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Nomenclatorial Notes On Eocene Mollusca

By

Katherine VanW. Palmer

July 1, 1938

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Ithaca, New York,
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NOMENCLATORIAL NOTES ON EOCENE MOLLUSCA

By

Katherine Van Winkle Palmer

At the time of the publication of the monograph on the Clai-bornian fauna[1] the reference showing *Cœlatura* Conrad, 1865[2] was preoccupied, had not been found. Since that time the author has located the citation which Conrad probably had in mind when he changed the name of the genus to *Actæonema.*[3]

The confusion in connection with these two names has been discussed in detail by the writer in the work on the fauna of the Claiborne and will not be repeated here. Conrad himself used *Cœlatura* previously in 1853[4] for a Naiad. *Actæonema* is therefore a substitute name for *Cœlatura* Conrad, 1865 and the problem of its genotype falls in that category. The one interpretation which was suggested on p. 156 of the Claiborne work may be eliminated.

Aldrichia Palmer[5] is preoccupied by *Aldrichia* Coquillett[6] in insects and Vaughan[7] in corals. *Aldrichia* Palmer is herein renamed *Timothia.*

Attention is called to the reference by J. W. Taylor[8] on the dates of the publication of the various parts of Moquin-Tandon's "Histoire Naturelle des Mollusques Terrestres et Fluviatiles de

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[1] Palmer, K. V. W., Bull. Amer. Pal., vol. 7, No. 32, p. 154, 1937.
[2] Conrad, T. A., Amer. Jour. Conch., vol. I, pp. 28, 35, 1865.
[3] Conrad, T. A., *ibid,* p. 147.
[4] Conrad, T. A., Acad. Nat. Sci., Phila., Proc. vol. 6, p. 268, 1853.
[5] Palmer, K. V. W., Bull., Amer. Pal., vol. 7, No. 32, p. 262, 1937.
[6] Coquillett, D. W., Trans. Amer. Entomol. Soc., vol. XXI, p. 93, 1894.
[7] Vaughan, T. W., U. S. Geol. Sur., Mon. vol. XXXIX, p. 70, 1900; Proc. Biol. Soc. Wash., vol. XVI, p. 101, 1903. *Aldrichia* Vaughan renamed.
[8] Taylor, J. W., Proc. Mal. Soc. London, vol. 6, p. 186, 1904.

France." The six parts were issued April 12, May 4, August 1, September 10, 1855; January 2, April 9, 1856 respectively. These dates definitely establish the priority of *Papillina* Conrad, January, 1855[9] over *Papillina* Moquin-Tandon, 1855.

F. Stearns MacNeil, United States National Museum pointed out to the writer that Herrmannsen[10] designated a type for *Clavilithes* Swainson, 1840 previous to other designations. Herrmannsen's statement of type was overlooked in the discussion of of the Claibornian *Clavilithes* by the author[11] and the work of Grabau[12] was followed. The problem of *Clavilithes* Swainson. 1840[13] begins with *Clavella* Swainson, 1835[14] for which it was a substitute name. However, it does not seem that with the exception of one genus (p. 7,"*Trochilea,* type *Trochus pileus.* Auct.") Swainson's "Elements of Modern Conchology" can be used for generic names without difficulty. He did not mention any specific names or references (exception p. 14, *Mitreola,* reference given). The generic names are descriptions without species and would therefore require special ruling as under Int. Rules Zool. Nomenclature Opinion No. 46. In case of *Clavella,* the description reads, p. 20, "The genus *Fusus,* again, has no plaits; it is so closely allied to the fossil genus *Clavella* (here now first defined), that there can be no doubt of its entering within the limits of this group"; p. 21, "*Clavella* Sw. Fuciform [fusiform]; channel long; no plaits, but the tip of the spire enlarged. Fossil only."

It appears that even though *Clavilithes* Swainson, 1840 was a substitute name for *Clavella* Swainson, 1835, since *Clavella* has no species, *Clavilithes* must take its type from the species mentioned under its own description and the type so established becomes the type of both genera (Int. Rules Zool. Nomen., Art. 30, f.).

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[9] Conrad, T. A., Acad. Nat. Sci., Phila. Proc. vol. 7, p. 262, 1855; Palmer, K. V. W., Bull. Amer. Pal. vol. 7, No. 32, p. 363, 1937.

[10] Herrmannsen, A. N., Indicis Generum Malacozoorum, vol. I, p. 246, 1846.

[11] Palmer, K. V. W., *ibid,* p. 356.

[12] Grabau, A. W., Smith. Misc. Coll., vol. XLIV, p. 104, 1904.

[13] Swainson, Wm., A Treatise on Malacology etc., p. 304, 1840.

[14] Swainson, Wm., Elements of Modern Conchology, pp. 20, 21, 1835.

Herrmannsen designated *Fusus noæ* (Chem.). This is a valid designation as *F. noæ* was listed in Swainson's original description of *Clavilithes,* 1840. The characters of *F. noæ* disagree with the original description of *Clavella* because *F. noæ* (Chem.) Lam. has plications on the columella during part of its life history, such disappearing with maturity. Mr. A. Wrigley, England[15] who was consulted in this matter has expressed the opinion that such a noncomformity eliminates the use of *F. noæ* (Chem.) Lam. as genotype of *Clavilithes.* This is the reasoning which Grabau[16] also used. The writer does not favor this interpretation because of the vagueness of the type of *Clavella* Swainson, 1835.

Using *F. noæ* Lam. as the genotype of *Clavilithes* Swainson causes a change in the current idea of the genus as well as a conflict with the subsequently named genus *Rhopalithes* Grabau,[17] type *F. noæ* Lam.

Rhopalithes Grabau becomes synonymous with *Clavilithes* Swainson, 1840 and the forms of *Clavilithes* typified by *C. parisiensis* (Mayer-Eymar)=*C. longævus* (Desh.) *non* Solander are without a generic or subgeneric name. It is in this last nonplicate group that the Claibornian species belong. However, there is some doubt that *Clavilithes* needs to be separated on the character of the columellar plications, particularly when those specimens which do have plications in the young stages of growth lose them in the adult.

The presence or absence of columellar plications cannot always be taken as a factor of generic differentiation in the gastropods. A typical example of a genus including plicate and nonplicate shells is the Claibornian Eocene genus *Mazzalina* Conrad, 1860 =(*Bulbifusus* Conrad, 1865).[18] Conrad made two genera on characters which are now known to be only specific and in some cases may not even be specific.

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[15] Personal letter, May 7, 1938.

[16] Grabau, A. W., *ibid,* p. 104.

[17] Grabau, A. W., *ibid,* p. 135.

[18] Harris, G. D., Ark. Geol. Sur., Ann. Rept. State Geol., vol. II, p. 165, 1892; Palmer, K. V. W., *ibid,* p. 349.

The problem of *Clavilithes* is already too complicated to be burdened with more names without further complete and thorough work. Until then, the author prefers to use *Clavilithes* Swainson, 1840, (=*Rhopalithes* Grabau, 1904) genotype by subsequent designation, Herrmannsen, 1846, *Fusus noæ* (Chem.) Lam. to include the nonplicate forms of *C. parisiensis* (Mayer-Eymar). Wrigley's[19] criticism of Grabau's study of the phylogeny of *Clavilithes* shows that additional investigation must be made on the group before a satisfactory conclusion is reached.

Since needless time is wasted in searching for *Eulimella* Forbes, 1846, as given by authors[20] it seems worthwhile to reiterate Iredale's[21] affirmation that no such reference exists. One will find that there is an article by Forbes in the Ann. Mag. Nat. Hist., vol. XIV, p. 412 but the genus *Eulimella* is no where mentioned in the article. The date of the reference is 1844 instead of 1846. Malaconchologists as H. and A. Adams, Fischer, Bucquoy, Dautzenberg and Dollfuss, Tryon, Sacco, Cossmann and many other standard authors continued the error in their work. According to Iredale, Jeffreys[22] was the first to mention *Eulimella* in literature. Jeffreys was followed by Gray[23] in the same year. Gray gave the name and selected a type. Iredale suggested that the name *Eulimella* as ascribed to Forbes was a manuscript name. Such a supposition appears reasonable for particularly Jeffreys was assisting Forbes[24] in the work on the British Mollusca. Iredale prefers to give Gray credit for publishing the genus. Thiele[25] in his Handbuch assigns the genus to Gray. However, it seems to the author that Jeffreys' reference of *Eulimella* is legitimate but with no designation of type. He states "*Eulimella* (Forbes)

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[19] Wrigley, A. G., Proc. Mal. Soc. London, vol. XVII, pp. 222, 234-237, 1927.

[20] Dall, W. H. and Bartsch, P., Bull. U. S. Nat. Mus., No. 68, pp. 10, 17, 1909. See Iredale, T., The Nautilus, vol. XXIV, No. 5, p. 53, 1910 for previous references.

[21] Iredale, I., *ibid*, p. 53.

[22] Jeffreys, J. G., Ann. Mag. Nat. Hist., vol. XIX, p. 311, May, 1847.

[23] Gray, J. E., Proc. Zool. Soc. London, pt. XV, p. 160, Nov. 9 (read), 1847.

[24] Jeffreys, J. G., *ibid*, p. 309.

crassula, Mal. and Conch. J. *E. MacAndrei,* Forbes in Ann. Nat. Hist., vol. XIV, p. 412 . . . .

Eulimella gracilis . . . . ." (Followed by a description of this last species.)

Authors[26] believe that the *E. crassula* Jeffreys equals *E. MacAndrei* Forbes and is the same as *E. scillæ* (Scacchi). *E. scillæ* (Scacchi) is the species which Gray used as the type of his *Eulimella* and it is the species which is commonly used when the genus is assigned to Forbes. Fortunately therefore the same species can be designated as the type of *Eulimella* (Forbes) Jeffreys and the established characters of the genus need not be disturbed. To bring this about, in case the authority of the genus is granted Jeffreys, the genotype of *Eulimella* (Forbes) Jeffreys, 1847 is herein designated as *E. crassula* (Jeffreys)=*E. MacAndrei* (Forbes)=*E. scillæ* (Scacchi). Recent. Great Britian and Scandinavia. Pliocene and Pleistocene of Italy and Sicily.

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[25] Thiele, J., Handbuch der Systematischen Weichtierkunde, pt. 1, p. 236, 1929.

[26] Forbes, E. and Hanley, S., Hist. British Moll., vol. III, p. 309. 1851; Dall, W. H. and Bartsch, P., U. S. Nat. Mus., Bull. No. 68, p. 10, 1909.

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Devonian Crinoids from the Mackenzie River Basin, N. W. T., Canada

By
Winifred Goldring

August 15 1938

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Ithaca, New York,
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DEVONIAN CRINOIDS FROM THE MACKENZIE RIVER BASIN, N. W. T., CANADA

By

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Recently a collection of crinoids from the Great Slave Lake region, Mackenzie River basin, Northwest Territories, Canada, was submitted to the writer for study by Doctor E. M. Kindle, Victoria Memorial Museum, Ottawa. Of this collection he writes, "The horizon is probably not far from that represented by crinoids described and figured by Springer in two of our reports".

In 1921 Springer described two new species *Melocrinus borealis* and *M. canadensis* collected by E. J. Whittaker from the Hay River section, the former below the Alexandra falls and the latter above the falls (ref. cit., p. 17). The Hay River section from which the crinoids were obtained was studied by Kindle who referred (1919, p. 4) the beds to the Upper Devonian, having found a characteristic Portage fauna in the Simpson shale below the strata from which the crinoids came. *Melocrinus borealis* is represented in the present collection from locality 7005, bed *h*, Lady Evelyn Falls section of the Kakisa River; a few plates from locality 7300, the gorge section of the Redknife River are doubtfully referred to *M. canadensis.* Springer relates *M. borealis* to *M. tersus*, a Missouri form described by Rowley (1893, p. 303; 1894, pp. 151, 153) from shales considered of Middle Devonian (Hamilton) age by early geologists and by later authorities of younger age (*see* Keyes 1894, p. 43; 1902, p. 271-273; Greger 1909, p. 374; Schuchert 1903a, p. 143, 1903b, p. 545; Weller, 1909, p. 264; Branson 1923, pp. 44-46). Springer concludes, "it is clear that the fossils of the Missouri and Mackenzie Devonian belong to the same palaeontological province, and are of approximately the same age" (ref. cit. p. 15).

In his later paper (1926) Springer adds three new species of *Melocrinus*: *M. kindlei* and *M. mackenzie* from the coral reef in limestone above the horizon of the Simpson shale, Root River section; and *M. whittakeri* from the beds at least 300 feet above the Simpson shale in the Trout River section. No specimens of *M. kindlei* appear in the collection, and only a single specimen that can be referred to *M. mackenzie* was found and this in the crinoid bed at the upper falls of the Redknife River. At least three specimens from the Redknife River section, in the crinoid bed at the upper falls, have been referred to *M. whittakeri*. Three new species, *M. subtilistriatus, M. sulcosutura* and *M. humei,* are here added from the Redknife River crinoid bed.

Springer also describes (p. 132) one species of *Hexacrinus* (*H. humei*); but *Melocrinus* is the only camerate genus represented to any extent in the three collections and it is so far represented by eight species. Except for *M. borealis* which shows close relationship to species of Iowa, Missouri and Wisconsin, as pointed out by Springer (1926, p. 127), the species of *Melocrinus* are "not only thoroughly distinct from that, but also from each other. And the interesting thing about them from a geological point of view is that in the characters by which they differ so completely from all other known American species, the three . . species [*M. kindlei, M. mackenzie* and *M. whittakeri*] exhibit a tendency to an asymmetrical construction of the calyx which is not observed among the abundant species of the Eifel limestone of the Middle Devonian, but which developed in certain species belonging to the Frasnian (or lower) member of the Upper Devonian in Belgium [*M. konincki, M. hieroglyphicus* (*non* Goldf.) Fraipont=*M. dewalquei* von Koenen, *M. benedeni* and *M. mespiliformis*]" (*see* also p. 129; Fraipont, 1883; Von Koenen, 1886). *M. borealis* has a similar, though less marked tendency to asymmetry of the calyx, and in the three new species described here it as well-marked as in the others. The single specimen of *Hexacrinus* in the collection studied by Springer (1926) represents "another very prevalent Middle Devonian genus in the Eifel, but rare in America,

. . . of a type completely different from that of the Eifel, but which is also represented in the Upper Devonian rocks of Belgium" (p. 127).

In the collection under consideration inadunate species of crinoids are represented from Lake Kakisa, one half mile back from the south shore, west end; the gorge section of the Bouvier River and eight miles above the mouth; above the upper falls of the Redknife River, in the gorge section and at the third chute. A single specimen representing the Flexibilia was collected from the crinoid bed near the base of the coral zone, Jean Marie River, and a starfish was found loose in the Trout River section, at the foot of the long heavy rapid, one half mile below the lower cascade. Only portions of the vertical side of two arms of the starfish are preserved, and not in very good condition, so that this species has not been placed.

The collections studied by Springer were made by E. J. Whittaker in the Hay River and Trout River sections; by G. S. Hume for the Root River section. In his later paper (1926, p. 128) Springer has incorporated notes by Mr. Whittaker and Mr. Hume, relative to the stratigraphy of the crinoid-bearing beds. The present collection, in so far as labelled, was collected by E. J. Whittaker. The species of crinoids described in all collections so far submitted for study are

CAMERATA

Melocrinus borealis Springer
M. canadensis Springer
M. kindlei Springer
M. mackenzie Springer
M. whittakeri Springer
M. sulcosutura Goldring
M. subtilistriatus Goldring
M. humei Goldring
Hexacrinus humei Springer

FLEXIBILIA

Synaptocrinus (?) rotundatus Goldring

INADUNATA

Undetermined sp.
Decadocrinus spinobrachiatus Goldring
Prininocrinus robustus Goldring
Linocrinus kindlei Goldring

DESCRIPTION OF SPECIES

CAMERATA

Melocrinus canadensis Springer

Melocrinus canadensis Springer, Geol. Surv., Canada, Bul. 33, p. 17, pl. 1, fig. 3, 1921.

Melocrinus canadensis was based by Springer upon a single specimen lacking basal plates and only partly free from the matrix. In this collection, from the Trout River section at the third falls (loc. 6978), are a few radial and interradial plates, partly separated, which might be referred to this species and then only with doubt.

The only description given with the figure is that this species is of a larger and more robust type with very low plates, in the flatness of which "this form is comparable with one from the Hamilton of western New York figured by Hall, but never described, under the name *M. breviradiatus*" (ref. cit., p. 17). The form figured by Hall in 1872 (pl. 1, figs. 18, 19) has since been described and refigured by the writer (1923, p. 127-130, pl. 13, figs. 1 2). There is even more resemblance to *Melocrinus clarkei* (Hall Ms) Williams from Genesee and Portage beds of the Upper Devonian of western New York (*see* ref. cit., p. 132-136, pl. 13, figs. 3-5; pl. 14). The figured specimen of *M. canadensis* shows a short anal tube, not characteristic of the other species under discussion nor found in any of the specimens in this collection.

Melocrinus whittakeri Springer

Melocrinus whittakeri Springer, Geol. Surv., Canada, Bul. 42, pp. 131, 132, pl. 24, figs. 14-17, 1926.

Melocrinus whittakeri was based by Springer upon three well-defined specimens in which the characters are thoroughly constant. The holotype came from the Trout River section, about 15 miles above its confluence with the Mackenzie, "from beds at least 300 feet above the Simpson shale and thought to be somewhat higher than the *M. borealis* horizon of the Hay River, Upper Devonian" (ref. cit., p. 132). In discussing the relationship of this species with *M. kindlei* and *M. mackenzie* from the Root River section Springer states that it is "readily distinguished from them and all others known by its marked ovoid contour, and extremely small column facet, which indicates a considerably different type of column from that of the genus as generally found. The tendency is usually to a broad base. None of the Belgian species is at all similar to this except in asymmetry" (ref. cit.).

In the collection submitted by Dr. Kindle are at least three specimens that might be referred to *M. whittakeri*, but from the same crinoid bed were collected three new species all showing a small column facet and two of them with elongate ovoid calyx. These new species are, however, easily distinguished from *M. whittakeri*.

One of the specimens referred to this species is abnormally large, measuring 27 mm. to the arm bases with a broken basal cup. The second specimen has a height for the calyx of 28.2 mm. (24 mm. to arm bases); the third 25.5 mm. (22.2 mm. to arm bases). All the specimens, therefore, are larger than those described by Springer; and the writer believes that they are more mature forms, as indicated by the character of the plates. Secondary thickening of crinoid plates develops in older forms sometimes with quite striking difference in plate characters. Springer describes the plates of the calyx as "smooth or slightly rugose, flat, with a slight tendency to pitting at the angles, but without convexity or median elevation either in dorsal cup or tegmen" (p. 131). In these three specimens the pitting at the corners is well shown. Thickening of the plates is seen at the margins, and there is a central raised area or flattened tubercle surrounded by a slight depression due to the thickening at the margins. In the second largest specimen an occasional plate shows a more prominent central tubercle.

Horizon and locality.—From the crinoid bed at the upper falls, Redknife River, locality 7288.

Melocrinus subtilistriatus n. sp. Plate 1, figs. 1-5

In the collection submitted by Dr. Kindle are a fairly large number of specimens which in the shape of the calyx and the small column facet bear a strong resemblance to *M. whittakeri.* This appears to be a smaller species. The specimens are of medium size, average calices measuring between 20.2 mm. and 22 mm. high with a width at the arm bases from 15.7 mm. to 18 mm. Two particularly large specimens have heights of 24.6 mm. and 25 mm. All the specimens have asymmetrical, elongate ovoid calices contracting more or less strongly below to a very narrow base, with the characteristic small column facet, and also between the rays into the very low tegmen with subcentral anal opening without a tube.

Specimens in this collection, if seen alone, might give the impression of being varieties of the species, or even different species, because of the presence in some of faint stellate ornamentation, in others of raised ridges and more tumid plates. However, the writer has picked out a series showing the relation of one stage to the next. One specimen shows the "smooth or slightly rugose, flat plates", referred to by Springer (1926, p. 131) in his description of *M. whittakeri,* with pitting at the angles. Closer inspection shows remnants of delicate carinæ crossing the suture lines, particularly well shown on the radials, first primibrachs and primary interbrachials. A second specimen shows beautifully a delicate ornamentation of groups of two or three fine carinæ extending from center to center of the basals, radials, first primibrachs and primary interbrachials. Usually the center ridge of each group is stronger. The higher plates of the radial and interradial series have strong ridges, usually only one running from center to center with an accompanying deeper pitting at the angles. As the individuals grew older changes in the character of the ornamentation took place, well-shown in the selected series of specimens. The carinæ thicken into ridges with the development of a low ridge following each radial series. Sometimes there is developed a central blunt tubercle, marking the junction of the carinæ at the center of the plates, particularly the primary interbrachials, and with this a rugose character is given to the plates. As this thickening process continues the plates become quite tumid, with the presence of carinæ indicated, if at all, only at the sutures and on the higher interbrachials, especially of the anal interradius. Thickening of the plates at the margin tends to develop depressed sutures.

Horizon and locality.—The cotypes are from locality 7288, the crinoid bed at the upper falls, Redknife River. There are other specimens from the same locality and from locality 7291, bed marked *e* (field No. 267), ¼ mile below the upper falls, Redknife River; probably also from locality 7005, bed *h*, Lady Evelyn Falls section, Kakisa River.

Remarks.—The specific name is given because of the finely striated character of the ornamentation which distinguishes this species from both *M. whittakeri* and *M. sulcosutura.*

Melocrinus sulcosutura n. sp. Plate 1, fig. 6

From the same crinoid bed in which *M. subtilistriatus* is so abundant was collected a single somewhat crushed specimen of the same type, but with enough differences to warrant placing it in a new species. Nearly all of the dorsal cup and part of the tegmen are preserved. A fragment from the gorge section at the lowest chute, Redknife River (loc. 7300) has also been referred to this species.

M. sulcosutura has an ovoid calyx as seen in *M. whittakeri* and *M. subtilistriatus* but is more rounded at the basals, which have a lower, broader saucer-shape, and likewise broader at the arms base. This is a more robust form, larger and heavier than the average of the specimens of *M. subtilistriatus* with a height to the arm bases of 24.5 mm.; height of calyx 28 mm. The asymmetry of this species is masked by a certain amount of crushing. The plates are somewhat elevated, flat or slightly rounded, beveled at their margins and with the suture lines giving the appearance of being widely grooved. In this respect the species differs from *M. whittakeri* and *M. subtilistriatus* and bears a resemblance to *M. bainbridgensis* described by Hall and Whitfield 1875 (*see* Goldring 1923, p. 130, pl. 12, figs. 5-9) from the Upper Devonian (Huron shales) of Ohio. The interradial plates above the primary interbrachial are usually quite tumid, sometimes even pointed and the same is probably true of the tegminal plates, judging from the little that is preserved. Nothing is known of the anal opening. The column facet is small as in *M. whittakeri* and *M. subtilistriatus.*

Horizon and locality.—The holotype is from the crinoid bed at the upper falls, Redknife River, locality 7288.

Remarks.—The grooved sutures suggested the specific name. These and the smooth, elevated bevel-edged plates distinguish this species from *M. whittakeri* and *M. subtilistriatus.*

An abnormality in the right postero-lateral interradius should be noted. It is comparable to the abnormality found in the right antero-lateral radius in *Melocrinus humei,* involving the right postero-lateral and right anterior interradii. As in the case of that specimen the condition apparently is connected with the asymmetrical development and occurs on the convex side. In this specimen the abnormality takes the form of an extra plate in the position of an anal plate between the right posterior and right antero-lateral radials. The radials in these two rays are smaller than average; the first primibrachs are slightly larger than average as also is the primary interbrachial in the right postero-lateral interradius.

Melocrinus humei n. sp. Plate 1, figs. 7, 8

Melocrinus humei comes from the same bed as *M. subtilistriatus* and *M. sulcosutura*. The description and figures are based upon a single, well-preserved calyx; but two other specimens from the same bed have been referred to this species.

M. humei is a robust species which has the asymmetrical calyx characteristic of the other species from this region. The dorsal cup has a height to the arm base of 25.5 mm. and a width between 23 mm. and 24 mm. (calyx 28.8 mm. high). As in *M. whittakeri, M. subtilistriatus* and *M. sulcosutura* the dorsal cup narrows rapidly below the radials to a small column facet, not however, as small as in these three species. The basals flare slightly outward to their junction with the first columnal. Above the basals the dorsal cup expands rapidly giving an inverted pyramidal shape to the calyx. The tegmen is low, flat near the central portion and with the ambulacral areas raised into low ridges which give a depressed effect to the interambulacral areas. The anus is subcentral and there is no anal tube.

The plates of the dorsal cup are generally flat with a suggestion on the radial series of a low, broad, longitudinal ridge. A slight thickening of the plates gives a beveled appearance to the edge of the plates and an appearance of grooving to the sutures, though this latter character is not conspicuous as in *M. sulcosutura*. The character of the plates suggests two Upper Devonian forms: *M. clarkei* from western New York and *M. bainbridgensis* from Ohio. The interradial series has the succession 1, 2, 3, 3, 4 or 1, 2, 3, 4, 4. A curious abnormality occurs in the right antero-lateral radius apparently in connection with the asymmetrical development of the specimen as it occurs on the convex side. The right postero-lateral and right anterior interradii have each three plates in the third rank so large that this series of the two interradii meet above the first primibrach in the right antero-lateral radius, separating it from the primaxil above. This character does not occur in the other specimens referred to this species. The plates of the dorsal cup are further characterized by small scattered tubercles more numerous on the basals, radials, first primibrachs, and primary interradials. The plates of the tegmen are small, usually flat and sometimes bearing a central tubercle particularly on the ambulacral series.

One of the other specimens referred to this species shows a slightly tumid condition in some of the plates, with the development of low nodes on the first secundibrachs. The tubercles have also thickened and sometimes have coalesced. The third specimen shows a different condition which might develop with maturity, but has led the writer to refer this specimen to the species with a query. The slightly grooved appearance of the sutures is shown and the flat character of the plates with the low ridge on each radial series. Only here and there is there a distinct tubercle seen, probably because the plates are so weathered and also because there has been a thickening of the plates and coalescence of tubercles. The plates are bordered by a narrow, flat thickened area suggestive of *M. bainbridgensis* but found also by the writer in specimens of *Megistocrinus depressus* as a character developing with maturity (1923, p. 231, pl. 33).

Horizon and locality.—The holotype, and the other two specimens as well were collected from the crinoid bed at the upper falls of the Redknife River (locality 7288).

Remarks.—The specific name is given in honor of G. S. Hume, one of the collectors in this area. The shape of the calyx together with the small column facet, the ornamentation and characteristic tegmen distinguish this species from all the others.

