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SOME VENEZUELAN AND CARIBBEAN MOLLUSKS

BY

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AND
GILBERT D. HARRIS

October 7, 1927

Harris Co.
Ithaca, N. Y.
U. S. A.

INTRODUCTION

The collections upon which this article is based were made in Venezuela for an American company. Only descriptions of species with general localities and general ages can be given at present, but later, when the interests of the company permit, we hope to publish definite localities and stratigraphic ranges for the species.

The species referred to "Williston MS." in the text are adapted from the unpublished manuscript of Mr. S. H. Williston, formerly with the Venezuelan Sun Company. Mr. Williston's manuscript consists of descriptions and figures of specimens collected in the State of Falcón, Venezuela, and was written at Cornell University in the summer of 1923. Where his specimens have been figured in the plates, acknowledgment is made.

Acknowledgments are due especially to Dr. Katherine Van Winkle Palmer and Dr. Pearl G. Sheldon for their help in sorting the Veneroids and Arcas, respectively, and in comparing them with described forms.

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66	22	for **Architectonia** read **Architectonica**
66	26	**for** be a little **read** be little
66	37	delete 2207
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DESCRIPTION OF SPECIES

Class PELECYPODA Goldfuss

Family PARALLELODONTIDÆ Dall

Genus CUCULLÆA Lamarck

Cucullæa perijana F. and H. Hodson, n. sp. Pl. 1, figs. 1, 3, 5.

Shell small, subquadrate, very inflated, higher than long, not produced posteriorly. The beaks are high, incurved over the narrow, short, ligamental area, which is somewhat wider behind the beaks; the ligamental area shows faint grooves parallel to the hinge line. The posterior part of the beaks is flattened and continuous with the flattened posterior end of the shell; the projection of the hinge line into the flattened end forms an elevation. The anterior ends of the valves are rounded. Both valves are ornamented with close-set concentric lines crossed by radials of about equal prominence; microscopically, the sculpture is closely recticulate. The superior edge of the hinge is straight and practically at right angles with the almost vertical anterior and posterior margins; the ventral margin is almost parallel to the hinge line. The central part of the hinge line is slightly narrower and carries short, close-set, vertical, taxodont teeth. Toward the ends of the hinge line, the teeth become increasingly oblique. The muscle scars are large, rounded, and impressed.

Age: Upper Cretaceous.

Locality: District of Perijá, State of Zulia, locality number 2220.

Genus PSEUDOCUCULLÆA Solger

Pseudocucullæa parijana Harris, F. and H. Hodson, n. sp.
Pl. 1, fig. 4; pl. 2, figs. 1, 3, 4; pl. 3, fig. 1.

Shell rather large, produced posteriorly and slightly gaping anteriorly. The cardinal area is marked by chevron-shaped grooves. The hinge plate is curved and rather heavy. The dentition consists of an anterior series of 3 or 4 parallel teeth elongated in the direction of the hinge plate and separated from a central taxodont series, under the beak, by a smooth area near the anterior third of the hinge. The central taxodont series forms the central part of the hinge, and is composed of teeth about vertical to the direction of the hinge plate; these become more oblique toward each end; this series terminates anteriorly a little in front of the beak and posteriorly grades into the posterior laterals. In the right valve, the posterior laterals consist of one strong lateral, with a smaller, lamellar, parallel one above it, and a shorter, strong, parallel, interior lateral near the muscle scar. The sculpture consists of close-set concentric lines, crossed by fainter radials.

Age: Upper Cretaceous.

Locality: District of Perijá, State of Zulia, locality number 2220.

Family ARCIDÆ Dall

Genus ARCA Linné

As the subgenera of Arca intergrade very closely, they have been considered here as of only subgeneric rather than of generic rank.

Subgenus ARCA s. s.

Arca (Arca) occidentalis Philippi

Arca occidentalis Philippi, 1847, Abbild. u. Beschr., 3, p. 14, pl. 17b, fig. 4 a–c.

Arca occidentalis Philippi, Dall, 1898, Trans. Wagner Free Inst. Sci. Philadelphia, vol. 3, pt. 4, p. 620.

Arca occidentalis Philippi, Sheldon, 1916, Paleont. Amer., vol. 1, p. 8, pl. 1, figs. 8–11.

Arca occidentalis Philippi, Maury, 1917, Bull. Amer. Pal., vol. 5, p. 327, pl. 55, fig. 3.

Arca occidentalis Philippi, Olsson, 1922, Bull. Amer. Pal., vol. 9, no. 39, pp. 181–182, pl. 22, fig. 1.

Arca occidentalis Philippi, Maury, 1925, Bull. Amer. Pal., vol. 10, no. 42, pp. 34–35, pl. 1, figs. 1, 2.

Arca occidentalis Philippi, Woodring, 1925, Carnegie Inst. of Washington, publication number 366, pp. 29–30, pl. 2, figs. 8, 9.

This is not an abundant fossil species in Venezuela.

Age: Miocene-Recent.

Locality: Districts of Colina, Democracia and Falcón, State of Falcón; Ter, Delta Amacuro; recent along the Falcón coast; locality numbers 185, 1033, 1131, 1504, 1818.

Arca umbonata pæzensis H. K. Hodson, n. subsp. Pl. 1, fig. 7.

In the Quaternary, along with *A. umbonta* Lamarck, is a larger form which seems to be a subspecies. It is not only larger, but has many fine riblets between the main longitudinal ribs, especially on the anterior.

Age: Quaternary.

Locality: District of Paéz, State of Zulia, locality number 526.

Subgenus NOETIA Gray

Arca (Nœtia) macdonaldi Dall

Arca (Nœtia) macdonaldi Dall, 1912, Smithsonian Miscellaneous Collections, vol. 59, no. 2, p. 9.

Arca MacDonaldi Dall, Olsson, 1922, Bull. Amer. Pal., vol. 9, no. 39, pp. 194–195, pl. 25, figs. 4–5.

Arca (Nœtia) macdonaldi Dall, 1925, Proc. U. S. Nat. Mus., vol. 66, p. 5, pl. 17, fig. 9.

The specimens from Venezuela are very poorly preserved; the shells are broken and frequently replaced and thickened with gypsum. They are apparently specifically identical to the Costa Rican form; they show an area of variable width as mentioned by Olsson, and have much the same trigonal shape as shown by Dall's figure of the type. Two of our specimens from Gatun seem typical of the species and almost identical with Dall's figure.

Age: Miocene.

Locality: District of Democracia, State of Falcón, locality numbers 1792, 2255, 2267; Gatun Spillway, Gatun, C. Z.

Subgenus SCAPHARCA Gray

Section SCAPHARCA s. s.

Arca (Scapharca) wiedenmayeri H. K. Hodson, n. sp. Pl. 1, figs. 2, 6.

The shell is rather rectangular, inflated, only slightly produced posteriorly. It is ornamented with about 32 ribs, which are about equal in width to the interspaces. The ribs of the right valve are slightly narrower and smoother than those of the left; the ribs of both valves are somewhat narrower in the center. On the left valve, the ribs are rather strongly nodose and bifurcate; posteriorly, they become less noded and carry secondary longitudinal lines. The beaks are full, medially sulcate, situated at about the anterior fourth of the shell. The cardinal area is lanceolate and bears about three lozenge-shaped grooves. The teeth and interior cannot be seen as all of the specimens consist of two valves fastened together.

Named in honor of Dr. C. Wiedenmayer, who collected the material.

Age: Oligocene.

Locality: District of Buchivacoa, State of Falcón, locality number 2447.

Arca (Scapharca) zuliana H. K. Hodson, n. sp. Pl. 4, figs. 7, 8, 10.

The shell is small, high, so tumid that a whole shell of two valves is about as thick as long, flattened behind the beaks, slightly produced posteriorly. The beaks are medially sulcate, posteriorly keeled, situated at about the anterior fourth of the whole length of the shell. There are 36-41 undivided ribs, crossed by growth lines which ornament them with knobs; the interspaces are wider than the ribs. The ribs of the right valve are narrower than those of the left, and separated by wider interspaces. The internal margin is deeply fluted in harmony with the external ribbing. The ligamental area extends slightly more than half the length of the shell, and bears about 5 chevron-shaped grooves. The teeth are vertical, straight, and arranged in an almost uninterrupted series with about 20 anterior and 28 posterior.

The adults are easily distinguished from other species by being proportionately higher, flattened posteriorly, and very tumid. From *A. zuliana maracaibensis* (n. subsp.), it is distinguished by its longer teeth, somewhat shorter hinge line and less produced posterior.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia; District of Buchivacoa, State of Falcón; locality numbers 6, 2040 (*cf.*).

Arca zuliana maracaibensis H. K. Hodson, n. subsp. Pl. 4, figs. 9, 11.

This subspecies is distinguished from *A. zuliana* (n. sp.) by being more produced posteriorly and having a somewhat longer hinge line. The teeth are fewer, shorter, somewhat bent, more widely spaced; the series is narrower at the center and wider at the ends. There are all intergradations between the species and subspecies.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia; District of Acosta, State of Falcón; locality numbers 6, 1415.

Arca (Scapharca) weeksi H. K. Hodson, n. sp. Pl. 4, figs. 4, 6.

The shell is high, small, inflated, ornamented with about 32 ribs. On the right valve, these ribs are a little wider than the interspaces and are knobbed. On the left valve, the ribs are noded only on the anterior and are about equal in width to the interspaces. The beaks are inflated and situated a little in front of the anterior fourth of the shell. The cardinal area is not large and carries about 2 chevron-shaped grooves. The teeth are long, close-set, and arranged in a scarcely interrupted series with about 14 anterior and 20 posterior. The inner margin is fluted in harmony with the external ribbing.

This shell is very close to *A. zuliana* (n. sp.), but there is no characteristic identical in the two species. *A. weeksi* (n. sp.) is smaller, has about 10 less ribs, is more irregularly shaped, has fewer teeth, fewer chevron-shaped grooves on the cardinal area, and narrower beaks.

Named in honor of Mr. L. G. Weeks, who collected the specimens figured.

Age: Oligocene-Miocene.

Locality: District of Buchivacoa, State of Falcón; District of Bolívar, State of Zulia; locality numbers 1943, 2420 (? large), 3222, 3250, 4619.

Arca (Scapharca) berjadinensis H. K. Hodson, n. sp.
Pl. 4, figs. 1, 2, 3, 5.

The shell is small, of variable shape, produced posteriorly and rounded anteriorly. The beaks are high, full, and situated at about the anterior fourth of the shell. The umbonal ridge is distinct throughout its length although toward the margin it becomes more rounded; behind this, the shell is concave. The ventral margin is straight or only slightly curved. The cardinal area is short and wide, occasionally marked with a few chevron-shaped grooves. The teeth are divided into two series, the anterior is more crowded and shorter, the posterior longer and more curved at the end. Most of the valves carry about 28 ribs, about 10 of which are behind the umbonal ridge; they are separated by interspaces only slightly narrower than the ribs, although on the anterior and in gerontic specimens, the interspaces are equal to or wider than the ribs. Rather strong nodes cover the ribs except near and on the umbonal ridge; here the ribs are noded only in the very young stages; if any nodes at all occur posterior to the umbonal ridge, they are found up near the cardinal area and are weak. The nodes on the left valve seem to be slightly stronger than those on the right. The inner margin is deeply fluted in harmony with the external ribs. Very large, gerontic specimens measure about 22 mm. in height, 26 mm. in length and 19 mm. in diameter (2 valves); these are very produced posteriorly and carry a few chevron-shaped grooves on the cardinal area. Average adult specimens measure about 14 mm. in height, 16 mm. in length and 14 mm. in diameter (2 valves).

This species differs from *Arca pittieri* Dall [1] in being smaller, more produced posteriorly, and in carrying fewer nodes on the ribs near the umbonal ridge. *A. lloydi* Olsson [2] is less produced posteriorly and carries an inter-

[1] Smithsonian Misc. Coll., 1912, vol. 59, no. 2, pp. 9–10.

[2] Bull. Amer. Pal., 1922, vol. 9, no. 39, pp. 192–193, pl. 24, figs. 10–12.

stitial thread not found in *A. berjadinensis* (n. sp.). The new species is smaller and more produced posteriorly than *A. hindsi* Olsson.[1]

A. berjadinensis (n. sp.) is a very common species of Arca in Venezuela and varies somewhat in shape, especially in the fullness of the umbones and in the twist of the posterior prolongation.

Age: Miocene.

Locality: Districts of Colina, Buchivacoa and Democracia, State of Falcón, localitly numbers 24, 67, 70A, 74A, 75, 79, 82, 83A, 90, 93, 94, 97, 150A, 150B, 184, 185, 187, 193, 193A, 216 (?), 225, 225A, 228, 273, 291, 298, 1000, 1007, 1010 (?), 1064, 1078, 1115, 1210, 1232, 1233, 1800, 1844, 1862, 1869, 1872, 1883, 1900, 1906B, 2036, 2054, 2375, 2377, 2383, 2384, 2391.

Arca grandis waringi Maury Pl. 7, figs. 1, 4.

Scapharca patricia Sowerby, C. J. Maury, 1917, Bull. Amer. Pal., vol. 5, no. 29, pp. 173–174, pl. 27, fig. 1 (*partim*).
Scapharca patricia waringi Maury, 1925, Bull. Amer. Pal., vol. 10, no. 42, pp. 58–59, pl. 3, figs. 2, 5.

Dr. W. P. Woodring [2] has examined a replica of the lectotype (selected by Blake and Sherborn) of *A. patricia* Sowerby [3] and found it to be equivalent to *A. tolepia* Dall [4]
pp. 649–650, pl. 33, figs. 7, 8.

and *A. arthurpennelli* Maury.[5] As long as this lectotype is considered valid, another name must be used for what has commonly been called *A. patricia*. *A. grandis waringi* seems the only logical name for this group.

In Venezuela, *A. grandis waringi* Maury is a very common and variable species. In Santo Domingo, occurs the larger form, *A. grandis* Sowerby, as has been previously stated by Dr. H. A. Pilsbry[6]; with this is found its sub-

[1] *Loc. cit.*, pp. 193–194, pl. 24, figs. 7–9.
[2] Science, December 4, 1925, vol. 62, no. 1614, pp. 518–519.
[3] Geol. Soc. London Quart. Jour., 1850, vol. 6, p. 52.
[4] Trans. Wagner Free Inst. Sci. Philadelphia, 1898, vol. 3, pt. 4,
[5] Bull. Amer. Pal., 1917, vol. 5, p. 342, pl. 55, figs. 9, 10.
[6] Proc. Acad. Nat. Sci. Philadelphia, 1921, p. 404.

species *waringi* as well as the similar form *A. chiriquensis* Gabb. Trindad is the type locality for the subspecies *waringi;* Dr. Maury's recorded "*A. patricia*" from there may be *A. grandis* or only one of the numerous intergradations between the species and its subspecies.

The numerous specimens from Venezuela have been carefully compared with fossil specimens from Santo Domingo, recent specimens of *A. grandis,* and Dr. Maury's figures of the Trinidad material. *A. grandis waringi* Maury is a very variable form and the ancestor of the more recent species, from which it differs mainly in its smaller size. It becomes larger and approaches the more recent species more closely as it is found through successively younger beds, with all gradations between the species and the subspecies present.

Age: Miocene and Pliocene.

Locality: Common in the State of Falcón, locality numbers 70, 71, 72, 74, 79, 83, 84, 90, 106, 122, 196, 203, 296, 298, 299, 355, 415, 785, 789 (?), 940, 1020, 1027, 1045, 1064, 1125, 1233, 1252, 1484, 1489, 1859, 1860, 1861, 1862, 1869, 1870, 1871, 1873, 1878A, 1882, 1883, 1885A, 1887, 1892, 1927, 2042.

Arca (Scapharca) saladillœnsis H. K. Hodson, n. sp. Pl. 5, figs. 1, 3.

The shell is very small, inflated, high, and posteriorly keeled. The right valve has about 28 ribs, about equal in width to the interspaces, and coarsely noded. The beak is medially sulcate, high, inflated, and situated at about the anterior fourth of the shell. The cardinal area is fairly large and carries a few grooves. The inner margin is fluted in harmony with the external ribbing. The series of teeth is only slightly interrupted with about 21 posterior and 12 anterior teeth; these are long, slender, and only slightly larger at the ends. The right valve has not yet been found.

This small species seems to be adult and is easily distinguished from the young of *A. zuliana* (n. sp.) and of

A. mirandana (n. sp.), with which it is associated, by its stronger posterior keel, narrower beak, coarser nodes on the ribs, and wider denticulations on the inner margin.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality number 6.

Arca (Scapharca) vueltana H. K. Hodson, n. sp.

Pl. 5, figs. 2, 4, 6.

The shell is very small, round, very round. There are about 25-27 ribs about equal to the interspaces in width, and ornamented with rather coarse nodes; the ribs on the posterior umbonal ridge are smooth and a little more widely separated. The beaks are full and situated at the anterior third of the shell. The cardinal area is of fair size but carries no grooves; it is shaped much like that of *Argina*. The hinge line is somewhat curved posteriorly. The teeth are long and slender and arranged with only a slight interruption; there are about 11 anterior and 16 posterior The inner margin is crenulated in harmony with the external ribbing.

This Arca is rare and usually poorly preserved. It is very small and easily distinguished from other species.

Age: Miocene.

Locality: Districts of Zamora, Democracia, and Colina, State of Falcón, locality numbers 86, 1010, 1335.

Arca vueltana falconensis H. K. Hodson, n. subsp.

Pl. 5, figs. 5, 7, 9.

This subspecies is less inflated than *A. vueltana* (n. sp.), and is more produced posteriorly. The beaks are lower, giving the subspecies a different shape, although the number of ribs, the cardinal area, and hinge line are about the same in the two forms.

Age: Miocene.

Locality: District of Democracia, State of Falcón, locality number 70A.

Arca (Scapharca) buenavistana H. K. Hodson, n. sp.
Pl. 3, figs. 3, 6; pl. 5, fig. 8.

The shell is small, trigonal, produced posteriorly, rounded anteriorly, and carries a sharp umbonal ridge running from the beaks to the margin. The ribs are evenly noded except for the 2 or 3 larger ones on the posterior slope; these, when well preserved, are almost smooth and carry about 5 fine longitudinal ridges; about 10 or 11 of the 32-34 ribs are located on the concave posterior slope. The beaks are full, high, prominent and located at the anterior fourth of the shell. The cardinal area is flat and carries about 6 chevron-shaped grooves. The ribs of the right valve are slightly narrower than those of the left, and the interspaces are correspondingly larger. On the left valve, the ribs are slightly wider than the interspaces except on the anterior; on the right valve almost all of the interspaces are slightly wider. The teeth are arranged in two series, the anterior of which is shorter; at the ends, where the teeth are larger, the hinge line curves down, especially at the posterior. The inner margin is deeply fluted in harmony with the external ribbing.

This species is seldom well preserved. Young specimens resemble *A. berjadinensis* (n. sp.), but the former have a sharper umbonal ridge and a longer, narrower, cardinal area.

Age: Miocene.

Locality: Districts of Colina, Democracia and Acosta, State of Falcón, locality numbers 80, 100, 185, 1033, 1127, 1255, 1450, 1818, 2207.

Arca veatchi matarucana H. K. Hodson, n. subsp. Pl. 3, figs. 4, 5.

This new subspecies is distinguished from *A. veatchi* Olsson [1] by its being more produced posteriorly and by having wider interspaces between the central ribs; in most of the Venezuelan specimens, the cardinal area carries

[1] Bull. Amer. Pal., 1922, vol. 9, no. 39, pp. 189–190, pl. 23, figs. 1–3.

more than 3 grooves. The teeth, the number of ribs, the sculpture, and the fluting of the inner margin, are the same as that of the species.

Age: Miocene.

Locality: District of Colina and Falcón, State of Falcón, locality numbers 122B, 123, 127, 155, 1013, 2207 (very young).

Arca (Scapharca) mirandana H. K. Hodson, n. sp. Pl. 5, figs. 12, 13.

The shell is small, almost elliptical in shape but abbreviated anteriorly, tumid, produced posteriorly. The beaks are medially sulcate and situated a little in front of the anterior fourth of the length of the shell. There are approximately 38 ribs in the smaller shells and 42 in the largest. These are narrow and crossed by concentric growth lines which ornament the central ones on the left valve with small square knobs. The ribs of the right valve are almost smooth and narrower than those on the left. The interspaces are usually wider than the ribs. The inner margin is deeply fluted in harmony with the external ribbing. The cardinal area extends about three-fourths the length of the shell, and usually bears 4 chevron-shaped grooves. The teeth are arranged in a series slightly interrupted posterior to the beak, and curved downward at the ends. In the adults, the teeth number about 25 anterior and 35 posterior, but this varies.

Age: Oligocene-Miocene.

Locality: District of Buchivacoa, State of Fulcón; District of Miranda, State of Zulia; locality numbers 6, 1070 (deformed), 1436 (deformed), 1628, 1939, 1951.

Arca (Scapharca) tirantensis H. K. Hodson, n. sp. Pl. 7, figs. 2, 3.

The shell is of medium or small size, inflated, produced posteriorly. The beaks are medially sulcate, high, full, and situated at about the anterior fourth of the shell. It is ornamented with about 33-34 ribs, which are about equal in width to the interspaces. Most of these are bifurcate;

they are widest posteriorly and narrowest in the center. The cardinal area is lanceolate, very deep-set, and slopes down toward the hinge line. On an adult shell, there are about 9 close, chevron-shaped grooves. The teeth are unknown as all the specimens consist of two valves fastened together.

The younger specimens of this species resemble *A. mirandana* (n. sp.), but are higher for their length.

Age: Miocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 1936, 2420.

Arca (Scapharca) cornellana H. K. Hodson, n. sp. Pl. 6, figs. 4, 5.

The shell is small, long and narrow, produced and somewhat keeled posteriorly. It is ornamented with about 31 narrow ribs separated by wider interspaces. Posteriorly, the ribs are wider, especially on the keel. On the right valve, the anterior ribs are usually bifurcase on adult shells. The beaks are medially sulcate, full, and situated at about the anterior fourth of the shell. The cardinal area is lanceolate, only moderately wide, and extends almost three-fourths of the length of the shell. The teeth are very short, rather widely spaced and longer on the ends of the series. They are arranged in a scarcely interrupted series, with about 22 anterior and 26 posterior. The inner margin is fluted in harmony with the external ribing.

This species is easily distinguished from *A. mirandana* (n. sp.) by its posterior keel and more quadrangular shape.

Age: Miocene.

Locality: District of Bolívar, State of Zulia, locality numbers 3249, 3250.

Arca (Scapharca) actinophora Dall

Scapharca (*Scapharca*) *actinophora* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 647, pl. 33, fig. 26.
Scapharca (*Scapharca*) *antinophora* Dall, Sheldon, 1916, Paleont. Amer., vol. 1, p. 50, pl. 11, fig. 13.

Arca actinophora Dall, Olsson, 1922, Bull. Amer. Pal., vol. 9, no. 39, p. 185, pl. 23, figs. 7, 8; pl. 25, fig. 3.

A. actinophora Dall is a rather rare species in Venezuela and not very well preserved. The few specimens found are like those figured by Dall and Olsson.

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 122A, 122B, 127.

Arca (Scapharca) lienosa Say Pl. 6, fig. 6.

Arca lienosa Say, 1832, Am. Conch., 4, pl. 36, fig. 1.
Arca lienosa Say, Tuomey and Holmes, 1855, Pleioc. Fos. S. Car., p. 40, pl. 15, figs. 2, 3.
Arca lienosa Say, Heilprin, 1887, Trans. Wagner Free Inst. Sci., vol. 1, p. 97, (*partim*).
Scapharca (Scapharca) lienosa Say, Dall, 1898, Trans. Wagner Free Inst. Sci., vol. 3, pt. 4, p. 636.
Arca lienosa Say, Sheldon, 1916, Paleont. Amer., vol. 1, no. 1, pp. 35–36, pl. 7, figs. 26, 27, 28; pl. 8, figs. 1, 2.

In Venezuela, there occurs a very abundant ark which is so close to *Arca lienosa* Say that it does not seem worthy of even varietal rank. In fact, some of the specimens are practically identical. Its ribs usually carry secondary grooves and the lower margin is usually arcuate. This same shell is still recent along the north coast of Venezuela although it is represented in the present collections by only two specimens. One of these is quite perfect; its lower margin is only slightly arcuate and the ribs carry only the main medial sulcus, but this seems to be mere variation. The recent and fossil specimens differ from *A. secticostata* Reeve in general shape and in the more closely set ribs.

Age: Miocene and Recent.

Locality: Districts of Colina and Democracia, State of Falcón, locality numbers 80, 131, 150B (?young), 155, 174, 182, 184, 185, 204 (? fragment), 206 (?young), 1033, 1252, 1255; recent from coast near La Vela, District of Colina, State of Falcón.

Arca (Scapharca) tamarana H. K. Hodson, n. sp. Pl. 5, figs. 10, 11.

The shell is small, inflated, posteriorly produced, ornamented with about 35 ribs. On the left valve, the ribs are rather strongly noded and about equal in width to the interspaces, except on the posterior keel where they are wider and smoother. On the left valve, the ribs are a little narrower and smoother. The beaks are situated a little anterior to one-fourth the length of the shell; they are medially sulcate and inflated, especially posteriorly. The cardinal area is lanceolate, marked with about 4 grooves, and is almost as narrow as in *Argina*. The teeth are short in the center and longer at the ends; they are arranged in an almost uninterrupted series with about 26 posterior and 19 anterior. The inner margin is scarcely grooved anteriorly, but is deeply fluted posteriorly.

This species is less inflated than *A. zuliana maracaibensis* (n. subsp.), has wider ribs, and a narrower ligamental area.

Age: Miocene.

Locality: District of Buchivacoa, State of Falcón; District of Bolívar, State of Zulia; locality numbers 1942, 3249, 3250, 4619.

Section ARGINA Gray

Arca (Scapharca) democraciana H. K. Hodson, n. sp.
Pl. 6, figs. 1, 2, 3.

The shell is rather small, plump, equivalve, keeled posteriorly and slightly produced. It is ornamented with about 32-34 low, wide ribs, which are separated by interspaces about half of the width of the ribs; the ribs on the right valve and on the anterior of the left valve are slightly farther apart; the ornamentation of the ribs is slight or worn off on all the available specimens. The beaks are low, close-set, medially sulcate, and situated at the anterior fourth of the shell. The hinge line is scarcely interrupted and has about 31 posterior and 14 anterior teeth. The cardinal area is very narrow and carries 3 or 4 grooves. The posterior end of the hinge line is prominent and looks like an ear. The crenulations of the inner margin correspond to the external ribs and are deeper posteriorly.

This abundant Arca is usually poorly preserved.

Age: Miocene.

Locality: Districts of Democracia and Colina, State of Falcón, locality numbers 70A, 118, 150B, 185, 187, 1026, 1869, 1872, 1883, 1934.

Genus GLYCYMERIS Da Costa

Glycymeris canalis Brown and Pilsbry

Glycymeris canalis Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Phila., p. 364, pl. 28, fig. 10.
Glycymeris canalis Brown and Pilsbry, Olsson (*partim*), 1922, Bull. Amer. Pal., vol. 9, no. 39, p. 177, pl. 18, figs. 2, 6, 7.
Glycymeris canalis Brown and Pilsbry, Maury, 1925, Bull. Amer. Pal., vol. 10, p. 183, pl. 29, figs. 3, 4.

We have several hundred specimens of this stock of *Glycymeris.* It is an exceedingly common and variable species; there are all variations, mutations and intergrading forms between the species, *sensu stricto,* and forms which have been described as *G. trilobicostata* Pilsbry and Brown and *G. lloydsmithi* Pilsbry and Brown. We see no reason for considering these latter forms other than subspecies. When the specimens show the "brace-shaped" or 3-parted character of the ribs prominently to the ventral margin, there is no reason why such forms may not be referred to the subspecies *trilobicostata.* Those specimens which, in the adult stages, tend to become smooth ventrally may be referred to the subspecies *lloydsmithi.* The peripheral outline of the valves in this group assumes very marked variations, varying from transversely elliptical to altitudinally ovate; gerontic specimens tend to be produced posteriorly.

Age: Oligocene and Miocene.

Locality: Common in the State of Falcón; District of Miranda, State of Zulia; Cartagena, Colombia; locality numbers 6, 23, 70A, 72, 75, 78, 79, 80, 81, 82, 83, 86, 90, 93, 94, 118, 122B, 122C, 123, 127, 130, 131, 149A, 150A, 150B, 153A, 154, 155, 159, 178, 182, 183, 184, 185, 187, 189, 193, 204, 206, 206A, 216, 291, 298, 300, 1007, 1012, 1013, 1033, 1034, 1035, 1100, 1111, 1255, 1335, 1629, 1887, 2027.

Glycymeris canalis lloydsmithi Pilsbry and Brown

Glycymeris lloydsmithi Pilsbry and Brown, 1917, Proc. Acad. Nat. Sci. Phila., vol. 59, p. 39, pl. 6, fig. 6.

Glycymeris lloydsmithi Pilsbry and Brown, Olsson, 1922, Bull. Amer. Pal., vol. 9, p. 353, pl. 28, figs. 8–10.

Variations which may be referred to this subspecies are found in several collections. Only those collections which contain rather abundant specimens of this subspecies are included in the list of localities.

Age: Miocene.

Locality: Districts of Colina, Miranda and Democracia, State of Falcón; Cartagena, Colombia; locality numbers 84, 131, 216, 225A, 1100, 1255.

Glycymeris canalis trilobicostata Pilsbry and Brown

Glycymeris trilobicostata Pilsbry and Brown, 1917, Proc. Acad. Nat. Sci. of Philadelphia, p. 39, pl. 6, fig. 5.

Glycymeris canalis Brown and Pilsbry, Olsson (*partim*), 1922, Bull. Amer. Pal., vol. 9, pp. 349–350, pl. 21, fig. 4.

Glycymeris trilobicostata Pilsbry and Brown, Maury, 1925, Bull. Amer. Pal., vol. 10, p. 184, pl. 29, fig. 11.

General remarks which apply to this form have been given under the discusion of th especies, *sensu stricto*.

Age: Oligocene-Miocene.

Locality: Districts of Colina and Miranda, State of Falcón; District of Bolívar, State of Zulia; Cartagena, Colombia; locality numbers 149A, 266, 1100, 1552, 3246, 3249, 3250.

Glycymeris canalis democraciana F. and H. Hodson, n. subsp.
Pl. 2, figs. 2, 5; pl. 3, fig. 2.

This subspecies differs from *G. canalis* Brown and Pilsbry mainly in being much larger and in being produced posteriorly. Our specimens average 40-45 mm. in altitude, and the greatest length is approximately equal to the altitude. There are 12 or more teeth on each half of the hinge line; the teeth nearer the center are more arcuate and larger. Young specimens cannot be told from the young of the species, *sensu stricto*.

It differs from the subspecies *lloydsmithi* Pilsbry and Brown in being more produced posteriorly and in having ribs distinct to the ventral margin.

Age: Miocene.

Locality: Districts of Democracia and Colina, State of Falcón, locality numbers 72, 81, 82, 93, 94, 148A (*cf.*).

Glycymeris tumefacta lavelensis F. Hodson, n. subsp.
Pl. 8, figs. 1, 4; pl. 9, fig. 1.

The shell is large, tumid, and slightly inequilateral. The submargins are only slightly curved. The beaks are strongly ribbed with about 13-15 main ribs which subdivide in low, wide, radially striate ribs. The pronounced character of the ribbing near the beaks soon disappears into indistinct, yet perceptible, ribs which carrry to the ventral margin; the ribs are striate with 3-5 radial threads; the interspaces are usually less than half the width of the ribs and carry 1–2 radial threads; thus, the whole shell is covered with radial threads; the ribs are scarcely distinguishable near the submargins, but the radial striation is conspicuous over the entire surface of the shell. The inner basal margin is strongly toothed. The cardinal area is moderately wide. The line of teeth is slightly arcuate; the dentition is very feeble under the beaks and forms an area which comprises a little less than one-third the total length of the whole hinge line; the anterior teeth (about 6 in number) are strong and oblique and become progressively smaller and more peg-like posteriorly.

This form belongs to the *G. tumefacta* Pilsbry and Brown [1] stock. This subspecies has much stronger ribbing on the beaks, which, also, tend to be a little higher; it has minute radial striation which is said to be lacking on the type from Colombia. The Venezuelan form is much larger than *G. jamaicensis* Dall from Bowden, Jamaica.

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 122B, 123, 131, 149, 154, 155, 160, 210, 322 (?), 1042, 1043, 1255, 1330, 1552.

Family OSTREIDÆ Lamarck

Genus OSTREA Linné

Ostrea wiedenmayeri F. Hodson, n. sp.

Pl. 8, figs. 2, 3, 5, 6; pl. 9, fig. 5.

Shell thick, moderately large, attached valve finely corrugated. The upper valve is comparatively flat and shows concentric lines of growth. The attached valve is usually deep and very thick in adult specimens; when not weathered, the outer layer shows numerous, closely spaced, radial riblets or plicæ; the area of attachment is usually large. When viewing the interior of the lower valve, the ligamental groove is twisted obliquely to the left. The submargins are denticulate near the beak.

The young specimens resemble *O. democraciana* (n. sp.), but are usually distinguished by the more numerous plicæ on the attached valve.

Named in honor of Dr. C. Wiedenmayer who collected the material.

Age: Oligocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 2424, 2426, 2452.

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1917, pp. 38–39, pl. 6, fig. 7.

Ostrea tacalensis F. Hodson, n. sp. Pl. 9, figs. 4, 6; pl. 10, figs. 2, 4, 6.

Shell is rather small with one valve plicate and the other smooth. The lower valve is ornamented with many plicæ, which are sometimes bifurcating and are usually wider than the interspaces; the valve is moderately deep and has a ligamental groove which turns very obliquely to the left; the margin is closely denticulate on the proximal half of the shell. The upper valve is smooth and not ornamented except by concentric lines of growth.

This species somewhat resembles the younger specimens of *O. wiedenmayeri* (n. sp.), but is a smaller shell and has coarser plicæ.

Age: Eocene-Oligocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 2438, 4609.

Ostrea democraciana F. Hodson, n. sp.
Pl. 9, figs. 3, 7; pl. 10, figs. 1, 3.

Shell small, attached valve plicate, upper valve smooth. The attached valve is deep; externally, it is ornamented with rather strong radial plicæ, which may be single or bifurcating; the plicæ frequently project beyond the margin of the shell as quasi spines. The ligamental groove is usually strongly recurved. The inside of the valves is denticulate on the submargins near the beak. The upper valve is usually moderately convex, and not ornamented exteriorly except by concentric lines of growth; the margin of this valve is not usually undulated as in the following subspecies.

The Ostrea and its varieties are very common and there are all intergradations between the species and its subspecies.

Age: Oligocene-Miocene.

Locality: Districts of Democracia, Federación, Acosta and Buchivacoa, State of Falcón; District of Urdaneta, State of Lara; locality numbers 6, 815, 995, 1231, 1627, 1703, 1705, 1705A, 1736, 1737, 1741, 1751, 1752, 1761, 1792, 1794, 1795, 1799, 1800, 1936 (?), 1939, 2022, 2023, 2027, 2049, 2096 (*cf.*).

Ostrea democraciana chiriguarana F. Hodson, n. subsp.
Pl. 10, fig. 5; pl. 11, figs. 1, 2, 3.

This subspecies is usually somewhat smaller than the species, *sensu stricto.* It is characterized by fewer, more pronounced plicæ, which cause the margins of both valves to be very undulating. The attached valve is frequently depressed between the half dozen or less strong corrugations or major plicæ, which are commonly found in most specimens. The internal denticulations near the beak are usually fewer on the anterior margin than on the posterior. The upper valve is moderately convex and usually somewhat plicate, but may or may not be plicate. This subspecies resembles *O. subfalcata* Conrad except that our form is smaller and carries denticulations on the margins near the beak.

Age: Miocene-Pliocene.

Locality: Districts of Buchivacoa, Colina, Zamora and Democracia, State of Falcón, locality numbers 80, 81, 83, 91, 171, 185, 300, 306, 1028 (?), 1065, 1353, 2410, 2416.

Ostrea democraciana cujiensis F. Hodson, n. subsp.
Pl. 12, figs. 1, 2, 3.

This subspecies is very thin, as both valves are comparatively flat. The attached valve is very shallow and is ornamented with radial plicæ which are not very pronounced. The upper valve is flat or slightly convex and is not radially ornamented; it shows concentric lines of growth.

The length of the valves tends to be greater in proportion to the height than in the species, *sensu stricto,* or in the other subpsecies; also the body cavity is smaller because the valves are relatively flatter.

Age. Miocene.

Locality: Districts of Buchivacoa, Democracia, Falcón, Colina and Miranda, State of Falcón, locality numbers 79, 80, 86, 95, 97, 154, 169A, 179, 184, 185, 187, 303, 307, 830 (?), 1033, 1232, 1334 (*cf.*), 1855, 1856, 1863, 1864, 1865, 1866, 1872, 1911, 1927, 2207.

Ostrea gatunensis aguaclarensis F. Hodson, n. subsp.
Pl. 10, fig. 7; pl. 11, fig. 4; pl. 12, fig. 4.

This subspecies is distinguished from *O. gatunensis* Brown and Pilsbry [1] by its larger size and by its ligamental groove usually being oblique in the opposite direction to that shown in the illustration of the type of the species. The attached valve is deep, and, viewing the interior, the short ligamental groove usually twists to the right; the exterior is ornamented with rather large, somewhat sharp corrugations in the younger stages; these corrugations or plicæ become more rounded in adult specimens and tend to bifurcate in some cases; there are usually 4 or 5 strong plicæ on each valve with some weaker ones on the attached valve. The upper valve is flat or slightly concave; in the younger specimens, it is sometimes somewhat convex. The margins of both valves usually show broad undulations. The upper valve carries less pronounced corrugations and is usually broadly undulated instead of having strong plicæ like those in the species, *sensu stricto*. Moreover, the beaks of the adult attached valve are usually somewhat excavated. Our subspecies lacks the rugose area on the margins near the beaks.

Age: Oligocene-Miocene.

Locality: Districts of Democracia, Miranda and Acosta, State of Falcón, locality numbers 729, 929, 1292, 1735, 1741, 1753, 1914.

Ostrea virginica Gmelin

Ostrea virginica Gmelin, 1792, Syst. Nat. p. 3336.
Ostrea virginica Gmelin, Dall, 1898, Trans. Wagner Inst. Sci., vol. 3,

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1911, p. 366, pl. 29, figs. 1, 2.

p. 687.
Ostrea virginica Gmelin, Maury, 1917, Bull. Amer. Pal., vol. 5, p. 348.
Ostrea virginica, Gmelin, Maury, 1925, Bull. Amer. Pal., vol. 10, pp. 232–233.

This species is not particularly common in Venezuela as a fossil.

Age: Pliocene-Recent.

Locality: Districts of Acosta, Colina and Democracia, State of Falcón, locality numbers 69, 1435, 1506, 1567.

Ostrea virginica falconensis F. Hodson, n. subsp.
Pl. 9, fig. 2; pl. 13, figs. 2, 4, 5.

Weathered specimens of this subspecies are common and grade into the ventricose varieties of *O. virginica* Gmelin. The short, attached valve is comparatively deep and is sometimes ornamented with coarse radial rugæ. The shell is typically thick and blunt at the attached end of the lower valve. The upper valve is flat and is not ornamented except by the successive lines of growth. Weathered specimens of the lower valve commonly appear to be about smooth.

Age: Miocene-Pliocene.

Locality: Districts of Buchivacoa, Democracia, Miranda, Colina and Acosta, State of Falcón, locality numbers 71, 74, 78, 80, 81, 87, 89, 90, 92, 112 (*cf.*), 196, 201, 203B, 242 (?), 415, 1003, 1019 (and variation), 1023, 1030, 1064, 1224, 1226, 1228, 1233, 1241, 1244, 1325 (?), 1437, 1500, 1567, 1860, 1861, 1862, 1874, 1880, 1882, 1887, 1888, 1889.

Family PECTENIDÆ Lamarck
Genus PECTEN Müller

There are so many intermediate forms between the subgenera of *Pecten* that we have preferred to retain the generic name, *Pecten,* instead of raising the subgenera to generic rank.

Pecten soror urumaconis Harris, n. subsp.
Pl. 13, fig. 1; pl. 14, figs. 3, 4.

Shell averaging from 45 to 60 mm. in height and width; valves very unequal, the left being concave and the right very convex; ribs about 20 on the concave valve, both these and the broad interspaces are covered with concentric squamose growth lines when not eroded; larger valve with about 22 ribs, rather wider than the interspaces; interspaces with indications of squamose growth-lines, seemingly farther apart than are those on the concave valve; ribs showing but few traces of growth lines; ears with fewer radii than seen in the following subspecies.

The greater size of this shell serves to distinguish it from typical *soror*.

Age: Miocene.

Locality: Districts of Democracia, Miranda and Colina, State of Falcón, locality numbers 70C, 73, 78, 79, 80, 81, 82 (and variation), 83, 83B, 84, 88A, 94, 97, 98, 100, 109, 110, 115, 120, 125, 137, 138C, 140, 146, 150A, 160, 165, 168, 185, 186, 188, 205, 207, 219A, 220, 224, 281, 292, 1064, 1254, 1866, 1869, 1870, 1871.

Pecten soror codercola Harris, n. subsp.

Pl. 13, fig. 3; pl. 14, figs. 1, 5; pl. 15, fig. 7.

Shell of moderate size, concave-convex; with about 19 well-defined costæ on each valve with 2 or 3 less-developed marginal ones; right valve concave centrally, but with uplifted margins fore and aft dorsally; wing with three strong and one or two additional radii; ear with less-pronounced markings; both ear and wing nearly right-angled at the hinge terminations; fine slightly imbricated lines pass concentrically over the whole exterior surface; interiorly the muscular scar is definitely marked above, indefinitely below, pit well marked, on either side of which, just below the dorsal hinge margin, there are radiating, tooth-like laminæ; right valve, when well developed and well preserved, shows an anterior ear somewhat bent out over the shell margin, ornamented with 6 radii much wider than their interspaces; below the ear, the shell margin is somewhat abruptly bent inward and carries fine radiating striæ, below which the regular ribbing commences, with small ribs at first, increasing to the fifth which is of normal size; posterior wing and margin very similarly ornamented, though the number of small-sized ribs is but two or three; whole surface finely engraved with slightly imbricated concentric lines, but these are often worn off on the summits of the ribs; each rib characterized, basally at least, by a median depression, hence giving a somewhat bifid appear ance; at the very basal margin, somewhat unusually well-preserved specimens show that there is a tendency to form another channel on the rib and hence produce a fine, raised, secondary rib upon the primary.

The exact relationship of this form to *soror* cannot be stated without access to better material from Santo Domingo than we have at present, or without much more detailed descriptions of the species. The size of this subspecies with dimensions extending to about 70 mm., whereas *soror* has no recorded dimension of over 47 mm.; the clearly defined grooving of the ribs in the right valve, and the more clearly defined radii on ear and wing tend to make this a fairly distinct variety. This species is analogous to the West coast *P. stearnsii* Dall.

Age: Miocene and Pliocene.

Locality: Districts of Democracia and Colina, State of Falcón, locality numbers 69, 123.

Pecten gatunensis Toula

Pecten (*Flabellipecten*) *gatunensis* Toula, 1909, Jahrbuch der k.-k. Geol. Reichsanstalt, Wien, vol. 58, (1908), pp. 711–712, pl. 26, fig. 2.

Pecten gatunensis Toula, Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. of Philadelphia, vol. 63, p. 365.

Pecten gatunensis Toula, Olsson, 1922, Bull. Amer. Pal., vol. 9, no. 39, p. 197, pl. 16, figs. 3, 4.

This is a very common species in our Miocene. The number of ribs is variable. Our specimens from Gatun and Venezuela usually show about 20 well developed ribs on the convex valve, in addition to the less prominent ribs which may be present on or near the submargins.

Age: Miocene.

Locality: Districts of Miranda, Colina, Buchivacoa and Democracia, State of Falcón; Gatun, C. Z.; locality numbers 84, 122A, 122B, 125 (?), 129, 131, 132, 133, 134, 136, 137, 138, 138B, 138C, 139, 140, 142, 144, 146, 148BB, 149A, 150B, 155, 156, 157, 158, 159, 160, 161, 162, 166, 168, 171, 174, 180, 185, 212, 219A, 235, 246, 259, 260A, 261, 266, 267, 270, 277, 282 (?), 283, 285, 188, 295, 308B, 313, 314, 318, 323, 327, 330, 332, 333, 334, 354, 359, 409, 421 (*cf.*), 1009, 1014, 1270, 1334, 1335, 1339, 1342, 1627 (*cf.*), 1823, 1823A, 1825, 1839, 1856, 1858, 1859, 1866, 1893 (*cf.*), 1898, 1908, 1931C.

Pecten MacDonaldi Olsson,

Pecten MacDonaldi Olsson, 1922, Bull. Amer. Pal., vol. 9, p. 370, pl. 19, figs. 1, 2.

This species is sparsely represented in our collections, having been found in only a few localities.

*Age*s Miocene.

Locality: District of Colina, State of Falcón, locality numbers 1009 (*cf.*), 1332, 1508 (*cf.*).

Pecten circularis venezuelanus F. and H. Hodson, n. subsp.
Pl. 14, fig. 6; pl. 15, figs. 2, 4, 5; pl. 17, fig. 1.

This subspecies, which is very common in the Miocene of Venezuela, stands exceedingly close to the recent *Pecten circularis* Sowerby [1] from the Pacific coast. While there are some variations which cannot be told from variations of the recent species, it is not difficult to separate most of the Venezuelan forms from the recent *P. circularis* by slight but rather constant differences. Our subspecies is slightly smaller, and the umbones are more pinches due to a narrowing and inflating of the umbones between the tips of the beaks and the submargins. The anterior ear usually shows stronger striæ than are present on the recent *P. circularis;* there are 4 or 5 strong striæ on the anterior ear

[1] Proc. Zool. Soc. London, 1835, p. 110.

of the right valve. In our large collections from many localities, we find many variations and all intergradations between the species, *sensu stricto,* and our subspecies *venezuelanus,* as well as between this subspecies and the subspecies *cornellanus.* The specimens average about 40 mm. in altitude.

Age: Miocene and Pliocene.

Locality: Common in the State of Falcón, locality numbers 68, 68A, 69, 70A, 71, 73, 74A, 75 (and variation), 78, 79 (and variation), 80, 81, 82, 83, 83A, 83B, 84, 85 (and variation), 88 (variation), 90, 91, 95, 96, 97, 98, 110, 111, 115, 118, 119, 120, 125, 150, 150A, 150B (and variations), 151, 154, 169A, 178, 184, 185, 186, 187, 1188, 196, 197, 198, 202, 205, 205A, 206, 206A, 207, 208, 209, 215, 216, 219, 220, 220A, 222, 225, 225A, 242 (variation), 243 (*cf.*), 290, 291, 296, 297, 298, 299 (variation), 300 (variation), 304, 307, 675, 697, 1000, 1004, 1006, 1011, 1026, 2027, 1030 (and variations), 1031, 1033, 1046 (variation), 1064, 1071 (variation), 1072, 1111, 1232, 1248 (and variation), 1255, 1332, 1353, 1354, 1430, 1450, 1500, 1867 (?), 1868, 1869, 1931C, 2054 (and variation), 2208.

Pecten circularis cornellanus F. and H. Hodson, n. subsp.
Pl. 14, fig. 2; pl. 15, figs. 3, 10; pl. 16, fig. 3.

This is a subspecies in which the ribs in the adult stage have steep, almost vertical, sides instead of the more sloping sides of the species, *sensu stricto,* and of the other subspecies, *venezuelanus;* the sides are even somewhat excavated in many cases, and the tops of the square ribs project slightly over them. The interspaces appear almost square; as in the related forms, the concentric growth lines swing down in the interspaces and swing up on top of the ribs. Like the other subspecies, this is an exceedingly abundant and variable form. The square shape of the ribs may be maintained entirely to the margin or it may give way to ribs with slightly sloping sides. Generally, this subspecies is somewhat smaller than *P. circularis venezuelanus,* averaging about 30-35 mm. in altitude, although some specimens exceed 40 mm.

This subspecies may be equivalent in part to *P. levicostatus* Toula,[1] but his figures are so poor that it is impossible to be sure. His type (fig. 4) has rounded ribs and is not to be confused with the square ribs so common in this Venezuelan subspecies. Toula's species may be only a variation or variety of *P. circularis.*

[1] Jahrbuch der k.-k. Geol. Reichsanstalt, Wien, 1909, vol. 58, (1908), p. 713, pl. 26, figs. 4–6.

Age: Miocene.

Locality: Common in the State of Falcón; Gatun, C. Z.; locality numbers 68A, 69, 70A, 70C, 78, 79, 80 (?), 81, 82, 83, 83A, 83B, 88A, 93, 94 (and variations), 95, 97, 109, 120, 121, 125, 127, 157, 182, 184, 185, 186, 193 (variation), 193A, 215, 216, 217, 219 (variation), 222, 224, 242, 307, 1007, 1010, 1027, 1029, 1030, 1031, 1033, 1066, 1078, 1111, 1115, 1232, 1255, 1256, 1332, 1447 (and variations), 1855, 1871. 1872, 1911.

Pecten circularis caucanus F. and H. Hodson, n. subsp.
Pl. 15, figs. 1, 8.

This subspecies is distinguished only in adult forms and is characterized by the radial striation of the ribs. The ribs typically have sloping sides as in the species, *sensu stricto*, but many specimens have been noted which have rather square ribs which are becoming distinctly striate. The number of striæ on a rib is very variable, but usually there is a strong stria, which may be almost a supplementary riblet, at the base of each rib, with 1–4 smaller striæ between the crest of the rib and the strong, basal, radial thread. Between the strong radial threads at the base of adjacent ribs, there is a deeply incised, channeled, radial sulcus.

The striation is never present on the younger shells, which cannot be told from young shells of either of our other two subspecies.

Age: Pliocene.

Locality: District of Democracia, State of Falcón, locality number 69.

Pecten (aff. **Plagioctenium**) **gilbertharrisi** F. and H. Hodson, n. sp.
Pl. 19, figs. 1, 2, 3; pl. 20, fig. 6.

Shell is about as wide as high, equivalve, and almost equilateral except for the ears. The valves are moderately convex, and ornamented with about 17 high, flat-topped ribs, the sides of which are almost vertical. The interspaces are about as wide as the ribs or a little wider. The flat-topped ribs are crossed transversely by elevated, incremental lamellæ. The anterior ear is radially striate, the posterior is smoother and crossed by curved growth lines.

This is an extremely common species but the specimens are almost never well preserved.

Named in honor of Prof. G. D. Harris, who has done splendid work in advancing our knowledge of Venezuelan paleontology.

Age: Miocene.

Locality: Districts of Democracia, Miranda, Colina and Buchivacoa, State of Falcón, locality numbers 100 (variation), 103, 221, 280 (*cf.*), 317 (?), 418, 1231 (with variations), 1823, 1823A, 1824, 1840, 1848, 1854, 1855, 1856, 1858 (and variations), 1859, 1860, 1862, 1863 (variation), 1864, 1867, 1892, 1893, 1905, 1906, 1908, 1910 (and variations), 1912, 2024.

Pecten gilbertharrisi democracianus F. and H. Hodson, n. subsp.
Pl. 20, fig. 5.

This subspecies differs in having rounded, V-shaped ribs, and in having the growth lines swing down on top of the ribs instead of crossing them straight and at right angles to the length of the ribs.

Age: Miocene.

Locality: Districts of Democracia and Miranda, State of Falcón, locality numbers 79 (variation), 95 (variation), 150A, 168 (variation), 169A (variation), 229, 236, 1848, 1866, 1869.

Pecten interlineatus aidei (Williston MS.) Harris, n. subsp.

Pl. 15, figs. 6, 9.

Williston's types, herewith figured, agree fairly well with Pilsbry's diagnosis and figure,[1] except they are practically twice the dimensions of his San Domingan type. The ears seem marked a little defferently in the two forms.

Closely related to these forms, is *P. crocus* Cooke,[2] from the "Oligocene" near Crocus Bay Anguilla.

Age: Miocene.

Locality: Districts of Democracia and Miranda, State of Falcón, locality numbers 84, 87, 1064, 1067 (*cf.*), 1866.

Pecten (Chlamys) buchivacoanus F. and H. Hodson, n. sp.

Pl. 16, figs. 6, 8, 10, 11.

Shell is of medium size, equivalve, varies from 20 to 50 mm. in altitude, and is usually about as wide as long. Young specimens are usually a little higher than long. Both valves are similar, moderately inflated, and carry 17–18 radially striate, rounded ribs, which are about as wide as the striate interspaces. The ribs carry 3 strong, radial striæ, the most prominent of which is down the middle of the rib; the other two primary striæ are on each side about half way between the crest of the rib and the middle of the interspaces; on top of the rib on either side of the middle radial thread, there sometimes appears an intervening secondary. In the middle of the interspaces, there is a radial thread which is stronger than the one on either side of it at the base of the ribs; in younger specimens, only the middle thread in the interspaces is present. The growth lines form scaly imbrications when they cross the radial striæ; the scales are easily worn away and are lacking in even slightly weathered specimens.

[1] Proc. Acad. Nat. Sci. Phila., 1921, p. 411, pl. 45, figs. 3.
[2] Carn. Inst. Wash., 1919, Publ. No. 291, p. 135, pl. 9, fig. 2a.

The hinge line is about two-thirds the width of the valves. The ears are approximately equal in length, radially striate, with 9–10 striæ of varying strength.

This species bears some resemblance to *P. sansebastianus* Maury.[1] Our species has more radial striæ in the interspaces and the shell is slightly wider.

Age: Oligocene.

Locality: Districts of Buchivacoa, Miranda and Petit, State of Falcón, locality numbers 36 (variation), 38 (or variation), 45, 46, 49 (variation), 58, 60 (or variation), 254, 155, 404, 1084, 1221, 1262, 1649, 1763, 1963, 1967, 2002, 2004.

