

REPORT ON THE MOLLUSKS COLLECTED BY THE INTERNATIONAL BOUNDARY COMMISSION OF THE UNITED STATES AND MEXICO, 1892-1894.

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Introductory remarks.—In the report of the first Mexican Boundary Survey, with Captain (afterwards General) W. H. Emory, U. S. Army, in command, no account appears of mollusks collected. Much space is given to the vertebrates, botany, and geology, and admirable illustrations adorn the several reports, but it is probable that no great number of mollusks was collected and the specimens obtained were overlooked or scattered.

It has long been known that the region north of Mexico, between the Rio Grande and the Colorado, is faunally distinct from the region of the Atlantic drainage, as well as from the fauna of the Pacific Coast. It has been named as a faunal region by several students of geographical distribution, and among students of mollusks has been usually termed the Central or Sonoran faunal region. So far as these animals are concerned, it seems rather a prolongation northward of the fauna of the mountains of northern Mexico than a southern extension of that of the Great Basin west of the Rocky Mountains. It presents features due to contributions from the Californian and Mexican regions, the latter predominating, with a few stragglers from the North. Seldom visited, arid, and inhospitable to molluscan life, the data relating to its fauna are widely scattered and mingled with those which concern those of other parts of the western country. It may, therefore, be useful to recall the names of those to whom, in the past, we have been indebted for collections made in the region, and to give a brief notice of the principal sources of information in the literature.

Some of the first shells described from this region formed part of a collection made by Berlandier, and were sold by him to Lieutenant (afterwards General) D. N. Couch, U. S. Army, of the original boundary survey, who generously presented them to the Smithsonian Institution. These were named by Dr. Isaac Lea in 1857, but appear to belong to the relatively low-lying region east of the Sierra Madre in the States of

Nuevo Leon and Tamaulipas. After the survey of the boundary came the surveys for a route for a Pacific railway, in which a number of the same officers were employed. By them and by other members of the parties engaged, a few mollusks were collected, including several fossil forms from the Colorado desert. Dr. John L. Le Conte and Prof. William P. Blake were among the contributors, and the mollusks were reported on by T. A. Conrad and Dr. A. A. Gould.

At a later date naturalists settled in California, and either directly or through the aid of collectors, obtained a few species from the borders of this region, which were described by Newcomb, Cooper, Yates, and others. After the establishment of the State geological survey contributions collected in Sonora were received from August Rémond, and from Lower California, collected by W. M. Gabb. Dr. Horn, of the Army, sent some interesting species from Fort Grant, Arizona, to Gabb, which were described by the latter. Under the auspices of the Smithsonian Institution collections were made in the vicinity of the boundary, by Dr. Edward Palmer. Later still, parties connected with the Department of Agriculture and the United States Geological Survey worked in the same region and a few species were added to the list of those known through explorations by Dr. A. K. Fisher, Vernon Bailey, Mr. Lloyd, Dr. C. Hart Merriam, E. W. Nelson, and others, most of which were reported on by Dr. R. E. C. Stearns.

Collections made by the French in Mexico form the basis of a sumptuous report by Messrs. Crosse and Fischer, who treat of the whole land and fresh-water fauna of the Republic in a manner which renders their work indispensable to all students of the subject.

A valuable and little known report on Mexican land shells was issued in Hamburg by Herr Hermann Strebel, assisted by Dr. G. Pfeffer, and should be consulted by anyone who is investigating this fauna.

In the important series of monographs by Messrs. Godman and Salvin on the biology of Central America, the mollusks are described by Dr. E. von Martens, and those parts which have appeared are of that masterly character which the reputation of that author has long led us to expect.

Latest of all, and practically simultaneously with the work of the Boundary Commission on which the present paper is based, may be mentioned explorations set on foot by the California Academy of Sciences in northwestern Mexico and the peninsula of Lower California, during which interesting collections were made by Messrs. Eisen, Bryant, Vaslit, and others, which have been reported on by Dr. J. G. Cooper and partly discussed by the writer.

The material collected belongs to three different faunal regions of very different degrees of interest, and each will be discussed separately. These are: (1) the Central or Sonoran region, extending from the Rio Grande of Texas to the Colorado River of Arizona, and on both sides

of the boundary line which divides the two; (2) the Texan region, to the east of the Rio Grande and south to the Gulf of Mexico; the fauna of this region is hardly to be discriminated from that of the State of Tamaulipas, west of the river, but in which no collections were made by the Commission; (3) lastly, west of the Colorado River in Southern California, the Californian coast fauna is encountered, and collections were made, not only on the mainland, but also on San Clemente Island, some 60 miles off the coast.

THE SPECIES OF THE CENTRAL OR SONORAN REGION.

The following species were received from Dr. Edgar A. Mearns, U. S. Army, from localities on either side of the international boundary line between the Rio Grande River, near El Paso, Texas, and the Colorado River of the West, near Yuma, Arizona.

The plains are almost uniformly arid and frequently alkaline, forming what was formerly called desert, and quite unfit for the subsistence of land snails. It will be understood that nearly all of the Pulmonates were collected from the upper levels of the various mountain ranges near the boundary, which rise from the plains into a region of moister air, which, though still dry, supports a certain amount of vegetation. Most of the snails are found dead on the surface of the soil; only when infrequent rains occur do the live animals venture from the nooks and crannies where they usually aestivate out of reach of the collector. Consequently good opportunities for collecting are rare and fresh specimens in a small minority. Even when fresh, many of them have the well-known texture characteristic of dwellers in arid regions, such as Arabia and the Sahara.

LAND SHELLS.

Family ENDODONTIDÆ.

Genus PYRAMIDULA, Fitzinger.

Subgenus PATULA, Held.

PATULA STRIGOSA, Gould.

Typical specimens of this species were obtained at San Jose Mountain, Sonora, Mexico; from Hachita Grande Mountain, Grant County, New Mexico, and from the summits of the Huachuca Mountains, Arizona, by Dr. Mearns and Mr. Holzner. A sharply carinated variety was collected at Tanners Canyon, Huachuca Mountains, Arizona, by Dr. Mearns.

The normal form, very variable in coloration, has a somewhat dome-shaped but low spire, appressed suture, and 5 whorls. It measures 19 in minor, 25 in major diameter, with a height of 13 mm. The carinate variety has a sharp peripheral keel, but is otherwise similar.

PATULA STRIGOSA var. CONCENTRATA, Dall.

Patula strigosa var. *concentrata*, DALL, Proc. U. S. Nat. Mus., XVIII, p. 1, 1895.

A variety, which exactly mimics the normal form above mentioned, has the same number of whorls, but measures only 13 mm. in minor and 16 in major diameter, with a height of 8 mm. Its coloration, when not bleached, is usually a dark-brown band above and below and a white periphery. It was found in some numbers on the summits of Hachita and the Huachuca Mountains, and preserves a marked uniformity, which would seem to entitle it to a varietal name.

Type.—No. 129999, U.S.N.M. Also on the Jemez Mountains, Ashmun.

The peculiarly arid climate, with irregular rainfall, which characterizes the region where these snails are found, is probably responsible for the viviparity which distinguishes them from the *Patula* of moister regions. The young shells exist in the oviduct of the parent, in numbers from 4 to 8, and reach a development of more than 2 whorls and a diameter of nearly 5 mm. before extrusion. When born they are quite able to take care of themselves, and can if necessary form a protective epiphragm at once. The soft-shelled eggs laid by the eastern species of *Patula* would doubtless dry up completely in an hour or two in the dry atmosphere of Arizona.

Family HELICIDÆ.

Genus THYSANOPHORA, Strebelt and Pfeffer.

THYSANOPHORA HORNII, Gabb.

A single dead specimen (No. 130001, U.S.N.M.) was sent in by Dr. Mearns, collected at the summit of the Hachita Grande Mountain, Grant County, New Mexico. The species was originally described from the vicinity of Fort Grant, Arizona, and is a characteristic species of the region. I have seen it from the drift of the Yaqui River, Mexico. When fresh it is translucent, dark brownish, the periostracum with oblique raised spiny lamellæ inclined at an angle to the incremental lines. This coating seems to have a certain sticky quality, so that grains of dirt adhere to it with such persistency that the shell can not be cleaned without destroying the periostracum. Dead specimens are rather solid, coarsely striated, and chalky-looking, hardly to be recognized as the same thing.

It occurs by some oversight in Pilsbry's revision of the Helices in the lists under both *Pyramidula* and *Thysanophora*. Without a knowledge of the anatomy its proper place can not be determined, but the aspect of the shell is more like some of the *Thysanophora* than *Pyramidula*.

Genus EPIPHRAGMOPHORA,¹ Döring.

EPIPHRAGMOPHORA ARIZONENSIS, Dall,

(Plate XXXI, figs. 11, 12.)

Epiphragmophora arizonensis, DALL, Proc. U. S. Nat. Mus., XVIII, p. 1, 1895.

Shell small for the genus, moderately elevated, light colored, with a narrow brown band just above the periphery, mostly concealed by the suture, but on the outer side visible within the aperture; whorls $4\frac{1}{2}$, of which $1\frac{1}{2}$ are nepionic and punctate, the remainder with rather well-marked incremental lines and microscopic vermicular markings, of which the longer axes are subparallel to the lines of growth; suture distinct; whorls full and rounded, but with the periphery slightly above the middle; the last whorl descending a little, near the aperture; base rounded; umbilicus narrow but deep; aperture expanded, the pillar lip reflected, but the outer lip not so; body with a slight wash of callus between the lips; height of shell 11, major diameter 17, minor diameter 13.5 mm.

A single specimen from the banks of the Santa Cruz River, Tucson, Arizona, Dr. Mearns (No. 130002, U.S.N.M.).

The type specimen is somewhat bleached, but otherwise in good condition, and is almost the smallest of the group with which it is associated and of which *E. traskii*, Newcomb, is an exemplar. It agrees with none of the species in detail, in general resembling most some small shells which in the National Museum are labelled as a dwarf race of *E. traskii*. *Arionta* var. *indioensis*, Yates, is very similar, but larger, with a more oval aperture and wider umbilicus, and the brown line is not covered by the suture. The species of this group are greatly in need of careful revision. Among those belonging to the peninsular or Sonoran faunæ several species have been confused or contested. Thus *E. carpenteri*, Newcomb, a depressed spirally striated shell has been generally united in synonymy with *Leptarionta remondi*, Tryon. The latter was described from specimens obtained by M. Rémond at Mazatlan, but which probably came from the peninsula of Lower California across the Gulf of California from Mazatlan. At least the Mexican habitat has not been confirmed by subsequent collectors. Gabb obtained it in the mountains of the peninsula near Trinidad and Muleje. One of Mr. Tryon's types is now before me agreeing perfectly with his description and showing the microscopic pustules which in perfect specimens probably support hairs. It has no spiral striae, and is a smaller and more elevated shell than *E. carpenteri*. It has been renamed *L. verrillii* by Ancy,² probably because he had received specimens of *E. carpenteri* under the erroneous name of *remondi*. Since *Polygyra*

¹ *Arionta* of American authors, not of LEACH.² Conch. Exchange, II, p. 63, Nov., 1887.

carpenteriana, Bland, belongs to a different group, Newcomb's name may properly stand, even if we admit the principle propounded by Crosse and Fischer to the effect that two species of one genus can not be named for the same person, a claim which rests upon no established rule, and is in fact in conflict with usage.

Two forms have been distributed or are found in collections under the name of *H. carpenteri*, Newcomb. Unfortunately the original type of Dr. Newcomb, which was a bleached shell obtained from Frick (whose localities are known to be often suspicious) with the erroneous locality, "Tulare Valley," is no longer to be found in his collection, the doctor having perhaps replaced it by what he considered better specimens of the same species. The exact measurements of his original do not agree with those of any specimen received from Dr. Newcomb or otherwise under the name *carpenteri*. It is probable that the printed height of the shell (16.5 mm.) is a misprint or a mismeasurement for 14.5 mm. Apart from this we learn from the diagnosis that the type was distinctly spirally striated and had $5\frac{1}{2}$ whorls. Now, one of the forms circulated under the name *carpenteri* has very distinct striation and the right number of whorls and diameter, and comes from the vicinity of San Diego, California, and especially from the Coronado Islands which are near San Diego off the coast. It is this which Mr. W. G. Binney received from Dr. Newcomb as *H. carpenteri* and has regarded as entitled to the name. In this view I agree, but suspect the shell to be a local race of *H. traskii*, Newcomb, which is somewhat more elevated and with fainter spiral striae. The other shell, which has been known as *carpenteri*, comes from Trinidad, Lower California, and near Mazatlan, State of Sinaloa, on the Mexican mainland, where it was collected by Gabb. It has only 4 to $5\frac{1}{2}$ whorls and is paler, with a thinner epidermis and few traces of striation. It is probably a distinct species.

Another species which has been contested is *H. lohrii*, Gabb, which is a depressed shell with a curious ovately rounded, widely expanded peristome, behind which the whorl is smaller though not abruptly constricted. One of Gabb's types has a maximum diameter of 22, a minimum diameter of 16.5, and a height of 10 mm.

The surface of the spire is almost flat, the periphery is formed by an almost angular shoulder high up on the whorl, and the umbilicus is scalar, revealing the whorls to the apex.

Through the courtesy of Prof. G. D. Harris, of Cornell University, and the authorities of the University, I have had an opportunity of comparing with typical specimens of *H. lohrii*, received from Gabb, the original types of *H. rowelli*, Newcomb, preserved in the Newcomb collection, now the property of the university. Gabb's species have very generally been referred to *H. rowelli* as a synonym, and they are very closely related. One of Dr. Newcomb's specimens, and perhaps two of them, belong to another species, *H. magdalenensis*, Stearns, but the more perfect ones upon which his description was founded are closely

related to *H. lohrii*, from which they differ by having a more elevated spire and the last whorl evenly rounded, instead of shouldered and subangular, and the shell is smaller, measuring 19 in major and 14.5 in minor diameter, and 9 mm. in height. The number of whorls, the aperture, nucleus, and umbilicus do not differ to any important extent in the two forms. It is probable, as originally stated by Newcomb, that his types came from Arizona, since the associated *H. magdalenensis* is not known from Lower California, and that, as in so many other cases, the specific form represented by *H. lohrii* has a large and a small race, fairly constant in their several localities, but connected by occasional intermediate specimens. As the oldest name is that of Newcomb, this should be kept for the species, while Gabb's name may be preserved for the larger and depressed peninsular race in a subspecific sense. Both are distinguished from *H. magdalenensis* and its allies by the wider umbilicus and by the wide reflexed lip, the peristome in the last-mentioned group being somewhat expanded and slightly thickened, but not forming a reflected lip, properly speaking.

EPIPHRAGMOPHORA MAGDALENENSIS, Stearns.

Helix (Arionta) magdalenensis, STEARNS, Proc. U. S. Nat. Mus., XIII, p. 207, pl. xv, figs. 7, 11, 13 (not 12), 1890.

Found by V. Bailey on top of a mountain 1,000 feet above Magdalena, Sonora, Mexico, among rocks; also by Dr. Fisher and Mr. E. W. Nelson, in Johnson Canyon, near the Panamint Valley, California, at an altitude of 6,000 feet; and by Vernon Bailey near Resting Springs, California, among rocks on a dry hill 900 feet above the springs, during the Death Valley expedition. A form (No. 130003, U.S.N.M.) which may be a dwarf of the next species or a variety of the present one was collected on San Jose Mountain, Sonora, Mexico, near the boundary line, by Dr. Mearns.

This species as originally described is small and depressed, having when fresh a translucent, polished dark-brown color, with a pale chestnut-brown line above the shoulder. The fact that dwarf specimens occur rather frequently with nearly all the species of this group renders it difficult to distinguish the normally small species from the small individuals of similar larger species. All the species being more or less variable in form and surface texture, the group is one which presents unusual difficulties to the student.

EPIPHRAGMOPHORA HACHITANA, Dall.

(Plate XXXI, figs. 7, 10.)

Epiphragmophora hachitana, DALL, Proc. U. S. Nat. Mus., XVIII, p. 2, 1895.