FLEXIBILIA

Synaptocrinus (?) rotundatus n. sp. Plate 1, fig. 9

There is only a single specimen of this species which has been referred with a query to the genus *Synaptocrinus*. The infrabasals are entirely within the ring of the basals. One of the basals, assumed to be the posterior, is elongate; but it is not strikingly larger than the others and is overlapped by the radials. There is no radianal in the position of the inferradial as in *Icthyocrinus* which this calyx otherwise resembles closely (*see* Springer, 1920, p. 264). One interradius shows an interbrachial plate above the first secundibrachs, two interradii do not show any and two are so poorly preserved and fractured as to show nothing of value. Springer's genus was based upon one species, *Synaptocrinus nuntius*. In discussing his genus Springer (ref. cit., p. 301) writes, "But if as in the case of *Wachsmuthicrinus* interbrachials should be found in some specimens, the genus would stand upon its other characters." The arms are dichotomous, joined or closely appressed. The species in question does not exactly fit into either the genus *Ichthyocrinus* or the genus *Synaptocrinus;* but it more nearly fulfills the requirements of the latter and the genus may prove to be variable in the matter of interbrachials and the size of the posterior basal.

The single crown representing this species is poorly preserved, with the left posterior ray in the best condition. The calyx is small, rounded, expanding distally, with a width of 12 mm. at the primaxils above which it expands to its greatest width at the second bifurcation of 14.1 mm. The total height preserved is 15.2 mm., and the indications are that the arms were incurved at this height. The base outside the column is 3.4 mm. A raised ridge, almost a tubercle, marks the sutures between the primibrachs of adjoining rays, prominent on the first primibrachs and flattening out at the top of the primaxil. A depression marks each interradius from the first primibrach to the secundaxil giving a raised appearance to the brachial series at this level. A similar depression separates the two half rays at the level of the secundaxils and above. The plates of the dorsal cup up to the top of the primaxils are fairly flat. Above this the plates of the brachial series are rounded.

The basals are small but proportionally larger than in *S. nuntius.* The posterior basal is noticeably larger than the other basals, but like them does not extend to the full height of the radials. It also terminates in an acute angle, leaving no surface for attachment of anal plates. The radials are considerably wider above than below, and the left posterior one is somewhat larger than the others. There are two primibrachs, much wider than high. All brachial plates are much wider than long. There are three secundibrachs, followed in one ray by at least ten tertibrachs without another division. The brachials seem to be joined at least as far as the fourth tertibrach. There is a rapid increase in width from the radials to the primibrachs which have the same width as the combined two secundibrachs immediately above. All the secundibrachs have about the same width and the arms narrow gradually above and have rounded backs. The interbrachial in the left postero-lateral interradius is long and narrow, resting upon the shoulders of the first secundibrachs and extending up to the second tertibrachs where the brachials of adjoining rays close above it with no indication of higher interbrachials.

The plates of the dorsal cup apparently have been smoothed in cleaning for there is indication from patches here and there that the surface of the plates originally was rugose. The brachials definitely have a rugose surface, giving almost a pitted appearance in patches.

Horizon and locality.—Crinoid bed near base of coral zone (station 1297), Jean Marie River.

Remarks.—The species is named from its decidedly rounded oval shape, particularly in the distal part of the crown. This species is readily distinguished from *S. nuntius,* among other characters, by the presence in the latter of nodes on the radials, primibrachs and all axillaries beyond and strongly elevated rays, angular in the middle; and by its own proportionally smaller posterior basal and the presence of at least an occasional interbrachial.

INADUNATA

Decadocrinus spinobrachiatus n. sp. Plate 2, figs. 1, 2

Among the inadunate forms is one which bears a resemblance, particularly in the character of the arms, to *Decadocrinus multinodosus* var. *serratobrachiatus* Goldring from the Hamilton (Moscow shale) beds of western New York (1923, p. 431, pl. 56, fig. 1). This species is based upon a crown in a fair state of preservation. A second specimen partially and poorly preserved is tentatively referred to it.

The crown is preserved to a height of 43.6 mm., but the distal portion of the arms is missing. The dorsal cup is low and flares rapidly. It has a height of 4.5 mm., a width at the top of the radials of 9.6 mm. and a width at the column facet of 2.2 mm. The infrabasals are very small, almost hidden by the basals which seem to be somewhat thickened in the lower portion. The basals are comparatively small, an average one having a height and width of 2.4 mm. The radials occupy the larger portion of the dorsal cup with a height of 3 mm., a greatest width at the shoulders in a typical plate (anterior) of 4.6 mm. and a width at the radial facet of 4 mm. The radianal is pentagonal, smaller than the basals and the anal *x* which is of about the size of the basals and projects above the radials. The first tube plate is not completely preserved but appears to be as large as the anal *x* and borders upon the radial and first primibrach in the right posterior radius, as well as the radianal and anal. Nothing more of the anal tube is preserved. The dorsal cup is unornamented except by deep pitting at the corners of the plates which gives the effect on the basals of short ridges crossing the suture lines to the radials above and the infrabasals below.

There are two primibrachs; the first quadrangular and about twice as wide as high, the primaxil pentagonal and slightly wider than high. With the exception of the one in the anterior ray, each first primibrach bears a spinose tubercle at the center of the upper margin. In addition there are more or less conspicuous, small spinose tubercles at each of the four corners. Each primaxil bears a short, sharp spine just below the point of bifurcation and in addition may have the small spinose projections at the four corners as do the first primibrachs. The brachials are wedge-shaped, not conspicuously so, but enough to give a zig-zag effect to the arms. Each brachial is provided with a short, sharp spine, the spines pointing alternately to one side and then to the other, giving a very pronounced serrated or saw-toothed appearance to the arms. In addition there may be spinose projections at the corners. Each brachial bears a pinnule on the higher side beneath the spinose projection, thus giving an alternate arrangement, as is the case with the spines. The pinnules are long and slender, composed of long ossicles; and they appear to be rounded on the dorsal side. The column appears to have been subpentagonal.

Horizon and locality.—From the bed marked *q*, at the third chute, Redknife River (locality 7298).

Remarks.—This species derives its name from the spiny character of the arms and may readily be distinguished from the Hamilton form to which it bears a resemblance. The spines ornamenting the brachials are short, sharp and rounded while in *D. multinodus* var. *serratobrachiatus* they are angular and tooth-like. The latter lacks the spinose projections at the angles of the brachials. *D. spinobrachiatus* has no nodes on the basals and apparently no surface ornamentation of the plates of the cups and arms.

The second specimen, tentatively referred to this species, was collected from the bed marked *l*, of the gorge section, Bouvier River. The specimen shows a crushed dorsal cup and portions of three arms, two preserved above the primaxils. The specimen, so far as preserved, agrees with *D. spinobrachiatus* in all characters except the presence of three primibrachs in the two rays preserved. The writer carefully examined the type for anchylosis of a possible second primibrach with the primaxil, but there was no indication of this though the anterior ray does show anchylosis of the first primibrach and the primaxil. The second specimen is a larger perhaps older specimen, so, since there is no knowledge of the character of the other rays or variability within the species, the writer feels this specimen should for the present be placed with *D. spinobrachiatus.*

PRININOCRINUS n. gen.

Prininocrinus is a dicyclic inadunate crinoid belonging to the subfamily Proteriocrininæ of the family Proteriocrinidæ. The genotype is *Prininocrinus robustus,* new species. The dorsal cup of the only species is bowl-shaped. The radial facet occupies the full width of the radial; and the arms are unbranched above the first axillary, composed of quadrangular brachials bearing pinnules alternately on each side. The ventral sac is unknown and the column appears to have been round. The radianal is in line with the radials, the anal *x* in large part above the radials and resting upon the radianal and left posterior radial.

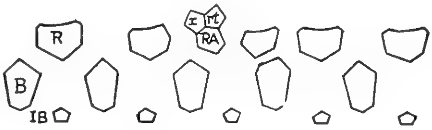

Figure 1. Analysis of dorsal cup of *Prininocrinus robustus,* genotype. *IB,* infrabasal; *B,* basal; *R,* radial; *RA,* radianal; *x,* anal; *rt,* right tube plate.

Of the other genera belonging to this family *Prininocrinus* resembles *Decadocrinus* W. and Sp. (Devonian to Carboniferous) in the character of the arms; but bears most resemblance in the character of the dorsal cup to two Carboniferous forms, *Zeacrinus* Hall and *Cromyocrinus* Trautsch (*see* Springer, 1913, pp. 223, 224; Bather, 1900, pp. 180, 181). Both of the last two genera have the wide radial facets and in both the anal *x* is high in the cup, extending above the radials. In *Cromyocrinus* the anal *x* rests upon a short face of the posterior basal as well as upon the radianal and left posterior radial. This genus has arms unbranched above the first auxillary. In *Zeacrinus,* with branching arms, the anal *x* rests only on the radianal and left posterior radial, but with a different arrangement for the plates.

The name is derived from the Greek *prininos* sturdy; *krinon,* lily.

Prininocrinus robustus n. sp. Plate 2, figs. 3, 4

Prininocrinus robustus is represented by five specimens from the Redknife River section. The figures and description are based largely upon one specimen, the holotype, because the others show no additional characters. Of the four other specimens one is a crushed dorsal cup, another a portion of an arm; a third shows the dorsal cup and portions of three arms; the fourth a portion of the dorsal cup and parts of the anterior, right antero-lateral and left antero-lateral rays. In the holotype 31.8 mm. of the crown are preserved and there is no indication that the arms are anywhere nearly complete.

The dorsal cup is narrowly bowl-shaped, widening gradually from the base and definitely rounded at the radials. It has a height to the top of the radials of 5.2 mm. and a width at the column facet of 1.3 mm. The width at the top of the radials is between 6 mm. and 8 mm. As the cup is crushed no accurate measurements can be made. The plates are apparently heavy, smooth and flat.

The infrabasals are five in number, small with a height of 1.1 mm. The basals are comparatively large, all pentagonal except the right postero-lateral which is the largest in the cup and hexagonal, since it abuts with a short upper face upon the radianal. An average plate (right anterior) has a height of 3.1 mm. and a greatest width at the shoulders of 3 mm. The radials are the largest plates in the cup, an average radial having a height of 3 mm. and greatest width at the shoulders of 4 mm. The anterior radial is slightly larger, the right posterior radial distinctly smaller than the average. The radial facet occupies practically the entire upper face. Two primibrachs are present in the holotype in all rays except the anterior where only the first primibrach is preserved. In the specimen showing parts of three arms one ray shows three primibrachs, and this could very well be the anterior ray. Some of the primibrachs have a suggestion of a crenulate margin. In this specimen the right anterior ray indicates unequal bifurcation on the primaxil, but this may be due only to the position in which the right branch is preserved.

The arms are rounded on the dorsal side, heavy, composed of quadrangular brachials, wider than high, with a tendency in some to wedge-shape; and they bear pinnules alternately on each side. The pinnules are apparently long, stout, composed of quadrangular ossicles, longer than wide. There is no trace of ornamentation on the arms. The column appears to have been round.

Horizon and locality.—The holotype is from the bed marked *q*, at the third chute, Redknife River, (locality 7298). The para type and other specimens are from the bed marked *i*, of the gorge section, Redknife River (locality 7294).

LINOCRINUS n. gen.

The genus is represented by a single known species, the geno-

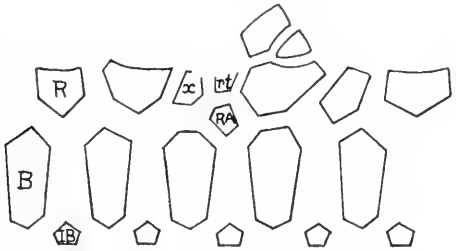

Figure 2. Analysis of dorsal cup of *Linocrinus kindlei*, genotype. *IB*, infrabasal; *B*, basal; *R*, radial; *RA*, radianal; *x*, anal; *rt*, right tube plate.

type, *Linocrinus kindlei,* new species, so the generic diagnosis of necessity is drawn from information furnished by this form.

Linocrinus is a dicyclic inadunate crinoid the affinities of which are closest to those of the family Cromyocrinidæ as defined by Bather (1900, p. 181) which includes genera placed by Springer (1913, p. 224) in the family Poteriocrinidæ Roemer, as emended by Wachsmuth and Springer.

The dorsal cup is elongate obconical. The five infrabasals are comparatively small and inconspicuous, the basals very large and the radials considerably smaller than the basals. The radial facet is very slightly curved and occupies the entire upper face of the radial. A radianal, anal and right tube plate lie within the cup and the anal plate is in line with the radial. The right antero-lateral radial, crowded by the right posterior radial, is considerably reduced in size and appears to bear no arm. The radial facet is very slightly curved and occupies the full width of the upper face of the radial. The arms are unbranched throughout their length, four in number and bear two pinnules to each brachial. The column is stout and round.

Linocrinus shows striking similarity to *Cradeocrinus* Goldring (1923, p. 347) in the character of the dorsal cup. It is distinguished by the four unbranched arms and the irregularity shown by the right posterior and right posterior-lateral radials. In the Permo-Carboniferous genus *Tribrachiocrinus* M'Coy irregularity is found similar to that shown in this genus with only three radials known definitely to bear arms, and those single (*see* Bather, 1900, p. 181; Springer, 1913, p. 224).

The name is derived from the Greek *linon,* strand (of a rope) and *krinon,* lily, because of the resemblance given by the long stout arms to an unraveled rope.

Linocrinus kindlei, n. sp. Plate 2, figs. 5, 6

This species is represented by two adult specimens, two young specimens and a small portion of two arms. The description is based entirely upon one specimen, the holotype. The crown is long and slender, measuring in the holotype 90 mm. with the arms incompletely preserved and showing no tapering as far as present.

The dorsal cup is slender, elongate obconical in shape. The crushed condition of the cup permits no measurement in width, but the height to the top of the radials is approximately 11.3 mm. There are five infrabasals, 2.3 mm. high, which give the appearance of a collar at the base of the cup, of practically the same width as the proximal columnal. The cup gradually widens above this. The basals are elongate and by far the largest plates in the cup. The least crushed plates are the posterior and right postero-lateral. The former has a height of 6.2 mm. and a width at the shoulders of 3.3 mm.; the latter a height of 6.3 mm. and a greater width of approximately 3.6 mm. The radials are of moderate size; the left posterior one has a greatest width of 4.7 mm. and a height of 3.3 mm.; the anterior a height of 3 mm. and a width of 4.6 mm. The left antero-lateral radial is missing but the shoulders of the basals indicate that this plate was present. The radial facets are very slightly curved. The right posterior and right antero-lateral radials are not typical. The former has a width of 4.6 mm. and a height at the posterior side of 3.5 mm. Between this radial and the first quadrangular brachial is a small wedge-shaped plate extending from the anterior side a little more than half way across the upper face of the radial. The right posterior radial encroaches upon the right antero-lateral radial which is considerably smaller than any of the others and almost in the position of an infer-radial. It has a very short upper face that apparently is not followed by any brachials. This condition cannot be regarded as an individual abnormality since it is also shown in one of the young specimens, the only other specimen showing the posterior side. The anal plates have the arrangement characteristic of most of the genera in this family. The anal x is in line with the radials. The pentagonal radianal, smaller than the anal x, borders upon the posterior and right postero-lateral basals, the anal x and right posterior radial and bears the right tube plate. The left tube plate is not preserved.

The arms are preserved to a length of 82 mm. and apparently are not nearly complete. They are unbranched throughout their length, four in number, and composed of quadrangular brachials of approximately equal length and width or longer than wide. An occasional one is wider than long. The noticeably long ones are formed by the anchylosis of two shorter brachials. In some the suture is faintly discernible, but their nature is also disclosed by the presence of two pinnules on each side. There is a pair of pinnules to each simple brachial, one on each side. They are short (4 mm.), stout in the proximal portion, tapering rapidly to a pointed tip, and fit into special niches or rounded sockets in the shoulders of the brachials.

The column is round, of practically the same diameter as the infrabasal ring, and composed of alternating thin and thick columnals with crenulate margins.

The species is named in honor of Dr. E. M. Kindle.

Horizon and locality.—The holotype was collected from the bed marked *l*, gorge section of the Bouvier River (locality 7275); the paratype and the other young specimen from station 122, of the Bouvier River, 8 miles above the mouth (locality 7281). The other two specimens are from the same locality as the holotype and the bed marked *q* at the third chute of the Redknife River (locality 7298).

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EXPLANATION OF PLATES

Explanation of Plate 1

All photographs were made by J. A. Glenn, Albany, N. Y.

Figure Page

Melocrinus subtilistriatus n. sp. 8

(All cotypes from locality 7288, the crinoid bed at the upper falls of the Redknife River).

1. Specimen showing the delicate ornamentation of fine radiating carinæ; anterior radius up.
2. View of right antero-lateral radius of a specimen so weathered that the fine carinæ have almost disappeared. Remnants are shown crossing the suture lines. Asymmetry shown.
3. A third specimen crushed. The plates begin to show tumidity and the carinæ are strengthened, having more the appearance of faint ridges; left antero-lateral radius up.
4. View of left antero-lateral radius of a specimen showing tumid plates and strong radiating ridges on all plates.
5. Mature specimen (right posterior radius up) showing strongly tumid plates with radiating ridges only on the higher interradial plates.

Melocrinus sulcosutura n. sp. 9

(Locality 7288; crinoid bed at the upper falls of the Redknife River).

6. View of right antero-lateral radius of holotype showing somewhat elevated flattened plates and deep grooves along the sutures. Note extra plate at left in position of anal.

Melocrinus humei n. sp. 11

(Locality 7288; crinoid bed at the upper falls of Redknife River).

7. View of left postero-lateral interradius of holotype; asymmetry well shown.
8. Right antero-lateral radius, showing interradial plates intercalated between the first and second primibrachs.

Synaptocrinus rotundatus n. sp. 12

(Locality 1297; crinoid bed near base of coral zone, Jean Marie River).

9. Holotype (left posterior radius) showing small rounded calyx with incurved arms; elongated posterior basal and single interbrachial in left posterolateral interradius, x 1½.

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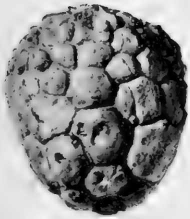

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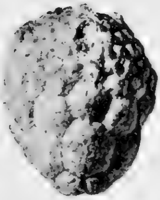

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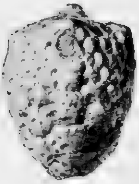

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Explanation of Plate 2

Figure Page

Decadocrinus spinobrachiatus n. sp. 15

[From the bed marked *q*, at the third chute of the Redknife River (locality 7298)].

1. Anterior view (anterior radial at left of the crown showing low, flaring dorsal cup and saw-toothed appearance of the arms due to the wedge-shaped spine-bearing brachials.

2. Dorsal cup, x 1½; anterior radial at left. The relatively large radials are well shown and the deep pitting at the corners of the plates.

Prininocrinus robustus n. sp. 18

From the bed marked *q*, at the third chute of the Redknife River

3, 4. Anterior and posterior views of the holotype x 1½. In the anterior view the pinnules are shown on the arm at the right.

Linocrinus kindlei n. sp. 21

[Holotype from bed marked *l*, gorge section of the Bouvier River (locality 7275); young specimen from station 122 of the Bouvier River, 8 miles above the mouth (locality 7281)].

5. Lateral view of holotype (posterior interradius at left) showing the long, rather heavy arms with stout rapidly tapering pinnules and the atypical right posterior and right antero-lateral radials.
6. Young specimen of the species x 1½.


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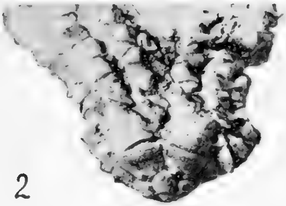
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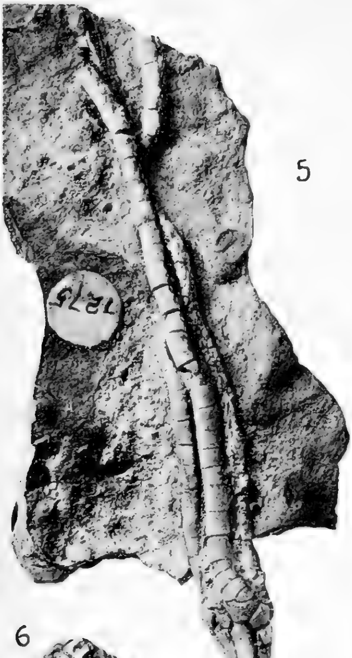

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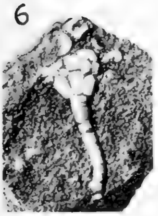
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By E. M. Kindle

With Appendix, 82 A, *Devonian Bryozoa of Gaspé*
By Madeleine A. Fritz

December 2, 1938

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CONTENTS

THE CORRELATION OF CERTAIN DEVONIAN FAUNAS OF EASTERN AND WESTERN GASPE

By
E. M. Kindle
Ottawa, Canada*

INTRODUCTION

The faunas and formations discussed in this paper represent areas in the most easterly and the most westerly parts of the Gaspé Peninsula, Province of Quebec. The eastern sections lie in the region adjacent to Gaspé Bay, while the western area studied is located about 120 miles west of the eastern end of the Peninsula in the Metapedia River valley. Both lie within the region of Appalachian Mountain folding, the eastern area representing the northeastern terminal region of these structures on the continent.

The faunas chiefly considered include the earliest Devonian fauna, the Gaspé Sandstone fauna of eastern Gaspé and the youngest Devonian fauna of western Gaspé.

Devonian formations are known to be present in the interior which is a timbered mountainous region, for the most part without roads. Here relative inaccessability has thus far prevented detailed investigation except in the upper part of the Cascapedia River valley and in the upper valleys of the Dartmouth, York and St. John's Rivers. In the latter region mapping by Dr. I. W. Jones of the Quebec Department of Mines (14a) has been in progress during recent years. The collections on which the present study is mainly based were made by the writer assisted by Dr. C. H. Kindle during the season of 1935 and by Dr. V. J. Okulitch in summer of 1936. Faunules representing the interior region collected by Dr. Jones and studied by the writer are recorded in Dr. Jones' Annual Reports (14a and 14b). Dr. M. A. Fritz has kindly determined the bryozoa.

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In the present inquiry emphasis will be placed on the physical environment of the faunas considered. "In order to understand the life history of the globe it is necessary to first know the physical history" (36). This viewpoint is helpful in dealing with Palæozoic history and often neglected in the study of fossil faunas.

In the present study both the physical and the faunal history will be utilized with a view to using the evidence of each to clarify the record of the other. The two kinds of evidence bear a supplementary relationship and the use of either alone fails to give the complete story which stratigraphic palæontology should supply. In any study of fossil faunas the environment of the life represented by them is of fundamental importance. The contrasts between faunas of successive geologic epochs produced by extinction, the emigration of species or the development of new ones are themselves largely the products of changing environments. The physical environment of aquatic life includes such potent factors as temperature, salinity, depth and nature of sediments. Study of the sediments enclosing fossil faunas gives much information regarding influences which have moulded and selected the species present. The maintenance of different temperatures in different parts of the same sea or ocean through marine currents of northern and southern origin has doubtless been of vital importance in moulding the composition of some unlike contemporaneous Devonian faunas in eastern North America. Contrasted faunas resulting from great differences in the height of tides were probably developed in Devonian seas as often as they are in modern seas. The oyster fauna, less than 200 miles from the Gaspé coast, in Northumberland Strait bordered by the cold water of the Gulf of St. Lawrence is a significant modern example of such contrasts. It is some 50 miles north of the Bay of Fundy where, owing to the high tides and consequent low average water temperature, the Acadian or Virginian fauna cannot live. The Northumberland Strait colony of the Acadian fauna affords a striking example of sharply contrasted adjacent living faunas separated only by temperature differences of the waters in which they live. Here shells like *Venus mercenaria* and the oyster which elsewhere are rarely found north of the southern

New England coast, flourish in habitats adjacent to areas in which the subarctic *Saxicava rugosa* is found, separated only by barriers of temperature and depth.

In the Devonian of Gaspé we appear to have analogues of these modern examples.

SKETCH OF PHYSICAL HISTORY

In times preceding and during Devonian sedimentation a land mass composed of Precambrian crystalline rocks occupied a considerable area in the region of the present continental shelf and the coast line of the Atlantic States. This land has been called Appalachia (33) or the Province of the Devonian highland. It extended northeasterly including either a great continuous land mass embracing much of the Atlantic sea-board states and the southeastern two-thirds of Newfoundland or a series of large islands corresponding more or less closely in position with the east coast "Palæozoic positive elements" of Prof. Schuchert (24) south of Ungava. Between Appalachia on the southeast and another old land mass lying northwest of the St. Lawrence and central New York stretched a seaway which at times could be more appropriately called the Appalachian Gulf (38). This seaway received the erosion products of lands north, east and west of it, thus becoming the cradle of the Appalachian Mountain system which near the close of the Devonian cycle of sedimentation began to develop. The erosion of the Devonian highlands and the accumulation of their muds and sands in the Appalachian Strait was followed by their deformation and uplift and the foundering of Appalachia. The net result of these two orogenic agencies was the Appalachian Mountains which replaced the Appalachian Strait and the Continental shelf which supplanted the Devonian highlands. The Appalachian Mountains now terminate at the eastern end of the Gaspé Peninsula in the north and disappear in the south under Cretaceous rocks in central Alabama less than 200 miles from the Gulf of Mexico. A Lower Devonian fauna reported in western Newfoundland by Schuchert and Dunbar (25) which resembles those in Gaspé and at Dalhousie, N. B. indicates that the early Devonian seaway continued beyond eastern Gaspé across the Gulf of St. Lawrence into southwestern Newfoundland. The Gulf between the Gaspé coast and St. George Bay, Newfoundland now shows depths ranging from 300 feet or more near shore to 1800 near the middle of the Gulf. Block faulting of post-Pennsylvania age has probably been responsible for bringing the Alleghany structures, which presumably once reached across the Gulf of St. Lawrence to Newfoundland, some hundreds of feet below sea level. It is probable that an area of Devonian rocks greater than that of Gaspé and New Brunswick combined is concealed below the Gulf of St. Lawrence.

The faunas and formations here considered lie at or near the northeasterly end of a belt of sediments which stretch more than 1500 miles in a southwesterly direction near the eastern border of the Continent from the Gulf of St. Lawrence nearly to the Gulf of Mexico. The seas which the Devonian formations and faunas show to have successively occupied this eastern continental belt differed greatly in extent and shape at different stages of Devonian time. From the long wide strait of the Lower Devonian sea, coastal emergence developed embayments or gulfs such as J. M. Clarke's "Appalachian Gulf" of early Portage time (66).

THE GASPE BASIN

EASTERN GASPÉ

PREVIOUS WORK

In the Gaspé Bay region folding and erosion have conspired to display to the best advantage the entire succession of Devonian formations. Orogenic forces have developed three wide northwest-southeast open folds. Erosion has etched away the eastern limb of the northeastern most of these structures on the northeast side of Gaspé Bay, leaving a zigzag scarp with sea cliffs facing the Gulf of St. Lawrence on the north side of the Forillon Peninsula and further north facing a narrow coastal plain shelf cut in the black shales and other sediments of the older rocks. The several thousand feet of Devonian sediments exposed in the cliffs on the northeast side of the Forillon Peninsula and the dip slopes of the southwest side have given this finger like peninsula exceptional importance in the development of the geological investigations made in eastern Gaspé.

Sir Wm. Logan prepared the first description of the formations of this area which was published in his 1844 report (17). In this he first described the Gaspé limestones and calcareous shales of the Cape Gaspé promontory. In the 1863 report (18) appeared his detailed section of the Devonian sediments. The importance of Logan's work is well indicated in Dr. J. M. Clarke's statement that "in all the years since elapsed from 1844 and 1845 little has been added to and naught subtracted from his achievements."