Pecten buchivacoanus maracaibensis F. and H. Hodson, n. subsp.
Pl. 17, fig. 6.

This subspecies differs in being more inflated and usually much larger, averaging 50–75 mm. in altitude. The striæ seem to appear at a slightly younger stage. The interspaces are somewhat narrower and the ribs are a little more prominent and less rounded on top. The subspecies *falconensis* differs in having slightly narrower, more V-shaped interspaces and in having striæ of about equal strength both on the ribs and in the interspaces. In the subspecies *falconensis*, there is a sulcus down the middle of the interspaces, which corresponds to a primary radial thread in the species, *sensu stricto,* and in the subspecies *maracaibensis*. There are all intergradations between this subspecies and the species, *sensu stricto*, as well as between the two subspecies.

Age: Miocene.

Locality: Districts of Democracia, Miranda, Colina and Acosta, State of Falcón, locality numbers 100, 136, 137, 138C, 139, 140 (variation), 143, 241, 269B, 270, 283, 288, 310, 314, 322, 331, 332, 359, 413, 418, 421, 717, 904, 1111, 1818, 1825A, 1833.

[1] New York Academy of Sciences, 1920, vol. 3, pt. 1, p. 19, pl.3, fig. 1.

Pecten buchivacoanus falconensis F. and H. Hodson, n. subsp.
Pl. 17, figs. 2, 3, 4, 5, 7.

This subspecies differs in having the ribs more sloping and in having the interspaces more V-shaped than in both the species, *sensu stricto*, and the subspecies *maracaibensis;* in the latter two, the interspaces are rather flat and terminated by the rather steep flanks of the ribs. This subspecies further differs in the character of the radial striæ, which are almost uniform in strength and regularly spaced over the ribs. In the adult stage, there are about 7 of these striæ regularly spaces on the sides and top of each rib; in the interspaces, there are 2 or sometimes 3 striæ, and, in the middle of the interspace, there is usually a sulcus instead of a radial thread. This subspecies is more inflated than the species, and sometimes is even more inflated than the subspecies *maracaibensis,* but the latter subspecies is usually larger.

Age: Miocene.

Locality: Common in the State of Falcón, locality numbers 68, 73, 78, 79, 80, 81, 83, 84, 88, 97, 98, 100, 109, 110, 115, 119, 120, 122B, 122C, 123, 125, 131, 132, 133, 137, 138, 138C, 142, 146, 149A, 149B, 150, 150A, 154, 155, 156, 159, 168, 174, 176, 178, 181, 183, 185, 205, 205A, 206, 207, 209, 215 (?), 220, 224, 227, 229, 232, 233, 236, 237, 241, 259, 261, 264, 266, 269A, 270, 277, 283, 289 (?), 297, 300, 303, 305, 306 (?), 311 (or variation), 330, 331, 338, 421, 753, 1006, 1011, 1013, 1017, 1033, 1035, 1111, 1116, 1231, 1255, 1266, 1270, 1334, 1337, 1430, 1507, 1552, 1704, 1817, 1825, 1827, 1854, 1855, 1856, 1858, 1859, 1860, 1861, 1863, 1866, 1868, 1871, 1892, 1897, 1927, 1931C.

Pecten (Æquipecten) effossus Brown and Pilsbry

Pecten (*Æquipecten*) *effossus* Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. of Philadelphia, p. 364, pl. 28, figs. 4, 6.

This species is not common in our Venezuelan collections, having been found in only two localities.

Age: Miocene.

Locality: Districts of Miranda and Democracia, State of Falcón, locality numbers 341, 1808.

Pecten (aff. Æquipecten) quirosensis Harris, n. sp.
Pl. 16, figs. 1, 2, 4, 5, 7, 9.

Shell small, tumid, inequivalve, equilateral; surface marked by 16 well-defined ribs, or 18, if the edges of the submargins are included; ribs of the left valve simple in earlier stages of growth, broader than the interspaces, becoming higher or subcarinate toward the ventral margin by the increase in height and size of the median portion of the rib; carinæ with a few distant nodules near the ventral margin; interspaces with sharply defined, distant, raised, concentric lines; right valve of about twice the depth of the left, similarly, but much less distinctly sculptured; ctenolium with about 6 teeth; anterior ear of right valve with 5 strong rays; ears of left valve and posterior ear of right valve ornamented with 4–6 fine, scaly radials, which become successively smaller toward the submargins; submargins sharply defined, narrow, and usually smooth; interior showing short, low-down, auricular crura, ligamental crura, and ribbing, strong marginally, dying out gradually before reaching the middle of the shell.

This shell would appear to be closely allied to *P. perlatus* of Crocus Bay, Anguilla, referred by Cooke to the "Oligocene." His diagnosis and figure seem to be of the right valve only. His expression "submargins with close radial riblets which form an uninterrupted series with those of the ears" [1] would seem to differentiate his from our species. In size and general appearance, the forms are very similar.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality number 6.

[1] Carn. Inst. Wash. Publ. No. 291, p. 131, pl. 13, fig. 3.

Pecten (aff. **Nodipecten**) **colinensis** F. and H. Hodson, n. sp.
Pl. 18, figs. 3, 6; pl. 19, fig. 4.

Shell averages 90–100 mm. in altitude, and is nearly equivalve, suborbicular and moderately convex. The right valve is ornamented with about 11 rather flat-topped, prominent, radially striate ribs, in addition to less well developed ribs and radial striæ on the submargins; the tops of the ribs carry 3 or 4 about equally spaced, coarse, radial striæ; the sides of the main ribs are steep; the interspaces are about as wide or slightly wider than the ribs and carry 1–3 strong, radial threads; the radial ornamentation is crossed by the concentric lines of growth which swing up over the top of the ribs; at the points of intersection of the two sets of ornamentation, small beads or prominences are formed on the radial striæ, but no large nodes or large imbricating scales are to be found on this valve, which easily distinguishes it from the left valve. The hinge line is straight and about one-half as long as the disc of the shell. The anterior ears are slightly longer than the posterior; both are radially striate with 5–6 or more, strong, radial threads which are slightly noded by the imbricate growth lines. The left valve is ornamented with about 12 main ribs in addition to the incipient ribs and striæ on and near the submargins. The tops of the ribs are slightly rounded and carry 3–5 slightly scaly, radial striæ; the interspaces are about as wide, or slightly narrower than, the ribs, and carry 1–3 strong radial threads of the same general character as those on the ribs; at periodic intervals, usually about 10–15 mm. apart, there occur concentric rows of prominences, which are noticeable on all the ribs and interspaces of the left valve; the characteristic feature of this species is that every third rib on this valve bears larger nodes or very prominent scales at points of intersections with the rows of concentric prominences.

The left valve of *P. nodosus* Linné usually has 9–10 ribs with every rib noded; the left valve of *P. pittieri* Dall[1] has about 10 ribs with every other rib noded more strongly; the left valve of the present species has 11–12 ribs with every third rib noded more strongly.

Age: Miocene-Pliocene.

Locality: District of Colina, State of Falcón, locality numbers 115, 125, 150, 151, 188, 205A, 207, 208, 209 (?), 292, 421 (?), 1011, 1252, 1353.

Pecten coderensis (Williston MS.) Harris, n. sp.
Pl. 18, figs. 2, 4, 5.

There are about 16 or 17 ribs on either valve that have a tendency, especially in the left valve, to be shaped like an inverted V; in the right, nearly flat valve, this angularity is generally somewhat modified, and occasionally in the left, the ribs are rounded; in old right valves, the ribs may be very much rounded over and tend to become obsolete. Concentric marking is seen on young and well preserved specimens to consist of beautifully even, fine, engraved lines. Towards the base there may be a rougher, coarser lining. The submarginal areas are smooth and narrow and drop off abruptly to the auricular areas. The anterior ear of the right valve is perhaps the most noticeable feature of the shell. It is very well developed as the figures show and carries 6 or 7 radii increasing in strength and scabrous ornamentation towards the hinge margin. The posterior ear is very large and triangular and is marked only by very fine lines of growth; ctenolium, in the best preserved specimen we have, with 5 or 6 teeth. The angular character of the ribs of the left valve makes them appear farther apart than in the opposite valve; the concentric lining is apt to be better preserved; the ears are more nearly equal in shape and size and carry 8 or 10 radii which with their interspaces are beautifully marked with

[1] Smithsonian Miscellaneous Collections, 1912, vol. 59, number 2, publication 2077, p. 10; and Proc. U. S. Nat. Museum, vol. 66, 1925, art. 17, pl. 17, fig. 6.

fine growth lines.

In the matter of marking and in some general characters, this species resembles *P. thompsoni* Maury of Santo Domingo, and in auricular matters, *P. vaun* Cooke from Anguilla. *P. maturensis* Maury from East Trinidad in very late Tertiary or early Quarternary times is of this general type, though in that, it is the left valve that tends to lose its ribbing and become flat. This *Pecten*, however, is considerably larger than the above-mentioned forms.

Age: Miocene-Pliocene.

Locality: Districts of Democracia, Colina and Zamora, State of Falcón, locality numbers 69, 1022 (and variation), 1355, 1358, 1497.

Pecten coderensis willistoni Harris, F. and H. Hodson, n. subsp.
Pl. 20, fig. 2.

This subspecies is easily distinguished from *P. coderensis* (Williston MS) by its smaller size, more convex valves, and sharper, more elevate ribs. However, there are all intergradations between these two forms, and the subspecies merely marks the limit of variation toward being smaller and more sharply ribbed.

Age: Miocene.

Locality: Districts of Democracia, Miranda, Colina, Zamora and Falcón, State of Falcón, locality numbers 69, 70A (variation), 70B (intermediate forms), 70C, 71 (variation), 98, 200, 298, 307, 1022, 1024 (*cf.*), 1027 (fragments, 1243 (variation), 1248, 1355, 1358, 1497, 1874 (variation), 1886 (?), 2205 (variation).

Pecten antiguensis churuguarensis F. and H. Hodson, n. subsp.
Pl. 20, figs. 1, 3, 4; pl. 22, fig. 2.

Shell is orbicular, inequivalve, translucent so that the internal liræ are frequently visible from the exterior. The altitude averages 50–70 mm. There are 13–14 undulating ribs which extend to the margin of each valve. The flat left valve in the younger stages has squarer ribs than the more convex valve; the flat valve tends to be a little concave in some specimens, although it is generally slightly convex. Both valves are ornamented with concentric growth lines which swing up over the rather low, undulating ribs, and down in the narrower interspaces. On each side of the interspaces, at the base of the ribs, are internal liræ, which usually are visible on the outside as radial dark lines separating the ribs and interspaces. The ears on the inflated right valve are pointed and produced above the hinge line as triangular projections on each side of the umbo. The liræ are about equally spaced in the younger stages, but on the margins of the adult shells the interspaces are a little wider than the intervals between the pairs of liræ. There is no contraction of the adjacent liræ toward the margin as mentioned in the description of *P. antiguensis* Brown.[1]

This species is similar in some respects to *P. antiguensis* Brown, but does not show the tendency to become smooth towards the margin of one valve, nor do the adjacent pairs of liræ tend to contract toward the margin. The pointed ears, also, are very characteristic of our species, which is very common in its occurrence.

Age: Oligocene.

Locality: Districts of Petit, Miranda, Federación and Buchivacoa, State of Falcón, locality numbers 16, 30, 32, 33, 36, 40, 41, 47, 58, 59, 254, 429 (?), 489, 496, 500, 973, 1036, 1038, 1050, 1051, 1054, 1057, 1058, 1130, 1141, 1217, 1637, 1662, 1954, 1963, 1965, 1966 (?), 1987, 2002C, 2004, 2005, 2008.

Pecten (Amusium) aguaclarensis F. and H. Hodson, n. sp.
Pl. 18, fig. 1; pl. 21, figs. 1, 2.

Shell averages 85–100 mm. in altitude, and is about as long as high. Both valves are moderately convex with in-

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1913, p. 613, pl. 18, figs. 1–3, 5.

conspicuous, concentric lines of growth. In well preserved fragments, the internal liræ are visible on the outside of the shell as dark, radial lines. The specimens are frequently very much thickened with gypsum; in some cases, the replaced shell is 10–15 mm. thick, instead of less than 1 mm., which is its normal thickness. The right valve is strengthened with about 10 pairs of internal liræ; the distance between each pair is 2–4 times as great as the interval between the constituent liræ. The left valve has 10–12 pairs of internal liræ; the distance between the pairs is about equal to or slightly greater than the distance between the liræ which constitute a pair. In both valves. the submargins are fairly wide. Specimens of either valve may occasionally show supplementary liræ adjacent to, and parallel to, the main pairs of liræ.

This character of having equally spaced liræ in one valve and paired liræ in the other valve is found in *P. pleuronectes* Linné, which is slightly larger and does not have such prominent liræ in the younger stages.

Age: Oligocene-Miocene.

Locality: Districts of Federación, Buchivacoa, Democracia and Miranda, State of Falcón; District of Urdaneta, State of Lara; locality numbers 15, 16, 806, 810, 995, 1058, 1129, 1264, 1287, 1290, 1291, 1294, 1733, 1735, 1736, 1737, 1740, 1939, 1979, 2035.

Pecten (Amusium) luna Brown and Pilsbry

Pecten (Amusium) luna Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. of Philadelphia, vol. 64, p. 514, pl. 23, fig. 1 (*lapsus calami* for pl. 24, fig. 1).

Pecten (Amusium) luna Brown and Pilsbry, Olsson, 1922, Bull. Amer. Pal., vol. 9, pp. 377–378, pl. 20, fig. 1.

This species is rather uncommon in our Miocene beds. The valves are about equal, except in convexity; one valve tends to be only flatly convex.

Age: Miocene.

Locality: Districts of Democracia, Colina and Miranda, State of Falcón; Cartagena, Colombia; Gatun, C. Z.;

locality numbers 68, 70A (?), 81, 83B, 84, 85, 108, 115, 120, 122B, 122C, 125, 138B, 146, 150, 152, 156, 160, 176 (*cf.*), 181, 188, 193, 205, 205A, 206, 207, 208, 209, 216, 219A, 222, 229, 232, 233, 234, 241, 291, 293, 301, 304, 1009, 1251, 1253, 1322, 1823, 1867.

Pecten (Amusium) mortoni Ravenel

Pecten Mortoni Ravenel, 1844, Proc. Acad. Nat. Sci. of Philadelphia, p. 96.
Pecten Mortoni Ravenel, Tuomey and Holmes, 1855, Pleiocene Fos. S. Car., p. 27, pl. 10, figs. 1, 2.
Pecten (Amusium) Mortoni Ravenel, Dall, 1898, Trans. Wagner Free Inst. Sci. of Philadelphia, p. 757.

Some large specimens of this species are found in the Pliocene of Venezuela. The Miocene species are slightly smaller.

Age: Miocene and Pliocene.

Locality: Districts of Democracia, Colina and Zamora, State of Falcón; Gatun Spillway, Gatun, C. Z.; locality numbers 69, 1022, 1030, 1357.

Pecten (Amusium) zamorensis F. and H. Hodson, n. sp.
Pl. 22, figs. 1, 3, 4, 5, 6.

Shell averages 40–50 mm. in altitude, is moderately convex and slightly oblique. The hinge line is a little less than a third of the length of the disc. The ears are smooth except for growth lines and demarked from the umbones by a low, steep ledge. The umbones carry about 18 low, narrow ribs, which extend some 10–15 mm. from the tip of the beaks before they disappear. The shell shows faint, concentric lines of growth. Internally, the distal half of the valve carries about 14 pairs of internal liræ, which extend about half-way from the margin toward the beak before they disappear; the young stages show no internal liræ; in the adult stage, the main interspaces between the pairs of liræ are about equal to or slightly greater than the distances between the constituent liræ which form a pair. The left valve is fragmentary or young in our collections, but seems to be similar to, but slightly flatter than, the right valve.

Age: Pliocene.

Locality: District of Zamora, State of Falcón, locality number 1353.

Family SPONDYLIDÆ Fleming

Genus PLICATULA Lamarck

Plicatula densata Conrad Pl. 23, figs. 1, 6.

Plicatula densata Conrad, 1843, Proc. Acad. Nat. Sci. of Philadelphia, vol. 1, p. 311.
Plicatula densata Conrad, 1845, Foss. of the Medial Tertiary, p. 75, pl. 43, fig. 6.
Plicatula densata Conrad, Whitfield, 1894, Monograph 24, U. S. Geol. Survey, p. 35, pl. 5, figs. 3–8.
Plicatula densata Conrad Dall, 1898, Trans. Wagner Free Inst. Sci. of Philadelphia, vol. 3, pt. 4, p. 763 (*partim*).
Plicatula densata Conrad, Dall, 1915, U. S. Nat. Mus., Bull. 90, p. 125 (*partim*).
Not *Plicatula densata* Conrad, Cooke, 1919, Carnegie Inst. Washington, publ. no. 291, p. 145, pl. 11, fig. 12 a–b.

This species is rather common and shows many variations in thickness of shell, size, and sculpture. In general, our specimens are a little thinner than most specimens of *P. densata* from the Maryland Miocene.

Age: Miocene.

Locality: Districts of Democracia and Miranda, State of Falcón, locality numbers 6, 73, 78, 79, 80, 81, 82, 83, 83B, 84, 85, 93, 94, 95, 96, 97, 185, 186, 204, 220, 225, 229, 230, 234, 273, 1033, 1064, 1065, 1232, 1552, 1855, 1856, 1858, 1871, 1911.

? **Plicatula densata democraciana** F. nd H. Hodson, n. subsp. Pl. 24, figs. 3, 4, 7, 8.

? *Plicatula densata* Conrad, Cooke, 1919, Carnegie Inst. Washington, publ. no. 291, p. 145, pl. 11, fig. 12 a–b.

This subspecies differs in having a very thin shell, which reflects the exterior sculpture as pronounced undulations on the inside of the valves; the internal "ribs" correspond to the interspaces between the plicæ on the exterior of the valves. The pallial line usually cannot be detected in our specimens; the interior of the valves, instead of being smooth and porceleous, is roughened with submicroscopic, radial striæ and, occasionally, faint, concentric lines of growth. Our subspecies is somewhat larger than the species, *sensu stricto*.

Age: Pliocene.

Locality: District of Democracia, State of Falcón, locality number 69.

Genus SPONDYLUS Linné

Spondylus falconensis Harris, n. sp. Pl. 23, figs. 4, 5; pl. 24, fig. 9.

Shell of medium size, inequivalve and somewhat oblique; surface markings consist of: (a) about 5 or 6 primary radii, heavily spined, (b) 5 to 10 secondary radii between the primaries, the middle one having a tendency to be strongest, (c) finer radii of various sizes; all radii strongly fimbriate or scaly.

Dr. Maury has given an excellent and detailed description of her *Spondylus lucasi*[1] and it would appear that *lucasi* and *falconensis* have much in common in detailed structure; but the small size of *lucasi* and its seeming lack of a half-dozen strongly spinose primary radii suggest noteworthy differences. Since the largest dimension for *lucasi* is 33 mm. and *falconensis* easily reaches 100 mm., we are dealing either with different species or very different stages of development in specimens. What is needed at present is good, enlarged, photographic illustrations of the exterior characteristics of *lucasi*.

The general aspect of the species is like that of *S. bostrychites* Sowerby as interpreted by Maury,[2] or *S. chiriquiensis* Olsson.[3]

Age: Miocene.

Locality: Districts of Colina and Miranda, State of Falcón, locality numbers 121, 151, 180, 182, 206, 275, 1012.

[1] Scient. Surv., N. Y. Acad. Sci., vol. 3, 1920.
[2] Bull. Amer. Pal., vol. 5, pl. 58, fig. 4.
[3] Bull. Amer. Pal., vol. 9, pl. 23, figs. 1, 3, 5, 6.

Spondylus carmenensis F. Hodson, n. sp. Pl. 25, figs. 1, 2, 3.

As in the case with most species of Spondylus, our form shows exceedingly great variations both in shape and sculpture. The average greatest altitude of our adult specimens is from 70–80 mm. The lower valve is very convex and deep. In the young stages, the flat valve is slightly convex, but soon becomes flat or even slightly concave. The beak of the lower valve extends moderately beyond the hinge line; both valves show a tendency to have striate, rather small ears. The radial sculpture in the convex valve consists of some 15–17 primary radials, which are occasionally rather hard to distinguish from the secondary radials, which typically occur about half-way between the primaries; the primaries, except those adjoining the submargins, tend to carry low, decumbent spines. Between the more prominent primary and secondary radials, there are 6 or more, small, scaly, teritiary threads which cover the interspaces; there are about 3–5 of these threads to the millimeter. The primary threads on the flat valve are closer together and usually bear low spines; between the primaries, there are secondary and, in well preserved specimens, scaly, tertiary threads; there are fewer tertiary threads between the larger ones than on the convex valve; the radial sculpture is crossed by close-set, slightly scaly growth lines.

The species is somewhat larger than *S. scotti* Brown and Pilsbry [1] and has a much flatter upper valve. It is much larger than *S. bostrychites* Guppy as interpreted by Cooke.[2]

Age: Oligocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 1649, 1967, 2436.

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1912, p. 514, pl. 25, figs. 1–2.
[2] Carnegie Inst. of Washington, no. 291, 1919, p. 144, pl. 11, figs. 11a–b.

Family ANOMIIDÆ Gray

Genus ANOMIA Müller

Anomia gabbi falconensis F. Hodson, n. subsp.
Pl. 24, fig. 1; pl. 26, figs. 1, 2.

This subspecies is exceedingly like *A. gabbi* Pilsbry and Johnson [1] in general appearance and ornamentation. The difference lies in the position of the minor byssal scar. The two major scars are located, respectively, at the top and near the postreior basal part of the major, somewhat rectangular, muscle attachment area; the smaller byssal scar lies more or less between the two major scars; it is slightly anterior of a line connecting the centers of the two largest scars, and may be equidistant from them or slightly closer to the lower scar; thus, the minor scar is always somewhat above and in front of the lower major scar. In the description of the species, *sensu stricto,* it is stated that the adductor impression is alongside the minor byssal scar, not lower down. Our subspecies is usually somewhat larger than *A. gabbi.* In some of our collections, the muscle scars are not well preserved, so that a few of our specimens may possibly belong to the species, *sensu stricto.*

Age: Miocene.

Locality: Districts of Miranda, Democracia and Colina, State of Falcón, locality numbers 70A, 71, 113, 219, 1227, 1233, 1500, 1856, 1861, 1862, 1863, 1875, 1889C (*cf.*), 1890, 1927, 2042 (*cf.*).

Anomia palmasensis F. Hodson, n. sp. Pl. 24, figs. 2, 5, 6.

Only the upper valve of this species has been found. One of the most characteristic features of this species is its doubly selliform shape; one large, convex, altitudinal saddle-shaped depression is found on the exterior, extend-

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1917, p. 193; Proc. Acad. Nat. Sci. of Philadelphia, 1921, p. 409, pl. 43, fig. 1.

ing from near the beak to the ventral margin; the other convex, transverse, selliform depression occurs on the inside of the valve and is caused by the turning up of the posterior and anterior edges of the valve; the two major, selliform folds are somewhat at right angles to each other. The altitudinal, selliform depression continues to the ventral margin, where it is produced as a sharp, subangular, depressed fold; the ventral part of the shell is frequently more pointed than the dorsal. The radial sculpture is variable, sometimes zigzagged, sometimes slightly imbricated along some of the concentric growth lines; it nearly always shows at least traces of secondary radials between the primaries in well preserved specimens. The muscle scars are located in a somewhat rectangular area along the internal ridge, which corresponds to the altitudinal, exterior, selliform depression; this area is very nearly central in its location; in it, there are two prominent scars, one being located at the top of the area, and the other near the base on the posterior side; the third is a medium-sized byssal scars, almost adjacent to, and alongside of, the prominent posterior basal scar, but not at all above it.

This species is somewhat like *A. gabbi* Pilsbry and Johnson (*loc. cit.*), but the striking and consistent difference in shape of the two shells makes it impossible to confuse them.

Age: Miocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 2267, 2278, 2392.

Anomia venezuelana Harris, n. sp. Pl. 23, figs. 2, 3; pl. 26, fig. 4.

Adult shell of rather large size; roundish but with a tendency to be drawn out posteriorly; shell substance rather thick, especially about the umbones; surface smooth about the umbones generally in young thin shells, but even on these there may be a suggestion of slight protuberances arranged roughly in rows; surface irregularities become more pronounced in large old specimens and seem to suggest a close relationship with some forms of *ephippium;* the ribbing sometimes becomes strong enough even to suggest a distant relationship with *gabbi.*

Only the left or upper valves are represented in any of our material. They sometimes show an irregularity on the hinge margin just anterior to the beak, consisting of a slight tooth-like projection and socket-like notch.

Age: Miocene and Pliocene.

Locality: Districts of Democracia, Colina, Miranda and Falcón, State of Falcón, locality numbers 69, 71, 84, 85, 86, 202, 203, 1021, 1027, 1233, 1243, 1244, 1881, 1886, 1887 (*cf.*), 2206.

Family PHOLADOMYACIDÆ Gray

Genus PHOLADOMYA Sowerby

Pholadomya falconensis F. and H. Hodson, n. sp.
Pl. 26, fig. 6; pl. 27, figs. 1, 2.

The shell is very large, oblong, and not very ventricose for its size. The beaks are high, broad, almost continguous, and located just behind the blunt, anterior extremity. The whole shell is ornamented with concentric ribs which are more pronounced on the umbones; the ribs are wider than the interspaces. The concentric sculpture is crossed by oblique, radial ribs, of variable strength; they become slightly farther apart and less pronounced on the posterior slope; the radial ribs are not found on the blunt, anterior end; the intersection of the concentric and radial ribs produces elevations or bumps.

This species is very large. It is much larger than *P. walli* Maury [1] and is much less ventricose.

Age: Miocene.

Locality: Districts of Colina and Democracia, State of Falcón, locality numbers 80, 131, 151, 205, 207, 260A, 1016.

[1] Bull. Amer. Pal., 1925, vol. 10, pp. 332–333, pl. 42, figs. 8–11.

Family CRASSATELLITIDÆ Dall

Genus CRASSATELLITES Kruger

Crassatellites aviaguensis F. Hodson, n. sp.

Pl. 28, figs. 4, 7, 8, 10.

The shell is large, somewhat elongate, and thick. The anterior end is shorter than the posterior, and the length of the shell somewhat greater than the height. The lunule is large, deeply impressed, and fairly wide; it is very variable in shape, length, width and depth; generally, it is deeply sunken and surrounded with a steep ledge; in specimens about 45 mm. in height, the lunule varies from 18 to 25 mm. in length, and from 6 to 10 mm. in width. The escutcheon is narrower and longer than the lunule; along the border of the escutcheon, on the posterior dorsal area of each valve, there are two small ridges (separated by a faint sulcus) which extend from the tip of the beak posteriorly. The thick shell is ornamented with rather evenly spaced, somewhat raised, concentric lines; this concentric sculpture tends to be slightly more elevated on the dorsal half of the valve than on the ventral; on the beaks, there are 4–6 concentric ribs or folds which are stronger than the succeeding ones.

Age: Oligocene.

Locality: District of Buchivacoa, State of Falcón, locality number 2447.

Crassatellites trinitarius venezuelanus F. Hodson, n. subsp.

Pl. 28, figs. 2, 6, 9.

Our form is closely related to *C. trinitarius* Maury [4] but is easily distinguished by certain differences: the lunule in the Venezuelan form is much shorter and wider; the shell is more excavated in front of the beaks. In the species, *sensu stricto*, the line from the beak to the anterior extremity is straight, but in this subspecies, there is a depression in front of the beaks.

[4] Bull. Amer. Pal., vol. 10, 1925, pp. 327–328, pl. 42, figs. 1, 7.

Age: Miocene.

Locality: Districts of Democracia, Miranda, Colina, Acosta and Buchivacoa, State of Falcón, locality numbers 81, 84, 86, 87, 89, 98, 112, 110, 150A, 150B, 163, 177, 187, 193, 206A, 216, 225A, 297, 298, 317, 329, 354, 1007, 1033, 1035, 1256, 1335, 1448, 1818, 1827, 1856, 1858, 1872, 1892, 1912.

Family CARDITIDÆ Gill

Genus VENERICARDIA Lamarck

Venericardia zuliana F. Hodson, n. sp. Pl. 28, figs. 1, 3, 5, 11.

Shell very small, convex, subcircular or slightly produced posteriorly in adult specimens. The beaks are somewhat inflated and located near the anterior third of the shell. The sculpture consists of 15–20 high, crested, closely nodulated ribs, somewhat narrower than the interspaces; usually, there are about 17 ribs in adult specimens; the interspaces are crossed by microscopic, irregular, concentric growth lines. The interior of each valve is deep; the margins are fluted internally.

This species is similar to its new subspecies *maracaibensis*, but is smaller, and has a thinner shell, finer sculpture, and closer nodulation. Our species somewhat resembles a miniature form of *V. scabricostata* Guppy (*fide* Olsson [1]) from Costa Rica, which usually has 18 instead of 17 ribs. *V. zuliana* (n. sp.) is always much smaller than any of the specimens commonly referred to *V. scabricostata* Guppy. Since our form is very common, there are many variations found in the different horizons and localities.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia; Districts of Buchivacoa and Acosta, State of Falcón; locality numbers 6, 10, 25, 1070, 1140, 1419, 1939, 2035, 2040, 3207.

[1] Bull. Amer. Pal., 1922, vol. 9, p. 388.

Venericardia zuliana weeksi F. Hodson, n. subsp.
Pl. 29, figs. 2, 4, 5.

This subspecies is characterized by the valves being less deep and slightly longer for their height. The ribs are a little sharper and the interspaces correspondingly wider. The number of ribs and character of the noding vary as in the species; there are usually 17 ribs. Figure 2 on plate 29 shows one of the many intermediate forms.

Named in honor of Mr. L. G. Weeks who helped collect some of this material.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality numbers 6, 1140.

Venericardia zuliana maracaibensis (Williston MS.) F. Hodson, n. subsp. Pl. 26, figs. 3, 5; pl. 29, figs. 1, 7, 10.

This subspecies is larger and heavier than *V. zuliana* or *V. zuliana weeksi,* but is of the same general type. The valves are more produced posteriorly and are not quite as deep as in the species, *sensu stricto.* The ribs are broader and a little more rounded. The number of ribs varies from 15 to 19, but the usual number is 17. The nodulation on the ribs tends to be slightly coarser, the nodules larger and usually less closely spaced. The lunule is very small and deeply impressed.

This subspecies is a direct evolutionary outgrowth of *V. zuliana;* all intergradations between them are found.

Age: Miocene.

Locality: Districts of Democracia, Miranda, Acosta and Colina, State of Falcón, locality numbers 71, 74, 86, 87, 90, 93, 94, 96, 100, 118, 121, 149, 150A, 150B, 184, 185, 187, 205, 206A, 225A, 273 (?), 290, 291, 292, 295, 298, 1033, 1212, 1256, 1447, 1448, 1825, 1860 (?), 1870, 1872, 1931C (?), 2036.

Venericardia quirosana F. Hodson, n. sp. Pl. 29, figs. 8, 12, 13.

Shell is rather small, subquadrate to subrectangular, squarely truncate posteriorly. The beaks are prosogyrate and located near the anterior quarter of the shell. The hinge plate is not quite parallel to the ventral margin, but tends to converge with it anteriorly. The beaks are arched above the hinge area, and almost conceal the lunule, which is very small. The sculpture consists of about 20 strong ribs with deep interspaces; the ribs are supported on each side at the base by a small, auxiliary, strengthening riblet; the ribs are ornamented with numerous, regularly spaced, transverse nodes, which are as wide as the tops of the rather square ribs. The whole shell is covered with fine, concentric growth lines. The posterior slope carries a marked depression in which there are one or two small ribs, usually not noded. Between the posterior depression and the hinge area, there are 2–3 noded ribs. The hinge plate is narrow; the inner margin shows moderately deep fluting.

This species is easily distinguished from *V. islahispanolæ* Maury [1] by its fewer ribs, deeper interspaces, and more marked posterior depression. It is a much smaller species than *V. hadra* Dall or *V. himerta* Dall.[2]

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia; District of Urdaneta, State of Lara; District of Buchivacoa, State of Falcón, locality numbers 6, 815, 1140, 2019.

Venericardia quirosana venezuelana F. Hodson, n. subsp.
Pl. 29, fig. 11.

This subspecies is less elongate, the height is greater in proportion to the length, than in the species, *sensu stricto*. This is a very variable stock and all intergradations are found between the species and subspecies.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia; District

[1] Bull. Amer. Pal., 1917, vol. 5, p. 362, pl. 59, fig. 2.
[2] Trans. Wagner Inst. of Science of Philadelphia, 1903, pt. 6, pp. 1429–1430.

of Acosta, State of Falcón; locality numbers 6, 1140, 1408.

Venericardia bowdenensis F. Hodson, n. sp. Pl. 29, figs. 6, 9.

Shell rather small, subquadrate, and ornamented with finely nodulated ribs. The posterior slope shows a very faint depression or flattening. The beaks are small and tend to overhang the small, impressed lunule. The sculpture consists of about 21 elevated, noded ribs, which bear an auxiliary supporting riblet on each side at the base. On each rib, there is a linear groove along the middle of each side; these grooves extend from the umbones to the ventral margin. The nodes on the ribs are very prominent and closely spaces; they originate near the groove on each side of the ribs and form sharply elevated, rounded nodes, which sometimes become sharply imbricated, especially on the posterior part of the shell. The valves are moderately deep and have a closely crenulated inner margin. The hinge plate is rather narrow.

This species has more numerous and more closely spaced ribs than our forms of the *V. quirosana* stock.

Age: Miocene.

Locality: Bowden Hill, Bowden, Morant Bay, Jamaica.

Venericardia olssoni F. Hodson, n. sp. Pl. 29, figs. 3, 14.

Shell large, coarsely ribbed, height greater than the length. The umbones are strongly arched; the lunule is small and deeply impressed. The sculpture consists of about 13 wide, low ribs with narrower, rather shallow interspaces. The concentric, undulating growth lines swing up gently over the low ribs and curve downward into the shallow interspaces. The hinge plate is rather heavy; the valves are fairly deep; the margins are coarsely crenulate.

This species somewhat resembles *V. terryi* Olsson,[1] but our form has much more pronounced ribbing and is a much larger shell.

[1] Bull. Amer. Pal., 1922, vol. 9, pp. 388–389, pl. 35, figs. 12, 13.

Age: Miocene.

Locality: Districts of Democracia and Colina, State of Falcón, locality numbers 83, 84, 137, 185.

Family CHAMIDÆ Lamarck

Genus CHAMA Linné

Chama buchivacoana F. Hodson, n. sp. Pl. 30, figs. 3, 6, 9, 11, 12.

The shell is small, heavy, and attached by the right valve. The attached valve is deep and its beak is very much inflated and arched over the cardinal area. The whole valve supeficially seems to be covered with crowded, irregular, vermicular papillæ; microscopically, the ornamentation appears to consist of more or less irregular, discontinuous radials, crossed by very irregular growth stages or prominences. The flat valve is ornamented with concentric growth flanges which are fluted and wrinkled. The muscle scars are elongate and not elevated.

Most of our better preserved specimens average about 20 mm. in altitude, but some exceed 30 mm.

Age: Oligocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 1216, 2379, 2394.

Chama quirosana F. Hodson, n. sp. Pl. 30, figs. 1, 2, 5, 7.

Shell small, attached by right valve, which is irregularly oblong. The attached valve has a ridge extending from the middle of the umbo to the ventral margin; this ridge divides the outside of the valve into two approximately equal parts; the top of the ridge bears a few low, imbricating scales at its intersection with growth lines; the scales extend from the ridge posteriorly; near the posterior margin, there is another row of decumbent scales, which obliquely crosses the close-set, papillate, faint, radial ribs; the main ridge extends to the inflated umbo as a sharp angulation; there are some imbricating scales on the anterior basal area. The attached valve is deep, and the rather elongate muscle scars are not elevated or very conspicuous. The free valve has not been found with certainty, but fragments of a free valve occurring in the same bed have the appearance of belonging to this species; the fragments show the valve to be thin, moderately deep, and bearing concentric waves of decumbent spines at least on the posterior extremity.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality number 6.

Chama berjadinensis F. Hodson, n. sp.
Pl. 30, figs. 4, 8, 10; pl. 31, figs. 2, 3, 5.

Shell is medium-sized, averages 35–45 mm. in altitude, is usually attached by the left valve, and has a small area of attachment near the beak; our biggest specimens measure 60 mm. in height. The attached valve is moderately deep; its curved beak is somewhat inflated and moderately elevated above the cardinal area. In the attached valve, the whole periphery of the internal margin, except the cardinal area, is closely denticulate with pronounced parallel striæ which are about at right angles with the peripheral edge of the valve. The elongate muscle scars are of moderate size. The most characteristic feature of the attached valve is the peculiar, irregular, radial, almost vermicular, papillate, close-set ribbing, especially noticeable in young specimens; the radial sculpture is crossed by irregular, concentric growth stages, which frequently interrupt the continuity of the radial ribs; in the more adult stages, the radial ribs become wider and the concentric lines frequently tend to produce short, decumbent spines and scales. The free valve is moderately shallow and shows fine radial sculpture of the same general type as on the other valve, but in the adult stages, the radial ribs tend to be narrower than on the attached valve.

Age: Miocene.

Locality: Common in the State of Falcón, locality numbers 24, 74, 75, 79, 80, 81, 84, 88A, 90, 92, 93, 94, 95, 98, 120B, 121, 122A, 184, 185, 193, 206A, 216, 225, 281, 299, 317, 341, 1007, 1017, 1064, 1065, 1078, 1335, 1842, 1869, 1870, 1872, 1892, 1897, 2377, 2386, 2391, 4615.

Family VENERIDÆ Leach

Genus DOSINA Scopoli

Section DOSINIDIA Dall

Dosinia elegans venezuelana H. K. Hodson, n. subsp.
Pl. 32, figs. 1, 4.

This subspecies is very similar to *D. elegans* (Conrad),[1] but it is proportionately higher, and has a thicker shell. The lunule is slightly larger, measuring about 8 mm. by 5 mm. in a shell about 56 mm. in height. *D. acetabulum* (Conrad)[2] is less produced anteriorly, has a lower beak, and is thinner.

This is an abundant species but almost never well preserved. Our largest specimen measures: height 65 mm., length 68 mm., diameter of both valves 31 mm.

Age: Miocene.

Locality: Districts of Colina, Miranda, Democracia, Acosta and Buchivacoa, State of Falcón, locality numbers 75, 80, 81, 84, 122B, 126, 131, 138C, 149B, 154, 155, 169A, 174, 178, 185, 205, 215, 219, 261, 281 283, 287, 317, 329, 339, 359, 1017, 1043, 1111, 1325, 1334, 1335, 1411, 1552, 1703, 1793, 1825, 1827, 1829, 1831, 1943.

Genus CLEMENTIA Gray

Clementia dariena (Conrad) Pl. 32, fig. 3.

Meretrix dariena Conrad, 1855, U. S. Pacific R. R. Expl., vol. 5, pt. 2, appendix, p. 328, pl. 6, fig. 55.
Clementia dariena (Conrad), Gabb, 1881, Jour. Acad. Nat. Sci. of Philadelphia, 2d ser., vol. 8, p. 344, pl. 44, figs. 16, 16a.
Clementia dariena (Conrad), Dall, 1903, Trans. Wagner Free Inst. Sci. of Philadelphia, vol. 3, pt. 6, p. 1235.
Clementia dariena (Conrad), Toula, 1909, Jahrb. der k.-k. Geol. Reich., vol. 58, (1908), pp. 725–726, pl. 27, figs. 9–10.

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1843, vol. 1, p. 325.
[2] Fossil Shells of the Tertiary Formations, 1832, p. 20, pl. 6, fig. 1.

Clementia dariena (Conrad), Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. of Philadelphia, vol. 63, p. 371, pl. 28, fig. 1.
Clementia rabelli Maury, 1920, New York Acad. of Sciences, Scientific Survey Porto Rico and Virgin Islands, vol. 3, pt. 1, pp. 37–38, pl. 6, figs. 2–3.
Clementia dariena (Conrad), Hubbard, 1921, New York Acad. of Sciences, Scientific Survey Porto Rico and Virgin Islands, vol. 3, pt. 2, (1920), pp. 118–120, pl. 19, figs. 10–12.
Clementia dariena (Conrad), Olsson, 1922, Bull. Amer. Pal., vol. 9, pp. 404–405, pl. 34, fig. 4.
Clementia dariena (Conrad), Spieker, 1922, Johns Hopkins Univ., Studies in Geology, No. 3, pp. 141–143, pl. 8, fig. 5.
Clementia sp. *cf. C. dariena* (Conrad), Woods, 1922, in Bosworth and others, Geology of the Tertiary and Quaternary Periods in the North-west Part of Peru, p. 113, pl. 20, figs. 4a, 4b, London.
Clementia dariena (Conrad), Maury, 1925, Bull. Amer. Pal., vol. 10, pp. 293–294, pl. 37, figs. 1, 3, 5–7.
Clementia dariena (Conrad), Harris, 1926, in Waring, Johns Hopkins. Univ., Studies in Geology, No. 7, p. 110, pl. 20, fig. 8.
Clementia (Clementia) dariena rabelli Maury, Woodring, 1926, Prof. Paper 147, U. S. Geol. Survey, p. 34, pl. 14, fig. 5.
Clementia (Clementia) dariena dariena (Conrad), Woodring, 1926, Prof. Paper 147, U. S. Geol. Survey, pp. 34–36, pl. 14, figs. 6–11.

We have exceedingly abundant collections of this species. As with most thin-shelled forms, this species is extremely variable and easily distorted; it is represented by casts more often than not. Dr. Maury's species seems to us to be only a variation which can be duplicated in almost any large collection of *Clementia dariena* throughout a wide range stratigraphically and geographically.

Age: Oligocene and Miocene.

Locality: Common in the State of Falcón; Gatun, C. Z.; locality numbers 29, 32, 75, 78, 79, 83, 85, 86, 100, 132, 141, 149B, 150A, 169, 172, 173, 174, 193, 198, 221, 261, 264, 283, 290, 292, 306, 313, 317, 323, 329, 332, 341, 354, 358, 406, 440 (*cf.*), 815, 919, 1015, 1017, 1069, 1073, 1256, 1265, 1266 (?), 1434, 1702, 1736, 1740, 1751, 1789, 1792, 1793, 1797, 1799, 1800, 1805, 1818, 1820, 1839, 1849, 1859, 1860, 1864, 1865, 1874, 1876, 1877, 1878A, 1897, 1898B, 1911, 1931C, 1936, 2005, 2019, 2019A, 2021, 2027, 2046, 2048, 2050 (*cf.*), 2207.

Genus MACROCALLISTA Meek

Macrocallista maculata (Linné) Pl. 32, fig. 6.

Venus maculata (Linné), 1758, Syst. Nat., 10th ed., p. 686; 1767, 12th ed., p. 1132.
Cytherea maculata (Linné), Lamarck, 1818, Anim. sans Vert., vol. 5, p. 566.
Cytherea maculata (Linné), Sowerby, 1842, Conch. Man., fig. 117d.
Cytherea dariena Conrad, 1857, Pacific R. R. Rept., vol. 6, p. 72, pl. 5, fig. 21.
Dione maculata (Linné), Reeve, 1863, Conch. Icon., *Dione*, pl. 3, figs. 11a, 11b.
Callista maculata (Linné), Gabb, 1881, Jour. Acad. Nat. Sci. of Philadelphia, 2d ser., vol. 8, p. 344.
Macrocallista (Chionella) maculata (Linné), Dall, 1903, Trans. Wagner Free Inst. Sci. of Philadelphia, vol. 3, p. 1256.
Macrocallista (Paradione) maculata (Linné), Maury, 1920, Bull. Amer. Pal., vol. 8, p. 100.
Macrocallista maculata (Linné), Olsson, 1922, Bull. Amer. Pal., vol. 9, pp. 406–407, pl. 34, figs. 6, 7.
Macrocallista (Chionella) maculata (Linné), Maury, 1925, Bull. Amer. Pal., vol. 10, pp. 297–298, pl. 36, figs. 1, 4, 5.

This species is common and shows many variations, as might be expected when a large number of specimens are examined. Our larger adult specimens frequently attain 55 mm. in length.

Age: Miocene.

Locality: Districts of Democracia, Colina, Miranda, Acosta and Buchivacoa, State of Falcón; Cartagena, Colombia; locality numbers 70A, 70C, 72, 86, 97, 122B, 131, 154, 155, 178, 185, 215, 248, 307, 254, 1102, 1013, 1033, 1035, 1232, 1825, 1827, 1831, 1839, 1856, 1892, 1908, 1912, 1928, 1931C.

Genus PITARIA (Römer)

Subgenus GILBERTHARRISELLA F. and H. Hodson, new subgenus

The shell is large, very thick, with its height about equal to its length. The beak is high and inflated. The external sculpture consists of concentric folds. The lunule is large and defined by an incised line; the escutcheon is not well defined. The pallial sinus is small, narrow, and does not reach the middle of the shell. The ridge behind the muscle scar is heavy and strongly elevated. The anterior lateral lamella is peg-like and received in a pit in the hight valve. The type of this new subgenus is *P.* (*Gilbertharrisella*) *lynei* F. and H. Hodson, n. sp.

Named in honor of Prof. G. D. Harris.

Pitaria (Gilbertharrisella) lynei F. and H. Hodson, n. sp.
Pl. 33, figs. 3, 5.

Shell thick, valves deep, umbones inflated. The lunule is large, cordate, and limited by a faint line near the beaks, but less distinctly demarked ventrally. The escutcheon is deep and rounded. The hinge plate is thick; the teeth are large. The anterior muscle scar is large, deeply impressed, and limited interiorly by a thickened ridge which becomes weaker ventrally. The posterior muscle scar is large but not impressed. The pallial sinus is low, rounded on top and pointed at the end. There is a gentle depression along the posterior slope adjacent to the escutcheon, but separated from it by a low ridge. The sculpture consists of concentric, flattened folds.

Named in honor of Mr. H. S. Lyne who collected the material.

Age: Upper Cretaceous.

Locality: District of Perijá, State of Zulia, locality number 2220.

Subgenus PITARIA s. s.

Pitaria (Pitaria) quirosana H. K. Hodson, n. sp. Pl. 32, figs. 2, 5.

The shell is thin, small, somewhat trigonal, produced posteriorly, polished. The lunule is small and defined by an incised line. The escutcheon is obscure. The beak is situated at about the anterior fourth of the shell. Posteriorly from the beak, a rounded keel extends to the margin. The pallial sinus is wide and extends forward more than half the length of the shell.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia; District of Acosta, State of Falcón; locality numbers 6, 1419.

Pitaria (Pitaria) colinensis H. K. Hodson, n. sp. Pl. 33, figs. 4, 6.

The shell is large, ovate, inflated and ornamented with close-set concentric lines, which grow coarser toward the basal margin. The beak is low and situated at about the anterior seventh of the shell. The lunule is wide, cordate, defined by an incised line, and sculptured like the rest of the shell. The escutcheon is poorly defined, similarly sculptured, and abruptly raised at its peripheral margin. The interior of the shell is concealed by the matrix.

This species is more ovate than *P. gatunensis* (Dall)[1] and *P. paraguanensis* (n. sp.).

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 123, 204, 205.

Pitaria (Pitaria) paraguanensis H. K. Hodson, n. sp. Pl. 33, fig. 1.

The shell is large, heavy, trigonal, and ornamented with close-set, concentric, raised lines, which become coarser toward the ventral margin. The beak is situated at about the anterior fifth of the shell and is moderately high. The lunule is cordate, wide, defined by an incised line, and sculptured like the rest of the shell. The escutcheon is poorly defined, similarly ornamented, and slightly raised at the peripheral margin. The interior of the shell is concealed by the matrix.

This species is more trigonal than *P. colinensis* (n. sp.) and *P. gatunensis* (Dall) (*loc. cit.*), and its beaks are situated a little more posteriorly.

Age: Miocene.

Locality: District of Falcón, State of Falcón, locality number 2207.

[1] Trans. Wagner Free Inst. Sci., 1903, vol. 3, pt. 6, pp. 1260–1261, pl. 54, fig. 1.

Pitaria (Pitaria) buenavistana H. K. Hodson, n. sp. Pl. 33, fig. 2.

The shell is of medium size, high, plump, ornamented with concentric sculpture which is not much stronger than growth lines. The lunule is large, cordate, and ornamented like the rest of the shell. The beak is high and situated a little back of the anterior fourth of the shell.

The species is rare and usually poorly preserved, due to its thin shell.

Age: Miocene.

Locality: District of Colina, State of Falcón, locality number 123.

Pitaria buenavista coroana H. K. Hodson, n. subsp. Pl. 33, fig. 7.

This subspecies is smaller than *P. buenavista* (n. sp.) and carries a depression behind the beak a well as in front of it. The beak is higher than in the species and is situated at about the anterior four-tenths of the length of the shell. The sculpture is about the same as that of the species.

Possibly, *P. buenavista coroana* (n. subsp.) should be of specific rank, but some of the specimens, although poorly preserved, seem to be intergradations between this form and *P. buenavista.*

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 122B, 155, 1335, 1552.

Subgenus HYPHANTOSOMA Dall

Pitaria (Hyphantosoma) mirandana H. K. Hodson, n. sp. Pl. 31, fig. 1.

The shell is small, somewhat trigonal, covered with the zigzag markings typical of the subgenus. The lunule is long, lanceolate, sculptured similarly to the rest of the shell. The escutcheon is poorly defined, strongly sculptured. The beak is low and smooth.

This species is very small, attaining only about 20 mm. in height. It is shaped something like *P. carbasea lavelana* (n. subsp.), but is more produced posteriorly. Very few specimens have been found.

Age Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality number 6.

Pitaria carbasea lavelana H. K. Hodson, n. subsp.

Pl. 34, figs. 6 7.

This subspecies is larger than *P. carbasea* (Guppy),[1] attaining 45 mm. in height instead of 32 mm. The lunule is marked with radial sculpture as well as concentric, which is not found in the Bowden form. The shape is much the same as that of the species. In the larger shells, the concentric sculpture is very coarse near the margin and stronger than the radial.

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 122B, 123, 155, 204, 1335.

Genus ANTIGONA Schumacher

Section VENTRICOLA Römer

Antigona palmeræ H. K. Hodson, n. sp.

Pl. 31, figs. 6, 7; pl. 35, fig. 8.

The shell is small, moderately inflated, posteriorly produced, ornamented with rather close-set, sharp, concentric, recurved lamellæ, which are separated by several fine secondary lines. The beaks are low. The lunule is cordate, long and narrow, covered with coarse lines marking the extensions of the lamellæ which cover the main part of the shell. The escutcehon is narrow, depressed and practically smooth. Although this is an abundant species, the exact shape of the shell cannot be determined as all of the specimens are more or less distorted or broken.

This species is very similar to the larger species, *A. blandiana* (Guppy),[2] but the beaks are much lower; the lunule is longer, more coarsely marked, and not depressed; the anterior is less produced.

[1] Quart. Journ. Geol. Soc. London, 1866, vol. 22, p. 292, pl. 18, fig. 13.
[2] Proc. Sci. Assoc. Trinidad, 1873, vol. 3, pp. 85–86, pl. 2, fig. 8.

Named in honor of Dr. Katherine Van Winkle Palmer.

Age: Oligocene-Miocene.

Locality: Districts of Buchivacoa and Acosta, State of Falcón; Districts of Miranda and Bolívar, State of Zulia; locality numbers 15, 29, 41, 777, 782, 1070, 1075C, 1080, 1221, 1408, 1436, 1437, 2016, 2046, 2265, 2266, 2268, 2269, 2274, 2447, 3205, 3207, 3251, 3352.

Genus CYCLINELLA Dall

Cyclinella falconensis H. K. Hodson, n. sp. Pl. 34, fig. 2.

The shell is small, suborbicular, ornamented with close-set, fine, concentric lines. The lunule is lanceolate, measuring about 10 mm. by 4.5 mm. on a shell about 34 mm. in height. The external margins of adjacent valves meet in an acute angle in the lunule. The beaks are low and only slightly raised above the outline of the shell.

The proportions and shape of the shell of this species are much like those of *C. venezuelana* (n. sp.), but the latter is larger and has a V-shaped depression instead of a sharp angular ridge where the margins of the valve meet in the lunule.

Age: Oligocene and Miocene.

Locality: Districts of Democracia, Buchivacoa and Acosta, State of Falcón, locality numbers 86, 1411, 1748, 1793, 1795.

Cyclinella venezuelana H. K. Hodson, n. sp. Pl. 34, figs. 3, 4.

The shell is large, plump, ornamented with slight folds which are scarcely more than growth lines. Toward the basal margin, the growth becomes irregular, making the shell thin and thicker periodically, forming little terraces in the sculpture. The shell is produced anteriorly, and is fullest along a line extending somewhat obliquely from the beak to the ventral margin; the beak is only slightly in front of the center of the shell. The lunule is lanceolate and measures about 12 mm. by 7 mm. on a shell about 45 mm. high.

This species is larger than *C. cyclica* (Guppy),[1] *C. gatunensis* Dall[2] and *C. cyclica domingensis* Pilsbry and Brown.[3] It differs from the first and last in shape, and is much thicker than *C. gatunensis* Dall. None of the adult specimens are perfectly preserved.

Age: Miocene.

Locality: Districts of Colina and Falcón, State of Falcón, locality numbers 281, 1073, 2207.

Genus CHIONE Megerle von Mühlfeld

Subgenus CHIONE s. s.

Chione (Chione) montañitensis H. K. Hodson, n. sp. Pl. 35, fig. 3.