Shell large, depressed, polished, sculptured with irregularly prominent incremental lines, but without spiral striation or surface granulation; with $4\frac{1}{2}$ rounded whorls; suture distinct; last whorl near the

peristome depressed; aperture oblique, with a thickened and somewhat dilated but not reflected lip; pillar lip broad near the body, united to the outer lip over the body by a thin callus; umbilicus moderate, deep, exhibiting nearly 2 whorls; color of the fresh shell pale reddish purple or livid waxen, paler near the umbilicus, with a single purplish-brown band above the periphery, bordering the suture below it, with an ill-defined pale band on each side of it somewhat wider than the brown one; the latter is also visible inside the aperture; bleached specimens are waxen white with the brown band more or less faded; major diameter of largest shell 26.5, minor diameter 21, height 12 mm. An average specimen measures 23.5, 19, 12, and the smallest adult 21, 16.5, 10.5 for the same dimensions.

Fort Huachuca, Arizona, A. K. Fisher; Tucson, Arizona, Cox, in Lea collection; below San Quentin, Lower California, G. P. Merrill; Doubtful Canyon, Peloncillo Mountains, southwest New Mexico, F. H. Fowler in United States National Museum; and by Dr. Mearns at the following localities: Top of Hachita Grande Mountain, altitude 8,270 feet, Grant County, New Mexico; near Carrizollilo Springs, New Mexico, on the top of two peaks near the boundary line; on Black Mountain, 12 miles south of boundary monument No. 77, in Northern Mexico; and in the Huachuca Mountains, Arizona, altitude 8,000 to 9,000 feet, by Dr. Mearns and F. X. Holzner.

. *Type*.—No. 130004, U.S.N.M.

In specimens from Tanners Canyon, Huachuca Mountains, the shell was somewhat more depressed and the colors darker than from other localities.

This seems to be the most abundant of the mountain species, and its dwarfs seem most easily distinguished from the *E. magdalenensis* by their somewhat more inflated and higher form and their reddish tint when fresh. The fully developed specimens which comprise the great majority are very much larger than *E. magdalenensis*, but bleached and dead dwarf specimens can hardly be distinguished from full grown *magdalenensis* in a similar condition. The specimen figured is of the depressed variety from Tanners Canyon, Huachuca Mountains.

EPIPHRAGMOPHORA COLORADOËNSIS, Stearns.

Helix (Arianta) coloradoënsis, STEARNS, Proc. U. S. Nat. Mus., XIII, p. 206, pl. xv, figs. 6, 8, 12 (not fig. 7), 1890.

Grand Canyon of the Colorado River, Arizona, opposite the Kaibab plateau, at an elevation of 3,500 feet; Dr. C. Hart Merriam.

This species, though belonging to the same region, has so far been collected only at the type locality. It is closely related to *E. magdalenensis*, but seems separable. In the original paper by Stearns the two figures representing the upper surface of the spire were transposed, so that the references to them are erroneous and should be reversed, as a careful comparison of them with the text of the description would

show. The surface of the freshest specimens has a certain fuzziness, as if, when quite perfect, they would be microscopically hirsute.

Genus POLYGYRA, Say.

POLYGYRA LEVETTEI, Bland.

Triodopsis levettei, BLAND, Ann. N. Y. Acad. Sci., II, 1881, p. 115.—BINNEY, Bull. Mus. Comp. Zool., XI, No. 8, p. 154, pl. I, fig. E, Dec., 1883; Man. Am. Landsh., p. 385, fig. 419, 1885; Bull. Mus. Comp. Zool., XIII, No. 2, p. 36, pl. I, fig. 15, 1886.—TRYON, Man. Conch., 2d ser., III, p. 143, pl. XXXIX, figs. 88, 89, 1887.—PILSBRY, Man. Conch., 2d ser., IX, p. 76, 1894.—ANCEY, Conch. Exch., II, p. 63, Nov., 1887.

Triodopsis levettei var. *thomsoniana*, ANCEY, Conch. Exch., II, p. 64, Nov., 1887.

Triodopsis levettei var. *orobana*, ANCEY, Conch. Exch., II, p. 64, Nov., 1887.

Santa Fé Canyon, near Santa Fé, New Mexico, Dr. Levette, Thomson; near Tucson, Arizona, Cox; Fort Huachuca, Arizona, Dr. Fisher; Huachuca Mountains, Arizona, near the summit of the higher peaks, Dr. Mearns. No. 130010, U.S.N.M.

This species is more of a *Polygyra* s. s. than a typical *Triodopsis*. It has the aspect of the former group, and only wants a V-shaped angle to the parietal tooth to satisfy the strict diagnosis. The form mentioned by Binney with a single basal tooth, rather bifid, as represented by his type in the national collection, is pathological and not a real variety. The whorls vary from 6 to 7, rarely less than $6\frac{1}{2}$. The varieties mentioned by Ancey are stated to have only $5\frac{1}{2}$ whorls and one hardly bifid basal tooth; var. *orobana*, Ancey, differs from *thomsoniana* only by having the aperture somewhat larger and less oblique. I have seen no specimens corresponding to Ancey's description; none of the specimens from any locality has so few as $5\frac{1}{2}$ whorls.

The species belongs at high altitudes in the New Mexican region and seems to be extremely rare. The surface under magnification shows minute irregularities approximately in harmony with the lines of growth; the striation is feeble and the general appearance of fresh specimens is polished dark yellowish brown. The variety without teeth mentioned by Binney is a distinct species.

POLYGYRA CHIRICAHUANA, Dall.

(Plate XXXII, figs. 9, 10, 12.)

Polygyra chiricahuana, DALL, Proc. U. S. Nat. Mus., XVIII, p. 2, 1895.

Shell depressed, thin, polished, of a dark brownish color, $5\frac{1}{2}$ whorls, sculptured only with fine incremental lines; suture distinct, the intervening whorls moderately rounded; periphery rounded, the termination of the last whorl constricted behind the lip and moderately descending; umbilicus deep, narrow, showing a small part of the penultimate whorl near the aperture; aperture oblique with a narrow, strongly reflected lip of a livid whitish color, the pillar and outer lips connected in fully

mature specimens by a smooth callus over the body; the outer lip is flexuous, receding near the periphery and more vertical at the base; the aperture is entirely destitute of teeth. Height 7.7, major diameter 18, minor diameter 14.8 mm.

Near Tucson, Arizona, Cox; Fly Park, Chiricahua Mountains, Arizona, at an elevation of 10,000 feet, Dr. Fisher, United States Department of Agriculture. No. 124481, U.S.N.M. Jemez Mountains, near Bland, New Mexico, and at Jemez Sulphur Springs, 8-10,000 feet above the sea, Ashmun.

This form has been mistaken for a variety of *P. levettei* without teeth, but is clearly another species. An examination of over seventy-five specimens shows that none of them has a trace of lip teeth, and there are no specimens otherwise intermediate. As compared with *P. levettei* the shell is uniformly larger and yet with 1 whorl less, but proportionally more depressed. The actual measurements of the largest specimen of *levettei* I could find are: Height 7.7, major diameter 15.7, minor diameter 13 mm. The surface, color, etc., are very similar in both species. Numerous specimens show a resting stage at about the last half of the last whorl, where the shell has been thickened and shows a slight constriction, followed by an opaque space, which, however, seems never to have had a reflected lip.

A variety shows a small feeble parietal denticle, like that of *P. pseudodonta*, but the lip is not denticulate.

With this species Dr. Fisher collected *Vitrea arborea*, Say, *Thysanophora ingersollii*, Bland, and *Pyramidula striatella*, Anthony. The locality is in Cochise County near the southeastern angle of Arizona, close to the Mexican boundary line.

Mr. Binney has compared this species to *P. mullani*, Bland, and *P. kiowaensis*, Simpson, but both these species are of the *Mesodon* type, and apparently not closely related either to *P. levettei* or *P. chiricahuana*. Neither *Mullani* nor *Kiowaensis* are known from the region in which alone, so far, the other two have been collected.

I have included this species here, as it belongs to the same faunal region, and is therefore naturally associated with the species collected by Dr. Mearns.

POLYGYRA ASHMUNI, Dall.

The Rev. E. H. Ashmun, of Albuquerque, New Mexico, has forwarded for examination some shells which appear to be fully adult and normal, and resemble extremely, in miniature, *Polygyra chiricahuana*. They differ from it in size, being only 14 mm. in greatest diameter and 7 mm. in height, and in the surface, which, when strongly magnified, is seen to be covered with sharp, delicate, spiral, incised lines, with wider interspaces. The number of whorls is but slightly less, if at all different from *P. chiricahuana*, and, if the element of actual size be ignored, the figure here given of the latter will equally well represent the present

shell. A careful scrutiny of a series of *P. chiricahuana* shows that occasional sparse, spiral, incised lines are found on some individuals, so that the present shell may only represent a dwarf race of it with more emphatic sculpture. However this may be, the difference is so great as to form at least a well-marked variety worthy of a name.

The types (No. 107610, U.S.N.M.) were collected at Bland, New Mexico, at an elevation of 8,000 feet above the sea. Mr. Ashmun notes that in coming down the mountains toward Bland, the typical *P. chiricahuana* was abruptly replaced by *P. ashmuni*.

POLYGYRA PSEUDODONTA, Dall.

Shell closely resembling *P. ashmuni* in form and size, but with the whorls slightly flattened above and below and of a yellowish straw color instead of livid brown, the spiral striation less sharp and largely obsolete. The aperture with a narrow reflected lip, pink or whitish, which has on the internal edge of the basal part a slight callosity which is divided by a narrow sulcus in the direction of the coil of the shell. Within the aperture and nearly midway between the outer and pillar lips is a small low simple short oblique parietal tooth, or ridge, with the outer end nearer the pillar. Greater diameter of the shell, 13.5 to 15 mm.; minor diameter, 11 to 13.5 mm.; altitude, 5.5 to 7 mm. in different specimens.

White Oaks, New Mexico, at an altitude of 7,500 feet, Ashmun. Type, No. 107611, U.S.N.M. The aperture of this form is quite peculiar.

With these shells were the following species, all said to be from New Mexico, but of which the exact locality was not stated: *Conulus fulvus*, *Vitrea arborea*, *V. indentata*, *Vallonia cyclophorella*, *Vitrina limpida*, Gould, *Helicodiscus lineatus*, *Pupa armifera*, and *Cionella lubrica*.

POLYGYRA MEARNsii, Dall.

(Plate XXXII, figs. 7, 8, 11.)

Polygyra mearnsii, DALL, Proc. U. S. Nat. Mus., XVIII, p. 2, 1895.

Shell depressed, 5-whorled, of a pinkish-brown color, sculptured only with moderately conspicuous incremental lines; spire much depressed, but not quite flat, a nuclear whorl and a half smooth, the rest striated more or less distinctly; in perfectly fresh specimens the surface is probably polished; suture very distinct; periphery rounded, but nearer the upper surface of the whorl; base rounded, but having a compressed appearance; umbilicus deep and narrow, except that a small portion of the half whorl preceding the last whorl is visible; termination of the last whorl slightly descending above and, below the periphery, strongly constricted behind the reflected lip of a very oblique aperture; peristome somewhat flexuous, reflected, united over the body by a distinct callus; body with two converging lamellae, not united at the inner ends into a Λ , the basal lamella stouter and its outer extreme bent

toward the umbilicus; basal part of the peristome with two distinct, clear-cut lamellæ transverse to the lip; outer lip broader than the rest, receding, with a similar lamella set on somewhat obliquely and more deeply within the aperture. Height of shell 5.5, maximum diameter 13, minimum diameter 11 mm.

Huachuca Mountains, Arizona, and Hachita Grande Mountain, Grant County, New Mexico, Dr. Mearns, at an altitude of 8,000 to 9,400 feet. No. 130012, U.S.N.M.

No living specimens were collected, but the number of dead ones indicates that the species is not uncommon where found. This species is instantly distinguishable from any of the other species of *Polygyra* which possess a Λ -shaped parietal lamella by the presence of three distinct, well-defined teeth on the outer lip. All the other forms have two, or two with an obscure undeveloped flattening in addition. These teeth closely resemble those of *Polygyra levettei*, and if that species had two parietal lamellæ and was more depressed, it would differ from *P. mearnsii* chiefly by its greater size and number of whorls. *P. mearnsii* therefore forms a connecting link between those forms which have been called *Dadalocheila* and *Triodopsis*.

Family PUPIDÆ.

Genus HOLOSPIRA, Martens.

This genus was separated from *Cylindrella* by Albers¹ under the name of *Acera*, which had already been used in zoology and for which Von Martens in his new edition of Albers's work² substituted *Holospira* and named *H. pilocerei*, Pfeiffer, as the type. The following is a free translation of the diagnosis of Albers:

"Shell with an umbilical chink, turreted or spindle-shaped, with a conical not truncate apex; 11 to 14 whorls of which the last is little or not at all protracted; base carinate; columella plicate; aperture quadrangular; peristome free, expanded."

Holostoma pilocerei appears to be a rare shell; at least I have not been able to examine a specimen, though many so named, but which proved different, have come under inspection. The figures of this species are somewhat discrepant as already noted by Crosse and Fischer,³ and may represent more than one species, since the internal structure was not examined by Pfeiffer and the external characters, beside being somewhat variable, are very similar in the different species. However, three of the original Pfeifferian specimens were examined by Strebel and Pfeiffer⁴ who describe the internal characters. It has a plait on the pillar and, near the end of the penultimate whorl, three other

¹ Heliceen, p. 209, 1850.

² Page 39, 1860.

³ Moll. Terr. et Fluviat. de Mexique, I, p. 330.

⁴ Beitr. zur Kennt. der Fauna Mex., p. 82, 1880.

lamella, one basal, one parietal, and one on the outer wall of the whorl less strongly developed. An examination of the anatomy by the authors cited shows that the group is related more closely to the *Pupidae* than to *Cylindrella* with which it was originally associated. The first information as to the internal characters of *Holospira* was given by Bland,¹ who pointed out that *H. goldfussii*, Menke, beside the ridge visible in the upper part of the throat of the aperture, possesses in the penultimate whorl four lamellæ; one very prominent descending from the roof of the whorl for half a gyration; a less prominent one arising from the floor of the whorl opposite the first; a third, more feeble, projecting inwardly from the outer wall, and a fourth revolving on the pillar, but obsolete on the axis above the penultimate whorl. These lamellæ are figured by Strebel and Pfeffer.² The axis in *Holospira* is tubular and under magnification is seen to be vertically streaked with opaque white and translucent markings. In the more slender species like *H. gonio-stoma*, Pfeiffer, the tube is quite slender; in those which have a shell more stout and clublike, e. g., *H. elizabethæ*, Pilsbry, the axis is wide and spindle-shaped, but in all the base of the adult shell has the axis closed and the umbilicus represented by an impervious chink.

The angulation of the terminal part of the last whorl varies in the different species, some of which have a keel above and others show one below, the aperture may be subcircular, subtriangular or subquadrate, and may or may not be provided with a columellar or parietal ridge running inward and usually not very prominent. From this ridge the internal lamellæ are entirely distinct.

An examination of the internal characters shows that the group is naturally divided into sections which may possess any or none of the lamellæ referred to, and that these characters appear to be constant and invariable within the species. By sacrificing the integrity even of single specimens, when the collection contained but one of a species, I have been able to determine the characters of a large number of forms. I find the following to be destitute of any armature upon the pillar and of any internal lamellæ, and therefore to be referable to the subgenus *Metastoma*, Strebel and Pfeffer, of which *H. roemeri*, Pfeiffer, is the type: *H. roemeri*, Pfeiffer, *H. pasonis*, Dall, *H. coahuilensis*, W. G. Binney, *H. tenuisculpta*, Stearns, *H. pfeifferi*, Menke, and *H. remondi*, Gabb, the first-mentioned species having the tubular axis exceptionally large. To these I am now able to add two new species *H. crossei*, Dall, and *H. pilsbryi*, Dall, which last has existed in our collection for a long time under the erroneous name of *H. tryoni*, Pfeiffer. The latter species has been examined by Strebel and Pfeffer and is shown by them from authentic specimens to have entirely different internal characters. They have proposed for it the sectional name of *Bostrichocentrum*, characterized by having a spiral ridge around the axis extending from

¹ Ann. Lye. Nat. Hist., N. Y., VIII, p. 160, 1865.