To the eastern Devonian faunas, first described by E. Billings (3), J. M. Clarke (7) added many new species and contributed a discussion of the geology and correlation of the faunas.

A map compiled by Dr. F. J. Alcock was issued in 1931 by the Geological Survey of Canada (No. 259A) which assembled the available geological data for all of the Gaspé Peninsula on a map scale of 1 inch to 8 miles. In 1931 Prof. Parks (19) published a summary of the work done up to that date on the geology of the Gaspé Peninsula. A map (12 miles to one inch) which accompanied it presented a generalized conception of the geology of the entire peninsula without discriminating between the little known or unknown and the intimately known areas. Reference to most of the work done up to the date of publication appear in it but without bibliographic references.

Dr. F. J. Alcock's Memoir on the Geology of the Chaleur Bay region issued in 1936 includes a seven page bibliography embracing nearly all of the literature touching the Gaspé Peninsula.

The eastern Gaspé formations (see pl. I) which will be considered in this paper are indicated in the following table.

Table of Formations in Eastern Gaspé

7036′	Gaspé Sandstone		Devonian
	Sonneau Brook beds	Ithaca shale (Senecan)	
	York River beds	Hamilton (Erian)	
800′	Grande Grève Limestone	Ulsterian and Oriskanian groups, New York faunas not clearly differentiated except Oriskany fauna.	
1050′	Cape Bon Ami beds		
160′	St. Albans beds	Helderbergian	
180′	Griffon Cove River beds	Keyser member, Helderberg formation	
	Cape Rosier shales		Ordovician and Cambrian

STRATIGRAPHIC RELATIONS

Ordovician Rocks.—The oldest rocks of this region are well exposed at Cape Rosier. The seashore at Cape Rosier light house exposes in shore cliffs and in the intertidal zone, black shales with bands of dark limestone extending seawards some 200 yards. Along the 2½ miles of the shore separating the light house and the base of the cliffs which expose a contact between the Devonian limestones and the Quebec group shales, much of the pre-Devonian sediments are concealed. But disconnected outcrops of the old rocks south of Cape Rosier light are seen to include here purple, red and olive shales, the latter associated with light grey sandstones. The Gaspé limestones and shales rise in vertical cliffs some 700 feet above the black slate series which J. M. Clarke conceived to be separated from the older rocks near the shore by a great overthrust fault which brought the Lower Devonian in contact with the "Ordovician-Cambrian" (8). Concerning this same contact Logan in 1844 expressed the cautious opinion that "I have not been able to satisfy myself" whether or not the Gaspé limestones and calcareous shales repose on the older series.

The faulting which can be demonstrated to have occurred in this area is of the horizontal offset type with very limited displacement. It is well illustrated about a half mile south of the Gaspé Limestone and Black shale contact south of Cape Rosier where a vertical dike extends some 60′ or more above high tide level. Two small horizontal faults have displaced the upper and lower portions of this dike in a northerly direction. The upper horizontal displacement is about 30 feet while the lower movement is just equal to the width of the dike,—about six feet. At the Quebec group and Devonian contact a fault plane nearly vertical trending at right angles to the shore line, is exposed just above high tide level on the shore between the Devonian limestone and the Black shale (see pl. II, fig. 1). Here the horizontally grooved and slickensided limestone surface (left side) also indicates an offset fault of horizontal throw probably comparable with those at the dike. No evidence appears to exist for any great thrust fault.

Frequent and abrupt changes in strike and dip make any close approximation of the total thickness of the Quebec series impossible in the vicinity of their eastern limit. There are however localities further west along the coast where the strike and dip are quite regular as at Cloridorme. The character of a part of these beds at Cape Rosier is indicated in the section below.

Section at Rosier light house

g.	Dark to black hard fissile shale interbedded with bands of green shale and occasional thin bands of limestone. Inclusions of coarse limestone conglomerate from 1′ to 6′ thick or more occur in the midst of the black shale at intervals.	200′
f.	Hard limestone conglomerate of various sized pebbles mostly 1″ or less but many 3″ or more across	4′-5′
e.	Thin bedded limestone in regular strata 3″ to 4″ thick	6′
d.	Dark and green shale alternating	50′
c.	Grey limestone conglomerate	3′-5′
b.	Grey, dark shale. Thin bedded limestone interbedded	65′
a.	Limestone conglomerate (to sea border low tide)	5′
		336′

Logan estimated at Cape Rosier a thickness of "not much under 900 feet" (p. 28). Other beds referred to by Logan near Cape Rosier (southeast) include strata comprising "red, purple, black and olive green shales" associated with light grey sandstone and thin layers of black bituminous limestone.

It is proposed to use in this paper the name Cape Rosier beds for the rock series exposed at Cape Rosier and along the shore southeast of the lighthouse as far as the Devonian limestone cliffs. The name St. Lawrence Shale which Dr. Ruedemann (20) applied to these beds is not available because it was given to a limestone formation in Wisconsin by Winchell (39) in 1874.

A graptolite zone found north of the Cape Rosier lighthouse by C. H. Kindle which occurs in the section below yielded a faunule which has been studied by Dr. Rudolph Ruedemann.

Section in cliff face behind small sandy beach north of Cape Rosier lighthouse about 200 yards.*

Sandy slates, some black (top of cliff)	12′	
Black shale		16″
Dark shale band (graptolites)		1″
Limestone argill. fine textured		2″
Dark shales with limestone bands	7′	
Limestone (base at high tide level)	2′	6″
Approx.	23′	

Dr. Ruedemann has furnished the following list of the graptolites found in this section: "The lot from Cape Rosier proved exceedingly interesting, especially from Locality C. H. K. No. 6, 150 yds. north of Cape Rosier lighthouse. This contained:

Dictyonema approximatum sp. nov.
D. pertextum sp. nov.
Licnograptus elegans gen. nov., sp. nov.
Dendrograptus fruticosus Hall
Callograptus salteri (Hall) var. *strictus* nov.
Tetragraptus similis (Hall), fragment.
Leptobolus sp."

"This fauna indicates a Deepkill or Point Levis age for the fauna, probably lower Point Levis."

In the graptolite faunules submitted for study by Dr. Ruedemann from four stations along the coast between the Cape Rosier light and Fox River, a distance of about 28 miles he recognizes two horizons, the older listed above, of Deepkill or Point Levis age and the younger of Normanskill age represented by the faunules listed below.

9a. East side of Griffin Cove
Corynoides gracilis Lapw.
Thamnograptus capillaris Hall
Nemagraptus gracilis (Hall)

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*(By road 150 paces north of the road speed sign near lighthouse).

N. gracilis var. *exilis*
N. gracilis var. *linearis*
Dicranogr. ramosus (Hall)
Cryptogr. tricornis (Hall)
Climacograptus modestus Rued.

This is lower Normanskill

9b. East of Gros Ruisseau 2 miles

Didymogr. sagitticaulis Gurley
Dicellogr. sextans var. *exilis* Lapw.
Dicranogr. ramosus Hall

Also Normanskill

9c. East of Gros Ruisseau 1½ miles

Nemagr. gracilis (Hall)
Dicranogr. gramosus (Hall)
Dicranogr. furcatus (Hall)
Diplogr. acutus Lapw.
Climacogr. parvus (Hall)

Lower Normanskill.

9d. East of Gros Ruisseau ¼ mile

Corynoides gracilis
Nemagr. gracilis
Didymogr. sagitticaulis
Dicellogr. cf. *moffatensis*
D. sextans
D. divaricatus
Diplograptus euglyphus
D. acutus
Climacogr. bicornis
C. modestus

Also lower Normanskill in age

Prof. Chas. Lapworth's study (16) of the graptolites of this area lead him to recognize a "Cape Rosier Zone," "Zone of *Dictyonema sociale* and *Bryograptus*" of Calciferous age equivalent to the Tremadoc rocks of Great Britain and the *Ceratopyge* and *Dictynema* beds of Norway. The younger *Cœnograptus* Zone of Griffin Cove and Marsouin River he made the equivalent of the Middle Llandeilo beds of Great Britain. Both Reudemann and Lapworth thus agree in considering the graptolites of

Cape Rosier to represent a fauna older than those at Griffin Cove. Various views have been held concerning the correlation of the Normanskill graptolites (21). These appear to indicate that its faunas may have a range from Beekmantown to Trenton. The evidence now available indicates that the sediments comprising the Cape Rosier beds include horizons ranging from lowest to middle Ordovician age in the Cape Rosier district. The close and in some places complex folding of these shales and associated limestones and sandy sediments must in different areas bring different horizons of the old rocks in contact with the Devonian sediments which rest on them. In the interior, *Agnostus,* sp. and representatives of one or more other Cambrian trilobite genera have been found by I. W. Jones in the Dartmouth River valley in these early sediments. Twenty miles southeast of Gaspé a middle or upper Cambrian formation was discovered and mapped a few years ago which holds a considerable Cambrian fauna. (C. H. Kindle, Fig. 8, Mem. 183, Geol. Surv. Can.)

Basal Devonian Sediments.—The lowest of the three Devonian formations which Dr. J. M. Clarke introduced to include the Devonian rocks below the Gaspé Sandstone he named the St. Albans beds, the type section being exposed in the cliffs of Mt. St. Albans (9) and near the northern end of the Devonian cliffs south of the Ordovician rocks section about Cape Rosier. The basal 70′ of these beds, No. 1 of Logan's section, he described as "grey limestones in layers of from six to eight inches thick which are separated by greenish calcareo-argillaceous shale gradually increasing towards the upper part."

In the Fox River Road section the divisions b and a, below St. Albans beds appear to include beds lower than those known to Dr. Clarke in that formation. They are here given the name Griffon Cove. River beds.

The section which follows is located about 13 miles northwest of the base of the Forillon Peninsula. It is exposed at the side of the Fox River—Gaspé highway and in the banks of the stream above the gorge cut in the Cape Rosier black shale and slates directly above the covered bridge. The other formation names previously used by Dr. Clarke are believed to approximate the limits given them by him in the coast section:

Fox River Road Section.—(Starting near top of south slope of Mountain ridge)

Sta. 20 g *Grand Grève Limestone* (Top of section)
Hard blue grey limestones decaying to soft buff rock 50′+
20 f *Cape Bon Ami Beds*
Shaly calcareous beds largely covered, with numerous trilobite tails etc ?
20 e Blocky green to drab rather soft shale with some bands of reddish shale 600±
Fossils scarce. *Taonurus* seen.
20 d Hard sandy shale with calcareous lenses, small *Spirifer* abundant 250′±
20 c *St. Albans Beds*
Coarse grey limestone in thin sheets interbedded below with sandy shale 170′±
Small brachiopods (*Spirifer*) and *Favosites* common.
20 b *Griffon Cove River Beds*
Shales with two calcareous reefs of Stromatoporoids. Large ostracodes abundant in rather dark shale below lowest reef 150′
20 a Sandy greenish shale with interpolated bands of limestone in basal 20′ 40′
Lowest limestone band with large ostracodes and corals abundant 10′
B *Cape Rosier Beds*
A Black shale with occasional thin lenses of conglomerate 30′+

The strike of beds in A and B is nearly at right angles to that of beds in the younger series above, thus indicating the great unconformity separating the Cape Rosier beds from those which follow.

The Griffon Cove River section is located about midway between Fox River and the Forillon Peninsula. It is exposed along

Griffon Cove River about 4½ miles from Griffon Bay and has considerable interest with reference to the lowest post-Ordovician faunules included in it. It includes in 35 p a crinoid genus ranging from West Virginia to Newfoundland previously unknown in Canadian sections. Like the Fox River Road section, it displays beds not exposed south of Cape Rosier at the contact of the St. Albans beds and the Ordovician shales of the Cape Rosier beds.

Griffon Cove River Section.—Top of section 35 s begins some 400 yards below waterfall over limestones at road bridge.

Griffon Cove River Beds

Sta. 35 s	Drab limestones softer than r and argillaceous partly covered	225′	
35 r	Thin bedded magnesian limestone bands with black stems of plants (?) and calcareous bands with small brachiopods Forms short gorge 20′ wide	20′	
35 q	Limestone shale and covered	40′	
35 p	Hard limestone bands with bulbous fossils (*Scyphocrinus*); 3 on surface of slab in place 2″ in diameter with four partitions	2′	
35 o	Red shale with bands of grey shale (plant fragments in latter)	60′	
35 n	Conglomerate largely of quartz and greenstone pebbles	15′	
35 m	Thin bedded calcareous sandy shale with hard limestone and conglomerate bands	2′	
35 l	Coarse conglomerate SiO^2 pebbles. Str. S. 25° E.—D. 28° S. W.		6″
35 l^1	Hard thin bedded magnesian limestone with small Spirifers	12′	
35 k	Covered	25′	
35 k^1	Grey shale	2′	
35 k^{11}	Conglomerate	2′	

Cape Rosier Beds

35 j	Red shale with green bands and bands of brecciated shale, 1″ ripple mark in upper part on red shale, and thin bands of green shale	125′
35 i	Blue-green laminated shale layers 1/16″ thick with one or more hard silicious limestone beds	15′
35 h	Red shale with bands of shale with small pebbles and lumps of shale	40′
35 g	Black and green shale	20′
35 f	Hard grey laminated limestone	5′
35 d,e	Red shale and covered	100′
35 c	Covered	40′
35 b	Hard grey limestone weathering green with red shale and blocky soft green shale with included shale fragments	12′
35 a	Coarse conglomerate with quartz pebbles up to 4″. Str. N.—S. At road thickness about 20′: at stream 2′	2′-20′

The base of the Devonian sediments is considered to be the conglomerate, 35 k^{11}. The absence of fossils from the lower part of the section together with lithologic resemblance of some of the Lower Devonian sediments to certain of the Cape Rosier sediments necessitates placing the boundary on a provisional basis in the Griffon Cove River section and it may be somewhat lower. The beds in this section above the coarse conglamerate, 35 j, with a thickness approximating 400′ in thickness are regarded as representing beds older than the St. Albans beds and believed to be the approximate equivalent of the Keyser member of the Helderberg formation of West Virginia. They are here called the Griffon Cove River beds.

The faunule in 35 p of the section includes cross sections of several specimens of the bulbous rooted crinoid *Scyphocrinus.* This genus represents a very unusual type of crinoid which has long been known in the Keyser member of the Helderberg formation of Virginia and Maryland. Schuchert and Dunbar (26) have described a section in which it is recognized under the name *Camarocrinus** from the early Lower Devonian rocks on west shore of St. George Peninsula, Newfoundland.

North Fork River Section.—Northwest of Fox River about six miles the North Fork branch of the Dartmouth River flows south across the strike exposing samples of all the Devonian formations and of the underlying Cape Rosier shales.

Along the old trail leading up this valley the Gaspé Sandstone is largely covered, only loose fragments being observed by the writer along the lower two miles of the valley underlaid by this formation. At the ford 2½ miles north of Dartmouth River the upper beds of the Grande Grève Limestone outcrop on the west side of Fork River where *Eatonia* and other fossils characteristic of the Grande Grève are common. Northward from the first ford for 3000 feet outcrops of Devonian limestone with few fossils appear at intervals dipping south at about 25°.

Grey argillaceous shales lie north of the limestones for 4000 feet. North of these up river at a lower horizon appear in successively lower beds **:

Contorted shale beds
Calcareous beds
Red and grey shales
Limestone beds with *Scyphocrinus* ?
Massive conglomerate 30 feet thick
Thin bedded limestone of Ordovician or Cambrain aspect
Crumpled shale,—Ordovician ?
Crumpled limestone with calcite veins and included pebbles of oolitic limestone
Covered interval
Black and red shale and crumpled limestone and shale,—Ordovician?

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*I am informed by Miss W. Goldring who confirmed my determination of the Griffin River crinoid as a *Camarocrinus* that this genus is a synonym of *Scyphocrinus*.

**From notes of C. H. Kindle.

The most interesting feature in this section across the Devonian sediments, which is poorly exposed in lower part, is the presence of limestone bands containing the partitioned bulbous roots believed to be *Scyphocrinus*. These fossils were observed by C. H. Kindle for several hundred feet, a quarter mile south of the conglomerate at the east-west stretch of Fork River 4½ miles north of its mouth. The basal limit of the Devonian is provisionally drawn for this section just south of the above mentioned east-west stretch of Fork River and the 30′ conglomerate which borders it. The discovery of the *Scyphocrinus ?* beds by C. H. Kindle in the Fork River Road section thirteen miles N. W. of the Griffon Cove River section in which they occur suggests that this zone probably has a considerable east-west distribution in the northern part of the Gaspé Peninsula. It is a useful zone in recognizing the lowest Devonian beds in a region where both Devonian and Ordovician sediments include conglomerates and where few fossils are found in the Ordovician sediments. It apparently increases in thickness westward. The Lower Helderbergian crinoid genus has now a known distribution, including Newfoundland along the axis of the Appalachian Mountain system of about 1500 miles. It occurs in Gaspé in a region where the thick Silurian sections of the Black Cape and Port Daniel areas are missing, but faunules considered to be Silurian have been found by Dr. Jones (14a) only a few miles west of the North Fork Valley.

CORRELATIONS OF GRIFFIN COVE RIVER BEDS

The earliest fauna found in the Griffin Cove River section occurs in a bed of hard magnesian limestone, 35 r. This fauna includes the following species.

1. *Schuchertella becraftensis* (Clarke)
2. *Camarotoechia semiplicata* (Conrad) a.
3. *Uncinulus globulus* Schuchert
4. *Stropheodonta* (*Leptostrophia*) *beckii* (Hall)
5. *Spirifer vanuxemi* Hall, var.
6. *Nucleospira ventricosa* Hall
7. *Rhynchospira cf. globosa* (Hall) r.
8. *Whitfieldella? cf. minuta* Maynard

9. *Goniophora perangulata* Hall, var.
10. *Proetus cf. protuberans* Hall

The discovery a little higher in the section 35 p of the peculiar crinoid genus *Scyphiocrinus* strongly supports the correlation of these beds with the Keyser member of the West Virginia Helderberg. Specific determination can not be made with certainty but it is probable that the specimens represent *S. stellatus* Hall which is an abundant species in the Keyser member of the West Virginia Helderberg formation.

The molluscan fauna supports the crinoid evidence for correlation with the Keyser. The species listed above include four species (5, 6, 7, and 8) which are characteristic forms in the Keyser fauna. This fauna appears to represent the lowest Helderberg fauna of the Gaspé section.

The Gaspé Limestone.—The 2010 feet of limestones and calcareous shales which succeed the Ordovician sediments Logan called the Gaspé Limestones. He recognized and described eight subdivisions of these. Three names of formation rank were introduced in place of these by Dr. J. M. Clarke. These are in descending order:—Grande Grève Limestone, Cape Bon Ami beds and St. Albans beds*. The limits between these formations are not sharply defined by any very abrupt changes in the sediments. Sedimentation was apparently uninterrupted during their deposition.

Shales with large or small percentages of lime and limestone mostly argillaceous comprise the entire series below the Grande Grève Limestone. In this formation the limestones reach their maximum purity.

The lowest division of Logan's Gaspé Limestones 70′ thick, comprises he states "grey limestones in layers of from six to eight inches thick which are separated by bands of greenish calcareo-argillaceous shale gradually increasing in amount towards the upper part". Neither in this nor in succeeding higher divisions of the Gaspé Limestones does either Logan or Clarke indicate the presence of beds of coarse quartz conglomerate such as have been described in the Fox River Road and Griffon Cove River sections by the writer. It therefore appears clear that the earliest

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*St. Alban beds of Clarke.— Eds.

member of the post-Ordovician formations was either unknown to them or considered part of the variable sediments comprising the Cape Rosier Ordovician beds. To this basal unit of the Devonian sediments the writer has given the name Griffin Cove River beds.

Contact of Grande Grève Limestone and Gaspé Sandstone.—At the top of the Grande Grève formation the limestone gives way rather abruptly to a formation of coarse sandstone to which Logan ascribed a thickness of 7036 feet. The best locality for observing the transition from limestones to sandstones is the angle in the southwest shore line of the Forillon Peninsula a half mile from Grande Grève church. The section there representing the transition which introduces a sandstone and shale formation more than a mile thick following a fairly pure limestone formation is as follows:

Thin bedded grey sandstone lowest layers nearly white, numerous plant fragments in lower half of beds and cross bedding in lower third (Gaspé Sandstone)	25′
Hard dark grey argillaceous magnesian limestone in thin bands (Grande Grève)	10′

The transition from limestone to sandstone is abrupt but no evidence of an erosion interval is present.

About 800 feet of the Gaspé Sandstone section following the basal 25 feet of the formation is covered. Cross bedded coarse sandstones are conspicuous in the beds following this covered interval. (Pl. I)

At the Dartmouth River gorge 9 miles above the bridge over the North Arm of Gaspé Bay the Grande Grève Limestone forms the lower end of the gorge and its contact with the Gaspé Sandstone can be seen in the bed of the river. No evidence of disconformable relations was observed. The occurrence of plant fragments in parts of the upper 60′ of limestone beds seem to foreshadow the arrival of Gaspé sedimentation with its abundant deposition of fragmented plants. More than 500 feet of coarse grained rather thin bedded Gaspé Sandstone follow the limestones of the gorge inclined at about 33°.

INTERPRETATION OF DEVONIAN SEDIMENTATION

The record of physical conditions on land and in the sea registered in the nine thousand feet of Devonian sediments represents a wide range of physical conditions during Devonian time in eastern Gaspé. The conglomerate beds with large quartz and jasper pebbles near the base of the earliest Griffon Cove River beds indicate that Devonian sedimentation opened in this region with an epoch of rejuvenated rivers on lands to the north or northeast. Both coarse and fine sediments—the latter represented by shales of red and green colours—were brought into the Devonian seaway. At a later stage of the first cycle of Devonian sedimentation, materials largely of terrestrial origin were supplanted by calcareous deposits in which stromatoporoid corals played an important rôle in reef building. During St. Albans sedimentation conditions for a time favoured calcareous sedimentation and checked the deposit of terrigenous sediments. The finer kinds of terrestrial sediment unite with calcareous sediments in varying proportions throughout most of the period of Cape Bon Ami deposition. The increase in the amount of the calcareous material in the sediments reached a climax near the end of Grande Grève sedimentation. The Grande Grève formation received only the finest sediments from the land. It is essentially a marine product. With the deposition of the Grande Grève Limestone, deposition of calcareous sediments in this region ended and a new cycle of terrigenous sedimentation began.

The carbonate content of the sediments increases as salinity of surface water becomes greater (31). Salinity in general increases with the temperature. A warmer climatic cycle may therefore be correlated with an increasing amount of calcium carbonate sediments such as we find in the Grande Grève. Conversely a change in the sediments of a region from limestones to sandstones and shales may be interpreted as possibly representing a period of cooler weather in the climatic cycle. However, it must not be forgotten, as Trask (31a) points out, "that there is a significant chance that the calcium content of some sediments reflects the climate, particularly with respect to rainfall at the time the sediments were deposited".

The Gaspé Sandstone sediments represent a great change in physical conditions which probably included a climate cooler, or a greater rainfall, than that of Grande Grève time. These sandstones, more than a mile in thickness comprise a series of clastic sediments representing green and red shales alternating with sandstone which often carries quartz pebbles an inch or more in diameter. The coarse texture of the sandstone indicates accelerated erosion in the lands supplying the sediments and deposition in coastal waters.

The coarse sandstone and conglomerate horizons of the Gaspé Series represent transportation of much of the sediment as bottom load by rivers which traversed Precambrian areas located presumably north or northeast of the eastern part of the Gaspé Peninsula. Sand wave transportation in the rivers and strong tidal currents in the estuaries and possibly floating ice were accessories in transportation. The coarse character of much of the material in these sediments points towards increased valley gradients in the transporting streams. These sandstones and their associated beds of shale follow a thick limestone series and present no more evidence of unconformity with it than might be expected from the gradual advance of the delta of a rejuvenated river system over the bottom of a shallow lime depositing sea. They do indicate very definitely a nearly complete change of conditions in the source region of the sediments from a long period of crystalline rock decay to a time of abundant precipitation and active erosion.

In the boulder bed at Miguasha and the very coarse conglomerates near Escauminac on the Bay of Chaleur we have outside the type region of the Gaspé, examples of the coarser products of Gaspé sedimentation which represent bottom load transportation down swift streams and further sorting and by waves and the currents of high tides in estuaries. During flood periods of some Rocky Mountain streams one becomes aware that the entire bottom of small boulders and coarse gravel is in motion through the continuous subdued roar rising from the stream bed. The finished product of such grinding and polishing of small boulders has in the case of the bed of small boulders in the Miguasha section been misinterpreted in the writer's opinion as the product of glacial agencies (10) where assemblage by wave action offers a more probable explanation.

The physical changes resulting in the sedimentation cycle inaugurated by the deposition of the lower beds of the Gaspé Sandstone probably included renewed uplift of the upper parts of the river valleys which carried Gaspé sediments to the sea, accompanied by increased precipitation and lower temperatures. The absence of limestone from the sediments suggests that temperatures lower than those of Grande Grève times prevailed throughout the period of Gaspé Sandstone sedimentation. The very small lime content of much of the Gaspé series leaves most of them very poorly cemented. Limestones with the exception of coquinas are not known to be forming anywhere in the colder seas of the present. The only limestone bands observed in the Gaspé Sandstone are of this type.

Plant fragments abound at various horizons in the thick series of Gaspé Sandstone sediments and fragments of fish plates are found abundantly at two or more horizons. Aside from these fragmentary remains of plants and fishes representing non-marine life, fossils are apparently absent in the Gaspé series on the N. E. side of Gaspé Bay save at a single locality where molluscs considered to belong to a brackish water fauna have been found. A short distance S. W. of this non-marine facies bordering the shores of Gaspé Bay the marine facies of the Gaspé is well developed and appears with an abundance of molluscan fossils interpolated between beds in which only plant fragments appear. The conditions under which continental deposits are now being laid down by the numerous distributaries of the Colorado River may have been approximated during parts of Gaspé Sandstone sedimentation. Such conditions have been very clearly shown by air views of the secondary delta fan of the Colorado with its scores of sediment spreading distributary streams (30).

Some of the studies of bottom deposits in coastal waters which include both shallow marine and adjacent non-marine areas help to visualize the significance of the contrasted facies presented by the Gaspé beds in adjacent areas and at successive horizons. Sediments for a radius of three miles off the mouth of the Southwest Pass—the largest mouth of the Mississippi River Delta outlets— Trowbridge found to be "practically without life or organic remains; in a zone 3 to 8 miles out there are foraminifera; beyond this there are calcareous foraminifera and beyond 10 miles pelagic forms constitute a portion of the bottom sediments". Like the sea bottom area described by Trowbridge (32) the Gaspé Sandstone sediments include an abundant marine fauna in some areas which in others is entirely absent. While marine molluscs ordinarily find conditions of life impossible near the mouth of a great river such as the Mississippi there are times when they penetrate a considerable distance up river with the heavy saline water at the bottom of a deep channel. At times salt water fishes invade the Mississippi River as far up as Baton Rouge where the channel reaches 60 feet below sea level. Several years ago an octopus was caught at this point which is more than 170 miles above the mouths of the river (23).