The shell is of medium size, elongate, produced posposteriorly in a kind of nose. In front of this posterior swelling, is a depression which is reflected in the ventral margin by a sinus. The concentric sculpture consists of very thin flanges, which occur closer together in the adult stages, running from the lunule to the escutcheon. The radial dominates over the concentric sculpture, and flutes the concentric flanges as strongly as the interspaces between them. These flanges are mostly broken off in all of our specimens, but judging from the fragments of them preserved, they either slope down or stand straight out from the shell, and do not curl up. The lunule is defined by a sharply incised line, and is unornamented except for growth lines. The escutcheon is impressed and carries only growth lines. The inside of the shell cannot be seen as all of the specimens consist of two valves fastened together in the matrix. The largest specimen found measures about 36 mm. in length.

The distinguishing mark of this species is the posterior nose with a depression and sinus in front of it.

[1] Quart. Journ. Geol. Soc. London, 1866, vol. 22, p. 282, pl. 26, fig. 15a–b.

[2] Trans. Wagner Free Inst. Sci., 1903, vol. 3, pt. 6, p. 1285, pl. 52, fig. 18.

[3] Proc. Acad. Nat. Sci. of Philadelphia, 1921, p. 424, pl. 47, fig. 8.

Age: Oligocene-Miocene.

Locality: District of Buchivacoa, State of Falcón; District of Urdaneta, State of Lara; locality numbers 440, 1939,

Chione (Chione) buchivacoana H. K. Hodson, n. sp. Pl. 35, fig. 1.

The shell is small, thin, elongate, ornamented with predominately radial sculpture. The posterior is somewhat produced and pinched. The lunule is lanceolate, defined by a sharply incised line. The concentric sculpture is fluted by the radial, but whether there were once wide flanges cannot be determined; the concentric ornamentation and growth lines extend over the lunule and large escutcheon, but are here uninterrupted by radial lines. The rays are prominent and bifurcate as the shell growth.

This species is much thinner than *C. montañitensis* (n. sp.) and lacks the posterior sulcus and swelling.

Age: Oligocene-Miocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 2490A, 3233.

Chione (Chione) cancellata (Linné) Pl. 35, fig. 5.

Venus cancellata Linné, 1767, Syst. Nat., ed. XII, p. 1130.
Chione cancellata (Linné), Dall. 1903, Trans. Wagner Free Inst. Sci., vol. 3, pp| 1290–1291.
Chione cancellata (Linné), Maury, 1920, Bull. Amer. Pal., vol. 8, no. 34, pp. 72–73.
Chione cancellata (Linné), Maury, 1925, Bull. Amer. Pal., vol. 10, no. 42, pp. 153–154, pl. 28, figs. 1, 5.

This common species occurs in Venezuela in the Miocene as well as from Pliocene to Recent. The specimens in the Miocene are small or medium in size, while those in the Quaternary are largest.

Age: Miocene-Recent.

Locality: Districts of Falcón, Democracia and Colina, recent along coast, State of Falcón; Districts of Paé, State of Zulia; locality numbers 82, 93, 94, 97, 426, 1265, 1504

Chione (Chione) paraguanensis H. K. Hodson, n. sp.
Pl. 35, figs. 2, 7.

The shell is sigh, inflated, produced posteriorly. The concentric sculpture is more conspicuous, consisting of numerous, close-set, fluted, concentric flanges, which point sharply upward, except on the very posterior and in the young stages where they stand straight out. The lunule and escutcheon are unornamented except for growth lines. The lunule is cordate; the escutcheon is depressed.

The high beak, acute posterior production, and close-set concentric laminæ easily distinguish this shell. Some specimens attain 37 mm. in height, as indicated by fragments, but the better preserved ones measure only about 26 mm.

Age: Miocene.

Locality: Districts of Democracia, Colina, Falcón and Miranda, State of Falcón, locality numbers 90, 94, 1507, 1892, 2207.

Subgenus LIROPHORA Conrad

Chione (Lirophora) quirosensis H. K. Hodson, n. sp. Pl. 35, fig. 9.

The shell is of moderate size, trigonal, ornamented with wide, thin flanges, which are widely separated. These flanges extend from near the lunule to the ridge which demarks the escutcheon and point straight out or are somewhat curved up. The lunule is elongate and marked only with growth lines and faint traces of the concentric flanges. The escutcheon is depressed and carries only growth lines.

This Chione is common but nearly always poorly preserved.

Age: Oligocene-Miocene.

Locality: Districts of Buchivacoa, Damocracia and Falcón, State of Falcón; Districts of Bolívar and Miranda, State of Zulia; District of Urdaneta, State of Lara; locality numbers 6, 7, 10, 811, 1128, 1288, 1289, 1290, 1405A, 1736, 7160, 2201, 2258, 2266, 2271, 2382, 2447A, 3208, 3218, 3219, 3247, 3251, 3330.

Chione quirosensis queralana H. K. Hodson, n. subsp. Pl. 34, fig. 1

This subspecies is very much larger than *C. quirosensis* (n. sp.). It has more concentric flanges than the latter, and in an adult shell, these are crowded very closely together at the margin.

Age: Oligocene and Miocene.

Locality: Districts of Buchivacoa, Miranda, Democracia and Federación, State of Falcón, locality numbers 257, 339, 342, 400, 1042, 1282, 1628, 1705, 1705A, 1792, 1934, 1936.

Chione (Lirophora) cartagenensis H. K. Hodson, n. sp.
Pl. 31, fig. 4; pl. 35, fig. 6.

The shell is of medium size, trigonal, and ornamented with numerous, almost confluent ribs, which are wide in the young stages and of various width in the adult. The ribs extend from the lunule, or very near it, to an area near the escutcheon, where they continue to the posterior ridge as low flanges. Anteriorly, the edge of the ribs is inclined to curl up in a thin flange, and in adult shells, the last few folds carry a somewhat thinner upper edge. The lunule is deeply impressed, lanceolate, and ornamented with only growth lines. The escutcheon is sharply defined and likewise carries only growth lines. Radial sculpture is lacking exteriorly as the shell does not carry even pits below the concentric folds.

Most of the specimens are small, but one attain 26 mm. in height. The ribs of this species are more confluent than in *C. chiriquiensis* Olsson.[1]

Age: Miocene.

Locality: Cartagena, Colombia.

Chione (Lirophora) falconensis H. K. Hodson, n. sp.

Pl. 35, fig. 10.

The shell is of medium size, plump, produced posteriorly, and ornamented with numerous narrow folds. The ribs are low and extend from near the lunule to an area

[1] Bull. Amer. Pal., 1922, vol. 9, no. 39, p. 248, pl. 32, figs. 9, 10.

in front of the escutcheon, where they become narrow, downward pointing flanges. At the base of each rib is a row of pits, representing the radial sculpture. The lunule is cordate, crossed only by growth lines and slightly heavier lines which are continuations of the concentric ribs. The escutcheon is sharply defined and similarly marked.

This common Venezuelan species has very different ribbing from *C. hendersoni* Dall, has a larger lunule, and is proportionately longer for its height. It is nearly always poorly preserved. The shell attains 26 mm. in height but is usually smaller.

Age Miocene.

Locality: Districts of Buchivacoa, Democracia, Colina and Acosta, State of Falcón, locality numbers 82, 90, 93, 185, 1005, 1335, 2386, 2412, 2413, 2801, 4615.

Chione (Lirophora) matarucana H. K. Hodson, n. sp.
Pl. 35, fig. 4.

The shell is small, high, rather flat, and shaped like an Astarte. It is ornamented with numerous narrow folds which extend from very near the lunule to the escutcheon. The lunule and escutcheon carry only growth lines. The right valve laps widely over the left along the escutcheon.

C. matarucana (n. sp.) resembles most closely a specimen in the Newcomb collection at Cornell University, which is labeled *C. brongniartii* Payraudeau from the Mediterraneon. The fossil species is larger and more produced posteriorly.

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 192, 203, 1020, 1242.

Chione (Lirophora) wiedenmayeri H. K. Hodson, n. sp.
Pl. 34, fig. 5.

The shell is large, high, produced posteriorly and inflated. The ornamentation is low and inconspicuous, with the radial and concentric of about equal strength, similar to that of *Chione mactropsis* (Conrad).[1] The lunule is

[1] *Fide* Olsson, Bull. Amer. Pal., vol. 9, 1922, pp. 417–418, pl. 33, figs. 7, 8.

large and crossed with only growth lines. The escutcheon is large and depressed.

This species is quite rare and most of the specimens are poorly preserved. It differs from *C. mactropsis* mainly in its proportionately greater hight, and it lacks the anterior foliaceous area of both *C. mactropsis* (Conrad) and *C. holocyma* Brown and Pilsbry;[1] also, it has a larger lunule and a depressed escutcheon. The general shape resembles that of *C. paraguanensis* (n. sp.). The largest specimen found measures about 38 mm. in height.

Named in honor of Dr. C. Wiedenmayer, who collected most of the specimens.

Age: Miocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 1934, 2267, 2272, 2282.

Chione (Lirophora) buenavista H. K. Hodson, n. sp.
Pl. 36, fig. 11.

The shell is large, very heavy, ornamented with flat, confluent ribs of various widths. These ribs terminate in thin flanges which are usually broken off. The radial sculpture is very slight, so that some specimens with the lateral flanges broken off look something like a Pitaria or Macrocallista. The lunule is set far under the beak and crossed with only growth lines. The escutcheon is demarked by a ridge and is likewise unornamented.

The radial ornamentation of this species is less strong than that of *C. mactropsis* (Conrad) (*loc. cit.*) and *C. holocyma* Brown and Pilsbry (*loc. cit.*), and the lunule is more excavated.

Age: Miocene.

Locality: Districts of Colina, Democracia and Acosta, State of Falcón, locality numbers 97, 120B, 121, 127, 154, 155, 179, 180, 189, 204, 1335, 1448.

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1911, vol. 63, p. 369.

Class GASTROPODA Cuvier

Family SOLARIIDÆ Chenu

Genus ARCHITECTONICA Bolten

Architectonica granulata (Lamarck) Pl. 36, fig. 7.

Solarium granulatum Lamarck, 1822, Anim. sans Vert., 7, p. 3; 1792, Ency Méthod., pl. 446, fig. 5a–b.
Architectonica perspectiva Tuomey and Holmes, 1857, Pleioc. Fos. S. Car., p. 120, pl. 26, fig. 6. Not *S. perspectiva* Linné, nor of Lamarck.
Solarium granulatum Lamarck, Dall, 1892, Trans. Wagner Free Inst. Sci. of Philadelphia, vol. 3, p. 329.
Solarium Villarelloi Bòse, 1906, Inst. Geol. de Mexico, numero 22, pp. 30–31, pl. 3, figs. 4–11.
Solarium gatunense Toula, 1909, Jahrb. der k.-k. Geol. Reichsanstalt, Wien, vol. 58, (1908), pp. 692–693, pl. 25, fig. 3.
Solarium granulatum Lamarck, Maury, 1917, Bull. Amer. Pal., vol. 5, no. 29, p. 131, pl. 23, fig. 3.
Architectnia granulata (Lamarck), Maury, 1922, Bull. Amer. Pal., vol. 9, no. 38, p. 108.
Architectonia granulata (Lamarck), Olsson, 1922, Bull. Amer. Pal., vol. 9, no. 39, p. 154, pl. 13, figs. 10, 11, 12.
Architectonia granulata (Lamarck), Maury, 1925, Bull. Amer. Pal., vol. 10, p. 388, pl. 51, fig. 1.

This is a common and variable species, which occurs in many of our collections. Forms commonly referred to *A. quadriseriata* (Sowerby) seem to us to be a little more than a flatter subspecies of *A. granulata,* and intergrade with it; there are all intermediate forms between them. Our adult specimens usually average 20–25 mm. in diameter.

Age: Oligocene and Miocene.

Locality: Common in the State of Falcón; District of Miranda, State of Zulia; Gatun, C. Z.; Bowden, Jamaica; locality numbers 6, 84, 85, 100, 131, 149, 149B, 150A, 150B, 154, 163, 169A, 178, 184, 185, 189, 215, 291, 341, 1017, 1033, 1255, 1815, 1818, 1825 (?), 1827, 1856, 1858, 1892, 1934, 1936, 1943, 2027, 2207, 2375, 2386, 2391, 2420, 2447A, 2475, 2823, 3214, 3241, 4614, 4615, 4619, 4620.

Family NATICIDÆ Forbes

Genus SINUM Bolten

Sinum quirosanum F. Hodson, n. sp. Pl. 36, figs. 10, 12.

Shell is small, flaring, consisting of about 4½ whorls. The first 2 whorls are smooth; the others are covered with fine, irregular, zigzag, spiral lines. The greatest altitude is about equal to the greatest diameter. The pillar is short, being about one-third the total altitude of the shell. The aperture is large, oval, and in a specimen 10 mm. in greatest diameter, the height is about 8 mm. and the width about 6 mm.; the inner margin of the aperture is flaring and produces a ridge so that there is a depression between the basal part of the body whorl and the inner lip; there is no umbilical chink.

This species is somewhat similar to *S. imperforatum* Dall [1] in size and general appearance, but our species is not as high for its width.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality number 6.

Genus NATICA Scopoli

Natica guppiana Toula Pl. 36, figs. 1, 4.

Natica (*Stigmaulax*) *Guppiana* Toula, 1909, Jahrb. der k.-k. Geol. Reichsanstalt, Wien. vol. 58, (1908), pp. 696–697, pl. 25, fig. 6.
Natica guppyana Toula, Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. of Philadelphia, vol. 63, p. 360.
Natica Guppyana Toula, Olsson, Bull. Amer. Pal., vol. 9, pp. 328–329, pl. 16, figs. 13–15.

Our collection shows this species to be quite variable and frequently the axial grooves or sulcations are farther apart than in typical *N. guppyana*.

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 185, 1033.

[1] Bull. 90, U. S. Nat. Museum, 1915, p. 109, pl. 5, fig. 8.

Natica canrena (Linné) Mörch

Natica canrena (Linné, *partim*) Moerch, 1877, Malak. Blatt. 24, p. 62.
Natica canrena (Linné) Mörch, Dall, 1892, Trans. Wagner Free Inst. Sci. of Philadelphia, vol. 3, pp. 364–365.
Natica canrena (Linné), Brown and Pilsbry, 1912, Proc. Acad. Nat. Sci. of Philadelphia, p. 508.
Natica canrena (Linné) Moerch, Maury, 1917, Bull. Amer. Pal., vol. 5, pp. 298–299, pl. 49, fig. 10.
Natica canrena (Linné) Olsson, 1922, Bull. Amer. Pal., vol. 9, p. 327, pl. 16, fig. 9.
Natica canrena (Linné) Moerch, Maury, 1925, Bull. Amer. Pal. vol. 10, pp. 390–391, pl. 51, fig. 8.

Our fossil specimens closely resemble the recent which are rather common along the north coast of the State of Falcón.

Age: Miocene-Recent.

Locality: Districts of Falcón and Colina, State of Falcón; Bowden, Jamaica; locality numbers 163, 185, 1033, 1109, 1255, 2207.

Natica precanrena F. Hodson, n. sp. Pl. 36, figs. 2, 6, 9.

Shell is small with about 5 rounded whorls. This species is smaller and his a higher spire than the recent *N. canrena* (Linné). Numerous tangential plicæ start from the suture line and usually become faint or disappear before they reach the middle of the body whorl. The aperture is broadly elongate, narrower at the top. The callus on the inner lip is continuous with the umbilical callus; the umbilicus is partly filled at the base, leaving a rather deep, comma-shaped depression.

This form differs from the recent *N. canrena* in its smaller size, higher spire and more sloping shoulders.

Age: Oligocene-Miocene.

Locality: District of Buchivacoa, State of Falcón; District of Miranda, State of Zulia; locality numbers 6, 25, 1140.

Genus POLINICES Montfort

Polinices subclausa (Sowerby) Pl. 36, fig. 5.

Natica subclausa Sowerby, 1849, Quart. Journ. Geol. Soc. London, vol. 6, p. 51.
Natica subclausa Sowerby, Guppy. 1866, Quart. Journ. Geol. Soc. London, vol. 22, p. 290, pl. 18, fig. 8.
Polinices subclausa (Sowerby), Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. of Philadelphia, vol. 63, p. 360.
Polinices subclausa (Sowerby), Maury, 1917, Bull. Amer. Pal., vol. 5, p. 300, pl. 49, fig. 14.

Polinices subclausa (Sowerby), Olsson, 1922, Bull. Amer. Pal., vol. 9, p. 329, pl. 16, figs. 16, 17.

Our specimens from Bowden, Jamaica, are usually larger than the Costa Rican forms and are about the same size or slightly smaller than those from Santo Domingo.

Age: Miocene.

Locality: Bowden Hill, Bowden, Morant Bay, Jamaica.

Polinices subclausa lavelana F. Hodson, n. subsp.
Pl. 36, fig. 8; pl. 37, figs. 12, 14.

This subspecies differs in having a pronounced umbilical notch in the callus on the inner lip just posterior to the spiral umbilical rib. The depth of this notch is variable. The callus on the upper half of the inner lip may have a straight margin at its distal contact or it may be slightly concave. The type from Venezuela is slightly weathered, and shows a rather concave margin at the contact of the callus of the inner lip with the preceding whorl; the characteristic, transverse groove at the top of the umbilical opening is present, but is not as distinct as it would appear in unweathered specimens. The Venezuelan form usually has a slightly heavier shell than the Bowden form, and tends to show a greater subsutural depression.

Age: Miocene.

Locality: Bowden, Jamaica; Districts of Colina and Democracia, State of Falcón, locality numbers 86, 93 (?), 154, 178, 185, 1033.

Polinices subporcana (Williston MS.), n. sp.
Pl. 36, fig. 3; pl. 37, figs. 5, 9, 16.

Williston's manuscript description is as follows:

"Our species is very close to *Polynices porcana* Spieker from the Zorritos formation of Peru, in size, shape, and general characteristics of the umbilical callus, but differs uniformly in having a small umbilical chink and a narrow V-shaped trough impressed in the callus near the lower margin of the peristome. The shell is large, low spired with a broad apical angle. Whorls about five, rounded and smooth except for growth lines. Sutures distinct but not channeled; base rounded."

The shell is thick and almost globular. One large specimen measures 47 mm. in height and another 60 mm. across greatest diameter of base. The bulbous, umbilical callus usually has a small semicircular area, delimited by a pronounced groove, near the aperture at the base of the body whorl.

Age: Miocene.

Locality: Districts of Democracia, Miranda and Colina, State of Falcón, locality numbers 70A, 70B, 70C, 72, 81, 82, 83, 83B, 85, 86, 87, 96, 97, 169A (?), 185, 225 (?), 1017, 1233, 1552, 1862, 1866, 1872, 1877, 1892, 1905, 1908 (*cf.*).

Polinices stanislas-meunieri venezuelana F. Hodson, n. susbp.
Pl. 37, figs. 10, 15.

This subspecies is rather abundant and although it sometimes grades into *P. stanislas-meunieri* Maury,[1] it usually is smaller. Typically, our subspecies, in addition to being smaller, has an umbilical notch more or less pronounced near the upper part of the lower half of the inner lip. The umbilical callus on the inner lip tends to be heavier below the umbilical notch and reduces the size of the umbilicus to a greater extent than in the species, *sensu stricto*. There is a slight, subsutural depression in both

[1] Bull. Amer. Pal., 1917, vol. 5, pp. 300–301, pl. 49, figs. 15, 16.

the species and subspecies.

Age: Miocene.

Locality: Districts of Democracia, Miranda and Colina, State of Falcón, locality numbers 70A, 86, 185, 187, 1033, 1233, 1255.

Polinices (Neverita) paraguanensis F. Hodson, n. sp.
Pl. 38, figs. 2, 3, 4.

Shell low-spired, polished, of moderate size, having 5 or 6 whorls. Each later whorl almost covers the preceding one. The curved growth lines are retractive from the upper suture to the umbilical callus. The growth lines are crossed by faint, close-set spirals which are about parallel to the upper sutural line. The upper half of the whorl is flattened but slightly arched; the flattening or rotundity of the upper part of the whorl is probably a secondary sexual character. The umbilicus is completely filled with callus.

Age: Miocene-Pliocene.

Locality: District of Falcón, State of Falcón, locality numbers 1073, 2207.

Polinices paraguanensis quirosana F. Hodson, n. subsp.
Pl. 38, figs. 1, 5, 7.

This subspecies differs principally in the umbilical callus which does not completely fill the umbilicus, but leaves a small chink or unfilled area. The upper half of the last whorl is more rotund or convex than in the species, *sensu stricto*.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality number 6.

Polinices paraguanensis buchivacoana F. Hodson, n. subsp.
Pl. 38, figs. 6, 9.

This subspecies is distinguished by its much smaller size and larger umbilical callus. The filling is bulbous and extends below the base of the shell; this bulbous callus completely fills the umbilicus, but frequently leaves a lunar or crescent-shaped groove between the callus and the body whorl. The upper part of the whorl is somewhat flattened. The spiral lines are very indistinct. The figured specimens of the subspecies represent the largest ones found. They are commonly smaller and more or less fragmentary.

Age: Oligocene.

Locality: District of Buchivacoa, State of Falcón, locality numbers 1139, 1215, 1217.

Genus AMPULLINA (Lamarck) Bowdich

Ampullina (?) santiagana F. Hodson, n. sp.
Pl. 38, fig. 8; pl. 39, figs. 1, 2.

Shell large with rapidly expanding whorls and a moderately high spire. There are 4 or 5 whorls, the sides of which have a rather uniform slope with small shoulders noticeable at the top of each whorl just below the suture line. The base of the shell is almost flat, and a large callus completely covers the umbilicus.

Unfortunately, the shell matter in our specimens is frequently weathered or recrystallized. The aperture is not well preserved in these large forms, which frequently measure 3 or 4 inches across the flat base. In the casts, there is a pronounced shoulder at the top of each whorl.

Ampullina amphora (Heilprin)[1] is a large form which has pronounced shoulders at the top of each whorl and the umbilicus only partly filled with callus.

Age: Oligocene.

Locality: Districts of Buchivacoa and Petit, State of Falcón, locality numbers 33 (variation), 59, 256 (*cf.*), 1036, 1037 (*cf.*), 2005.

Family VERMICULARIIDÆ Dall

Genus PETALOCONCHUS Lea

Petaloconchus sculpturatus domingensis Sowerby Pl. 38, fig. 10.

Petaloconchus domingensis Sowerby, 1849, Quart. Journ. Geol. Soc.

[1] Explorations in Florida, 1887, p. 112, fig. 50.

London, vol. 6, p. 51, pl. 10, figs. 9a, b, c.
Vermetus (Petaloconchus) sculpturatus (H. C. Lea), Dall, (*partim*), 1892, Trans. Wagner Free Inst. Sci. of Philadelphia, vol. 3, p. 305.
Petaloconchus domingensis Sowerby, Brown and Pilsbry, 1911, Proc. Acad. Nat. Sci. Philadelphia, vol. 63, p. 359.
Petaloconchus domingensis Sowerby, Maury, 1917, Bull. Amer. Pal., vol. 5, no. 29, p. 128, pl. 22, fig. 11.
Petaloconchus domingensis Sowerby, Hubbard, 1921, Sci. Surv. Porto Rico and Virgin Islands, N. Y. Acad. of Sci., vol. 3, (1920), pt. 2, p. 139.
Petaloconchus sculpturatus H. C. Lea, Olsson, 1922, Bull. Amer. Pal., vol. 9, no. 39, pp. 146–147, pl. 14, figs. 10, 15.
Vermetus (Petaloconchus) domingensis (Sowerby), Pilsbry, 1921, Proc. Acad. Nat. Sci. of Philadelphia, vol. 73 (1921), p. 377.
Petaloconchus sculpturatus domingensis Sowerby, Maury, 1925, Bull. Amer. Pal., vol. 10, pp. 378–379, pl. 52, figs. 2, 4, 7.

Most of the numerous specimens in Venezuela have flat sides like those from Trinidad, Santo Domingo and Costa Rica; some are rounded. A comparison has not yet been made with specimens of *P. sculpturatus* H. C. Lea from the Chesapeake Miocene, and later when this comparison is made, it may be necessary to put tihs variety in synonymy with the older species.

Age: Miocene.

Locality: Districts of Democracia, Colina, Miranda, Falcón and Buchivacoa, State of Falcón, locality numbers 70A, 74, 82, 100, 103, 118, 120B, 121, 122A, 131, 149B, 154, 178, 180, 184, 185, 189, 204, 273, 283, 298, 299, 307, 1007, 1033, 1034, 1043, 1066, 1072, 1818, 1856, 1931C.

Family MARGINELLIDÆ Jousseaume

Genus MARGINELLA Lamarck

Marginella saladillœnsis F. Hodson, n. sp. Pl. 37, figs. 6, 7.

Shell is small, thin, smooth, and has a tapering spire. The outer lip is sharp, arcuate, but not denticulate. The inner lips bears 4 oblique, columellar plicæ; the anterior of these forms the twisted base of the pillar; the plicæ are subequally spaced, the two anterior folds being a little closer together than the others and a little more oblique. There is no marked columellar callosity. The aperture is much wider anteriorly; the anterior canal is wide and well defined; the posterior sinus is inconspicuous and is not notched. The spire has a nearly uniform taper which is almost constant for the upper half of the shell. The number of whorls in the spire could not be determined because a thin coat of enamel covers the sutures as well as all the whorls.

This species has about the same contour as *M. impagina* Dall from the Tampa Silex beds, but our form is larger and the outer lip is not elevated posteriorly.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality numbers 6, 1140.

Marginella quirosensis F. Hodson, n. sp. Pl. 37, figs. 3, 4, 8.

Shell is small, solid, and moderately convex. The spire and body whorls are covered with a coat of enamel, which somewhat obscures the nuclear whorls and sutures. The aperture is narrow but becomes wider anteriorly. The outer lip is thickened, especially toward the middle, and is protracted posteriorly on the preceding whorl. The posterior sinus is rounded, narrow, and very slightly reflexed. The columella is short and carries 4 prominent subequal folds, of which the anterior two are more oblique and closer together; the anterior of these oblique folds forms the lower, twisted edge of the columella. On the inner lip, behind the columellar folds, and more or less at right angles with them, is a longitudinal ridge covered by the columellar callus; the ridge is parallel to the inner margin of the outer lip and extends along the posterior two-fifths of the aperture. The inner lip is delimited from the body whorl by a slightly thickened, elevated callosity. The height of the spire is variable but the holotype represents the more common appearance.

This species is analogous to, and closely resembles, *M.*

elegantula Dall,[1] but does not carry the denticulation on the inner margin of the outer lip. There seems to be a slight difference in the spacing of the columellar plaits and a more prominent columellar callosity in our species.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia; District of Buchivacoa, State of Falcón; locality numbers 6, 1140, 2040.

Marginella quirosensis paraguanensis F. Hodson, n. subsp.
Pl. 37, figs. 1, 2.

This subspecies differs mainly in being much larger. The outer lip stands out a little more abruptly at the base of the spire than is common in the species, *sensu stricto*.

Age: Miocene.

Locality: District of Falcón, State of Falcón, locality number 2207.

Marginella berjadinensis F. Hodson, n. sp.
Pl. 37, figs. 11, 13; pl. 40, figs. 16, 18.

Shell is small, solid, and moderately convex. The spire is short, blunt and covered with a coat of enamel which extends over the body whorl. The enamel somewhat conceals the sutures of the earlier whorls. The aperture is narrow, and widens a little anteriorly. The outer lip is thickened, somewhat arcuate, marginate, and marked with a longitudinal groove along the dorsal margin; the lip is terminated posteriorly rather abruptly; it becomes thinner adjacent to the aperture and is not denticulate. The posterior sinus is rather narrow. The columella carries 4 folds, the anterior two of which are more oblique and closer together; the anterior of these forms the lower edge of the columella.

This species differs from *M. quirosensis* (n. sp.) in having a much shorter spire and in lacking such a definite

[1] Trans. Wagner Free Inst. Sci. of Philadelphia ,1890, vol. 3, pt. 1, p. 54, pl. 4, fig. 7; and Bull. 90, U. S. Nat. Museum, 1915, p. 53, pl. 16, fig. 11.

longitudinal ridge along the upper part of the inner lip.

Age: Miocene.

Locality: District of Buchivacoa, State of Falcón, locality number 2391.

Marginella gatunensis colinensis F. Hodson, n. subsp.
Pl. 40, figs. 15, 17, 19.

This subspecies is very close to *M. gatunensis* Brown and Pilsbry [1] as described and figured. We have compared specimens from Gatun with our Venezuelan form. The main differences are in the shape of a transverse section of the shell, in the larger size of our subspecies and in the lack of internal denticulation on the outer lip of our form. The difference in the transverse section is due to the columnar callosity being produced on the side opposite the aperture. On the back of the shell at the termination of the heavy callus, there is a slight longitudinal depression, which is continuous with the depression or margination behind the thickened outer lip; hence, on the back of the shell, there is a more or less continuous groove running back of the callosity of the inner and outer lips. The Venezuelan form does not taper as rapidly anteriorly and the aperture tends to be slightly narrower.

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 121, 178 (?), 184, 185, 299, 1033, 1255.

Marginella democraciana F. Hodson, n. sp. Pl. 40, fig. 20.

Shell large, heavy, widely ovate, narrower anteriorly. Outer lip is somewhat arcuate, thickened, with a margination behind it, but is not denticulate within. The inner lip shows a slight columellar callus and strong, subequally spaced, columellar plaits; the anterior plait forms the twisted base of the pillar; the two anterior plaits are slightly closer together and more oblique than the others. The aperture is constricted posteriorly, and the posterior

[1] Proc. Acad. Nat. Sci. of Philadelphia, 1911, p. 347, pl. 24, fig. 10.

sinus is well marked at the top of the lip. The spire is moderately high, tapers abruptly, and ends in a rather sharp apex; the spire is composed of 4 or 5 whorls; the sutures are hidden by the enamel, which coats, also, all the whorls.

This species resembles the recent form *M. cærulescens* Lamarck, which is very common along the north coast of Venezuela. It is distinguished from this recent species by its larger size, sharper spire, more arcuate outer lip, and by a more rapid taper of the shell anteriorly.

Age: Miocene.

Locality: District of Democracia, State of Falcón, locality number 70A.

Subgenus PERSICULA Schumacher

Marginella (Persicula) venezuelana F. Hodson, n. sp.
Pl. 40, figs. 13, 14.

Shell small, broadly ovate, somewhat narrower anteriorly, enameled. Outer lip is rather thick, arcuate, internally denticulate, and only slightly marginate. The inner lip bears a fold bordering the anterior canal; near the anterior third of the inner lip, there is a strong, grooved, or double, columellar fold lying at about right angles with the axis of the shell; just behind the double plait or fold, there is a depression which is more or less marked; posterior to the double plait, there are 3 or 4 small, short, columellar folds, also lying at about right angles with the axis of the shell. The shell is rather thick and the spiral color bands are so concealed by enamel that it is not possible to count them except when the shell is weathered or partly digested with dilute acid, in which case there are about 22 narrow, spiral, color bands exposed.

This species is the direct forerunner of the subspecies *lavelana*, from which it differs principally in its smaller size.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality numbers 6, 1140.

Marginella venezuelana lavelana F. Hodson, n. subsp.
Pl. 40, figs. 3, 10, 11.

This subspecies differs mainly in being much larger, more plump, and in having a more prominent longitudinal ridge on the upper part of the inner lip; this ridge is more or less parallel to the upper part of the aperture. This subspecies sometimes shows a slight margination behind the outer lip. The outer lip is thick, rounded, and somewhat hollowed out near the middle of its ventral edge so that its profile shows a slight central depression (as viewed laterally). There are more small, columellar folds behind the strong, grooved, anterior fold than in the species, *sensu stricto.*

Age: Miocene.

Locality: District of Colina, State of Falcón, locality numbers 184, 185, 1033, 1255.

Marginella venezuelana falconensis F. Hodson, n. subsp.
Pl. 40, figs. 4, 5.

This subspecies is an outgrowth of the subspecies *lavelana.* It is more cylindrical and less inflated. The anterior and posterior sinuses are deeper and more pronounced. There are only about 3 small, posterior, columellar folds behind the strong, grooved, anterior fold.

Age: Miocene.

Locality: District of Falcón, State of Falcón, locality number 2207.

Marginella (Persicula) maracaibensis F. Hodson, n. sp.
Pl. 40, figs. 1, 6.

Shell small, pyriform, enameled. Outer lip is sharp, arcuate, faintly denticulate, and without a margination. The inner lip carries a strong, oblique fold bordering the anterior canal, and a stronger, grooved or double columellar fold posterior to it. The double fold is almost at right angles to the direction of the aperture. Behind the double fold, there are about 5 equally spaced, smaller folds. The aperture is wider and paralleled by a longitudinal ridge on the upper half of the inner lip, which is covered by the columellar callus. The narrow, spiral color bands are perceptible but could not be counted.

This species resembles *M.* (*Persicula*) *mirandana* (n. sp.), but differs in having a wider aperture and a sharper outer lip, which is not wedge-shaped in cross section as it is in the former species.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality numbers 6, 1140.

Marginella (Persicula) zuliana F. Hodson, n. sp.
Pl. 40, figs. 7, 12.

Shell is small, ovate, and slightly enameled. The outer lip is moderately thickened and internally denticulate. The inner lip carries two strong, anterior columellar folds, but there is a much slighter depression behind the second anterior fold than in *M.* (*Persicula*) *mirandana* (n. sp.). The second anterior fold is grooved and stronger than the more oblique basal one which limits the anterior canal. The columellar and body callus is present but is much thinner than in *M.* (*Persicula*) *mirandana.* On the upper half of the inner lip, there is a slight longitudinal ridge, which is about parallel to the outer lip. The aperture is wider than in *M.* (*Persicula*) *mirandana.* There are about 20 narrow, chestnut-colored, spiral bands, which are crossed by more closely spaced, incremental lines; on a well preserved specimen, this gives the shell a microscopically reticulate appearance.

This species is related to, and most closely resembles, *M.* (*Persicula*) *mirandana* (n. sp.), but it is longer, more slender, has a wider aperture, less prominent callosity and more spiral color bands.

Age: Oligocene-Miocene.

Locality: District of Acosta, State of Falcón; District of Miranda, State of Zulia; locality numbers 6, 1140, 1415.

Marginella (Persicula) mirandana F. Hodson, n. sp.
Pl. 40, figs. 2, 8, 9.

Shell is small, enameled, pyriform, with a depressed spire. The outer lip is thickened, but thins toward the aperture; it is denticulate internally. The inner lip carries two very strong, anterior, columellar folds; the first of these borders the anterior canal; the second is very strong, usually double or divided, and almost at right angles to the direction of the aperture. Behind the double columellar fold, there is a more or less marked depression. Posterior to this double plait, there are 3–5 smaller columellar folds. On the upper part of the inner lip, there is a pronounced longitudinal ridge covered with callus; this ridge is about parallel to the inner margin of the outer lip and varies in length from two-fifths to more than half of the length of the aperture. The columellar callus grades into the thick coat of enamel which covers the entire shell and more or less conceals the narrow, chestnut-colored, spiral bands, about 16 or 17 in numbers; in weathered shells, these spiral color bands stand out as revolving ridges separated by wider, channeled interspaces.

This species is extremely variable as to length and shape of the shell, the width of the aperture, the amount and nature of the thickening of the outer lip, as well as in the amount of depression found behind the double anterior columellar fold. It is somewhat smaller and more pyriform than *M.* (*Persicula*) *cercadensis* Maury,[1] which has a wider aperture and lacks the pronounced longitudinal ridge found in our species on the upper part of the inner lip.

Age: Oligocene-Miocene.

Locality: District of Miranda, State of Zulia, locality number 6.

Family TURRITELLIDÆ Gray

Genus TURRITELIA Lamarck

Turritella zuliana palmeræ F. Hodson

Turritella zuliana palmeri F. Hodson, 1926, Bull. Amer. Pal., vol. 11, pp. 179–180, pl. 6, figs. 1, 4.

A correction is noted here for the wrong ending inadvertently given to the name *palmeræ* in the original description.

[1] Bull. Amer. Pal., 1917, vol. 5, p. 237, pl. 37, fig. 9.

PLATE 1

Printed plates furnished for this publication by
F. and H. Hodson; photography by F. and H.
Hodson; engraving and printing by
L. Winkler & Co.

PLATE 1

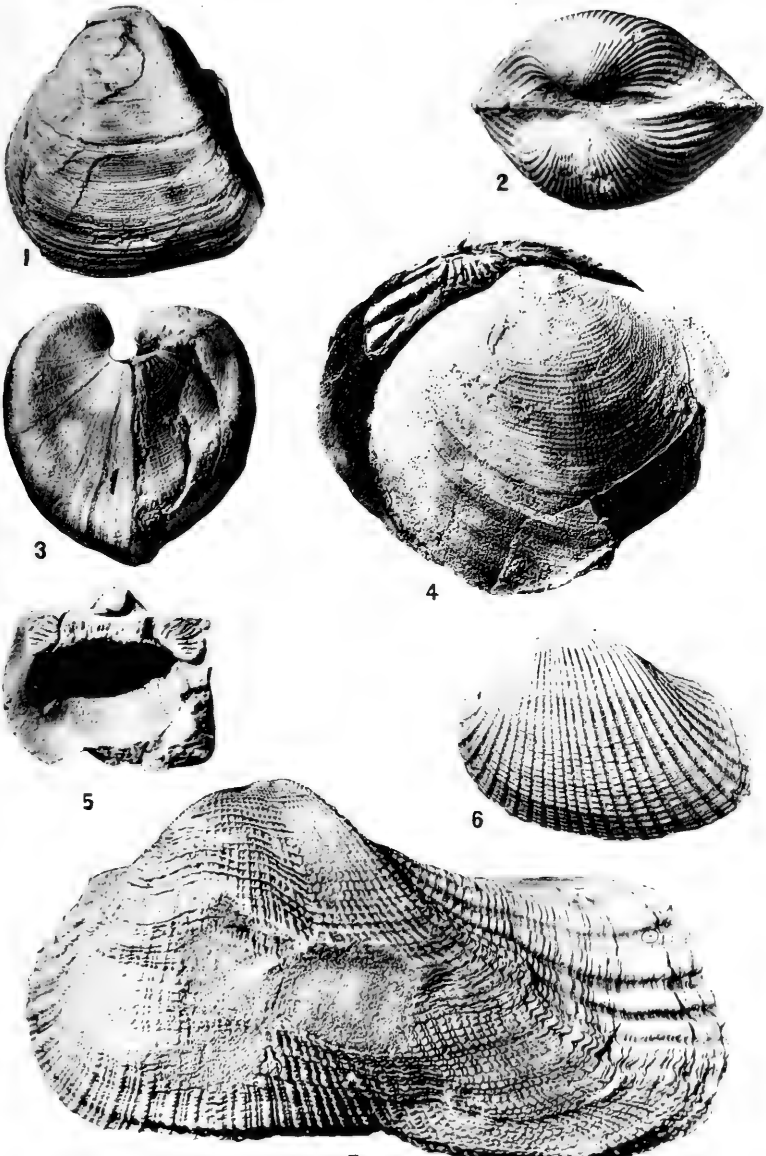
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PLATE 2

PLATE 2

FIGURE		PAGE
1.	**Pseudocucullæa perijana** Harris, F. and H. Hodson, **n. sp.** Holotype from Loc. No. 2220; length 60 mm., height of fragment 59 mm., diameter of valve 22 mm.	1
2.	**Glycymeris canalis democraciana** F. and H. Hodson, n. subsp. Holotype from Loc. No. 82, length 41 mm., height 40 mm., diameter of valve 12 mm.	17
3.	**Pseudocucullæa perijana Harris,** F. and H. Hodson, n. sp. Holotype, same specimen as fig. 1	1
4.	**Pseudocucullæa perijana Harris,** F. and H. Hodson, n. sp. Paratype from Loc. No. 2220, greatest length of fragment 76 mm.	1
5.	**Glycymeris canalis democraciana** F. and H. Hodson, n. subsp. Holotype, same specimen as fig. 2	17

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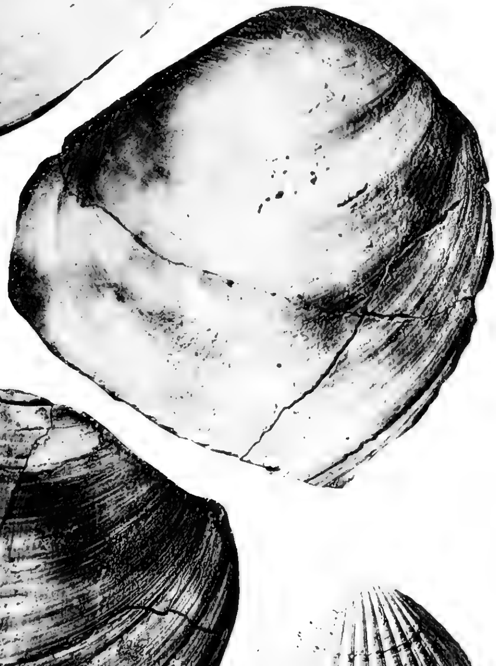

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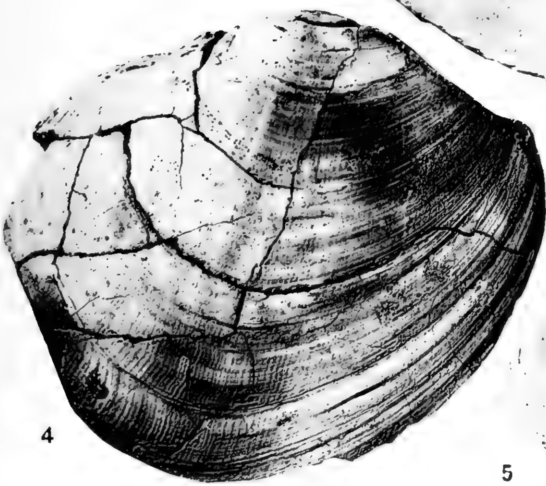

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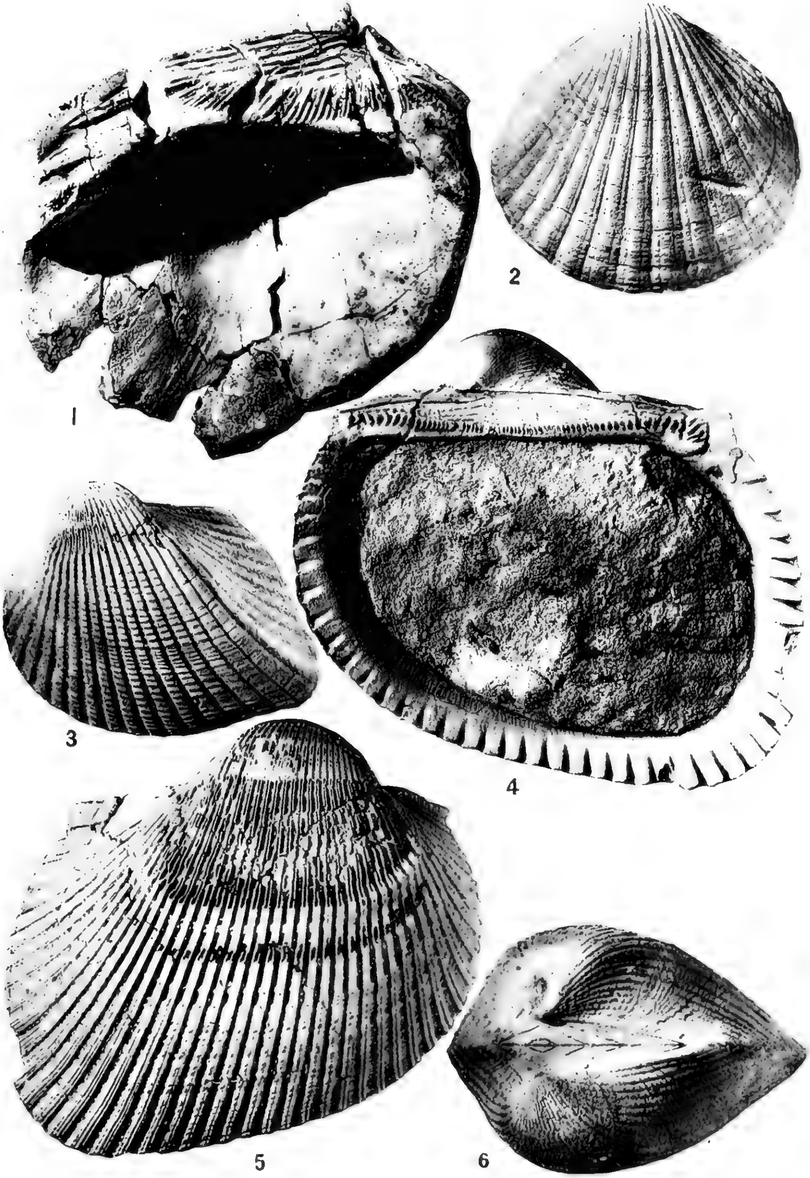
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PLATE 4

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FIGURE PAGE

1. **Arca (Scapharca) berjadinensis** H. K. Hodson, n. sp. Paratype from Loc. No. 2384; length 17 mm., height 15 mm., diameter of both valves 14 mm. 6
2. **Arca (Scapharca) berjadinensis** H. K. Hodson, n. sp. Holotype from Loc. No. 90; length 16 mm., height 14 mm., diameter of valve 7 mm. 6
3. **Arca (Scapharca) berjadinensis** H. K. Hodson, n. sp. Holotype, same specimen as fig. 2 6
4. **Arca (Scapharca) weeksi** H. K. Hodson, n. sp. Paratype from Loc. No. 3250; length 16 mm., height 13.5 mm., diameter of valve 7 mm. 5
5. **Arca (Scapharca) berjadinensis** H. K. Hodson, n. sp. Paratype, gerontic specimen, from Loc. No. 93; length 26 mm., height 22 mm.. diameter of valve 11 mm. 6
6. **Arca (Scapharca) weeksi** H. K. Hodson, n. sp. Holotype from Loc. No. 3250; length 16.5 mm., height 14.7 mm., diameter of valve 7 mm. 5
7. **Arca (Scapharca) zuliana** H. K. Hodson, n. sp. Holotype from Loc. No. 6; length 18 mm., height 16.5 mm., diameter of valve 8.5 mm. 4
8. **Arca (Scapharca) zuliana** H. K. Hodson, n. sp. Paratype from Loc. No. 6; length 19 mm., height 15 mm., diameter of both valves 18 mm. 4
9. **Arca zuliana maracaibensis** H. K. Hodson, n. subsp. Holotype from Loc. No. 6; length 18 mm., height 14 mm., diameter of valve 8 mm. 5
10. **Arca (Scapharca) zuliana** H. K. Hodson, n. sp. Holotype, same specimen as fig. 7 4
11. **Arca zuliana maracaibensis** H. K. Hodson, n. subsp. Holotype, same specimen as fig. 9 5

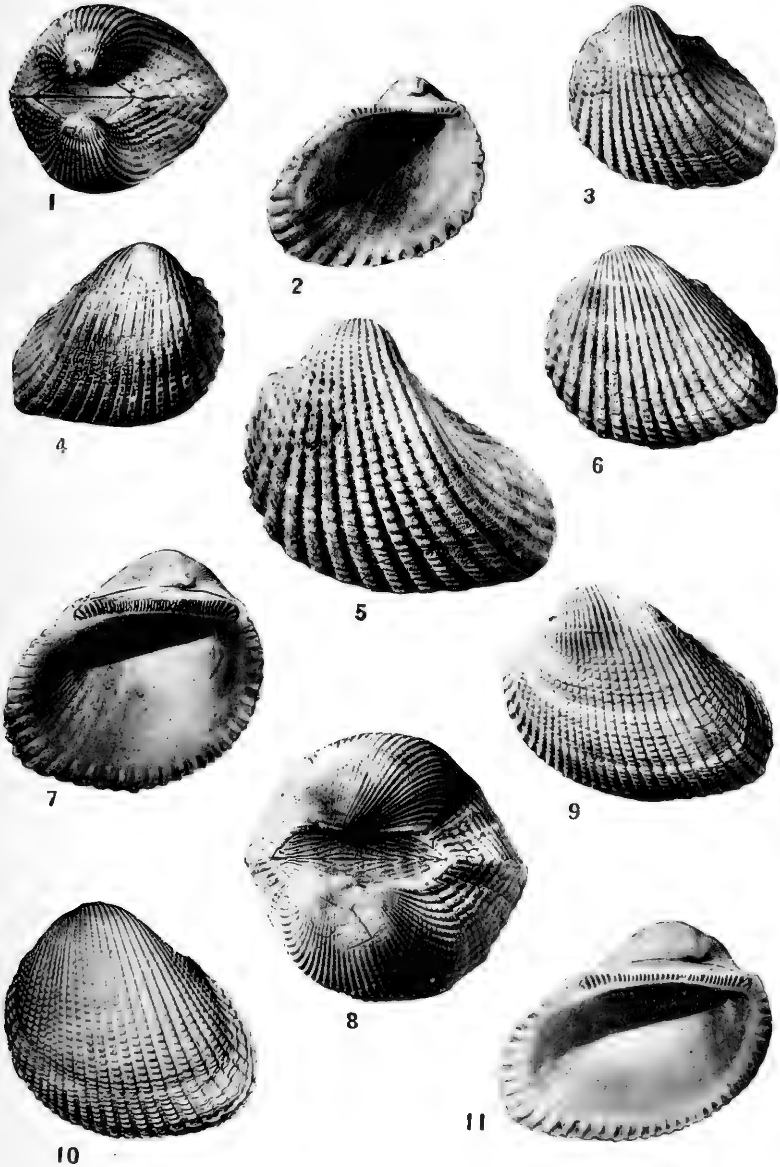
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PLATE 5

PLATE 5

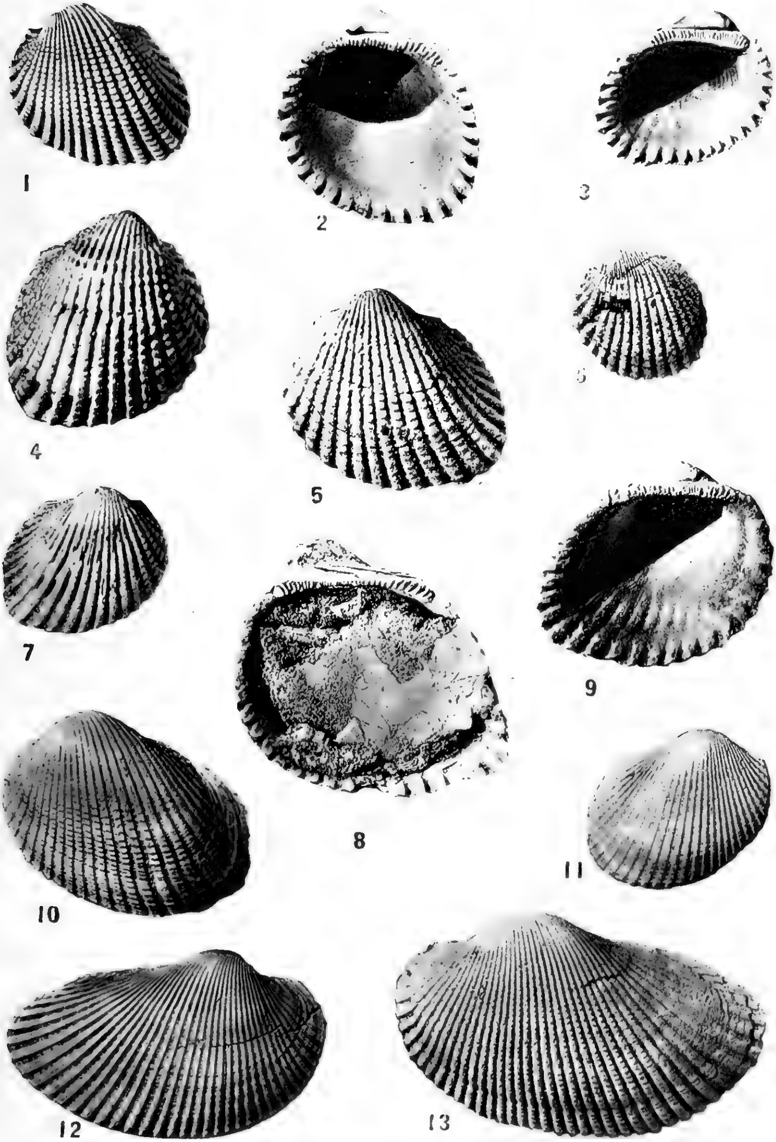
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PLATE 6

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PLATE 6

FIGURE PAGE

1. **Arca (Scapharca) democraciana** H. K. Hodson, n. sp. Holotype from Loc. No. 118; length 25 mm., height of fragment 17 mm., diameter of valve 8 mm. 14
2. **Arca (Scapharca) democraciana** H. K. Hodson, n. sp. Paratype from Loc. No. 187, shows common appearance, length 15.5 mm., height 11.5 mm., diamete rof valve 5 mm. 14
3. **Arca (Scapharca) democraciana** H. K. Hodson, n. sp. Paratype from Loc. No. 150B; length 16 mm. (slightly broken), height 13.5 mm., diameter of both valves 12 mm. 14
4. **Arca (Scapharca) cornellana** H. K. Hodson, n. sp. Holotype from Loc. No. 3250; length 26 mm., height 14 mm., diameter of valve 7 mm. 12
5. **Arca (Scapharca) cornellana** H. K. Hodson, n. sp. Paratype from Loc. No. 3250; length 25 mm., height 14 mm., diameter of valve 6 mm. 12
6. **Arca (Scapharca) lienosa** Say. Recent along coast, State of Falcón; length 64 mm., height 41 mm., diameter of valve 18 mm. 13


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PLATE 7

PLATE 7

FIGURE		PAGE
1.	**Arca grandis waringi** Maury. From Loc. No. 71; length 74 mm., height 65 mm., diameter of valve 31 mm.	7
2.	**Arca (Scapharca) tirantensis** H. K. Hodson, n. sp. Holotype from Loc. No. 2420; length 32 mm., height 20 mm., diameter of both valves 20 mm.	11
3.	**Arca (Scapharca) tirantensis** H. K. Hodson, n. sp. Holotype, same specimen as fig. 2	11
4.	**Arca grandis waringi** Maury. Same specimen as fig. 1	7