² Plate XIV, fig. 17B.

the last whorl upward throughout the spire, but no other lamellæ internally. Their specimens agree with Pfeiffer's types now in the Dohrn collection.

It is obvious from the preceding observations that some shells which are distinctly separated by their internal features show very similar external characters, and I may add that the examination of large numbers of specimens of several species indicates that the internal characters are persistent and invariable within the species. I propose to use these characters for arranging the genus *Holospira* into subordinate groups as follows:

Genus HO LOSPIRA, Von Martens.

Type.—*H. pilocerei*, Pfeiffer.

Subgenus HOLOSPIRA, s. s.

Axis large, with a ridge or plait developed in the penultimate whorl, and with parietal, basal, and peripheral lamellæ projecting into the lumen of the whorl.

Type.—*H. pilocerei*, Pfeiffer.

This includes *H. goldfussii*, Menke, sp., and *H. goniostoma*, Pfeiffer.

Section BOSTRICHOCENTRUM, Strebel and Pfeffer, 1880.

Axis moderate, with a continuous plait on it extending from the last whorl nearly to the apex.

Type.—*H. tryoni*, Pfeiffer.

H. veraeruziana, Dall, belongs in this section.

Section HAPLOSTEMMA, Dall.

Haplostemma, DALL, Nautilus, IX, p. 50, Sept., 1895; Proc. U. S. Nat. Mus., XVIII, p. 2, 1895.

Axis moderate, with a short, stout, axial lamella extending about half a gyration in the penultimate whorl, but elsewhere simple and smooth.

Type.—*H. mearnsii*, Dall.

Section EUDISTEMMA, Dall.

Eudistemma, DALL, Nautilus, IX, p. 50, Sept., 1895; Proc. U. S. Nat. Mus., XVIII, p. 3, 1895.

Penultimate whorl with a short axial and a parietal lamella only, the axis moderately large.

Type.—*H. arizonensis*, Stearns.

Section DISTOMOSPIRA, Dall.

Distomospira, DALL, Nautilus, IX, p. 50; Proc. U. S. Nat. Mus., XVIII, p. 3, 1895.

Penultimate whorl with a short strong axial and a basal lamella only; axis smooth, moderately large.

Type.—*H. bilamellata*, Dall.

Subgenus **METASTOMA**, Strebel and Pfeffer.

Axis smooth, without plaits or sinuosity; penultimate whorl without internal laminae.

Type.—*H. roemeri*, Pfeiffer.

This comprises most of the species included hitherto under the name of *Holospira*.

Subgenus **COELOSTEMMA**, Dall.

Coelostemma, DALL, Nautilus, IX, p. 50; Proc. U. S. Nat. Mus., XVIII, p. 3, 1895.

Axis vertically ribbed as in *Coclocentrum*, capacious, shell otherwise as in *Metastoma*.

Type.—*H. elizabethæ*, Pilsbry.

The *Holospiras* are included in a subfamily Eucalodiinae of the Pupidae, by Crosse and Fischer, though formerly referred to the *Cylindrellidae*. It might, perhaps, be premature to attempt to separate this group as a family from the Pupidae. There are, however, some interesting parallels in the groups included under the names of *Cerion*, *Holospira*, *Coelocentrum*, and *Eucalodium*. These groups seem to vary in somewhat similar directions as regards internal characters. Thus *Coclocentrum* is characterized by curious vertical ribs on the axial wall, such as exist in *Holospira* (*Coelostemma*) *elizabethæ*, Pilsbry; the shell is habitually decollate, with a pervious axis, and externally flexuously ribbed with transverse riblets. A few species have also spiral striation. To this group Crosse and Fischer referred the *Cylindrella irregularis* of Gabb from Lower California, which by its general character is doubtless most nearly related to *Coelocentrum*, but differs by wanting the most remarkable of the generic characters assigned to that genus. Instead of having the axial wall vertically ribbed as in *Coelostemma*, it has a revolving inflation extending the whole length of the axis as in *Bostrichocentrum*, and should therefore be separated as a subgenus for which I have proposed the name *Spartocentrum*.¹ In this conclusion Mr. Pilsbry agrees, and I take this opportunity of expressing my serious obligations to that gentleman for valuable advice and suggestions afforded during the course of a free correspondence relating to the subject-matter of the present report.

In the genus *Eucalodium*, Crosse and Fischer, we have an allied group habitually decollate like *Coclocentrum*, but having a solid axis. They are large shells living on the surface of the ground in moist places, under dead leaves and similar accumulations. Here also we find two groups indicated by the internal characters of the axis. The typical species, *E. giesbrechtii*, Pfeiffer, has the axis sinuous and provided with a plait extending its whole length, except in the immediate vicinity of the aperture. The radula is wide with a formula of 65:1:65 for the transverse row. The other group has a straight, smooth axis and a narrow

¹ Nautilus, IX, p. 51, Sept., 1895; Proc. U. S. Nat. Mus., XVIII, p. 3, 1895.

radula, the latter with a transverse series of 36:1:36. For this division of the genus Mr. Pilsbry proposed the sectional name *Oligostylus*, of which *Eucalodium blandianum*, Crosse and Fischer, serves as the type. The relation of these two groups to each other recalls that of *Bostrichocentrum* to *Metastoma* among the *Holospiras*. In the genus *Cerion* I have already divided the group into sections characterized by the internal laminae, which appear to afford good characters and recall to some extent the features exhibited internally in *Holospira*. There is a curious similarity in general form and top-heaviness between many of the species of *Cerion* and *Holospira*.

In this connection I have added the descriptions of four Mexican species belonging to *Coelocentrum*, *Anisospira* and *Streptostyla*, which were obtained by Mr. E. W. Nelson while exploring for the United States Department of Agriculture in this region, as it seemed desirable to concentrate the published data on this fauna and would add to the interest of this report.

HOLOSPIRA (METASTOMA) CROSSEI, Dall.

(Plate XXXI, fig. 2.)

Holospira (Metastoma) crossi, DALL, Proc. U. S. Nat. Mus., XVIII, p. 3, 1895.

Shell small, compact, 12-whorled, of a brownish gray color; nuclear whorls 2, smooth, polished, apically blunt, succeeding 4 gradually and evenly increasing, after which the shell is cylindrical; sculpture of pretty even, slightly oblique, rounded riblets, extending from suture to suture and separated by interspaces twice as wide as the ribs; suture distinct; base rounded, with a shallow umbilical chink; aperture simple, slightly oblique, not projecting beyond the periphery of the preceding whorl, the lip slightly expanded in front of a faint constriction, the opening subcircular without internal ridges, the outer anterior part obtusely angular; axis small, regularly increasing to the last whorl, not inflated. Length of shell 11, maximum diameter 4 mm.

Top of Hachita Grande Mountain, Grant County, New Mexico, Dr. Mearns. No. 129989, U.S.N.M.

This species resembles *H. goldfussii*, Menke, but is slightly smaller, with a shorter neck to the aperture and a less reflected and triangular peristome. It is entirely destitute of the remarkable internal lamellae which characterize *H. goldfussii*. It is named in honor of M. H. Crosse, who has monographed the genus.

HOLOSPIRA (METASTOMA) PASONIS, Dall.

(Plate XXXI, figs. 4, 5.)

Holospira pasonis, DALL, The Nautilus, VIII, p. 112, Feb., 1895.

This fine species was obtained by Mr. Singley from a collection made at Mule Canyon, El Paso County, Texas, at an elevation of 4,000 feet. As it belongs to the same general region and may be advantageously

compared with the following species, I have included this reference and figure here. It belongs to the typical section of the genus without internal lamellae, and has a length of 22.5 and a maximum diameter of 6.5 mm.

HOLOSPIRA (METASTOMA) PILSBRYI, Dall.

Holospira (Metastoma) pilsbryi, DALL, Proc. U. S. Nat. Mus., XVIII, p. 4, 1895.

Shell small, bluish or pinkish white; the nucleus darker, 2-whorled, smooth, not much projected, followed by 6 obliquely striate, gradually increasing whorls which form a beehive-shaped dome to the spire, after which follow 6 nearly equal, almost smooth whorls, forming a nearly cylindrical spire; the last whorl slightly smaller, the base and neck near the aperture somewhat irregularly transversely wrinkled; suture distinct, here and there edged by wrinkles transverse to the whorl, but more or less obsolete, except near the suture; umbilical chink shallow; aperture a little oblique, subcircular, with a faint angulation near the upper outer corner; lip expanded, but hardly reflected; the peristome, viewed in its own plane, does not project beyond the lines representing the sides of the cylindrical part of the spire, but as the last whorl is smaller than those preceding it, the peristome projects slightly from it; throat of the aperture whitish, without ridges; axis straight, slender, axial wall smooth. Length of large specimen 13, diameter 4 mm., with 14 whorls; length of short specimen 10.25, diameter 3.75 mm., with 12 whorls.

Arizona or New Mexico, Dr. E. Palmer, U.S.N.M.; also abundant around sulphur springs near the city of Puebla, State of Puebla, Mexico, from the Mexican Geographical Commission. No. 56932, U.S.N.M.

A single specimen was found among loose shells brought home by Dr. Palmer after a trip through Arizona and New Mexico, but no particular locality could be assigned to it. Another from an unknown collector appears in the national collection marked simply "Mexico," but a fine series from the city of Puebla was presented by the Mexican Geographical Commission, and about the locality of these there is no doubt whatever. The Academy of Natural Sciences, Philadelphia, has the species from the same locality. It was long marked *H. pilocerei* in the collection, but belongs to a different section of the genus. Externally it can hardly be distinguished from *H. tryoni* as figured by Crosse and Fischer.

HOLOSPIRA (DISTOMOSPIRA) BILAMELLATA, Dall.

(Plate XXXI, fig. 3.)

Holospira (Distomospira) bilamellata, DALL, Proc. U. S. Nat. Mus., XVIII, p. 4, 1895.

Shell elongate, slender, blunt-tipped, with two smooth nuclear and 15 subsequent whorls; the spire increases evenly to the eighth whorl and then very slowly attenuates; sculpture of slightly oblique little

raised, nearly straight riblets with doubly wide interspaces marked by somewhat irregular lines of growth; the sculpture between the ninth and the last whorl is more or less obsolete, but on the last whorl is strong, crowded, and a little irregular; suture distinct; base a little appressed; umbilical chink small; aperture as in *H. crossei*, but projecting beyond the periphery of the last whorl. Length of shell 20.5, maximum diameter 5 mm. With *H. crossei*, not uncommon. No. 129990, U.S.N.M.

This species in form recalls *H. semisculpta*, Stearns, but is smaller, without the polished surface of the latter and of a ferruginous white instead of the bluish color of *H. semisculpta*. The aperture in some specimens projected more than in others which seemed fully adult. The internal armature consists of a short very wide flange near the base on the pillar and a low but strong basal ridge extending about one-third of a gyration slightly nearer the inner than the outer wall of the whorl.

HOLOSPIRA (HAPLOSTEMMA) MEARNsii, Dall.

(Plate XXXI, fig. 1.)

Holospira (Haplostemma) mearnsii, DALL, Proc. U. S. Nat. Mus., XVIII, p. 4, 1895.

Shell small, compact, with 14 whorls, of which 2 are nuclear, polished, and smooth; blunt above, gradually increasing to the ninth whorl and subsequently slightly attenuated; sculpture and aperture much as in *H. crossei*, the base slightly appressed and the ribs closer and more prominent than on the previous whorls; umbilicus not conspicuous; aperture projecting somewhat beyond the preceding whorl, the peristome hardly reflected, subtriangular, little thickened, without folds; axis small, subcylindric, with a strong, short lamella near the base in the penultimate whorl. Length of shell 14.5, maximum diameter 4.5 mm. Found with *H. crossei*, but less common. No. 129991, U.S.N.M.

This species resembles *H. crossei* in general appearance, but is larger, with more projecting aperture, and frequently has an intercalary raised line dividing the interspaces of the ribs axially. The specimens are of a whitish color.

The following species contained in the National Museum was named *H. tryoni*, Pfeiffer, on an old label, but on comparison with the literature proved to be quite distinct from that species, which is asserted by Crosse and Fischer to be quite destitute of internal armature.

HOLOSPIRA (BOSTRICHOCENTRUM) VERACRUZIANA, Dall.

Holospira (Bostrichocentrum) veracruziana, DALL, Proc. U. S. Nat. Mus., XVIII, p. 4, 1895.

Shell closely resembling the enlarged figure of *H. microstoma*, Pfeiffer,¹ but with a shorter apical cone and larger aperture. According

¹ Crosse and Fischer, Miss. Sci. au Mexique, Moll., p. 337, pl. xvii, figs. 9, 9a.

to the descriptions of *H. microstoma*, the present species differs by having 17 whorls in a total length of 17.5 mm. against 18 whorls in a length of 15.5 mm. for *H. microstoma*, both having a maximum diameter of 5 mm. The last whorl in the present species is rounded below, that of *H. microstoma* angulated: in *H. veracruziana* the aperture is expanded, with the outer posterior part hardly angular where the outer lip meets the parietal portion; the diameter of the aperture is 3.5 mm. (against 2.6 in *H. microstoma*), and the parietal portion is very little extended beyond the periphery of the preceding whorl; the whorls of the nucleus ($1\frac{1}{2}$) are smooth and polished, those of the apical cone finely ribbed, those of the rest of the spire striate, with a few coarse riblets just behind the peristome.

Three specimens from Mizantla, province of Vera Cruz, were presented to the National Museum by the Mexican Geographical Commission. -

This species has a strong, short fold at the base of the axis in the penultimate whorl, but no traces of any other laminae. It is possible that the type of *H. microstoma* of Pfeiffer may have the aperture abnormal and be identical with this species, but, in the uncertainty, I have preferred to name the latter.

The following list comprises all the known species of *Holospira* to date:

- Holospira goniostoma*, Pfeiffer. Southwestern Mexico.
Holospira pilocrei, Pfeiffer. State of Puebla, Mexico.
Holospira goldfussi, Menke. Southwestern Texas, west of Colorado River.
H. (Bostrichocentrum) tryoni, Pfeiffer. State of Puebla, Mexico.
H. (Bostrichocentrum) veracruziana, Dall. Vera Cruz, Mexico.
H. (Haplostemma) mearnsii, Dall. New Mexico.
H. (Eudistemma) arizonensis, Stearns. Arizona.
H. (Distomospira) bilamellata, Dall. New Mexico.
Metastoma roemeri, Pfeiffer. Texas, west of the Colorado River.
Metastoma pasonis, Dall. El Paso County, Texas.
Metastoma coahuilensis, W. G. Binney. Coahuila, Mexico.
Metastoma semisculpta, Stearns. Chihuahua, Mexico.
Metastoma pfeifferi, Menke. Sonora, Mexico.
Metastoma rémondii, Gabb. Sonora, Mexico.
Metastoma crossei, Dall. New Mexico.
Metastoma pilsbryi, Dall. Puebla, State of Puebla, Mexico.
M. (Cyllostemma) elizabethæ, Pilsbry. State of Guerrero, Mexico.

The interior of the following species is unknown:

- Holospira gealei*, H. Adams. Puebla, Mexico.
Holospira imbricata, Martens. Mexico.
Holospira cretaeca, Pfeiffer. Mexico.
Holospira microstoma, Pfeiffer. Mexico.
Holospira teres, Menke. Puebla, Mexico.

Total, 22 species.

The geographical distribution of the group is as follows: In the southern extreme of Mexico, Puebla affords 5, Vera Cruz 1, Guerrero 1, and other localities probably in this region 4, in all 11 South Mexican

species. In northern Mexico, Sonora offers 2, Chihuahua 1, and Coahuila 1, making 4 for this area; while on the United States side of the boundary, Texas west of the Colorado River affords 3, New Mexico 3, and Arizona 1 species or 7 in all, of which 3 described in this paper are due to the collections made on the Boundary Commission by Dr. Mearns. A large number of species probably remain to be made known.