Opportunities for the overlapping and interfingering of marine and fresh water faunas, such as the mouths of the Mississippi River and some of the lagoons of the Atlantic coast afford, were doubtless responsible for the contrasted barren and richly fossiliferous areas of the Gaspé Sandstone. Judging from such data as that recorded by Trowbridge and Russell for the Mississippi River, Gaspé sediments must be expected to display abrupt faunal changes both horizontally and vertically if they are delta deposits. Such characteristics they display in marked degree. The Gaspé sediments northeast of Gaspé Bay are barren of marine fossils but rich in fragmentary plant remains. Southwest of Gaspé Bay the same beds hold in various places in the York and St. John River valleys faunules in which marine invertebrates abound separated by beds apparently quite barren of marine fossils.

The anomalies presented by contrasted facies in different parts of the Gaspé Sandstone series may be more easily analyzed and understood if reviewed in the light of the faunal relations which exist between fresh and salt water biotas in certain large lakes closely connected with the sea. In deep lakes with tidal inlet connections, the factors of depth and salinity may unite to preserve some elements of the marine fauna and to exclude others. Lake Melville on the Labrador Coast affords an example of this type of selection and exclusion. While caplin abound during the spawning season about the lower end of the Lake Melville inlet, and cod are plentiful in the adjacent marine waters, both are unknown in the lake. Marine invertebrates which belong to the shallow water facies of the intertidal zone are likewise excluded from the lake. *Littorina rudis* var. *grœnlandica,* barnacles and other shells commonly associated with them stop abruptly at or near the head of the Lake Melville inlet (15). But in the lake 50 miles above the head of the inlet a typical marine fauna was dredged by the writer in depths of 15 to 26 fathoms at Mulligan Bay. This fauna includes one starfish, several brittle stars and a variety of small mollusca. The fresh and relatively light surface water from large inflowing rivers however, prevents this marine fauna from occupying the shallow water zone where a depth of 10 feet or less prevails. This shallow zone is barren because the water is too brackish for a fresh water fauna, and too fresh for marine species.

Some of the peculiarities in the distribution of the Gaspé Sandstone marine fauna become understandable when viewed in the light of the ecology of large tidal lakes which like Lake Melville receive the rivers of a considerable drainage basin.

FACIES OF THE GASPÉ SANDSTONE

The erratic distribution of the invertebrate fauna of the Gaspé Sandstone is a feature which has been neglected in earlier studies of this fauna. Opportunities for studying the Gaspé rocks exposed along the shore line and in ravine sections of the southwestern side of the Forillon Peninsula are exceptionally good, but marine invertebrates in this northeasterly part of the Gaspé Sandstone area appear to be almost entirely absent. One locality however, on the east side of Gaspé Bay at D'Aigullon Wharf has furnished a marine fauna now in the McGill University Museum collected by J. W. Dawson which the writer has had the privilege of examining. This fauna includes two or more species of *Lingula* and a few species of small pelecypods. None of the species in it are known in the region west of Gaspé Bay. This eastern region of nearly barren Gaspé Sandstone includes the type section of the preceeding Grande Grève Limestone in which marine fossils abound. In the lower St. John and York River valleys however, west and south of Gaspé town, marine fossils abound in the Gaspé Sandstone at horizons which are low in these sediments. Occasional discoveries of fossil plants retaining an upright position suggest that parts of the Gaspé Sandstone represent delta surface conditions. Rain drop impressions reported by Logan also point to continental conditions for parts of the formation.

The entirely new set of environmental conditions to which Gaspé Sandstone sedimentation introduced the marine fauna of the Grande Grève Limestone resulted in complete extinction of the old Grande Grève fauna over much of the area which it had occupied, coupled with preservation of a very few species of the old fauna in the southwestern part of its earlier habitat. Only eight of the 154 Grande Grève species known to Dr. J. M. Clarke (11) persisted into the Gaspé Sandstone sediments. This small legacy from the ancestral Grande Grève fauna indicates the effective character of the selective influence exercised on the old fauna by the entirely new environmental conditions of Gaspé Sandstone sedimentation.

The association of species in several marine faunules which have been collected and studied by the writer are indicated in the faunule list which follows. Most of these fossils belong in the lower part of the Gaspé Sandstones in the portion which Professor H. S. Williams called the York River beds (34). Red beds in the York River facies are relatively rare and marine invertebrates are present in certain beds in extraordinary abundance. On the northeastern side of Gaspé Bay the beds at a similar horizon furnish non-marine vertebrates and plant fossils. In this eastern area the fish and plant bearing facies of the Gaspé Sandstone supplant the marine molluscan facies of the western area. This fresh or brackish water facies has, however, interpolated in it at one locality at least, a marine fauna characterized as previously stated by Lingulas and small pelecypods quite unlike any faunule known in the western facies. The exposures on the north side of Gaspé Bay at and near the bridge ¼ mile east of the base of the Peninsula sand spit display well the red green and grey beds which characterize this eastern facies of the Gaspé rocks. A thin band in the small quarry at the bridge contains an abundance of fish fragments of small size and poor quality. The beds characteristic of this eastern facies of the Gaspé Sandstone may be designated at the Peninsula Facies. It is considered the stratigraphic equivalent of the York River beds which hold a marine fauna as well as beds which may be higher than these. The eastern or Peninsula facies includes all of the sediments of the Gaspé Sandstone series, northeast of Gaspé Bay and a narrow strip on the southwestern side, which are considered to represent a bathymetric zone of slight depth and low salinity. Bordering this eastern facies with only local evidence of a distinctly marine fauna and interfingering with it is the York River or western facies representing a deeper and more seaward area which was characterized by greater salinity. The York River facies is characterized by a marine fauna which embraces some survivors of the Grande Grève fauna and several representatives of the Hamilton fauna together with some species peculiar to the Gaspé Sandstone. The following faunules are selected from the 50 or more which have been studied by the writer with a view to showing both the more common and the rarer types of the associations represented.

GASPÉ SANDSTONE FAUNA

Faunule Associations.—St. A. 20 Portage road west of town of Gaspé*

Loose blocks of Gaspé Sandstone contain an abundance of fossils. These occur on the south slope of the mountain ridge a few hundred yards south of the crest which is formed of Grande Grève Limestone dipping south at about 25°.

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*Collections from west side of Portage road in field 1/3 mile north of S. W. arm of Gaspé Bay.

The following fauna was collected:

Tentaculites carteri Clarke
Chonetes hudsonicus gaspensis Clarke
Chonostrophia dawsoni Billings
Schuchertella becraftensis Clarke
Leptostrophia blainvillii (Bill.)
Leptocoelia flabellites Conrad
Rensselæria ovoides gaspensis Clarke
Nuculites oblongatus Conrad
Modiella pygmæa (Conrad)

A sandstone slab showing many specimens of *T. carteri* oriented by current action has been figured by the writer in The Jour. of Palaeontology vol. 12, p. 515, 1938.

Sta. 26, S. W. of Carters P. O., 1½ miles, bed of brook Lot 7 Range 4 (4½ miles southwest of Douglastown).

Fossils from this station occur in bed of a small brook, containing rocks poorly exposed. Moulds occur in argillaceous fine sandy material closely crowded together and form a conglomerate of fossils in the beds at this locality.

Tenaculities carteri Clarke
Chonetes hudsonicus var. *gaspensis* Clarke
Leptostrophia blainvillii (Billings)
Spirifer gaspensis Billings
Leptocoelia flabellites (Conrad)
Rensselæria ovoides var. *gaspensis* Clarke
Beachia amplexa Clarke ?
Megalanterus cf. thunei Clarke

Sta. 31, South side St. John River opposite Juniper Island. Section shows 15′ of green sandstone with an abundance of fossil plants in lower two thirds. Heavy bedded sandstone above plant beds contain the following invertebrates:

Tentaculites sp.
Chonetes (*Eodevonaria*) *hudsonicus* var. *gaspensis* Clarke
Orthothetes (*Schuchertella*) *becraftensis* Clarke
Leptostrophia blainvillii (Billings) = *L. perplana* Conrad
Spirifer gaspensis Billings

Leptocoelia flabellites (Conrad)
Rensselaria ovoides var. *gaspensis* Clarke
Palæoneilo maxima var.
Tropidocyclas brevilineatus (Conrad) (Hall)
Holopea gaspesia Clarke ?

Sta. 32, North side of St. John River ½ mile above South Fork opposite Bluff pool. A band of rock six inches thick, composed almost entirely of fossils occurs about 1′ above water level in a 15 foot cliff of Gaspé Sandstone. The fossils collected here are as follows:

Orthothetes (*Schuchertella*) *becraftensis* Clarke
Leptostrophia blainvillii (Billings)
Spirifer gaspensis Billings
Leptocoelia flabellites
Rensselæria ovoides var. *gaspensis* Clarke
Actinopteria (*Pterinea*) *fronsacia* Clarke
Bellerophon cf. leda Hall
Holopea gaspesia Clarke ?
Limoptera macroptera (Conrad)

Sta. 29A, East branch of Sonneau Brook*, Galt township. Fossils are mainly from a soft layer of plant fragments in sandstone left side of Falls at dam just above junction of East branch of Sonneau Brook. Plant fragments are more plentiful than invertebrates. Black bituminous bands 1/8 of an inch to paper thinness, highly irregular and of slight horizontal extent, traverse parts of the fossil bearing sediments.

Ischadites cf. squamifer (Hall)	(r)
Tentaculites carteri Clark	(r)
† *Botryllopora socialis* Nich. ? 29A H.	(a)
† *Fenestrellina gaspensis* Frtiz n. sp.	(a)
† *Polypora orientalis* Fritz n. sp.	(a)
Chonetes sp.	(r)

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*Sonneau Brook is a N. E. tributary of Big Fork of York River in the west part of Galt township.

†Bryozoa determined by Dr. M. A. Fritz.

Leptostrophia blainvillii (Billings)	(r)
Spirifer cf. gaspensis	(r)
Spirifer cf. medialis	(r)
Leptocoelia flabellites (Conrad)	(c)
Platyceras sp.	(r)
Devonaster eucharis (Hall) var. *goldringæ* Ruedemann	(r)
Crystolites expansus Hall	(c)
Phacops cf. bufo var. *rana* Green	(r)

At this station the second starfish discovered in the Gaspé Sandstone was collected in 1936. This collecting station is located about 6 miles north and slightly east of the Fourth Lake Brook section which supplied the first echinoderm found in the Gaspé Sandstone (22). A third specimen of this starfish was found by Dr. I. W. Jones in 1937 on the south side of York River, about 2½ miles N. W. of the original locality.* It was found in a green sandstone with numerous plant fragments but with no associated invertebrates.

Unusual interest attaches to this faunule because it represents a fauna notably different from any displayed by the other faunules known from the Gaspé Sandstone. Three species of bryozoa are present. One of these is the most abundant fossil in the faunule and represents a species which is abundant in the Heppel formation a hundred miles to the westward in the Metapedia Valley. *Rensselæria ovoides gaspensis* which in most other faunules is very abundant is missing. The Spirifers present are too fragmentary for definite determination but they include one or more species not found in the other faunules of the region. The gastropod species are unknown in other faunules. The unusual character of the fauna and the peculiar bituminous bands in the enclosing sediments justify giving these beds a distinct name; they will be called the Sonneau Brook member of the Gaspé Sandstone. The correlation of this fauna which is considered the latest in the Gaspé Sandstone will be discussed in later pages of this paper.

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*Station F 20, Jones, Twin Lakes Brook 480′ upstream from its junction with York River.

Correlation of the Gaspé Fauna.—Divergent opinions have been held concerning the position of the Gaspé Sandstone fauna in the Devonian time scale. In 1900 Schuchert (27) stated that "On the basis of the known fossils there is no positive evidence that the lower 1100 feet of these sandstones should not be regarded as of Oriskany or at least Esopus age." Prof. H. S. Williams believed the Gaspé Sandstone fauna to be a Lower Devonian fauna of Oriskanian age not younger than the Schoharie Grit. Prof. Charles Schuchert (29) expressed the opinion in discussing Prof. Williams' paper that the Gaspé fauna might be properly considered of Onondaga age, while Dr. J. M. Clarke (12) has argued for placing it still higher as a Hamilton fauna. Sir Wm. Dawson (14) had, long before Clarke's Gaspé studies, on the basis of fossil plants, considered the Gaspé Sandstone to be equivalent to the Devonian System. In his original discussion of the Gaspé Sandstone fauna Dr. Clarke wrote: "The assemblage presents a strange and unusual combination. In majority of number the species are unquestionably those of the Hamilton of New York, but with these are several pronounced Oriskany species (13)."

This fauna is "strange and unusual" not only on account of the associations of species present but because of the absence of some common and widely distributed Devonian species. An example of these is the ubiquitous long ranging *Atrypa reticularis,* recorded as "a characteristic fossil of the Silurian and Devonian throughout the world (28)." It is unknown in the sandstone fauna although present in the St. Albans formation a few hundred feet below the Gaspé Sandstone. At the time Dr. Clarke's report on the Gaspé fauna was published not a single representative of the echinoderms was known in the fauna. A single species of starfish has since been discovered and is now known from three specimens found at localities separated only by a few miles. Corals are extremely rare in the Gaspé Sandstone. Bryozoans are also rare,* only a single species being recorded by Dr. Clarke.

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*Sta. 29A affords one exception to this statement. Bryozoa abound in this unique faunule.

The 1936 collections have added another genus known only from a single locality . Two trilobite genera are now known in the fauna. The ostracodes are still without known species in the fauna.

The explanation of the absence or extreme scarcity of fossils representing groups like the corals, echinoderms and the trilobites becomes apparent when we recall that each of these groups are represented almost entirely by species which require a strictly marine habitat and could survive only in waters of normal marine salinity. The physical features of the Gaspé sediments, coarse sand, pebbles and abundance of plant fragments point toward estuarine conditions where the water was always more or less brackish, thus eliminating from the fauna the less tolerant types of marine invertebrates of the time. Under such low salinity conditions as both the known features of the sediments and the composition of the fauna indicate we should not expect to find in the Gaspé Sandstone a fauna which closely matches any of the typical marine faunas of the New York section which might be considered to have been possibly contemporaneous with it.

The time significance commonly attributed to the several Gaspé species known elsewhere as Hamilton fossils is indicated in the following list which includes the invertebrates recognized by the writer and earlier students of this fauna.*

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*Localities are indicated by station numbers following names. The localities cited are as follows: Species without station numbers are cited in the authority of Billings or J. M. Clarke and followed by B. or C. Species of bryozoa determined by Dr. M. A. Fritz are followed by F.

Collecting stations cited in list:

A.20, Portage road west of Gaspé; 26, S. W. of Carters P. O. 1½ miles; 31, South side of St. Johns River, opposite Juniper Island; 32, North side St. Johns River above South Fork, opposite Bluff pool.

Stations of I. W. Jones. F. 11, Dinner Island Brook, Laforce tp. F.25, Fourth Lake Brook near mouth S. side York River. F.26, Fourth Lake Brook 1720 feet from York River junction. F.36, Fourth Lake Brook 11560 feet from York River junction. F.48, Fourth Lake Brook at 50′ falls, about 2500 feet from York River junction. F.50, Mouth of Brook S. side York River 6000′ W. of N. S. centre line of Baillargen tp., Gaspé Co. F.55, Little Fork York River 7950′ above mouth. F.58, Between Little Fork York River and York River, Galt tp. F.62, Small Brook entering Sonneau Brook 2900 feet up from north.

Gaspé Sandstone Species.—

	Hamilton species
Coelenterata	
Ischadites cf. squamifer (Hall) St. 29A	
Favosites sp. (F. 36)	
Annelids	
Tentaculites carteri Clarke St. A 20, 26	
Gyrichnites gaspensis Whiteaves	
Echinodermata	
Hystricrinus ? sp.	
Devonaster eucharis (Hall) var. *goldringæ* Ruedemann (29A)	
Bryozoans	
Botryllopora socialis, Nich. ? 29A, F.	x
Fenestrellina gaspensis Fritz 29A, F.	z
Polypora orientalis Fritz 29A, F.	
Hederella blainvillii C.	
Brachiopods	
Orbiculoidea montis Clarke (F 26)	
Chonetes hudsonicus gaspensis Clarke St. 31, 20	
C. billingsi Clarke C.	
C. cf. complanata Hall, C.	
Chonostrophia dawsoni (Billings) Sta. A. 20	
Dalmanella penouili Clarke C	
Orthothetes becraftensis Clarke St's. 31, 32	
Leptostrophia blainvilli (Billings) St's. 31, 32	z
Spirifer gaspensis Billings St. 31, 32	z
Spirifer varicosus Hall var. F 48	x
Cyrtina hamiltonensis Hall C.	
Athyris hera Clarke C.	
Leptocoelia flabellites (Conrad) St's. 31, 32	
Eatonia peculiaris (Conrad)*C.	

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*J. M. Clarke recorded *E. peculiaris* from lower Gaspé Sandstone beds as very rare. Where seen by writer sandy beds associated calcareous beds indicated transition beds between Grande Grève and Gaspé Sandstones.

x Identical with Hamilton species.

z Closely related to Hamilton species.

Rensselæria ovoides gaspensis Clarke St. 31, 32	
Cryptonella sp. C.	
Pelecypods	
Lunulicardium ? convexum Clarke St. 20	
Leda brevirostris Hall St. 20	x
Paracyclas cf. tenuis Hall (F. 55)	
Palæoneilo maxima (Conrad) St. 31	x
P. cf. constricta (Conrad)	
Nuculites cf. oblongata Conrad (F. 50) (A 20)	
Nuculites triquetrus (Conrad) Hall. C.	x
Nucula cf. randalli Hall (F. 11)	
Schizodus appressus Hall. C.	x
Sphenotus truncatus (Conrad) F 26, F 48	x
Mytilarca cf. nitidae Billings F 62.	
Phthonia cylindrica Hall	x
Modiella pygmæ (Conrad) St. A 20	x
M. modiola Clarke C.	
Modiomorpha inornata Billings B	
Modiomorpha cf. mytiloides (Conrad) Silver Brook	
Grammysia canadensis Billings B	x
Goniophora cf. hamiltonensis Hall F 62	
Goniophora sp.	
Goniophora tethys Billings (F. 58)	
Palæopinna flabellum Hall C.	
Actinopteria cf. communis (Hall) (F. 48)	
Actinopteria (Pterinea) fronsacia Clarke St. 32	z
Aviculopecten textilis (Hall) (F 25)	
Limoptera macroptera Conrad St. 32	x
Gastropods	
Tropidocyclus rotalinea (Hall St. 31)	x
T. brevilineatus (Conrad) C.	x
Euphemus ? quebecensis Clarke C.	
Bellerophon cf. leda Hall St. 31	
Callonema cf. bellatulum Hall C.	x
P. sulcomarginata Conrad var. *lecercqui C.*	z

Holopea gaspeisa Clarke St. 31, ,32	z
H. wakenhami Clarke C.	
Platyceras sp.	
P. gaspense Clarke C.	x
Murchisonia egregia Billings B.	
Diaphorostoma perceense Clarke (F. 25)	
Pteropods	x
Hyolithus cf. aclis Hall C.	
Cephalopods	
Michelinoceras sp. St. 26	
Phyllocarida	
Tropidocaris belli (H. Woodward) C.	
Trilobites	
Phacops cf. rana (29A)	x
Phacops sp. (F. 48)	
Eurypterids	
Pterygotus sp. C.	

Interpretation of Evidence.—The Gaspé Sandstone fauna includes seven species which are represented in the preceding Grande Grève Sandstone. These hold over species are interesting as examples of shells which were capable of adapting themselves to the new environment represented by Gaspé sedimentation. They demonstrate the ability of certain species to persist and survive in the midst of new conditions which eliminated nearly all of the Grande Grève fauna. These survivors include among others the long ranging and highly adaptable *Leptocoelia flabellites.* They belong in the class of relict species and have no important role with respect to correlation of the fauna.

The 70 species which comprise the invertebrate fauna now known from the Gaspé Sandstone include 23 species which may be regarded as highly significant from the standpoint of age and correlation. These 23 species, nearly one-third of the fauna, are either identical with or closely allied to Hamilton species. All of these Hamilton species make their first appearance in the eastern Gaspé section in the fauna of the Gaspé Sandstone. Correlation of this fauna with the Hamilton fauna of New York appears to be the only disposition of it which present evidence warrants, if we accept the principle that the age of a fauna is that of the youngest species in it. The absence from the fauna of many species which are present in the Hamilton of New York and southern Ontario reflects in some degree the contrast between the physical conditions of sedimentation in eastern Gaspé and the New York-Ontario region which prevailed during Hamilton time. Temperature contrasts probably kept out of the Gaspé region such warm sea species as *Tropidoleptus carinatus* which is unknown in North America north of the Ontario Peninsula. Relatively low salinity would probably have barred some other characteristic New York species from the eastern Gaspé sea. Allowance should be made for the great differences between the Gaspé Sandstone sediments of eastern Gaspé and the Hamilton sediments of central New York which would entail considerable contrasts between the marine life facies of the two regions. If this is done the identity of about one-third of the species in the two regions will appear to be as much as should be expected of synchronous faunas associated with unlike sediments and separated by about ten degrees of latitude.

WESTERN GASPÉ

Both the faunas and the stratigraphy of western and eastern Gaspé afford instructive contrasts. In this respect they remind one strongly of the Devonian sections of eastern central and western New York where great changes in the same fauna are often recognizable in an easterly and westerly direction. The western faunas of the Gaspé Peninsula are but slightly known as compared with those of eastern Gaspé.

G. W. Crickmay (4) in 1932 published a list of four species from the Causapscal formation, the basal division of the Devonian in the Metapedia Valley. This fauna he stated "indicates a correlation with the Grande Grève Limestone of Cape Gaspé and the Oriskany of New York". This correlation if correct, illustrates the contrasts in composition between the eastern and western facies of the Grande Grève fauna. *Eatonia peculiaris* and various other characteristic and abundant fossils of the eastern

Grande Grève Limestone are unknown in this western area. The four species in Crickmay's list of Causapscal fossils represent in some degree the relatively small number of species in this western fauna as compared with that of the Grande Grève Limestone with a fauna of 154 species in the Forillon peninsula.

The Four Mile Brook Section.—It is proposed here to confine discussion of the writer's study of Devonian faunas in the Metapedia valley to that part of the Devonian section which follows the Causapscal formation, the lowermost member of the Devonian. This is the Gaspé Sandstone of Crickmay (5) and the Heppel formation of F. J. Alcock (2). The list of species published by Alcock and determined by G. W. Crickmay contains such familiar Gaspé Sandstone species as *Spirifer gaspensis* and *Rensselæria* cf. *ovoides* which afford evidence that at least part of the Heppel Sandstone is the western equivalent of the eastern Gaspé Sandstone. This formation as defined by Dr. Alcock however appears to include a fauna which is of a very different type from the *Spirifer gaspensis* association. It occurs in shales and merits a name which will distinguish it from the considerable thickness of sandstone and red shales which lie below. The relations of the highly fossiliferous shales and the beds with sandstones dominant are well displayed in a section east of Causapscal about six miles along Four Mile Brook. Frequent changes in dip and strike and covered intervals prevent any close estimate of the thickness of the sediments represented in this section. The following section indicates the two contrasted types of rocks and gives an approximation to the thicknesses seen.

Drab argillaceous shale, with sandy beds near base and numerous fossils (Four Mile Brook member Heppel Sandstone	600±
Coarse sandstone in beds 6″ to 2″ thick mostly grey or green with 75 feet at base largely of red and green shales. (Heppel Sandstone)	1500±

The shales at top of this section will be called the Four Mile Brook member of the Heppel Sandstone.

The fauna represented in the following list was collected along the timber company road where it descends to the level of Four Mile Brook.

St. 17 Fauna of the Four Mile Brook Beds.—

Heliophyllum ? sp.
Crinoid stems
Botryllopora socialis Nich.
Anastomopora quebecensis Fritz, n. sp.
cf. Coscinium striatum H. & S.
Fenestrellina occidentalis Fritz, n. sp.
Fenestrellina gaspensis Fritz, n. sp.
Polypora orientalis Fritz, n. sp.
Sulcoretepora cf. incisurata (Hall)
Tœniopora penniformis Nich.
Tœniopora exigua Nich.
Pholidops, sp.
Strophalosia truncata (Hall) var. (See Pl. 2)
Productella, sp.
Stropheodonta cf. demissa (Conrad)
Dalmanella, sp.
Rhipidomella vanuxemi Hall var.
Camarotoechia, sp.
Eodevonaria hudsonicus var. *gaspensis* Clark
Chonetes, sp.
Cyrtina cf. hamiltonensis Hall
**Spirifer pennatus posterus* Hall & Clarke
Spirifer audaculus (Conrad) var.
Leptodesma cf. rogersi Hall
**Actinopteria boydi* Conrad
Modiomorpha cf. sublata Conrad
**Nucula corbuliformis* Hall
Nucula, sp.
Cypricardinia cf. indenta (Conrad)
**Paracyclus lirata* Conrad
Goniophora cf. carinata Conrad
Goniophora cf. rugosa (Conrad)
**Palæoneilo plana* Hall
Palæoneilo cf. muta Hall
Phacops cf. rana Green
Proetus, sp.

*Species which occur in the Ithaca fauna.

Tentaculites cf. bellulus Hall
**Bellerophon cf. leda* Hall

This is a typical marine shale fauna without the fragmented plant remains so characteristic of the shales of the Gaspé Sandstone area of eastern Gaspé.

The bryozoa of this Four Mile Brook fauna which have been studied by Dr. M. A. Fritz supply a definite contribution toward the evidence for its correlation with a fauna in the Gaspé Sandstone series of eastern Gaspé. The bryozoan fauna of the Gaspé Sandstone, as hitherto recorded, was limited to a single species. The writer's collections have added three species to this eastern fauna, all of which are from a single locality 29A in the York River valley. Two of these, *Fenestrellina gaspensis* Fritz and *Polypora orientalis* Fritz, are found to be identical with species from the Four Mile Brook beds and another *B. socialis* is probably identical with a second species in the western fauna. It thus appears that one-quarter and possibly one-half the bryozoa species, now known from the Gaspé Sandstone, are common to these two faunas which are separated by about one hundred miles and characterize respectively the Sonneau Brook member of the Gaspé Sandstone in the east and the Four Mile Brook beds in the west. The Sonneau Brook beds in addition to supplying three of the four eastern Gaspé Sandstone broyzoa species now known, have furnished the second starfish found in the Gaspé Sandstone series. The unique character of the Sonneau Brook fauna is further indicated by the presence in it of the only species of *Ischadites* known from the Gaspé Sandstone series. These have significance however chiefly in suggesting for this horizon a different and later stage of development than that represented by the ubiquitous *Spirifer gaspensis* fauna of the York River beds. For the correlation of the Four Mile Brook beds of the Metapedia Valley and the Sonneau Brook member of the eastern Gaspé Sandstone series here proposed we have to rely on the bryozoan fauna from the two areas.

The bryozoa and the remainder of the inverterbrate fauna of the Four Mile Brook beds may now be considered with respect to the evidence which they afford concerning the position of this fauna in the Devonian time scale.

