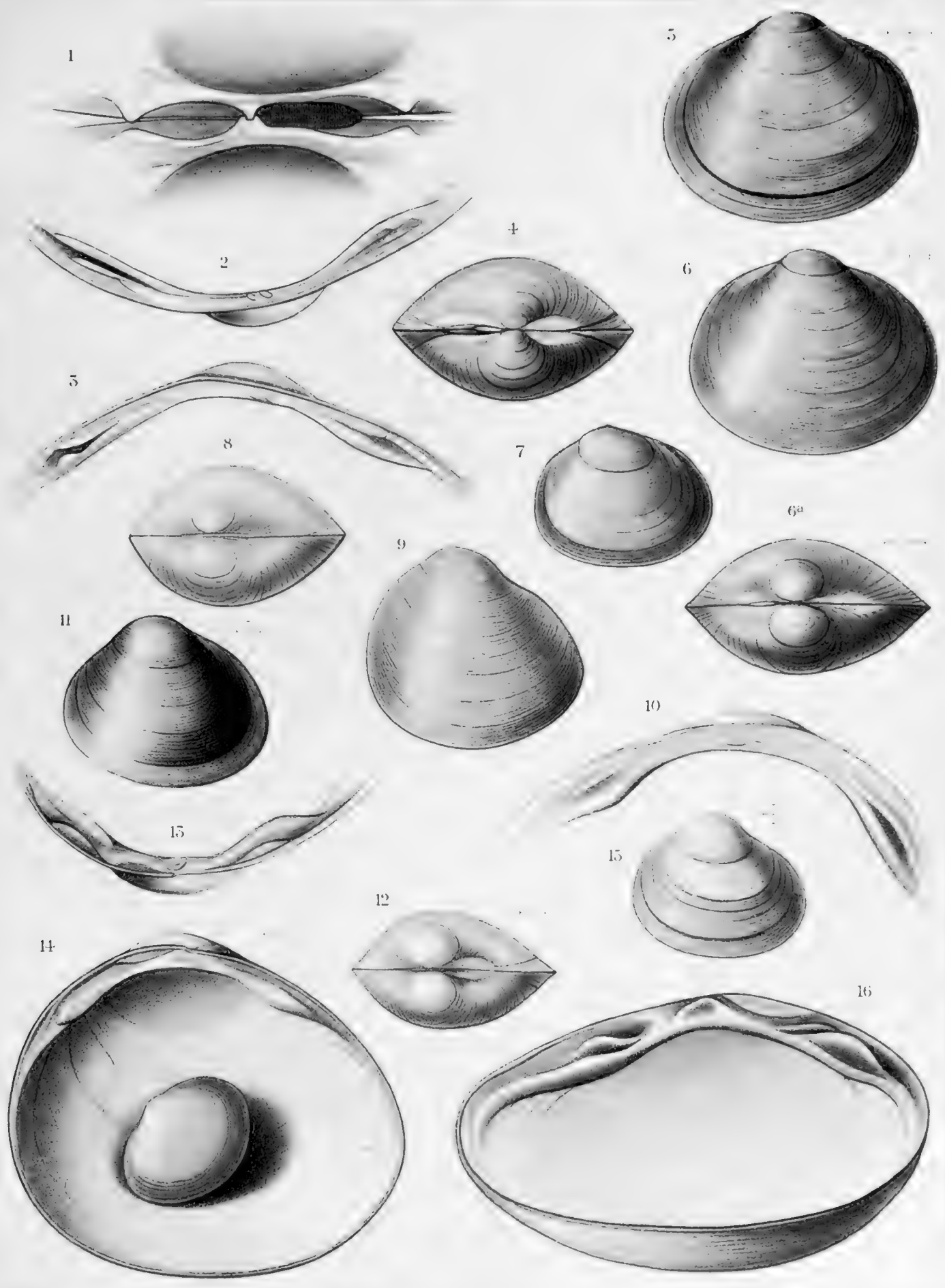
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LYMNÆA, LITTORIDINA, MUSCULIUM, PISIDIUM.