Genus COELOCENTRUM, Crosse and Fischer.

COELOCENTRUM NELSONI, new species.

(Plate XXXIII, figs. 5, 6.)

Shell, large, strong, decollate, retaining 9 whorls subcylindric, attenuated more rapidly at the upper 2 or 3 whorls, periphery flattish, suture distinct, strong, not deep; transverse sculpture of numerous rather asperate concavely arched little raised ridges stronger near the sutures and usually with wider interspaces; spiral sculpture of somewhat vermicular obscure character like the markings left by a "sandblast," but occasionally developing sparse distant fine spiral riblets, and stronger on the later whorls; base rounded except for the obscure peripheral line, the umbilicus almost closed; aperture rounded below, slightly angular, oblique, free from the body whorl, with the margin continuous and reflected but narrow; axis normal, nearly closed at the decollation where it is small but large in the later whorls; color pale straw. Length 53, maximum diameter 18, diameter at decollation 8 mm.

Type from Tuxtla, Mexico; collected by E. W. Nelson, of the United States Agricultural Department. No. 107368, U.S.N.M.

This shell recalls *Eucalodium compactum*, Pilsbry, but is more cylindrical and stouter, besides having a totally different axis. It is the largest known species of the genus, and is dedicated to the indefatigable naturalist, E. W. Nelson, who has added so largely to our knowledge of the American fauna from Alaska to Guatemala.

COELOCENTRUM PFEFFERI, new species.

(Plate XXXIII, figs. 1, 2.)

Shell subcylindric, with $8\frac{1}{2}$ whorls, attenuated above, rounded below, solid, decollate, the whorls gently rounded with a distinct suture, without spiral sculpture, transverse sculpture of delicate, hardly arched, little raised, crowded lines, subequal over the whole surface; base rounded, the basal area bounded by an obscure line, umbilicus reduced to a minute perforation, aperture rounded below, slightly angular above, usually free but occasional adnate to the body whorl; axis normal, small at the decollation; color pale livid pink, whitish near the aperture. Length 43, maximum diameter 15, diameter at the decollation 7 mm. No. 107367, U.S.N.M.

Types from Ocozucantla, Mexico; collected by E. W. Nelson.

This species is shorter, stouter, and less cylindrical than *C. turris*, Pfeiffer, which has proportionally more numerous whorls and is smaller and more fusiform than *C. nelsoni*. It is respectfully dedicated to the distinguished naturalist of Hamburg, Dr. G. Pfeffer, well known for his work on Mexican land shells in conjunction with H. Strebél.

Genus ANISOSPIRA, Strebél and Pfeffer.

ANISOSPIRA STREBELI, new species.

(Plate XXXIII, figs. 7, 8.)

Shell thin, white, solid, opaque, decollated, the rejected spire having 14 whorls and the remainder of the shell from $7\frac{1}{2}$ to 9 whorls; apex of the young shell blunt, slightly dome-shaped, the nepionic shell smooth or faintly transversely striated, subsequent whorls to the fifth sub-cylindric, the fifth slightly constricted, the spire very slowly increases in diameter until the decollation is reached; the first four whorls after the nucleus are conspicuously, elegantly, transversely ribbed, the riblets nearly straight, with subequal interspaces. Beyond the constriction the riblets are less conspicuous and more crowded and more oblique, and so continue evenly over the adult shell where the suture is distinct but not deep, the form somewhat fusoid, the basal whorl slightly contracted and subangulate at the periphery, the umbilicus closed and the aperture suborbicular and lightly reflected. The axis is moderately stout and twisted, with a single plait on the pillar, anteriorly, in the last and penultimate whorls, not however visible from the aperture, much as in *A. liebmanni*, Pfeiffer. Length of decollate spire, 21 mm.; of decollated shell, 29 mm.; maximum diameter of shell, 10 mm.; of decollation, 6 mm.

Types from Huilotepec, Oaxaca, Mexico; collected by E. W. Nelson. No. 107366, U.S.N.M.

This species is shorter and more slender than *A. hyalina*, Pfeiffer, which has always 1 and sometimes 2 more whorls. It is of a whitish, not a pinkish tint, and the decollated portion of the spire is more cylindrical than in *A. hyalina*, which has a proportionally larger and more trumpet-like mouth. *A. liebmanni* is larger, stouter, of a brownish yellow color, and has a whorl less than the present species, which is respectfully dedicated to Herr H. Strebél, joint author of the work on Mexican land shells already alluded to.

Genus CIONELLA, Jeffreys.

CIONELLA LUBRICA, Müller.

A single specimen was obtained at an altitude of about 9,400 feet on the summit of the Huachuca range, Cochise County, Arizona, by Dr. Mearns. This is the most southern locality definitely known in the United States for this species. It has been obtained by Hemphill in the Weber Canyon, Utah, and at White Earth, Colorado, by Ingersoll,

but these localities are several hundred miles to the northward of Dr. Mearns' station. There would seem to be no reason why the species may not extend still farther south in suitable localities among the mountains of Mexico. The species is reported from near Caracas, Venezuela, by Jousseau. The Arizona specimen, like other southern individuals, is somewhat smaller than the best developed northern form, and might be referred to the variety *lubricoides*, Ferussac, if worth naming.

Genus BULIMULUS, Leach.

The Bulimuli considered in this paper belong to the subgenus *Orthotomium*, Crosse and Fischer, as restricted by Pilsbry. If we follow the obnoxious practice of rejecting names which have been used in another gender with a different spelling, as synonyms, we must replace the section *Leptobyrsus*, Crosse and Fischer, by *Sonorina*, Pilsbry, for species of the *spirifer* type. *Orthotomium*, s. s., practically covers the rest, except a few aberrant elongated pupiform species for which Cooper's name, *Plicolumna*, may be used.

The Bulimuli of northern Mexico are intimately related to those of the southwestern United States and of the peninsula of Lower California. The fauna of the last mentioned region has something of an insular character, having been in comparatively recent geological time isolated from the continent by an arm of the sea extending in the vicinity of the international boundary line from the Pacific to the Colorado Basin and the head of the Gulf of California.

Owing to the intercourse between the opposite coasts of the Gulf of California it has happened that species have been submitted to naturalists as coming from the peninsula which really belong to the mainland, but it is by no means certain that there are not a number of common species. I received from Dr. J. G. Cooper, in the same parcel with well known peninsular species and without any distinctive label, a number of specimens of *Bulimulus baileyi*, which is also represented in the National Museum collection by specimens collected on the peninsula by W. J. Fisher. Dr. Cooper now thinks that his specimens of *B. baileyi* were collected at Hermosillo, Mexico, and we have specimens from northern Mexico, collected by Bailey. So it seems that a doubt is thrown on the peninsular habitat of *B. baileyi* which it will require further researches to dispel. It must be remembered, however, that *B. pallidior* is represented by a very slightly modified variety on the mainland as far south as Costa Rica, notwithstanding the fact that its center of distribution is certainly the mountains¹ of the peninsula.

Epiphragmophora hachitana was collected by Merrill a little to the south of San Quentin, Lower California (lat. 30° N.), although it seems

¹ It is hardly necessary to insist on the errors of habitat which assigned this species to Peru and the South Sea Islands, from which no specimens are known.

to be a characteristic species of the mountain peaks of northern Mexico. It is evident, therefore, that it will not do to be dogmatic about doubtful localities connecting the mainland and peninsular faunas. The isolation of each by desert tracts of lowland is almost as complete as if it were by water, but a thorough search will probably reveal a number of species common to both regions.

Although the Boundary Commission at the northern border of Lower California did not reach the mountains where the peninsular fauna flourishes, it seems permissible here to discuss some species of the latter which are genetically connected with others touched on in this report and belong to the same faunal region in its broader sense.

Since this paper was originally written (January, 1895) Mr. Pilsbry has proposed a revision of the American *Bulinuli*, based on the typical species of each group and especially the characters of the nepionic shell. This revision¹ has been utilized and the names adopted in it have been used here in place of those previously current.

In discussing the land shells of Lower California, Dr. J. G. Cooper has expressed certain opinions to which it seems necessary to refer, as otherwise some misconceptions might be perpetuated in spite of Mr. Pilsbry's revision. The subgenus *Rhodea* was created by the brothers Adams in 1858 for the *Achatina californica* of Pfeiffer. The type is now known to inhabit the mountains of New Grenada and the adjacent region and to have no relation to the African genus *Columna*, Perry, to which it was referred by Adams as a subgenus. An excellent review of the group (raised to generic rank) containing good figures of the species was published by H. Crosse,² and it is also treated of in the great work on the Mexican land shell fauna by Crosse and Fischer. For historic details the reader is referred to these monographs.

The principal characters of *Rhodea* consist in its elongated parallel-sided form, smooth, dome-shaped, *Stenogyra*-like nucleus, the distinct sutural keel more emphasized in the later whorls; the constriction of the last whorl, medially; the gyrate columella in the last whorl or two, making a pervious axis; the channel behind the columella which forms a rounded prominent fasciole encircling the axis, and in the adult terminates in an angular sinus in the otherwise continuous peristome. The anatomy is helicoid, the jaw is furnished with a few strong, distant vertical ribs, and the animal is ovoviviparous, like *Stenogyra*. One of the species is sinistral, the others dextral, but all are very much alike and sculptured only with transverse striations.

The California Academy of Sciences has sent several expeditions into the adjacent parts of Mexico and the peninsula of Lower California, during which interesting land shells were collected by Dr. G. Eisen and other members of the party. These have been described in the publications of the academy by Dr. J. G. Cooper. Among them were some

¹ The Nautilus, IX, No. 10, pp. 112-115, Feb., 1895.

² Journ. de Conchyl., XXIV, p. 5, 1876.

elongated forms strongly resembling the original *Rhodca californica* and others of *Stenogyra*-like aspect which, in default of anatomical details, were provisionally referred to *Melaniella*. Later explorations resulted in obtaining from the Sierra San Lazaro, about 25 miles north of Cape St. Lucas, living specimens of *Bulimulus artemesia*, W. G. Binney, *Columna ramentosa*, Cooper, *Melaniella eiseniana*, Cooper, and *Vitrea indentata*, Say, examples of which were sent to me by Dr. Cooper in order that their true relations might be determined by an examination of the anatomy.

Recent researches on the anatomy of the Helicidae by Ihering, Pilsbry, Hedley, and others have shown conclusively that the external modifications of the shell alone are not a sufficient guide to the genetic relations of the animals concerned, and that under similar environmental influences the Helicidae, taken in a broad sense, of different countries and different genetic history, produce strikingly similar modifications of their shelly envelopes. These have hitherto naturally been assumed to indicate a relationship which we now know does not exist. Further, it appears that a more minute scrutiny of the shells referred to does in many cases reveal characters in them which, in the light of our new information, point to their real affinities, but which have hitherto been overlooked or regarded as of too little importance to be worth dwelling upon.

An examination of Dr. Cooper's shells affords striking confirmation of the new views above referred to and shows that notwithstanding superficial similarities the Californian and South American forms can not be associated in the same minor group and genetically are of different origin. I should state here that I considered in a recent paper on the Bulimuli of Lower California¹ a number of the species collected by the expeditions of the California Academy and forwarded to the National Museum by Dr. Cooper in connection with a large series, including most of the original types or author's specimens of species of this group hitherto described from this region by Gould, Gabb, W. G. Binney,² and others. In his paper on "Land and fresh-water mollusks of Lower California, No. 4," Dr. Cooper, who had not had access to a series named by me or to the original types above mentioned, ventured on some criticisms of my work. These criticisms are almost wholly based on misidentifications of species or misconception of facts, and, in general, are vitiated by these errors. I will mention only one instance, as I have no desire to enter into controversy and prefer to allow the specimens, properly identified in the Museum series, to speak for themselves. Dr. Cooper is under the impression that *Bulimulus pallidior* exists as a South American species, and that Binney and Bland have described the dentition of Peruvian specimens. Now, these authors specifically state that their specimen was from Lower California, and it has long been

¹Proc. U. S. Nat. Mus., XVI, pp. 639-647, 1893.

²Proc. Cal. Acad. Sci., 2 ser., IV, pp. 130-143, 1894.

known that the reference of *B. pallidior* to South America was merely an error of habitat; that the species is only known from Lower California and Costa Rica. Hence there is no need of considering any (hypothetical) Peruvian species, as in the case of *B. proteus* where two very similar shells of different habitats had been confounded. Gould's type of *B. vegetus*, now in the National Museum, establishes its absolute identity with *B. pallidior*. Since Dr. Cooper's paper was printed it has been possible for me to examine a series of the species named by him from the collections made by the Academy expeditions to Lower California, which he kindly forwarded at my request.

Subgenus ORTHOTOMIUM, Pilsbry.

Orthotomium, PILSBRY, Nautilus, IX, No. 10, p. 114, Feb., 1896.

> *Orthotomium*, CROSSE and FISCHER, Moll. Mexique, 1875.

> *Leptobyrsus*, CROSSE and FISCHER, op. cit., 1875.

> *Globulinus*, CROSSE and FISCHER, op. cit., 1875.

The type of *Orthotomium* is *Bulimulus sufflatus*, and the group as a whole comprises the sections *Orthotomium*, s. s.; *Leptobyrsus*, Crosse and Fischer, (type *B. spirifer*, Gabb) or *Sonorina*, Pilsbry; and *Plicolumna*, Cooper (+ *Pseudorhodea*, Dall), of which the type is *B. ramentosus*, Cooper.

Section SONORINA, Pilsbry.

BULIMULUS (ORTHOTOMIUM) BELDINGI, Cooper.

Bulimulus inscendens beldingi, COOPER, Proc. Cal. Acad. Sci., III, p. 209, 1892; p. 340, pl. XIII, fig. 5; IV, p. 137, 1894.

Bulimulus (Leptobyrsus) inscendens, BINNEY, var. *beldingi*, DALL, Proc. U. S. Nat. Mus., XVI, p. 643, 1893.

Mountains of Lower California, Eisen and others.

I noted my suspicion in 1893 that this form is specifically distinct from *B. inscendens*, and, after examining Dr. Cooper's series, I am confirmed in this opinion. I do not find on careful scrutiny the intermediate stages which would connect the two species, and I now separate them definitively. To the typical form, as originally described by Cooper, I add two varieties, named and characterized in the above-mentioned paper as var. *alta* and var. *monticola*.

The jaw of *B. beldingi* is essentially like that of *B. artemesia*, but heavier, with the plications carried to the dorsal edge. The teeth differ only in being more numerous. The animal is dark, slaty-black above and pale below, with the edge of the foot margined by a row of granulations.

BULIMULUS (ALTERNATUS var.?) NIGROMONTANUS, Dall.

Shell short, wide, white, with 5 whorls, rather rudely striated in harmony with the lines of growth; nuclear whorls 2, neatly, evenly sculptured with fine, usually wavy, minute ribs, the summit with a small central

funicular dimple; whorls moderately rounded, the last much the largest, the spire obtusely conical; base full and rounded, with a rather large, deep, and subcylindrical umbilicus; outer lip sharp, hardly reflected; pillar lip reflected rather widely near the body around (not over) the umbilicus; body with a thin wash of callus, the outer lip strongly incurved at its junction, giving a somewhat tubular look to the suture; substance of the shell thin, without markings. Length 18, of the last whorl 13, maximum diameter 11 mm.

Summit of Black Mountain, Sonora, Mexico; Dr. Mearns. No. 129993, U.S.N.M.

The shells above described are not in the best condition, and I have some hesitation in describing them; but after an exhaustive comparison with the *Bulimuli* of the region and of Lower California I find none to which the present form can be confidently assigned. It recalls somewhat *B. xantusi*, Binney, and *B. baileyi*, Dall, but is smaller and more globose than either. In form some of the varieties of *B. alternatus*, Say, come nearest to it, but have a different surface and markings which are absent from the present form, and none of them has so deep and cylindrical an umbilicus. I have thought it best, therefore, to put it on record until the reception of more material shall enable a final decision to be made.