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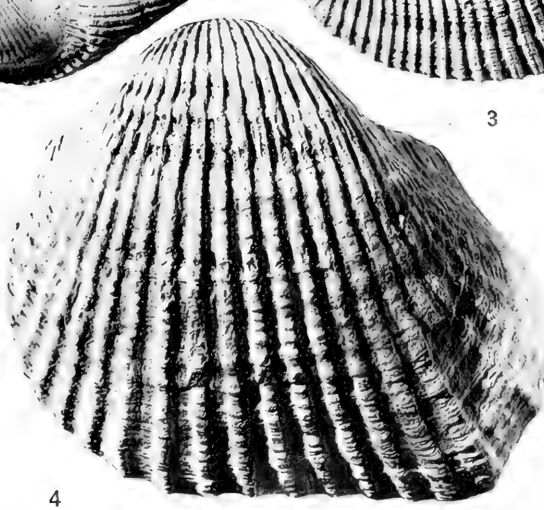

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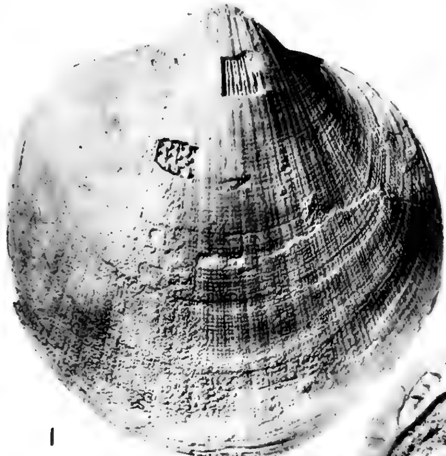
PLATE 8

PLATE 8

FIGURE		PAGE
1.	**Glycymeris tumefacta lavelensis** F. Hodson, n. subsp. Holotype from Loc. No. 123, length 56 mm. (slightly broken), height 57.5 mm., diameter of valve 20 mm.	17
2.	**Ostrea wiedenmayeri** F. Hodson, n. sp. Paratype, young specimen, attached valve from Loc. No. 2452, greatest height 26 mm., diameter 5 mm.	18
3.	**Ostrea wiedenmayeri** F. Hodson, n. sp. Paratype, same specimen as fig. 2	18
4.	**Glycymeris tumefacta lavelensis** F. Hodson, n. subsp. Holotype, same specimen as fig. 1	17
5.	**Ostrea wiedenmayeri** F. Hodson, n. sp. Holotype, attached valve from Loc. No. 2426, greatest height 91 mm. (slightly broken), greatest diameter 35 mm.	18
6.	**Ostrea wiedenmayeri** F. Hodson, n. sp. Paratype, flat valve from Loc. No. 2424, greatest height 44 mm., approximate diameter of both valves 15 mm.	18



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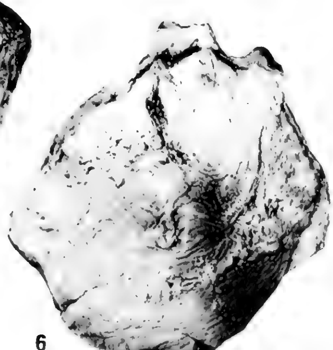

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PLATE 9

PLATE 9

Figure		Page
1.	**Glycymeris tumefacta lavelensis** F. Hodson, n. subsp. Paratype from Loc. No. 123; length 48 mm., height 47 mm., diameter of both valves 33 mm.	17
2.	**Ostrea virginica falconensis** F. Hodson, n. subsp. Paratype, flat upper valve, from Loc. No. 1241; greatest length 51 mm., greatest height 44 mm.	22
3.	**Ostrea democraciana** F. Hodson, n. sp. Paratype from Loc. No. 1705, lateral view of both valves, greatest height of fragment 43 mm., diameter 16 mm.	19
4.	**Ostrea tacalensis** F. Hodson, n. sp. Paratype, upper valve, from Loc. No. 2438, greatest height 32 mm., diameter 8 mm.	19
5.	**Ostrea wiedenmayeri** F. Hodson, n. sp. Same specimen as Pl. 8, fig. 5	18
6.	**Ostrea tacalensis** F. Hodson, n. sp. Holotype from Loc. No. 4609, greatest height 40 mm., approximate diameter of both valves 13 mm.	19
7.	**Ostrea democraciana** F. Hodson, n. sp. Paratype from Loc. No. 1751, shows variation, greatest height 45 mm., greatest diameter of both valves 11 mm.	19

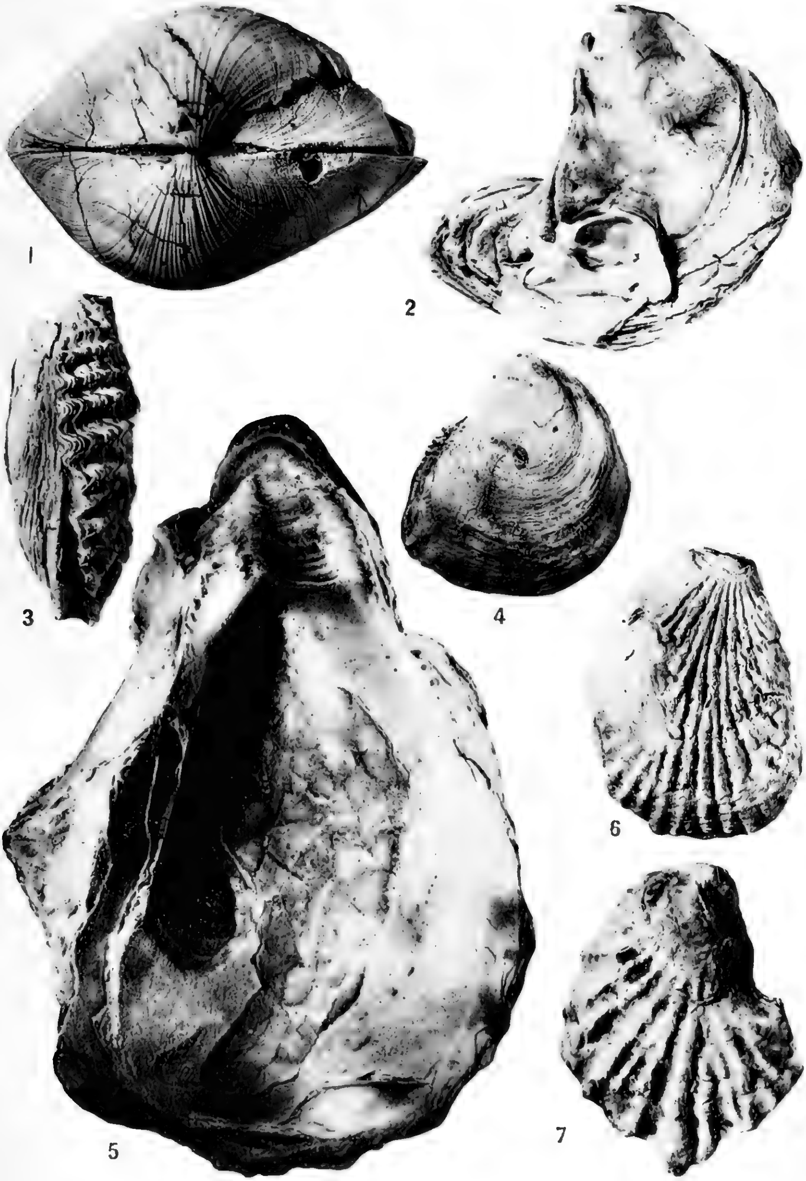
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PLATE 10

PLATE 10

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PLATE 11

PLATE 11

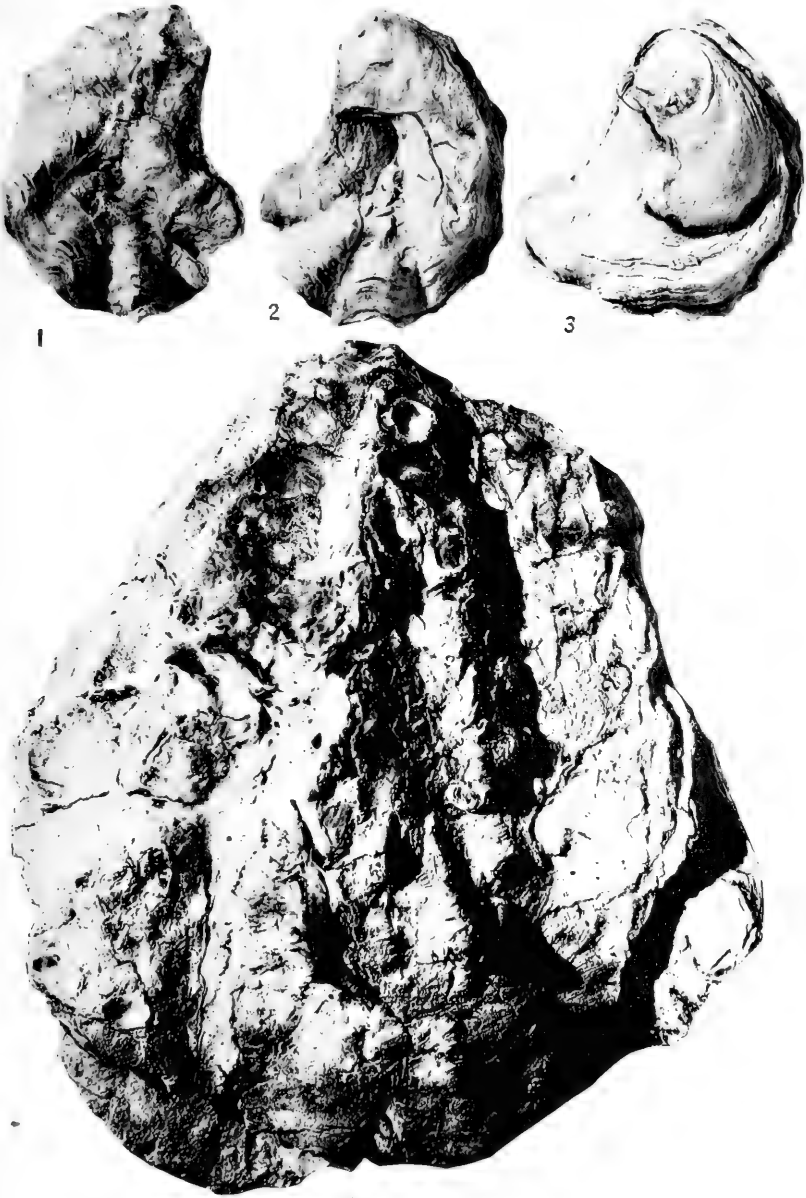

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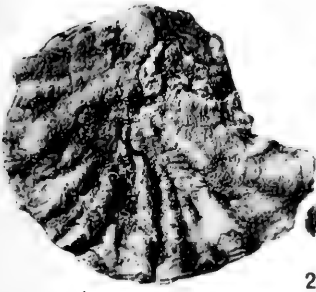
PLATE 12

PLATE 12

FIGURE		PAGE
1.	**Ostrea democraciana cujiensis** F. Hodson, n. subsp. Attached valve of holotype from Loc. No. 1855; greatest height 31 mm., about flat	20
2.	**Ostrea democraciana cujiensis** F. Hodson, n. subsp. Upper valve of paratype from Loc. No. 1855; greatest height 31 mm., about flat	20
3.	**Ostrea democraciana cujiensis** F. Hodson, n. subsp. Paratype, elongate variation, attached valve, from Loc. No. 1855, greatest height 33 mm., approximate diameter of valve 7 mm.	20
4.	**Ostrea gatunensis aguaclarensis** F. Hodson, n. subsp. Upper valve of holotype from Loc. No. 1753, somewhat concave, greatest height of specimen 160 mm., greatest diameter of both valves 53 mm. Same specimen as pl. 10, fig. 7, and pl. 11, fig. 4	21



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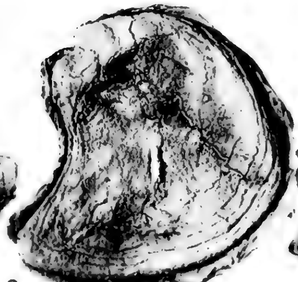

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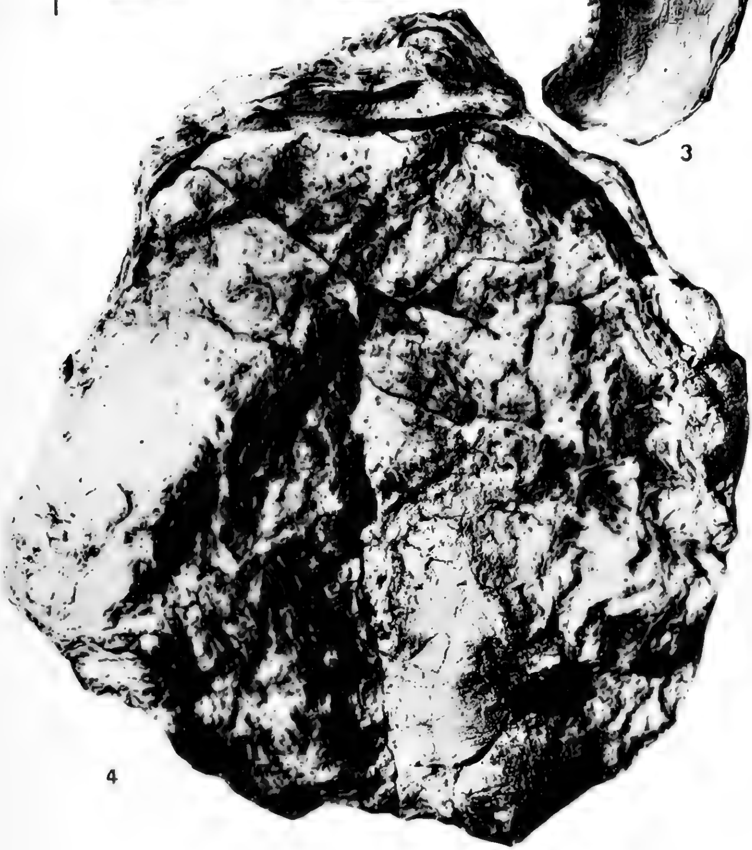

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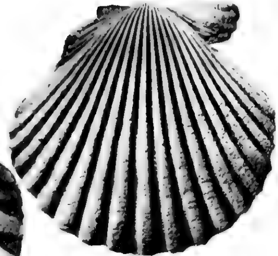

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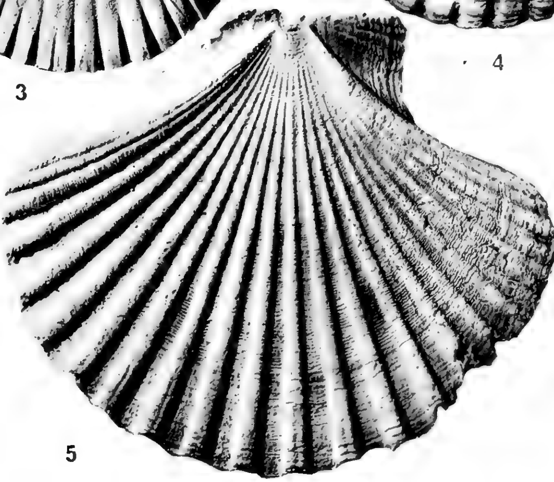

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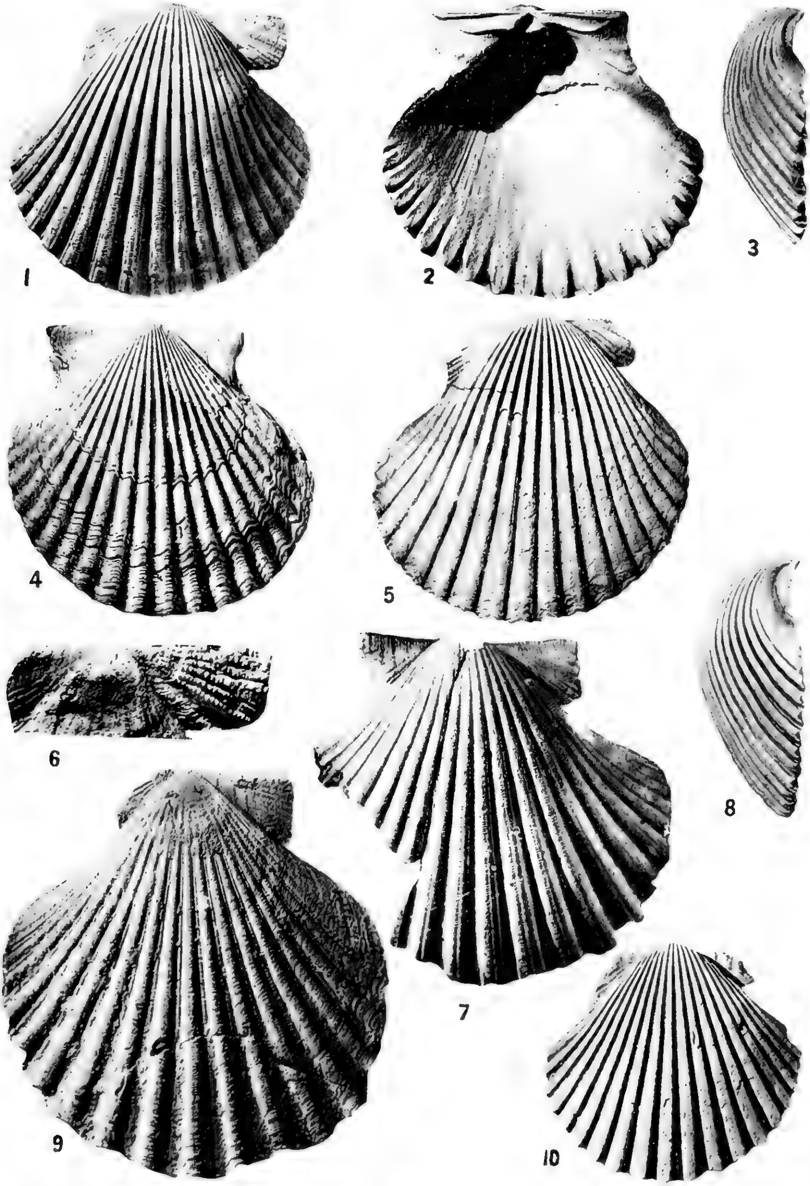
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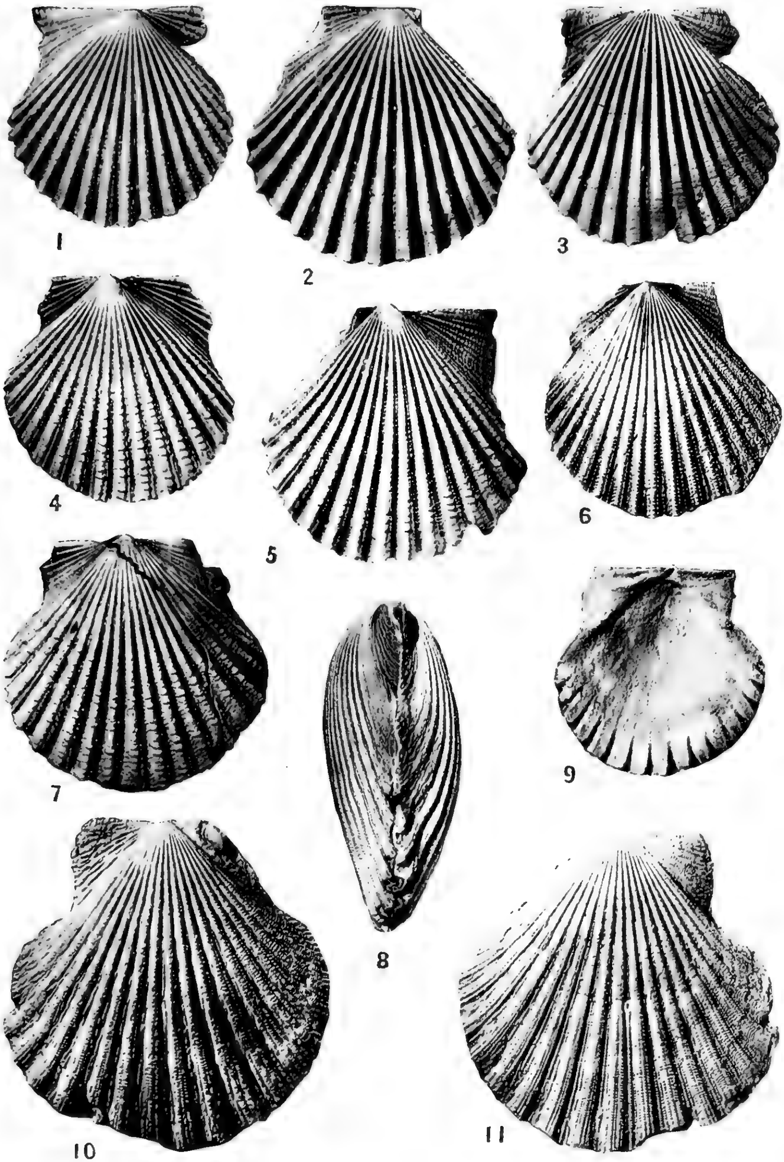
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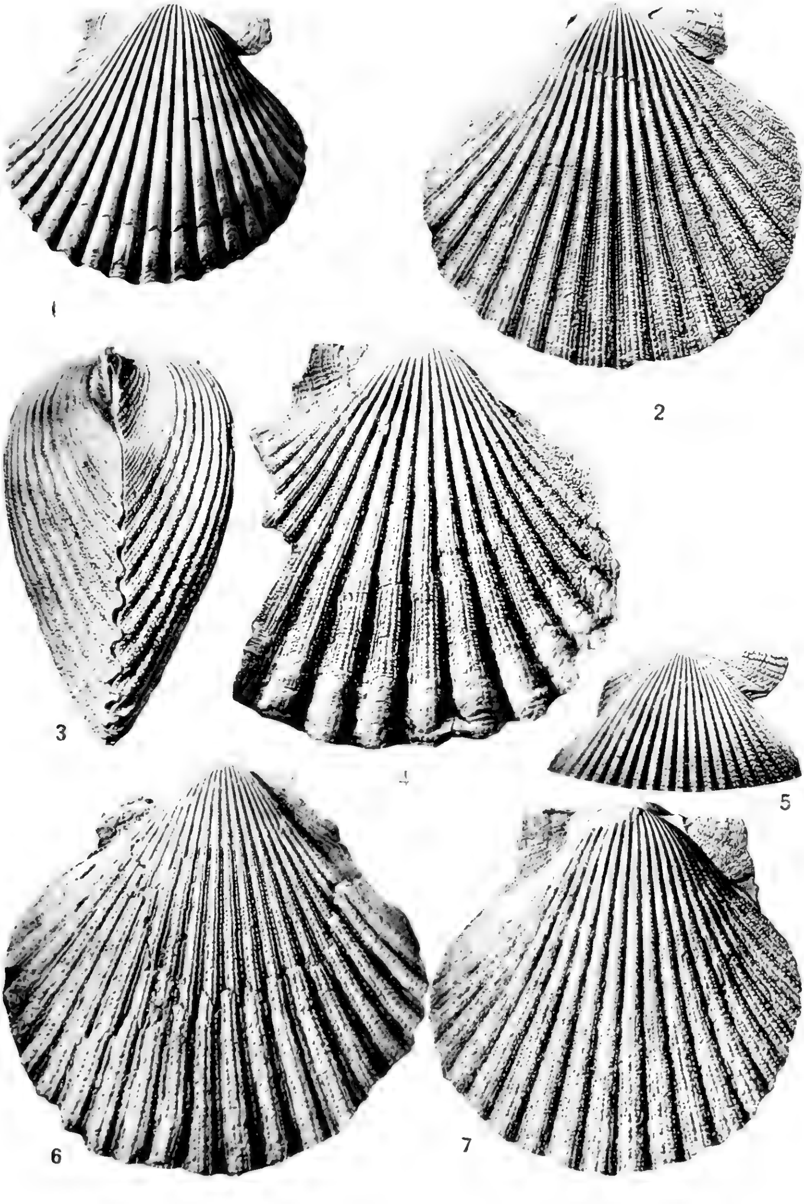
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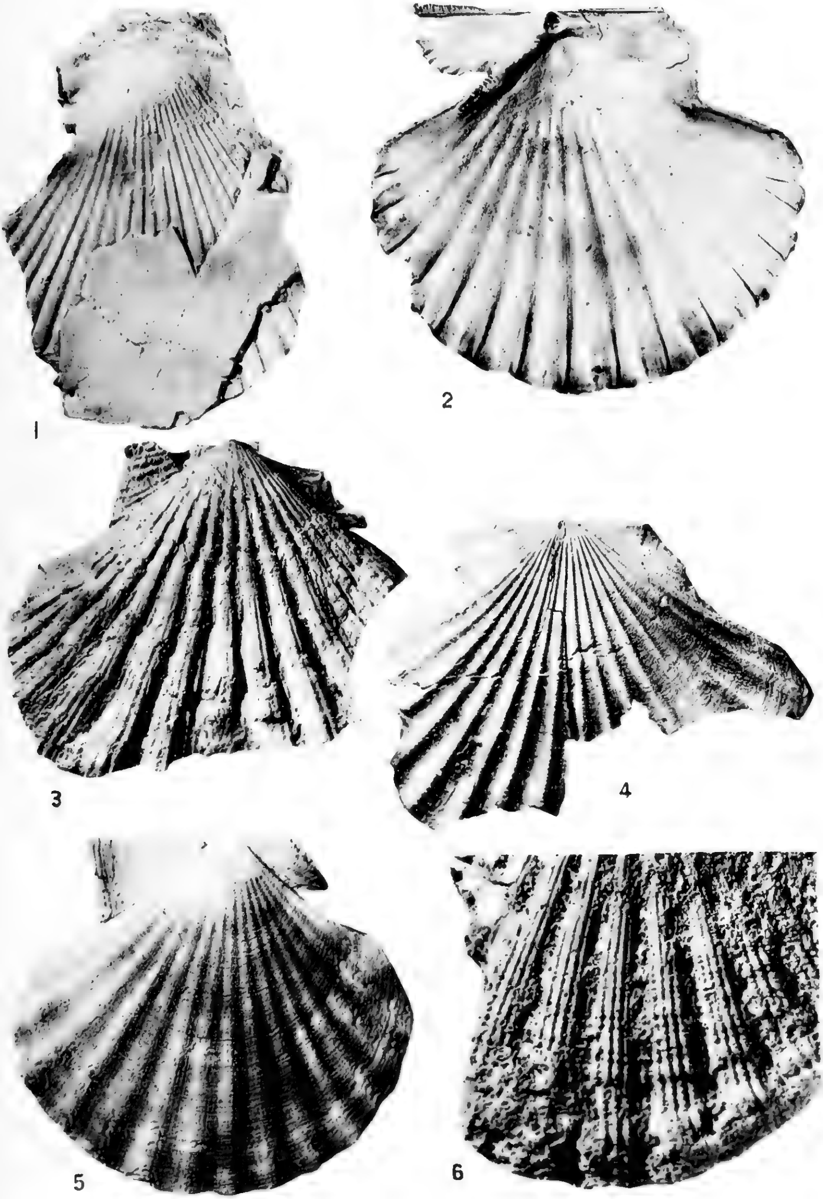
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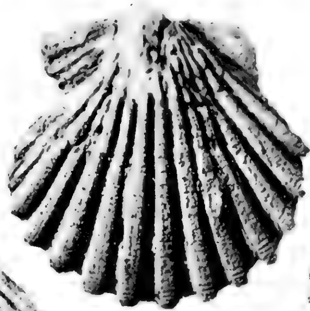

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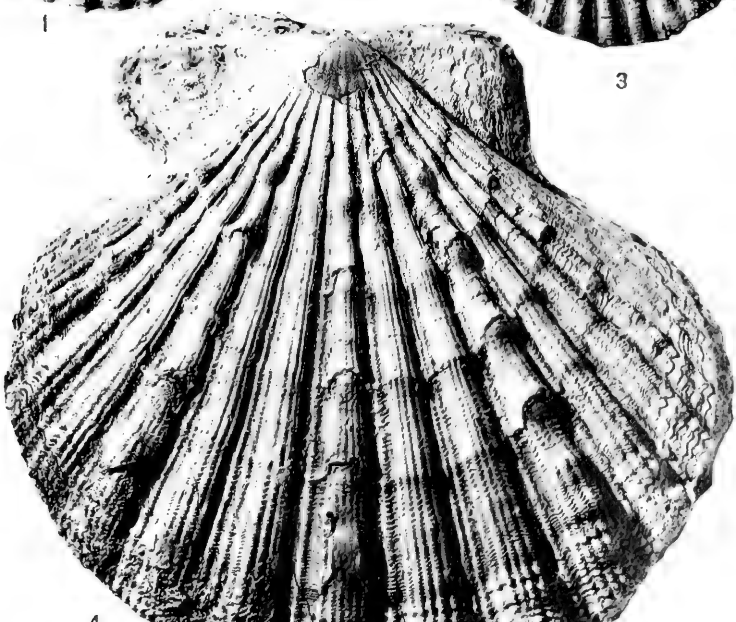

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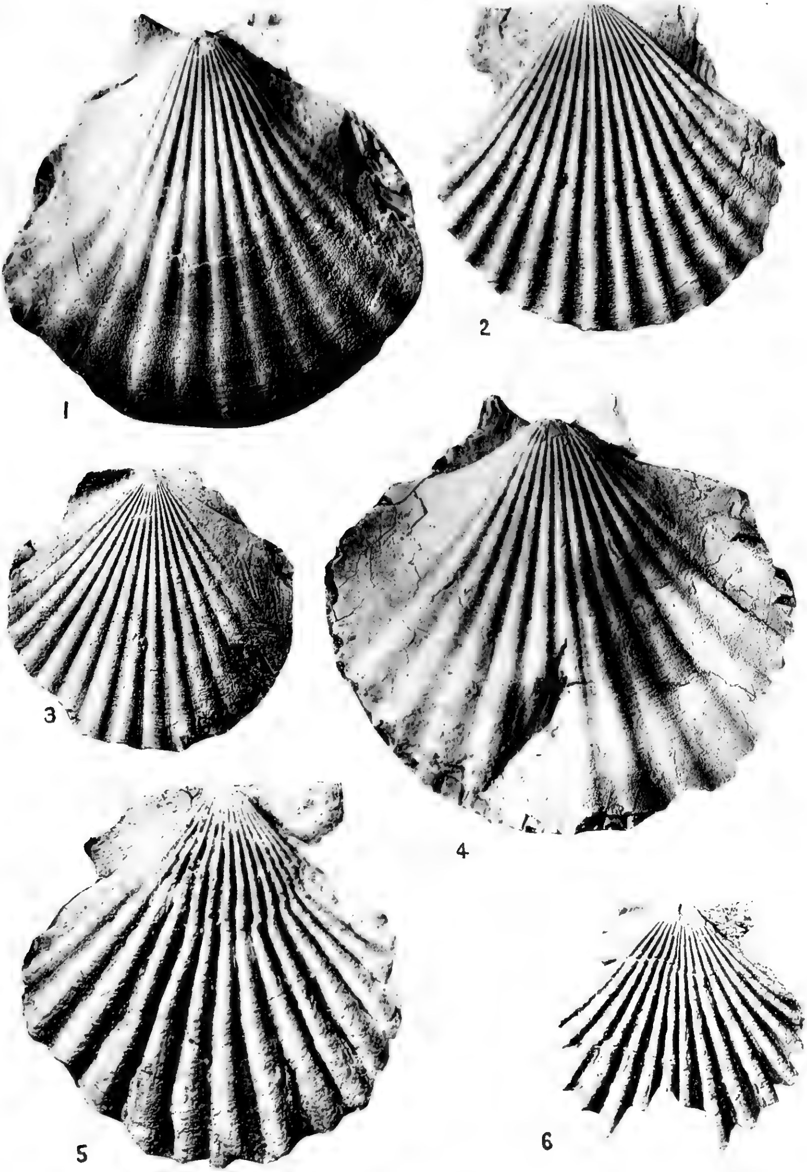
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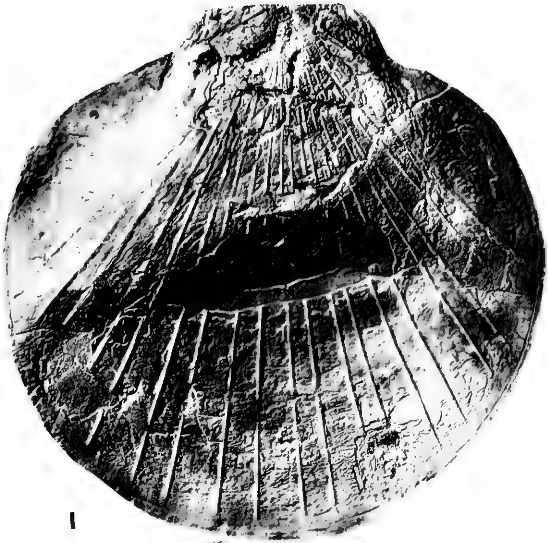

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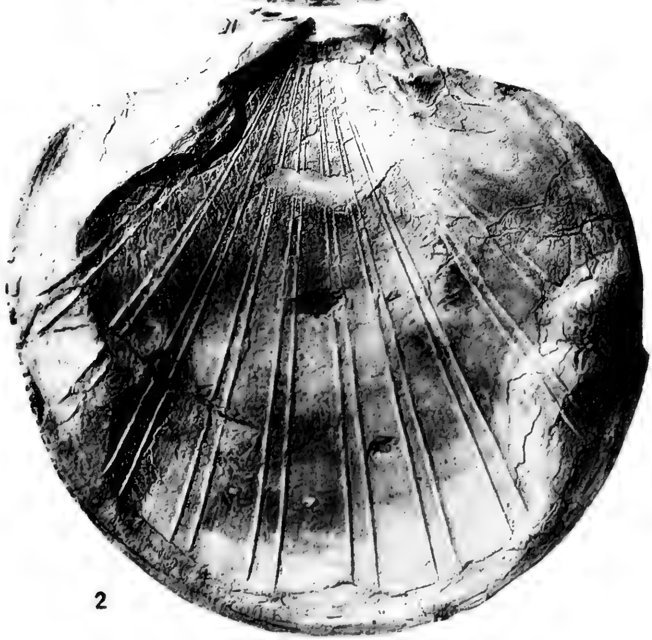

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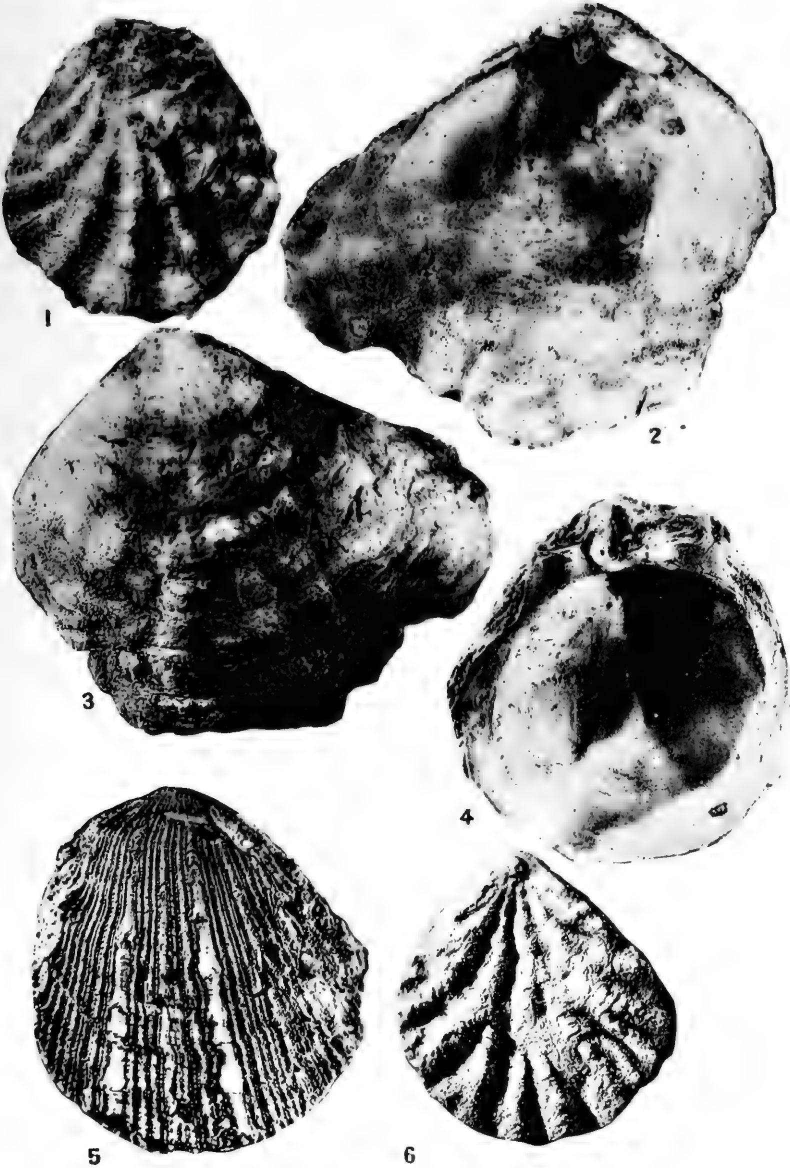
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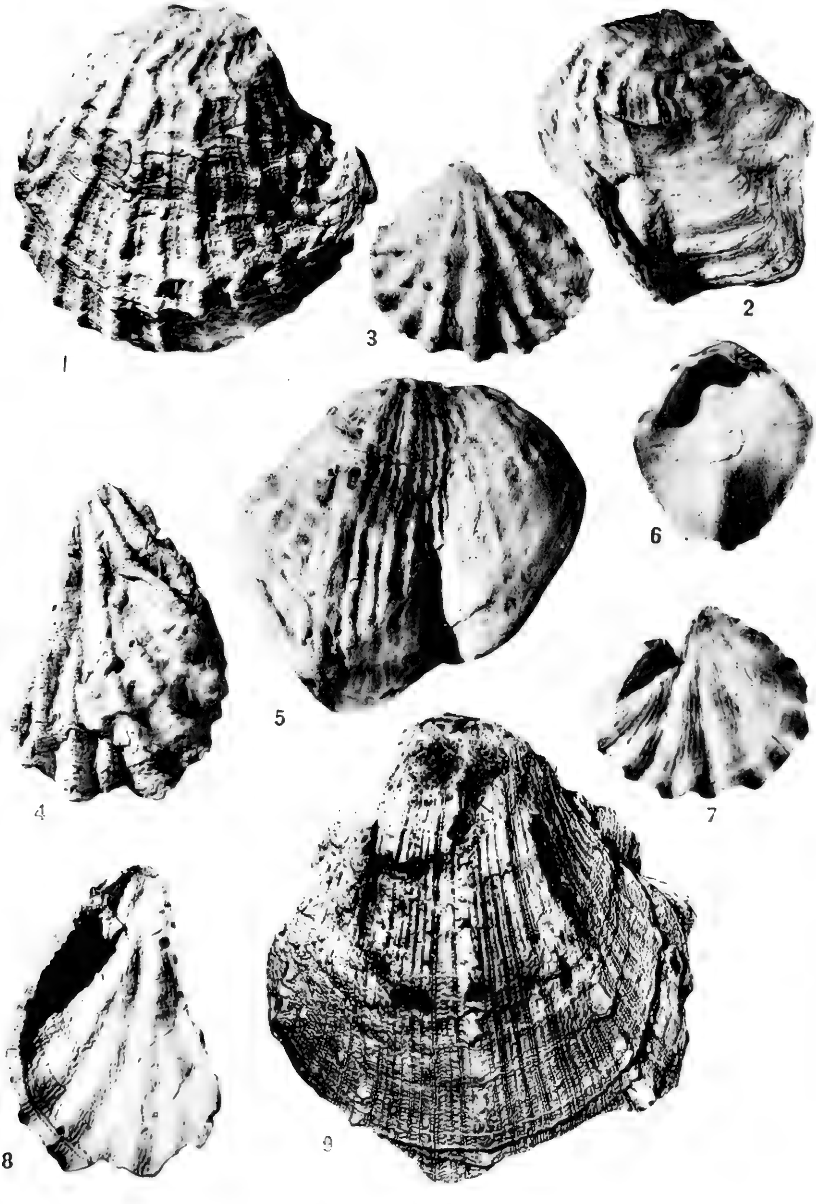
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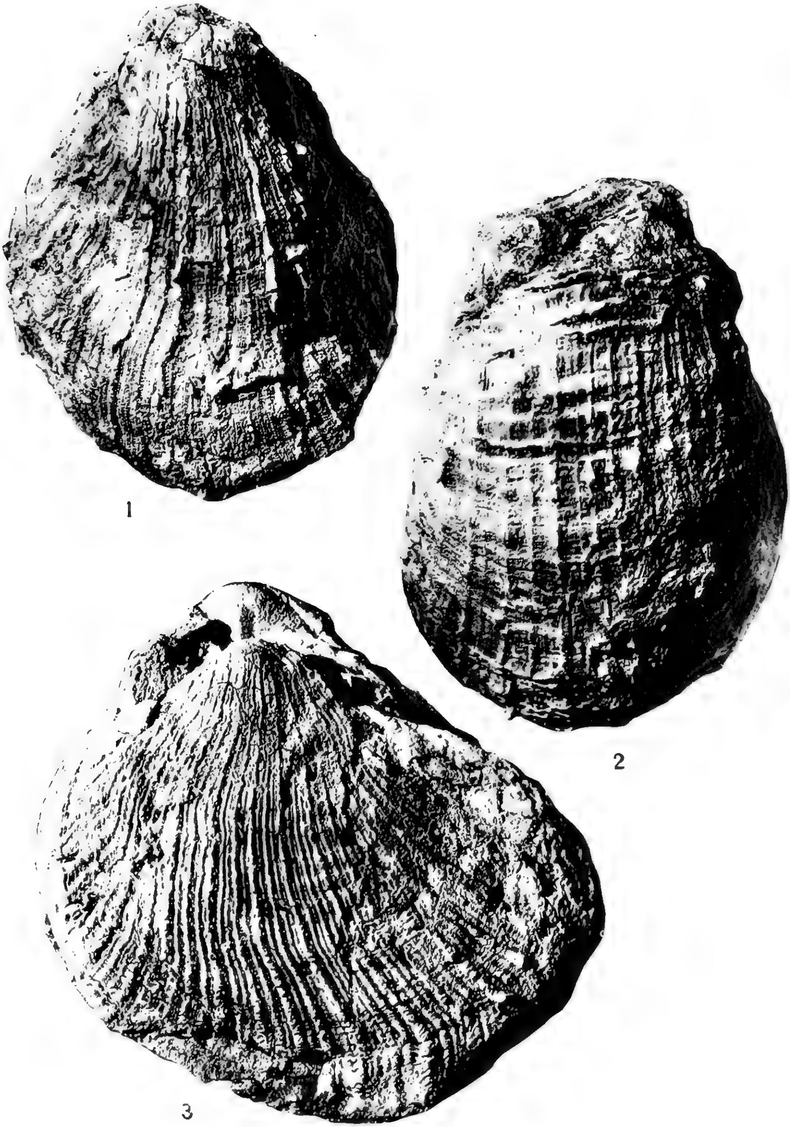

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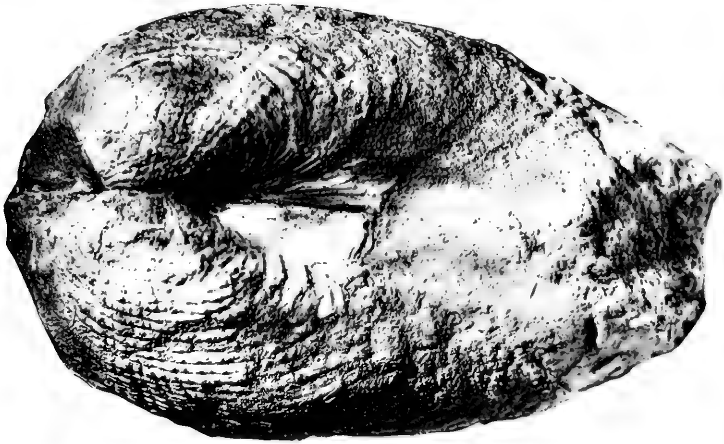

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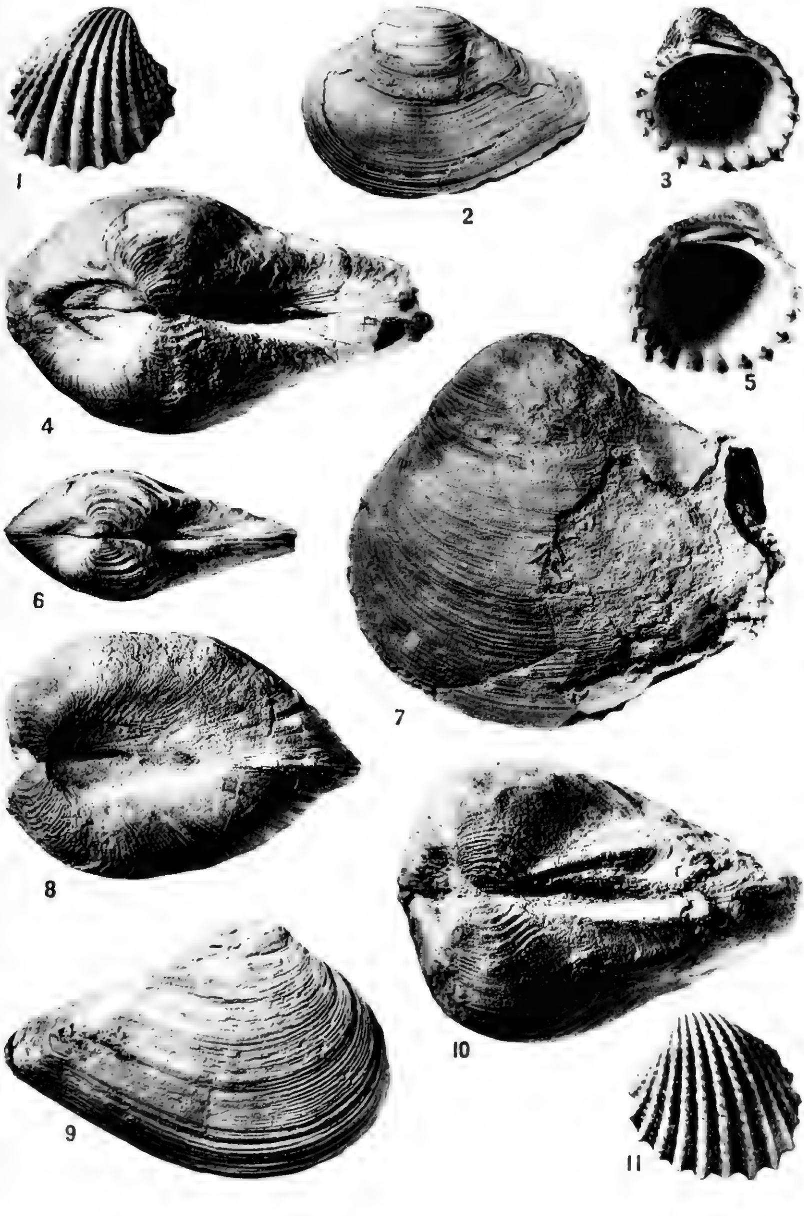

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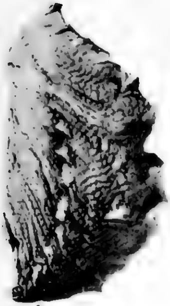
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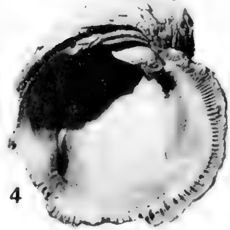
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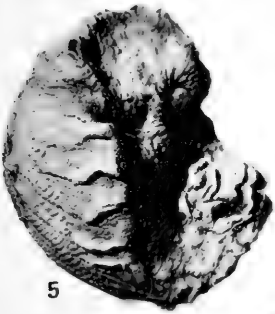
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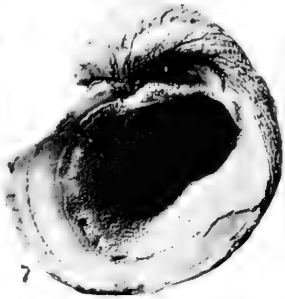
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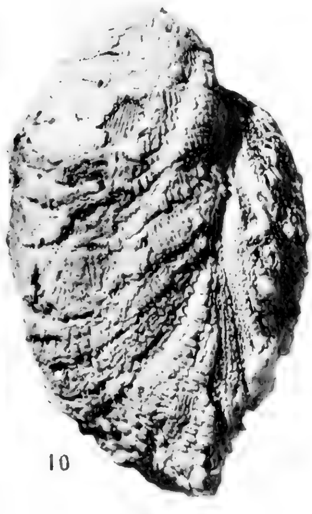
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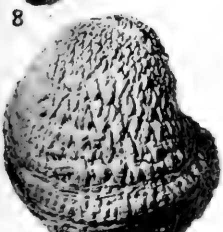
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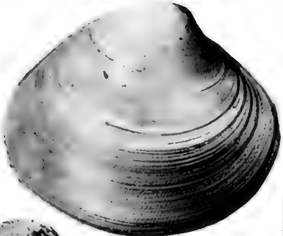

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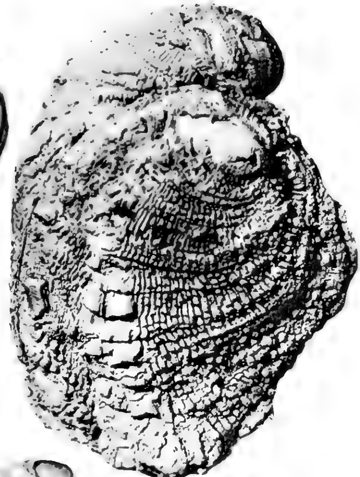

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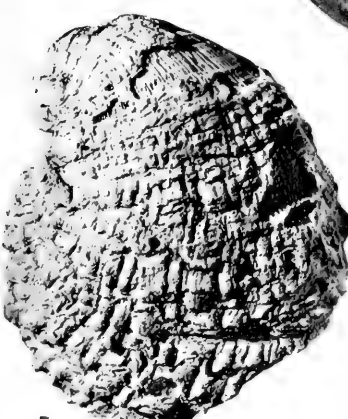

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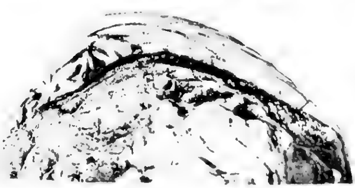

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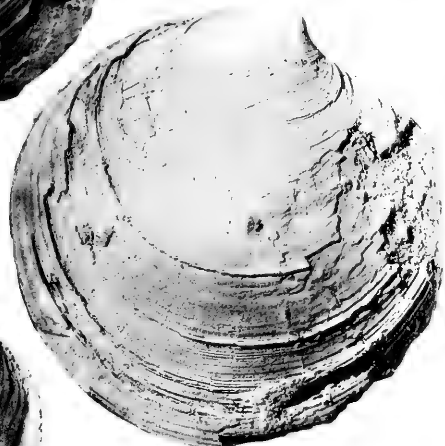

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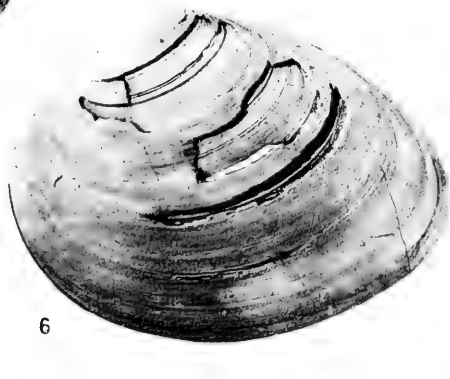

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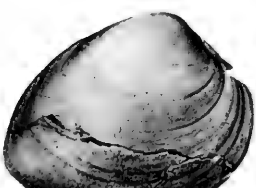

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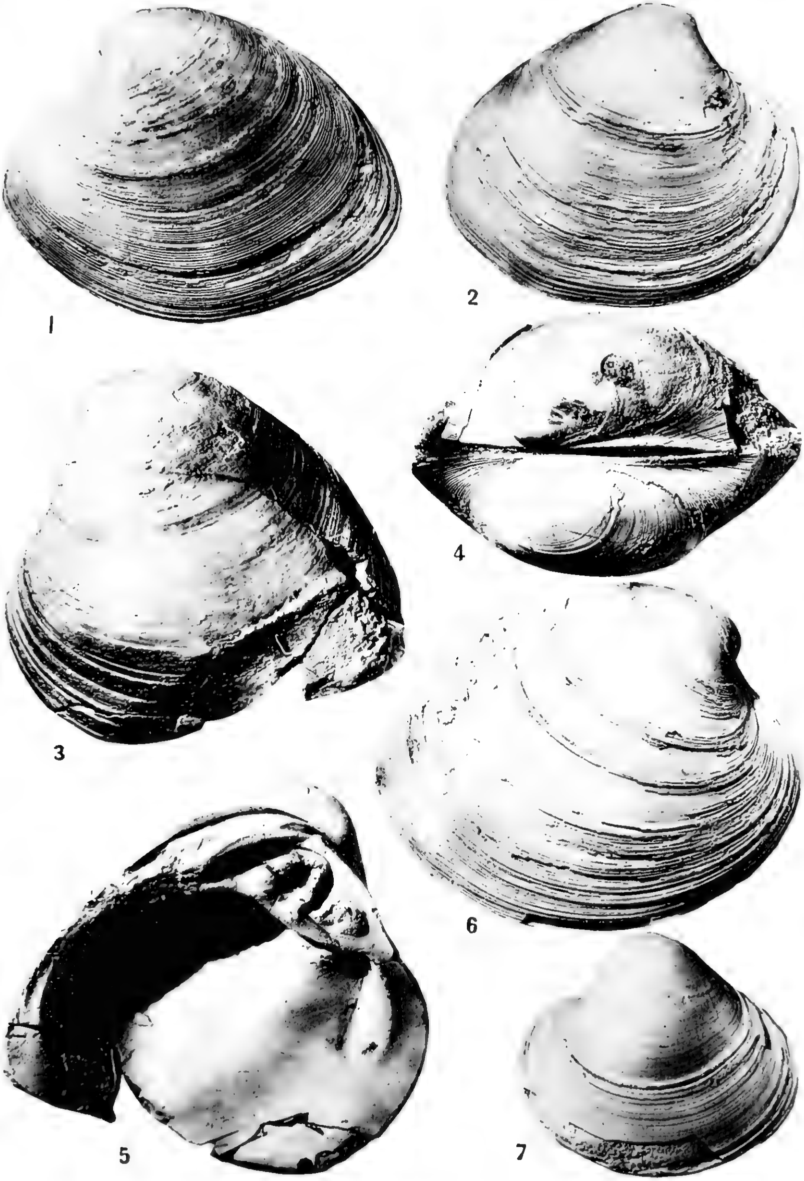
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FIGURE PAGE