Five of the eight species of bryozoa from the Four Mile Brook beds have been reported from Hamilton horizons in N. Y., Ontario and elsewhere. A large percentage of the brachiopod and pelecypod species, which comprise most of the remainder of this fauna, are also known from Hamilton horizons elsewhere. These would lead to placing the fauna in the Hamilton without challenge, but for the presence of certain species. One of these, *Strophalosia truncata* Hall var. has not been recognized before in eastern Canada. Associated with this species is another brachiopod not distinguishable from *Spirifer pennatus posterus* H. & C. These two species are the most abundant brachiopods in the Four Mile Brook fauna. These brachiopods, four pelecypods and one gastropod, starred in the list, represent species which are known in the Ithaca fauna of the Cayuga Lake section. The association of these seven species in the Four Mile Brook fauna, two of which are exceedingly abundant, justifies its correlation with the Ithaca shale fauna of the Portage formation in the writer's opinion. Prof. H. S. Williams in his final discussion of the Ithaca fauna wrote: "The Ithaca fauna as a whole may be called the *Spirifer pennatus posterus* fauna". *Paracyclas lirata,* one of the pelecypods of the Four Mile Brook beds, characterizes a zone in the Ithaca shale. (Fig. 20, U. S. G. S. Folio 169). Two other brachiopods in the fauna *Spirifer audaculus* (Con.) var. and *Rhipidomella vanuxemi* Hall var. show small variations from Hamilton examples of these species, but may be regarded as representatives of a slightly modified Hamilton fauna. Seven of the pelecypods are either identical with or closely related to Hamilton species, but they are also species known in the Ithaca fauna. This fauna is regarded as representing a late stage in the evolution of the Hamilton fauna and corresponding to the Ithaca stage of the New York Upper Devonian.

The Ithaca beds of the Cayuga Lake section were first shown to hold a modified Hamilton fauna by H. S. Williams (35a). The Portage elements in this Ithaca fauna have been indicated by E. M. Kindle. (Bull. Am. Palæontology, No. 6, Vol. 2, 1896.)

A few species from this fauna collected by Dr. Alcock (2a) and referred to the writer in 1935 were reported without specific determination to represent a Middle Devonian horizon. Study of the large collection now available indicates for this fauna an early Upper Devonian horizon.

At Escuminac Bay in the southwestern part of Gaspé Peninsula the fossil plants of the Hugh Miller cliffs have been recently restudied by Dr. Chester A. Arnold (Contributions from the Museum of Palaeontology, Univ. of Michigan, Vol. 5, No. 2 pp. 37-48, 4 pls. 1936). He concludes that "the plant fossils indicate that the cliffs are more recent than the plant-bearing horizons of the Gaspé Sandstones which are exposed at the eastern extremity of the peninsula, and are probably comparable in part to the Portage and Chemung formations in northern Pennsylvania and southern New York, where a similar flora also occurs" (P. 38). These beds (Escuminac beds of E. M. Kindle, Summ. Rept. 1928 Pt. C. Geol. Surv. Can. sect. opp. p. 83c (1930) with plants and fishes the writer regards as the probable continental equivalent of the marine sediments of the Four Mile Brook beds.

The complex relations of the Hamilton and succeeding Portage and Ithaca faunas along an east-west section across New York state have been indicated in J. M. Clarke's diagramatic section (13th Annual Rept. State Geol. of N. Y., p. 55a, 1894) and H. S. Williams (Folio 169, U. S. Geol. Surv. 1909).

The stratigraphic succession in the Cayuga Lake section, with which this western Gaspé fauna is compared, is given together with the Gaspé equivalents as interpreted by the writer in the following correlation table.

CORRELATION TABLE

Cayuga Lake, N. Y. Section	Western Gaspé Section	Eastern Gaspé Section
Portage formation Ithaca Shale member *Paracyclas lirata Zone*	Heppel formation (Gaspé Ss.) Four Mile Brook Shale member with *Paracyclas lirata* and *Strophalosia truncata* var.	Gaspé Sandstone Sonneau Brook beds with bryozoa common to western and eastern Gaspé
Genesee Shale	Not differentiated	
Tully Limestone	Not present	
Hamilton formation	Heppel formation Sediments chiefly sandstone, red or brown toward base	York River beds of Gaspé Sandstone
Marcellus Shale Onondaga Limestone Oriskany Sandstone	Not present	Grande Grève Limestone Many Onondaga and Oriskany species present

SUMMARY

The occurrence in eastern Gaspé of a fauna with *Scyphocrinus* and other lowest Devonian fossils which is correlated with the Keyser member of the Helderberg in Maryland and West Virginia is described. These beds directly follow the graptolite bearing Ordovician sediments. The physical conditions which assembled or selected the several elements of the Gaspé Sandstone fauna are compared with analagous marine conditions now existing near the eastern seaboard of Canada. The presence of two well defined lithologic facies in the Gaspé Sandstone is pointed out and the position of the Gaspé Sandstone fauna in the time scale is critically reviewed. The conclusion is reached that it is of Hamilton age, except for a terminal member,—the Sonneau Brook beds,— which holds an abundant bryozoan fauna. This member is correlated with the Four Mile Brook beds of western Gaspé.

In the Metapedia River Valley in western Gaspé the discovery of *Strophalosia* and other fossils significant as horizon markers has lead to the recognition of a terminal division of the Heppel Sandstone, the Four Mile Brook beds or member, which is correlated with the Ithaca fauna of central New York thus giving it and the Sonneau Brook beds an early Upper Devonian or Senecan age.

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EXPLANATION OF PLATES

PLATE I (III)

EXPLANATION OF PLATE 1 (3)

Fig. 1 A Grande Grève Limestone at Grande Grève, Forillon Peninsula

B Contact of Gaspé Sandstone (left) and Grande Grève, Limestone (right), three miles N. W. of Grande Grève. Man is pointing to top layer of limestone

C Cross-bedded Gaspé Sandstone about 1000 feet above Grande Grève Limestone contact shown in B

C

B

A

PLATE II (IV)

EXPLANATION OF PLATE 2 (4)

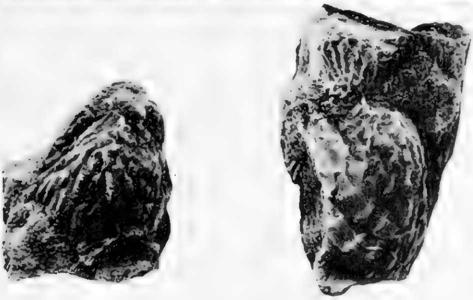
Fig. 1 Fault contact between the St. Albans Limestone (left) and Cape Rosier black shales (right). Well defined horizontal striæ characterize the slickensided limestone face of the fault.

Fig. 2 *Strophalosia truncata* Hall var. showing attachment truncation on ventral valves x 3

Fig. 3 Dorsal and ventral valves (right).
Detached spines and spine bases (left) x 2

1

2



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(*APPENDIX 82 A*)

DEVONIAN BRYOZOA OF GASPE

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CONTENTS

INTRODUCTION

Up to the present time very few bryozoa have been recorded from the Devonian rocks of Gaspé[1]. John M. Clarke, in describing the faunas of this region, lists only three species from the Grande Grève Limestone and one species from the Gaspé[2] Sandstone. The present paper deals with a rather limited collection of bryozoa of Gaspé Sandstone age obtained in the summer of 1936 by Dr. E. M. Kindle of the Geological Survey of Canada. The localities from which this material was collected are situated in two widely separated parts of the peninsula. One locality (No. 17) is along Four Mile Brook, near Causapscal, Quebec, in the Matapedia Valley of western Gaspé. Here, the strata are brownish gray shales rich in bryozoa. The other locality (No. 29A) is along the east branch of Sonneau Brook on the north side of the York River Valley in eastern Gaspé. The strata in this area consist of coarse sandstones with an abundance of interbedded bituminous material. Fewer species of bryozoa are found at this locality than at the former, the bituminous sandstones lending themselves apparently to the preservation only of the more resistant forms. It is thought that further collecting in this locality might possibly reveal more bryozoan types. On the whole the preservation of the material in both areas is poor, the fossils, for most part, consisting merely of casts and moulds or impressions.

Dr. Kindle in his recent paper[3] on the Gaspé faunas has dealt in considerable detail with the problem of correlation. He regards the Four Mile Brook beds of the West and the Sonneau Brook beds of the East as early Upper Devonian in age.

LIST OF SPECIES IDENTIFIED

	Loc. 17 (West)	Loc. 29A (East)
Botryllopora socialis Nich.	x	x?

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[1] Clarke, J. M., N. Y. S. M., Mem. 9, pt. I, p. 215.

[2] *Op. cit.*, p. 242.

[3] Kindle, E. M.: *Correlation of certain Devonian Faunas of Eastern and Western Gaspé*, Bulletin American Paleontology, Vol. XXIV, No. 82 1938, pp. 40-45,

Anastomopora quebecensis, n. sp. Fritz	x (rare)	-
Sp. *cf. Coscinium striatum* H. & S.	x	-
Fenestrellina occidentalis, n. sp. Fritz	x (common)	-
Fenestrellina gaspiensis, n. sp. Fritz	x (rare)	x (common)
Polypora orientalis, n. sp. Fritz	x (rare)	x (common)
Sulcoretepora cf. incisurata (Hall)	x	-
Tæniopora exigua Nich.	x	-
Tæniopora penniformis Nich.	x	-

NOTES ON SPECIES RECOGNIZED OTHER THAN NEW SPECIES

Botryllopora socialis Nich. is represented at locality 17 by seven well preserved impressions. At 29A a single, poorly preserved cast leaves some doubt as to the presence of this species at that locality. This unique little bryozoan has a widespread geographical distribution. It is recorded from the Hamilton of Ontario, New York, Michigan, and in Kentucky at the Falls of the Ohio.

Hederella blainvillii Clarke is listed from the Gaspé Sandstone of the eastern part of the peninsula. Clarke's specimens apparently came from the York River beds which represent a lower horizon in the sandstone. These beds are below the Sonneau Brook beds or the Four Mile Brook beds dealt with in this paper. This species incrusts the shells of *Leptostrophia blainvillii* (Billings). Though this brachiopod is present in the strata under consideration, no trace of the associated bryozoan has been seen during the present study.

Sp. *cf. Coscinium striatum* H. & S. At locality 17 several small fragments strongly suggest the presence of this species. Owing to the unsatisfactory nature of the material, however, a positive determination is not warranted.

Sulcoretepora cf. incisurata (Hall) is among the common branching bryozoa at locality 17. It is quite possible that with better material on hand to study, certain individual characteristics might be detected in the Gaspé representative of this common Ontario and New York species .

Tæniopora penniformis Nich. and *Tæniopora exigua* Nich. Among the material from locality 17 are numerous moulds of a branching bryozoan that undoubtedly belongs to the genus *Tæniopora*. Forms are present that show a very prominent carina as well as others in which this structure is not so well defined. Though the condition of preservation does not permit a determination of the finer details of structure, it is believed that the Gaspé forms, if not identical, are close relatives of the New York and Ontario species.

DESCRIPTION OF NEW SPECIES

The four new species described in this paper all belong to the Family Fenestrellinidæ[4]. They include one species of *Anastomopora,* two species of *Fenestrellina,* and one species of *Polypora.*

Anastomopora quebecensis, n. sp. Plate 1, fig. 5

This species is known only from fragments. The largest fragment, which shows the basal attachment, is a cast measuring 48 mm. by 33 mm. It suggests an infundibuliform zoarium.

Obverse. The branches are broad, round, sinuous, and subparallel. Their surface is marked by fine, flexuous striations. The average maximum width of a branch is approximately 0.75 mm. The branches are connected by short, broad dissepiments which are slightly depressed below the general plane of the branches. About three dissepiments appear in the space of 5 mm. measuring longitudinally. The fenestrules are oval. They are 0.75 mm. long and 0.4 mm. wide. About four appear in 5 mm., those on one side of a branch alternate fairly regularly with those on the other side. The zoœcia are chiefly in four ranges. They are arranged in sinuous, longitudinal rows. About twenty-two zoœcia appear in 5 mm. Each zoœcium is separated from its neighbor by a space equal to the diameter of an aperture. The peristomes appear to have been prominent.

Reverse. The branches are strong, smooth, zigzag, and angular due to the presence of a slight carina. The dissepiments cannot be clearly distinguished from the branches. The fenestrules, which are oval, are situated in the centre of sloping hexagonal areas and are arranged in fairly well defined longitudinal and oblique rows.

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[4] Fossilium Catalogus, 1, Animalia, pt. 67, pp. 19, 20.

Remarks.—*Anastomopora quebecensis* is related to *A. perundata* (Hall) and *A. petoskeyensis* McNair. It differs from both these species in details concerning the size of the branches, dissepiments, fenestrules, and zoœcia. The constancy of four rows of zoœcia readily distinguishes the species from the more closely allied forms.

Cotypes.—Nos. 9172; 9173 National Museum of Canada, Ottawa.

Occurrence.—Gaspé Sandstone, Four Mile Brook beds, locality 17.

Fenestrellina occidentalis, n. sp. Plate 2, fig. 2

Numerous fragments of this species occur but, for the most part, they consist merely of impressions. The best preserved specimen, the one selected as the type, measures 37 mm. by 40 mm. This fragment suggests a flabellate expansion for the zoarium.

Obverse. The branches are slender and parallel, their average maximum width is 0.3 mm. The surface of the branches on this side is not well preserved. The branches are connected by long, slender dissepiments slightly depressed below the general surface. The dissepiments are distinctly broader where they meet the branches. The fenestrules are somewhat quadrangular, from seven to ten appear in 5 mm. measuring longitudinally. The zoœcia are numerous, twenty-five in 5 mm.; those on one side of the faintly developed, slightly sinuous carina, alternate with those on the other side.

Reverse. The branches are characterized by fine, clearly marked, longitudinal striations, and by sharply defined nodes. The latter are situated in the centre of the branches, one node commonly appearing opposite each dissepiment.

Remarks.—The non-celluliferous side of the zoarium, with the finely striated branches and well marked nodes rather regularly located opposite the dissepiments, readily distinguishes this species from others in this region. *F. curvata* (Hall) resembles this form in the more or less regular arrangement of the nodes while

F. marcida (Hall) is similar in respect to the finely striated obverse side of the branches. With these two species *F. occidentalis* probably is most closely allied.

Holotype.—No. 9174, National Museum of Canada, Ottawa.

Occurrence.—Gaspé Sandstone, Four Mile Brook beds, locality 17.

Fenestrellina gaspiensis, n. sp. Plate 1, figs. 1, 3, 4

This species, though abundant, is known only by impressions and casts of the celluliferous surface. The description, therefore, is of necessity limited owing to the obliteration of certain of the more important details of structure. In spite of this discrepancy the morphology of the zoarium is well preserved. It forms rather shallow, infundibular shaped structures. From a small, pointed basal attachment the colony rapidly expands to a diameter exceeding 20 mm., becoming distinctly folded towards the outer margin.

Obverse. The branches appear to have been round. They are slightly sinuous or anastomosing. Their maximum width, as observed from casts, is 0.4 mm. The fenestrules are oval, five appear in 5 mm. The dissepiments are strong, the exact measurements cannot be ascertained with certainty but four can be counted in a 5 mm. space on an impression measuring longitudinally. The zoœcia number twenty in 5 mm. A carina was obviously present but the preservation is so poor that its character has not been observed.

Reverse. Unknown.

Remarks.—This species shows certain affinities with *F. sinuosa* (Hall) and *F. erectipora* (Hall).

Cotypes.—Nos. 9168; 9169; 9170 National Museum of Canada, Ottawa.

Occurrence.—Gaspé Sandstone. Rare in Four Mile Brook beds, locality 17; common in Sonneau Brook beds, locality 29 A.

Polypora orientalis, n. sp. Plate 1, fig. 2; Plate 2, fig. 1

This species, like the one previously described, is known only by casts and impressions in which the shape of the zoarium and the celluliferous surface are well preserved. In the shape of the zoarium the present form is strikingly like *Fenestrellina gaspiensis.* The colony in this instance, however, is more expanded (in the type the diameter must have exceeded 50 mm.) and the marginal folds form broader undulations.

Obverse. The branches are round and parallel, their surface being marked by flexuous, interrupted striæ. The maximum width of a branch is 0.6 mm. The fenestrules are oval, seven or eight in 5 mm. measuring lengthwise. The dissepiments are strong, five or six in 5 mm. along a similar line. The zoœcia are in two to four rows with an average of twenty-two in 5 mm., the peristomes are prominent.

Reverse: Unknown.

Remarks.—Since the reverse side is not present the generic reference of this species is somewhat doubtful. In certain respects the obverse side suggests the genus *Anastomopora.* The species, however, is distinct from *A. quebecensis* from locality 17. In view of the parallel arrangement of the branches and the rather distinct dissepiments the species is herein ascribed to the genus *Polypora.*

Holotype.—No. 9171 National Museum of Canada, Ottawa.

Occurrence.—Gaspé Sandstone. Rare in Four Mile Brook beds, locality 17; common in Sonneau Brook beds, locality 29 A.

SUMMARY AND CONCLUSION

From the foregoing study of a small collection of bryozoa from strata of Gaspé Sandstone age, obtained from two widely separated localities in the Gaspé Peninsula, nine species have been identified. Four of these species are new and they are herein described. Though the similarity in forms at these two localities is not striking, at least two species have definitely been found in common in the two areas. It is felt that more extensive collecting in these two areas would reveal a still further resemblance.

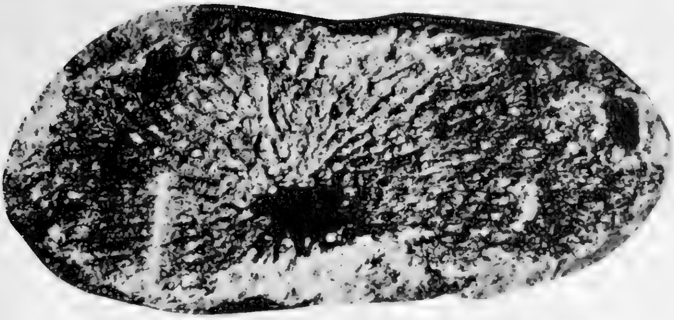
The bryozoan fauna, on the whole, bears a close relationship to the Hamilton fauna of New York. Certain brachiopods and pelecypods, however, strongly suggest the Genesee of New York. On this evidence Kindle prefers to regard the strata as Upper Devonian.

Although, as indicated above, only nine species have been recorded, the presence of numerous poorly preserved fragments of many other species suggests a prolific fauna for this region. With this fact in mind it is not unreasonable to believe that the bryozoa were as abundant in Gaspé in Middle or possibly early Upper Devonian times as they are known to have been in the more classic areas of New York and Kentucky.

PLATE I (V)

EXPLANATION OF PLATE 1 (5)

Figure		Page
1.	**Fenestrellina gaspiensis** Fritz, n. sp. Cotype No. 9168, National Museum of Canada, Ottawa; x5	7
2.	**Polypora orientalis** Fritz, n. sp. Holotype No. 9171, National Museum of Canada, Ottawa; x1	7
3.	**Fenestrellina gaspiensis** Fritz, n. sp. Cotype 9169, National Museum of Canada, Ottawa; x1	7
4.	**Fenestrellina gaspiensis** Fritz, n. sp. Cotype No. 9170, National Museum of Canada, Ottawa; x1	7
5.	**Anastomopora quebecensis** Fritz, n. sp. Portion of cotype No. 9172, National Museum of Canada, Ottawa; x5	5



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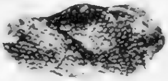

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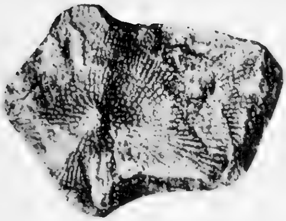

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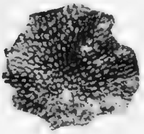

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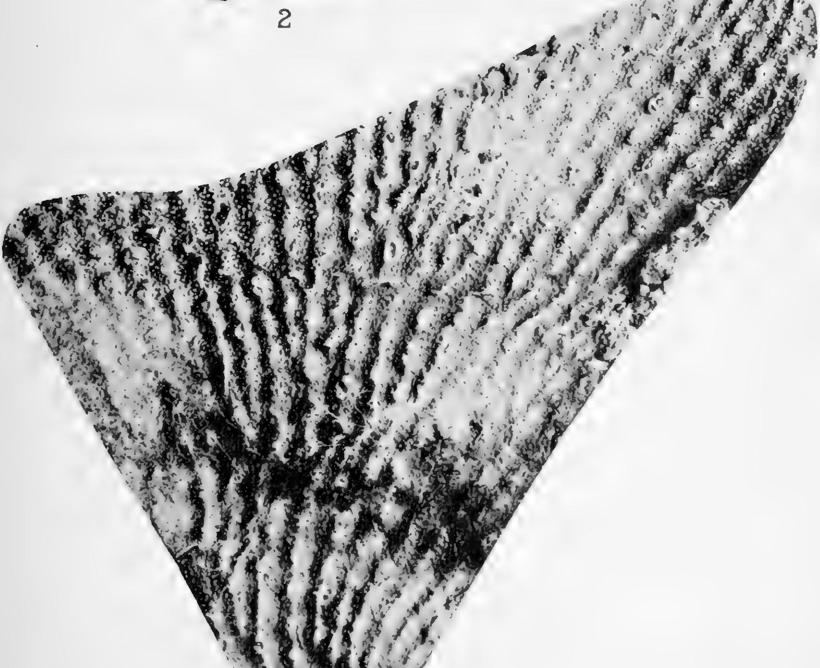
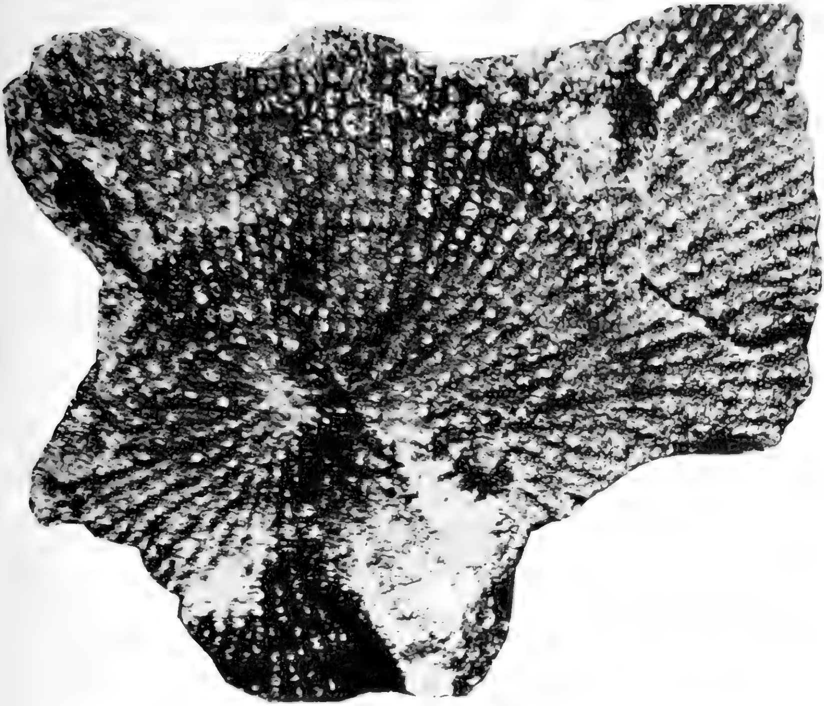


PLATE II (VI)

EXPLANATION OF PLATE 2 (6)

Figure		Page
1.	**Polypora orientalis** Fritz, n. sp. Holotype No. 9171, National Museum of Canada, Ottawa; x5	7
2.	**Fenestrellina occidentalis** Fritz, n. sp. Portion of holotype No. 9174, National Museum of Canada, Ottawa; x5	6



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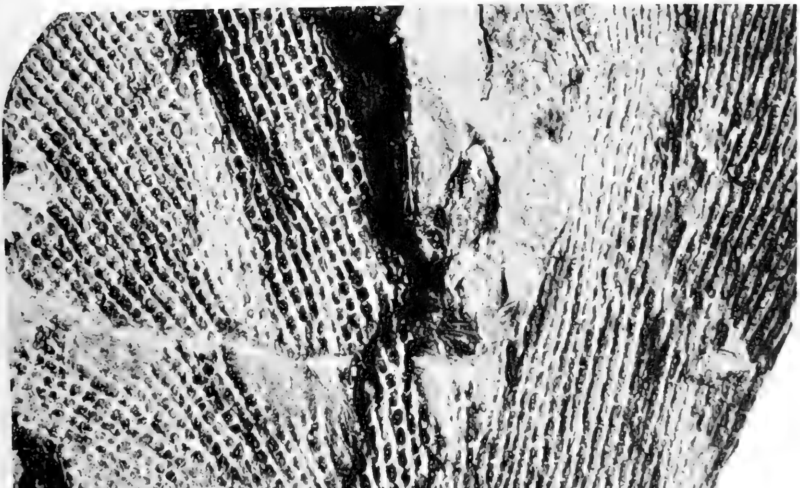

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A Devonian Fauna from Colombia

By Kenneth E. Caster

(Including Stratigraphic Notes by Axel A. Olsson)

April 8, 1939

Paleontological Research Institution
Ithaca, New York
U. S. A.

CONTENTS

A DEVONIAN FAUNA FROM COLOMBIA*

By

Kenneth E. Caster

University of Cincinnati

ABSTRACT

The description of the more striking elements of the first Devonian fauna found in the State of Colombia, South America, is the objective of this paper. Olsson and Caster briefly discuss the stratigraphic relationships of the Colombian Devonian in the first part of the paper. Caster, in the second part of the paper, treats the systematic paleontology and discusses the probable age of the fauna. The assemblage is evaluated as essentially the equivalent of North American early Onondagan faunas, with some Oriskanian derivatives of unusual aspect. The fauna proves to have a more striking ''boreal'' than ''austral'' flavor, and opens the problem of the isolation of South America during the early Devonian. Forty-nine species and varieties, chiefly brachiopods, assigned to thirty-seven genera, are recognized and illustrated. Of these, twenty-three species and five varieties are described as new to science. Five new genera (plus nine new genera not represented in the Colombian faunule), one new family, three new subfamilies and three new tribes are proposed in the Brachiopoda. There are several new generic records for South America. A partial reclassification of the crenulate-hinged Strophomenacea, principally as known in the Western Hemisphere, is outlined.

ACKNOWLEDGMENTS

To Mr. Axel A. Olsson and Dr. Parke A. Dickey goes credit for the original discovery of the Colombian Devonian strata. Their original collection, and so far as known the only collection yet made, is the basis for this study. The kind coöperation of these gentlemen and of the International Petroleum Company by whom they were employed has made the present investigation possible. The results are now presented for publication with the permission of Dr. O. B. Hopkins, Director, and Mr. O. C. Wheeler, Chief Geologist of that company. I am especially grateful to Mr. Olsson for turning this material over to me for study. Mr. Olsson has generously waived his rights of co-authorship through discovery and no little preliminary preparation and study of the fauna. His interest and assistance during the course of the work have been of great benefit.