BULIMULUS (ORTHOTOMIUM) COOPERI, Dall.

Bulimulus pilula (CROSSE and FISCHER), COOPER, Proc. Cal. Acad. Sci., III, pp. 209, 340, pl. v, fig. 12, 1894.

Bulimulus cooperi, DALL, Proc. U. S. Nat. Mus., XVIII, p. 5, 1895.

The specimen figured as *pilula*, from San Jose del Cabo, by Dr. Cooper, is *B. pilula*, Crosse and Fischer, but not of Binney. The former, judging from their figure and from somewhat weathered specimens, has a peripheral band or bands, in which two darker bound a central paler zone; the surface has well-marked incremental lines, but no spiral striae or granulations. It has been well figured by Crosse and Fischer and Cooper, though the latter does not show the bands, his specimens being bleached. There can be no doubt that this species is distinct from the original and only true *B. pilula*, and, since it does not seem to have been named, I have proposed for it the name of *Bulimulus cooperi*.

BULIMULUS (ORTHOTOMIUM) DECIPIENS, Cooper.

Bulimulus decipiens, COOPER, Proc. Cal. Acad. Sci., 2 ser., V, p. 164, June, 1895.

A third species was among these referred at first to *B. pilula*, with some doubt, by Dr. Cooper in the series submitted to me. Unfortunately, the specimens, though living when obtained, are not adult. They appear, however, to represent a very distinct species. The shell is of pale, livid, pinkish brown, with a peripheral, narrow, pale-yellow band. The largest specimen has a *Leptobysus* nucleus (not keeled) of

2 whorls, and about $2\frac{1}{4}$ rapidly enlarging later whorls. The suture is distinct, but not deep, the shell, when adult, is probably about the shape of *sufflatus*, but thinner; the umbilicus is deep, but very small, and almost hidden by the reflection of the pillar lip; the base is rounded; the surface marked by inconspicuous incremental lines and by spiral, microscopic but sharp, distant, slightly elevated lines, between which are still finer spiral striations. The general surface is not polished, even when perfectly fresh, but the wear on the fine elevated lines seems to polish them, so that under a strong triplet they shine against the duller background of the rest of the surface. This sculpture is very characteristic and quite unlike that of any other Lower Californian species. The shell above described measures 11.5 mm. high, of which the last whorl stands for 10 mm. and 9.5 mm. in diameter. It was collected by Eisen in the Sierra San Lazaro, near Cape St. Lucas, in September, 1894.

BULIMULUS (ORTHOTOMIUM) LEVIS, Dall.

Bulimulus xantusi var. *levis*, DALL, Proc. U. S. Nat. Mus., XVI, p. 641, 1893.—

COOPER, Proc. Cal. Acad. Sci., 2 ser., IV, p. 139, pl. v, fig. 14, 1894.

Bulimulus levis, DALL, Proc. U. S. Nat. Mus., XVIII, p. 5, 1895.

Several fresh specimens obtained by Dr. Eisen on his last trip show that this species is covered with a smooth, polished, greenish-yellow epidermis, with vertical darker streaks instead of dark brown, as in *B. xantusi*, and it is absolutely without granulation. There is no doubt but that this is a distinct species, which can retain the varietal name in a specific sense. Decorticated specimens may have been distributed under the name of *xantusi* by collectors, but the original figured type of Mr. W. G. Binney must be taken as the standard for that species. With it the *B. gabbii* of Crosse and Fischer is identical, and must fall into synonymy.

BULIMULUS (ORTHOTOMIUM) PILULA, W. G. Binney.

This species does not appear among the shells forwarded for examination by Dr. Cooper. Of those sent under this name the majority were small or immature specimens of *B. sufflatus*, Gould, and its variety, *chinchensis*, Cooper.

Section PLICOLUMNA, Cooper.

Plicolumna, COOPER, Proc. Cal. Acad. Sci., 2 ser., V, p. 164, June, 1895.

Pseudorhodea, DALL,¹ Nautilus, IX, p. 51, Sept., 1895; Proc. U. S. Nat. Mus., XVIII, p. 5, 1895.

Shell resembling that of *Rhodea*, Adams, but without a keel on the upper side of the suture in the later whorls, without a channel behind

¹The duplication of names is the result of my absence in Alaska at the time of the printing of both Dr. Cooper's paper and my own, which, as manuscript, was the earlier of the two.

the pillar and consequently without the resulting convex fasciole marginating the pervious axis; with a rounded and not excavated base; with a ribbed and funicular nepionic apical stage instead of a smooth and dome-like one, with a jaw differing as elsewhere described from the jaw of *Rhodea*, and probably by being oviparous.

The dentition of *Rhodea* has not been figured, so no comparisons can be made with it. *Plicolumna* is intimately related to the group of *Bulimulus*, including *Leptobyrus* and such species as *B. artemesia*. It is probably the result of special factors of the environment acting on part of the same phylum. From them it differs by the persistence of a gyrate columella in the last 2 whorls and the resulting pervious axis, features which are absent from its nearest relative, *B. artemesia*. It is probable that the South American *Rhodea* is a similar modification of some local phylum, induced by analogous features in the environment.

BULIMULUS (ORTHOTOMIUM) ARTEMESIA, W. G. Binney.

(Plates XXXI, fig. 6; XXXII, fig. 6.)

Bulimulus (Leptobyrus) artemesia (W. G. BINNEY). DALL, Proc. U. S. Nat. Mus., XVI, p. 642, pl. LXXII, fig. 5.

In my paper above referred to, this species was placed in a subdivision of the section *Leptobyrus*, characterized by the absence of the concealed flange on the pillar which is so curious a feature of *B. bryanti*, *B. spirifer*, and *B. reseyianus*. Dr. Cooper supposing his *Columna ramentosa* to belong to *Rhodea*, and observing the indications of affinity between *B. artemesia* and his *Columna ramentosa*, criticises me for placing the former in the same group with the *Leptobyrus* (= *Sonorina*, Pillsbry), and observes that it would better have been placed in *Peroncus* until it was certain that it does not belong with *Columna* (= *Rhodea*). Now *Peroncus (pupiformis)* is a Chilean form, with the dome-shaped smooth nucleus of *Bostryx* belonging to that region, and, while the general outline is very like that of *B. artemesia*, the nuclear whorls are as far as possible removed from the ribbed funicular form which characterizes the species of Lower California. Consequently, though having but a single specimen of the shell, the type of *B. artemesia*, I did not hesitate to place it among the forms, which by propinquity, as well as nepionic characters, were distinctly pointed out as related to it. On the other hand, the shell has not a single one of the characters upon which the true *Rhodea* must rely for its validity. Yet Dr. Cooper, judging the true *Rhodea* by the shells, which at first under the name of *Columna* he wrongly referred to it, was not incorrect in supposing these to be related to *B. artemesia*. They are very closely related to it, and, without doubt, are derived from the same stock, and the similarity of *Columna* (Cooper) to *Rhodea*, Adams, is dynamic and superficial and not genetic, as I shall now proceed to show.

In nearly all the Lower Californian *Bulimuli*, from the great *B. montezuma* down to the small *artemesia*, the nepionic or nuclear whorls

present a special aspect rather unusual among species of this genus. The subspherical or bulb-like protoconch with which the shell begins, and which is formed within the egg, when the coiling of the whorls commences, is tipped over and obliquely infolded by the first gyration; a section shows more of the protoconch below than above the first sutural line. The coiling whorl is often strongly keeled on the shoulder, so that from the keel toward the suture is a straight downward slope, while the external surface from the keel toward the periphery is rounded. The circular sweep of the keeled first whorl thus forms an apical funicular depression where the point of the spire usually is. In those cases where the first whorl is not keeled it nevertheless shows a dimple or pit at the apex, though not so sharply emphasized. The first $1\frac{1}{2}$ or 2 whorls are regularly ribbed with small, distinct, even ribs and about equal interspaces, directed vertically or parallel with the axis. Beyond this point the ribs fade and are represented by oblique more or less flexuous elevated incremental lines, often granulated by the crossing of about equally strong spiral striae with equal interspaces. This granulation is often inconstant; some of the species may show it well developed over the whole shell, or may be almost free from it, though there are some which are always smooth or even polished, and others which are not known without a well-marked granulation. In strongly granulated perfect shells (and markedly in *B. artemesia*) the granules, or certain rows of them, are regularly tipped with projecting points of epidermis which are very deciduous. The surface shown by Cooper's¹ figure 26 as belonging to *B. montezuma* is an eroded surface and bears no resemblance to the granulation exhibited by an unworn specimen. Figures 29 and 30, on the other hand, are very good and give an excellent idea of the surface of the respective species.

Now, the peculiar apex and surface above described are exhibited perfectly by *B. artemesia* when in perfect and well developed condition, but it should be noted that the ribbing of the nepionic whorls is easily removed by wear; and a worn specimen, even when living, may have much of it lost and the worn area polished, almost as if it never had been ribbed. The granulation of the latter surface (as already mentioned), though always existent, is inconstant in strength and distribution. The granules begin to erode before the rest of the shell, owing to their prominence, and hence in worn specimens their places are often occupied by rows of punctures caused by erosion.

The peristome is usually thickened and the outer lip but little reflected. The pillar in all the specimens I have seen is nearly straight and in none of them is the axis in the least pervious. Behind the reflected pillar lip is a chink or umbilical fissure which varies in size in different individuals. The last whorl is often peripherally appressed and usually a little attenuated in front, features greatly exaggerated in "*Columna*" *ramentosa*. Now, Dr. Cooper tells us that his "*Columna*"

¹Cooper, Proc. Cal. Acad. Sci., 2 ser., V, No. 4, pl. vi.

ramentosa abbreviata has the apex, surface, and general form of *B. artemesia*, but with a gyrate pillar and pervious axis in the last whorl. In the only specimen I have seen of variety *abbreviata*, the axis is not pervious and the shell is pathologically distorted. I do not doubt that some of Dr. Cooper's examples of this form (of which only nine specimens were collected in two years) have a pervious axis, but I am inclined to regard the shell as a variety of *B. artemesia* rather than *C. ramentosa*, and as a peculiar pathological product rather than a normal development. I fully agree to the proposition that *B. abbreviata*, if it is normal, presents characters (analogous to the gyrate axis of *Leptobyrus spirifer* in its penultimate whorl) in many respects intermediate between *B. artemesia* and "*Columna*" *ramentosa*, and that all three are derived from the same stock. The specimens had unfortunately been put into very strong alcohol at first and consequently had been so contracted that not only the head and associated parts, but also the anterior end of the foot had been invaginated within the general surface of the body and all attempts at relaxing them failed entirely. It was observed, however, that the body above was slaty black, with large, elongate, pustular granulation, the foot paler, bordered above and at the edge by a narrow row of shorter pustules distinct from those of the general surface. The sole was marked by a deep median groove, on each side of which, extending to the marginal border, is a broad reptary band or longitudinally striate, nearly smooth reptary surface. The tail end is somewhat rounded with no visible mucus gland; the front edge subtruncate. The characters of "*Columna*" *ramentosa* were similar on a smaller scale.

The jaw of *B. artemesia* is fairly strong; the upper part smooth, the lower part with about 12 somewhat irregular ribs, smooth or low on the side toward the median line and with a thin, ragged, projecting edge outwardly. They looked as if the jaw had been repeatedly split upward from the cutting edge about half way to the upper margin, with a dull knife held obliquely. These ribs, if they can be so called, hardly project from the surface of the jaw, and contrast very strongly with the few strong distant ribs which are found on the jaw of *Rhodea*. The jaw in these *Bulimuli* is always reinforced by a thin chitinous sheet which protects the roof of the mouth from the points of the teeth on the radula. It is usually left off or neglected in figures of the jaw. This appendage is connected with the lower margin of insertion of the jaw proper and extends back about three or four times as far as the antero-posterior width of the jaw. It is usually smooth and almost transparent. In *B. artemesia* the anterior central part has the punctate, or rather cellular appearance of adenoid tissue, being covered with minute circular impressions or markings only visible under high magnification. If these are elevations or depressions on the surface of the sheet (which for convenience may be called the oral shield) they are probably on the side which is attached to the flesh and are perhaps due to the cellularity of the tissue they protect. (See Plate I, fig. 6.)

The jaw, on the whole, resembles that of *Thysanophora*, as figured by Pilsbry. The teeth of the radula are also of the normal bulimuloid type with about 35 laterals on each side of the rhaclidian tooth. The latter is symmetrical and has the lateral cusps practically absent, though there is a shoulder on the side of the median cusp where the lateral cusps are usually situated. The lateral teeth are very similar; the outermost are shorter and wider and have the inner and outer cusp more separated or less fully developed, but otherwise, as in *B. alternatus*, resemble the inner laterals. The radula as a whole differs chiefly from that of *B. alternatus* in having the individual teeth a little wider in proportion to their height.

BULIMULUS (ORTHOTOMIUM) RAMENTOSUS, Cooper.

(Plate XXXI, fig. 8.)

Rhodea californica var. *ramentosa*, COOPER, Proc. Cal. Acad. Sci., 2 ser., III, p. 102, 1891.

Columna ramentosa, COOPER, loc. cit., p. 215, 1892; p. 338, 1893.

Plicolumna ramentosa, COOPER, loc. cit., V, p. 164, June, 1895.

Near the edge of lagoons near San Jose del Cabo, Lower California, Bryant and Eisen; also in the mountains by Eisen, Vaslit, etc., but the altitude is not stated. (Cooper.)

This species has precisely the nucleus of *B. artemesia* and the external appearance of the animals as far as could be determined in the very contracted specimens does not differ. The jaw is almost exactly the same size as that of *B. artemesia*, and agrees in every particular in the mode of its construction. If a number of jaws of the two species were mixed no one could determine to which species any particular jaw properly belonged. The teeth and radula agree with equal closeness except that it is somewhat narrower, the formula being 28:1:28 in the specimen examined, and the outermost laterals were proportionately a little wider than in *B. artemesia*.

The distinctions between this form and *Rhodea* have been pointed out in the sectional diagnosis, but it may be as well to call attention to some minor details. The base of the last whorl in *B. ramentosus* is rounded and the constriction of the peripheral part of the whorl is variable in different specimens. It would almost seem as if the constriction and the gyration of the pillar were in some way correlated, as the pillar above the last 2 whorls is not gyrate, though somewhat tortuous, and consequently the perviousness of the axis does not extend, as supposed by Cooper, to the entire axis, but only to that part of it included in the last whorl and a half or two whorls. The columellar muscle is exceptionally long, and attached for several whorls, so that it is very difficult to withdraw the animal from its shell, even after it has been long in alcohol. The axis appears to be destitute of any lamelle, plications, or projections of any kind. In fact, the creature, so far as its shell is concerned, is a very attenuated *Leptobyrsus* with its gyrate axis continued into the adult state, whereas in the ordinary

Leptobryus the gyration ceased in time for the pillar of the completed shell to appear normally straight and the axis impervious. In a perfectly adult *B. ramentosus* the margins of the aperture are expanded and slightly thickened, but not reflected. The diameter of the hollow axis varies in different specimens.

Family GLANDINIDÆ.

Genus PSEUDOSUBULINA, Strebel and Pfeffer.

PSEUDOSUBULINA EISENIANA, Cooper.

It has already been shown by Strebel and Pfeffer (1882) that some of the small Mexican species with a shell closely resembling *Stenogyra* and *Spiraxis* are destitute of a jaw and have a dentition closely resembling that of *Glandina*. These were separated under the name of *Pseudosubulina*, with a longitudinally ribbed *Stenogyra*-like shell having a smooth nuclear portion and a truncate pillar (Ex. *P. chiapensis*, Pfeffer). To this group a subgenus was added under the name of *Volutaxis*, distinguished by having axially ribbed nuclear whorls and the pillar not truncate, but slightly thickened and twisted, and passing more or less directly into the sharp-edged peristome. The species described by Dr. Cooper, under the provisional name of *Melaniella (tastensis and M. eiseniana*, the latter being sinistral), are almost exactly intermediate between the typical *Pseudosubulina* and *Volutaxis*, indicating that the two groups should be consolidated. In these two species the nuclear whorls, when perfect, are delicately axially ribbed; the young shells have a straight pillar, not truncate, but with an angle at the base which, in the adult, is more or less obsolete, while the pillar becomes not plicate, but somewhat thickened.