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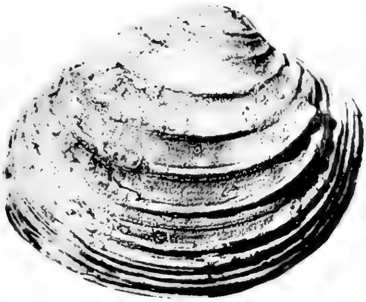

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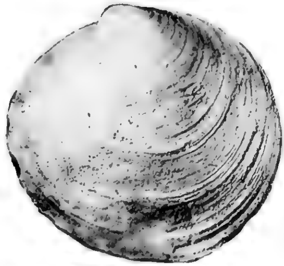

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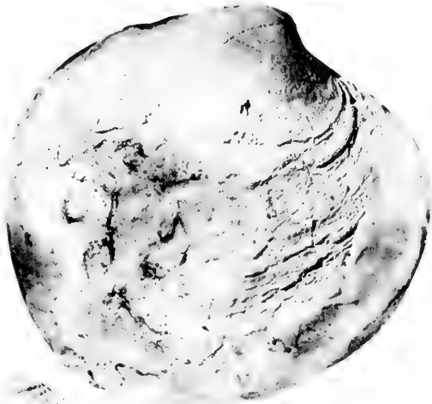

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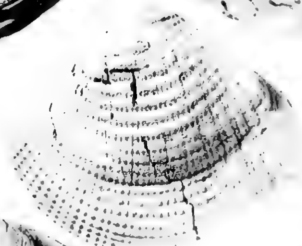

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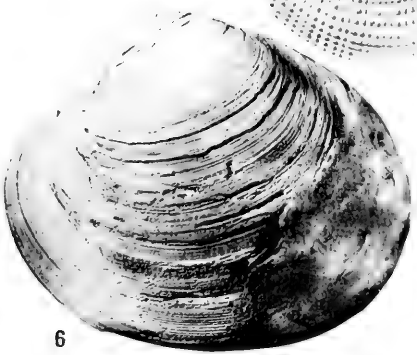

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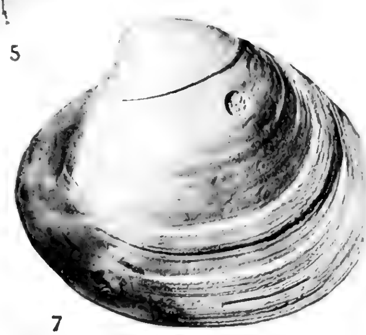

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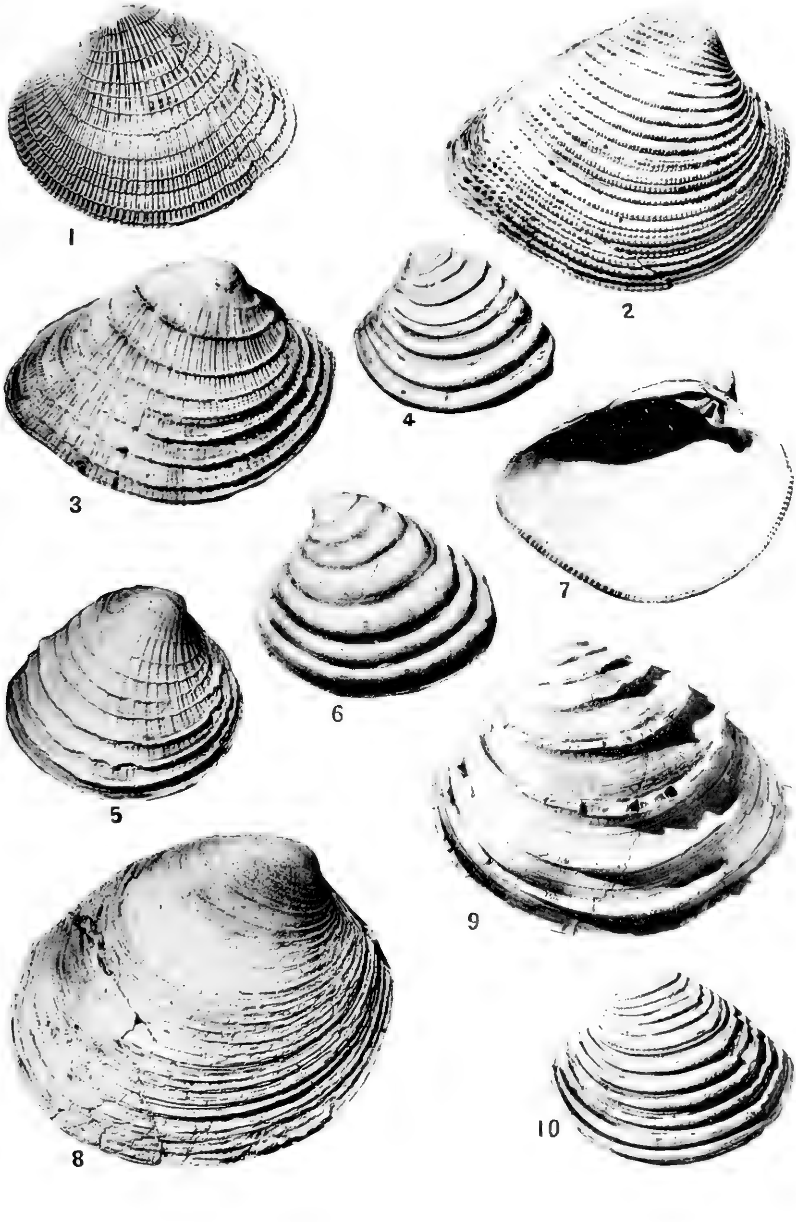
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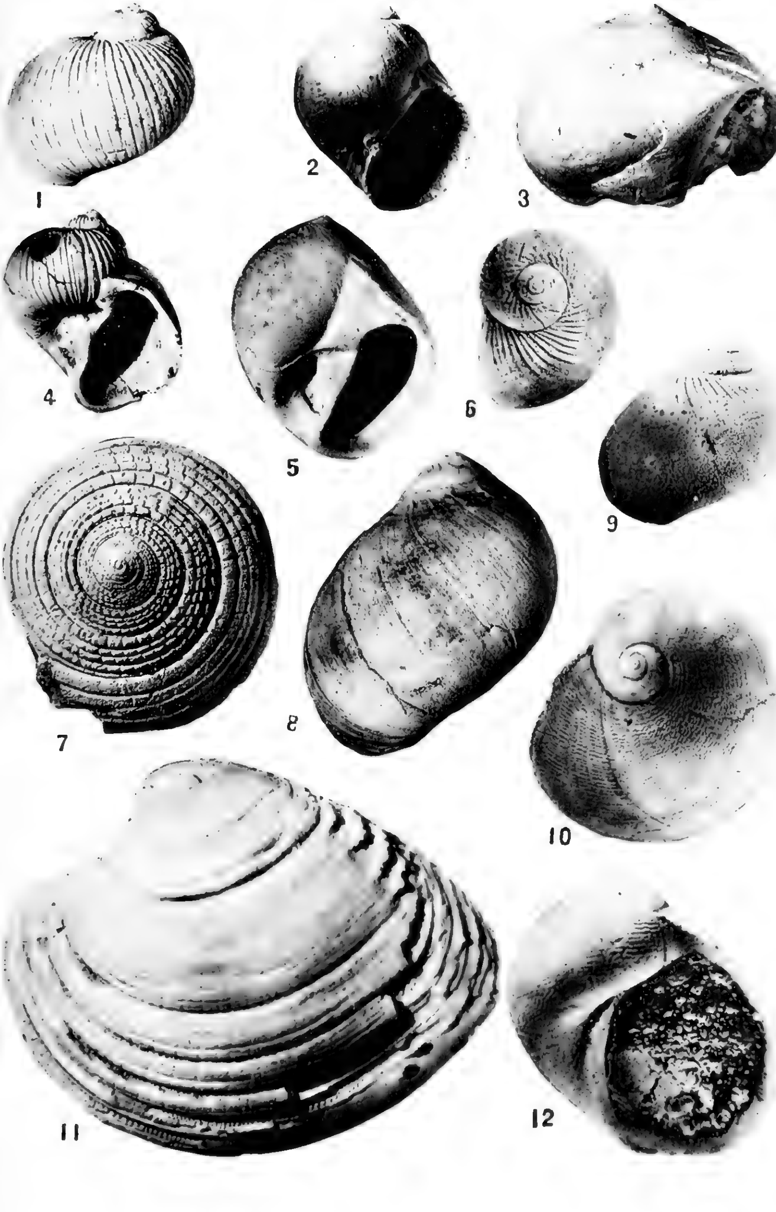
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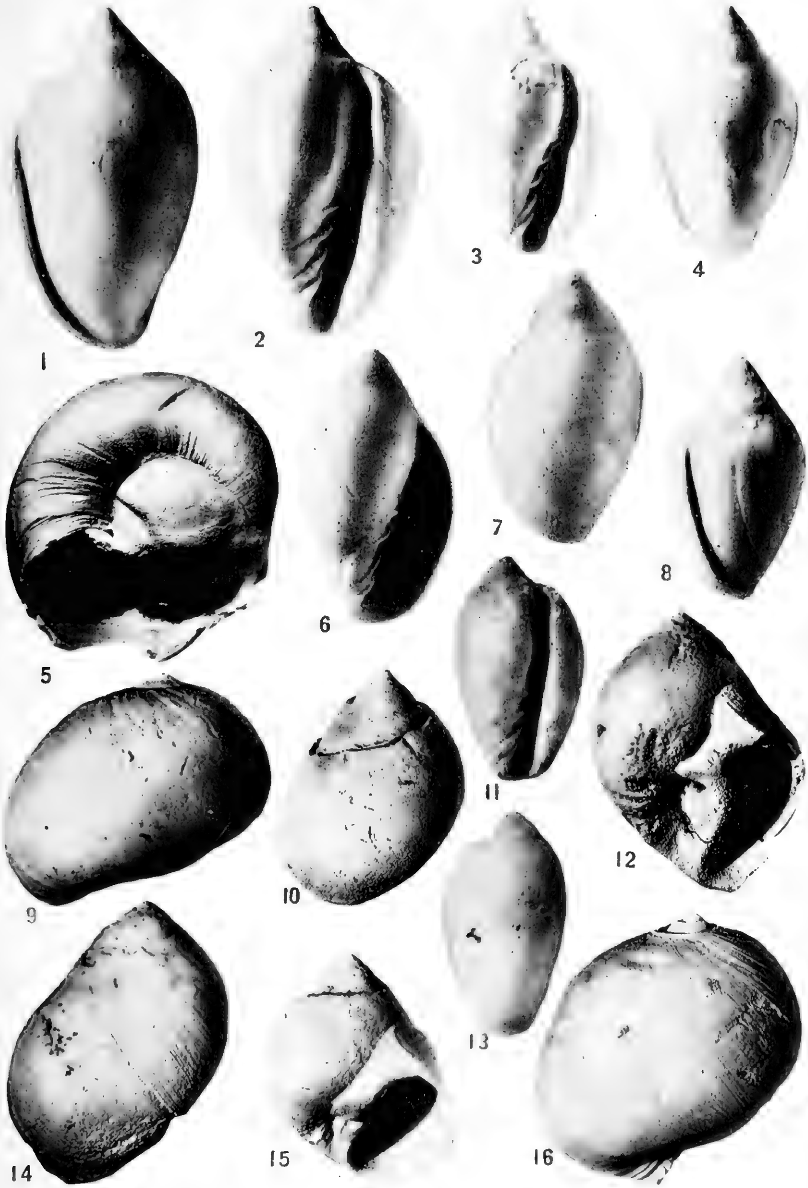
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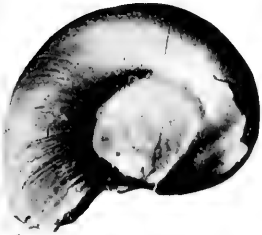
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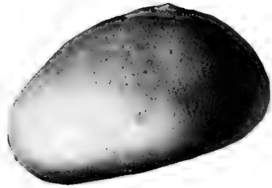
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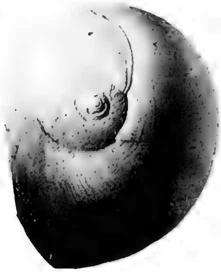
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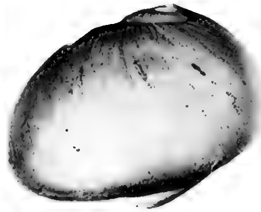
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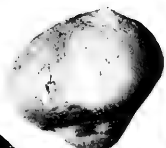
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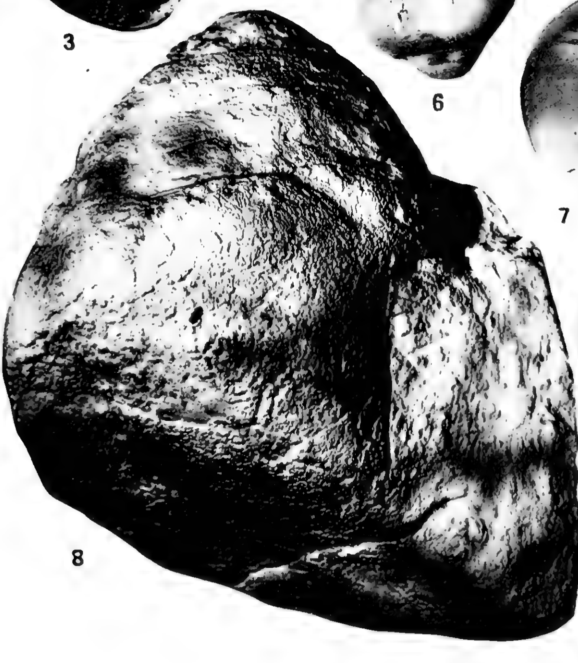
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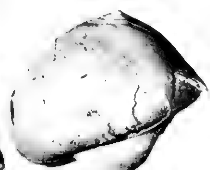
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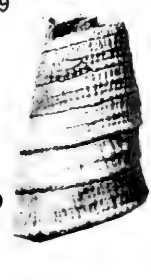
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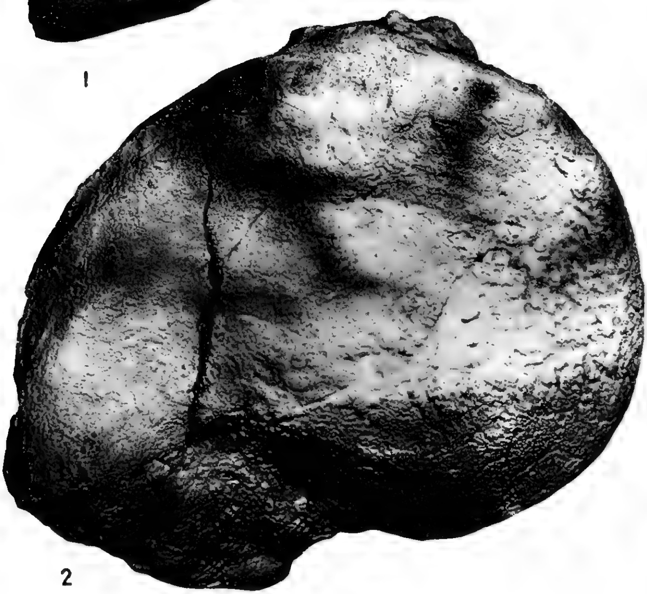

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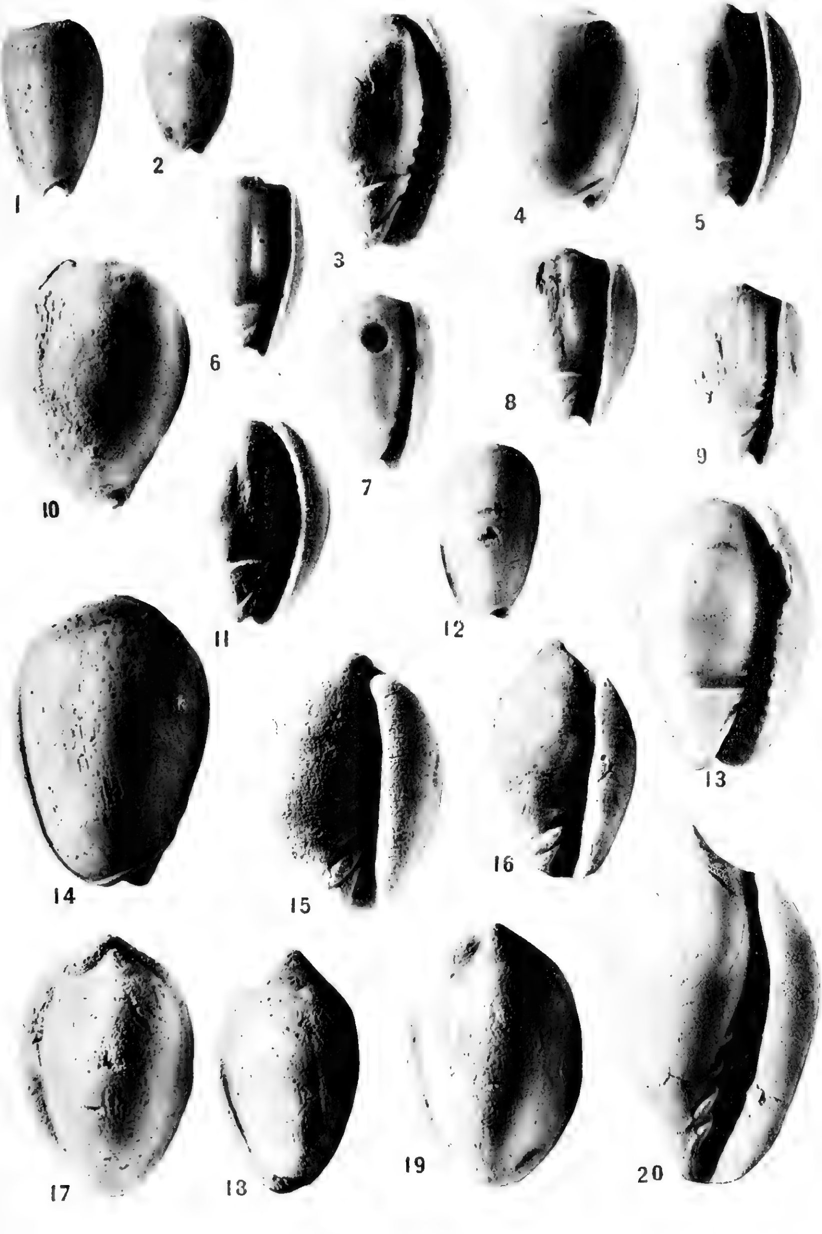
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BULLETINS

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Vol. 13

No. 50

SOME EARLY TERTIARY RHINOCEROSES AND HYRACODONTS

BY

HORACE ELMER WOOD 2nd

Submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy, in the Faculty of Pure Science, Columbia University

Decemer 3, 1927

Harris Co.

Ithaca, N. Y.

U. S. A.

SOME EARLY TERTIARY RHINOCEROSES AND HYRACODONTS[1]

By HORACE ELMER WOOD, 2ND[2]

Following the work of Cope, Osborn, Peterson, Troxell, and others, the time seems ripe for a revision of the Eocene hyracodonts and the earlier true rhinoceroses, from a phylogenetic standpoint. The progress of discovery since Osborn's monograph of 1898 and his paper of 1900 calls for a new survey of the lines of evolution followed; and in particular, the discovery of the long-postulated Upper Eocene ancestors of the true rhinoceroses gives a new starting-point from which to consider the phylogeny of the group. The most that can be hoped for is an approach toward the formulation of the actual relationships; further discoveries will doubtless modify extensively the lines of descent drawn in this, as in all earlier attempts.

This paper includes a systematic revision, with special reference to problems of phylogeny, and the description of three new genera and seven new species. However, the extenuating plea is submitted that distinctly more names are demoted to the rank of synonyms.

It is a pleasure to acknowledge my obligations to Professor H. F. Osborn, Dr. W. D. Matthew and Mr. Walter Granger for permission to use undescribed American Museum specimens and for facilities in carrying on this study; to Prof. Osborn, Mr. Granger, Mr. H. C. Raven, Miss Jannette Lucas, Prof. J. J. Galloway, and especially to Dr. Matthew for various helpful suggestions; to Dr. J. W. Gidley for permission to use the National Museum collections and for various courtesies in connection with my visits to Washington; to Mr. O. A. Peterson for permission to use the Carnegie Museum material and for innumerable

[1] Investigation aided by a grant from the New York Academy of Sciences.

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ERRATA for BULLETIN 50

For *Hyrachus* read *Hyrachyus* on pages 7, 8(twice), 15, 23, 33(twice), Table VII(three times),

For *Hyracodone* read *Hyracodon* on page 28

For LM 1 - ∕ read LM 1 - 3 ∕ page 104, fig. 34.

courtesies during and after my visits to Pittsburgh; to Professor R. S. Lull for permission to study the collections at Yale; and to Profesor Lull, Dr. E. L. Troxell and Dr. M. R. Thorpe for various courtesies; to Professor W. J. Sinclair for permission to study the Princeton collections, and to Professors W. B. Scott and M. S. Farr for various other courtesies during my visit to Princeton. I am indebted for secretarial assistance to Miss N. E. Binger, and, especially, to Mrs. C. P. Meadowcroft.

The drawings of the specimens in the Carnegie and the National Museums are the work of Mr. Sydney Prentice. For the other drawings I am indebted to Dr. Florence Dowden Wood. Finally, I wish to recognize most emphatically my debt to Professor William K. Gregory for first suggesting this subject and for his invaluable advice and encouragement.

In this paper I shall use the orthodox molar terminology for the molars and for the analogous (but perhaps not always homologous) elements in the premolars. It must be emphasized, however, that these terms as applied to the upper teeth are arbitrary topographic terms and do not represent the actual order of cusp development. The subject has been discussed fully by Gregory (1922).

I shall use the following classification for the rhinoceroses:

Superfamily Rhinocerotoidea Gill, 1872, modified by Osborn, 1898.
- Family Hyrachyidæ = Hyrachyinæ, Osborn and Wortman, 1892.
- Family Amynodontidæ, Scott and Osborn, 1883.
- Family Hyracodontidæ, Cope, 1879.
- Family Rhinocerotidæ (Rhynocerotidæ Gray, 1821, corrected to Rhinocerotidæ by Owen, 1845).

I agree with Scott (1913) that it would be slightly preferable to rank the rhinceroses as a family, with the different lines as subfamilies. The other classification is firmly imbedded in the literature, however, and has at least the convenience of giving room for still another stage in classification, above the rank of genus. It seem impossible to join the *Hyrachyus* group with any one of the later lines rather than with another, nor does it seem justifiable to unite any two of the later groups more closely with each other than with the third. In the other direction, the resemblance between the Hyrachyidæ and the Lophiodontidæ is obvious, though perhaps increased through parallelism.

Ringström (1924) once more recognizes the elasmotheres as an independent family, equivalent to the other lines, although a large part of his paper is devoted to showing that they are fairly closely related to the more typical true rhinoceroses, through the new genus *Sinotherium* Ringström (1923). If the elasmotheres constitute a family on account of their unusual bulk, the baluchitheres certainly should be considered a new order.

Superfamily Rhinocerotoidea

Horns when present are epidermal structures, composed of keratinized fibers. The orbit and temporal fossa are fully confluent. There is never an antorbital depression. A diastema is present anterior to the premolars. Both upper and lower molars are lophodont. The paracone is smaller than the metacone in M 1–2/, and the ectoloph forms an acute angle with the protoloph and metaloph. M 3/ is usually triangular, due to complete or partial fusion of the ectoloph and metaloph, associated with the suppression of the posterior buttress. In the lower cheek teeth, the talonid is distinctly lower than the trigonid. The lower molars are composed of two asymmetrical crescents, the posterior limb of each being the dominant element, but the anterior limb is never completely lost. There is no posterior accessory cusp on M /3. The digital formula is IV–III to III–III.

Family Hyrachyidae

Type genus: *Hyrachus* Leidy. North American, primitive rhinocerine perissodactyls; Wind River, Bridger and Uinta; manus tetradactyl; rudimentary horns may appear; nasals not shortened, nasal incision slight; I 3/3 C 1/1 P 4/4–(3) M 3/3; canines are tusks of moderate length; fairly long diastema; permanent premolars never molariform;[1] upper molars with the cusps not fully fused into lophs, with the parastyles large independent cusps arising from the anterior cingulum, and usually with well-developed cristæ; posterior extension of ectoloph of M 3/ always large; anterior limbs of lower molar crescents small.

Genera: *Hyrachus, Colonoceras, Metahyrachyus.*

Family Amynodontidae

Type genus: *Amynodon* Marsh. North American and Eurasian semiaquatic rhinoceroses; Uinta to Oreodon Beds; manus tetradactyl; hornless; nasals shortened; I 3–2/3–1 C 1/1 P 4–3/4–2 M 3/3; incisors originally small and progressively reduced; canines huge tusks; rather short diastema; upper premolars unprogressive and become molariform beginning posteriorly; premolars progressively overshadowed in size by the molars; upper molars have the parastyle plastered against the paracone; the posterior extension of the ectoloph of M 3/ is always large and everted; lower molars are disproportionately long for their width.

Genera: *Amynodon, Metamynodon, Cadurcotherium.*

Family Hyracodontidae

Type genus: *Hyracodon* Leidy. North American and probably Asiatic, cursorial rhinoceroses; Bridger to Protoceras Beds; manus tridactyl; hornless, nasals shortened. I 3/3 C 1/1 P 4/(4)–3 M 3/3; canines become incisiform and little larger than the incisors by Oligocene time; dia-

[1] The only approach being in P /4, where, however, the entoconid never fully fuses with the hypoconid to form a talonid crescent, except after prolonged wear.

stema rather short; P /1 reduced and lost before the Oligocene; premolars become molariform starting posteriorly; upper molars with parastyle plastered on paracone; crista usually present; M 3/ with posterior extension of ectoloph somewhat reduced but nearly always present.

Genera: *Hyracodon, Prothyracodon, Triplopus, Ardynia ? Cænolophus ?*, etc.

Family Rhinocerotidae

Type genus: *Rhinoceros* Linn. North American, Eurasian and African true rhinoceroses; Bridger to Recent; manus tetradactyl to tridactyl; hornless or horned; long nasal incision; I 3–0/3–0 C 1–0/0 P 4–3/4–3 M 3/3; tusks, when present, I 1/ and I /2; progressive mediad reduction and eventual loss of front teeth; canines always small; long diastema; premolars become progressively molariform, beginning with P /4 in the lower jaw, and with P 2/ or P 4/ in the upper jaw; upper molars with parastyle plastered on paracone and early loss of the crista; posterior extension of ectoloph of M 3/ progressively reduced in Eocene, and wanting from Oligocene on.

Genera: *Rhinoceros, Opsiceros, Elasmotherium, Sinotherium, Teleoceras, Baluchitherium, Diceratherium, Trigonias*, etc., etc.

No extended discussion of the European rhinoceroses has been included in this paper. Guesses as to their affinities, based on the chaotic literature, are of limited value without re-study of the specimens themselves; and, with the probable exception of that very obscure genus, *Prohyracodon,* they are too specialized in structure and too late in time to throw much light on the early Tertiary development of the North American forms. Several of the new Mongolian forms raise interesting questions, but, with the possible exception of *Ardynia,* I am, at present, inclined to regard them as side lines, which do not materially contribute to the history of the American forms.

It is desirable to re-emphasize the correction of certain mistakes in the identification of the front teeth of the true rhinoceroses. As shown by Lucas (1900), Hatcher (1901), and Peterson (1911, 1920), the following changes are necessitated:

	Corrected Nomenclature	Osborn 1898, 1923a, 1932b and others
Upper tusk is	I 1/	not I 2/
Next upper incisor is	I 2/	not I 3/
Lower tusk is	I /2 (possibly I /3)	but not C /1

In certain of his more recent papers, Osborn, by a *lapsus calami,* refers to the incisor tusks of the rhinoceroses as "the *second incisor* above and the *second incisor* below" (1923b, pp. 210, 214). A glance at *Trigonias osborni* shows that the upper tusk is the first incisor, as there are two other incisors and a canine behind it. The exact resemblance of this tooth in the genera in which it is present, from *Trigonias* to *Rhinoceros,* is convincing evidence that it is the same tooth. The lower tusk, with one tooth behind it in *Trigonias,* is most probably the second incisor, but the possibility that it is the third incisor instead must be kept in mind. The same confusion occurs in Osborn's discussion of *Baluchitherium* (1923a, p. 6), where the tusk is called the second upper incisor. Certainly in the true rhinoceroses the tusk is I 1/, in the amynodonts and hyrachyids it is C 1/ and there is no tusk in the hyracodonts. It cannot be the canine in *Baluchitherium* as there is a small alveolus immediately behind it, with the premaxillary-maxillary suture still further back. So far as these points go they tend to support Osborn's view that *Baluchitherium* belongs among the true rhinoceroses. Perhaps it descended from *Trigonias osborni.* I agree with Matthew (footnote, Osborn 1924) that *"Baluchitherium" mongoliense* is not a baluchithere, but more probably a coelodont rhinoceros.

Peterson (1920, pp. 453–456, pl. LXVI) has shown conclusively that in *Menoceras* (= *Diceratherium*) *cooki* dI /3 is present in the very young stage, but that the lower tusk (presumably I /2) takes over the space of both dI /2 and dI /3. The alveolus for dC /1 remains for a time shortly behind I /2 before being obliterated.

What is perhaps this same alveolus (possibly an accidental or pathological hole, however) is found on one side of a mature jaw of *Subhyracodon* (= *Aceratherium*) *tridactylum* in the American Museum, No. 543. And A. M. N. H. No. 1112, *Subhyracodon tridactylum* from the Protoceras Beds near the Cheyenne River, a young right ramus, contains the root of dI /1, the alveolus of dI /2, the root of dI /3, the alveolus of dP /1, also dP /2, dP /3, dP /4 and M /1 just cutting the gum. This is what would be expected. It emphasizes the gradual nature of the loss of teeth in the rhinoceroses.

In *Trigonias* a tooth was certainly present in the adult for a time at least, immediately behind the lower tusk. It was probably I /3 but not dI /3, if analogy with the calves described by Peterson (loc. cit.) has any bearing. It may, however, have been the canine or the deciduous canine retained.

At the suggestion of Dr. Gregory I compared the lower front teeth of *Hyrachyus* and *Hyracodon* with the true rhinoceroses. In *Hyrachyus,* A. M. N. H. No. 12355, and *Hyracodon,* A. M. N. H. Nos. 1491, 12460, and 14433, these teeth are sufficiently well preserved to justify comparison. In all of these I /2 accords most closely in position and character with the lower incisor tusk in the true rhinoceroses. In general this is borne out, or at least not contradicted, by all other less well preserved specimens I have seen at the American Museum and Yale Peabody Museum. In *Hyracodon,* No. 12460 (fig. 8), this resemblance is especially striking. I /2 is set with its crown squarely across the jaw, rather than parallel or nearly parallel to it, and the crown shape has a striking resemblance to the lower tusks in *Trigonias* and *Subhyracodon.*

An additional argument is the *a priori* unlikelihood that I /3 should become the functional opponent of I 1/, the upper tusk. All these lines of evidence taken together make it seem justifiable to regard the lower tusk as most probably the second incisor. It will be so referred to throughout the remainder of this paper.

Before describing what is regarded as a new genus of true rhinoceroses from the Eocene it is necessary to settle its relation to the Eocene hyracodonts, represented by the forms which have been referred to the genera *Triplopus* Cope and *Prothyracodon* Scott and Osborn. This necessitates a re-study of these forms.

Family Hyracodontidæ Cope 1879

Subfamily Triplopodinæ Osborn and Wortman 1892 = Triplopodidae Cope 1881

Triplopus Cope 1880

Genoholotype: *Triplopus cubitalis.* Small, Eocene cursorial rhinoceroses, with a remarkably precocious cursorial adaptation, since the radius and ulna are relatively much longer compared to the other segments of the front leg than in any other rhinoceros. It differs from other rhinoceroses of the same age in the presence of an ossified auditory bulla. I ?/3 C 1/1 P 4/4 M 3/3. The canines are apparently considerably larger than the incisors. The cingulum is interrupted internally on P 3/ and P 4/. M 1–3/ have no internal cingula. M 1/ has no external cingulum. The posterior cingulum on the upper molars is never very large. The parastyles of M 1/ and M 2/ have slightly more the character of rounded, semi-independent cusps, than in the true rhinoceroses. The parastyle of M 3/ is no larger than in the Eocene true rhinoceroses, described below.

Triplopus cubitalis Cope 1880 Pl. 2, Figs. 2, 3, 4

The holotype is A. M. N. H. No. 5095, collected by Cope, in 1873, from the Lower Washakie, near South Bitter Creek, Washakie Basin, Wyoming. It was described and figured by Cope (1880a and 1885a). Further development of the specimen has brought to light a number of previously unknown characters. I ?/3 C 1/1 P 4 (3?)/4 M 3/3. P 2–4/ are rather similar in external view. The parastyle forms a slight ridge along the anterior edge of the tooth. A depression follows, succeeded by the very prominent ridge of the paracone. The metacone forms a slight ridge which scarcely interferes with the general concave sweep of the posterior half of the ectoloph, ending with the metastyle, ridged on P 3/ and P 4/. The external aspect of M 1/ and M 2/ is similar, except that the valley between the parastyle and paracone is more pronounced. P 1/ (dP 1/ ?) is a simple blade with no internal cusps. P 2/ retains a more primitive condition than any other known member of the Rhinocerotoidea, its closest resemblance being to *Eohippus* and *Homogalax* (= *Systemodon*). The external aspect resembles P 3/ and P 4/. The internal part of the tooth slopes away rapidly from the ectoloph. Besides the slope of the ectoloph, the chief internal element appears to be the basal cingulum, which rises to form two cuspules, on the slopes of the paracone and metacone, respectively. The posterior is the larger of the two, and is connected with the anterior part of the metacone by a very small and insignificant "metaloph." The tooth is subtriangular. In P 3/ the protoloph and metaloph join to form a U. There are two moderately deep outlets from the median valley, of nearly the same depth, at the outer ends of the U, between the protoloph and the paracone, and between the metaloph and the metacone. The protoloph and metaloph are incipiently separated by a well-marked groove across the crest continuing down the internal face of the tooth. P 4/ has no separation whatever between the protoloph and metaloph which form an undivided U, enclosing a deep basin. The lowest point on the ridge is between the metaloph and the metacone, at which point there is a deep outlet. There is no internal cingulum on the upper molars. M 1/ has no external cingulum. There is a crista on M 1/ but none on M 2/ or M 3/. The posterior cingulum of M 2/ is exceptionally small. M 3/ is still in the alveolus. It shows a distinct advance over the Hyrachidæ, but there is still a well-developed, posterior extension of the ectoloph, of somewhat the same type as in *Hyracodon,* but farther from the median line. An ossified auditory bulla is present, a structure which has not been found in other rhinoceroses of at all similar age. The manus is tridactyl. Detailed measurements are given below, as well as a more accurate and complete figure than those of Cope (1885a and 1887).

Additional development of the type brought to light a number of important new characters of the upper cheek teeth, and makes it possible to correct several mistakes in Cope's description and figures. Cope's "extra ridge" and "pot-hook" on dP 4/ and M 1/ were simply due to part of the metaloph being broken off and separated from the rest. The enormous crista-like swellings which partly blocked the valleys of M 2/ and M 3/ proved to have no certain connection with those teeth, although it is also possible that they represent a deposit of cement. If so, this is another surprisingly progressive character.

Part of a lower jaw (fig. 4), consisting of the symphysis and left ramus, accompanied by the right femur (A. M. N. H. No. 2344), from the "Middle" (probably Lower, see below) Washakie, south of Haystack Mountain, in the Washakie Basin, Wyoming, collected by Dr. Wortman in 1895, are probably referable to this species. M /1 and M /2 compare closely in character and measurements with those of the type. The dental formula for the lower teeth given above, of this genus and species, is, therefore, based on this jaw.

The jaw is long and slender, especially anteriorly. Its proportions suggest those of *Mesohippus*. LC /1, RI /1, the roots of RI /2 and I /3, RC /1–P/2, RP /3 (mostly lost), and RP /4–M /3 are present. I /1 resembles I /1 of *Hyrachus* in being a broad, slightly curved, nearly transverse blade, tapering somewhat toward the root. C /1 has a rather unusual character. It is not much larger than I /1, somewhat elongated, and the antero-ventral border is recurved. The diastema is, relatively, rather long. P /1 is a simple blade with an anterior cuspule clearly defined, and a very slightly developed posterior cuspule. P /2 is functionally an antero-posterior blade, but the paraconid is slightly internal, and the protoconid and metaconid, which are almost continuous, form a blade sloping internally, at a slight angle to the paraconid. Thus the trigonid shows the faint beginning of a crescent. The talonid is a simple antero-posterior blade, lapping up on the postero-external slope of the trigonid. P /3 is broken and lost, except for the hypocone, which resembles that of P /4. P /4 is quite primitive. The trigonid crescent is well developed. The anterior cingulum surrounds the paraconid completely, starting at the metaconid, and, in an attenuated form, running completely around the anterior end of the tooth. The hypoconid is mainly a conical cusp, with an anterior extension which overlaps the trigonid. The entoconid is a small cuspule, adjoining the hypoconid, but much lower. They would not become confluent until an advanced stage of wear. The basal cingulum is very distinct, behind and internal to, the entoconid. Altogether, this tooth is very reminiscent of *Hyrachyus*. The molars are progressive. The anterior and posterior cingula are reduced. The coronoid process of the mandible is markedly recurved over the condyle.

The ventral spine of the atlas is conical, and on the central part of the ventral surface, instead of at the posterior edge, as in rhinoceroses in general. (In *Hyracodon*, the condition is intermediate.) The odontoid process of the axis is a long peg, not confluent with the prezygapophyses. (See Cope 1885a, Pl. LVa.)

The coracoid process of the scapula is well-developed and clearly defined. There was probably a supracondyloid fenestra on the humerus. (See Cope 1885a, Pl. LVIa.) If there was not an actual vacuity, the bone must have been a mere film. This condition, of course, is correllated with the straightening of the limb in a high degree of cursorial specialization, resulting in pressure of the olecranon process on the humerus and resorption of the bone. The posterior descending process of the magnum is remarkably long in proportion to the size of the animal, and the unciform has a very peculiar descending process, which is nearly as long (fig. 2).

This form is quite highly specialized, in its remarkably complete cursorial adaption for so early a time, in which it greatly exceeds *Hyracodon,* coming somewhere near the proportions of a race-horse in its front leg (see table of limb ratios below, and Gregory, 1912). It is virtually impossible for it to have been ancestral to any other known genus of rhinoceroses. However, it shows various resemblances both to *Prothyracodon,* and to the Eocene true rhinoceroses described below.

Lophialetes (Matthew and Granger, 1925c) is a remarkable form. The resemblance to *Triplopus cubitalis* in P 3/–M /3 is striking; yet P 2/ is very much more progressive, approaching P 3/ in character, and M /3 has the typical lophiodont heel. The most likely explanation is probably parallelism, on the part of a lophiodont.

Triplopus grangeri, new species Pl. 2, figs. 5, 6, 7; Pl. 4, figs. 14, 15

The holotype is A. M. N. H. No. 1972, collected near the White River, Utah, top of Horizon B, Uinta, by Mr. Walter Granger, in 1895. I ?/3 C ?/1 P ?/? M 3/3. The tips of the premaxillaries are appressed, but entirely separate. I 1/ is of typical hyracodont pattern, and shows no tendency toward enlargement. The cingulum is interrupted internally on P 4/ and M 1–3/. P 4/ is slightly more advanced than in *Triplopus cubitalis*, having a slight division posteriorly between the metaloph, and the protoloph which curls around it, but none internally. The parastyles of M 1/ and M 2/ are slightly more independent than in any of the true rhinoceroses. M 2/ and M 3/ have cristæ. M 1/ is too worn to indicate whether a crista had been present or not. It has no external cingulum on the metacone. There is a very well-developed posterior extension of the ectoloph on M 3/, somewhat intermediate in character between the conditions found in *Hyrachyus* and in *Hyracodon*. The parastyle of M 3/ is like that of the new, Eocene true Rhinoceroses described below. There is an accessory ridge beside the crista of left M 3/, which is not present on right M 3/. The antero-ventral border of C /1 is recurved, as in A. M. N. H. No. 2344, referred to *Triplopus cubitalis*. It is larger than the incisors. The lower molars are not especially distinctive.

The type consists of fragments of the upper and lower jaws, originally imbedded in a single block of sandstone. The more important fragments are: LP 4/, LM 1–3/, RM 2–3/, the back of the left ramus with M /2–3, the corresponding part of the right ramus with M /1–3, the badly damaged symphysis with the roots of the three left incisors, the left canine, right I /1 (damaged), and the root of right I /2, and the tips of both premaxillaries, with the stub of I 1/ in the left, and most of I 1/ and the stub of I 2/ in the right (figs. 5 and 6).

Carnegie Museum No. 2336 (fig. 7), from Horizon B of the Uinta, represented by left P 3/–M 3/, should probably be referred to this species.

Carnegie Museum No. 3110 (figs. 14 and 15), from Uinta A, right P 3/–M 2/ and left P /2, P /3, and M /1–3, is more doubtfully referable to this species.

These two Carnegie Museum specimens are probably referable to *Triplopus grangeri*—unless a new species be created for each—but both specimens differ somewhat from the type, and from each other.

C. M. No. 2336 retains a large root to indicate the upper canine. There were four upper premolars, the first two indicated only by their roots. P 3/ is much like the corresponding tooth of *Triplopus cubitalis.* The cingulum is interrupted internally, and the protoloph and metaloph are distinctly separated, though this separation would be obliterated after considerable wear. There is no crista. For P 4/, it is a question of definition whether the cingulum is interrupted internally or not. There is a well-developed crista. The molars have their parastyles as in the type of *T. grangeri.* The cingula are interrupted internally, as in the type, but M 2/ has a larger rudiment across the internal valley, and this is more extensively, though still very faintly, developed on M 3/. M 1/ has a large crista, M 2/ and M 3/ rudimentary ones. M 2/ is surprisingly long in proportion to its width. M 3/ is much like the type.

C. M. No. 3110 has several interesting features. The teeth are more worn than in either A. M. N. H. No. 1972, or C. M. No. 2336. The internal separation between the protoloph and metaloph of P 3/, if it ever existed, has been obliterated. Apparently, however, the protoloph coils around the metaloph, making the outlet of the valley posterior, as in most other primitive rhinoceroses. This was certainly the situation in P 4/. Neither premolar had a crista, and the cingulum was interrupted internally on each. M 1/ and M 2/ were devoid of internal cingula, except the usual rudiments at the outlet of the median valley.

Apparently M 1/ had a crista, whereas M 2/ did not. There were four lower premolars. P /2 has an antero-posterior, blade-shaped hypoconid, with a cingulum completely enclosing the talonid basin. P /3 has a similar hypoconid as the highest part of the talonid, but connecting with the entoconid, forming the ghost of a crescent. P /4 is lost, except for a small fragment, which shows the entoconid not fully joined to the hypoconid, and partly connected, by the cingulum, to the metaconid. The lower molars have no unusual features.

Epitriplopus, new genus

The genoholotype is *Prothyracodon uintense* Peterson. I ?/3, C ?/1, P 4/4–3, M 3/3. P 2/ has an ectoloph, and a single large internal cusp connected with the paracone by a cross-crest. M 2/ is very long in proportion to its width. The posterior buttress of M 3/ is lost completely, except for a trace near the base. The manus is tridactyl.

Epitriplopus uintensis (Peterson) 1919. **Prothyracodon uintense** Peterson. Peterson, 1919 Pl. 3, fig. 9

The holotype is C. M. No. 3007a, from horizon C, Uinta, Eocene, six miles east of Myton, Utah. The animal is larger than any other known Eocene hyracodont, approximating in size the new genus of Eocene true rhinoceroses described below. I ?/3, C ?/1, P 4/4–3, M 3/3. No metaloph is present on P 2/. The cingulum is absent internally on M 1/ and M 2/, except across the median valley. M 3/ has no trace of the posterior extension of the ectoloph, except possibly at the base of the tooth, a condition otherwise unknown among the hyracodonts, except in *Ardynia,* which may be a composite form. The lower incisors and canine are much as in *Hyracodon,* except that the canine is somewhat larger proportionately. P /1 is small or missing.

As stated by Matthew and Granger (1925a), "Peterson's species can hardly be cogeneric with *P. obliquidens* (Scott and Osborn), in which M 3/ retains the free posterior flange of the ectoloph, but may be comparable with *Prohyracodon* Koch of the Eocene of Hungary."

In the type skull described and figured by Peterson (1919), the deciduous premolars had not been replaced, and the crown of M 3/ would probably not have cut the gum. Cutting small windows showed that, at least, right P 2/ and left P 2/ and P 3/ were developing. At my request, Mr. Peterson very kindly had left P 2/ and P 3/ exposed. The results were disappointing, as the crowns were incompletely calcified. P 2/ shows the ectoloph, and a single internal cusp, the protocone, slightly elongated antero-posteriorly, and connected with the paracone by a cross-ridge. The protoloph is developed, therefore, but there is no trace of a metaloph. This condition is more progressive than that in *Triplopus cubitalis;* it is much less so than *Prothyracodon obliquidens.* P 3/ is an amorphous mass; its interpretation is, to say the least, problematical. DP 4/ is molariform, with both protoloph and metaloph well-developed. The internal cingulum is slightly interrupted by the protoloph, and broadly by the metaloph. In general, Peterson's figure (1919, Pl. XLV) of the type skull is excellent except that the protocone of left M 1/ has a misleading appearance, as a result of fracture, and the parastyle of M 3/ is not shown. M 1/ is a little disproportionately long for its width, and has a tendency to taper posteriorly. Both these tendencies are carried much further in M 2/, giving it a strikingly individual character, at first glance. M 1/ has a crista, M 2/ and M 3/ have not. Basal singula are present anteriorly, posteriorly and in the median valley of M 1/ and M 2/. They are absent from the rest of the internal surface, as well as from the ectoloph M 3/ has a parastyle of moderate proportions, about as in *Triplopus cubitalis.* The top eight millimeters of the crown has no trace of the posterior buttress at all, being a perfectly smooth curve. Basally, there is an incipient ridge, on which a posterior cingulum would presumably have been deposited later. Perhaps a slight trace of the posterior buttress would also have been formed in this region. The general character of the tooth markedly suggests *Prohyracodon Koch.* M 2/, however, is entirely different in these two forms.

Peterson's figure (1919, Pl. XXXVI) is quite accurate in its representation of the type lower jaw. The second incisors are more asymmetrical than they are represented, with their median sides the longer. M /1 and M /2 have posterior cingula, which are not shown. C. M. No. 2990 is provisionally referred to this species by Peterson. The lower canines are rather large.

The following specimens have also been referred to this species by Peterson. C. M. No. 2990 includes a right radius—length 174 mm. C. M. No. 3007 (not 3097, Peterson, p. 134, line 28) includes the scapulæ and humerus. These bones are rather suggestive of *Hyrachyus.* The length of the humerus is 156.5 mm. With No. 2990, this would give the ratio R/H = 1.11, which is between the ratios of *Triplopus cubitalis* and *Prothyracodon obliquidens.* However, even if both specimens are correctly assigned to this species, the fact that the radius and humerus are from different individuals makes the probable error so large that the significance of this ratio is minimal. C. M. No. 3201 is doubtfully referred to this species.

The provisional reference of this form to the Triplopodinæ, rather than to the Hyracodontinæ, is largely based on its considerable resemblance to the Carnegie Museum specimens assigned to *Triplopus grangeri,* and on its more general resemblance to *Triplopus cubitalis.* It does not seem possible, however, to consider it cogeneric with *Triplopus cubitalis.* The character of the lower front teeth, and the reduction of P /1, appear to bar it from the Rhinocerotidæ; and the very primitive character of P 2/ separates it distinctly from the Hyracodontinœ.

There are some resemblances to the new Eocene forms described below. However, the small size of P 1/1 and the character of M 3/ are quite different. And if, as is argued below, these forms are ancestral true rhinoceroses, they would, unquestionably, have had a tetradactyl manus, whereas *Epitriplopus uintensis* had a tridactyl manus.

Epitriplopus uintensis (Peterson) may have given rise to *Ardynia præcox* of Mongolia, as suggested by Matthew and Granger (1925a). In addition to the great reduction of P /2 in the Mongolian form, P 2/ in *Epitriplopus* appears to be in a much more primitive stage.

The relationships of *Ardynia* (Matthew and Granger, 1923), provided the various parts are correctly associated, are very puzzling. It does not fit definitely into any one of the families of rhinoceroses. In view of the fragmentary nature and uncertain association of the parts attributed to the type specimen, it is perhaps permissible not to consider its relationships further, at this time, than to refer its provisionally to the Hyracodontidæ.

Cænolophus (Matthew and Granger, 1925b) from the Shara Murun formation (Upper Eocene) of Mongolia, is not at all close to any American genus. The skull and feet are unknown. So far as the fragmentary dentition shows, it occupies an isolated position, not assignable definitely to either the Triplopodinæ or the Hyracodontinæ, and, possibly, not to the Hyracodontidæ. *Cænolophus obliquus* may not be cogeneric with the genotype, *C. promissus*. *Cænolophus proficiens*, Matthew and Granger (1925c), retains all four lower premolars, although P /4 is already molariform. This combination, unique in the Hyracodontidæ, emphasizes the isolated position of this genus. Matthew and Granger refer it provisionally to the Hyracodontidæ.

Subfamily Hyracodontinae Steinman and Döderlein 1890, correctly redefined by Osborn and Wortman 1892

Prothyracodon Scott and Osborn 1887

Pl. 3, figs. 10, 11, and Scott and Osborn 1889.

The genoholotype is *Prothyracodon obliquidens* (Scott and Osborn) 1887. Uinta hyracodonts with tridactyl manus. I 3/3, C 1/1, P 4/(4)–3, M 3/3. Canines larger proportionately than in *Hyracodon.* The basal cingulum is continuous internally around P 3/, P 4/ and the protocones of M 1–3/. There is no trace of an internal groove on the protocones of P 3/ and P 4/ (to mark an incipient separation of the hypocone from the protocone), but the protoloph hooks around the metaloph. P 2/ is subtriangular, rather than subquadrate, but much farther advanced than in *Triplopus cubitalis.* M 1/ has a distinct external cingulum on the metacone. The upper molars apparently have no cristæ. M 3/ has a distinct trace of the posterior extension of the ectoloph, of much the same character as in *Hyracodon.* P /4 and P /3 are not yet fully molariform, but suggest *Hyrachyus*, with the entoconid a separate cuspule, which does not become fully confluent with the hypoconid to form the talonid crescent, until after prolonged wear. This genus is probably ancestral to *Hyracodon.*

Prothyracodon obliquidens (Scott and Osborn) 1887

Hyrachus obliquidens Scott and Osborn. Scott and Osborn, 1887, p. 259.
Prothyracodon intermedium Scott and Osborn. Scott and Osborn, 1887, p. 260.
Triplopus obliquidens (Scott and Osborn). Scott and Osborn, 1889.
Prothyracodon obliquidens (Scott and Osborn). Peterson, 1919.

The type of *Hyrachyus obliquidens* is P. U. No. 10,402, a lower jaw (for figure see Scott and Osborn, 1889, Pl. XI) with left M 3/. The type of *Prothyracodon intermedium* is P. U. No. 10,403, left upper P 3/–M 3/. M 3/ as originally present was seriously damaged and has now been sufficiently further injured so that it is impossible to check up on the published figure (loc. cit.). Fortunately, however, A. M. N. H. No. 1971 has right P 2/–M 3/, left P 4/, left M 3/, and both rami of the lower jaw, with both P /3's and P /4's and with fragments or roots of the other cheek teeth (figs. 10 and 11). Dr. Hay left a manuscript note to the effect that this specimen represented a new species, but since it checks very closely with the lower jaw and upper M 3/ of the type of "*Hyrachyus*" *obliquidens*, and with P 3/–M 3/ of the type of *Prothyracodon intermedium*, I regard it as conspecific. I could not compare M 3/ of the latter, due to its loss, and the figure (Scott and Osborn 1889) shows some discrepancies, but I do not think they should be given serious weight. As the occlusal relations, the result of both the orginal structure and subsequent wear being complimentary, of the upper and lower teeth of A. M. N. H. No. 1971 are exact, there can be no reasonable question of association. For this reason I follow Scott and Osborn (1889) and Peterson (1919) in regarding *Prothyracodon intermedium* as a synonym of *Prothyracodon obliquidens*. The description will be based on all three specimens, since they supplement each other in the parts that are missing and agree closely in the parts common to any two of the specimens.