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* Published with the permission of Dr. O. B. Hopkins, Director, and Mr. O. C. Wheeler, Chief Geologist, of the International Petroleum Company, Toronto.

I am fortunate in having had the opportunity to work and examine collections during the course of the investigation at the University of Cincinnati Museum, the Paleontological Research Institution in Ithaca, New York, the New York State Museum in Albany, and the United States National Museum. The facilities and collections in Ithaca were made available through the courtesy of Dr. K. V. W. Palmer and Prof. G. D. Harris; in Albany through Dr. Chas. C. Adams, Director of the State Museum, and Dr. Winifred Goldring, Assistant State Paleontologist; and in Washington through Dr. R. S. Bassler, Head Curator of Geology, and Dr. G. A. Cooper, Assistant Curator of Paleontology. Dr. Cooper has been exceedingly generous in his coöperation during the study, and in helpful criticism of the manuscript. The opinions and conclusions expressed in the paper are, however, entirely the responsibility of the writer.

Publications not available in Cincinnati were generously loaned or contributed by the Paleontological Research Institution, Dr. Rudolph Ruedemann, Dr. Thore Halle of Sweden, Dr. Robin S. Allan of New Zealand, Dr. Ramon Kozłowski of Poland, Dr. Pierre Pruvost of France, Drs. Etienne Asselberghs and Eugène Maillieux of Belgium, and Dr. R. Mendez-Alzola of Uruguay. Photostats of several inaccessible papers were made through the courtesy of Dr. Pearl G. Sheldon of Ithaca, New York.

I am indebted to Professor G. D. Harris and the Board of Trustees of the Paleontological Research Institution for facilities of publication. The defrayal of the cost of the collotype plates has been met by the Faber Publication Fund for Paleontology at the University of Cincinnati Museum. Much of the photography for the paper has been creditably done by Mr. Stewart Jones, student in geology at the University of Cincinnati. The constant coöperation of Anneliese S. Caster has facilitated the preparation of the manuscript and the seeing of the paper through the press.

All of the Colombian faunal material on which this study is based is on deposit at the Paleontological Research Institution.

KENNETH E. CASTER

University of Cincinnati
November 5, 1938

PART I

GENERAL CONSIDERATIONS

By

Axel A. Olsson and Kenneth E. Caster

OCCURRENCE

During the winter of 1935, while engaged in a geological reconnaissance of the Cordillera Oriental, or Eastern Andean Range of northeastern Colombia, Axel A. Olsson and Paul Dickey discovered the Devonian faunule described in this report. A preliminary notice of the occurrence and content of the faunule was presented by Olsson and Caster, 1936 (1937), before the Paleontological Society. The fossils here described were obtained at the north side of the small village of Floresta, long. 72°53′ W., lat. 5°51′ N., on the automobile road between Santa Rosa and Corrales in the western part of the Departmento de Boyaca, Colombia. Geographically this is a little east of north from the town of Sogamosa, the terminus of the railroad from Bogota.

It has long been suspected that Paleozoic rocks occur in the Eastern Andes but the discovery of fossils to prove the surmise is of relatively recent occurrence. Marine Carboniferous strata are now known to be widely distributed in Colombia, especially in the Gacheta and Villavicencio districts to the east and southeast of Bogota, although as yet they have not been critically studied. Some fossils believed to belong to the Lower Devonian were collected in Quebrada Honda, north of Villavicencio, from loose boulders by R. Scheibe, 1917 (1933) (described by W. E. Schmidt, 1933), and by R. E. King (according to Schuchert, 1935, p. 673) from a nearby locality. The discovery at Floresta by Olsson and Dickey is the first record, so far as we are aware, of the finding *in situ* of Devonian strata in the State of Colombia, although Devonian rocks are well known in the Sierra de Perija of western Venezuela (Weisbord, 1926; Liddle, 1928; etc.).

The Eastern Andean Range has long been known to be composed principally of Cretaceous strata which rest on an older series called the Giron or "Old Red" series. It had been hitherto supposed that the Giron in this region rests directly upon a metamorphic and igneous complex of gneisses, mica schists and diorite granites. In western Boyaca a wedge of Devonian strata apparently intervenes. These strata, for which the name *Floresta* is proposed below, consist of rather soft, yellowish to cream colored shales with some thoroughly indurated layers. The buff shales may originally have contained considerable calcium carbonate, for they have the appearance of being a residual deposit from a highly calcareous argillite. The fossils are preserved solely as external or internal molds which show structural details in fine perfection. The present study has been carried out principally by the use of plasticine casts. The name *Floresta series* is introduced for the Devonian sequence between the Giron and the igneous-metamorphic complex. It seems clear that the Floresta sequence underlies the Giron, but opportunity for detailed field study of the relationships has not yet been available. For a short distance toward Santa Rosa from the Floresta occurrence exposures are absent, then follow barren yellowish shales which are directly overlain by the harder, slaty red beds of the Giron series. In the opposite direction, toward Corrales, the first exposures met with are deeply weathered crystallines. These relationships seem clearly to show that the Floresta series lies between the typical red beds of the Giron and the basement complex, but whether they are transitional with the "Old Reds" or unconformably underlie them has not been established.

The Cachira series of western Venezuela, usually considered as lower Middle Devonian in age, is extensively developed in the Sierra de Perija. According to Liddle, 1928, the Cachira is comprised of a thick sequence of sandstones, shales and limestones, and apparently occupies a similar stratigraphic position in relation to the "Old Red" and the crystallines as does the Floresta series. It seems quite clear from the faunal comparisons that the Cachira and Floresta series are in part at least contemporaneous, although they have only a few species in common. The Cachira fauna and stratigraphy are very imperfectly known as yet, however, and certainly there is a striking facies difference in the fossiliferous horizons of the two series. The Venezuelan material described by Weisbord came principally from a massive limestone replete with corals. Molluscs, brachiopods and bryozoans are also common in his fauna, whereas in Colombia, brachiopods and bryozoans are exceedingly abundant, but corals are extremely rare, and molluscs nearly equally sparse. The two faunas seem to be more alike in trilobite content. This aspect the two faunas appear also to share equally with the Bolivian Devonian, described by Kozłowski, 1923. Further study of larger collections may show this similarity to be a preliminary illusion. The abundant bryozoan fauna of the Cachira and Floresta series is an unusual feature for South American Devonian strata. This phase of the Colombian fauna is now being studied by Dr. A. H. McNair of Dartmouth College.

PART II

THE FAUNA

By

KENNETH E. CASTER

AGE AND RELATIONSHIPS

The Floresta fauna described in this paper is only a small portion of what seems clearly will be very extensive biota when more careful and detailed collecting is possible. The small amount of material on hand, however, shows so many interesting features that it has seemed worthy of description despite its inadequacy for a complete picture. Several years have already elapsed since the original collection was recovered, and at least three unsuccessful attempts have been made to secure additional material by colleagues in Colombia primarily on other assignments. The reader will do well to bear in mind the reconnaissance nature of the present paleontologic report and withhold final evaluation of the discovery until a more complete report is possible.

In the following list of species occurring in the Floresta series of Colombia, the symbols in the adjacent columns refer to the key, below. The species bearing an asterisk are new generic stocks in South America.

I

APPARENT PLACE IN THE NORTH AMERICAN DEVONIAN SYSTEM, BASED ON SPECIES AFFINITIES

1. Helderbergian series: North American Lower Devonian.
2. Oriskanian series: upper Lower Devonian*. (Grande Grève

---

* North American section, after Clarke and Schuchert, 1899.

facies of principal importance).

3. Ulsterian series (especially lower Onondagan): lower Middle Devonian.
4. Erian (Hamilton) series: upper Middle Devonian.

In the faunal list, column I, when referring to the key above, the italicized numbers indicate closest resemblances.

II
REGIONAL DISTRIBUTION OF CONGENERS IN SOUTH AMERICA AND ENVIRONS

1. Amazonas region of Brazil (Hartt, Rathbun, Clarke, Katzer, etc.).
2. Bolivia (d'Orbigny, Ulrich, Knod, Kozłowski, etc.).
3. Argentina (Clarke, Thomas, etc.).
4. Uruguay (Mendez-Alzola, etc.).
5. Venezuela (Weisbord).
6. Falklands (Morris and Sharpe, Clarke, etc.).

III
PRINCIPAL DISTRIBUTION OF THE SPECIES GROUPS

A. "Austral" (Distribution principally south of the Caribbean and Mediterranean).

B. "Boreal" (Distribution principally North America and Europe).

C. "Cosmopolitan" (Known at least from most regions having Devonian faunas of comparable age).

THE FLORESTA FAUNA

	I	II	III
Pholidops florestæ Caster	2	1?	B
Leptæna boyaca Caster	3	?	C?
Megastrophia hopkinsi Caster*	*3*-4	?	B
M. pygmæa Caster*	3	?	B
Cymostrophia schucherti Caster*	1-*3*	?	B
C. waringi Caster*	1-*3*	?	B
C. dickeyi Caster*	1-*3*	?	B
Dictyostrophia cooperi Caster*	*3*-4	?	B
Stropheodonta kozłowskii Caster	*3*-4	2?	C? B
?Stropheodonta, sp.	?	?	?
Rhytistrophia caribbeana, var. colombia Caster	1-*3*	5	A, B
Strophonella meridionalis Caster*	2	?	B

Strophonella floweri Caster*	2	?	B
Schellwienella goldringæ Caster	1-3	1,2,5,6	C
S. goldringæ, var. juvens Caster	1-3	1,2	C
Productella cf. spinulicosta Hall	3-4	?	B
Eodevonaria imperialis Caster	2-3	1,5	C
E. imperialis, var. parva Caster	2-3	1,5	C
E. imperialis, var. transversa Caster	2-3	5	C
?Chonetes cf. stübeli Ulrich	?	2?	A,B
?Chonetes cf. billingsi Clarke, gens.	2	?	A,B
Chonostrophia knodi Caster*	2-3	?	B
Atrypa harrisi Caster	3	?	B
A. harrisi, var. nasuta Caster	?	?	B?
Meganteris australis Caster*	2-3	?	A,B,C?
Meristella wheeleri Caster	3	?	B
Pentagonia gemmisulcata Caster*	3-4	?	B
Elytha colombiana Caster*	3-4	?	B
"Spirifer" kingi Caster*	3-4	?	B
Acrospirifer olssoni Caster	2-3	1,2,5	C
Australospirifer cf. antarcticus, var. 1.	2?	1-6	A-B?
A. cf. antarcticus, var. 2.	?	1-6	A
	I	II	III
Brachyspirifer palmeræ Caster	3-4	1,5,2?	C
Paraspirifer, sp.	3-4	1,5	C
?Spinocyrtia cf. valenteana Hartt	3-4	1	A,B
Vitulina, sp.	3-4	2?	C
Anoplotheca cf. silvetii (Ulrich)	3-4	2	C
?Camarotoechia, sp.	?	2?	?
?Cryptonella, sp.	?	?	?
?Derbyiana, sp.	?	1?	A
Cypricardinia cf. subindenta Weisbord	3-4	5	A,B
?Aviculopecten, sp. A.	?	5?	C?
?Aviculopecten, sp. B.	?	5?	C?
?Pterinea, n. sp.	?	?	C?
?Fenestella venezuelensis Weisbord	3	5	C?
Phacops cf. salteri Kozłowski	3-4	2,5	C?
?Dalmanites cf. patacamayaënsis Kozłowski	?	2	A
?Cyphaspis, sp.	?	2?	A
?Homalonotus, sp.	?	2?	A

DISCUSSION

The tabulation brings out the predominently "boreal" flavor of the Colombian fauna, rather than an "austral" aspect which one might expect in view of virtually all previously described South American faunas. The Venezuelan fauna of Weisbord, 1926, is the unique exception among described faunas, unless the Amazonas fauna of Hartt and Rathbun, 1874, proves similarly allied. Their identifications and comparisons strongly suggest this. The faunas of Brazil, described by Clarke, 1913, seem to be more closely related to what we ordinarily think of as the typical "austral" faunas of Uruguay, the Argentine, and the Falkland Islands. The Bolivian faunas, which are perhaps best known of all in South America, lend a curious suggestion of antipodal admixture, the "boreal" aspect of which seems to increase northward. In northern South America the Devonian faunas thus far reported are almost wholly of a "boreal" stamp. Without discussing in detail the relative age relations of the Floresta Devonian in terms of the North American or European column, it appears probable that in Colombia and Venezuela we have a southward continuation of the early Middle Devonian faunas of the Appalachian geosyncline. At any rate, there seems to be good evidence of seaway communication between the continents when the Venezuelan and Colombian strata were formed. That this seaway extended across the Llanos region of today and around the Guiana shield into the northern and northwestern part at least of the Amazonas basin is also likely. From the strong admixture of southern and northern elements in Venezuela and Colombia, and decreasing importance of "boreal" species and genera southward, it would appear that open seaways extended between most, if not all, the known Devonian areas in South America, and that distance principally acted as a barrier between the two foci of faunal distribution. These two foci apparently did not exist in Ordovician times, when truly cosmopolitan faunas existed in the southern and central Andean region of South America, as brought out by the cosmopolitan graptolite faunas of the Andes. In Silurian times what may have been happening in the "austral" region of the Western Hemisphere is practically unknown. The so-called

Silurian beds in Argentina described by Clarke are possibly Devonian, as far as can be judged from the fauna described and illustrated. This is also the verbal opinion of colleagues who have examined the fauna in the field. The Argentine fauna may be somewhat older than those of Brazil, Bolivia and Colombia, but not more than an epoch of the Devonian seems at most to intervene. It is the "austral" purity of the Argentine fauna that has made correlation difficult. The faunal statistics would suggest that near the beginning of Oriskanian time in the North, in the Western Hemisphere at least, occurred an extremely important diastrophic event, which opened the western seaways from the Gaspé Peninsula in the north to the South Atlantic for commingling of previously more or less separated faunas. The maximum spread of the seaways in the South presumably came in Onondagan time (as did it not also in the North?), when most "boreal" forms reached the southern continent. The northern fauna seems to have been a dominant one, however, for to my knowledge, no typically southern genera or species reached the North American continent, whereas Venezuela and Colombia were virtual "boreal" outposts. If further study brings substantiation to these paleogeographic speculations, it is not impossible that the present highly unsatisfactory intersystemic boundary between the Silurian and Devonian must be re-examined in the interest of trying to reconcile a major diastrophic break of systemic importance to the insignificant place of separation it now holds between present divisions of the extended Lower Devonian (Clarke and Schuchert 1899).

From the tabulation it is seen that the present interpretation of the Colombian (and Venezuelan) fauna would align it essentially with the early Onondagan of the North. Scheibe, 1917-1933, Schmidt, 1933, and Schuchert, 1935, have thought of the fragments of Devonian rocks hitherto found in Colombia as Lower Devonian in age. The determination was based on the fragmental crinoid fauna described by Schmidt, and was recognized as only a temporary age assignment. The present fauna is preëminently early Onondagan in aspect, but also has strong similarities to that of the limestone facies of the Oriskanian so well developed in the Gaspé Peninsula of Quebec. It may be that in the south there was a longer carry-over of Oriskanian elements than in the north. There are, however, no elements in the present fauna that are especially reminiscent of the Schoharie fauna of the north. That there may be a very close affinity between the northern Andean Devonian faunas and those of the western United States is suggested by the few published reports, and even more so by undescribed material from the west which I have had the opportunity to examine. A somewhat similar carry-over seems to have occurred in the west also. As yet, however, in the absence of detailed modern studies (published) not much more satisfactory correlation can be ventured between the presumable Oriskanian-Onondagan strata of the western United States and those of the Appalachian region, than between the Colombian strata and the typical Oriskanian-Onondagan.

SYSTEMATIC PALEONTOLOGY

BRACHIOPODA

Subclass **GASTROCAULIA** Thomson

? Order **NEOTREMATA** Beecher

? Superfamily **CRANIACEA** Waagen

? Family **CRANIIDÆ** Gray, 1840

Genus **PHOLIDOPS** Hall, 1859, or **LINGULAPHOLIS** Schuchert, 1913

Pholidops (or **Lingulapholis**) **florestæ** Caster, n. sp. Plate 1, figs. 1-3

Shell large for either *Pholidops* or *Lingulapholis.* Outline of both valves subcircular; apex submarginal and only very slightly produced posteriorly. Length and maximum width subequal; greatest width is a little anterior of the middle. Ventral valve of low convexity; dorsal valve planate or slightly concave centrally. Both valves show a relatively wide peripheral area of contact which in one specimen (5454) is developed into a rounded convex peripheral flange in the dorsal valve, (*see* fig. 3). Ventral valve shows a weak subventral cementation scar (figs. 1,2). Growth was holoperipheral in early ontogenetic stages, but became hemiperipheral (or possibly mixoperipheral) before half grown. Both valves show a tendency for a narrow posterior plate or "false area" to develop between the valves as in *Lingulapholis*. Varices relatively prominent, imbricating and becoming fascicularly lamellate in the later half of the shells. Postlateral slopes show faint suggestions of radii. Musculature of ventral valves not known. Muscle attachments of the dorsal valve are very prominent; located subcentrally on either a callus platform, or on a deep central invagination of the dorsal shell. The appearance of the mold suggests a subcircular platform on which the bilobate anterior adductor impressions are most prominent. The posterior adductor impressions are extended outside the central prominent zone as faint postlateral lobate scars. The median impression (diductor scar?) between the anterior adductor lobes is very distinct.

Dimensions.—Length of types is 7 mm. and maximum width 6.5 mm.

Discussion.—Schuchert, 1913 (p. 296), has questioned the position in the Brachiopoda of the genus *Pholidops,* and has pointed out that the genus (and *Lingulapholis* as well) has fully as many atremate as neotremate characteristics. The inferred relationship to the Craniacea and Craniidæ, largely hypothetical as yet, is postulated on general similarity in form. These matters need not especially concern us at this time.

So far as known, this is the first clear-cut record of the genus *Pholidops* (or *Lingulapholis*) in the Southern Hemisphere Devonian. Thomas, 1905 (p. 258), lists a problematical fossil from the Argentine Devonian as *Pholidops?,* but did not describe or illustrate it, and I have no way of knowing the bearing of this record on our species. The affinities of this fossil seem to lie with forms described from the Lower and lower Middle Devonian in North America. The generic assignment would be definitely *Pholidops* Hall, *s. s.* were there not suggestions of a pseudoarea such as Schuchert, 1913 (p. 296, pl. 53, figs. 14-19), described for *Lingulapholis terminalis* (Hall) from the Oriskanian of Maryland. The Colombian specimens do not recall the genotype, however, nearly so much as they recall *P. areolata* Hall, 1867 (p. 31, pl. 3, figs. 4, 5; Hall and Clarke, 1892, pl. 4i, figs. 25, 26), from the Schoharie grit of New York (which Dunbar, 1919, p. 86, lists also from the Camden Chert) especially in the shape and proportions of the muscular platform. If, however, I am correct in judging the tiny areas shown on plate 1, figs. 1, 2, as cementation sites, then it is possible that the similarity is more apparent than real, for the comparable markings in Hall's specimens are assigned to the ventral valve. Hall, 1867, and Hall and Clarke, 1892 (p. 155), were under the impression that this genus is unattached, and always expressed doubt as to the identification of the two valves. Schuchert, 1913 (p. 295), pointed out that *Pholidops* was cemented, and apparently did not have a functional pedicle. It appears that the Colombian specimens were attached in the *Pholidops* manner, but very meagerly. They seemingly also had a functional pedicle, if a faint pseudoarea, as in the free genus *Lingulapholis,* is an acceptable criterion for judging the presence of a pedicle. The well developed peripheral flange of the dorsal valve in the Colombian species easily sets them apart from North American forms.

P. arenaria Hall, 1867 (p. 413, pl. 3, fig. 10; Hall and Clarke, 1892, pl. 4i, fig. 24), of the Oriskanian is smaller and with less clearly differentiated muscular areas, and *P. tumida* Schuchert, 1913, from the Maryland Oriskanian (Shriver Chert) is far too linguloid to warrant detailed comparison. *Lingulapholis terminalis* (Hall) differs as outlined above. *P. bellula* Walcott, 1884 (p. 113, pl. 2, fig. 6), from the Lower Devonian of the Eureka District is much smaller and has a distinct U-shaped muscle seat. His *?P. quadrangularis* is so doubtfully congeneric with our forms that comparison is unnecessary. *P. ovata* Hall, 1859 (p. 490, pl. 103B, fig. 7; Hall and Clarke, 1892, p. 157, pl. 4i, figs. 22, 23), from the lower Helderberg (Coeymans) has a more quadrangular muscle platform, and more prominent and extensiform posterior adductor lobes. The form from the Grande Grève limestone compared with *P. ovata* by Clarke, 1908 (p. 212, pl. 47, figs. 10, 11), recalls the South American material somewhat more than the topotype material in the apparently total absence of postlateral adductor impressions. The form referred to *P. ovata* by Weller, 1903 (p. 226, pl. 20, figs. 27-29), shows a peripheral flange, but is a much smaller fossil. The *P. ovata* of Schuchert, 1913, from the Helderberg of Maryland has far too lobate muscle impressions to be confused either with Hall's original material or the South American material.

It is not impossible that when better material has been found of the fossil referred to *Lingula*, sp. by Reed, 1903 (p. 167, pl. 20, fig. 3), from the Bokkeveld beds of South Africa that it will be assigned to *Pholidops* rather than to *Glossina* (Reed, 1925, p. 35). The general contour only suggests this.

Types.—Holotype: Pal. Res. Inst. No. 5454; paratype: No. 5454A. This material is on deposit at the Paleontological Research Institution, Ithaca, New York, and likewise all the rest of the material on which this study is based.

Order **PROTREMATA** Beecher

Suborder **STROPHOMENOIDEA** Oepik

Superfamily **STROPHOMENACEA** Schuchert

Family **RAFINESQUINIDÆ** Caster, new

With the elevation of the strophomenoids to subordinal rank, the long-awaited reorganization of this important branch of the Brachiopoda seems to be at hand. At this place only those phases of the superfamily are considered which the Colombian fauna may help illustrate. It is here proposed that the group formerly known as the subfamily Rafinesquininæ Schuchert, 1893, be elevated to family rank. The new family Rafinesquinidæ apparently contains several subfamilies, one of which will be restricted Rafinesquininæ, centering around the genus *Rafinesquina.* It is highly probable that the genus *Leptæna* should be considered the nucleus of another subfamily. The present study will not warrant any proposals in this connection, however.

Genus **LEPTÆNA** Dalman, 1828

Genolectotype.—*Productus rugosa* Hisinger. Ordovician.

Leptæna boyaca Caster, n. sp. Plate 1, figs. 4-13; Plate 10, figs. 1-3

Large, concavo-convex strophomenoid having the general characteristics of typical representatives of "*Leptæna rhomboi* *dalis,*" but showing what appear to be specific differences: length to hinge width usually as 2 to 3; hinge line usually auriculate; both valves in adulthood prominently geniculate, convexly in the ventral and concavely in the dorsal. Postgeniculate surface, *i. e.*, "visceral discs," of both valves slightly convex and prominently rugose, with usually 14 or 15 rugæ in adult shells. These corrugations are irregular and asymmetrical, the front slope of each being gentler than the rear. The amplitude of the corrugations increases regularly toward the front. The geniculate condition apparently appears only in adulthood. Height of geniculate "trail" measured on the ventral valve is usually about half of the length of the rugose surface of the ventral valve, and slightly less than half the length of the corresponding area when measured on the dorsal one. Surface radially multistriate; striæ relatively straight and regular on planate surfaces, but wavering and crowded on geniculate area. The striæ are fine and thread-like, and are separated by rounded interspaces about twice as wide as the diameter of a single stria. The radii increases by intercalation (appearing as bifurcation when viewed in the external molds) and usually originate on the crest of the corrugations on the posterior surfaces of the shell, but arise very irregularly on the up-bent zone. Internally, the "trail" is partially dissociated from the body cavity of the shell by a low sub-angular callus septum, or "diaphragm" in the *ventral* valve immediately anterior of the last corrugation. (*See* Dunbar and Condra, 1932, p. 178, for nomenclature of analogous dorsal structure in the Productidæ.) No evidence of such a "diaphragm" has been seen in the dorsal valve, but may be present, in as much as most *"Leptæna rhomboidalis"* specimens show such a structure.

The external characteristics of the cardinal areas are not known; some intimations of these are, however, shown by internal molds. The interiors of adult shells show evidence of considerable secondary calcification. The surface corrugations are only obscurely represented on internal molds, and the entire inner surface, especially of the dorsal valve, is papillose or granular. The papillæ are drop-like with the tapering end directed toward the beak, and show a general longitudinal orientation. In both valves the internal papillæ are most concentrated and less elongate in the immediate region of the muscle platforms. Toward the front of the shell and in the auricular zones they tend to be aligned so that they somewhat resemble the surface pustules of *Reticularia.*

The internal characteristics are shown on plates 1 and 10. The ventral muscle platform is well developed, and sharply outlined by an elevated peripheral extension of the dental lamellæ. The only interruption of this lamellar wall is in the front and middle. The platform is usually transverse, as in 5469 (plate 1, fig. 5), but may be subcircular, as in 5468 (plate 1, fig. 4). It is chiefly occupied by the flabellate diductor scars which show radial striations. Mesially the diductor scars are separated but not enclosed by an elevated anteriorly expanding ridge to which the adductors were attached. The postlateral borders of the scar are delimited by narrow elevated carinæ which become evanescent at about the anterior third where the whole adductor scar is slightly expanded. At the place of maximum expansion the adductor scars are less elevated than in the middle. For virtually its entire length the adductor ridge bears a narrow center carina or knife-edge which separates the right and left scars. The median ridge stops abruptly at the anterior edge of the muscle platform, but is not delimited by the wall of dental lamellæ as is the diductor area on either side. The teeth are very large, and widely divergent. The hinge line is essentially straight.

In the dorsal valve the musculature is equally striking. (*See* plate 1, fig. 7; plate 10, figs. 1-3). As in the ventral valve, the attachment seats are elevated on a callosity from the interior of the shell, but are not so well defined by the dental lamellæ as they are in the ventral valve. The cardinal process is bipartite, and extends only slightly, if at all, beyond the cardinal line as strong diverging carinæ. This can be seen on the plate 10, figs. 2, 3. The dental sockets are relatively large to accommodate the large opposing teeth. The crural platform is well developed posteriorly, where it is elevated on either side considerably above the hind periphery of the muscle platform. Forward extensions of the crural platform outline the narrowly flabellate posterior adductors in much the same manner as the dental lamellæ outline the ventral diductor scars. These extensions reach further to the front as weak, recurving and incurving borders of the narrow and anteriorly attenuate forward adductor scars. From the base of each part of the cardinal process prominent angular ridges extend toward the front. These are considerably elevated above the level of the muscle platform, and converge toward the middle at about the contact of the anterior and posterior adductor scars. They increase in elevation forwardly, where, united, they continue as a low septum recessed in a depression between the adductor scars. This septum is evanescent in the deepest part of the recess, which occurs at about the mid-zone of the anterior adductors, but increases in prominence in the front quarter of the platform. Near the anterior border of the platform the septum is well elevated and spade-like, and extends for some distance over the pallial region in front of the muscle-scar structures. In the rear part of the shell, between the extensions of the cardinal process before they unite, there is a low median septum on the narrow elevated platform which their outward fusion creates. This median carina is conspicuous to the point of evanescence of the median structure near the middle of the muscle platform.