In *P. eiseniana* there is no jaw. The animal is pale colored, and was so contracted in the specimens that the existence of labial palpi, of which there was no evidence, could not be absolutely denied. It is, however, probable that there are none. The very minute radula is of the shape of the same organ in *Glandina*, oval, with the rows of teeth meeting at a sharp angle in the median line. There are about 13 slender, arched, needle-like teeth on each side of a very small, low, slender, narrow rhachidian. Some of the laterals appeared to have a double cusp, which may have been pathological; in general they resembled the laterals of *Glandina*, but had the cusps more drawn out, slender, and relatively about twice as long compared with the base.

Genus STREPTOSTYLA, Shuttleworth.

STREPTOSTYLA NEBULOSA, new species.

(Plate XXXIII, fig. 4.)

Shell of a brilliant yellowish brown, clouded irregularly with opaque blotches, thin, ovoid, with $5\frac{1}{2}$ whorls; nucleus smooth, the apex blunt,

the second whorl wider between the sutures than the third; surface of the shell polished, with the incremental lines occasionally and irregularly conspicuous; spire short, the suture deep and channeled, but narrow; base slightly attenuated, pillar with its edge thickened, twisted and slightly reflected; outer lip thin, sharp, nearly straight. Length 22, maximum diameter, 10 mm.

Found inside of a large *Helix* at San Cristobal, Chiapas, Mexico, by E. W. Nelson. No. 107369, U.S.N.M.

This species is nearest to *S. bocourti*, Crosse and Fischer, but has a more oval form, less pointed and less elevated spire.

Family SUCCINEIDÆ.

Genus SUCCINEA, Draparnaud.

SUCCINEA LUTEOLA, Gould.

Specimens of what appears to be this species were found sparingly at Lake Palomas in the Mimbres Valley, northern Mexico, near boundary monument No. 19, and in the drift of the Santa Cruz River at Tucson, Arizona. It is also abundant at Fort Clark, Texas.

LIST OF THE KNOWN PULMONATE FAUNA.

The following list of land mollusks belonging to the Central region includes all that are known to inhabit it south of latitude 42° to the Mexican border. North of about that parallel there are various intruders, and the Sonoran element of the fauna is excluded by the climate. The region south of the boundary is too insufficiently known to take into consideration. Those species which are marked with an asterisk (*) are relatively northern, and not known south of the locality following the name. Those marked with a dagger (†) belong to the mountain tops of the warmer region about the boundary line, and are probably all found south of the line some distance into Sonora and Chihuahua, the border States of Mexico. The northernmost locality of some of them which are not known north of the boundary follows the name. The fresh-water species, on account of having a different distribution from the land pulmonates, are here omitted; also the border species of Texas and Lower California, which are not known to enter the region indicated.¹

Family VITRINIDÆ.

† *Vitrina pfeifferi*, Newcomb. Fort Wingate, New Mexico; Jemez Sulphur Springs, Ashmun.

* *Vitrina limpida*, Gould. Colorado (Ingersoll); New Mexico.

¹I am indebted to Dr. V. Sterki for assistance in making up the list of *Pupa* and *Vertigo*.

Family ZONITIDÆ.

- * *Fitrea arborea*, Say. Rio Chama, New Mexico; Arizona.
 * *Fitrea radiatula*, Aldee. Arizona; New Mexico.
 * *Fitrea minuscula*, Binney. Northward from Yucatan; Arizona.
 * *Fitrea (Glyphyalinia) indentata*, Say. Mountains of Lower California and New Mexico.
 * *Fitrea (Glyphyalinia?) subrupicola*, Dall. Clinton's Cave, Utah.
 * *Conulus fulvus*, Draparnaud. New Mexico.

Family ENDODONTIDÆ.

- Patula strigosa*, Gould. North to Wyoming and Idaho from Sonora.
Patula strigosa var. *concentrata*, Dall. New Mexico and Arizona.
Patula hemphilli, Newcomb. Arizona to Idaho.
Pyramidula cronkhitei, Newcomb. Nevada and California.
 * *Pyramidula striatella*, Anthony. Fly Park, Arizona; White Oaks, New Mexico, Ashmun.
 * *Helicodiscus lineatus*, Say. Rio Chama and White Oaks, New Mexico.

Family HELICIDÆ.

- Thysanophora ingersollii*, Bland. Fly Park, Arizona; New Mexico.
Thysanophora hornii, Gabb. Yaqui River, Mexico; Arizona.
Polygyra levettei, Bland. New Mexico; Arizona.
Polygyra levettei var. *Thomsoniana*, Ancey. Santa Fé, New Mexico.
 † *Polygyra mearnsii*, Dall. Arizona and New Mexico.
 † *Polygyra chiricahuana*, Dall. Arizona.
 † *Polygyra ashmuni*, Dall. New Mexico.
 † *Polygyra pseudolonta*, Dall. New Mexico.
 * *Epiphragmophora indioensis*, Yates. Indio, California.
Epiphragmophora rowellii, Newcomb. Phoenix, Arizona.
 † *Epiphragmophora magdalenensis*, Stearns. Mexico to California.
Epiphragmophora coloradoensis, Stearns. Grand Canyon, Colorado.
Epiphragmophora arizonensis, Dall. Tucson, Arizona.
 † *Epiphragmophora hachitana*, Dall. Southwestern New Mexico to Lower California.
 * *Fallonia costata*, Müller. San Marcial, New Mexico.
 * *Fallonia pulchella*, Müller. Rio La Plata, Colorado.
 * *Fallonia cyclophorella*, Ancey. Arizona to Idaho; New Mexico.
 * *Fallonia gracilicosta*, Reinhardt. Arizona to Dakota.

Family LIMACIDÆ.

- Limax montanus*, Ingersoll. Colorado.
Limax campestris, Binney. Nevada.

Family PHILOMYCIDÆ.

- † *Philomycus sallei*, Crosse and Fischer. Sonora and Lower California.

Family BULIMULIDÆ.

- * *Cionella lubrica*, Müller. Arizona; Venezuela.
 † *Bulimulus nigromontanus*, Dall. Sonora, Mexico.
 † *Bulimulus baileyi*, Dall. Sonora, Mexico.

Family PUPIDÆ.

- † *Holospira* (*Haplostemma*) *mcarnsii*, Dall. New Mexico.
Holospira (*Eudistemma*) *arizonensis*, Stearns. Arizona.
 † *Holospira* (*Distomospira*) *bilamellata*, Dall. New Mexico.
 † *Metastoma* *coahuilensis*, Binney. Coahuila, Mexico.
 † *Metastoma* *semisculpta*, Stearns. Chihuahua, Mexico.
Metastoma *pfeifferi*, Menke. Sonora, Mexico.
Metastoma *rémondii*, Gabb. Sonora, Mexico.
 † *Metastoma* *crossi*, Dall. New Mexico.
 * *Pupa fallax*, Say. Arizona, New Mexico, and northward (*P. arizonensis*, Gabb).
 * *Pupa muscorum*, Linné. Arizona (Palmer).
 * *Pupa blandii*, Morse. Colorado; New Mexico (Ashmun).
 * *Pupa syngenes*, Pilsbry. New Mexico; Arizona to Montana.
Pupa gabbii, Dall. New Mexico, Arizona (= *P. arizonensis*, W. G. Binney, non Gabb).
Pupa hordacca, Gabb. Fort Grant, Arizona, to Texas.
 * *Pupa procerca*, Gould. New Mexico to Texas; Minnesota to Rhode Island.
 * *Pupa armifera*, Say. New Mexico (Ashmun).
Pupa hordacella, Pilsbry. Arizona to Florida.
 * *Pupa holzingeri*, Sterki. New Mexico to Manitoba.
Pupa pilsbryana, Sterki. New Mexico; Arizona.
 * *Pupa pentodon*, Say. Nevada; Texas.
 * *Sphyradium edentulum*, Draparnaud. Colorado; Europe.
Sphyradium edentulum var. *allicola*, Ingersoll. Colorado.
 * *Vertigo corpulenta*, Morse. Nevada; Colorado.
 * *Vertigo decora*, Gould. Colorado to Alaska (+ *P. ingersollii*, Ancey, + *P. coloradoensis*, Cockerell).
Vertigo decora var. *concinna*, Cockerell. Colorado.
 * *Vertigo binneyana*, Sterki. New Mexico to Manitoba.
 * *Vertigo orata*, Say. New Mexico; Arizona to Montana.
 * *Vertigo ventricosa*, Morse, var. Arizona.
 * *Vertigo tridentata*, Wolf. Arizona to Montana, etc.
 * *Vertigo milium*, Gould. New Mexico (fossil).

Family SUCCINEIDÆ.

- * *Succinea lineata*, Binney. Sonora to Fort Union, Nebraska.
 * *Succinea rusticana*, Gould. Nevada.
 * *Succinea nuttalliana*, Lea. Salt Lake City, Utah.
 * *Succinea sillimani*, Bland. Nevada.
 * *Succinea stretchiana*, Bland. Nevada.
Succinea luteola, Gould. New Mexico; Texas.

The reader will note what a very large number of species of this list are small and extend from a more congenial habitat in more northern regions along the mountain ranges into this hot and dry region. Doubtless there are many species to be discovered yet by those who are ready to brave rattlesnakes by turning over fragments of volcanic rocks on the sun-scorched mountains near the boundary; and especially by those who may be fortunate enough to be there during the infrequent rains, when these animals for a time lose their timidity and venture abroad. Especially among the *Holospiras* may new forms be looked for, as they are remarkably similar to one another externally and are usually found in large numbers where they occur at all. Not until the fauna of

northern Mexico is well known, will it be possible to generalize correctly on the geographical distribution of the mollusks of this region and the extent to which different elements are represented in the fauna of the boundary.

For a long time peculiarities in the distribution of the land mollusks of this and adjacent regions have suggested to the writer that during the Oligocene the highlands of northern Mexico were separated from the mainland of North America by an arm of the sea. It is certain that the peninsula of Lower California was so separated, and the separation may have persisted until even more recent times. The existence of comparatively fresh marine shells, fossil in the sands of the desert far to the eastward of the Colorado, and the fact that the height of land or watershed between the Colorado and the Rio Grande is at present only 3,000 or 4,000 feet above the sea, while the evidences of volcanic activity are abundant—all these facts give color to the hypothesis, which requires fuller and more exact investigation for its establishment. If such a barrier has not been interposed, it is difficult to account for the failure of the land-shell fauna of western Texas to make a distinct impression on that of the boundary region, and to find reasons why the genus *Epiphragmophora* should have failed to extend its range to the eastward of the Mexican uplift. But this problem is for the future to solve, and we may rest content with having stated it.

FRESH-WATER SPECIES.

Genus LIMNÆA, Lamarck.

LIMNÆA BULIMOIDES, Lea.

Found sparingly at Fort Worth, Texas, and in the Rio Grande near El Paso, Texas.

LIMNÆA DESIDIOSA, Say.

A few very slender specimens with elongated spires were found in the drift of the Santa Cruz River, Tucson, Arizona, by Dr. Mearns. Also at San Rafael, New Mexico; Ashmund.

Genus PHYSA, Draparnaud.

PHYSA MEXICANA, Philippi.

Collected by Dr. Mearns at Fort Worth and Fort Clark, Texas; in the Guadalupe Canyon, and San Bernardino River, New Mexico; at Lake Palomas, in the Mimbres Valley, Mexico; from Seven Wells, the Colorado River, and the Santa Cruz River near Tucson, Arizona; at Laguna, 20 miles north of Campo, and at Cameron's ranch, San Diego County, California. Some strongly shouldered specimens in a subfossil state, from the Colorado desert, are perhaps a variety of this species, which is extremely variable.

Genus APLEXA, Fleming.

APLEXA HYPNORUM, Linnæus.

A single specimen of this species was found in the drift of the Santa Cruz River, near Tucson, Arizona, by Dr. Mearns. This is the most southerly locality yet reported for this species, about the identification of which there seems to be no doubt. The Santa Cruz is a tributary of the Gila River.

Genus PLANORBIS, Guettard.

PLANORBIS LIEBMANNII, Dunker.

A single specimen was received from 20 miles north of Campo, San Diego County, California.

PLANORBIS TUMIDUS, Pfeiffer.

Specimens of this species were sent in by Dr. Mearns from Las Moras Creek, Kinney County, Texas, and the Rio Grande River, near El Paso; from Seven Wells, the Santa Cruz River near Tucson, San Bernardino River, and the Colorado River at Yuma, Arizona; from the San Bernardino River and Sonoyta River, northern Mexico, near the boundary line; near monument No. 219; in Gardner's Laguna, Lower California, and at Laguna Station, New River, San Diego County, California.

This species varies enormously. Some of the specimens are less elevated, with a wider umbilicus and one whorl more than others of the same size, and taken separately would be regarded as distinct, but the intermediate gradations are so numerous that I am unable to regard them as forming a different species or even a really constant variety.

Genus BYTHINELLA, Moquin Tandon.

The following species has been kindly determined by Mr. Pilsbry, who has made a special study of this genus.

BYTHINELLA PALOMASENSIS, Pilsbry.

(Plate XXXI, fig. 9.)

Bythinella palomasensis, PILSBRY, Nautilus, IX, p. 68, Oct., 1895.

Shell small, ovate, rapidly tapering above from the periphery of the body whorl to a blunt apex; composed of 4 very convex whorls, the last about five-sixths the entire length of the shell, well rounded out; surface showing only faint incremental lines; aperture ovate, subangular above, its longest axis about half the length of the shell; peristome thin, continuous across the parietal wall and nearly straight there, though not appressed to the body whorl; umbilicus minutely perforate; color whitish corneous and somewhat translucent. Height of shell 2.75, maximum diameter 1.80, longer axis of aperture 1.36 mm.

Two specimens from Lake Palomas, northeastern Mexico, collected by Dr. Mearns. No. 130016, U.S.N.M.

One of the specimens has the latter third of the last whorl free from the body, as in *Lyogyrus*, a somewhat common pathologic condition in species of this and allied genera, but in the other and evidently normal specimen the peristome is quite free from the adjacent body whorl, not appressed thereto. Neither example retained the operculum or dried soft parts, and therefore the generic reference can not be verified by examination of the dentition, but the form of the shell is that of a *Bythinella* rather than an *Amnicola*. It is a stumper shell than *B. bimneyi*, Tryon, and has far less inflated whorls than *B. brevissima*, Pilsbry, but these two, among United States species, are conchologically its nearest allies. Of the short-spined Mexican forms *Amnicola orizabensis*, Crosse and Fischer,¹ is totally diverse, although the figures in their work look somewhat like this species. *A. guatemalensis*, Crosse and Fischer, is larger, with a relatively smaller aperture [Pilsbry].

Genus SPHÆRIUM, Scopoli.

SPHÆRIUM SOLIDULUM, Prime.

Numerous specimens of this species were obtained in Arizona from the San Bernardino River.

Genus PISIDIUM, Pfeiffer.

PISIDIUM COMPRESSUM, Prime.

Collected by Dr. Mearns in the San Bernardino River, Arizona, and Lake Palomas, south of the boundary line in the Mimbres Valley, northeastern Mexico.

PISIDIUM ABDITUM, Haldeman.

San Rafael, New Mexico; Ashmun.

Genus UNIO, Retzius.

The notes upon this group and *Anodonta* are by Mr. Charles T. Simpson, of the United States National Museum.

UNIO COUCHIANUS, Lea.

Unio couchianus, LEA, Journ. Acad. Nat. Sci., IV, p. 371; Obs. on the Genus Unio, VIII, p. 53, pl. LXVI, fig. 196.