I 3/3, C 1/1, P 4/(4)–3, M 3/3. The canines are larger than the incisors. P 2/ is subtriangular, being much more primitive than in *Hyracodon* or the new true rhinoceros from the Uinta described below, but far more advanced than in *Triplopus cubitalis*. The protoloph runs postero-internally and joins the metaloph. There is a small internal cingulum on the protoloph which is not fully continuous with the anterior cingulum and does not surround the postero-internal part of the tooth at all. P 3/ and P 4/ are similar to each other, with the protoloph hooking around the metaloph, leaving a posterior outlet for the median valley in the unworn tooth, and with a continuous cingulum around the anterior, internal and posterior sides. There is no crista on any of the upper molars. M 1/ and

M 2/ are rhinocerotic. The basal cingula surround their protocones anteriorly and internally. M 1/ has a distinct external cingulum on the metacone. M 3/ has a complete cingulum anteriorly, internally and posteriorly, but it is rather faint internally. The parastyle is slightly more prominent than in *Hyracodon* and much more than in *Triplopus* or the true rhinoceroses. The posterior extension of the ectoloph is present, slightly less prominent than in *Triplopus cubitalis* or the type of *Triplopus grangeri*. P /1, when present, is very small. P /2 is known only from the roots. It was of normal size. P /3 is not yet molariform, since the entoconid is a separate cuspule, not connecting with the hypoconid to form the talonid crescent until an advanced stage in wear. The anterior cingulum is weak but complete. P /4 is similar in structure but its proportions are more molariform and the anterior cingulum is both complete and distinct. Both these teeth are more advanced than in *Hyrachyus*. There is nothing diagnostic about the lower molars.

The manus is known to be tridactyl, from the manus associated with the type (Scott and Osborn 1889). Peterson (1919) described two fore legs, with similar wrist bones, which he refers to *Prothyracodon obliquidens*. The limb ratios differ so markedly from *Triplopus cubitalis* that it is improbable that they could belong to *Triplopus grangeri*, the only other known Uinta tridactyl rhinoceros of about the right size. In the table of limb ratios therefore, this specimen is indicated as *Prothyracodon ? obliquidens ?*. The ratios are rather similar to *Hyracodon apertus*, as would be expected.

The important differences from *Triplopus* in *Prothyracodon* are: the ratios in the front leg, the presence of internal cingula on the molar protocones, the absence of an ossified auditory bulla, the absence of cristæ, the much greater progressiveness of P 2/, the greater progressiveness of P 4/, the greater reduction of the posterior buttress of M 3/.

C. M. No. 3201, the skull figured by Peterson (1919) and provisionally referred to this species, is probably correctly assigned. I 3/?, C 1/1, P 4/3, M 3/3. It has a striking resemblance in general character to *Hyracodon.* As its condition is such that it is unsafe to separate the upper and lower jaws, it is not possible to state definitely that it is not *Triplopus grangeri.*

Prothyracodon obliquidens would seem to have the characters to be expected in the ancestor of *Hyracodon.* The internal cingulum is better developed on M 1–3/ than in *Hyracodon,* though there appears to be a very large range of individual variation in this respect in *Hyracodon.*

Hyracodon Leidy 1856

The type of the genus is *Rhinoceros nebraskensis* (Leidy). American, Oligocene, cursorial rhinoceroses; I 3/3, C 1/1, P 4/3, M 3/3; P 2/ is rectangular, with protoloph and metaloph parallel but not fully separate; M 3/ retains a small posterior buttress near the postero-lingual corner of the tooth; the three lower premolars are molariform; medium size; manus tridactyl. The most recent papers on the genus by Troxell (1921), Sinclair (1922) and Wood (1926) indicate that the following species are well established.

Hyracodon petersoni Wood, Titanotherium Beds, has no molariform upper premolars. The median valleys of P 3/ and P 4/ open widely to the rear, the hypocone being firmly attached to the protocone.

Hyracodon arcidens Cope, Titanotherium and Oreodon Beds, has no molariform upper premolars. The protoloph curves around the metaloph in P 2/—P 4/, coalescing, after slight wear, into a continuous crescent. *H. priscidens* Lambe, *H. arcidens mimus* Troxell, and *H. selenidens* Troxell, are probably inseparable from this species. Morphologically, the types of *H. petersoni, H. priscidens, H. selenidens,* and *H. arcidens,* form an excellent series, with the only marked break between *H. petersoni* and *H. priscidens.*

Hyracodon nebraskensis (Leidy), Oreodon and Protoceras Beds, has the protoloph and metaloph of P 4/ parallel, but intimately joined by a "mure." The hypocone is now more closely attached to the metaconule than to the protocone.

Hyracodon apertus Sinclair, Oreodon and Protoceras Beds, has the protoloph and metaloph of P 4/ only, separate and parallel.

Hyracodon leidyanus Troxell, Protoceras Beds, (earlier range doubtful) has the protoloph and metaloph of both P 3/ and P 4/ separate and parallel.

The method of metamorphosis of the upper premolars in this subfamily, presents some interesting features. In P 2/–P 4/ of *Prothyracodon,* the protoloph, consisting of the protocone and protoconule, is the main transverse crest, the metaconule forming a lower, minor crest abutting against the protocone. Then the protocone elongates antero-posteriorly, looping around the internal edge of the metaconule, and an incipient split appears to delimit the hypocone from the protocone, the median valley opening posteriorly. This condition is found in *Hyracodon petersoni.* Here P 2/ is the most progressive, with P 3/ and P 4/ about equally advanced. Then the hypocone unites with the metaconule, while still attached to the protocone, forming an enclosed basin in *Hyracodon arcidens.* The metaconule attaches itself to the rear or middle of the hypocone loop. Thereafter, first P 4/ and then P 3/ catch up with, and pass, P 2/, which remains virtually unchanged. In *Hyracodon nebraskensis* the protoloph and metaloph of P 4/ are parallel and separate, except that they are intimately joined by a "mure"; which, in this case, is simply the remains of the protocone-hypocone connection; in *Hyracodon apertus,* the metamorphosis of P 4/ is complete; and in *Hyracodon leidyanus,* P 3/ also has become molariform. In this stage the hypocone is attached to the metaconule alone. Sinclair (1922) has shown that the general stratigraphic succession of these forms accords closely with their apparent phylogenetic relationships; and Troxell's reference of the type of *Hyracodone leidyanus,* which was collected in the "old days," to "Middle or Lower Oligocene" is insufficient evidence to extend the known range of this species much below the Protoceras Beds, to which Sinclair (1922) refers a specimen to this species.[1]

The anterior part of the trigonid sometimes forms a supplementary loph in itself in dP /2 and more especially in dP /3, in many of the early rhinoceroses. In two specimens of hyracodonts (a young hyracodont, C. M. No. 318, collected by Mr. O. A. Peterson from the Titanotherium Beds, Sand Creek, Sioux County, Nebraska, and a young *Hyracodon* sp., C. M. No. 3581, collected by Mr. O. A. Peterson from the Oreodon Beds, Bad Land Creek, Sioux County, Nebraska), this "paralophid" approaches, in size and distinctness, the metalophid and hypolophid (figs. 12 and 13).

Family Rhinocerotidae Gray, 1821

Eotrigonias, new genus

The genoholotype is *Eotrigonias rhinocerinus,* new genus, new species. *Eotrigonias petersoni,* new species, is referred to this genus. The generic name from ἠώς, dawn, + *Trigonias,* refers to its geological horizon and to its apparent possession of all the characters needed for an ancestor of *Trigonias.*

[1] Since sending this paper to the editor, I came across an article by Prof. Othenio Abel, "Die Molarisierung der oberen Prämolaren von *Hyracodon nebrascensis* Leidy," Paleont. Zeit., VIII, 3, p. 224–245, Oct. 9, 1926. We agree as to the course of premolar metamorphosis in *Hyracodon.* P 2/ of *Hyracodon leidyanus* is not yet fully metamorphosed, Troxell's figure to the contrary; his type specimen, and Sinclair's and Abel's referred specimens, all have a mure crossing the valley between the protoloph and metaloph. The Vienna specimen is from Sheep Mountain, and, therefore, probably from the Oreodon or Protoceras Beds. I do not regard Prof. Abel's revised nomenclature of the species of *Hyracodon* as an improvement, and much of it is definitely untenable from the point of view of priority.

I ?/?, C ?/?, P 4/?, M 3/3. These are Upper Bridger and Uinta true rhinoceroses, with the parastyles of the upper molars reduced to ribs on the paracones as in later true rhinoceroses.

P 4/ resembles *Trigonias osborni* in general character. The protoloph curves around behind the metaloph, so that the median valley escapes posteriorly. There is a small internal groove on the protocone, indicating an incipient separation of the hypocone from the protocone, and the cingulum is interrupted internally. M 1/ and M 2/ are typically rhinocerotic. They have no trace of an internal cingulum except at the outlet of the median valley. M 1/ has a marked external cingulum on the metacone. M 3/ shows a progressive reduction of the posterior extension of the ectoloph from a condition more primitive than *Triplopus grangeri*, in the Bridger species, to a condition scarcely more primitive than that seen in some specimens of *Trigonias osborni*. It has no crista.

If the relationships of this genus are correctly inferred, it presumably had a tetradactyl manus and a dental formula of I 3/3, C 1/?, P 4/4, M 3/3. It is very unfortunate that the structure of the manus and front teeth of the members of this genus is unknown. When they are discovered, they will furnish a valuable check as to the phylogenetic bearings of this form.

Eotrigonias petersoni, new species Pl. 4, fig. 16

This species is based on A. M. N. H. No. 2341, consisting of left P 4/–M 3/, from the "Middle" Washakie, south of Haystack Mountain, Washakie Basin, Wyoming, collected by Mr. O. A. Peterson in 1895 and previously identified as "*Hyrachyus.*" The specific name is given in recognition of the many services of the collector to vertebrate paleontology.

This is an Upper Bridger ? primitive rhinoceros, with the parastyles reduced to ribs on the paracones. In P 4/ the protoloph overlaps the metaloph, allowing the median valley to escape posteriorly. There is an incipient internal division on the protocone, hinting at the future separation of the hypocone from the protocone. The cingulum is widely interrupted internally. M 1/ is typically rhinocerotic. There is no trace of an internal cingulum, except a small cuspule on the flank of the hypocone near the outlet of the median valley. There is no definite evidence of a crista but the tooth is well worn and a slight swelling may indicate that one was present in the unworn tooth. There is a well defined external cingulum on the metacone. M 2/ is also rhinocerotic. It has a small crista. The only trace of an internal cingulum is that partly blocking the median valley. M 3/ shows a marked advance over any known member of the Hyrachyidæ in reduction of the parastyle and in the tendency to flatten out the posterior extension of the ectoloph, which, however, is still large. It is more advanced than *Prothyracodon* in the former character. It resembles *Triplopus* in the shape of the posterior buttress and post-fossette, and in the complete absence of an internal cingulum, differing from *Prothyracodon obliquidens* in both these characters.

This form might be mistaken at first glance for *Hyrachyus,* to which genus it was previously referred. It is more like *Prothyracodon obliquidens,* and still more like *Triplopus grangeri.* It shows little real resemblance to *Metahyrachyus bicornutus* Troxell, from which it differs in the less precocious P 4/, the greater reduction of the parastyles, and the ridge-shaped posterior extension of the ectoloph, instead of the more cuspidate type found in the Hyrachyidæ. It is not placed in the genus *Triplopus,* on account of its still closer resemblance to *Eotrigonias rhinocerinus* (fig. 17) in the shape of P 4/, the reduction of the parastyles of M 1/ and M 2/, and the almost exact identity in size. It fulfills all the requirements, so far as its fragmentary condition shows, for ancestry to *Eotrigonias rhinocerinus* and all later true rhinoceroses.

The level of this specimen was recorded as "Middle Washakie," before the stratigraphy of that formation had been cleared up by Granger (1909). Dr. W. D. Matthew states (verbal communication) that considering the matrix and the ideas on stratigraphy current at the time the specimen was collected, it is probably from the Lower Washakie of Granger, equivalent to the Upper Bridger of the standard continental section.

Eotrigonias petersoni differs from *Triplopus* in its larger size, the incipient internal division of the protocone and the character of the metaloph of P 4/, and in having less reduction of the crista in the molars. If it is correctly assigned to *Eotrigonias*, it also differed in other special characters of that genus, besides those visible on P 4/–M 3/. The absence of an internal cingulum and the general shape of the posterior buttress of M 3/ are approximated in *Triplopus grangeri.* The internal cingulum, however, shows a still closer resemblance to *Eotrigonias rhinocerinus;* and the difference in the specialization of M 3/ is not more than could reasonably be expected in an Upper Bridger ancestor of the Uinta species. The general morphological resemblance to *Triplopus* may well be, in part at least, due to parallelism. It differs from *Epitriplopus uintensis* in the proportions of M 1/ and M 2/, its more primitive M 3/ and its earlier geological level.

Eotrigonias petersoni differs from *Prothyracodon obliquidens* in its earlier geological level, its larger size, in the incipient internal division of the protocone of P 4/, in the almost entire absence of an internal cingulum on P 4/–M 3/, in the greater reduction of the parastyle of M 3/, and in the greater primitiveness of the posterior buttress of M 3/.

The assumption here made of a tetradactyl manus is utterly without direct proof, but the extraordinary resemblance of this species to *Eotrigonias rhinocerinus* is so striking, except in the character of M 3/, that it seems out of the question to refer it to either *Triplopus or Prothy-*

racodon. It certainly does not belong to *Hyrachyus,* nor to the Hyrachyidæ. It might be difficult to separate it generically from *Triplopus,* except for the strong probability that it is definitely on the true rhinoceros side of the fence, that P 2/ was very different, and that the manus was tetradactyl. Whether the front teeth already show rhinocerine affinities is much more doubtful, but it seems likely that already I 1/ and I /2 were specialized in the direction of their future lines of progress, and that the canines were no larger than the third incisors.

A. M. N. H. No. 19231, consisting of left P 3/—M 3/ and the right femur, collected by Mr. Miller of the Expedition of 1922 from horizon B3, Bridger, Cottonwood Creek, Bridger Basin, Wyoming, may belong to this species. Its general appearance would warrant this reference. Unfortunately, every diagnostic character that would definitely settle its affinities as between *Eotrigonias* and *Hyrachyus* was destroyed, apparently in shipment. There are internal cingula on P 3/–M 2/. There is a collector's note that the specimen had a peculiar M 3/, which is suggestive of *Eotrigonias petersoni,* rather than of any hyrachyid. This is of importance only as a plausible suggestion of a possible downward extension of the range of *Eotrigonias.*

Eotrigonias rhinocerinus, new species Pl. 4, figs. 17, 18, 19

The holotype, Y. P. M. No. 13331, was collected by Messrs. Smith and Heisey, August 8 or 9, 1874, near the mouth of Lake Fork, in the Uinta Basin. It was mixed, perhaps in unpacking, with fragments of *Hyrachyus* sp., including right M /2–M /3, and with left P /3–M /2 of *Homogalax uintensis* Troxell.[1]

[1] With the specimen are two separate field labels: "Rare Lake Fork Aug 8th / 74 J Heisy" and "Very Rare Lake Fork Aug 9th / 74 Sam Smith." The corresponding part of Smith's report to Marsh is as follows:

"Sept. 1874.

Catalogue of Fossils from Lake Fork uintia valley

Aug.	1st	Very Rare Du Shien near the mouth [= Du Chesne]						
"	8th	gar Pike near the mouth Lake Fork 15 miles south of [south-west] agency [= Uinta Indian Agency]						
”	”	Rare	”	”	”	”	”	
”	9th	Very Rare	”	”	”	”	”	”
”	”	” ”	”	”	”	”	”	”
”	”	Crocodile	”	”	”	”	”	”

I ?/?, C ?/?, P 4/?, M 3/3. The paracone and metacone appear as well-defined ribs on the lateral aspect of P 2/–M 3/. The internal cingulum is complete on P 2/ and P 3/, interrupted on P 4/, and absent on M 1–3/. P 1/ is represented by part of the alveolus. It was probably of fair size. P 2/ is the most advanced premolar, with the protoloph and metaloph pretty well separated from each other. The protoloph is not yet firmly attached to the paracone and slants slightly more to the rear than in the Oligocene forms. The hypocone was a conical cusp, with the metaloph attached to the anterior end. The tooth is subquadrate, as in the true rhinoceroses, not subtriangular, as in *Prothyracodon* and *Triplopus*. In general this tooth shows a close approach to the more primitive Oligocene rhinoceroses. In P 3/ the protoloph and metaloph are confluent, with an internal groove incipiently separating the hypocone from the protocone, much as in *Trigonias osborni* (fig. 24). The tooth is sufficiently worn so that it is impossible to state definitely whether the outlet of the median was posterior or internal. On right P 3/ the cingulum is very briefly interrupted internally; it is uninterrupted on left P 3/. In P 4/ the protoloph swings around posterior to the metaloph, which is in contact with it. There is a posterior outlet for the median valley, as in

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Fossils are very Scarce in this Country and very Rotton.

. . . .

Sept. 20th

Yours Very Respct
Sam'l Smith"

From August 19–23 they collected from the White River near the mouth, and from September 1–17, from "Loan" Tree, Henry's Fork, Bridger Basin, Wyoming. There seems, therefore, absolutely no reason to doubt either the Uinta age or the geographic locality of the fossils. Two subsequent rough labels state "Wyoming," but these can be disregarded.

This would seem to be one of the few cases when the rather frequent diagnosis of one of the early collectors, that the fossil was very rare, had eventually turned out to be correct.

This specimen had been tentatively identified as *Hyrachus bairdianus* and later as *Hyrachus affinis*.

many of the Oligocene rhinoceroses. Its protocone is notched internally also, much as in *Trigonias osborni.* On M 1/–M 3/ the only trace of the internal cingulum is the small shelf at the outlet of the median valley. There is no trace of a crista, but M 1/ and M 2/ are sufficiently worn so that this is no proof of its absence, especially as regards M 1/. The parastyles are reduced to their proportions in Oligocene true rhinoceroses. M 1/ and M 2/ are typical primitive rhinoceros molars. M 1/ has a well-defined external cingulum on the metacone. M 3/ is scarcely more primitive than some specimens of *Trigonias osborni* (fig. 23), the posterior extension of the ectoloph being a swelling rather than a ridge. Rudiments nearly as well defined occur in various American Oligocene rhinoceroses, and in the third left upper molar of *Baluchitherium grangeri.* In *Eotrigonias rhinocerinus* this structure is present on both sides, about equally well defined. The post-fossette is prominent, due to the enlarged base of the posterior buttress, together with a well-developed posterior cingulum. The lower molars are similar to those of Oligocene true rhinoceroses. The posterior cingulum of M /3 is reduced to very small proportions.

The specimen consists of left P 2/–M 3/, right P 3/–M 3/ (all damaged except M 3/), and part of each ramus of the lower jaw, containing M /1–3. There are also a few *Hyrachyus* lower cheek teeth, a few doubtful fragments, and P /3–M /2 of *Homogalax uintensis.* Fortunately, there is no question of the association of the teeth of the type. The upper teeth are identical on both sides, and the occlusal relations, the algebraic sum of the original size and pattern, and the subsequent wear, are exact.

There is some resemblance to the Hyrachidæ in the external ribbing of the upper cheek teeth. On the other hand, slight changes—obliteration of the trace of the posterior buttress, and increase in size, would give *Trigonias.*

Although this form is still near the parting of the ways, it is definitely on the true rhinoceros side of the line. This is emphasized by both its resemblances to, and its advances on, *Eotrigonias petersoni.*

On the basis of Koch's inadequate figures of a badly damaged specimen, it is difficult to separate this form, generically, from *Prohyracodon orientale* Koch. The measurements are very similar. On the other hand, it seems very unsafe to refer an American form to a Transylvanian genus on such tenuous grounds. It differs from *Prohyracodon orientale* in the presence of a probably rather more pronounced rudiment of the posterior extension of the ectoloph of M 3/. Both species have a posterior cingulum on M 3/. Other characters are difficult to detect, owing to the damaged character of the type of *Prohyracodon orientale,* but the following are apparent differences: the much shorter length of P 3/ and P 4/ in the American form, and the much greater length of M 2/ in the European form, which, in this character, approaches *Epitriplopus uintensis.* If I have interpreted Koch's figures correctly, both P 3/ and P 4/ of *Prohyracodon orientale* are more advanced than P 4/ of *Prothyracodon obliquidens* or even P 3/ and P 4/, respectively, of *Eotrigonias rhinocerinus,* in a greater tendency toward separation of the protoloph and metaloph.

Eotrigonias rhinocerinus differs from the type of *Prothyracodon intermedium* (P. U. No. 10,403), in the greater size, absence of an internal cingulum around the protocones of the upper molars and its interruption, internally, on P 4/, and in the presence of an incipient internal groove on the protocone of P 4/.

Eotrigonias rhinocerinus differs from the type of *Prothyracodon obliquidens* (P. U. No. 10,402) in having a much longer tooth series.

It differs from *Epitriplopus uintensis* in having a metaloph less recurved posteriorly on M 2/, and in having M 1/

and M 2/ of normal proportions.

The two new forms, *Eotrigonias petersoni*, and *Eotrigonias rhinocerinus* compare so exactly, not only in the characters mentioned, but in the impression due to the sum total of their characters, with *Trigonias* and the true rhinoceroses, rather than with the Eocene hyracodonts, that I feel no hesitation in assigning them to the Rhinocerotidæ, even in advance of any knowledge of their front teeth or fore-feet. *Eotrigonias rhinocerinus* will probably be found to have four digits in the manus, and the full placental complement of teeth, with the canines no larger than the third incisors and 1 1/ and 1 /2 enlarged to form the tusks. *Eotrigonias petersoni* should also prove to be tetradactyl, and its front teeth should prove to be less specialized.

Eotrigonias rhinocerinus is perhaps already a shade too far advanced to have given rise to the *Trigonias* line. The general resemblance, however, is so great, that it seems rather probable that they are more closely related than by common descent from *Eotrigonias petersoni*, and that the split had occurred not long before.

Eotrigonias rhinocerinus shows a striking morphological resemblance to *Hyracodon petersoni*. The chief differences that can be stated definitely in words are the absence of a cingulum, internally, on P 4/, and the greater reduction of the posterior buttress of M 3/, in the former. However, in many minutiæ, *Eotrigonias* suggests *Trigonias*, whereas the hyracodont affinities of *Hyracodon petersoni* are unquestionable.

Prohyracodon Koch 1897

A small true rhinoceros, from the "Middle Eocene" of Transylvania. None of the premolars are molariform. In M 3/ the ectoloph and metaloph are almost completely confluent, with little trace of the posterior extension of the ectoloph.

This genus is based on *Prohyracodon orientale* (Koch) 1897.

The generic name is based on what is almost certainly a misconception of its relationships. The name is unfortunate, especially as it is easily confused with *Prothyracodon* Scott and Osborn 1887, which really is a member of the Hyracodontidæ.

Prohyracodon orientale (Koch) 1897.
Prohyracodon orientalis Koch. Koch, 1897.
Prohyracodon orientale (Koch). Abel, 1910.

A small rhinoceros from the "Middle Eocene" of Transylvania. [The Eocene age of this form has been questioned by Stehlin, and Abel (1910). A recent letter from the Hungarian Geological Survey states that, so far as they know, Koch's determinations are still valid. Prof. J. J. Galloway of Columbia University has interpreted the lists of fossil invertebrates that overly and underly the level from which *Prohyracodon* comes as being Lutetian and Ypresian, respectively. This would indicate, for *Prohyracodon*, an age about equivalent to lower middle Eocene.]. The animal is slightly smaller than *Hyracodon*. Length of M 1–3/ is 50 mm. (fide Koch). In P 3/ and P 4/, the protoloph and metaloph form a single V-shaped ridge, incipiently separated by a small notch at the apex. The internal cingulum is complete on P 3/, obscure in the figure of P 4/, absent on M 1–3/. The internal cingulum on M 2/ in Abel's reproduction of Koch's figure is apparently due to misinterpretation. The posterior buttress of M 3/ seems to be nearly lost.

Further comparison of Koch's type with *Epitriplopus* and *Eotrigonias* would be desirable. A new drawing of his type is essential.

In the table of measurements that follows, as well as in the other tables throughout this paper, I am responsible for all measurements unless the contrary is explicitly stated. Even where measurements had been published previously, it seemed desirable to obtain strictly comparable measurements. Wherever possible, measurements from both sides of the animal are given, to serve as a check on each other, and to indicate the very large amount of variation possible in the individual, thereby giving the minimum range of variation for the species. All measurements are in millimeters.

The genus *Trigonias* is in need of revision. Lucas' original description of the genus (1900), based on rather scanty material, lacks figures or description of the cheek teeth; and valuable new material, collected since Lucas (1900) and Hatcher (1901) discussed this genus, is still undescribed. This very primitive true rhinoceros furnishes an excellent starting place for an attempt to reconstruct the phylogeny of the later forms. It is, therefore, possible to give, with more certainty than previously, the generic characters of *Trigonias* as well as the specific characters of *Trigonias osborni*. The definitions of Lucas, Hatcher and Troxell for this genus and of the various authors for the other genera and species discussed have been so much modified that it seems best to present them without quotation marks or asterisks.

Trigonias Lucas 1900

Genoholotype: *Trigonias osborni* Lucas, U. S. Nat. Mus. No. 3294. Locality: South Dakota. Age: Titanotherium Beds (Chadron Formation).

The skull is elongated, chiefly anterior to the orbit. The premaxillæ are very closely appressed and may be more or less suturally connected. The nasals and premaxillæ are very long. Hornless. I 3/3, C 1–0/0, P 4/4, M 3/3. The front teeth, except I 1/ and I /2, are nearly functionless. P 1/ is large for a first premolar and P 3/ and P 4/ are never fully molariform, their hypocones being principally attached to the protocones. The frequent presence in *T. osborni* of a posterior buttress (the remains of the posterior extension of the ectoloph) on M 3/ tends to unite this genus, through *Eotrigonias*, with the other lines, breaking down one of the chief family distinctions. In *Trigo-*

Table I a

(d= deciduous) (e= estimated)	*Eotrigonias rhinocerinus* Holotype Y.P.M. 13331		*Eotrigonias petersoni* Holotype A.M.N.H.2341	*Prohyracodon* [illegible] Holotype ([illegible] greatest length and breadth)		*Triplopus cubitalis* [illegible] A.M.N.H.5095		*Triplopus* [illegible] Holotype A.M.N.H. 1972		*Triplopus* [illegible] C.M. 3110	*Triplopus* [illegible] C.M. 2538
	R.	L.	L	R.	L.	R	L	R.	L	R	L
Across Zygoma											
Pmx to Condyle											
Nasals to occipital crest											
Height occiput above condyle						25.0	34.3				
Width between P2's						15.7					
Width between M2's						---	—				
P1 - M3											
P2 - M3	--	79				---	—				
P1 - 4	--	—				d27.7	d29.[illegible]				
P2 - 4	--	32				---	20.[illegible]				
M1 - 3	49	47	49.0	50	49	32.0	---		40.0		
Diastema	--	—				12.0	---				
Length P1	--	—					5.0				
Width P1	--	--					3.2				
Length P2	--	10				---	5.[illegible]				
Width P2	--	11				---	5.3				
Length P3	e10	1[illegible].5			[illegible]	---	7.[illegible]			[illegible]	[illegible]
Width P3	--	14			[illegible]	—	7.[illegible]			[illegible]	[illegible]
Length P4	11.7	11.4	11.4		[illegible]	—	[illegible]		[illegible]	[illegible]	[illegible]
Width P4	16.3	16.4	15.[illegible]		[illegible]	—	[illegible]		11.[illegible]	[illegible]	[illegible]
Length M1	16	14.6	14.6	16		[illegible]	[illegible]		[illegible]	—	—
Width M1	17.6	17.5	17.[illegible]	17		[illegible]	[illegible]		[illegible]	—	[illegible]
Length M2	--	16.6	17.3		[illegible]	[illegible]	[illegible]	14.4	14.[illegible]	[illegible]	[illegible]
Width M2	—	19.5	18.7		[illegible]	12.4	---	[illegible]	[illegible]	-	13.[illegible]
Length M3	17.2	17	17.5			[illegible]	---	[illegible]	[illegible]	[illegible]	13.[illegible]
Width M3	19.6	19.1	18.3	20		[illegible]	—	[illegible]	[illegible]	—	13.9

Table I b

(d = deciduous) (e = estimated)	[illegible] [illegible] [illegible]		P. obliquidens ? or P. grangeri ? C.M. 3201	Prothyracodon intermedius Holotype P.U. 10403	Prothyracodon obliquidens Holotype P.U. 10402		Prothyracodon obliquidens A.M.N.H. 1971		Hyracodon petersoni Holotype C.M. 3572	
				L	R	L	R	L	R	L
[illegible]									--	--
[illegible]			2830						--	--
[illegible]									--	--
[illegible]									--	--
[illegible]									--	--
Width between [illegible]									--	--
[illegible]			[illegible]				68.9		--	95.7
[illegible]									53.8	--
[illegible]	[illegible]		[illegible]				28.1		--	45.0
[illegible]	--	41.8	43.[illegible]				41.0		--	42
[illegible]	--	--	13.[illegible]						--	16.0
Length P1	--	--							10.7	--
Width P1	----	--							11.0	--
Length P2							7.6		--	13.6
Width P2							9.0		15.4	15.2
Length P3							8.6		--	14.4
Width P3							--		--	18.5
Length P4				10.4			10.3	10.0	15.5	14.7
Width P4				13.7			12.5	12.6	20.8	20.6
Length M1	15.5	14.8		13.2					17.3	17.3
Width M1	16.5	18.0		15.3					20.2	20.2
Length M2	17.5	17.5		15.2					19.1	18.5
Width M2	20.0	18.8		16.5					22.4	21.7
Length M3	--	13.7 +		—	15.1	14.9	13.5	13.4	--	16.2
Width M3	--	e17.8		—	18.4	18.8 +	15.0	15.1	--	22.1

(d =dec
(e = est

A - P
A - P
A - P
A - P
Diasten
Length
Length
Length
Length
Length
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Depth r
below
Depth r
below
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Width F
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Width
Length
Width F
Length
Width I
Length
Width
Length
Width I
Length
Width

Table II

(d = deciduous) (e = estimated)	*Eotrigonias rhinocerinus* Holotype Y.P.M. 13331 R	L	*Triplopus cubitalis* Holotype A.M.N.H. 5095 R	L	*Triplopus cubitalis* A.M.N.H. 2344 R	*Triplopus grangeri?* C.M. 3110 L	*Triplopus grangeri* Holotype A.M.N.H. 1972 R	L	*Epitriplopus uintensis* Holotype C.M. 3007a R	L	*Epitriplopus uintensis* C.M. 2990 L	Prothyracodon? obliquidens? C.M. 3201	*Prothyracodon obliquidens* Holotype P.U. 10402 L	*Prothyracodon obliquidens* A.M.N.H. 1971 R	L
A - P I_1	---														
A - P I_2	---														
A - P I_3	---														
A - P C_1	---										8.4				
Diastema			14.5	11.7+	16.0						19.5	19.7	12.4		
Length of Symphysis			16.8+		33.0						48.2		33.7		
Length P_1 - M_3	---		---	---		71.4			------				75.8		e 70.0
Length P_2 - M_3	---		---	---					------			71.0	72.3	57.3	e 69.0
Length P_{1-4}	---		---	---					------				34.5	---	27.0
Length P_{2-4}	---		---	d 26.0		27.8			------			28.8	30.3	26.3	26.1
Length M_{1-3}	50.5	49	---	---	36.0	43.8	40.4		------			43.5	42.6	41.3	---
Depth ramus below P_2	---	---	14.6	14.1	15.4	18.7			------		24.0	18.8	20.0	19.4	19.0
Depth ramus below M_2	35.5	33.2	16.1	16.1	e 20.0	23.7	21 +		------			29.6	e 27	---	---
Length P_1	---		---	---	5.2				d? 5.8				---	-	1.7
Width P_1	---		---	---	2.5				d? 2.6	---			---	---	1.8
Length P_2	---		---	---	7.2	8.7			-------				7	6.8	6.2
Width P_2	---		---	---	3.2	5.0			-------				---	---	---
Length P_3	---		---	---	---	9.2			-------				10.5	10.0	10.0
Width P_3	---		---	---	---	6.5			------				---	5.7	6.0
Length P_4	---		---	---	9.4	---			-----				11.5	10.5	10.0
Width P_4	---		---	---	6.0	---			------				---	6.7	6.5
Length M_1	15.3	15.4	9.8	9.6	10.0	13.0	12.3		15.8	16.0			e 13.4	12+	---
Width M_1	9.6	10.0	7.2	6.5	7.5	6.9	8.0		10.6	10.5			---	---	8.0
Length M_2	17.3	17.2	11.0	11.2	12.0	14.0	14.2	14.4	16.7	e 16.0			e 14.5	12+	14.4
Width M_2	10.3	10.3	7.3	7.3	8.3	9.8	9.0	9.0	11.3	11.0			10.0	--	9.0
Length M_3	18.3	17.7	---	---	14.3	16.4	14.5	15.4	------				15.7	14.7+	14.5
Width M_3	10.2	10.5	---	---	7.3	9.5	9.6	9.0	------				9.4	---	---

nias, as in all other rhinoceroses except the hyrachyids, the paracone and metacone are completely fused to form the ectoloph, and the parastyle is plastered on the paracone, in wide contrast to the well-marked separate cusps in *Hyrachyus.* The manus is tetradactyl, digit V being rather smaller, proportionately, than in the tapir.

I follow Lucas and Hatcher in identifying the only constantly missing tooth in *Trigonias* as C /1 rather than I /3. This may be erroneous (see above) but is probably correct.

Hatcher's idea of the excessive elongation of the skull in *Trigonias* was somewhat exaggerated. It was founded on the crushing and distortion of Carnegie Museum No. 95 (No. 96).

Trigonias osborni Lucas 1900 Pl. 5, figs. 20–28

Trigonias osborni Lucas. Lucas, 1900.
Trigonias osborni Lucas. Hatcher, 1901.
Cænopus platycephalus nanolophus Troxell ? Troxell, 1921a.
Trigonias tetradactylum Osborn. Osborn, 1923b.

I 3/3, C 1/0, P 4/4, M 3/3. The incisive foramen is large. The premaxillaries are closely appressed but not really suturally connected in the type specimen. None of the upper premolars are yet submolariform. The hypocone of P 2/ is well developed but still widely confluent with the protocone. There is no hypostyle on the upper premolars. On P 3/ and P 4/ the protocone and hypocone are absolutely confluent well above the cingulum, and the median valley escapes posteriorly, until, after prolonged wear, it becomes an enclosed basin, due to the confluence of the hypocone and the metaconule. There is little or no trace of an internal groove on P 3/ and P 4/ to separate the protocone and hypocone. There is little or no trace of an internal cingulum on M 1–3/. The ectoloph and metaloph of M 3/ form a very wide obtuse angle. There is a well developed posterior cingulum on M 3/ and usually a small posterior buttress, the remains of the posterior extension of the ectoloph, which recalls the condition in *Eotrigonias,* the hyracodonts and even *Hyrachyus*. The lower premolars are increasingly molariform posteriorly. P /4 is virtually molariform except that an extension of the entoconid as a low cingulum usually blocks the inner end of the talonid valley. P /3 is well advanced. P /1 and P /2 function mainly as antero-posterior blades. P /2 resembles P/1 in character more than it does P /3. I /2 has a sharp ridge on the median side but is usually smooth or nearly so on the outside. The posterior margin of the nasal incision is vertically above the posterior border of P 2/.

This species, the genotype, was described by Lucas in 1900, being founded on U. S. National Museum No. 3924 (figs. 20 and 21), with U. S. National Museum No. 4815 as paratype (fig. 25). The type is the snout of an old individual with the three incisors, canine, and first three premolars on the right side, the third incisor, the alveoli for the other front teeth, and the first three premolars on the left side. Its only ascription is to the "Miocene" of Washington County, South Dakota. It was presumably collected by Hatcher. Lucas undoubtedly mistook a break for the upper part of the premaxillary-maxillary suture, figured in his original description (1900) and reproduced by Scott (1913).

Lucas' paratype, U. S. National Museum No. 4815, collected by Mr. J. B. Hatcher, 1886, in Washington County, South Dakota, consists of the complete left ramus with all the cheek teeth, and the symphysis, with both incisor tusks, the first incisors being represented by their roots and the third incisors by their alveoli. It is a mature individual, with the teeth well worn. The stage of advancement of the premolars agrees exactly with the other lower jaws ascribed to *Trigonias osborni*. The ridge on the outside of I /2, distinctly less developed than in the other specimens, gives this tooth a character somewhat intermediate between other representatives of *Trigonias osborni* and the lower jaw, A. M. N. H. No. 13226 b, belonging to one of the larger species of *Trigonias* described below; most of the measurements accord closely with the other specimens of *Trigonias osborni,* but the size of the jaw and a few tooth measurements accord more closely with the larger lower jaw mentioned above. The entoconids of P /3 and P /4 are not yet fused with the rest of their posterior crescents but are separate, distinct cusps. It seems best on the whole to refer it tentatively to *Trigonias osborni.*

Hatcher correctly assigned to this species Carnegie Museum Nos. 95 (96), 97, and 98, from the Lower Titanotherium Beds, three miles north of Warbonnet Ranch, Sioux County, Nebraska, collected in 1900 by Messrs. Hatcher and Utterback. He described and figured all these specimens (1901). Carnegie Museum No. 98 may be regarded as the plesiotype. There is a conflict between Hatcher's description and the actual numbering and cataloguing of the specimens. Carnegie Museum No. 97 is, as stated, the lower jaw of a young individual and No. 98 is also correctly referred to. But Hatcher's "No. 96" is the skull actually labeled No. 95 and mounted with the composite skeleton but recorded separately as No. 96 in the catalogue.

Skull No. 95 (96) is nearly complete but much distorted and elongated by crushing. The teeth are greatly worn and several are lost. The following teeth are represented: Right: I 1/, P 2/–M 3/, alveoli of I 2/, I 3/, C 1/, roots of P 1/; Left: I 1/, P 2/, P 4/–M 3/, alveoli of I 2/, I 3/, C 1/, P 3/, roots of P 1/.

Skull No. 98 has more parts actually missing but it is not greatly distorted. P 2/–M 3/ of both sides are present in good condition. The top and front of the skull are restored in plaster (fig. 24, and Hatcher 1901).

The premaxillaries in No. 95 were apparently united in life by a tongue and groove suture, the tongue and groove running obliquely forward and upward along their appressed median surfaces. There was doubtless also a ligamentous connection but the two bones were not coossified.

As restored they are not in contact but this is quite certainly the result of distortion. There is a strongly marked sagittal crest. The individual was old and the teeth are greatly worn. On the right M 3/ of this specimen there is a well marked posterior extension of the ectoloph (fig. 22), somewhat exaggerated in distinctness by a coincident break, and a distinct trace of it on the left side (fig. 23). There is also a very slight trace of it on No. 98 (fig. 24 and Hatcher, 1901). All this suggests the condition in *Eotrigonias,* the hyracodonts and even, less markedly, in *Hyrachyus.* (See Hatcher, 1901, p. 138. He is in error in saying that the metacone is not present in M 3/.) This is a very important character phylogentically and helps to connect the true rhinoceroses with the other rhinocerine lines. The remnant of this posterior extension of the ectoloph is often found in "*Cænopus*" *platycephalus.* A specimen of *Subhyracodon tridactylum,* A. M. N. H. No. 8088, collected from the White River Oligocene of White Buttes, N. D., by Cope in 1883, has this same type of buttress, very well developed, on both M 3/'s, but closer to the mid-line than in the ancestral forms. A possible reversion in this direction (although the buttress is much closer to the midline), appears on the left of M 3/ of a *Menoceras* (*Diceratherium*) in a corner of the Agate Springs Quarry block in the Carnegie Museum, in Carnegie Museum No. 1555 (figured by Peterson, 1920, pl. LVIII), and on the right M 3/ of *Menoceras,* A. M. N. H. No. 14229.

To *Trigonias osborni* must also be referred Carnegie Museum No. 3914a, the symphysis of an old individual with the following teeth present: Right: I /1 (broken off), I /2 (tip lost), I /3 (root), P /1 (broken), P /2–M /1, M /2 (badly damaged); Left: I /1 (stub), I /2 (root), I /3 (stub), P /1 (roots), P /2, P /3, P /4 (damaged). The only interesting features are the unusually long symphysis, the presence of the broken stub of I /3 instead of the alveolus, as is usually the case, and the unusually strong ridge down the antero-inferior aspect of the symphysis.

This species is represented in the American Museum collections by the badly damaged skull of a very old individual, No. 12389, an exchange from the Carnegie Museum, which was collected from the Lower Titanotherium Beds, West Fork of Corral Draw, Washington County, South Dakota, by Mr. J. B. Hatcher in 1901. This furnishes little new information. There is a trace of the posterior extension of the ectoloph on the left M 3/, but none on the right side. There is also part of a lower jaw, American Museum No. 9792 (fig. 26), collected by the Expedition of 1902, in the Titanotherium Beds of South Dakota. This includes part of the right ramus with all the cheek teeth and the symphysis with I /1 and I /2 on each side, as well as the alveolus for I /3 on the right side. This lower jaw is certainly conspecific with that (figs. 27 and 28) described and figured by Hatcher (1901). It is an older individual, as all the permanent teeth are in place. The incisor tusks have a sharper lateral ridge than in other specimens of this species. The occlusal relations of this specimen appear to coincide with Lucas' type upper jaw, tending to strengthen its reference to *Trigonias osborni,* along with the young lower jaw described by Hatcher (Carnegie Museum No. 97).

The mounted skeleton of a specimen of *Trigonias* cf. *osborni* is figured by Cockerell (1923).

Individual Variation in Trigonias osborni

There are considerable individual differences among the specimens included in this species. Lucas' paratype, U. S. N. M. No. 4815 (fig. 25), has an external valley on P /1 between what correspond to the trigonid and the talonid, also seen in an incipient form in Carnegie Museum No. 914a. This is not present in Carnegie Museum No. 97 nor in A. M. N. H. No. 9792 (figs. 27 and 26). A. M. N. H. No. 9792 has an abnormally slender ramus. Carnegie Museum No. 3914a has an unusually long symphysis. I /2 usually has a delicate lateral ridge; in A. M. N. H. No. 9792 this ridge is unusually well defined. There is variation as to whether I 3/ or C 1/ is the larger, whether C 1/ is erect or procumbent, in the degree of reduction of the posterior buttress of M 3/, in the length of the diastemas in both upper and lower jaws, in the crown-length of I /2 (largely a function of wear), and in measurements in general. In certain of these characters there is about as much variation between the two sides of the same animal as between two different animals (see tables of measurements). This is also well shown by the position of the mental foramina. In Carnegie Museum No. 97, it is double on the right side beneath the posterior root of P /2 and the anterior root of P /3. On the left side it is single beneath the anterior root of P /2. This is as great a difference as there is between any two different specimens.

All these differences are distributed in no particular order and are purely individual. The animal most different from the group is A. M. N. H. No. 9792, but its individual differences (perhaps partly a matter of sex) do not seem important enough to require any nomenclatural recognition.

Individual Variation in Living Rhinoceroses

The living African black rhinoceros, *Opsiceros bicornis*, furnishes another measure of the large degree of individual variation possible in a given species of rhinoceros. There are, of course, great differences in tooth pattern, according to the degree of wear. It is sometimes not realized that there may still be seven upper cheek teeth on a side, functioning at one time. There is a fine series of about thirty skulls in the American Museum, and among them, seven (Nos. 34743, 14136, 54124, 54283, 27758, 34739, and 54311) retain d P 1/ on one side after all the other permanent cheek teeth are in use. In No. 54311, d P 1/ is retained on both sides, as well as the right d P /1. In several specimens, especially in subadults, the alveolus of d P /1 is still present.

The first deciduous lower premolar is present in most of the calves. In No. 34741, which has M 2/ partly erupted, both d P /1's are present, and small alveoli occur for d I /1 and d I /2, the alveolus for d I /2 being much the larger. The deciduous premolars are retained, except that d P /2 has been lost and P /2 is erupting. In No. 27754, with M 1/1 in place, all d P 1/1's are retained and there is a small alveolus for right d I /2, with left d I /2 just cutting the gum. In No. 27759, a still younger calf, with all the deciduous premolars in place and with the first upper and lower molars just erupting, the alveoli of right d I /1, d I /2, and left d I /1 are present, and left d I /2 is present, barely cutting the gum.

In a calf of *Rhinoceros unicornis*, A. M. N. H. No. 70445, with all the deciduous premolars in place and M 1/1 not yet above the level of the gum, alveoli of left d I /1 and both d I /2's are present, with right d I /1 in place, barely cutting the gum.

All this is another illustration of the amount of individual variation possible, and of the danger of using the presence or absence of a tooth which is in process of being lost, as a definite criterion of specific distinction, still less as a proof of generic distinction.

Professor Osborn has pointed out (verbal communication) the presence of a small roughening of the skin over the frontals, in a specimen of *Rhinoceros unicornis,* A. M. N. H. No. 54456, which would indicate that a very small horn had been present, corresponding in position to the frontal horn of *Opsiceras.* The alternative interpretations of such a condition—parallel mutations in forms with similar genetic constitution, or reversion to an ancestral condition—are obvious. Conversely, Lydekker (1907) mentions the photograph of a fresh-killed full-grown white rhinoceros showing the posterior horn reduced to a scarcely noticeable nubbin, and quotes Selous to the effect that the posterior horn is sometimes a mere lump two or three inches high. It may be questioned whether the number of horns always has the great phylogenetic significance that is usually attributed to this character.

Trigonias, undescribed species ? near **Trigonias osborni**

A. M. N. H. No. 12308, collected from the Titanotherium Beds, Indian Creek, near the Cheyenne River, South Dakota, by Mr. Albert Thomson in 1904, a jumble of unassociated fragments of various animals, includes the second right upper incisor and the fourth left upper premolar of a member of the genus *Trigonias* (fig. 37). The incisor shows nothing new but the premolar is much more advanced than any specimen of *Trigonias osborni* I have seen; for although it is inside the range in size of specimens of *Trigonias osborni,* the hypocone is a separate, conical cusp, attached to the protocone at the base and separated from the metaconule by a wide deep valley.

This tooth shows just the characters that would lead to the second of the two new species of *Trigonias* described below. It probably represents a valid species but it seems better to leave it to be named from some more complete specimen.

Trigonias wellsi, new species Pl. 6, figs. 32, 33, Pl. 7, fig. 34.

The holotype is A. M. N. H. No. 13226 (1). This animal is a third larger than *Trigonias osborni.* I 3/?, C 1/?, P 4/?, M 3/?. The canine is larger than the third incisor. None of the upper premolars are anywhere near **molariform.** The metaloph is incomplete on P 2/. The hypocone on P 2–4/ is merely a bud on the protocone, the two cusps being fully confluent, with an internal notch. The median valley opens widely, posteriorly. A well developed hypostyle is present on P 2/ and P 3/ of both sides, and on left P 4/, but is absent on right P 4/ (fig. 33). The presence of a hypostyle as a free cusp (not as an up-growth of the cingulum), which is otherwise unrecorded among rhinoceroses, living or fossil, bars this species from ancestry to any other known form. The pattern of P 1/ is almost obliterated by wear but what is left indicates a pattern identical with the second new species of *Trigonias* described below. A weak internal cingulum is present on all the molars. The ectoloph and metaloph of M 3/ form a straight line. The posterior cingulum of M 3/ is reduced. The post-glenoid and post-tympanic processes are well separated below the external auditory meatus.

This species is founded on a skull, without lower jaw, of an old individual, A. M. N. H. 13226 (1), with which parts of the skeleton are doubtfully associated. This specimen was collected in the Upper Titanotherium Beds, Corral Draw, in the Big Badlands of South Dakota, by Mr. H. F. Wells in 1906, for whom the name is given.

The first and third left incisors, both canines, what is apparently the left deciduous canine abnormally retained to old age, and all the cheek teeth are present. There is also associated a loose first right upper incisor, which may have dropped out of this specimen. If so, it must have done so after death but before fossilization, since the alveolus is filled with completely consolidated matrix. The position and size of the other front teeth are indicated by their alveoli. Since *Trigonias wellsi* is so much larger than *Trigonias osborni* the virtual identity in size of I 1/ is somewhat surprising. The cheek teeth are badly worn but much of the pattern can still be determined. There is an incipient antecrochet on left P 3/. There is nothing very striking about the molars except their large size for so early a form. There is a small, more or less defined tubercle in the valley of M 3/. The roof of the skull is completely lost.

As P 2–4/ of *Trigonias wellsi* are more primitive than the corresponding teeth of *Trigonias osborni,* or even of *Eotrigonias rhinocerinus,* it seems most probable that the

Trigonias line separated from the *Eotrigonias* line before the *E. rhinocerinus* stage, and that the *T. wellsi* line separated from the *Trigonias* stock before the *T. osborni* stage.

Trigonias gregoryi, new species Figs. 39 and 40

The holotype is A. M. N. H. No. 13226a. This form is almost as large as *Trigonias wellsi.* I 3/?, C 1/?, P 4/?, M 3/?. The upper canine is larger than the third incisor. The pattern of the P 1/'s is similar to that of the paratype of "*Cænopus*" *platycephalus,* figured by Osborn (1898, Pl. XIII, fig. 9). Upper premolars 2–4 are very progressive for *Trigonias,* bearing more resemblance to "*Cænopus*" *platycephalus* than to either of the other two species of *Trigonias,* or to any other hitherto known form. There is no hypostyle on the upper premolars. P 2/ is virtually molariform, with a complete metaloph which is separate from the protoloph down to the level of the cingulum. P 3/ and P 4/ are also progressive, although less advanced than P 2/. The hypocone of P 3/ is nearly independent of the protocone but is not completely joined to the metaconule. It is more advanced in both respects, however, than either *Trigonias wellsi* or *Trigonias osborni.* The metaloph is almost complete on the right P 4/ but much less so on the left P 4/, where the hypocone is rudimentary. There is what appears to be an antecrochet on the right P 4/. This is an unprecedentedly early appearance for this structure. The molars have no internal cingulum. The ectoloph and metaloph of M 3/ form a straight line. The posterior cingulum of M 3/ is well developed. The posterior margin of the nasal incision is vertically above the anterior border of P 2/.

This species is founded on the skull of a young adult, A. M. N. H. No. 13226a, without the lower jaw, with doubtfully associated parts of the skeleton, which was collected in 1906 by Mr. H. F. Wells from the Upper Titanotherium Beds, Corral Draw, Big Badlands, South Dakota. The specific name is given in recognition of Professor William K. Gregory. The left canine, all the cheek teeth, and the alveoli of the other front teeth, are present. The rear half of the skull is badly mutilated, especially on the right side, where it is largely missing. There is nothing striking about the molars except their large size for a lower Oligocene true rhinoceros. There is a very poorly defined tubercle in the valley of M 3/. The cheek teeth are in somewhat the same stage of evolution as those of *"Leptaceratherium" trigonodum*. They are, however, very much larger, and P 1/, P 3/, and P 4/ are less advanced toward the molar pattern.

Trigonias gregoryi, especially in the progressiveness of P 2/, tends to break down the clear distinction between *Trigonias* and the later forms, usually referred to *Cænopus*, as this name was used by Troxell (1921a). In the totality of its characters, however, it resembles *Trigonias* more than any of the later forms. The presence of this intergrading form certainly is no reason for abandoning the otherwise valid genus *Trigonias*—unless for a believer in special creation.

Trigonias gregoryi ? Wood Pl. 6, fig. 38.

I ?/3, C ?/0, P ?/4, M ?/3. The erupting permanent incisor tusks resemble those of the later Oligocene rhinoceroses in being ridged on the median side only, as in some specimens of *Trigonias osborni*, rather than the other specimens with external ridges as well. I /2 procumbent. P /3 and d P /4 are molariform, P /2 nearly so. P /2 resembles P /3 more than it does P /1. P /1 is nearly as advanced as P /2 of *Trigonias osborni*. P /2 and P /3 are much further metamorphosed than the corresponding teeth of *Trigonias osborni*. The basal cingulum of P /2 and P /3 surrounds the posterior crescent, both behind and internal to it, lapping over on the metaconid.

This description is based on a complete lower jaw, 13226 b, of a young individual, collected from the Upper

Titanotherium Beds in Corral Draw, Big Badlands, South Dakota, by Mr. H. F. Wells in 1906. The first and third incisors are represented by alveoli only, the permanent second incisors are partly erupted, the first premolars are in place, the second and third permanent premolars are erupting, the greatly worn fourth deciduous premolars are still in place, the first and second molars are in place and the erupting third molars are still well below the level of the gum.

This form is too large and too progressive to be referred to *Trigonias osborni*. It is difficult to refer it with any assurance to either *Trigonias wellsi* or *Trigonias gregoryi*. It is also possible, though not at all likely, that it represents still a third species. The mode of fossilization is the same as the type of *Trigonias gregoryi* and it was regarded by the collector as the lower jaw belonging with the skull. It cannot be the same individual, however, as shown by the occlusal relations and especially by the considerable wear of the upper molars of the type of *Trigonias gregoryi*, since M /1 and M /2 of this lower jaw are absolutely unworn. Judging from the occlusal relations of the first and second molars, this individual when fully grown would have been appreciably larger than the type of *Trigonias gregoryi* and, apparently, slightly larger than the type of *Trigonias wellsi*. It would, however, have been well inside the probable range of variation in size of either species, even using the narrow limits of specific variability permitted by modern systematic zoologists.

I assign it provisionally to *Trigonias gregoryi*, since the premolars show more advance over those of *Trigonias osborni* than would be expected in the lower premolars of *Trigonias wellsi*, judging by the stage of evolution of the upper premolars of *Trigonias wellsi*.

Perhaps associated with this lower jaw there is a left first upper incisor with enough of the premaxillary bone adherent to prove that it was part of still a third skull.