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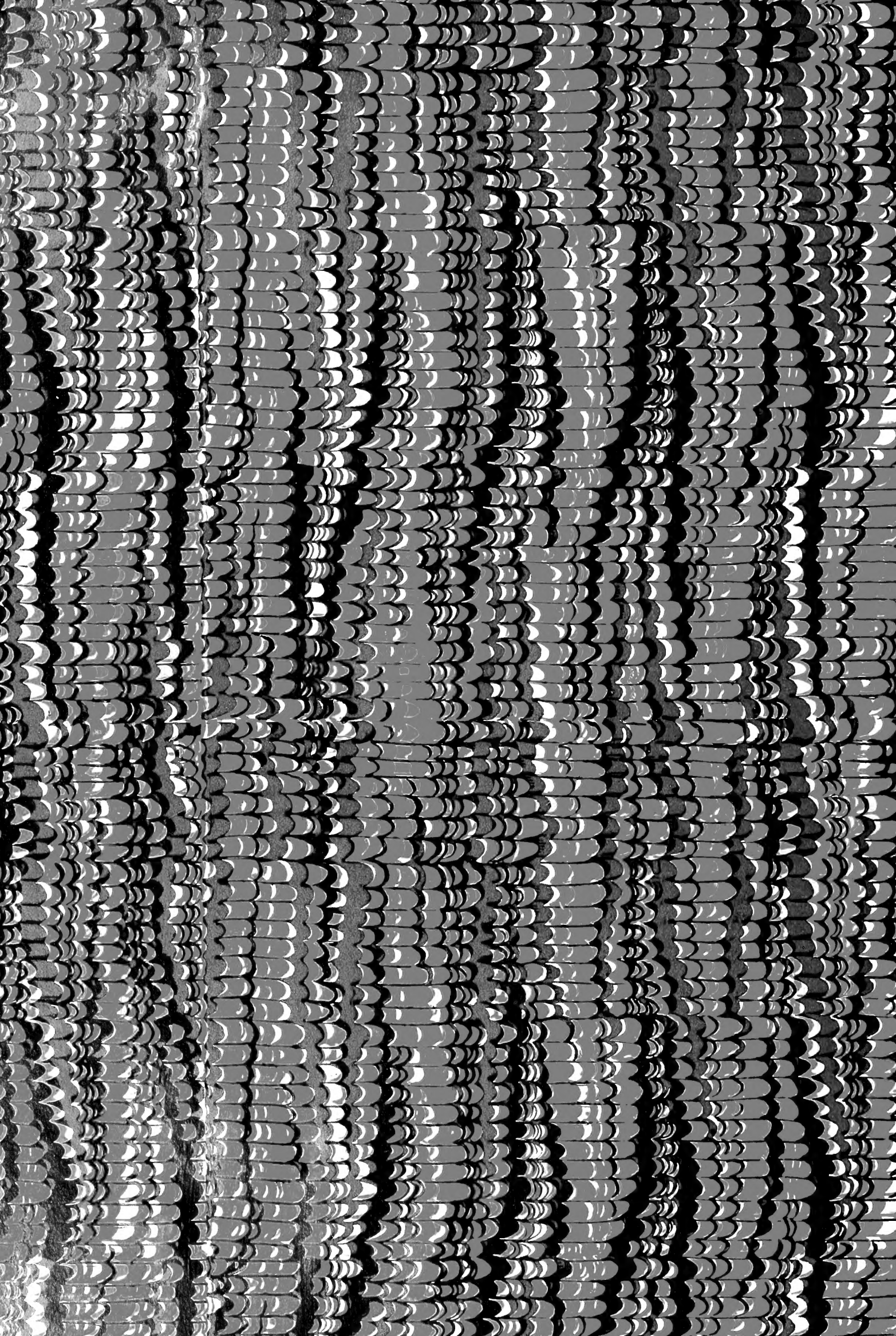