The dorsal muscle platform is much narrower, and more elongate than the ventral one. The sides are subparallel, converging only slightly anteriorly. The posterior adductor scars are irregularly hexagonal in outline. They are bounded postlaterally by the vertical edge of the crural platform; postmesially and mesially by the sloping edges of the cardinal process extensions; anteromesially by the recessed edge of the anterior muscle scars; and anterolaterally by an incurving of the peripheral crural extension at the most elevated part of the muscle platform where there is a vertical elevation from the inner shell surface; and laterally by the crural extensions which here are subparallel. The entire posterior scar rises from the floor of the valve toward the front. Delicate arborescent ridges cover the posterior impressions. In each of these impressions there are two zones. The part lying between the forward apex of the crural platform and the mesial convergence of the cardinal process extensions is slightly more elevated than the rest of the scar. The front portion of the scars is bordered by a flange of crural extension. The anterior adductors are of the same general shape as the posterior, but are somewhat narrower, and more produced toward the front, which gives them an equal sided, subtriangular outline. If the most forward extension of the rear adductors is taken as the apex of the triangle, the side extending from this point to a point a short distance in back of the convergence of the process extensions is subequal to the slightly arcuate anterolateral side. The bases of the triangles diverge from the posterior apices and the intermediate zone is excavated. The surface of the anterior scars is on a lower plane than the posterior ones and is undulatory throughout, the posterior part being slightly higher than the anterior, and centrally concave. This creates the appearance of a flange adjacent to the mesial fossa. The attenuated crural extensions disappear toward the front and do not extend quite so far forward as does the mesial carina. The diductor fossa, while excavate throughout, is deepest toward the front, where the septum is most produced. The entire surface of the median platform rises toward the front, so that the converging anterior boundaries stand out in bold relief from the pallial region. There is no evidence of an internal concentric carina or "diaphragm" in the dorsal valve at the point of geniculation as in some species of this genus.

Dimensions.—The dimensions in millimeters of a representative suite are as follows:

	5468	5469	5470*	5471	5472*	5473	5474	5475
Width hinge	inc.	50	32	45	40	40	16	24
Length hinge	35	35	28	33	25	inc.	9	17
Length "trails"	inc.	16	5	14				
Length "visceral disc"	30	31	26	25	25	inc.	9	17
Length muscle scar	15	16	19			8		
Width muscle scar	14	23	11			12		

All of the above specimens are either casts or molds as follows: 5468, 5469 and 5473 are internal ventral molds; 5470 is an internal dorsal mold; 5471 and 5475 are external ventral molds; 5472 is an external dorsal mold, and 5474 is an external cast.

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*Dorsal valves

valve probably dorsal.

Discussion.—Of the generic assignment of the Colombian material there can be no question; the pattern is too similar to the genotype, *Leptæna rhomboidalis.* As always, when a new species of *Leptæna* is proposed, there immediately is entailed the search for tangible differences by which the new form may be differentiated from the many forms found at so many horizons over the world which have been assigned to *"Leptæna rhomboidalis"*. First, the writer is of the impression, shared by Grabau, 1931 (p. 20), when describing new Devonian *Leptæna,* that the many forms assigned to this species are quite likely homeomorphs. Second, with such inadequate information on facies variation in the Southern Hemisphere, it seems unwise to propose subspecific names at this time. The criteria for specific differentiation in the genus lie, it would seem, principally in the minutiæ of the musculature, size and general contour.

South American representatives of the genus, either listed as *"L. rhomboidalis"* or under other names, are very rare. Fragmental material from the Devonian of Rincon de Alonso in Uruguay has been provisionally listed as *Leptæna,* sp. by Mendez-Alzola, 1934 (p. 32), but may be corrugated Leptostrophias, or possibly the fossil described as *Stropheodonta argentina* Thomas, 1905 (p. 261), but assigned to *Leptæna* by Clarke, 1913 (pp. 290, 340-341), after examination of the material. (*See* below). *Leptostrophia caribbeana* Weisbord, 1926 (p. 10), from Venezuela, which he considered close to the Argentine material, is, however, a true leptostrophid. The Venezuelan species, which is here referred to a new genus, is also present in our fauna, but has no bearing in the present comparison. The "austral" association of leptænids and corrugated leptostrophids has a parallel in the Oriskanian (Grande Grève limestone) of the Gaspé Peninsula in the north. In immaturity *Leptæna* looks very much like *Leptostrophia oriskania.* This was commented on by Clarke, 1908 (p. 184), in his description of the Gaspé fauna. While I am unconvinced as yet of the wisdom of Clarke's pronouncement on the Argentine fossils, and am still receptive to the idea that the material may be stropheodontid, the differences in appearance should be mentioned. Thomas's fossils are far less rugose, smaller, and if his description and illustrations can be relied on, have virtually none of the typical leptænid muscle characteristics. They do show faint corrugations of the shell, which Clarke said were minimized by Thomas, and are apparently slightly geniculate. No other reports, to my knowledge, carry identifications of *Leptæna* from the South American Devonian.

The Colombian material is very similar to the Helderbergian, Oriskanian and Onondagan forms of *Leptæna* described from North America. Especially reminiscent is *L. rhomboidalis*, var. *ventricosa* (Hall) of the Oriskanian. This form, as described by Hall (*Strophomena rugosa*, var. *ventricosa* Hall), 1859 (p. 417), Hall and Clarke, 1892 (pl. 15 A), and Schuchert, 1913 (p. 308), from New York and Maryland, is presumably specifically distinct and may well be taken for the nonce as typifying the leptænid development in the Oriskanian. The Colombian fossils share the abnormally large size of Hall's species, but show ephebic geniculation not present in the North American material. There are other important differences, as a comparison of the plates will show, especially in the internal characters. Hall's, 1859, drawing and Schuchert's, 1913, photograph of the same specimen, when compared with *L. boyaca*, show very clearly a more prominent and massive cardinal process in the dorsal valve, a less strongly delimited muscle platform, shallower median depression, and more striking and continuous median septum or carina. The Hall species has a dorsal callosity or "diaphragm", but no "trail". The South American material at hand shows no evidence of a diaphragmal callosity. The ventral interior of the Oriskany form bears a nearly circular muscle scar, the halves of which almost enclose a median depressed zone of lenticular shape. In the Colombian specimens, this central zone is slightly expanded and open in front. The Oriskanian material apparently does not have a median carina in the midst of the ventral process.

There seem to have been at least two strains of leptænids in the Lower Devonian. Those of the Helderbergian are usually smaller and recall Silurian and even Ordovician representatives, whereas the Oriskanian and Onondagan forms, as Nettelroth, 1889 (p. 150), and others have pointed out, are consistently larger, more flabellate and ventricose than the previous forms. Dunbar, 1919 (p. 86), illustrated *Leptæna* (cf.) *rhomboidalis* from the Camden chert of Tennessee. His specimens show *L. ventricosa* characteristics and also Helderbergian attributes.

Leptæna boyaca is one of the commonest fossils in the Colombian fauna, and shows considerable variation, but all specimens bear sufficient characters in common to warrant the present assumption that we are dealing with a single leptænid strain, which is in all likelihood closely related to *L. ventricosa* of the North American Oriskanian.

Types.—Holotype: Pal. Res. Inst. No. 5470; paratypes: Nos. 5468, 5469, 5471-5474, 5471A, 5474A.

Family **STROPHEODONTIDÆ** Caster, new

The crenulate-hinged Strophomenacea are the subject of a more extensive study now in progress by the writer. In the final report on the investigation, the major classification of those brachiopods will be discussed in some degree of fullness. It seems wise to digress here sufficiently to outline the general scheme of classification of the lower categories, and point out some of the criteria of value in defining the more striking generic lines. This seems necessary in order better to bring out the structural and stratigraphic correlations of the Colombian fauna.

It appears that the entire group of crenulate-hinged Strophomenacea bears characters of structural value adequate to warrant recognition as a separate family of the Strophomenacea. The name STROPHEODONTIDÆ is hereby proposed for this new family centering around the genus *Stropheodonta* to which most crenulate-hinged brachiopods were at one time or another referred. The possession of a crenulated hinge in these rafinesquinoid shells, coupled with a community of quite similar internal structures, seems to be of family value. It appears after a rather careful study of the better part of the entire group as developed in the Western Hemisphere, that in this stock at least, the character of resupination is not so important as former classifications would imply. Schuchert and LeVene, 1929, for example, dissociated the strophonellids from the stropheodontids mainly on resupination it would seem, and referred the former to the Orthotetinæ, with which they seem to show, omitting reversed convexity, no major classificatory correlation. It seems to express relationships much better to place both groups in a common family and recognize the resupination as principally a subfamily, or even less significant characteristic in this stock. In the stropheodontids *Douvillina* and *Douvillinella,* the latter being resupinate, the character is apparently not of more than generic value. The part which wholesale homeomorphy plays in the Brachiopoda daily grows more obvious, but to what extent differently derived lines can almost precisely "mimic" each other has in each case to be thoroughly proved. It seems more probable in this case that both lines were derived from the rafinesquinids and soon after inception, resupination was established in one as a dominant trait. For this basal cleavage of the family Stropheodontidæ two subfamilies are proposed in line with the characteristics suggested above: the *Stropheodontinæ* and the *Strophonellinæ.*

Within the Stropheodontinæ three great groups are recognizable, as Hall and Clarke, 1892, understood long ago when proposing subgeneric names for the all-inclusive genus *Stropheodonta.* These groups are here designated *tribes* of the subfamily and take their names from the respective genera which they recall: *Stropheodontini, Leptostrophiini,* and *Douvillinini.* The first tribe, as here considered, embraces three types of shells for which separate tribal groupings may eventually prove necessary. The groups are here listed as the "brachyprionids", the "douvillinoid stropheodontids" and the "true stropheodontids". Several new generic groups and species assemblages are also present in the Strophonellinæ. Keys and abbreviated discussions of these matters follow:

Key to the Subfamilies and Tribes of the Stropheodontidæ

A. Rafinesquinoid shells which are concavo-convex, plano-convex, or rarely bi-convex and have a partially or completely crenulated hinge at some stage of their ontogeny. .... *STROPHEODONTINAE,* new.

B. Adult shells concavo-convex or subconcavo-convex.
  C. True braceplates (Stützplatten) present in the dorsal valve, shells usually small, and muscle scars usually strongly encircled by lamellar deposits. .... Tribe *Douvillinini*, new.
  CC. True braceplates absent in the dorsal valve, although false braceplates may be well developed for muscle attachment; shells of moderate to large size in most species, and muscle scars ordinarily not encircled in the douvillinoid manner. .... Tribe *Stropheodontini*, new.
BB. Adult shells plano-convex or subplano-convex; no braceplates in dorsal valve. .... Tribe *Leptostrophiini*, new.
AA. Strophomenoid shells which are convexo-planate (resupinate) and have a partially or completely crenulated hinge at some stage of their development; braceplates not known in the dorsal valve. .... *STROPHONELLINAE*, new.

Subfamily STROPHEODONTINAE Caster, new

The following genera principally represent the tribes of the Stropheodontinæ as recognized at the present time:

Stropheodontini

The Brachyprionids

Brachyprion Shaler. *Strophomena leda* Billings, genotype. Silurian.
Mclearnia Caster, new. *Brachyprion mertoni* McLearn, genotype. Silurian.
Shaleria Caster, new. *Strophomena gilpeni* Dawson, genotype. Silurian.

The Douvillinoid Stropheodontids

Protomegastrophia Caster, new. *Leptæna profunda*, Hall, genotype. Silurian.
Megastrophia Caster, new. *Stropheodonta concava* Hall, genotype. Middle Devonian.
Dictyostrophia Caster, new. *Dictyostrophia cooperi* Caster, new, genotype. Middle Devonian.
Cymostrophia Caster, new. *Leptæna stephani* Barrande, genotype. Middle Devonian F2.

The True Stropheodontids

Stropheodonta Hall, *s.s.* *Strophomena demissa* Conrad, genotype. Middle Devonian.

Douvillinini

Douvillina Oehlert. *Strophomena dutertrei* Murchison, genotype. Frasnian F2
Douvillinella Spriesterbach. *Douvillina filifer* Schmidt, genotype. Middle Devonian.
Group of *Strophomena inæquistriata* Conrad, *auct.* Middle Devonian.
Group of *Stropheodonta cayuta* Hall. Upper Devonian.
Group of *Stropheodonta arcuata* Hall. Upper Devonian.

Leptostrophiini

Primitive Leptostrophids

Group of "*Leptostrophia planulata*" (Hall), Manlius and Helderbergian.
Group of "*Stropheodonta*" *bipartita* Hall, Manlius and Helderbergian.

The Perplana Group

Protoleptostrophia Caster, new. *Strophomena blainvillii* Billings, genotype. Oriskanian.
Group of "*Leptostrophia perplana*" (Conrad), *auct.* Middle Devonian.

The Corrugated Leptostrophids

Rhytistrophia Caster, new. *Stropheodonta beckii* Hall, genotype. Helderbergian-Erian.

The Nervose Leptostrophids

Nervostrophia Caster, new. *Stropheodonta nervosa* Hall, genotype. Erian-Senecan. (?Chemung).
Group of *Leptostrophia junia* (Hall). Middle Devonian.

The Sulcate Nervosæ

Sulcatostrophia Caster, new. *Leptostrophia camerata* Fenton and Fenton, genotype. Upper Devonian.
Linguate forms and other forms of Sulcate Nervosæ in the Eifel.

Edentulous Leptostrophids

Australostrophia Caster, new. *Leptostrophia ?? mesembria* Clarke, genotype. Onondagan, Brazil.

True Leptostrophids

Leptostrophia Hall and Clarke, *s.s.* *Strophomena magnifica* Hall, genotype. Oriskanian.
Leptostrophia explanata (Sowerby) - Subgeneric strain of *Leptostrophia.* Coblenzian.

The subfamily Stropheodontinæ is characterized by a general rafinesquinoid contour in most of the species. This varies relatively slightly so far as the outline goes, but there is considerable variation in the detail of relative convexity and concavity. The surface is commonly ornamented with fine elevated costellæ which ordinarily are arranged in alternations of several fine radii between more prominent costellæ. Concentric surface ornament, excluding simple varices, is rare in the group as a whole, although apparently reaches generic proportions in isolated lines. Internally virtually all genera and species have a strong pair of ventral dental lamellæ (plus paradental lamellæ in some cases), which vary in length and direction. In some forms accessory calcareous muscular "diaphragms" separate the adductors from the diductors. A v-shaped posterior ventral "process" of greater or less development and in some cases a strong ventral median septum are generally present, but vary greatly in detail. In the dorsal valve the cardinal process is usually well developed, and may be either sessile or pedunculate; the strength and general plan of the parts of the process vary considerably in different genera. Crural plates are well developed in virtually all forms, but their length and direction vary a great deal. The presence or absence of a median dorsal septum and anterior adductor plates or braceplates (Stützplatten) are also important generic criteria. The ventral "process" in most forms fits between the prongs of the dorsal process, thus creating an effective articulation which is reminiscent of the cyclodont condition in the pelecypods. The true hinge teeth and sockets are in general obsolescent, but occasionally are rather well developed.

Tribe *Stropheodontini* Caster, new

The brachiopods falling in the tribe Stropheodontini conform most closely to the original plans of the genus *Stropheodonta.* It was especially the groups of *Stropheodonta demissa* and *Stropheodonta concava* that Hall apparently had in mind when the crenulated strophomenoids were differentiated. It is highly probable that in the completed study of the stropheodonts, however, that the *"concava"* group (*Megastrophia*) will be elevated to the rank of tribe. The protean brachyprionids and the close congeners of *Protomegastrophia,* all in the Silurian, will also be separated into one or two new tribes. The information, gleaned principally from North American faunas, suggests these steps. It seems best to let the matter rest until European species can also be included with some degree of certainty.

A Key to the Divisions and Principal Genera of the Stropheodontini.

A. Hinge either partially or wholly crenulated, but usually incompletely so; surface usually marked by an alternating pattern of radii which are not especially fasciculate; partial or complete encirclement of the muscle scars of one or both valves relatively common; strong varices of growth uncommon.

B. Ventral median septum well developed; shells usually of small size; delthyria primitively gaping; hinge crenulations restricted to very few on either side of the delthyria, usually located on a tiny expanded zone of the hinge; shells thin ....The Brachyprionids.

C. Ventral median septum undivided anteriorly.

D. Ventral muscle scars flabellate, expanded, and bordered post-laterally by what appear to be elongate continuations of the dental lamellæ; hinge crenulations very few, restricted to a small triangular zone adjacent to the delthyria; process in dorsal valve very weak .... *Brachyprion* Shaler, *s.s.*

DD. ventral muscle scars narrow, elongate, rather than transversely flabellate; scars rectangular in outline; crenulations few, located on a narrow, tear-shaped expansion of the hinge plate adjacent to the delthyria; ventral muscle scars nearly surrounded by lamellar extensions..*Mclearnia* Caster, new.

CC. Ventral median septum divided anteriorly in the plectambonitid manner: in some species (not in the genotype) the forks of the septum join the paradental lamellæ completely to encircle the muscle scars .... *Shaleria* Caster, new.

BB. Ventral median septum obsolescent or absent; shells usually of medium to very large size; delthyria in adulthood usually partially or completely closed, but may be secondarily opened by abrasion or other factors; hinge crenulations usually do not extend for more than half the length of the hinge, but may, in forms having strongly differentially wrinkled shells, nearly fill the hinge; shell usually relatively thick and may be wrinkled longitudinally either regularly or differentially; cardinal process usually very prominent. .... The Douvillinoid Stropheodonts.

E. Shells large and thick; anterior dorsal diductor scars not strongly scoriaceous nor especially elevated or elongate, although of large size; hinge crenulations extend from one-third to slightly less than one-half the width of the hinge; ventral muscle scars large, flabellate, and only posteriorly delimited by lamellar extensions; delthyria may be open, partially closed by lateral ingrowths which resemble paradeltidia, or by an internal deltidial callosity; delthyrial zone usually an equal sided triangle; surface usually regular .... *Protomegastrophia* Caster, new.

EE. Shells large, but may be relatively thin; anterior dorsal diductor scars are either elongated, elevated and roughened areas, which in some cases become scoriaceous plates of attachment (pseudo-braceplates), or elongate submerged pits with roughened surfaces separated by a broad median septum or callus.

F. Shells large, relatively thick; ventricose; alternating radial ornamentation with faint varices, no corrugations or wrinkles; anterior dorsal diductor scars are elevated, but not much produced beyond the adductor scars; hinge crenulations extend for about half or slightly more than half the hinge width; ventral muscles are large, flabellate and nearly, if not completely, encircled by lamellar extensions; dorsal adductor scars usually subtrigonal; only anterior dorsal median septum, if any, present; delthyria closed by deltidia, but always very narrow, usually linear and sometimes inconspicuous; cardinal process foliaceous .... *Megastrophia* Caster, new.

FF. Shells large, relatively thin; usually not especially ventricose; alternating ornamentation with faint growth lines in some specimens; shells uniformly differentially corrugated or wrinkled in a seersucker manner; anterior dorsal diductor scars are much elongated as scoriaceous subparallel ridges in front of the adductor scars. These are the pseudo-braceplates. Hinge crenulations extend for nearly the full width of the shell; strong median dorsal septum arises from a callus at base of prominent dorsal process; anterior portion of shell often geniculated, leaving posterior portion of both valves somewhat flattened to recall a visceral disc. .... *Cymostrophia* Caster, new.

FFF. Shells large, relatively thin; usually not especially ventricose; alternating radii with very strong concentric elevated lines forming a striking dictyate surface pattern; radial subangular plications of the shell follow the principal radii even onto the early portions of the shell. Anterior dorsal diductor scars are located in depressed, elongate pits which are roughened internally. The pits are separated by a median callus or septum, probably corresponding to the anterior median septum. Ventral muscle scars are not strongly delimited, and are of medium size. Dorsal adductor scars are very small, and subcircular. .... *Dictyostrophia* Caster, new.

AA. Hinge in adult shells holocrenulate, or nearly so; shells of medium size, regular, without any striking folds or corrugations; surface radii coarse and usually strongly fasciculate and not truly alternating in pattern; lamellose varices common in several forms; ventral muscle scars relatively large, flabellate, and not conspicuously limited by dental lamellæ, which are usually obscure; paradental lamellæ not known; ventral median septum usually frail, obsolescent or absent; dorsal process relatively strong, and usually sessile. .... *Stropheodonta* Hall, *s.s.*

The Brachyprionids

Only our inability to judge as yet the part played by homeomorphy in this early group of stropheodontids prevents assigning them to a separate tribe or possibly splitting them into two tribes. It seems likely that all lines of the later crenulate-hinged brachiopods had antecedents within this essentially Silurian stock, or "amalgam". The genera here outlined are only a very small part of the latent genera typified by the widely varying species of "*Brachyprion*". In the following generic discussions the characteristics of the genotype species have been principally considered. In making these comparisons the collections of the U. S. National Museum, New York State Museum, and University of Cincinnati Museum have been of inestimable value. In view of the absence of true brachyprionids in South American strata, only a skeleton discussion in here presented.

Brachyprion Shaler, 1865

In addition to the characters indicated in the key above, the genotype, *Strophomena leda* Billings, as represented from Jumpers, Anticosti, in the U. S. National Museum (94397), shows a sessile cardinal process which rises from a low postumbonal platform. The prongs of the process are subterete and project very slightly to overhang the hinge and notothyrium. On either side of the process socket, ridges divaricate at a high angle, leaving a rather prominent dental socket between them and the hinge crenulations. Medially the posterior platform extends toward the front as a low rounded callus. In the ventral valve it appears that the true dental plates are elongate and constitute the marginal limits of the muscle scars. None of the specimens of the genotype has shown evidence of the paradental plates found in *Mclearnia* and *Shaleria,* nor any evidence of a strong median ventral septum such as we find in those genera. The cotypes of *Brachyprion newsomensis* Foerste, 1919, (U. S. Nat. Mus. 87032) and *Brachyprion plana* Foerste, 1909, (U. S. Nat. Mus. 84914) from the Ohio Silurian appear to be assignable to this genus in the strict sense. The genus seems to occur exclusively in the Middle and Upper Silurian of the Northern Hemisphere, but may range into the Helderbergian.

Shaleria Caster, n. gen.

Diagnostic in this new genus is the character of the ephebic plates which lie immediately *inside* the elongate dental plates and extend beyond them anteriorly as delimitations of the ventral muscle scars. These accessory plates are here termed *paradental* plates. These are the plates which apparently fuse indistinguishably with the true dental plates in *Mclearnia* and join the rami of the bifid median septum completely to encircle the muscle scars. In *Stropheodonta gilpeni* Dawson, the genotype, the dental plates themselves are elongate, nearly vertical to the hinge and nearly subequal in length to the paradental structures. The paradental plates are outwardly deflected toward the front in a broad arc which is essentially concentric with the arcuate branches of the median septum. This is of course a variable feature, and hardly of constant generic value. Examples of *Shaleria gilpeni* from the Stonehouse formation on McPherson's Brook, Arisaig, N. S., in the U. S. National Museum collection (36942) show the nature of the paradental structures very well. It appears that *Strophomena ornatella* Salter (*e.g.* Davidson, 1874, pl. 43, figs. 16-20) is a *Shaleria,* although the bifid median septum and paradental plates are anchylosed to surround completely the muscle zone. This may prove to be a distinct generic development when there is opportunity to study Salter's species. Davidson's figures (*e.g. idem,* fig. 19b) suggest the presence of overlapping dental and paradental plates in this species. The types of *Brachyprion shaleri* Williams, 1913, (U. S. National Museum 58952) show in some specimens a faint tendency for the median septum to split distally. Here also the dental plates are very long, but no sign of paradental overlap has been observed. The Williams material, however, shows additional dorsal features, such as strong postlateral muscle delimitations, prominent cardinal teeth and sockets. These may, when coupled with the structures mentioned above, prove of generic value. I fail to see any very close comparison between Williams' species and the resupinate *Strophonella striata* (Hall), 1843, a comparison which Williams stressed. The genus *Shaleria* is known only from the Upper Silurian (Middle?) but may range into the Helderbergian.

Mclearnia Caster, n. gen.

Of considerable value in the classification of the stropheodontids is the nature of the ventral muscle scars. The size and shape of the scars and degree of delimitation by a peripheral carina or callus are the important criteria. The principal features of generic importance are brought out in the preceding key. It appears likely that the specimens from the Ardenne Devonian of Belgium identified by Asselberghs, 1930, as *Stropheodonta ornatella* (Salter) may be a holocrenulate congener of *Mclearnia.* The bearing of Salter's typical material has been discussed above under *Shaleria.* Kozłowski's, 1929, *Brachyprion subinterstrialis* and var. *serentensis* from the Polish Silurian may belong to *Mclearnia.* Several specimens of Kozłowski's species were examined in the U. S. National Museum (84320-84322), but certain diagnostic characters are concealed in this material. Barrande's *Leptæna costatula*, 1847, 1879, also seems to have the internal features of the present genus. This is especially true of the material identified as Barrande's species by Kozłowski, 1929 (p. 100). If these conclusions are correct, it is possible that *Mclearnia* is the direct antecedent of *Stropheodonta demissa* and allies. The known range of the genus is Upper Silurian, but holocrenulate derivatives probably also occur in the Helderbergian.

The Douvillinoid Stropheodontids

Four genera among the stropheodontids are here likened to the Douvillinini, but it is presupposed that the similarities are largely homeomorphic. The genus *Protomegastrophia* (*Leptæna profunda* Hall) presents few of the characters recalling the douvillinids, but does appear in other respects to be antecedent to the genus *Megastrophia* (Lower? and Middle Devonian) which shows incipient douvillinoid characters. The genera *Cymostrophia* and *Dictyostrophia* show these homeomorphic aspects well developed. The principal douvillinoid features of the group occur in the dorsal valve, where are found scoriaceous anterior diductor lamellæ which are grossly comparable to the braceplates in the Douvillinini, with which they may be homologous. The scoriaceous plates in the present group differ from those in the Douvillinini principally in not having a median apex which is much the highest point on the douvillinid plates. There is no sign of incurvature of the plates toward the median line to form a cone or tube as they do in the Douvillinini. Large, and strongly encircled ventral diductor scars are much like those usually found in the Douvillinini. The shells of the douvillinoid stropheodonts also recall on a gigantic scale the general shield shape of the true douvillinids. At first the entire group, excepting *Protomegastrophia* and doubtfully *Megastrophia*, was assigned to the Douvillinini, but further study seems to point to the present arrangement of the classification. The range of the stropheodontid genera showing strong douvillinoid traits appears to be Oriskanian through Erian. This is of course antecedent to the most characteristic development of the Douvillinini in the late Middle and Upper Devonian.

Protomegastrophia Caster, n. gen.