The tooth is somewhat damaged. The measurements are as follows:

Crown length	13.0 mm.
Antero-posterior	18.0 mm.
Transverse	10.5 mm.

The American Museum specimens which have just been described as *Trigonias wellsi, Trigonias gregoryi,* and *Trigonias gregoryi ?,* are all parts of an associated find, including parts of at least five individuals, from the Upper Titanotherium Beds, according to the original correspondence of the collector, Mr. H. F. Wells. They were provisionally catalogued as two skulls and a large part of the skeletons of a new species of *? Trigonias.*

Trigonias paucidens, new species Pl. 6, fig. 35, Pl. 7, fig. 36.

The holotype is A. M. N. H. No. 11865, a skull without the lower jaw, from the Lower Titanotherium Beds of Quinn Draw, Big Badlands, South Dakota, collected by Mr. H. F. Wells in 1903. It was provisionally catalogued as *Cænopus platycephalus,* and has only now been sufficiently prepared and reinforced to be available for study. The skull belonged to a fairly old individual, since the pattern is nearly obliterated on P 1/–P 3/ and on M 1/.

I 3/?, C 0/?, P 4/?, M 3/?. The skull is a shade larger than any measured specimen of *Trigonias osborni.* It is appreciably smaller than the other species of *Trigonias,* or than *"Cænopus" platycephalus.* I 2/ is larger than I 3/. None of the cheek teeth has an external cingulum. The pattern of P 1/–P 3/ is nearly obliterated by wear, but it must have been much like *Trigonias osborni.* There is a strong internal cingulum on P 2/–P 4/. The pattern of P 4/ is indistinguishable from that of *Trigonias osborni.* The upper molars have no internal cingulum, except a trace across the median valleys of M 1/ and M 2/. M 3/ is inside the range of variation of *T. osborni,* having a very faint trace of a posterior buttress and a well-developed post-fossette.

Right I 1/ and left I 1/ and I 2/ are represented by their alveoli, only. These teeth presumably dropped out after the death of the animal. Left P 3/ and P 4/ are also missing, but were almost certainly lost during life, as there was apparently some deposition of bone in their alveoli. Right P 4/, left M 2/ and left M 3/ each have a slight pit at some point on the occlusal surface, which may, perhaps, be due to caries.

On the basis of the loss of C 1/, there would be precedent for erecting this species into a new genus. However, there does not seem to be any necessity for such a step. Except for the lost tooth, it could easily be included in *Trigonias osborni.* If I 3/ instead of C 1/ is the missing tooth, it would seem to approach the definition of *Leptaceratherium;* but, actually, it has little in common with *"Leptaceratherium" trigonodum.* However, the missing tooth is almost certainly the canine. Although the premaxillary suture abuts against the middle of the lateral front tooth, nevertheless this tooth appears, actually, to be set in the premaxillary. Additional confirmation is furnished, by the fact that, in other species of *Trigonias,* this suture runs well anterior to the canine, sometimes coming in contact with I 3/, and by the presence, in the type of *Trigonias paucidens,* of slight pits which may have held the deciduous canines, well behind the last front tooth. Detailed measurements are given below.

Trigonias paucidens was probably very close to the ancestor of *"Cænopus" platycephalus,* if not actually ancestral to it. Troxell's suggestion (1921a) that *"Leptaceratherium" trigonodum* was ancestral to *"Cænopus" platycephalus* seems, at the least, highly improbable, since the former species has lost the first lower premolar (A. M. N. H. Nos. 529 and 1489), which is typically retained in the latter (A. M. N. H. Nos. 542 and 545). The fact that P 3/ of *"Leptaceratherium" trigonodum* is so much more progressive than P 3/ of *"Cænopus" platycephalus* is an objection of still greater weight. On the other hand, *Tri-*

gonias paucidens fulfills all the necessary requirements for the ancestor of "*Cænopus*" *platycephalus.*

Trigonias cf. **osborni** Lucas, or cf. **Trigonias paucidens** Wood.
Caenopus platycephalus nanolophus Troxell. Troxell, 1921a

The holotype, Yale Peabody Museum No. 12489, was collected from the Oligocene of Colorado by Mr. Devendorf. The type consists of right P 1/ and left P 1/–M 3/. Its geological level seems to be entirely uncertain, beyond being Oligocene. It falls right into place as a specimen of *Trigonias osborni,* or, perhaps, *Trigonias paucidens.* It agrees with the other specimens of *Trigonias osborni,* not only in detailed measurements, but in almost every other character. (This resemblance is only partly shown by a comparison of Troxell's figure with mine.) The most striking common characters are the very deep valley, opening posteriorly on P 3/ and P 4/, which is found in all but the most worn specimens of *Trigonias osborni,* and the union of protocone and hypocone on P 2/, although they are separated internally by a deep groove. I am unable to regard the few characters in which it differs from other specimens of *Trigonias osborni* as making it worthy of specific or subspecific distinction. These characters are: the slightly greater length of the molars, especially M 1/, and the fact that the protoloph of P 1/ is nearly perpendicular to the ectoloph, instead of swinging well posteriorly as in the holotype (U. S. N. M. No. 3924). This specimen (Y. P. M. No. 12489) shows just the characters needed for an ancestor of *Trigonias gregoryi.*

Troxell recognized the fact that this form was very different from any other well known form. The unsatisfactory character of the published figures of *Trigonias osborni,* together with the highly dubious assignment of Y. P. M. No. 12489 to the Middle or Upper Oligocene, prevented him from recognizing it closest relationships. The only published figures of the cheek teeth of *Trigonias* were the very badly worn specimens in Hatcher's paper, which suggest slight resemblance to the little-worn teeth of the Yale specimen. And, of course, *"Cænopus" platycephalus* has retained much of its heritage from the *Trigonias* stage. This specimen is more probably referable to *Trigonias osborni* than to *Trigonias paucidens*, in view of the fact that the former species is much better represented, numerically, in the collections. However, strictly speaking, the species is indeterminate, due to the absence of the front teeth, which furnish the only real distinguishing character between *Trigonias osborni* and *Trigonias paucidens*.

Troxell's figure and description are very complete, and furnish a valuable reference specimen—the first not badly worn—for *Trigonias osborni*. The figure is misleading to the extent that there is no posterior hook on the hypocone of P 2/ of the specimen.

An unworn right P 4/ in the Yale Museum, No. 12562, is unquestionably the same form.

In the tables that follow, certain measurements given by Lucas or Hatcher are omitted. The "greatest length of the premaxillaries" is often hard to determine, due to the difficulty in distinguishing sutures from cracks. The "crown length" of I 1/ or I /2 is valueless, since it is dependent on the amount of wear. In various cases measurements are not given when the specimen is so badly damaged or distorted that figures would be valueless or misleading.

The American true rhinoceroses of the middle and upper Oligocene, formerly referred to *Aceratherium* Kaup, 1832, are now usually referred to *Cænopus* Cope, 1880 (Genoholotype, *Aceratherium mite*). If these rhinoceroses are regarded as a single genus, the name *Subhyracodon* Brandt, 1878 (originally including *Aceratherium mite, Aceratherium occidentale* and *Aceratherium quadriplicatum*) must hold for all of them. Matthew implies this (Osborn and Matthew, 1909, and Cope and Matthew, 1915) but does not make the statement explicitly. As *Aceratherium quadriplicatum* was made the type of *Anchisodon*

Table III a

	Trigonias osborni Holotype U.S.N.M. 3924 R	L	*Trigonias osborni* C.M. 96 (95) R	L	*Trigonias osborni* C.M. 98 R	L	*Trigonias osborni* A.M.N.H. 12389 R	L	*Trigonias* sp. indesc. ? A.M.N.H. 12308 R	*Trigonias wellsi* Holotype A.M.N.H. 13226 R	L	*Trigonias gregoryi* Holotype A.M.N.H. 13226a R	L	*Trigonias paucidens* Holotype A.M.N.H. 11865 R	L	*Trigonias* "nanolophus" Holotype Y.P.M. 12439 R	L	*Trigonias* "nanolophus" Y.P.M. 12562 R
I^1 - C^1 over all	63	60−	60.5+	66+	---	---	---	---		82+	110	70+	76+	---	---			
A-P diam. of I^1	26	---	---	e23	---	---	---	---		v26	24	---	v22	---	v23			
Tr. diam. of I^1	11	---	13	16.5	---	---	---	---		v13	13	---	v12.5	---	v10			
Crown length of I^2	7	---	---	---	---	---	---	---	7.5	---	---	---	---	9+	---			
A-P diam. of I^2	11	---	13	12.5	---	---	---	---	10.5	---	---	---	---	11	v10.5			
Tr. diam. of I^2	7	---	8	8	---	---	---	---	6.5	---	---	---	---	7	v9			
Crown length of I^3	5.5	5	---	---	---	---	---	---			6	---	---	7	6.5			
A-P diam. of I^3	9	9	9.5	9	---	---	---	---			9.5	---	---	10	9			
Tr. diam. of I^3	6	6	7.5	7	---	---	---	---			8	---	---	6	6.			
Crown length of C^1	5.5	---	---	---	---	---	---	8.5		8	d 8 p 8	---	7.5	---	--			
A-P diam. of C^1	7	---	9.5	8.5	---	---	---	8		11.5	d 11.5 p 11.5	---	12.5	---	---			
Tr. diam. of C^1	5.5	---	6.5	6	---	---	---	5.5		7	d 7.5 p 7.5	---	7.5	---	---			
Diastema	28	28	33.5	40	---	--	---	46.5		46	32	37	37	55	61			
Length, P^1-M^3	--	---	---	---	---	---	e183			256	261	250	252	201	---		s207	
Length, P^2-M^3	--	---	168	161	186	188	171	---		230	232	226	228	179.5	---		s188	
Length, P^{1-4}	---	---	---	---	--	---	---	---		[illegible].5	120	114	115	91.0	---		s95	
Length, P^{2-4}	---	---	64.5	61	79	79	67	---		90	89.5	88.5	88.5	[illegible]	---		s75.5	
Length, P^{1-3}	67	67	---	---	---	---	---	--		82.5	88	82.5	8[illegible]	64.5	---		s67	
Length, M^{1-3}	---	---	104	102	107	109.5	105	---		143.5	141.5	139.5	[illegible]	113.5	116		s116	
s Length of P^1	23	21	---	---	---	---	---	---		25.5	27	26	25.5	23	23	19	20	
s Width of P1	17	17	---	---	---	--	---	---		23	20	23	24	16.5	18	16	17	
Index of P^1	135.3	123.5	---	---	--	---	---	--		110.9	135.0	113.0	106.[illegible]	139.4	127.8	118.8	117.[illegible]	
a Length of P^2	22.5	22.5	---	---	20	22	20	21		28	[illegible]8	27.5	27.5	19.5	21.5	---	23	
a Width of P^2	31	30	---	---	28	27.5	24+	24+		37.5	37	35	35	26.5	27	---	28	
Index of P^2	72.6	75.0	---	---	71.4	80.0	--	---		74.7	75[illegible]	78.6	78.6	73.6	79.6		82.[illegible]	

[illegible]

Table IIIb

	Trigonias osborni Holotype U.S.N.M. 3924		*Trigonias osborni* C.M.96 (95)		*Trigonias osborni* C.M. 98		*Trigonias osborni* A.M.N.H. 12389		*Trigonias* sp. indesc.? A.M.N.H. 12308	*Trigonias wellsi* Holotype A.M.N.H. 13226		*Trigonias gregoryi* Holotype 13226a		*Trigonias paucidens* Holotype A.M.N.H. 11865		*Trigonias* "nanophus" Holotype Y.P.M. 12439		*Trigonias* "lophus" Y.M.P. 12562
	R.	L	R	L	R	L	R	L	L	R	L	R	L	R	L	R	L	R
^{m}Length of P^3	25	25	20	---	27	26	22	22		27.5	30	29	29.5	23	---	26.5	26.5	
^{a}Width, P^3	40	38+	33	---	38	35.5	^{e}35	^{e}35		47	46.5	45	44.5	28	---	34	34	
Index, P^3	62.5	---	60.6	---	71.5	76.1	^{e}62.9	^{e}62.9		58.5	65.2	64.4	66.3	83.9	---	77.9	77.9	
^{m}Length, P^4	---	---	24.5	21.5	25	26.5	25	25	26	32.5	32	32	31	26	---	27	27	29
^{a}Width P^4	---	---	38	37.5	40	39.5	39	39	39	52	53.5	50	50	40.5	---	30	^{e}40	40.5
Index, P^4	---	---	64.5	57.3	62.5	67.0	64.1	64.1	66.7	62.5	59.6	64.0	62.0	64.2		69.2	^{e}62.5	71.6
^{m}Length, M^1	---	---	28.5	26	32	34	33	32		43	43	43.5	44	32.5	34	37	38	
^{a}Width, M^1	---	---	43	41.5	^{e}45	43	41	42		55	55	55.5	55	44.5	45	43	45	
Index, M^1	---	---	66.3	62.7	71.1	79.1	80.5	76.2		78.2	78.2	78.4	80.0	73.0	79.1	86.0	88.4	
^{m}Length, M^2	---	---	37.5	34.5	39	39	36	---		49.5	48.5	48	48	41.5	41	^{e}40	42	
^{a}Width, M^2	---	---	44.5	46	46.5	47	48	---		61	61	63	63	49	49	48	47.5	
Index, M^2	---	---	84.3	75.0	83.9	82.9	75.0	---		81.1	79.5	76.2	76.2	84.3	83.7	^{e}83.3	88.4	
^{m}Length, M^3	---	---	38	38	38	38.5	36.5	34.5		50	51	49.5	50.5	41	39	---	40	
^{a}Width, M^3	---	----	42.5	42 5	43	43	^{e}45	44		59	58	60	60.5	45.5	46.5	---	43	
Index, M^3	---	---	89.4	89.4	88.4	89.8	^{e}81.1	78.4		84.7	87.9	82.5	83.5	90.1	83.9	---	93.0	
Pmx to oc. condyle	---	---	[distorted] 512	536	---	---				598	696	---	---	500	508			
Width across zygomes	---	---	[crushed] 187		245					-----		-----		256				
Depth incision ant. nares	90+	67.5+	142	154	---	---				---	---	127	153.5	133				
Height occiput above oc. condyle	---	---	155.5	160	143	141				---	---	---	---	140	140			
Width bet. P^2's	---		[badly crushed] 56.5		31					63		33.5 (crushed)		55				
" M^3's			36.5		61					65.5		65.5 "		67				

a, greatest width of anterior half of tooth
d, deciduous
e, estimated
g, greatest
m, middle axis
p, permanent
s, as set in plaster
v, alveoli only

Table IVa

	Trigonias osborni? Paratype U.S.N.M. 4815		Trigonias osborni C.M. 97		Trigonias osborni? C.M. 3914a		Trigonias osborni A.M.N.H. 9792		Trigonias gregoryi? A.M.N.H. 13226b	
	R	L	R	L	R	L	R	L	R	L
Tip of I_c to back of I_3	52	52	54.5	53	------		43.5	---		
Crown length of I_1 (from root)	---	---	9.5	10	------			14.5	---	---
g A-P diam. I_1 at root	8	9	8	8	6.5	8	6	7.5	---	---
g Tr. diam. I_1 at root	7	7	8	8	7	7	7	7	---	---
g A-P diam. I_2	12	13	13	13.5	14.5	14.5	11	11.5	11+	14+
g Tr. diam. I_2	16	17	19	20	20.5	19	16	16	16.5+	17.5+
Crown-length I_3 from root	--	--	--	--	--	--	--	---	---	---
A-P diam. I_3 at root	6	7	---	---	7	7	5	---	7	---
Tr. diam. I_3 at root	7	7	4	5	5	5	4	---	6	---
Diastema	36	36	35	29	27	34	26.5	---	40	40
$P_1 - M_3$	---	210	e 217	e 210	---	---	202	---	e 270	e 263
$P_2 - M_3$	---	197	e 197	e 191	---	---	166.5	---	e 249	e 252
P_{1-4}	---	90	97	94.5	e 89	e 86	84	---	122.5	112.5
P_{2-4}	---	75	79.5	78	71	75.5	71	---	103	103
M_{1-3}	---	122	e 117	e 117	---	---	118.5	---	e 167	e 160
g Length, P_1	---	18	17	17	---	---	13.5	---	21	20.5
g Width, P_1	---	10	8	8	---	---	8	---	11.5	11
Index, P_1	---	180.0	212.5	212.5	--	---	168.8	---	182.6	186.4
m Length, P_2	---	22	24	22.5	21	22	18.5	---	31	31
g Width, P_2	---	16.5	16	15	16.5	15.5	13	---	20	20
Index, P_2	---	133.3	150.0	150.0	127.3	141.9	142.3	---	155.0	155.0

d, deciduous
e, estimated m, middle axis
g, greatest

For lower cheek teeth the width is taken across the talonid.

Table IVb

	Trigonias osborni? U.S.N.M. 4815		Trigonias osborni C.M. 97		Trigonias osborni? C.M. 3914a		Trigonias osborni A.M.N.H. 9792		Trigonias osborni A.M.N.H. 13226b	
	R	L	R	L	R	L	R	L	R	L
m Length, P_3	---	25	27	27.5	23	23	25	---	.34	34
g Width, P_3	---	20.5	20	19	19.5	19.5	17.5	---	e 26	26
Index, P_3	---	122.0	135.0	144.7	117.4	117.4	142.9	---	e 130.8	130.8
m Length, P_4	---	26	29	29			28	---	d 36	d 36
g Width, P_4	---	25	22	22			19.5	---	d 24	d 25
Index, P_4	---	104.0	131.8	131.8			133.3	---	d 150.0	d 144.0
m Length, M_1	---	34	35	39			32.5	---	43.5	43.5
g Width, M_1	---	26	25	25.5			24	---	27	27.5
Index, M_1	---	130.8	140.0	152.9			127.1	---	161.1	158.2
m Length, M_2	---	41.5	43	46			37	---	50	50
g Width, M_2	---	30	29	27			25	---	31.5	32
Index, M_2	---	128.3	148.3	170.4			148.0	---	158.7	156.3
m Length, M_3	---	46	--	---			44	---	---	---
g Width, M_3	---	28	--	---			22.5	---	---	---
Index, M_3	---	164.3	--	---			151.1	---	---	---
Symphysis to angle		413	392	391			---	---	466	481
Coronoid above angle		201+	190	191			---	---	212	209.5
Length, symphysis		82	85			95	71.5		97	
Depth of ramus below P_2		50	49	51	60	55	38	---	43	43
Depth of ramus below M_2		67	51	48			47	---	59	57

Table IVa

	Trigonias osborni? Paratype U.S.N.M. 4815 R	L	*Trigonias osborni* C.M. 97 R	L	*Trigonias osborni?* C.M. 3914a R	L	*Trigonias osborni* A.M.N.H. 9792 R	L	*Trigonias gregoryi?* A.M.N.H. 13226b R	L
Tip of I_2 to back of I_3	52	52	54.5	53	------		43.5	---		
Crown length of I_1 (from root)	---	---	9.5	10	------			14.5	---	---
g A-P diam. I_1 at root	8	9	8	8	8.5	8	6	7.5	---	---
g Tr. diam. I_1 at root	7	7	8	8	7	7	7	7	---	---
g A-P diam. I_2	12	13	13	13.5	14.5	14.5	11	11.5	11+	14+
g Tr. diam. I_2	16	17	19	20	20.5	19	16	16	16.5+	17.5+
Crown-length I_3 from root	--	--	--	--	--	--	--	---	---	---
A-P diam. I_3 at root	6	7	---	---	7	7	5	---	7	---
Tr. diam. I_3 at root	7	7	4	5	5	5	4	---	6	---
Diastema	36	36	35	29	27	34	26.5	---	40	40
$P_1 - M_3$	---	210	e217	e210	---	---	202	---	e270	e263
$P_2 - M_3$	---	197	e197	e191	---	---	188.5	---	e249	e252
$P_1 - 4$	---	90	97	94.5	e89	e86	84	---	122.5	112.5
P_{2-4}	---	75	79.5	78	71	75.5	71	---	103	103
$M_1 - 3$	---	122	e117	e117	---	---	118.5	---	e167	e160
g Length, P_1	---	18	17	17	---	---	13.5	---	21	20.5
g Width, P_1	---	10	8	8	---	---	8	---	11.5	11
Index, P_1	---	180.0	212.5	212.5	--	---	168.8	---	182.6	186.4
m Length, P_2	---	22	24	22.5	21	22	18.5	---	31	31
g Width, P_2	---	16.5	16	15	16.5	15.5	13	---	20	20
Index, P_2	---	133.3	150.0	150.0	127.3	141.9	142.3	---	155.0	155.0

d, deciduous
e, estimated m, middle axis
g, greatest

For lower cheek teeth the width is taken across the talonid.

Table IVb

	Trigonias osborni? U.S.N.M. 4815 R	L	*Trigonias osborni* C.M. 97 R	L	*Trigonias osborni?* C.M. 3914a R	L	*Trigonias osborni* A.M.N.H. 9792 R	L	*Trigonias osborni* A.M.N.H. 13226b R	L
m Length, P_3	---	25	27	27.5	23	23	25	---	34	34
g Width, P_3	---	20.5	20	19	19.5	19.5	17.5	---	e26	26
Index, P_3	---	122.0	135.0	144.7	117.4	117.4	142.9	---	e130.8	130.8
m Length, P_4	---	26	29	29			26	---	d36	d36
g Width, P_4	---	25	22	22			19.5	---	d24	d25
Index, P_4	---	104.0	131.8	131.8			133.3	---	d150.0	d144.0
m Length, M_1	---	34	35	39			32.5	---	43.5	43.5
g Width, M_1	---	26	25	25.5			24	---	27	27.5
Index, M_1	---	130.8	140.0	152.9			127.1	---	161.1	158.2
m Length, M_2	---	41.5	43	46			37	---	50	50
g Width, M_2	---	30	29	27			25	---	31.5	32
Index, M_2	---	128.3	148.3	170.4			148.0	---	158.7	156.3
m Length, M_3	---	46	--	---			44	---	---	---
g Width, M_3	---	28	--	---			22.5	---	---	---
Index, M_3	---	164.3	--	---			151.1	---	---	---
Symphysis to angle		413	392	391			---	---	466	481
Coronoid above angle		201+	190	191			---	---	212	209.5
Length, symphysis		82	95			95	71.5		97	
Depth of ramus below P_2		50	49	51	60	55	38	---	43	43
Depth of ramus below M_2		67	51	48			47	--	59	57

Cope, 1879, and in any case is merely a synonym for *Aceratherium occidentale ?*, given to the milk teeth, and as *Aceratherium mite* was later made the type of *Cænopus, Aceratherium occidentale* becomes the genolectotype of *Subhyracodon*, fixed by elimination (Cope and Matthew, 1915). As a descriptive name *Subhyracodon* is seriously misleading; unfortunately there can be no question of its validity.

I shall try to show that this group splits naturally into three rather widely separated series, which would seem to deserve subgeneric or generic rank. As they appear to be distinct through most of the Oligocene and as only the largest line can be traced with any great probability to any known member of the genus *Trigonias*, they are here ranked as distinct genera. This has the incidental merit of simplifying the nomenclature, reducing the scope of the name *Subhyracodon*, and keeping the historic name *Cænopus* from being relegated into the synonymy.

Caenopus Cope, 1880

Genoholotype: *Aceratherium mite* Cope, 1875.

Questionably referred species: *Cænopus ? dakotensis* Peterson, 1920. *Cænopus ?? minor* (Filhol) 1884.

Small, North American and European ?, Oligocene rhinoceroses; heavier but no taller than *Hyrachyus eximius* Leidy; I 2/2, C 0?/0, P 4/3, M 3/3; P 2/ and P 4/ have the metaloph definitely separated from, and parallel with, the protoloph; P 3/ is less advanced. The very progressive character of P 4/ is the most striking character. A very weak and interrupted internal cingulum is present on the upper molars. Manus tridactyl?

This genus may be ancestral to *Menoceras* (= *Diceratherium*) *cooki* (Peterson). The possible inclusion of one or more European forms inside the limits of this genus is an interesting question which should be left open for the present.

"Cænopus" persistens Osborn is probably referable to *Diceratherium*.

It is possible that the European genus *Præaceratherium* Abel is congeneric with *Cænopus.* The teeth of *Præaceratherium minus* (Filhol), figured by Abel (1910), are almost exactly identical with those in the maxilla of *Cænopus mitis* in size and are strikingly similar in character. P 4/ is molariform and P 2/ is more advanced than P 3/. An extensive synonymy is given by Abel. The specimen referred by Koch to *Præaceratherium minus* is more suggestive of *Subhyracodon* cf. *occidentale* (Koch, 1911; Abel, 1914).

Caenopus mitis (Cope), 1875 Fig. 36, Osborn, 1898

Aceratherium mite Cope. Cope, 1875.
Aceratherium (*Subhyracodon*) *mite* (Cope). Brandt, 1878.
Cænopus mitis (Cope). Cope, 1880.
Aceratherium pumilum Cope. Cope, 1885 (name only).
Cænopus pumilis Cope. Cope, 1891.
Aceratherium mite Cope. Osborn, 1898.
Cænopus mitis (Cope). Osborn and Matthew, 1909.
Cænopus (= *Subhyracodon*) *mitis* (Cope). Cope and Matthew, 1915.
Cænopus mitis (Cope). Troxell, 1921 a.

The holotype is a mandible, A. M. N. H. No. 6325. The paratype, a badly damaged set of supper cheek teeth, A. M. N. H. No. 6325, is probably associated with the type. Mixed with these specimens there are also some upper teeth, A. M. N. H. No. 6326, formerly regarded as a paratype but here referred to *Subhyracodon copei.* Associated with these specimens there are parts of a left premaxillary with the anterior tip of the maxillary attached, which shows the alveoli, a right femur and astragalus, a left radius and tibia, an axis and various other vertebræ, as well as fragments. These specimens were collected by Professor Cope in 1873 for the Hayden Survey from the Upper Titanotherium Beds of Cedar Creek, Logan Co., Colorado. I 2/?, C 1–0/?, P 4/3, M 3/3. The alveolus for the upper canine is very small. P 2/ is molariform with separate parallel lophs. The hypocone of P 3/ is connected about equally closely to the protoloph and the metaloph. P 4/ has a clearly separated metaloph, partly connected with the protoloph by a spur near the internal margin. If continued all the way across the valley, this spur would become what Troxell has named the "mure." Phylogenetically, the mure is probably merely the reduced isthmus between the protocone and hypocone. The upper molars have no cristæ and very weak internal cingula. I /2 is semiprocumbent.

The doubtfully associated foot bones are figured by Cope and Matthew (1915, Pl. CIV and CV). Measurements are given by Cope (1875). The number of toes in the manus is not definitely known. A carpus in the Princeton Museum referred, perhaps incorrectly, to this species, has an undivided distal facet on the unciform (Wortman, 1893). Osborn and Scott regarded this carpus as probably tridactyl but Wortman considered the evidence inconclusive. The reference is uncertain, as *Subhyracodon copei* occurs in the same beds and is about the same size. The latter was in all probability tridactyl. Until, therefore, a manus and skull of *Cænopus mitis* are found certainly associated, the question must be left open.

Cænopus ? dakotensis Peterson, 1920 Fig. 39, Osborn, 1898

Aceratherium mite ? Cope. Osborn, 1898.
Cænopus dakotensis ? Peterson. Peterson, 1920.
Cænopus tridactylus (Osborn). Troxell, 1921 a.

The holotype is A. M. N. H. No. 1110, collected from the Protoceras Beds, near the Cheyenne River, S. D., by the American Museum Expedition of 1894.

I /2, C /0, P /3, M /3. I /2 is semiprocumbent.

By a lapsus calami Troxell (1921 a) calls *Cænopus dakotensis* Peterson a synonym of *Cænopus tridactylus* (Osborn). As Peterson (1920) explains, *Cænopus dakotensis* is a provisional name, given largely on stratigraphic grounds, to the lower jaw of an animal even smaller than the type of *Cænopus mitis.* Is was described and figured by Osborn (1898). Detailed measurements are given below.

Menoceras Troxell, 1921

This genus is doubtfully distinct from *Diceratherium* Marsh. If it be regarded as the end-product of a distinct line of evolution, as yet largely unknown, the separation seems warranted. The structural differences, however, are hardly worthy of generic rank—certainly not if it is a descendant of *Subhyracodon tridactylum.* The more individual characters of *Menoceras cooki* are: relatively small size, knob-shaped horn cores at the tip of the nasals (as opposed to the long narrow horn of the larger forms; little tendency for a mure to develop on the upper premolars; enlargement of the crista of d P 2/ into a full-sized transverse crest; pattern of the upper cheek teeth extremely complicated; animal much more specialized for cursorial life than *Subhyracodon tridactylum,* and therefore, probably, than the large diceratheres. (See table of limb ratios below.)

Menoceras cooki (Peterson) 1906 Pl. LX, Peterson, 1920

Diceratherium cooki Peterson. Peterson, 1906.
Diceratherium arrikarense Barbour. Barbour, 1906.
Dioeratherium schiffi Loomis. Loomis, 1908.
Diceratherium aberrans Loomis. Loomis, 1908.
Aceratherium stigeri Loomis. Loomis, 1908.
Diceratherium loomisi Cook. Cook, 1912.
Diceratherium cooki Peterson. Peterson, 1920.
Menoceras cooki (Peterson). Troxell, 1921 b.

Genoholotype: Carnegie Museum No. 1572. Horizon: Upper Harrison. Locality: Nebraska. I 2/2, C 0/0, P 4/3, M 3/3. I /2 erect to semi-erect.

This species has been monographed by Peterson (1920) and made the type of the genus *Menoceras* by Troxell (1921 b). The further splitting off of *Metacœnopus* Cook from *Diceratherium* seems totally unjustifiable.

It seems possible that *Menoceras cooki* is derived from *Cænopus ? dakotensis* as suggested by Peterson (1906 and 1920), or from *Cænopus mitis.* At least other possibilities seem less likely. The much smaller size is a considerable difficulty in the way of deriving it from *Subhyracodon tridactylum.*

In a specimen of *Menoceras cooki* in the American Museum, Field number 9, expedition of 1914, the first deciduous right lower premolar is retained after all the permanent cheek teeth have come into use. It is very small.

The crista of d P 2/, as pointed out by Peterson, is elongated into an independent transverse crest, almost as long as the protoloph or metaloph. This tooth shows more specialization over the corresponding tooth in *Subhyracodon* than any other tooth, deciduous or permanent. No correlated specialization occurs in d P /2.

Subhyracodon Brandt, 1878

The genoholotype (fixed in Cope and Matthew, 1915, by elimination) is *Aceratherium occidentale* (Leidy). (The genotypes, as given by Brandt, are *Aceratherium mite, Aceratherium occidentale*, and *Aceratherium quadriplicatum.* See above.) These are moderate sized North American Oligocene rhinoceroses, which merge into *Diceratherium,* developing paired horns on the nasals in the male. The manus is tridactyl. I 2/2, C (1)–0/0, P 4/(4)–3, M 3/3. I 3/ is the first upper tooth to be lost in this series, as distinct from the larger series, in which C 1/ is the first upper tooth to be lost. P 2/ is molariform. P 3/ and, later, P 4/ become progressively molariform. The internal cingulum on the premolars is complete and prominent. There is a well-developed internal cingulum on the upper molars, which is usually more or less interrupted. I /2 is semi-erect to procumbent.

Referred species: *Subhyracodon trigonodum* (Osborn and Wortman), *Subhyracodon copei* (Osborn), *Subhyracodon metalophum* (Troxell), *Subhyracodon tridactylum* Osborn.

Leptaceratherium Osborn, 1898

The genoholotype is *Aceratherium trigonodum* Osborn and Wortman, 1894. I 2/2, C 1–0/0, P 4/3, M 3/3. I /2 is semi-procumbent to procumbent.

This generic name is here placed in synonymy with *Subhyracodon.* The upper premolar pattern is not very different from that of more typical members of the genus, although it is somewhat more primitive, and the exact degree of reduction of the upper canine is certainly not a character of generic importance.

Meninatherium Abel may be congeneric with *Subhyracodon.*

Subhyracodon trigonodum (Osborn and Wortman)

Fig. 46 c, Osborn, 1898

Aceratherium trigonodum Osborn and Wortman. Osborn and Wortman, 1894.
Aceratherium (*Cænopus*) *mite* Cope. (A. M. N. H. No. 521.) Osborn and Wortman, 1894.
Leptaceratherium trigonodum (Osborn and Wortman). Osborn, 1898.
Aceratherium copei Osborn (paratype, A. M. N. H. No. 521). Osborn, 1898.
Leptaceratherium trigonodum (Osborn and Wortman). Osborn and Matthew, 1909.
Cænopus (*Leptaceratherium*) *trigonodus* (Osborn and Wortman). Troxell, 1921 a.

The holotype is A. M. N. H. No. 528, from the Upper Titanotherium Beds of South Dakota, collected by the Expedition of 1892. Range: Upper Titanotherium Beds to Lower Oreodon Beds.

Slightly larger than *Subhyracodon copei* or *Cœnopus mitis,* slightly smaller than *Subhyracodon occidentale.* I 2/2, C 1–0/0, P 4/(4)–3, M 3/3. P 2/ is fully molariform with the lophs united well above the cingulum. In both P 3/ and P 4/ the hypocone is very slightly developed as a distinct cusp. In P 3/, when even slightly worn, the protoloph and metaloph are connected like a blunted V, inclosing a deep basin. I /2 is semiprocumbent to procumbent.

An unworn specimen such as the type is very easily recognized, as the small and poorly defined hypocone of

P 3/ and P 4/ is united firmly to the metaconule but separated by a slight constriction from the protocone.

In P 3/ the metaconule is attached to the posterior edge of the hypocone instead of the anterior edge as in *S. copei* and *S. occidentale.* In P 4/ the median valley would always escape internally, never posteriorly as in *S. copei* and *S. occidentale,* until the tooth was sufficiently worn so that the valley was completely enclosed.

There is additional confirmation of Osborn's discovery (1898) that *Subhyracodon trigonodum* retained the upper canine into maturity. The partly prepared skull of a very old individual from the Lower Oreodon Beds (A. M. N. H. No. 9790) probably referable to this species, has well marked alveoli for right I 1/, I 2/, and C 1/. The transfer of the paratype of *Subhyracodon copei* (A. M. N. H. No. 521), which has a superior canine, to this species, is still further confirmation. That this transfer is necessary can be seen by comparing P 3/ of No. 521 with the types of the other two species. (See Osborn, 1898, fig. 448.)

A. M. N. H. No. 1131, probably referable to this species, has on both third upper molars a very slight trace of the posterior extension of the ectoloph, with a fairly distinctly defined post-fossette.

U. S. N. M. No. 8430 should be referred to this species. L P /1 (probably Ld P /1) and the roots of the corresponding tooth on the opposite side are retained. The connection between the protoloph and metaloph of P 2/ is carried unusually high for this species. This is a young specimen with all the deciduous fourth premolars still in place and with the third upper molars just cutting the gums. P /3 is almost molariform, P /2 is definitely premolariform.

Subhyracodon copei (Osborn) 1898 Fig. 44 A, Osborn, 1898

Aceratherium (*Cænopus*) *mite* Cope. (A. M. N. H. No. 522.) Osborn and Wortman, 1894.
Aceratherium copei Osborn. Osborn, 1898 (A. M. N. H. No. 522).

Cænopus (= *Subhyracodon*) *copei* (Osborn). Osborn and Matthew, 1909.
Cænopus copei (Osborn). Peterson, 1020.
Cænopus copei (Osborn) in part. Troxell, 1921 a.

The holotype is A. M. N. H. No. 522 from the Lower Oreodon Beds of South Dakota, collected by the Expedition of 1892. I 2/?, C 1/?, P 4/?, M 3/?. This species is smaller than *Subhyracodon trigonodum* or *Subhyracodon occidentale.* This shows most clearly in the molar series, which is shorter by about a sixth. P 3/ is also much more primitive than in either of the other species. P 2/ is molariform, P 3/ and P 4/ are still unmetamorphosed. The protoloph and metaloph of P 2/ are united well above the cingulum. In P 3/, well into maturity, the hypocone is not attached to the metaconule, letting the median valley escape posteriorly. P 4/ resembles *Subhyracodon occidentale* in shape more closely than it does *Subhyracodon trigonodum.* It is slightly more advanced than P 3/, so that, in the type specimen, the posterior outlet of the valley is already closed.

The "paratype" of *Cænopus mitis,* A. M. N. H. No. 6325, should be referred to this species.

The "paratype" of *Subhyracodon copei,* A. M. N. H. No. 521, should be referred to *Subhyracodon trigonodum.* Comparison of Osborn's figures (1898, p. 147) suggests this strongly, and on comparison of the specimens this change is virtually necessitated by the character of P 3/, which has the enclosed basin characteristic of P 3/ and P 4/ in *Subhyracodon trigonodum.* As the specimen is young, still retaining d P 4/, the characters of this tooth cannot be used as an additional check.

The failure to refer these two paratypes to their correct species is in large part the cause of the general confusion as to the characters of these species. This has been particularly the case with *Subhyracodon copei* and *Subhyracodon occidentale.* Besides the obvious difference in size and the retention of the upper canine, there is a marked difference in P 3/. "Third and fourth upper premolars with tetartocone spurs united chiefly with protoloph"—(Osborn, 1898). In *Subhyracodon occidentale,* on the other hand, P 3/ has its protoloph and metaloph approximately parallel and partly separate, with an internal outlet for the median valley. *Subhyracodon copei* differs from *Subhyracodon trigonodum* in the pattern of both P 3/ and P 4/, where the outlet of the valley is median.

There are two specimens referred to *Subhyracodon copei,* A. M. N. H. Nos. 6326 and 12452, from the Upper Titanotherium Beds.

The closest relationships of *Subhyracodon copei* are with *Subhyracodon occidentale,* to which, as Osborn has pointed out (1898), it is in all probability ancestral. Increase in size, earlier loss of C 1/ and a slight advance in P 3/ are the chief advances necessary to give the later form.

Subhyracodon occidentale (Leidy) 1854 Pl. XII, Leidy, 1854 a

Rhinoceros occidentalis Leidy. Leidy, 1850. Proc. Phil. Acad. Nat. Sci., V, p. 119. This is a nomen nudum, as the type is lost and would, in any case, be indeterminable.
Rhinoceros occidentalis Leidy. Leidy, 1854 a.
Aceratherium occidentale (Leidy). Leidy, 1854 b.
Aceratherium (*Subhyracodon*) *occidentale* (Leidy). Brandt, 1878.
Aceratherium occidentale (Leidy.) Cope, 1879 a.
Aceratherium occidentale (Leidy). Osborn, 1898.
Cænopus occidentalis (Leidy). Osborn, 1900.
Cænopus (= *Subhyracodon*) *occidentalis* (Leidy). Osborn and Matthew, 1909.
Cænopus trigonodus allus Troxell. Troxell, 1921 a.
Cænopus copei Troxell (not Osborn) in part. Troxell, 1921 a.
Aceratherium occidentale (Leidy). Osborn, 1923 a.

I agree with Osborn (1898) and Sinclair (1924) that *S. occidentale* is valid, in preference to Troxell's opinion (1921) that it should be abandoned in favor of *S. copei.*

The neotype is U. S. National Museum No. 114. The range of this species is probably the Lower and Middle Oreodon Beds. This animal was slightly larger in nearly all dimensions than *Subhyracodon copei.* The molar series is markedly longer than in *Subhyracodon copei.* The premolar series is distinctly shorter than in *Subhyracodon metalophum* and less advanced (especially P 4/). Its inferiority in size as compared with *Subhyracodon tridactylum* is still more apparent.

There are no traces of horn cores. The manus is tridactyl. I 2/2, C 0/0, P 4/3, M 3/3. d I 2/2, d C 0/0, d P 4/4. I 2/ is still large. P 2/ has parallel, separate lophs. P 3/ has its protoloph and metaloph fully confluent after slight wear but the hypocone is better developed than in *Subhyracodon trigonodum* and, unlike *S. copei,* the outlet of the valley is median. The metaconule of P 4/ usually turns anteriorly and abuts against the outer side of the hypocone, which is only partly distinct from the protocone. The median valley usually escapes posteriorly (much like P 3/ of *Subhyracodon copei*) until a moderately advanced stage of wear. I /2 is semi-erect.

The character of P 4/ before excessive wear is well shown in A. M. N. H. No. 6330, collected by Cope in Colorado in 1873, in the White River Beds. These teeth show clearly the original pattern of the type specimen before it was greatly worn. (See Pl. XII, Leidy, 1854 a.) It is also well shown in A. M. N. H. No. 1113, collected by the A. M. N. H. Expedition of 1894, from the "Turtle-Oreodon Layer," Oreodon Beds, Cheyenne River, South Dakota, a specimen younger than the type of *Subhyracodon copei,* about the age of the type of *Subhyracodon trigonodum,* for M 3/ is not quite fully erupted. P 3/ has its metaloph already complete, united to the protoloph and completely enclosing the median valley. P 4/, very slightly worn, shows a posterior outlet for the median valley between the hypocone and the metaconule.

The specimen which Koch (figured by Koch, 1911 and Abel, 1914) referred to *Præaceratherium minus* seems distinct from the type. On the other hand, both in size and dental characters, it seems so like *Subhyracodon occidentale,* that if it had been found in North America, it would have been referred to that species.

Subhyracodon occidentale (Leidy)
Cænopus trigonodus allus Troxell. Troxell, 1921 a (figs. 1 and 2).

The holotype is Y. P. M. No. 12052, from the Oreodon Beds of Nebraska, collected by Mr. H. C. Clifford. This is a young individual. The third right upper molar was just about to erupt, as were both third lower molars.

I fail to see any marked resemblance between this specimen and the type of *Subhyracodon trigonodum*. It does not have the one really distinctive feature of the latter species, the confluent protoloph and metaloph on P 4/, forming a V with a median outlet for the valley, nor the somewhat loose attachment of the hypocone to the metaconule, notched by a deep valley posteriorly, on P 2/. In size, loss of C 1/, and general character, it resembles *Subhyracodon occidentale*.

The figures in Troxell's paper are accurate, except that they fail to show a small antero-internal descending rib, between the protoloph and ectoloph of P 1/ and the "mure" connecting the protocone and hypocone of P 2/.

Subhyracodon gidleyi, new species Figs. 29, 30, 31

The holotype, U. S. N. M. No. 11337, was collected by Mr. J. B. Hatcher in 1886, from the "White River Tertiary." It is slightly smaller than the type of *Subhyracodon occidentale*, from which the premolars are indistinguishable. The name is given for Dr. J. W. Gidley. M 1/ and M 2/ have part of the median valley completely cut off by the upgrowth of the antecrochet, to form medifossettes.

The specimen consists of left P 2/–M 2/, with the roots of P 1/ and fragments of M 3/, and right P 4/–M 2/, with the roots of P 1/–P 3/ and the front half of M 3/, fragmentary lower teeth, and the astragalus. Associated with it are *Mesohippus* and *Oreodon* teeth.

P 1/ had two roots. P 2–4/ have complete internal cingula. P 2/ has the protoloph and metaloph separate and parallel, but connected well above the level of the cingulum. P 3/, rather worn, has the same character as the type of *S. occidentale*—or of most other members of the genus after a corresponding amount of wear. P 4/ has the character of *S. occidentale* or *S. copei,* in that the hypocone is a bud from the protocone, and the metaconule joins its anterior end. The molars have incomplete internal cingula. M 1/ is well worn. It has a medifossette completely cut off by the antecrochet. The internal cingulum, absent from the inner slopes of the two lophs, is very strongly developed across the valley, forming a dam of considerable height. M 2/ has no internal cingulum, except a slight one on the protocone, which does not close off the median valley. The antecrochet cuts off a deep medifossette. There is a faint trace of a crochet on the left side, but none on the right. The protocone of M 3/ interrupts the cingulum internally. There is a trace of the posterior buttress, and a distinct post-fossette. The molars have no external cingula, except a faint trace on the paracone of M 1/, and an extension along the ectoloph of M 3/ external to the posterior buttress.

The lower teeth are in very fragmentary condition, but they show unusually heavy cingula. Right P /2 is completely surrounded by a cingulum, except for a short space posteriorly. Left P /3 is almost completely surrounded by a cingulum, except for short interruptions by the metaconid and entoconid. The anterior, posterior, and external valleys are definitely enclosed at their feet. Right M /1 has a cingulum extending from the paraconid onto the metaconid, enclosing the anterior valley, and another from the metaconid to the entoconid, blocking the posterior valley.

The level of this form is not known. It gives a surprising mixture of characters, since the premolars are indistinguishable from *Subhyracodon occidentale,* and the molars, by themselves, would probably be referred to a new species of *Diceratherium* (in the restricted sense). It seems quite possible that the explanation of this apparent discrepancy lies in the field of genetics, rather than of paleontology.

Subhyracodon metalophum (Troxell) 1921

Aceratherium occidentale (Leidy). Osborn, 1898 (A. M. N. H. No. 1123, Pl. XIII, Fig. 1).
Cænopus tridactylus metalophus Troxell. Troxell, 1921 a (fig. 4).

"Holotype, No. 10245, Y. P. M. Probably Middle Oligocene, Rushville, Nebraska." Another specimen virtually identical with this, A. M. N. H. No. 1123, from the Upper Oreodon Beds, collected by American Museum Expedition of 1894, was described and figured by Osborn (1898). This form was larger than *Subhyracodon occidentale,* smaller than *Subhyracodon tridactylum* and probably hornless in both sexes. I 2/?, C 0/?, P 4/?, M 3/?. I 2/ is still large. The protoloph and metaloph of P 4/ are separate and parallel. The upper molars are smaller individually and collectively than in *Subhyracodon tridactylum* and have no secondary folds.

Osborn regarded this form as an advanced evolutionary stage of *Subhyracodon occidentale,* whereas Troxell considered it a primitive sub-species of *Subhyracodon tridactylum.* It is probably simplest to raise it to specific rank, and this would seem to be justified by its difference in character and level. Both stratigraphically and morphologically, it succeeds the typical *Subhyracodon occidentale,* and precedes the typical *Subhyracodon tridactylum.* Morphologically, it is also possible to derive it from *Subhyracodon trigonodum.* Stratigraphically, either form would answer equally well as an ancestor.

Y. P. M. No. 10254 has no trace of a mure on the upper premolars. In A. M. N. H. No. 1123, however, there is a mure on both P 4/'s, and on right P 2/ (omitted in Osborn's figure, 1898), but no trace of it on left P 2/.

The Effects of Wear in Subhyracodon

An old *Subhyracodon copei* would assume the same pattern as an old *Subhyracodon occidentale.* A worn *Subhyracodon trigonodum* would be less easily distinguishable from a worn *Subhyracodon occidentale.* It would, however, never become absolutely identical with it, for P 4/ of the former would always have the protoloph and metaloph forming a blunted V, whereas, in the latter, the metaconule would always hook on to the antero-external edge of the hypocone, so that the hypocone projects backward beyond the metaconule, although the extent to which it projects is progressively reduced by wear. A worn *Subhyracodon occidentale* may become indistinguishable from a worn *Subhyracodon metalophum,* and vice versa.

There is no reason to confuse the unworn pattern of any of the four species with any of the others.

Subhyracodon Brandt 1878

Anchisodon Cope 1879

The genoholotype is *Aceratherium quadriplicatum.*

Subhyracodon ? quadriplicatum (Cope) 1873

Hyracodon quadriplicatus (Cope) 1873
Aceratherium quidriplicatum (Cope). Cope, 1875.
Aceratherium (Subhyracodon) quadriplicatum (Cope). Brandt, 1878.
Anchisodon quidriplicatus (Cope). Cope, 1879.
Aceratherium quadriplicatum (Cope). Matthew, 1899.
Anchisodon quadriplicatus (Cope). Osborn and Matthew, 1909.

The holotype, A. M. N. H. No. 6339, from the (? Upper) Oreodon Beds, Cedar Creek, Logan County, Colorado, was collected by Professor Cope in 1873. It consists in the first and second left upper deciduous premolars and the first, second, and third right upper deciduous premolars. They are probably referable to some member of the genus *Subhyracodon,* even as here restricted, and, more likely than not, to *Subhyracodon occidentale* or *metalophum,* but they are not certainly determinable. The genus is regarded tentatively as a synonym of *Subhyracodon,* and the species as indeterminable.

Subhyracodon tridactylum (Osborn) 1893
Pl. XIII, fig. 8, and Pl. XVII, Osborn, 1898

Aceratherium tridactylum Osborn. Osborn, 1893.
Diceratherium proavitum Hatcher. Hatcher, 1894.
Aceratherium tridactylum Osborn. Osborn, 1898.
Cænopus tridactylus (Osborn). Osborn and Matthew, 1909.
Cænopus tridactylus (Osborn). Troxell, 1921 a.
Cænopus tridactylus proavitus (Hatcher). Troxell, 1921a.
Diceratherium tridactylum (Osborn). Osborn, 1923, b, p. 215.

The holotype is A. M. N. H. No. 533, a skull and nearly complete skeleton, collected by the Expedition of 1892, from the Protoceras Beds of South Dakota. Incipient horns are present in the males. I 2/2, C 0/0, P 4/(4)–3, M 3/3. I 2/ is small. The protoloph and metaloph of P 4/ are separate and parallel. Secondary wrinkles may appear on M 1/ or M 2/. I /2 is semi-erect to semi-procumbent. This species differs from *Subhyracodon metalophum* in its horizon, larger size, the presence of incipient horns on the male, greater length and width of the upper molars, occasional greater complication of the pattern of the upper molars, and the more frequent development of incipient mures on the upper premolars.

The type skull has an alveolus for the third left lower incisor and the first right lower premolar. The occasional presence of four lower premolars is almost certainly due to the abnormal retention of d P /1, a very small tooth, agreeing with what is unquestionably d P /1 in calves of *Subhyracodon occidentale* and *Subhyracodon tridactylum.* This tooth is both smaller and simpler than the P /1 (or possibly d P /1) of *Trigonias osborni* and *Trigonias ? gregoryi.* A calf lower jaw of *Subhyracodon tridactylum,* A. M. N. H. No. 1112, from the Protoceras Beds, has the formula I /2, C /0, d P /4 (M /1 just about to erupt). The alveolus for d P /1, which has dropped out, measures 12 x8.5 mm.

Osborn's original description is incorrect in two points. The union of the post-glenoid and post-tympanic processes in the type skull is apparently due to crushing. And, as Peterson pointed out (1911), the statement "no trace of fifth digit" is inexact, as the same nubbin representing metacarpal V, with its facet on the unciform, is present, as in *Subhyracodon occidentale* and *Menoceras cooki.*

If *Subhyracodon tridactylum* were transferred to the genus *Dicatherium*, as was done by Osborn (1923 b), it would have the advantage of making the latter genus nominally, as well as actually, monogenetic (see Miller, 1923, for definition of this term), according to the phyletic tree suggested below. However, it does not seem desirable to transfer a species to a different genus on quite such a slim basis, and this species really agrees more closely with *Subhyracodon occidentale,* the type of its genus, than with *Diceratherium armatum,* the type of the succeeding genus.

U. S. N. M. No. 11340 is apparently referable to this species, although it is very small, agreeing in size with the type of *S. occidentale.* Its red matrix suggests strongly that it came from the Oreodon Beds, but its level and exact locality were not recorded.

Diceratherium Marsh 1875

The genoholotype is *Diceratherium armatum* Marsh, Y. P. M. No. 10003, from the Lower John Day of Oregon. These were large Miocene rhinoceroses with paired horn cores on the nasals in the males, the females being hornless or nearly so. The horn cores are antero-posterior ridges, near to, but not on the ends of the nasals, and not knob-shaped. The upper cheek teeth are simple in pattern for Miocene rhinoceroses, with relatively few secondary crests and folds. A mure frequently ocurs on the upper premolars.

The splitting off of *Menoceras* Troxell as a separate genus from *Diceratherium* Marsh is here tentatively accepted. The splitting off of *Metacænopus* Cook from *Diceratherium*, on the basis of sex characters, seems totally unwarranted, and *Metacænopus* (Cook, 1909) is here considered as congeneric with *Diceratherium.*

The following species seem to be quite certainly valid:

Diceratherium armatum Marsh — John Day and Great Plains
Diceratherium annectens (Marsh)—John Day
Diceratherium cuspidatum Troxell—John Day
Diceratherium lobatum Troxell—John Day
Diceratherium niobrarense Peterson—Great Plains
Diceratherium avum (Troxell)—Great Plains.

Y. P. M. No. 10235, "*Diceratherium* cf. *armatum*," from the Upper Oligocene, North Fork of the White River, collected by Mr. H. C. Clifford, resembles *Diceratherium armatum* so closely that there does not seem to be any reason against referring it definitely to that species. The only appreciable difference is the presence of a mure on P 4/, which is absent in the John Day form.

What seems the most plausible view of the interrelationships of the different species is given in the phyletic tree near the end of this paper.

Diceratherium avum (Troxell) 1921

Cænopus tridactylus avus Troxell. Troxell, 1921 a (fig. 5).

The holotype is Y. P. M. No. 10251, collected by Mr. Brown from the Protoceras Beds of South Dakota. The animal was slightly larger than *Subhyracodon tridactylum*. There is a mure on P 2/ and P 3/. M 1/ and M 2/ have a crochet running from the metaloph which cuts off part of the median valley, giving an enclosed basin, as in *Subhyracodon gidleyi*, although smaller and arising in a different way.

This form was described and figured by Troxell, who regarded it as an advanced subspecies of *Subhyracodon tridactylum*. It seems sufficiently advanced over that form to deserve specific rank. Its greater size and the increasing complexity of the cheek teeth make it seem preferable to include it tentatively in *Diceratherium*. The intergradation of the two genera is so close, that any line of separation is rather arbitrary.

Diceratherium ? persistens (Osborn) 1904

Cænopus persistens Osborn. Osborn, 1904.

The type of this species is A. M. N. H. No. 9081, collected from the Miocene of Logan County, Colorado, by the Expedition of 1893.

This animal was probably a female dicerathere. The teeth are so worn that any specific determination would be highly questionable.