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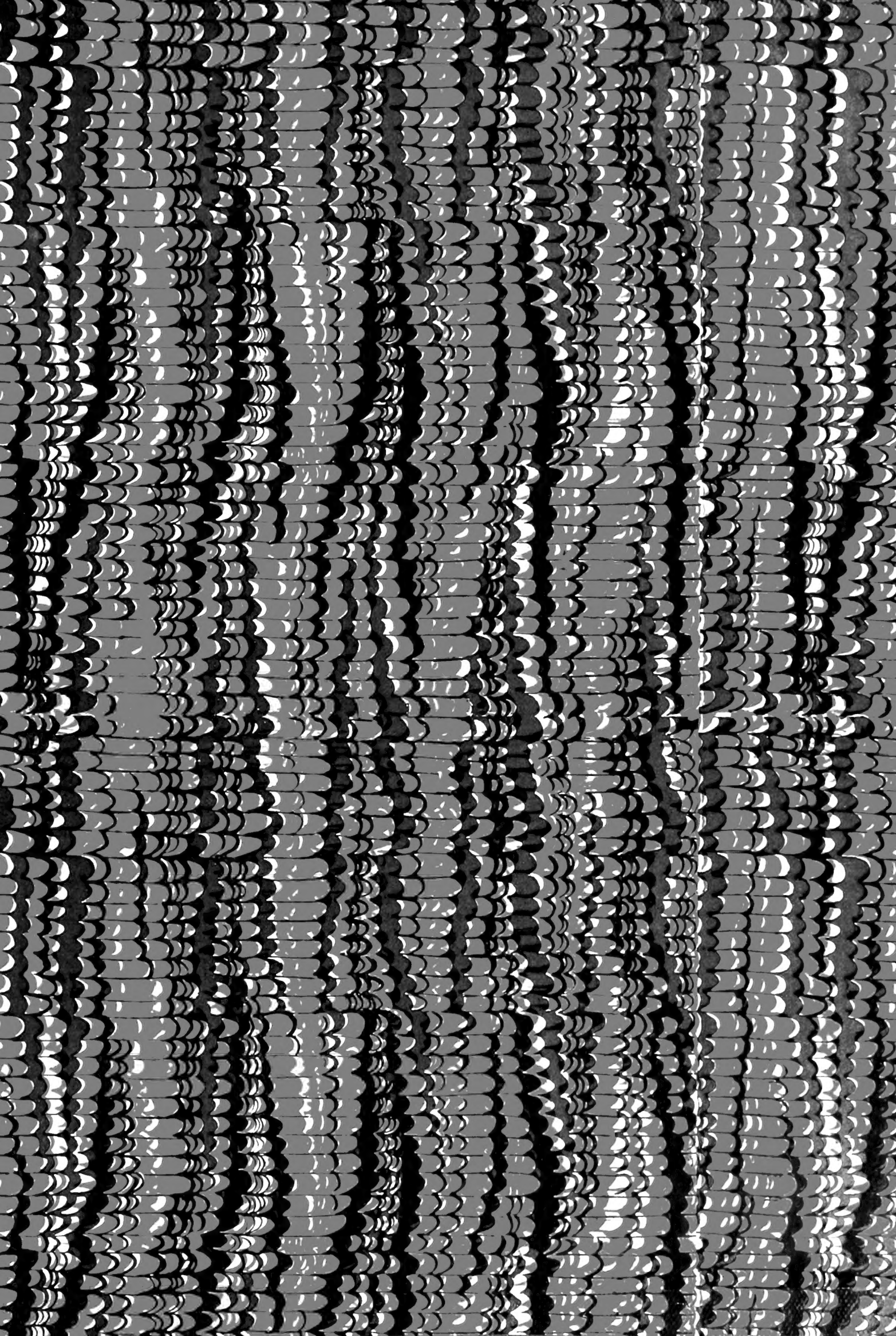
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