This rare species was described by Dr. Lea from half a dozen odd valves sent to him by the Smithsonian Institution, which were procured by Lieut. D. N. Couch, U. S. A., from Dr. Berlandier's collection. The shell has the general form of an inflated *U. asperimus*, but is much less tuberculate. Dr. Lea describes it as smooth, but a careful examination

¹Plate I, figs. 4a, 4b.

shows the surface, especially near the beaks, to be covered with slight pustules, which in the types are worn, and the valves have the radiating wrinkles on the posterior slope common to the species of the *Asperri-mus* group.

Dr. Mearns procured a single right valve of what I believe is the young of this species. It is in a better state of preservation than Lea's specimens, and exhibits quite distinct, scattered tubercles.

UNIO UNDULATUS, Barnes.

Unio undulatus, BARNES, Am. Journ. of Science, VI, p. 120, pl. II, fig. 2.

Unio laticostatus, LEA, Trans. Am. Phil. Soc., X, pl. I, fig. 2; Obs. on the Genus Unio, IV, p. 42, pl. I, fig. 2.

A single, badly broken, and much worn right valve of what is no doubt this species was obtained in Kinney County, Texas. *Unio laticostatus*, though sometimes more delicately and evenly plicate than *Unio undulatus*, is undoubtedly a mere variation of Barnes' species.

UNIO POPEI, Lea.

Unio popei, LEA, Journ. Acad. Nat. Sci., IV, p. 372; Obs. on the Genus Unio, VIII, p. 54.

The types of this species came from Devils River, Texas, and the Rio Salado, New Leon, Mexico. Since the time of publication it has been rediscovered in both the typical localities by the Biological Expedition of the United States Department of Agriculture. Dr. Mearns obtained numerous valves in tolerably fair condition from Kinney County, Texas.

This, with *Unio poeyanus*, Lea, a closely allied form from Mexico, forms a small group which does not seem to be very closely related to the Unione fauna of Texas, but rather belongs to that of Mexico and Central America; and the two species are evidently closely allied in their somewhat sulcate sculpture and delicate, soft, lurid nacre, to the group typified by *Unio rowelli* of Lake Nicaragua.

UNIO MITCHELLI, Simpson.

(Plate XXXII, figs. 1-3.)

Unio mitchelli, SIMPSON, Proc. U. S. Nat. Mus., XVIII, p. 5, 1895.

Shell rhomboid-oval, solid, rather inflated, rounded before, somewhat biangulate behind; dorsal margin curved; base slightly rounded or straight, or sometimes a little emarginate; growth lines strong, irregular anteriorly; ligament rather large and prominent; epidermis coarse, often shining, varying from light yellowish brown to black; beaks fairly prominent, showing slight traces of concentric and rather strong, corrugated sculpture; cardinal teeth rather strong, short, and stumpy, slightly ragged; laterals short, heavy, and club-shaped, covered with granular sculpture which has a tendency in very solid shells to become

vertical; anterior adductor scar small and deep, posterior round and well impressed; pallial line well defined; naere a soft, silvery white.

Length of type 55, height 33, diameter 20 mm.

Guadalupe River, Victoria County, Texas, J. D. Mitchell.

This species, which was first sent to the National Museum by Mr. Mitchell, taken at the above locality, has since been received from Mr. J. A. Singley from the Guadalupe River at New Braunfels, and from the United States Agricultural Exploring Expedition from the Rio Salado, New Leon, Mexico; and in all there are now in the collection fourteen specimens. The species varies greatly in size and considerably in form, the Mexican shell being 92 mm. in length by 55 mm. in height. Young specimens show faint traces of dark rays in the middle of the shell, and some individuals have slight traces of pustules.

In other shells there are very slight plications on the disk and on the posterior slope. Two specimens from the Guadalupe River in Victoria County are much shorter and wider, and are lighter colored than the rest, and recall *Unio aureus* to some extent. The species probably groups with *Unio rowelli* and *scamnatius*, though no other members of the group have pustules or plications.

Genus ANODONTA, Bruguière.

ANODONTA DEJECTA, Lewis.

(Plate XXXII, figs. 4, 5.)

Anodonta dejecta, LEWIS, Field and Forest, August and September, Nos. 2 and 3, 1875, p. 26.

Anodonta mearnsiana, SIMPSON, Nautilus, VI, No. 12, April, 1893, p. 131.

This species was described by Dr. Lewis, but not figured, in Field and Forest. It was brought with the material of the expedition under Lieut. George M. Wheeler west of the one-hundredth meridian, and was said to have been collected by Dr. H. C. Yarrow, naturalist of the expedition, in the Arkansas River or its tributaries. The types were placed in the National Museum, but by some accident were put away with a lot of rubbish.

When Dr. Mearns sent the shell from San Bernardino ranch the writer could not identify it with anything and concluded that it was new and named it in honor of its discoverer. Subsequently in going over and arranging the entire naiad collection of the National Museum, I found Lewis' types, and saw at once that his species and my *mearnsiana* were the same. Lewis' types consist of a pair and a left valve, all considerably broken and somewhat distorted, yet from their peculiar form, the color of the naere and epidermis, and the texture of the shell, there can be no doubt of the identity of the two.

Though differing much in appearance from *Anodonta angulata*, Lea, the two species are closely related—a fact that would never be suspected if it were not that intermediate specimens almost connect the two. Certain specimens of *A. angulata* are almost entirely destitute

of the strong, sharp ridge on the posterior slope, which is usually characteristic of that species. They are more compressed and thinner in texture, and are much like *A. dejecta* in the lurid color of the naere, general texture, and color of the epidermis, as well as the beak sculpture; and the soft parts of the two are much alike.

Hemphill states¹ that *Anodonta angulata* burrows in beds of compact sand and gravel in the Snake River, with the smaller end of the shell downward, and the angular solid end level with the surface, and no doubt this thickening of the shell and the prominent ridge tend to strengthen it against the shocks of the current. The thinner and more compressed specimens of *A. angulata* probably live in less rapid water, and Dr. Mearns found *A. dejecta* in soft mud.

The following is a description of *A. dejecta*, prepared from a large number of individuals:

Shell rhomboid or rhomboid-oval, sometimes slightly alate, compressed anteriorly, gradually becoming inflated posteriorly, smooth and shining, with numerous lightly marked growth lines, moderately solid; having a thin epidermis which easily wears off in exposed places, varying from bright green to brownish and pale yellow, sometimes broadly and faintly rayed in the posterior region; beaks rather compressed, sculptured with a half dozen or more wavy, concentric sulcations; naere soft, lurid, brownish or purplish in the cavity of the shell, shading to lighter color at the edges.

Length of an average specimen 80, height 45, diameter 22 mm.

San Bernardino ranch, Mexican boundary, Arizona.

This species was found by Dr. Mearns in the following additional localities: Tucson, Arizona; Colorado River, near the Mexican boundary; Santa Cruz River, near Tucson, Arizona; San Bernardino River, Mexican boundary; New River, Laguna Station, San Diego County, California; mouth of Colorado River.

ANODONTA CALIFORNIENSIS, Lea.

Anodonta californiensis, LEA, Trans. Am. Phil. Soc., X, pl. XXV, fig. 45; Observations on the Genus Unio, V, p. 42, pl. XXV, fig. XLVII.

¹ Specimens of what are perhaps this species, but which are too much worn to be determined with certainty, were found at monument 219, Mexican boundary line, and at New River, Laguna Station, San Diego County, California. These were merely bleached valves, generally without any epidermis, and in some cases lacking a part or all of the outer shell layer. Wherever the beak sculpture remained it was shown to be much finer and to have more numerous sulcations than that of *A. dejecta*, and in this respect it is like that of *A. californiensis*. The two species evidently approach closely, and I believe the group typified by *Anodonta angulata* to be nearly related to that of which *A. californiensis* is a member.

¹ Zee, I, No. II, p. 326.

Summary.—The collections made by the Commission in the Central region cover thirty-nine species and varieties, of which seven belong strictly to the Mexican fauna, as far as yet known. Twenty-four of these are land shells, of which half are new, and one new *Unio* belonging to the same general region brings the number of new species up to twelve. Doubtless a thorough examination made during a rainy period would add several species to this list, but considering the circumstances under which the collection was made, and the arid and unfavorable character of the region, it would seem that Dr. Mearns met with unexpected success. As a whole, omitting species of universal range, it would seem that the land-shell fauna represents a northward extension of the mountain fauna of Mexico, rather than a modification of the molluscan life of regions north, west, or east of the territory explored. So little is known of the Mexican mollusks that extended comparisons can not at present be made. Only two of the land shells are common to other regions than Mexico and the south central basin west of the Atlantic drainage, a fact which emphasizes the insular character of the mountain tops and the faunal distinctness of their population.

SPECIES OF THE TEXAN REGION.

The following species belonging to the Texan region of the Eastern fauna were collected by Dr. Mearns:

GLANDINA TEXASIANA, Pfeiffer.

A few dead specimens at Fort Clark, Kinney County, Texas.

BULIMULUS DEALBATUS, Say.

Numerous, mostly dead specimens, Fort Clark.

BULIMULUS DEALBATUS RAGSDALEI, Pilsbry.

This small and strongly striated variety of *B. dealbatus* was as common at Fort Clark as the normal form with which numerous intermediate specimens completely unite it, though extreme specimens seem very distinct.

POLYGYRA THYROIDES, Say.

Immature specimens feeding on the leaves of *Phaseolus*.

POLYGYRA TEXASIANA, Moricand.

Found at Fort Clark and Fort Worth abundantly, the range of the species, so far recorded, extending from Fort Gibson, Indian Territory, south and west to the State of Tamaulipas, Mexico.

POLYGYRA (MESODON) ROEMERI, Pfeiffer.

A single specimen at Fort Worth.

SUCCINEA LUTEOLA, Gould.

Numerous specimens were sent from Fort Worth, others from Lake Palomas, Mexico, and the drift of the Santa Cruz River at Tucson, Arizona, this being a species common to the two regions.

HELICINA ORBICULATA, Say.

Abundant, dead, at Fort Clark and Fort Worth.

SPECIES OF THE CALIFORNIAN REGION.

The following land and fresh-water shells were collected in San Diego County, California, or just below the boundary line on the Lower Californian side, or on San Clemente Island off the coast.

SELENITES VOYANA, Newcomb.

A single dead and broken specimen was obtained near El Nido.

EPIPHRAGMOPHORA TUDICULATA, W. G. Binney.

Two dead specimens were obtained at El Nido, others in the Nachoguero Valley, Lower California, and a specimen verging toward the variety *cypreophila*, Newcomb, at San Diego.

EPIPHRAGMOPHORA PANDORÆ var. BENITOSENSIS, Pilsbry.

Los Benitos Islands, Lower California.

EPIPHRAGMOPHORA ARNHEIMI, Dall.

Arionta californiensis, LEA, var. *raementosa*, GOULD (small var.), W. G. Binney, Bull. U. S. Nat. Mus., XXVIII, p. 133, fig. 108 (2 views), 1885.

Epiphragmophora arnheimi, DALL, Proc. U. S. Nat. Mus., XVIII, p. 6, 1895.

Small island in marshes of San Pablo Bay, J. S. Arnheim (33675); San Pablo, Contra Costa County, California, A. W. Crawford (12320) and Stearns (58502); Nachoguero Valley, Dr. Mearns (128949). Type, No. 39612, U.S.N.M.

This small species has been referred to *californiensis* as a subvariety, and, in the collection, has found a place as a variety of *arrosa* or *exarata*, with which it has little affinity. A series of forty-three specimens, collected at different times and by different people, indicates very uniform size (max. diam. 18, min. diam. 15, alt. 11 mm.); the whorls range from 5 to 5½; the suture is deep, the umbilicus deep and subcylindric; the lip not much reflected, but in adults unusually thick for the size of the shell, especially near the pillar, and the deposit when fresh is of a pinkish tint; the brown band is narrow, the paler margin not conspicuous, and the suture revolves at its lower edge. The sculpture is entirely different from that of *raementosa*, which has the granulations obliquely spaced by ungranulated intervals, forming a distinct pattern, and is

besides a much larger shell. In *E. arnheimi* the nucleus is punctate, as in *ramentosa*, and followed by close-set striae in harmony with the lines of growth, the intervals between which are like elevated threads, the surface of which is broken into low pustules which become more close-set and elongate as the shell grows; the earlier ones are rounded and rather sparse, the later ones are irregularly disposed along the threads, the intervals between them having no regularity and not forming oblique channels or a pattern but tending to arrange themselves, so far as they are arranged at all, in horizontally revolving lines.

I have no doubt that this shell is distinct from either *ramentosa* or *exarata* and have named it for Mr. J. S. Arnheim, of San Francisco, California, by whom the majority of specimens seen were collected.

EPIPHRAGMOPHORA KELLETTII, Forbes.

Monument No. 258, on the boundary line, also at Campo and Ocean Beach, San Diego County, and the San Ysidro ranch, Lower California.

EPIPHRAGMOPHORA INTERCISA, Binney.

San Clemente Island.

EPIPHRAGMOPHORA STEARNSIANA, Gabb.

San Clemente Island; Colorado Islands.

EPIPHRAGMOPHORA GABBI, Newcomb.

San Clemente Island.

GLYPTOSTOMA NEWBERRYANUM, Binney.

Nachoguero Valley, and Campo, San Diego County.

MELAMPUS OLIVACEUS, Carpenter.

La Jolla, near San Diego.

PHYSA HUMEROSA, Gould.

Subfossil near monument No. 219.

AMNICOLA PROTEA, Gould.

Subfossil with the last.

MARINE MOLLUSKS.

As the termination of the boundary line is at the Pacific Ocean, Dr. Mearns was able to collect a number of marine species on the shore, and others during a visit to San Clemente Island, which lies west from the shore of San Diego County, about 60 miles in the Pacific, forming the southernmost of the Santa Barbara group of islands. Those to which no locality is appended were obtained at the end of the boundary line just south of San Diego.

- Aemac mitra*, Eschscholtz. Ocean Beach.
Aemac persona, Eschscholtz. Ocean Beach and La Jolla.
Aemac patina, Eschscholtz. La Jolla.
Aemac pelta, Eschscholtz. San Clemente.
Aemac scabra, Nuttall. San Clemente.
Astralium undosum, Wood. San Clemente.
Bittium quadrifilatum, Carpenter. Ocean Beach.
Bulla nebulosa, Gould. San Diego Bay.
Calliostoma gemmulatum, Carpenter. Ocean Beach.
Cardium biangulatum, Sowerby. San Clemente.
Cardium substriatum, Conrad. Ocean Beach.
Cerithidea sacrata, Gould. Ocean Beach.
Chama erogyra, Conrad. Ocean Beach.
Chama pellucida, Sowerby. Ocean Beach.
Chlorostoma aureotinctum, Forbes. San Clemente.
Chlorostoma funebre, A. Adams. Ocean Beach.
Chlorostoma fuscescens, Philippi. Ocean Beach.
Chlorostoma gallina, Forbes. San Clemente.
Conus californicus, Hinds. San Clemente, Ocean Beach, etc.
Crepidula adunca, Sowerby. Ocean Beach.
Crepidula rugosa, Nuttall. Ocean Beach.
Crucibulum spinosum, Sowerby. Ocean Beach.
Cryptomya californica, Conrad. La Jolla.
Cumingia californica, Conrad. La Jolla.
Cyprva spadicca, Gray. San Clemente.
Donax californicus, Conrad. Ocean Beach.
Drillia mæsta, Carpenter. Ocean Beach.
Erato vitellina, Hinds. Ocean Beach.
Fissurella volcano, Reeve. La Jolla.
Glyphis murina, Carpenter. San Clemente.
Haliotis cracherodii, Leach. San Clemente.
Haliotis fulgens, Philippi. San Clemente.
Haliotis rufescens, Swainson. La Jolla.
Hipponyx tumens, Carpenter. La Jolla.
Littorina planaxis, Nuttall. La Jolla, Ocean Beach, etc.
Lucapina crenulata, Sowerby. San Clemente.
Lucina californica, Conrad. San Clemente.
Macoma nasuta, Conrad. San Clemente.
Monoceros eugonatum, Conrad. San Clemente.
Mopalia muscosa, Gould. San Clemente.
Muricidea incisa, Broderip. San Clemente.
Mytilus californicus, Conrad. La Jolla, etc.
Nassa fossata, Gould. Ocean Beach.
Nassa mendica, Gould (pl. XXXIII, figs. 3 and 9). Ocean Beach.
Nassa perpinguis, Hinds. Ocean Beach.
Nassa tegula, Reeve. San Clemente.
Norrisia norrisii, Sowerby. San Clemente, etc.
Olivella buetica, Carpenter. Ocean Beach.
Olivella biplicata, Sowerby. Ocean Beach and San Clemente. Also on the top of the Huachuca Mountains, Arizona, where it had been doubtless carried by Indians and used in some of their religious rites.
Pecten aquicostatus, Carpenter. San Diego Bay, etc.
Pecten latiauritus, Conrad. La Jolla.
Psammobia rubroradiata, Conrad. San Clemente.
Purpura ostrina, Gould. San Clemente.