Paracænopus Breuning 1923

Genoholotype: *Præaceratherium filholi* (Osborn).

Aceratherium filholi Osborn. Osborn, 1900.
Præaceratherium filholi (Osborn). Abel, 1910.
Acerotherium filholi Osborn. Roman, 1912.
Paracænopus filholi (Osborn). Breuning, 1923.

The most useful figure of this species, in addition to Osborn's (1900), is published by Abel (1914). It shows the premolars in exactly the stage of evolution of *Subhyracodon occidentale,* with, however, a well-marked remnant of the posterior buttress on M 3/.

Breuning refers this genus to a new subfamily, the Cænopinæ. The closest resemblances of this genus would seem to be with *Subhyracodon* or with *Amphicænopus,* new genus, judging by the published figures. If it is eventually held to be congeneric with the former, it becomes, of course, a synonym. If it is congeneric with the latter, it takes precedence. That it is generically distinct from both is still another possibility.

Amphicænopus, new genus

The genoholotype is *Aceratherium platycephalum* Osborn and Wortman. This genus consists of very large, unprogressive Oligocene rhinoceroses, extending from the Titanotherium Beds to the Protoceras Beds. They are hornless in both sexes. The manus is unknown. P 3/ resembles *Trigonias gregoryi,* with the median valley escaping posteriorly. The internal cingulum on the premolars is complete, but, relatively, slightly weaker than in members of the genus *Subhyracodon,* as here restricted. The internal cingulum on the upper molars is altogether absent, or very weak. When present, the chief trace surrounds the protocone of M 3/. A trace of the posterior extension of the ectoloph appears rather frequently on M 3/. I /2 is procumbent. This genus shows its closest relationships to *Trigonias*, especially to *Trigonias paucidens*, and through it, to *Trigonias osborni* (see above). It seems probable that these two species are in its ancestral line. C 1/ is the first upper tooth to be lost, in this line.

This genus, as suggested by Osborn (1900), shows definite resemblances to *Paracænopus filholi* (Osborn). (See Abel 1910 and Roman 1912.) It is also remotely possible that it is related to the genus *Protaceratherium* Abel (1910). *Paracænopus* differs chiefly in having a well developed internal cingulum on the molars. Its premolar metamorphosis commences with P 2/, as in the American forms, but P 3/ is more advanced, whereas P 4/ is much more primitive, than in *Amphicænopus*. *Protaceratherium* resembles *Amphicænopus* in the reduction of the internal cingulum of the molars, but is much more advanced. Unless, however, the contrary is proved, it seems much more probable that the American forms are a separate line of autochthonous development, arising from *Trigonias*.

Amphicænopus platycephalus (Osborn and Wortman) 1894
Pl. XVIII, Osborn, 1898

Aceratherium platycephalum Osborn and Wortman. Osborn and Wortman, 1894.
Aceratherium platycephalum Osborn and Wortman. Osborn, 1898, Pl. XIII and XVIII.
Cænopus platycephalus (Osborn and Wortman). Osborn and Matthew, 1909.
Cænopus platycephalus (Osborn and Wortman). Troxell, 1921 a.

The holotype is a skull, A. M. N. H. No. 542. A. M. N. H. No. 540, consisting of right P 1/–M 3/ is the paratype. Both these specimens, and all other known specimens referred to this species, except A. M. N. H. Nos. 1478 and 12453, are from the Protoceras Beds. I 2–(1)/2, C 0/0, P 4/4–3, M 3/3. I /2 is semiprocumbent. These are hornless rhinoceroses exceeding *Subhyracodon tridactylum* in size, with rather unprogressive premolars. The internal cingulum is complete and quite well developed on the upper premolars. P 1/ is relatively small, and simple in the slight development of its protoloph and metaloph. P 2/ is well advanced. Its protoloph and metaloph are parallel, and are separate until an advanced stage of wear. P 3/ is never molariform. Its hypocone is a conical cusp, distinct from both protocone and metaconule until a fairly advanced stage of wear, when it becomes confluent with the protocone. The principal outlet of the median valley is posterior. P 4/ is variable. In A. M. N. H. No. 540, it resembles P 3/ closely, with the hypocone an independent cusp, but more closely attached to the protocone, making the principal outlet of the median valley the posterior one. In the type, A. M. N. H. No. 542, the deepest outlet of the median valley is internal, on both sides. Right P 4/ has the hypocone attached to the metaconule, though it may well have been separate in the unworn tooth. Left P 4/ is more molariform, and resembles some specimens of *Subhyracodon tridactylum.* There is no internal cingulum, except a rudiment in the valley on M 1/ and M 2/. M 3/ apparently has none in the type, but a nearly complete, although rather faint one in the paratype.

In the original description (Osborn & Wortman, 1894), the type is given as No. 545. Osborn (1898, page 140) gives No. 542 as the type. No. 540 is given as co-type (= paratype) in 1894, and in 1898 on page 140. In the same paper, however (Osborn 1898, page 141 and Plates XIII and XVIII), No. 540 is referred to as the type, and No. 542 as the co-type. This confusion can be cleared up definitely, as the type description is of the skull, No. 542, although, by a misprint, it is called No. 545. The set of right cheek teeth, No. 540, is therefore the paratype.

Osborn (1898) described the lower jaw from A. M. N. H. No. 1444. Its most diagnostic character is the large size of the teeth and the jaw.

Amphicænopus platycephalus ? (Osborn and Wortman)

Aceratherium platycephalum Osborn and Wortman. Osborn, 1898, p. 141, A. M. N. H. No. 1478.

This description is based on A. M. N. H. No. 1478, collected by Mr. J. W. Gidley, in 1896, from the Titanotherium Beds, Sand Creek, Hat Creek Basin, Nebraska. I 1/(3)–2, C 0/0, P 4–3/4–3, M 3/3. The specimen consists of the skull with the lower jaw, with P 2/–M 3/ of both sides, left P /4–M /3 and right M /2 and M /3, with cervicals 2–5, and a metatarsal, and both I 1/'s, right I /1–2, left I /1–3, left P /1–3 and right P /2–M /1, represented by their alveoli. The individual was very old, and the teeth are exceedingly worn, so that most of the pattern is obliterated. The following characters are still apparent. The internal cingula on the upper premolars are complete, but not especially prominent. P 4/ has the hypocone still connected with the protocone (although partly separated from it by a groove, internally), allowing the median valley to escape posteriorly. Both third upper molars retain faint traces of the posterior buttress. The upper molars are without an internal cingulum. There are very small alveoli for the third left lower incisor and the first left lower premolar, but there is no trace of either on the right side.

It is rather probable that a younger specimen would show differences of specific value from *Amphicænopus platycephalus*, but it seems best to allow the new species, if it is one, to be founded on some less nondescript type specimen. A younger specimen would be likely to show a closer approach toward *Trigonias paucidens*. If a new species were named from this specimen, the chief character would have to be its horizon. There are minor morphological differences. It is slightly smaller throughout. The mandible is much shallower under P /2. The lower jaw of *Amphicænopus platycephalus*, A. M. N. H. No. 1444, has a double mental foramen under the lower incisor tusk. In this specimen it is single, under P /1 on the left and anterior to P /2 on the right side. The character of this foramen, however, seems to be very variable and of little or no diagnostic importance. Judging from the characters that are still preserved, this form is noticeably more advanced than *Trigonias paucidens*, in the loss of I 3/ (and I 2/??), in the increase in size of the hypocone of P 4/ and in its closer approach to separation from the protocone.

A. M. N. H. No. 12453, collected by Mr. H. F. Wells in 1905, from the Upper Titanotherium Beds, Cane Creek, South Dakota, a very badly damaged lower jaw, has the same abnormally slender rami as No. 1478. This may turn out to be a good specific character.

Amphicænopus ? simplicidens (Cope) 1891 Fig. 43, Osborn, 1898

Cænopus simplicidens Cope. Cope, 1891.

Aceratherium simplicidens (Cope). Osborn and Wortman, 1894.

Cænopus (= *Subhyracodon*) *simplicidens* (Cope). Osborn and Matthew, 1909.

Cænopus simplicidens Cope (of doubtful validity). Troxell, 1921 a.

The holotype is A .M. N. H. No. 10708, from the Oligocene, Big Badlands, S. D., consisting of the third left upper molar with rather more than half of the second left upper molar attached to it. It is not determinable specifically, nor, with absolute certainty, generically. M 2/ has no internal cingulum, M 3/ has a weak one. It is more probably *Amphicænopus* cf. *platycephalus* than anything else, but might almost equally well be referred to as *Trigonias* cf. *osborni* or to *Trigonias* cf. *paucidens*, and other references might be conceivable. The degree of resemblance certainly does not warrant reducing *Amphicænopus platycephalus* to synonymy. This "species" has only an antiquarian interest and should be dropped from faunal lists.

DISCUSSION

There are several interesting conclusions that can be drawn from the last table. It would appear that the ratios Mtc III/R, and, to a lesser extent, Mts III/T, tend to be

Table V a

	Caenopus mitis Paratype A.M.N.H. 6325		Subhyracodon copei Holotype A.M.N.H. 522		Subhyracodon copei A.M.N.H. 6328		Subhyracodon trigonodum Holotype A.M.N.H. 528 Paratype 529		Subhyracodon "trigonodum allum" Holotype Y.P.M. 12052		Subhyracodon occidentale Neotype U.S.N.M. 114		Subhyracodon occidentale A.M.N.H. 6330		Subhyracodon gidleyi Holotype U.S.N.M. 11337		Subhyracodon metaloshum Holotype Y.P.M. 10254	
	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L
$I^1 - C^1$, over all	---	---	48	48	---	---			---	---	---						---	---
A-P diam. I^1	---	---	20.5	18	---	---			23.5	24	---						25	24
Tr. diam. I^1	---	---	9.5	10.5		12.5			10	11	---						11	11
							No. 528											
Crown-length of I^2	---	---	---	---	---	---		7.5	12	13	---						---	---
A-P diam. I^2	---	---	13.5	13.5		17		9	10	13	---						---	---
Tr. diam. I^2	---	---	9.5	9.5		12.5		5.5	7.5	8	---						---	8.5
Crown-length of C^1	---	---	---	---					---	---	---						---	---
A-P diam. C^1	---	--	7.5	5	---	4.5			---	---	---						---	---
Tr. diam. C^1	---	---	6	7	---	7			---	---	---						---	---
Diastema	---	---	36	38	---	34			37	37	---	37					---	36
Length, P^1-M^3	---	---	158.5	158.5	---	---	174	---	---	---	---	182					---	195
Length, P^2-M^3	---	---	145	144	---	----	160.5	163.5	---	---	---	165					183	176.5
Length, P^{1-4}	69.5	---	76.5	76.5	---	---	82.5	---	96	94	85	e 85					---	95
Length, P^{2-4}	58	---	59.5	60	59	---	68.5	69.5	76	73.5	72	67			---	62.6	76	76
Length, M^{1-3}	---	---	84.5	83	---	---	100.5	101.5	---	----	---	100		106.0		---	108	105
Length, P^1	13	---	17	17.5	---	---	17.5	---	20	20	---	e 19			---	---	---	20
Width, P^1	---	---	16.5	16	---	---	18	---	17.5	18	---	---			---	---	---	19.5
Length, P^2	17	---	18.5	20	18	---	20	19.5	23.5	22.5	22.3	20.5			---	19.4	25	28
Width, P^2	23	---	24.5	25	23	--	--	22.5	26	26	---	26			---	25.0	30	---
Length, P^3	19	---	20.5	20.5	19	---	23	22	26	26	21.5	22.3			---	21.0	26	26
Width, P^3	28	---	29.5	29	27.5	---	31	31	33.5	33	---	34.1			---	27.3	36	35.5
Length, P^4	20	20	20.5	21.5	---	---	22.5	23	26	26.5	24.3	25.5		27.0	22	22.6	25.5	27
Width, P^4	33.5	33.5	32	32	---	---	33.5	32	37	37	---	37		36.5	31.8	32	40	39
Length, M^1	27	27	26	25.5	26.5	27	29	28.5	33	33	31	30.5		33.0	29	28.3	34	34
Width, M^1	33	33	32.5	33	31	31.5	36	36.5	37	37.5	---	38.8		---	---	34.0	39.5	39.5
Length, M^2	---	30.5	29	28.5	29.5	---	34	34	37	38	36	34.6		35.7	31	32	36	35
Width, M^2	---	36	35.5	36	e 35	---	38.5	38.5	39.5	40	---	41.5		42.0	36.5	36	39.5	41
Length, M^3	---	---	29.5	29.5	e 33	---	31.5	32	---	---	---	34.5		38.0	---	---	36	35
Width, M^3	---	---	33.5	34	---	---	38.5	39	---	---	---	40.5		39.0	---	---	37	39.5
							No. 529											
Tip nasals to oc. crest	---	---	406.5	402			451	434.5	---	---		----					---	---
Pmx to oc. condyle	---	---	409.5	406.5			---	---	---	---		---					---	e 461
Greatest width across zygomas	---	---	198				198.5		---	---		----					---	---
Depth incision ant. nares	---	---	77.5	73			e 80.5	65.5	67	67		---					---	---
Height occiput above condyle	---	---	116	111.5			115.5	112	---	--		----					150	157
Least width bet. R and L. P^2's	---	---	30.5				41		---	-		24.6					---	---
Least width bet. R and L. M^3's	--	---	52.5				59		---	-		48.4					---	---

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Table V b

	Subhyracodon metalophum A.M.N.H. 1123		*Subhyracodon tridactylum* Holotype A.M.N.H. 538		*Subhyracodon proavitum* Holotype P.U. 10965		*Diceratherium avum* Holotype Y.P.M. 10251		*Diceratherium lobatum* Holotype Y.P.M. 12487		*Amphicaenopus platycephalus* Holotype 542		*Amphicaenopus platycephalus* Paratype A.M.N.H. 540	*Amphicaenopus platycephalus* ? A.M.N.H. 1478		*Amphicaenopus ? simplicidens* Holotype A.M.N.H. 10708
	R	L	R	L	R	L	R	L	R	L	R	L	R	R	L	L
I^1 - C^1, over all	----		56.5	---	---	---	---	---	---	---	---			---	---	
A-P diam. I^1	^{v}22	---	28	29	---	---	---	---	20.5	20	---	---		21.5	21.5	
Tr. diam. I^1	^{v}11.5	---	13.5	12	---	---	---	---	8.5	8.5	---	---		9	9	
Crown-length I^2	----		12	13	---	---	-----		9.5	11	---	---		---	---	
A-P diam. I^2	^{v}18.5	---	9.5	9.5	---	---	----		13	14	---	---		---	---	
Tr. diam. I^2	^{v}9.0	---	8	6.5	---	---	----		7	7	---	---		---	---	
Crown-length C^1	---	---	---	---	---	---	----				---	---		---	---	
A-P diam. C^1	---	---	---	---	---	---	---	---			---	---		---	---	
Tr. diam. C^1	----		---	---	---	---	---	---			---	---		---	---	
Diastema	44.0	---	51.5	60	---	---	---	---	57	51	---	---		107	---	
Length, P^1-M^3		196.5	215	221	---	---	---	---	---	--	236	238	241	234	---	
Length, P^2-M^3	176	176	^{t}198		---	---	---	---	---	---	217	226	220.5	215.5	216	
Length, P^{1-4}		94	^{t}102.5	^{t}107.5	97	98.7	109	111	116	116	94	99.5	116	116.5	---	
Length, P^{2-4}	74.5	73.5	^{t}83.5	^{t}86	76.8	75.6	86	90	83	83	79	86	84.5	87.5	85	
Length, M^{1-3}	106.0	105	^{t}118		---	---	---	---	---	---	138.5	141	136	129	131.5	
Length, P^1	---	21.5	22	23	21.0	21.0	23	25	---	25	---	---	23.5	---	---	
Width, P^1	---	21.0	21	21	20.8	22.4	23.5	21	---	21	---	---	17	---	---	
Length, P^2	22.0	22.0	^{t}24	^{t}26	24.5	24.8	26.5	26	^{e}25	26	---	23.5	23.5	26	26	
Width, P^2	28.5	30.0	^{e}34	---	31.5	32	33	31	33	33	---	36.5	29	33	34	
Length, P^3	26.0	25.0	^{t}29	^{t}29	24.4	25.4	28	30	33	33.5	27.5	27.5	27	30	29	
Width, P^3	37.5	37.0	---	---	37.3	39.0	39.5	39	45	45	---	41.5	40.5	42.5	41	
Length, P^4	25.5	25.5	^{t}31	^{t}31	27.0	27.0	^{d}33.5	^{d}34	34	33.5	33	33	33	31	30	
Width, P^4	40.0	40.5	---	---	43.4	43	^{d}37	---	50	50	49	48	48.5	48	47.5	
Length, M^1	32.5	34	^{t}37	^{t}36	35.4	32.7	38	37	---	45.5	45	44.5	41	37.5	38	
Width, M^1	40.0	39.0	---	---	---	44.5	44	43	.	54	54.5	53	53	51.5	---	
Length, M^2	36.0	36.0	^{t}45	---	38.2	37.5	--	40	—	---	45	47.5	48.5	46	46	
Width, M^2	44.0	44.0	---	---	---	47	46	43	--	53	56	58	58.5	58.5	57	^{e}50
Length, M^3	35.0	35.0	41.5	---	---	---	---	---			48	50	48	47.5	48	42.5
Width, M^3	40.0	40.0	---	---	---	---	---	---			57	56.5	53	57.5	57	47.0
Tip nasals to oc. crest	----		^{e}510	---	496	492	---	---			---	62.5.		---	---	
Pmx. to oc. condyle	468	---	^{e}502	---	---	---	---	---			---	---				
Greatest width across zygomas	----				281		---	---			^{e}360	---		293		
Depth incision ant. nares	----		106	108	105	108	---	---			125	118.5		---	---	
Height occiput above condyle	----		176	---	---	153	---	---			—	141.5+		158+	162.5+	
Least width bet. R. and L. P^2's	^{e}35		---		------		---	---			55					
Least width bet. R. and L. M^3's	63.0		---		------		---	---			83			68		

d, deciduous

e, estimated

t, measured along ectoloph

v, alveoli only

tenta-

Table VI

	Caenopus mitis Holotype A.M.N.H. 6325		Caenopus dakotensis Holotype A.M.N.H. 1110		Subhyracodon trigonodum A.M.N.H. 529		Subhyracodon "trigonodum allum" Holotype Y.P.M. 12052		Subhyracodon tridactylum Holotype A.M.N.H. 538		Amphicaenopus platycephalus A.M.N.H. 1444		Amphicaenopus platycephalus? A.M.N.H. 1478		Amphicaenop platycephal? A.M.N.H 12453	
	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L
Tip I_2 to back of I_3	---	---	---	---	---	---	---	---			---	---	---	---		
Crown length of I_1	---	---	---	---	---	---	---	---	9.0	---	---	---	---	---		
A-P diam. I_1 at root	---	---	---	---	---	---	---	---	7.5	---	6	6	6	6		
Tr. diam. I_1 at root	---	---	---	---	6	5.5	---	---	7.0	---	6	6	6	4.5		
A-P diam. I_2	9	9	9	---	---	14.5	-----		22.0	19.0	---	32.5	24.5	27.5		
Tr. diam. I_2	---	10 +	13	---	---	21	-----		280	30.0	---	38.5	19.5	15.5		
Crown length I_3 from root	---	---	---	---			-----			-----	---	---	---	---		
A-P diam. I_3 at root	---	---	---	---			----			----	---	---	---	6		
Tr. diam. I_3 at root	---	---	---	---			----			----	---	---	---	6		
Diastema	---	---	e22	---	[illegible]	18	----		53.0	66.5	---	73	78	58.5		
$P_1 - M_3$	---	---	---	---			----			----	---	---	---	22.0		
$P_2 - M_3$	---	---	124	e127.5	170	---	- -		203.5	205.5	---	221	213.5	212.5	226	224
P_{1-4}	---	---	---	---			-	---		----	---	---	---	91		
P_{2-4}	---	57	48.5	e50	66	---	---	---	85.0	89.0	---	82	90	82.5		
M_{1-3}	87	---	75.5	77	105.5	---	---	---	122.0	---	---	142	132.5	132		140
P_1, length	---	---	absent		absent		----			----	---	---	---	---		
P_1, width	---	---	absent		absent		----			----	---	---	---	---		
P_2, length	---	14.5	13.5	---	21.5	---	----		26.0	25.0	---	19.5	---	---		
P_2, width	---	8	---	---	12.5	---	----		16.5	---	---	14.5	---	---		
P_3, length	---	19.5	17.0	---	23.5	---	----		31		---	31	---	---		
P_3, width	---	11	13.5	---	16	---	----		---		---	24.5	---	---		
P_4, length	---	18	18.5	18.0	24	---	---	28	31		---	32	---	32.5		
P_4, width	---	12	14.5	14.5	18	---	---	20.5	---		---	30.5	---	27		
M_1, length	25	26	20.0	21.5	28.5	---	33.5	33.5	35.		---	40.5	---	40		
M_1, width	e19	17.5	15.5	---	27	---	21	21	---		---	33	---	32.5		
M_2, length	e28	---	27.5	27.0	37	---	38	36.5	42		---	50	46.5	46		
M_2, width	e19	- -	16.5	16.5	23	---	2[illegible].5	22.5	---		---	36	33	34		
M_3, length	31	---	27	27	40.5	---	---	---	44		---	55.5	51.5	54.5		55.5
M_3, width	e19	---	18	15.5	22	---	---	---	---		---	33.5	32	33		33.[illegible]
Symphysis to angle	---	---	252.5	271.5	331	---	- -	---	---	452	---	529	513	507		
Coronoid above angle	---	---	146 +	140.5 +	180	---	---	170 +	e261		---	---	252.5	249		
Length of symphysis	43	---	48.5		61		----		103		---	125	98.5		100	
Depth ramus below P_2	---	40	38.5	---	45	---	----		70	---	---	84	57	60	---	53
Depth ramus below M_2	---	---	48.5	15.5	62	---	53.5	54	e74.0		---	e93	84	86	63	55

Table VII

	Humerus (H)	Radius (R)	Metacarpal III (Mtc III)	R/H (H=1)	Mtc. III / H (H = 1)	Mtc. III / R (R=1)	Femur (F)	Tibia (T)	Metatarsal III (Mts. III)	T/F (F=1)	MtsIII / F (F = 1)	MtsIII / T (T = 1)
Opsic. (Ceratotherium) simum A.M.N.H. #51358	495	417	187	.85	.38	.45	523	397	175	.76	.34	.44
Opsiceros bicornis A.M.N.H. #27757	475	414	190	.87	.40	.46	495	376	172	.76	.36	.46
Didermoceros sumatrensis A.M.N.H. #54763	412	313	159	.76	.39	.51	446	326	145	.73	.33	.4[illegible]
Subhyracodon tridactylum A.M.N.H. #538	363	289	145	.79	.40	.50	423	353	130	.83	.31	.37
Caenopus mitis, perhaps mixed with S. copei, A.M.N.H. #6325		204					291	234		.80		
Trigonias osborni C.M. # 95	306	262	126.5	.86	.41	.48						
Teleoceras fossiger[x]	305[e]	238	114	.78	.37	.48	408	233	105	.57	.26	.45
Metamynodon planifrons[x] (After Peterson)	393	320	153	.81	.39	.48	480	250	118	.58	.25	.42
Menoceras cooki	250	250	138	1.00	.55	.55	323	275	125	.8[illegible]	.39	.45
Hyracodon apertum P.U. # 11414	227	218	123	.96	.54	.56	260	.230	118	.88	.45	.51
Prothyracodon? obliquidens? C.M. # 2942	140	146	72.5	1.04	.52	.49						
Triplopus cubitalis A.M.N.H. # 5095	112	145	70	1.29	.62	.46						
Hyrachus eximius[x]	197	197	93	1.00	.47	.47	254	243	110	.96	.43	.45
Hyrachus affinis gracilis Y.P.M. #11170		154	79			.51	154		83		.54	
Hyrachus, from Huerfano A.M.N.H. #17435	198.	175.	93.	.88	.4[illegible]	.53	281	235		.84		
Eohippus sp.[x]	121	110	64	.91	.53	.58	162	162	8[illegible]	1.00	.51	.51
Euprotogonia puercensis[x]							105	107	45	1.02	.43	.42

x, after Gregory
e, estimated

quite stable in the Rhinocerotoidea. The great divergence of *Triplopus* in R/H from all other rhinoceroses, even the most highly cursorial, is an evidence of its remarkably high cursorial specialization, which seems even more out of place on account of its very early age. The two living African rhinoceroses are seen to be very close together, throughout. This is probably due to the combination of rather close relationship and generally similar habitus. The striking parallelism between *Teleoceras* and *Metamynodon,* and between *Menoceras, Hyracodon,* and *Hyrachyus,* may be regarded as due solely to convergence in members of the same general group. The first case represents a semi-aquatic, hippopotamus-like development; whereas the second represents a fairly high degree of cursorial adaptation. Various other deductions of a less striking character could be drawn.

The new genus, *Eotrigonias,* throws the first definite light on the Eocene history of the true rhinoceroses. Study of the genus *Trigonias* shows the close resemblance of *Trigonias osborni* to *Eotrigonias rhinocerinus* leading, in the other direction, through *Trigonias paucidens* to the *Amphicænopus* line. The trace of a posterior buttress on M3/ in most specimens of *Trigonias osborni,* as well as its sporadic occurrence in other Oligocene forms, is of considerable interest as showing a retention of, or reversion toward, the primitive condition.

The generic names, *Trigonias, Cænopus* and *Diceratherium* as generally used in the past, represent a horizontal classification and not a vertical, or truly genetic one. *Trigonias* is "multiserial," and *Cænopus* and probably, *Diceratherium* are "polygenetic"; but the American Eocene and Oligocene Rhinocerotidæ as a whole are only multiserial. There is no evidence whatever that they are polygenetic (See Miller, 1923, for definitions of these terms). For this reason, the "*Cænopus*" group is split into three genera, and the splitting off of *Menoceras* from *Diceratherium* is tentatively accepted.

Osborn's division (1898) of the American Oligocene Rhinocerotidæ into two series, largely on the basis of the position of the premolar hypocone, is in part artificial, since this character is chiefly indicative of the stage of evolution. His series "II" is, in all probability, a real one, but his series "I" is composite and artificial. Series "II," the *Subhyracodon copei-Diceratherium armatum* line, has gradually been confirmed in increasing detail.

Osborn's statement (1898) of the methods of metamorphosis of the upper premolars in the Oligocene rhinoceroses can now be restated more clearly and accurately, and in greater detail. (It will be noted that the method differs in almost every respect from that followed by the horses.) The metamorphosis of the upper premolars in the true rhinoceroses, hyracodonts and hyrachyids takes place as follows:

1. The protoloph, consisting of the protocone and protoconule, is the main transverse crest, the metaconule being a minor crest abutting on the protocone. *Hyrachyus, Prothyracodon.*

2. The protocone elongates antero-posteriorly, and the hypocone commences to split off from it. *Eotrigonias, Hyracodon petersoni, Trigonias osborni.* In both these stages, the median valley opens posteriorly.

3 a. The hypocone is, for a time, a separate cusp, conical in *Trigonias gregoryi, Amphicænopus platycephalus,* and elongate in *Metahyrachyus bicornutus.*

3 b. The hypocone unites with the metaconule before separating from the protocone, giving an enclosed basin. *Triplopus ?* (cf. *Lophialetes*), *Hyracodon arcidens, Leptaceratherium trigonodum, Subhyracodon occidentale, Colonoceras agrestis.*

(*Cænopus mitis* is already so progressive, that the question which course its ancestors took must be left open, but, judging from P 3/, it followed 3 b. Osborn's putting this species in "I" is apparently based on the assignment of a specimen of *S. copei* to this species as paratype.

3 x. P 2/ is most progressive, *Trigonias, Amphicænopus, Subhyracodon, Hyracodon petersoni.*

3 y. P 4/ is most progressive. *Hyrachyidæ, Amynodontidæ, Cænopus mitis,* most European true rhinoceroses, *Hyracodon nebraskensis, H. apertus.*

4. P 2/–P 4/ have all become molariform, with the protoloph and metaloph separate and parallel. *H. leidyanus* and the Miocene to recent rhinoceroses.

There does not seem to be any reason to attach profound significance to these differences in the exact order of appearance of equivalent stages in different lines. The hereditary material of these forms must have been fundamentally similar; it is entirely to be expected that the same characters should appear in the various lines, but in different order.

The method of metamorphosis of the upper molars in the Amynodontidæ is uncertain, as they are already well advanced when they first appear. It seems rather likely that the metaloph is developed from the metaconule only, and that no hypocone ever developed, giving still another mode.

Metamorphosis of the lower premolars takes place as follows in the Hyrachyidæ, Triplopodinæ, and Hyracodontinæ:

1. The hypoconid is a simple antero-posterior ridge, well below the level of the trigonid.

2. The entoconid appears as a separate, low, conical cusp.

3. The entoconid elongates transversely, reaching the base of the hypoconid, but not attaining its height.

4. The hypoconid and entoconid fuse into a continuous, asymmetrical crescent, as in the molars.

Judging from the condition in some specimens of *Trigonias osborni,* the earliest true rhinoceros in which the lower premolars are known, the Rhinocerotidæ follow a similar course, except that instead of stage 3, the hypoconid throws off a hook mediad which fuses with the conical entoconid. The method followed by the Amynodontidæ is unknown.

Peterson (1920) and Troxell (1922 a) have endorsed Marsh's suggestion (1877) that the horned rhinoceroses of the Miocene were descended from the horned Eocene forms (*Colonoceras* and *Metahyrachyus*). This seems highly improbable. The horns are rather too far posterior on the nasals to give rise to the condition in *Menoceras.* But a more important objection is the great improbability that the true rhinoceroses are polygenetic, still more that any true rhinoceros could be derived from a Bridger hyrachyid, especially in view of the degree of advancement of the genus *Eotrigonias.* The ancestry of *Diceratherium* (as restricted by Troxell) seems too definitely established to make it necessary to consider this suggestion as applied to it. *Metahyrachyus bicornutus* seems clearly worthy of generic distinction, and shows, as Troxell has pointed out, a number of resemblances to true rhinoceroses. The horn cores are so far posterior, however, that it seems highly unlikely that it could have been ancestral to any other known rhinoceros. Comparison with *Eotrigonias* indicates that it is simply the most progressive of the hyrachyids, paralleling the true rhinoceroses in some respects.

The terms "Diceratheriinæ" and "Aceratheriinæ," when used in their customary complimentary sense for the horned and hornless American forms, are useless and misleading, and should be abandoned. If they are to be replaced at all, which seems of doubtful utility in the present state of our knowledge, they should be replaced by names indicating the separate lines of development.

Phyletic trees are extremely useful, if regarded as tentative summaries of contemporary knowledge. It is much easier to deal intelligently with a group of related forms if they can be visualized as a unified whole, in their probable or possible relations to each other, rather than as a series of isolated items in a card catalogue. And certainly, in principle at least, the phylogenetic viewpoint is closer to the truth. The "family tree" (fig. 1) is given as my interpretation of the most probable relationships of the forms discussed in this paper and of a few others. The assumed lines of descent are based primarily on tooth structure, secondarily on the structure of the limbs. The subdivision of the old "*Cænopus*" agglomeration also coincides with the bodily size of the different groups, giving series of small, intermediate, and very large forms.

In regard to relative level of different forms in the Titanotherium Beds, Dr. Matthew states (verbal communication) that it does not seem possible to correlate, even between finds in different parts of the same general area. He believes that these deposits were made by streams which were constantly shifting their beds, and that the top of the beds in one locality may be equivalent to their bottom a few miles away. However, in the chart, forms from the Titanotherium Beds are placed in the level given by the collector, whenever it was recorded.

SUMMARY

1. During the lower Eocene, the rhinoceroses apparently split into four main lines, the little-modified descendants of the primitive type, the Hyrachyidæ; the Amynodontidæ; the Hyracodontidæ, which shortly split into two divergent lines, the Hyracodontinæ and the Triplopodinæ; and the Rhinocerotidæ.

2. The Hyrachyidæ kept most of their primitive heritage. The manus was always tetradactyl. No teeth were lost, except P /1. The premolars never became molariform. The cusps of the upper molars never fully lost their separate identity by fusion into lophs.

3. The Amynodontidæ increased progressively in bulk. The tetradactyl manus was retained, and horns were never developed. The canines and molars increased enormously in size, whereas the incisors and premolars were reduced in number and size.

4. The Hyracodontidæ developed cursorially, with tridactyl manus. The Hyracodontinæ achieved moderate cursorial specialization and the premolars became progressively molariform. The Triplopodinæ developed aberrantly, achieving great cursorial specialization associated with primitive or aberrant premolar characters.

5. The Rhinocerotidæ, appearing in the Middle Eocene of America, developed, first as tetradactyl, then as tridactyl forms, with I 1/ and I /2 greatly enlarged, and with progressive reduction of the other front teeth. The posterior buttress of M 3/ was soon lost. In the Oligocene of North America, there were three main lines of evolution, the small forms such as *Cænopus mitis* with P 2/ and P 4/ molariform; the larger forms such as *Subhyracodon occidentale,* in which metamorphosis commenced with P 2/, and the still larger series including *Trigonias* and *Amphicænopus platycephalus,* in which the premolar metamorphosis was much retarded.

6. Premolar metamorphosis in the rhinoceroses seems to occur as follows. In the upper teeth, the protocone elongates antero-posteriorly, and develops an incipient separation across the middle, marking off the posterior half as the hypocone. Either at this stage, or else after the separation is complete, the metaconule becomes attached to the hypocone, forming a complete metaloph. As a result, the median valley opens internally instead of posteriorly. There is a gradual backward rotation of the metaloph, until it becomes approximately parallel with the protoloph. This is accomplished partly by backward migration of the hypocone, partly by shifting the outer attachment of the metaconule anteriorly.

Metamorphosis of the lower premolars takes place as follows in the Hyrachyidæ, Triplopodinæ, and Hyracodontinæ:

1. The hypoconid is a single, antero-posterior ridge, well below the level of the trigonid.

2. The entoconid appears as a separate, low, conical cusp.

3. The entoconid elongates transversely, reaching the base of the hypoconid, but not attaining its height.

4. The hypoconid and entoconid fuse into a continuous, asymmetrical crescent, as in the molars.

Judging from the meagre evidence, the Rhinocerotidæ follow a generally similar course, except that instead of stage 3, the hypoconid sends of a hook mediad, which fuses with the conical entoconid. The method followed by the Amynodontidæ is unknown.

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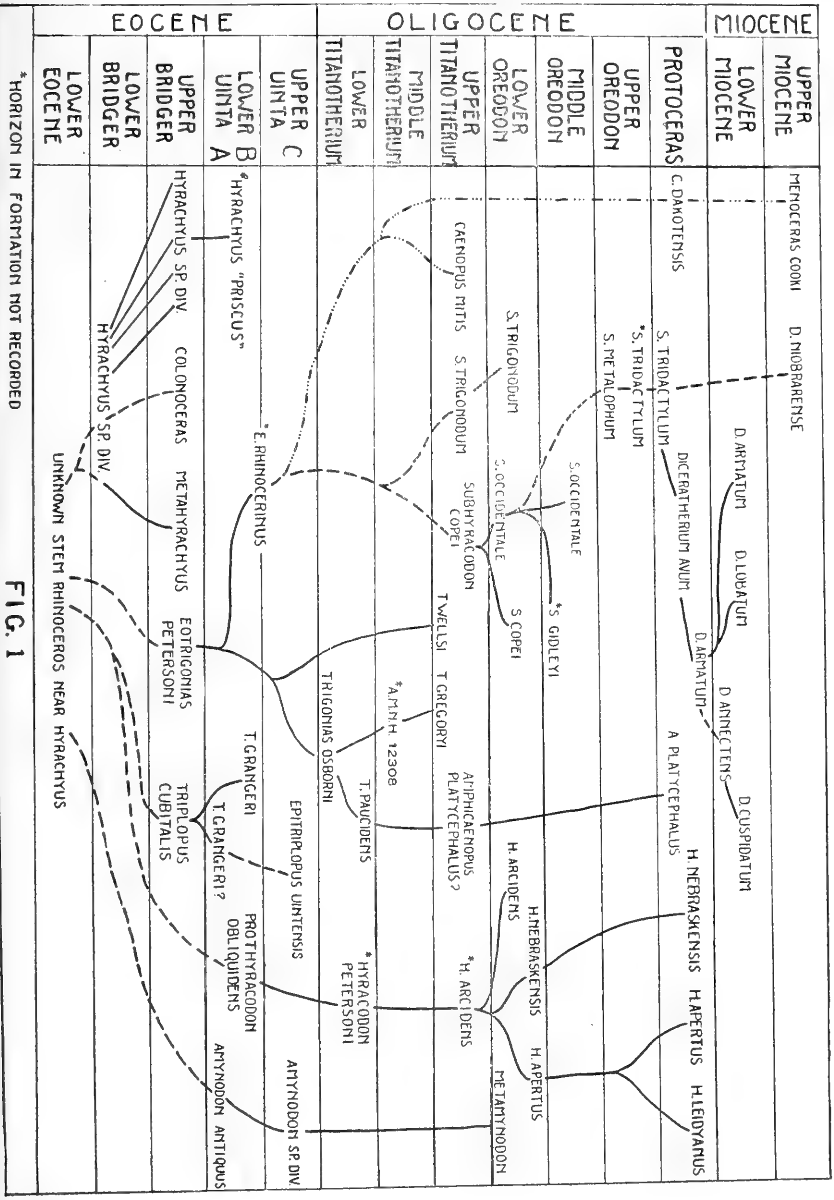
THE END

Explanation of Figures

EXPLANATION OF

PLATE 1

Fig. 1. Phylogenetic Chart. Page 81.



*HORIZON IN FORMATION NOT RECORDED

FIG. 1

EXPLANATION OF

PLATE 2

FIGURE

2. *Triplopus cubitalis,* type, A. M. N. H. No. 5095, right manus, x 1.

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3. *Triplopus cubitalis,* type, A. M. N. H. No. 5095, L P 1/–M 3/ (M 2–3/ reversed from right side), x 1.
4. *Triplopus cubitalis ?* A. M. N. H. No. 2344, R C /1–M /3, x 1.
5. *Triplopus grangeri,* type, A. M. N. H. No. 1972, R M /1–3, x 1.
6. *Triplopus grangeri,* type, A. M. N. H. No. 1972, L P 4/–M 3/, x 1.
7. *Triplopus grangeri ?,* C. M. No. 2336, L P 3/–M 3/, x 1.

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8. *Hyracodon nebraskensis,* A. M. N. H. No. 12460 L I /1–C /1, x 1.

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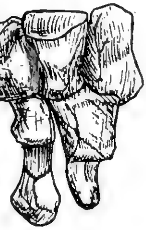

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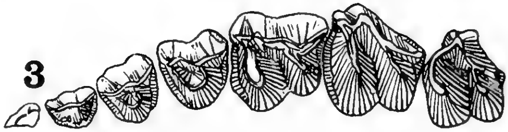

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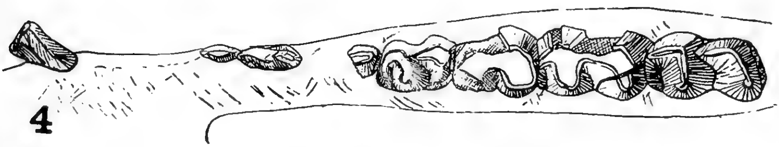

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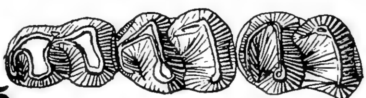

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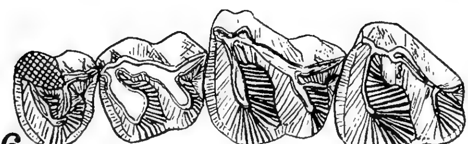

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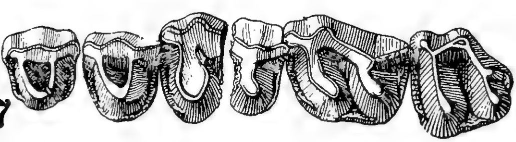

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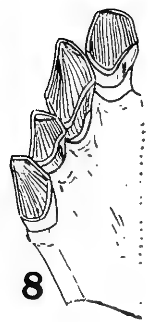

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EXPLANATION OF
PLATE 3

FIGURE

9. *Epitriplopus uintensis*, type, C. M. No. 3007 a,
L P 1–3/,–d P 4/, M 1–3/, x 1.
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10. *Prothyracodon obliquidens*, A. M. N. H. No. 1971,
R P 2/ – M 3/, x 1.
11. *Prothyracodon obliquidens*, A. M. N. H. No. 1971.
L P /1 – M /3, x 1.
Page 22

12. Young *Hyracodon* sp., C. M. No. 318,
L d P /3 – M /1, x 1.
13. Young *Hyracodon* sp., C. M. No. 3581,
L d P /4 – M /1, x 1.
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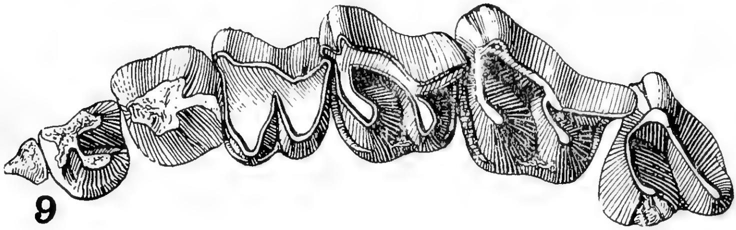
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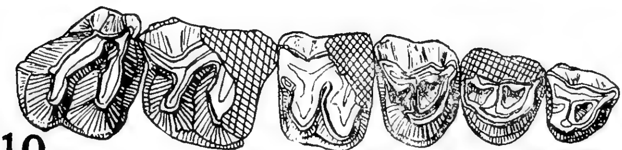
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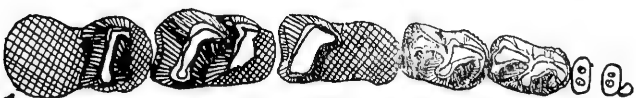
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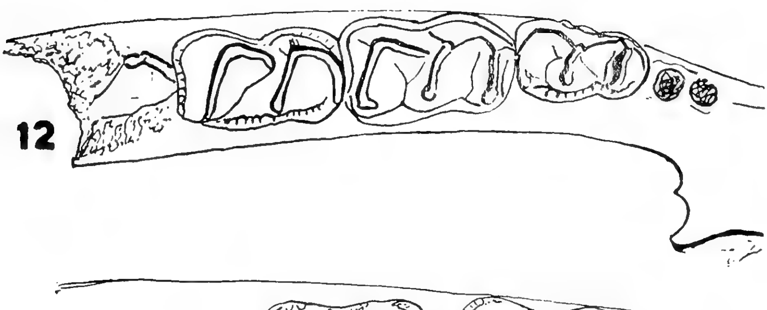
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EXPLANATION OF
PLATE 4

FIGURE

14. *Triplopus grangeri ?*, C. M. No. 3110,
R P 3/ – M 2/, x 1.
15. *Triplopus grangeri ?*, C. M. No. 3110,
L P /2 – M /3, x 1.

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16. *Eotrigonias petersoni*, type, A. M. N. H. No. 2341,
L P 4/ – M 3/, x 1.

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17. *Eotrigonias rhinocerinus*, type, Y. P. M. No. 13331,
L P 2/ – M 3/, x 1.
18. *Eotrigonias rhinocerinus*, type, Y. P. M. No. 13331,
R M 3/, x 1.
19. *Eotrigonias rhinocerinus*, type, Y. P. M. No. 13331,
R P /4 – M /3, x 1.

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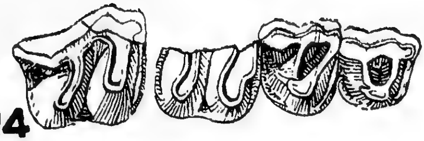

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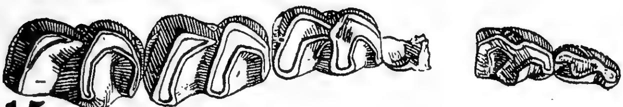

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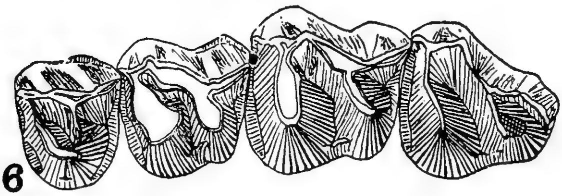

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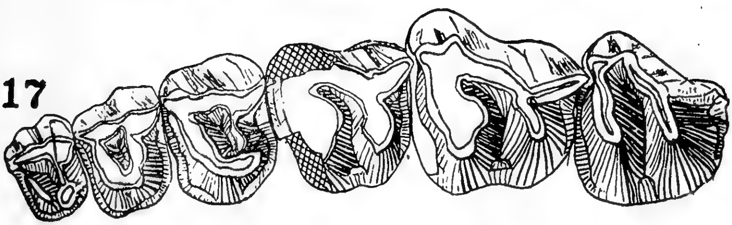

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EXPLANATION OF
PLATE 5

FIGURE

20. *Trigonias osborni*, type, U. S. N. M. No. 3924, L P 1–3/, x ½.

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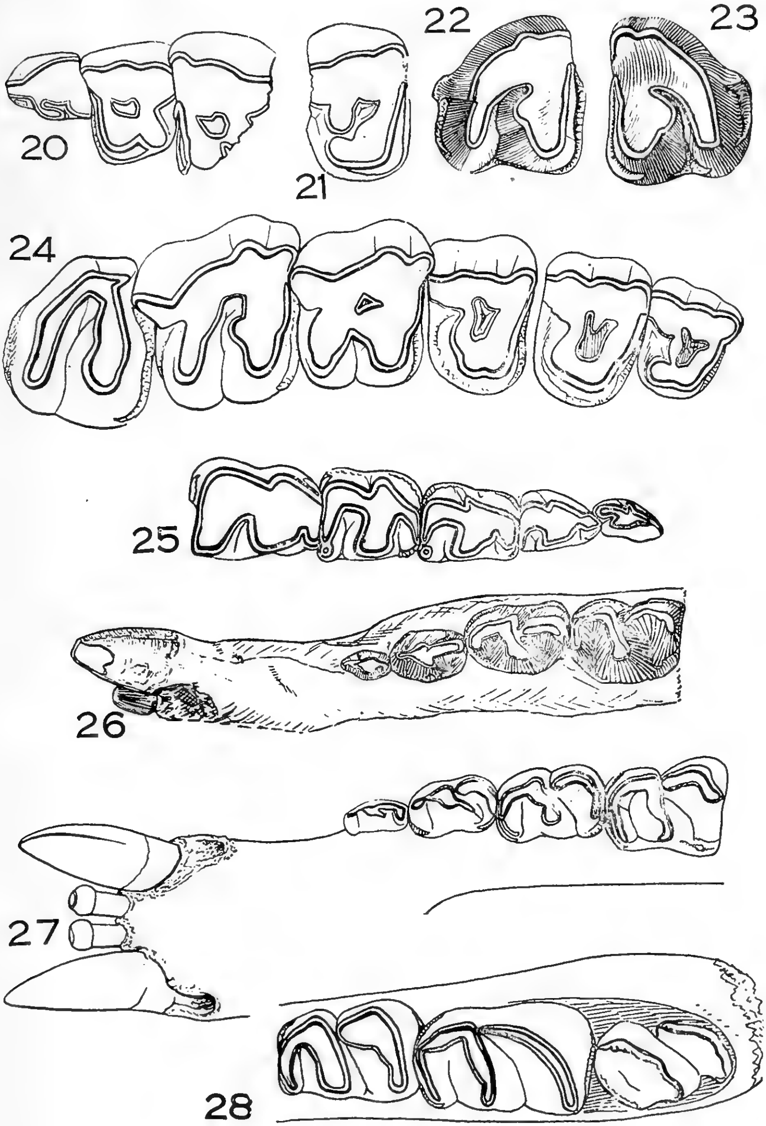
21. *Trigonias osborni*, type, U. S. N. M. No. 3924, R P 3/, x ½.
22. *Trigonias osborni*, C. M. No. 95, R M 3/, x ½.
23. *Trigonias osborni*, C. M. No. 95, L M 3/, x ½.
24. *Trigonias osborni*, C. M. No. 98, R P 2/ – M 3/, x ½.
25. *Trigonias osborni*, U. S. N. M. No. 4815, L P /1 – M /1, x ½.
26. *Trigonias osborni*, A. M. N. H. No. 9792, R I /1 – P /4, x ½.
27. *Trigonias osborni*, C. M. No. 97, lower incisors and R P /1–4, x ½.
28. *Trigonias osborni*, C. M. No. 97, R M /1-3, x ½.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EXPLANATION OF

PLATE 6

FIGURE

29. *Subhyracodon gidleyi*, type, U. S. N. M. No. 11337, R P /2, x ½.
30. *Subhyracodon gidleyi*, type, U. S. N. M. No. 11337, L P /3, x ½.
31. *Subhyracodon gidleyi*, type, U. S. N. M. No. 11337, L P 2/ – M 3/, x ½.

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32. *Trigonias wellsi*, type, A. M. N. H. No. 13226 (1), L I 1/, I 3/, d C 1/, C 1/, x ½.
33. *Trigonias wellsi*, type, A. M. N. H. No. 13226 (1), L P 1–4/, x ½.

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35. *Trigonias paucidens*, type, A. M. N. H. No. 11865, R-I 2–3/, L I 3/, x ½.

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38. *Trigonias gregoryi ?*, A. M. N. H. No. 13226 b, R P /1-3, d P /4, x ½.

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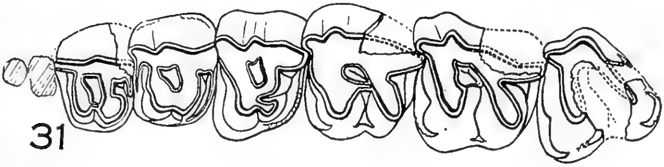

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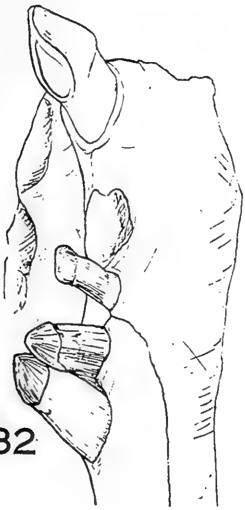

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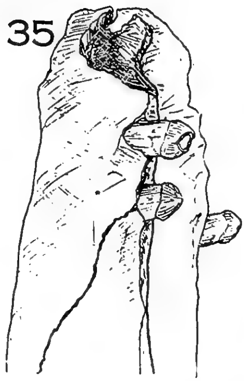

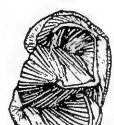

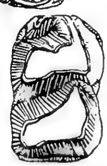

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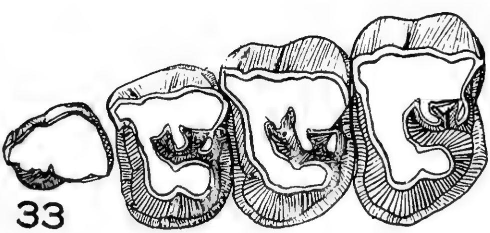

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EXPLANATION OF

PLATE 7

FIGURE

34. *Trigonias wellsi*, type, A. M. N. H. No. 13226 (1), L M 1–/, x ½.

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36. *Trigonias paucidens*, type, A. M. N. H. No. 11865, R P 1–4/, x ½.

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37. *Trigonias* sp., A. M. N. H. No. 12308, L P 4/, x ½.
39. *Trigonias gregoryi*, type, A. M. N. H. No. 13226 a, L P 1–4, x ½.
40. *Trigonias gregoryi*, type, A. M. N. H. No. 13226 a, L M 1–3/, x ½.

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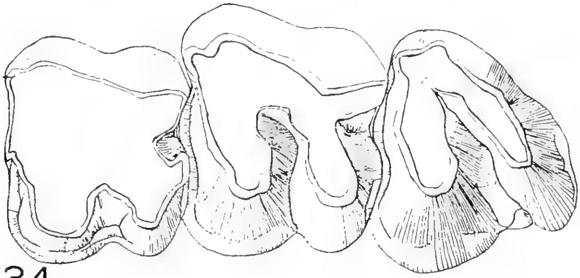

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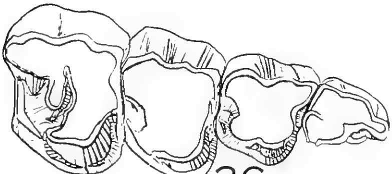

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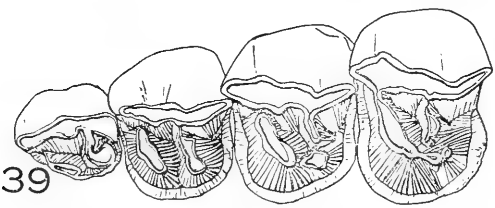

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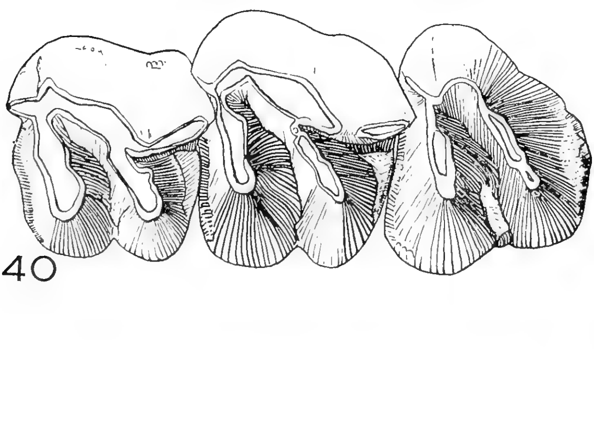

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Note:—Numerals refer to the continuous paging and not to the separate bulletins.

Ordinary numerals refer to paging; heavy, to plate numbering.