- Ranella californica*, Hinds. San Clemente.
Sanguinolaria nuttallii, Conrad. La Jolla.
Saxidomus aratus, Gould. La Jolla.
Scurria (Lottia) gigantea, Gray. La Jolla, Guadalupe Island, San Clemente, etc. Some of these specimens, especially from the islands, were of remarkably large size.
Semele pulchra, Sowerby. Ocean Beach.
Semele rubropicta, Dall. Ocean Beach.
Semele rapinum, Sowerby. La Jolla.
Septifer bifurcatus, Conrad. La Jolla.
Tapes staminea, Conrad. La Jolla.
Tellina bolegensis, Hinds. La Jolla.
Terebratalia transversa, Sowerby, var. *caurina*, Gould. Ocean Beach.
Tivela crassatelloides, Conrad. Mouth of the Colorado River and also on the Pacific. Fresh specimens of this species were found near Tucson, where they had probably been brought by Indians who use marine shells in some of their religious rites.
Tresus nuttallii, Conrad. Ocean Beach.
Turritella goniosoma, Valenciennes. Ensenada.

It may be noted that marine shells in a subfossil but rather fresh condition, sometimes even containing the ligament, occur toward the edge of the lowlands until the ranges east of Tucson, Arizona, are reached. These are probably Post-Pliocene and evidences of the eastward extension of the sea, which, at a comparatively recent geological epoch, almost insulated Mexico from the continent north of it. A discussion of the points involved has been omitted, as they will be discussed by Dr. Mearns in his report on the natural history work. Among the species recognized were *Solenosteira pallida*, Broderip, *Polynices (Nevritya) recluziana*, Reeve, *Mulinia coloradoensis*, Dall, and *Tivela crassatelloides*, Conrad.

EXPLANATION OF PLATES.¹

PLATE XXXI.

- FIG. 1. *Holospira (Haplostemma) mearnsii*, Dall; 14.5 mm.; with profile of aperture; p. 350.
 2. *Holospira (Metastoma) crossi*, Dall; 11 mm.; with profile of aperture; p. 348.
 3. *Holospira (Distomospira) bilamellata*, Dall; 20.5 mm.; profile of aperture; p. 349.
 4. *Holospira (Metastoma) pasonis*, Dall; 23 mm.; p. 348.
 5. The same in profile.
 6. Jaw of *Bulinulus (Leptobyrus) artemesia*, Binney; greatly magnified; from camera lucida drawing by W. H. Dall; pp. 360, 362.
 7. *Epiphragmophora hachitana*, Dall; front view of a rather depressed specimen; 26.5 mm.; p. 339.
 8. Jaw of *Bulinulus (Plicolumna) ramentosus*, Cooper; greatly magnified; from a camera lucida sketch by W. H. Dall; p. 363.
 9. *Bythinella palomasensis*, Pilsbry; 2.75 mm.; p. 369.
 10. *Epiphragmophora hachitana*, Dall; basal view; major diameter, 26.5 mm.; p. 339.
 11. *Epiphragmophora arizonensis*, Dall; front view; 17 mm.; p. 337.
 12. The same, basal view.

¹The actual length in millimeters of the specimen figured follows the reference in each case.

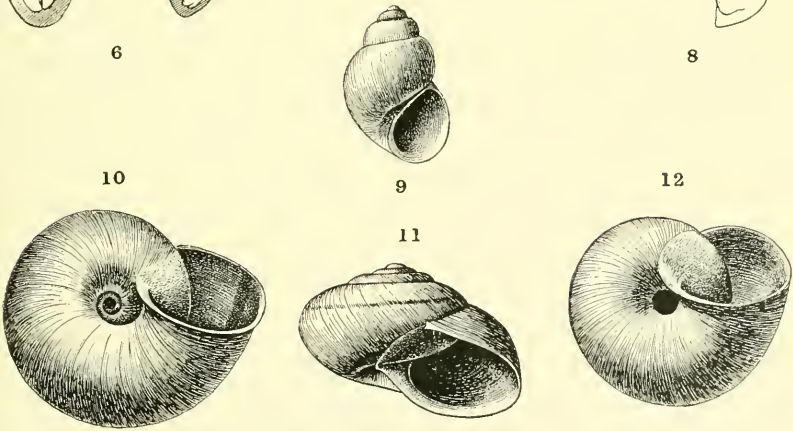
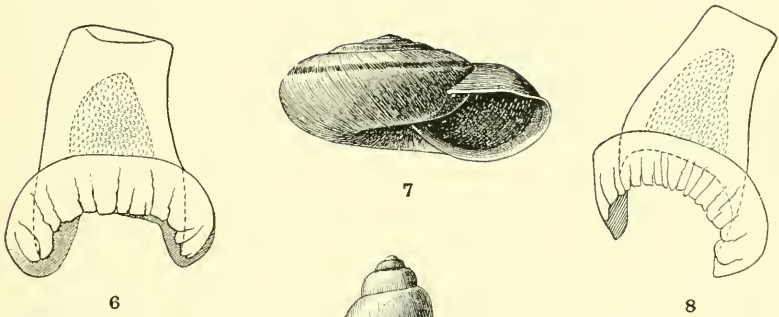
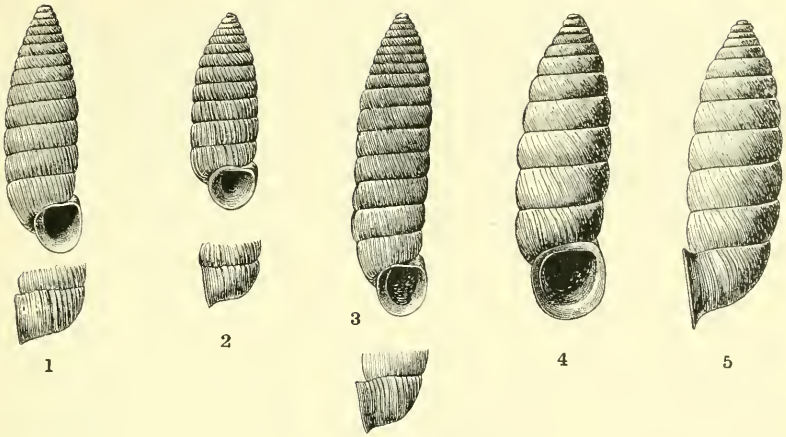
PLATE XXXII.

- FIG. 1. Inside view of right valve of *Unio mitchelli*, Simpson; 54 mm. long; p. 371.
2. Dorsal view of the same.
3. External view of left valve.
4. *Anodonta dejecta*, Lewis; dorsal view of specimen, 75 mm. long; p. 372.
5. The same, side view.
6. *Balimulus artemesia*, W. G. Binney; a large worn specimen, not showing spiral sculpture; 31 mm. long; p. 360.
7. *Polygyra mearnsii*, Dall; front view; 13 mm.; p. 343.
8. The same from above.
9. *Polygyra chiricahuana*, Dall; front view, 18 mm.; p. 341.
10. The same from above.
11. *Polygyra mearnsii*; basal view; p. 343.
12. *Polygyra chiricahuana*, Dall; basal view, p. 341.

PLATE XXXIII.

- FIG. 1. *Coelocentrum pfefferi*, Dall; 43 mm.; p. 352.
2. *Coelocentrum pfefferi*, Dall; view of base, same enlargement; p. 352.
3. *Nassa mendica*, Gould; slender southern form; No. 46634, U.S.N.M.; p. 377; compare fig. 9.
4. *Streptostyla nebulosa*, Dall; 22 mm.; p. 364.
5. *Coelocentrum nelsoni*, Dall; 53 mm.; p. 352.
6. *Coelocentrum nelsoni*, Dall; view of the base, same enlargement; p. 352.
7. *Anisospira strebeli*, Dall; showing adult decollate shell, with the portion of the spire which is dropped; 29 and 21 mm.; p. 353.
8. *Anisospira strebeli*, Dall; view of base, same enlargement; p. 353.
9. *Nassa mendica*, Gould, var. *cooperi* Forbes, a strongly ribbed form; No. 46636, U.S.N.M.; p. 377.

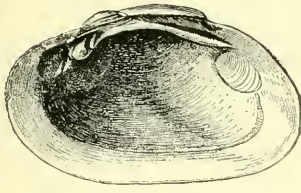




SHELLS OF THE MEXICAN BOUNDARY.

FOR EXPLANATION OF PLATE SEE PAGE 378.

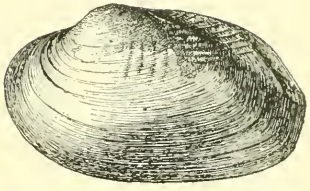




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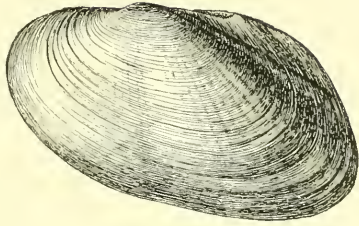
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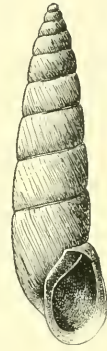
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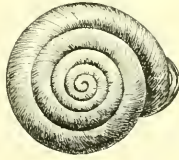
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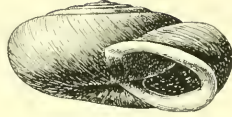
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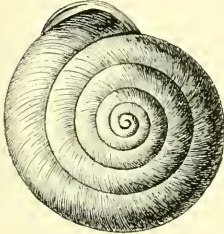
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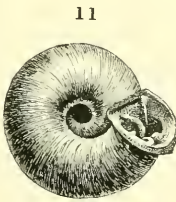
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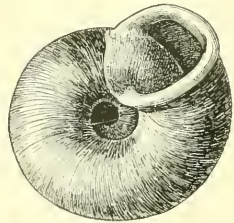
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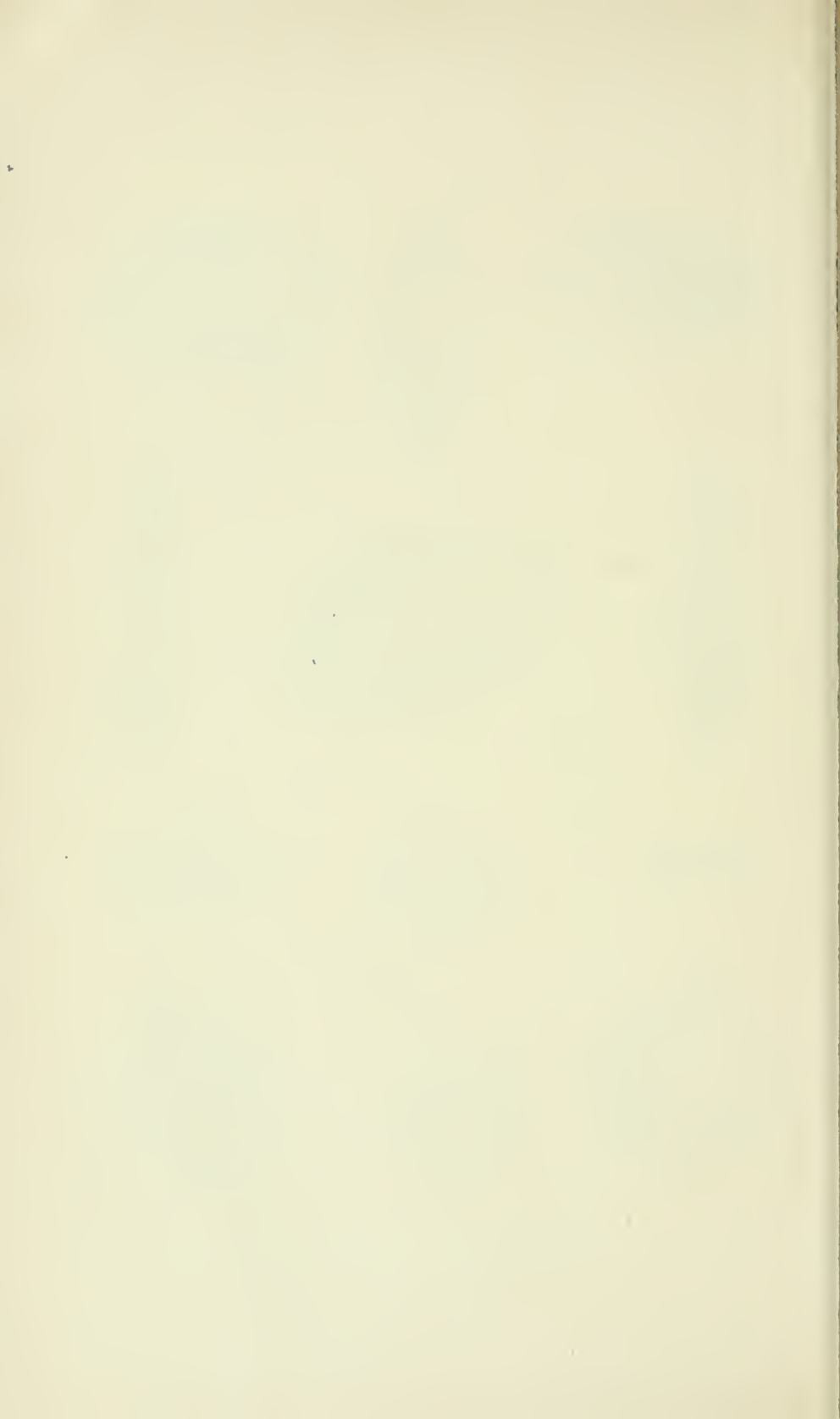
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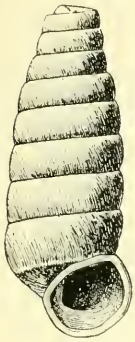


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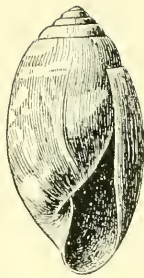
SHELLS OF THE MEXICAN BOUNDARY.

FOR EXPLANATION OF PLATE SEE PAGE 379.





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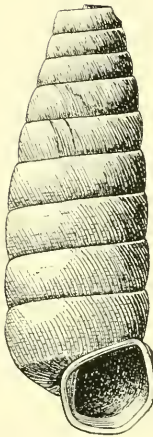
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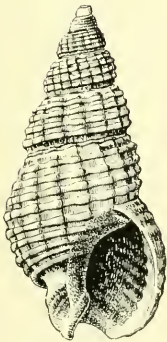
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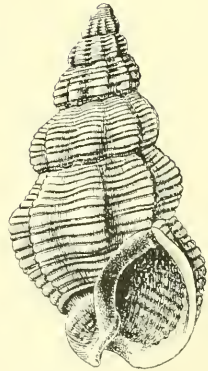
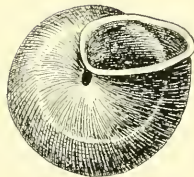
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SHELLS OF THE MEXICAN BOUNDARY.

FOR EXPLANATION OF PLATE SEE PAGE 379.