The genotype, *Leptæna profunda* Hall, 1852, from the Middle Silurian (best development in the Waldron) has in recent writings been ordinarily assigned to the genus *Brachyprion.* So generalized is the structure of the species group that it could still be assigned nearly as readily to the brachyprionid group of genera as to this douvillinoid assortment. Typical material of the genotype has been examined in the fine collections of Waldron material at the University of Cincinnati, the U. S. National Museum, and at Albany, New York. *"Leptæna" profunda* is one of the largest of a considerable number of large Silurian crenulate-hinged brachiopods. The shell material is exceptionally thick. The ventral valve is extremely ventricose in most instances, and the dorsal valve correspondingly concave. The crenulations extend further along the hinge than in the three genera of brachyprionids described above. The ventral muscle seats are large, flabellate, striate, and in all respects very similar to those of the genus *Megastrophia,* lacking only very strong lamellar margination. It seems that virtually all of the traits of the Devonian genus are anticipated in subdued style by the Silurian giant. The curiously spatulate cardinal process of some species of *Megastrophia* (undescribed as yet, but usually referred to *Stropheodonta concava, s. l.*) is anticipated in *Protomegastrophia.* Likewise, the weak ventral process, which is of little articulatory function, is found. Examples of *Protomegastrophia* (species not described) in the University of Cincinnati Museum, from the Racine formation, show rather well the subequal sided delthyrium and notothyrium, each closed by a convex plate or callus in adulthood. The notothyrium usually has the appearance of being closed by a callus deposit, possibly associated with a convex chilidium. The deltidium appears to be a convex plate in the apex of the delthyrium and is excavate toward the commissure plane, which it attains only on the margin of the delthyrium. In some cases it seems as though paradeltidial plates, with a short convex deltidium between them, are present in the apex of the delthyrium. The Racine specimens show ventral diductors of the size and proportion seen in *Megastrophia,* which similarly completely surround the lenticular adductors. In shells assigned to the genotype, Hall, 1852, described the structure which we have called the "ventral process" as a "projecting, grooved and bidentate process in the ventral valve through which the pedicle passes". The delthyrial foramina are usually gaping in immaturity, but closed in maturity as previously explained. Oblique crenulations extend less than half the hinge width and diverge from the beak. In many respects of proportion and structural detail, the Silurian species foreshadows *Megastrophia hemispherica* of the Onondagan. *Stropheodonta niagarensis* Winchell and Marcy, if not conspecific with the genotype, certainly belongs in the new genus, and likewise, *Stropheodonta convexa* Prouty of the Maryland Silurian. The genus is known from the Niagaran, and may possibly occur in the Upper Silurian. No true representatives are anticipated in the Helderbergian, although *Megastrophia* will probably occur there.

Megastrophia Caster, n. gen.

The genus *Megastrophia* is taken as the prototype of the group here called the Douvillinoid Stropheodontids. The principal structural features of the genus are brought out in the key and foregoing discussion of the supposedly antecedent genus in the Silurian. In studying this genus the excellent collections of *Stropheodonta concava* Hall, genotype, and allies in the U. S. National Museum, the New York State Museum, and the University of Cincinnati Museum have been of great value, and the characters outlined are based on these collections. The ventricosity, great size and thickness of the adult shell, incomplete hinge crenulation, encirclement of the large, heart-shaped ventral adductor scar, essentially linear delthyrial area, and general ponderous irregularity of the ephebic shell, all seem to point to phylogerontism. Yet the genus ranges from Oriskanian through Hamiltonian time. The cardinal process in this genus is usually spatulate, and broadly pedunculate; at all times ponderous.

In the genotype of *Megastrophia* the posterior diductors of the dorsal valve are attached to elevated, anteriorly expanded and relatively narrow platforms which bear linear ridges and nodules. These platforms originate just in front of the cardinal process and terminate near the front margin of the elongate adductors. The posterior adductor carinæ are usually separated by a relatively deep fossa. In front of the adductor scars and cuneiform posterior diductors, the anterior diductors are attached to roughened or scoriaceous, elongate-ovate elevated zones which usually do not rise so high above the floor of the valve as the posterior muscle platform. Between these roughened scars there is an anterior median septum in ephebic shells. Gerontism may exaggerate the septum. This septum usually does not reach the rear platform and extends forward slightly beyond the anterior diductor scars. In "austral" representatives, at least, of *Cymostrophia,* described below, the median septum extends from the base of the cardinal process as a very prominent tapering structure. Here also, the anterior diductor scars are much extended and elevated so that they appear like scoriaceous lamellæ which are excavate above, but have a superficial resemblance to the braceplates (Stützplatten) in the Douvillinini. They do not show any of the detailed structure of the braceplates, however, and there can be no question of their being principally places of muscle attachment. These false braceplates of the *Megastrophia* allies are termed *pseudo-braceplates.* In *Dictyostrophia* they are only slightly developed and usually appear as elongate scoriaceous excavations rather than elevated lamellæ. The surface ornament of *Megastrophia* is made up of alternating costellæ which are crossed by concentric elevated lines, ordinarily finer than the finest radial ornament. The result is a fine dictyate pattern. The concentric lines are usually very inconspicuous, and often cannot be distinguished without a lens. This type of ornament is greatly exaggerated in *Dictyostrophia.*

Most North American representatives of the genus, without much critical examination, have been assigned to *Stropheodonta concava* or closely allied species. There are apparently a great many valid undescribed species thus concealed. *Stropheodonta murchisoni* (d'Archaic and de Verneuil) of the Lower Emsien of Belgium (U. S. National Museum 87244-9) shows a slight development of the pseudo-braceplates, the while sharing many telling features with *Dictyostrophia,* yet will probably be referable to a new genus. *Stropheodonta herculea* Drevermann of the Siegen Devonian in Germany also has weak pseudo-braceplates, but its more continuous dorsal median septum recalls the genus *Cymos-*

trophia. Two species of *Megastrophia* are described from the Colombian faunule, below.

Cymostrophia Caster, n. gen.

This new genus with the genotype *Leptæna stephani* Barrande from the Devonian F2 fauna of Konieprus, Bohemia, will include a large number of differentially corrugated shells having the general aspect of *Stropheodonta corrugatella* Davidson in Great Britain, *Stropheodonta patersoni* Hall (and authors), *Stropheodonta reticulata* Stainbrook, etc., in North America. Among the characters brought out by the preceding structural key and following description of "austral" species, certain ones appear to be of primary generic value. These would include, without selective arrangement as to importance: large size of the adult shells which are concavo-convex, but not ordinarily extremely ventricose; shell material which is relatively thin, especially so for shells as large as these; ornament consisting of strong rounded elevated costellæ with intercalated finer costellæ, which thus create an alternating pattern; concentrically corrugated shell in the intermediate zone of fine costellæ. The corrugations are interrupted by the coarser radii, thus creating a surface which looks like the fabric seersucker. This makes the recognition of the genus easy from only a fragment of the shell material. So far as can be judged, this character is of genetic significance, and does not seem to have appeared in divergent lines. The ventral diductor scars are large, flabellate, and not strongly delimited. They enclose subfusiform adductor scars. In the dorsal valve the cardinal process is relatively stout, and sessile. It has at its base an elevated median septum which seems to have acted as a buttress. There are radial secondary buttresses also, presumably representing a split socket plate, or perhaps socket plates and crural plates. There are also relatively inconspicuous pseudo-braceplates which are upwardly excavate and coarsely scoriaceous for muscle attachment. The hinge is nearly completely crenulated.

The genus *Cymostrophia* was probably derived from or is possibly a homeomorphic recurrence parallel to the differentially corrugated rafinesquinids in the Ordovician. Holtedahl, 1916 (pl. 3), *e. g.* has illustrated from the Kristiania region several similarly corrugated rafinesquinids: *Rafinesquina? schmidti* Jagel, *R. münsteri* Holtedahl, and *R.? ringerikensis* Holtedahl. They presumably represent a distinct generic line in the rafinesquinids, but might be the antecedents of the stropheodontids here considered. Willard's genus *Ptychoglyptus,* 1928, was proposed for somewhat more regularly corrugated rafinesquinids from the Chazyan, which may also be related to this development.

The genotype of *Cymostrophia* is so well illustrated by Barrande, 1879 (pl. 40, figs. 10-30; pl. 55, figs. vi, 1-9), that very little additional information can be added. The F2 fauna of Konieprus bears many brachiopods which recall the lower Middle Devonian of North America. The representatives of the genotype which I have examined (U. S. National Museum 53453) came from the type locality in Bohemia. *Stropheodonta patersoni* Hall of the North American Onondagan is apparently closely allied to the species, and gives a very satisfactory picture of the genus here. Hall's species, like most North American ones of this generic bearing, shows less closely spaced corrugations than the Bohemian form, and in this respect is reminiscent of the South American species described below. In none of the species known to me do the differential corrugations extend in adulthood much beyond the zone of greatest gibbosity. The corrugation is principally a feature of the zone that in other genera might be termed the visceral disc. Barrande shows the nature of the corrugation extremely well in his original illustrations. Apparently the strong mucronation exhibited by the genotype is unknown in the Americas. Three Colombian species of *Cymostrophia* are described below.

Dictyostrophia Caster, n. gen.

Like the other douvillinoid stropheodontids, this genus is characterized by large to gigantic size, and relatively ventricose shells which are concavo-convex. The shell material, even in maturity is relatively thin. The surface is marked by radial costæ and intervening costellæ, usually four or five in number. There are also concentric elevated cords which are subequal to the series of costellæ and cross them to form a very striking grid pattern resembling cord netting. The shell is subangularly corrugated along the lines of the principal costæ, thus creating an unusual combination of surface detail. The concentric lines are not ordinarily present on the earliest third of the shells, but the subangular corrugations extend to the very apex in most cases. The dorsal valve has a flattened "visceral disc" peripherad of which the shell is rather sharply geniculated. There may be developed internally a low callous diaphragm at the line of up-bending in the dorsal valve, although not so prominently as in *Megastrophia*. The ventral valve has moderately large and flabellate ventral muscle scars which are relatively faint and indifferently encircled by lamellar extensions. The dorsal valve has remarkably small recessed and subovate adductor scars which are separated by a weak median septum extending from the base of a frail cardinal process. The posterior diductors are obscure, but were apparently attached to narrow submerged zones on either side of the median septum and between the small adductor scars. The anterior diductor scars are deeply excavated, elongate muscle pits which have a scoriaceous lining; between the pits is a low callous ridge, or possibly anterior median septum. The submerged pits are thought to be homologues of the excavate surfaces of the pseudo-braceplates in *Megastrophia* and *Cymostrophia*.

In "boreal" faunas *Stropheodonta concava, sensu lato,* will probably contain the relatives of this genus best developed, as far as known in the Colombian Devonian, although rumors are afoot of fine examples in the Nevada Devonian section. As shown under *Megastrophia,* above, the *Stropheodonta concava* group has both radial and concentric ornament, but in a lesser degree. The interiors of the two groups in the strict sense, are however, quite different.

The European *Stropheodonta murchisoni* (d'Archaic and de Verneuil) of the Belgian Emsien deposits has angular surface plications very similar to *Dictyostrophia,* but does not, to my knowledge, show a reticulated surface pattern. The dorsal interior of the Belgian material does recall that of *Dictyostrophia* to a certain degree, but they differ in ventral characters, especially in the extraordinarily strong development of a much elevated and broad muscle platform and median septum in the latter. As mentioned before, the Belgian species is probably typical of a generic strain, but appears to belong to this same group of stropheodontids. The genotype, *Dictyostrophia cooperi* Caster, from Colombia is described below.

THE DOUVILLINOID STROPHEODONTIDS OF COLOMBIA

Genus **Megastrophia** Caster, n. gen.

Genotype.—*Stropheodonta concava* Hall. Middle Devonian.

Megastrophia hopkinsi Caster, n. sp. Plate 3, fig. 19; Plate 4, figs. 1-2

Ventral valve very large, ventricose or inflated centrally; hinge line and length subequal; anterior outline shield-shape to subcircular; hinge line broadly produced, and terminally rounded; anterolateral periphery slightly expanded; anterior produced slightly; posterior two-thirds of shell essentially planate, rising toward the front; most produced on mesial fold; anterior part subgeniculate; mesial swell or fold is obsolescent in the largest specimens. From small fragments of the surface characters on the larger mold, the shell is seen to be coarsely punctose and multistriate. The striæ appear to be of an alternating sort, with the primary ones rising like fine threads, subangularly from excavate interspaces of about two or three times the width of a primary costella. The interspaces are finely striate, there being a variable number of striæ in each interspace, but from 6 to 12 have been counted. Concentric ornament, if present, is of extreme delicacy. Palintrope relatively high, apparently externally smooth, and crenulate on the commissure surface in the mesial part for a little more than half the hinge length; mesial height of the palintrope about 3 mm.; centrally (on either side of the delthyrial opening which is not known) the crenulations of the hinge are continued externally for about 1 mm. on the external palintrope surface, and taper off to nothing where the hinge crenulations themselves disappear. The demarcation between the smooth palintrope surface and the crenulate zone is very sharp. Subumbonally the shell of the palintrope is about 2.5 mm. in thickness, and decreases toward the hinge apices.

The ventral interior is dominated by elongate, flabellate diductor muscle scars having an angle of about 65°, and is very prominently bordered both on the sides and in front by an elevated extension of the dental plates. The muscle scars are incised in a callus which extends across the entire posterior part of the shell. A broad "moat" is excavated around the enwalled muscle scars. It is deepest laterally and becomes evanescent antero-mesially. The "moat" is coarsely granulose and ridged throughout. The diductor scars completely encircle the lenticular adductor scars which are raised on an obscure mesial elevation and separated by a weak median septum. The greatest radial length of the diductor impressions is slightly more than their greatest combined width; the mesial length is to the radial length about as 3 is to 4. The lateral boundaries of the scars are very much elevated above the floor of the valve. They are highest toward the rear where the muscle seat is slightly excavate, and of about the same height above the floor of the valve anteriorly, but are there filled to the crest by secondary calcification within the muscle seat. The extended dental lamellæ rise from the floor obliquely and pronouncedly overhang the muscle seat on the sides. In front they are nearly vertical, where recurved mesially the bordering carinæ stand lowest as cordate delimiting ridges. Here they unite with a median anterior boss from which the obscure septum extends for a short distance into the pallial zone. Unfortunately the subumbonal characters are not preserved, but it appears on specimen 5406 that there is a slight cavity for the reception of the cardinal process. On this specimen are also preserved under the beak the front ends of the posteriorly converging crests of the "ventral process," which very likely met at the palintrope wall. The adductor muscle scars occupy a relatively large central lenticular area which completely separates the diductor muscles. Posteriorly the adductors are recessed below the general level of the diductor seats, and are bordered by low, anteriorly diverging ridges which become evanescent at about the zone of maximum width of the adductors. A low, irregular continuation of these ridges separates the adductors in front from the diductor seats. Along the median line the adductor scars rise on the slope of an obscure septum, which appears to separate them by an evanescent carina extending forward beyond the muscle markings. The front portion of the adductor scars rises very steeply from the general level of the muscle seats onto a prominent callus which marks the place where the right and left diductors and the attenuated adductors meet. Both the adductor and diductor scars are radially striate, and the adductor scars at least seem to have been arborescently marked. The whole extramuscular area of the shell interior is ridged and striated with fine pustulosities. The inner corrugations and pustules are strongest on the postlateral flanks of the muscle platform. The internal striæ and ridges appear to be negative reflections of the surface markings. In specimen 5406 the striæ of the middle zone appear to converge just anterior of the edge of the visceral surface or disc. They appear to be much finer here than elsewhere on the interior.

Dimensions.—

	5406	5453
Hinge width	55 mm.	80 mm.
Length of shell	55 mm.	70 mm.
Maximum height of shell	25 mm.	25 mm.
Length visceral disc	40 mm.	45 mm.
Max. width visceral disc	37 mm.	46 mm.
Max. radial length diductors	22 mm.	33 mm. (left) 40 mm. (right)
Mesial length muscles	20 mm.	25 mm.
Max. width adductors	13 mm.	15 mm.

Discussion.—"Austral" comparisons are restricted to the present fauna, for no stropheodont in the Southern Hemisphere, known to me, approaches the Colombian material in size or general characteristics. The wider affinities appear to be with "boreal" American forms and more distantly with those of the European Devonian. The present species is much the largest stropheodont in the Colombian fauna. The outline is more subcircular than for any of the other four representatives in the fauna. The internal ventral characters of the other species are unfortunately not known, but the surface markings are so clearly differentiable that few other structures are necessary for quick recognition. *Dictyostrophia cooperi* is angularly plicate or fasciculate and has very pronounced secondary costellæ and varices creating a regular upraised reticulation on the surface which makes even a small fragment recognizable. *Cymostrophia schucherti* has radii of two sizes, the smaller being far more numerous than the primary, and the whole surface is finely wrinkled after the manner of the "boreal" *Stropheodonta patersoni* Hall or the European *S. corrugatella* Davidson, but without concentric elevated varices. *Cymostrophia dickeyi* is another Colombian concavo-convex stropheodont of large size. It is smaller and more transverse than *M. hopkinsi* and has curious duplex primary radii in the mesial region and is finely cancellate. The interior of the dorsal valve of *C. dickeyi* has two curious subparallel carinæ extending frontward from the beak, and the cardinalia are more delicate in this species than in *Dictyostrophia cooperi. Megastrophia pygmæa* is much smaller, but otherwise quite similar to the present species. It may be a juvenile form of this giant.

In the "boreal" Devonian, *Megastrophia hopkinsi* seems to be most like *Megastrophia concava* (Hall) and *M. hemispherica* (Hall). The shape, ventricosity and ornamentation are all very similar, but the strongly bordered muscles of the pedicle valve in *M. hopkinsi* have no North American duplicate to my knowledge. The size of the ventral muscle scars is comparable to certain forms of *M. concava* in the Onondagan of New York (N. Y. State Museum; U. S. National Museum), but the muscle angle of our material is much smaller, the muscles themselves more divergent anteriorly and more deeply re-entrant anteromesially. Specimen No. 5453 in our collection recalls *"Stropheodonta concava"* illustrated by Kindle, 1901 (pl. 6, fig. 1), from the Jeffersonville limestone of Indiana.

This appears to be a common species in the Colombian fauna, but is known as yet only from internal molds of ventral valves. No dorsal valves of this magnitude, ornamentation, or general contour have been found.

Types.—Holotype: Pal. Res. Inst. No. 5406; paratypes: Nos. 5453 and 5453A.

Megastrophia pygmæa Caster, n. sp. Plate 3, figs. 16-18; Plate 5, figs. 1-4; Plate 6, figs. 11-13; Plate 8, figs. 13-14

Ventral valve convex shield-shaped with subequal length and width; hinge straight and slightly produced at extremities; umbonal area most expanded, but entire mesial zone is broadly elevated into an undefined fold. The outline is regularly rounded ellipsoidally; postlaterally it is slightly constricted in front of the hinge extensions. Toward the front the shell shows signs of geniculation, and is peripherally slightly scalloped. The surface is radially finely striate in an alternating manner, there usually being two or three fine striæ between the coarser ones. New striæ of both types originate interstitially. No tendency toward corrugations or fascicular arrangement of the striæ has been observed. Concentric lines are not visible on the specimens at hand. The palintrope is flat and slightly apsacline. It is relatively high mesially and slopes off toward the extremities, and is vertically striated. The hinge is apparently crenulated for nearly the entire length.

On either side of the ventral delthyrial region there are two low hinge teeth. Dental lamellæ extend around relatively large, elongate, and collectively heart-shaped diductor muscle scars, thus very clearly delimiting these structures. The diductor scars nearly completely surround the mesial adductors which are situated on elongate, spindle-shaped elevations separated by a mesial furrow. Just outside these adductor elevations and overlapping their front ends are two ridges which originate in the diductor zone and extend forward into the pallial region for a distance about equal to the length of the adductors. Out of the diductor scars arise two posteriorly converging angular carinæ which meet before attaining the inner palintrope (deltidial) wall to which the resultant confluent median process is attached. This is the so-called "ventral process". The posterior terminus of the "process" protrudes slightly above the hinge line and appears to enter the hinge zone of the dorsal valve in a position that would be just behind the cardinal process or between the prongs of this structure if its branches are sessile. The inner wall of the palintrope on either side of the median process is slightly concave as though to receive the prongs of the dorsal process. The deltidium appears not to reach the commissure plane, thus leaving a slight open space for admission of the cardinal process. The palintrope wall overhangs the interior of the ventral valve and is excavate beneath. The pallial zone about the muscle scars is slightly granulose. The remainder of the shell interior appears to be smooth or only very slightly striate. The following measurements are based on the holotype:

Dimensions.—

Hinge width	20 mm.
Median length shell	19 mm.
Maximum width ventral muscles	9 mm.
Radial length ventral muscles	6.5 mm.
Length adductors	5 mm.

Discussion.—*Megastrophia pygmæa* may prove upon further study to be either a variant or ontogenetic stage of the preceding species. The structural features are highly distinctive, however, and are certainly of specific value so far as the material at hand will indicate. The absence of any shells intermediate in size between the gigantic and probably gerontic *Megastrophia hopkinsi* and this small shell is, of course, hard to explain in terms of ontogeny. Until more can be learned of the life habits of these organisms, this condition cannot be properly evaluated. Too frequently such an association is taken to mean genetic distinctness, when it may only indicate an unusual adolescence.

Perhaps the best contrast in internal structures is brought out by the natural size figure of a plasticine cast of *Megastrophia hopkinsi* and an enlarged one of the present species shown on plate 3, figs. 19 and 17. The surface details of the small species are very different from those of the large one, as even casual scrutiny will show. A comparision of plate 5, fig. 1, with the internal mold upon which some of the surface features are impressed (plate 4, fig. 1) demonstrates this very well. Plate 8, fig. 14, also shows surface details of the small species.

There is nothing in "austral" faunas with which this species might be compared since the entire group is new to the Southern Hemisphere. In North American faunas "*Brachyprion*" *schuchertana* Clarke, 1909 (*e.g.* pl. 9, fig. 10), from the Dalhousie beds, has somewhat similar ornament, and is comparable in size. It also shows the same irregularity of anterior outline that is found in the Colombian species. Clarke's species is as little known as the Colombian, and further comparisons are really of small value.

Types.—Holotype: Pal. Res. Inst. No. 5398-5398A, external and internal molds of a ventral shell; paratypes: Nos. 5398B, C. D, and 5405A.

Genus **Cymostrophia** Caster, n. gen.

Genotype.—*Leptæna stephani* Barrande. Devonian F2 (Coblenzian) Bohemia.

Cymostrophia schucherti Caster, n. sp. Plate 1, figs. 14-17; Plate 2, figs. 1, 4-6; Plate 3, fig. 2; Plate 6, figs. 7-10; Plate 10, figs. 4-6

Large shells, strongly concavo-convex; hinge line greatest width of shell and slightly produced in acute, subacute or rounded auricular extensions; width somewhat greater than length; sides constricted immediately in front of the hinge and regularly rounded toward the front of the shell which is also regular. The valves appear to be very closely appressed in life, and therefore have nearly opposite contour. Posterior seven-eighths, or thereabouts, of the shell is very nearly planar, (*i.e.* only slightly convex in ventral valve and slightly concave in dorsal one) anterior fraction of shell is abruptly but arcuately geniculated, and may be even very slightly constricted in life. Most shells as now recovered are considerably constricted peripherally. Some shells appear to have been more regularly rounded throughout and may have been even slightly ventricose. Other shells are slightly produced anteromesially. There are shallow sinuses in the ventral valve extending from the margin of the shell at the lateral constrictions toward the beak, which thus separate the hinge zone from the rest of the shell. The hinge zone is regularly convex in the ventral valve, and rises slightly above the general contour of the shell. The palintropes are very narrow, and detailed features are not known.

Both valves are broadly regular in contour, but are differentially corrugated in a manner recalling the fabric seersucker. (*See* plate 1, figs. 14-17.) This shell structure is brought out by the interruption of relatively regular concentric corrugations by strongly elevated primary radii. The corrugations are proportionally much closer spaced on the earlier portions of the shells than on ephebic portions, and may be completely absent on the geniculated zone, although usually not. In some shells the corrugations are very indistinct, and in others differentially so. The corrugations, whatever their degree, usually affect the whole shell.

External ornamentation consists of alternating radii (*e.g.* p. 1, fig. 15; pl. 6, fig. 8) composed of strong elevated costæ. About 14 principal costæ are present on the earliest part of the beak, and increase by intercalation. New costæ appear to arise each as a fine stria in the midst of a narrow furrow. Approximately 28 of the primary costæ constitute the chief ornament over most of the shells. Toward the zone of geniculation this number is approximately doubled, and on the geniculated zone the number may be again doubled. The primary radii increase in strength toward the front of the shell, but very gradually. This means that the initial set is always very slightly stronger and more prominent than the later appearing radii. Between the primary ribs in slightly depressed interspaces are 14 or 15 fine elevated striæ which appear also to increase by intercalation, but apparently do not become primary costæ toward the front. The striæ seem to double in number somewhat in advance of the intercalation of new costæ, so that as soon as a new costa is visible, it has the usual number of striæ separating it from adjacent costæ. In some shells (*e.g.* 5450, pl. 2, fig. 5) the fine striæ are not well developed, and the intercalation of primary costæ is much more rapid, and their final number much greater than average. Very fine concentric striæ are sometimes preserved as shown on plate 6, fig. 15. Usually they show best on aberrant examples in which the fine radial striæ are indistinct. They can be detected in some specimens with a lens as tiny, discontinuous acicular extensions from the sides of the microstriæ.

The interiors of both valves are negatively striate, *i.e.* incised furrows correspond to the principal costæ on the surface. The finer radial ornamentation does not leave an impression on the interior. The differential corrugations of the shell show on the interior, though less distinctly than on the exterior, due to a slight amount of internal secondary calcification. The central region of the shell is granulose or punctose, especially adjacent to the muscle platforms. The hinge is essentially holocrenulate, except for the mesial zone. The crenulations are borne on a triangular zone on the floor of the dorsal valve and on a triangular thickening of the ventral palintrope. In the dorsal valve the crenulations cease abruptly at the crural plates which are strongly developed on the posteriorly upbent surface. (*See* plate 6, figs. 9, 10.) In the ventral valve the crenulations cease at the hinge teeth. The denticles decrease in size toward the hinge apices, and are essentially normal to the hinge line throughout.

The interior of the ventral valve is dominated by large, flabellate diductor muscle scars which completely enclose the adductors. The musculature reaches at least half way to the anterior margin, and sometimes a little further. The diductor scars are recessed behind and are strongly delimited postlaterally by broad callous ridges rather than extensions of the dental lamellæ. From the line of their greatest width forward and around the front margin they are indistinctly outlined, and in some forms merge inconspicuously with the floor of the valve. The surface of the scars is marked by radial lines, some of which extend forward beyond the general confines of the scars. Anteriorly the diductor scars are separated by a low median septum which seems to be an extension of the forwardly tapering lenticular adductor platform.

The adductor muscles are attached to a subfusiform arborescently ridged zone which is located mesially in the hind third of the shell. Like the diductor scars, the adductors are depressed below the general level of the adjoining shell (in this case the diductor scars) posteriorly, and rise anteriorly on a platform which stands at a slight elevation above the diductor level. On the midline the rear adductor scars are separated by a deeply incised fossa which widens posteriorly, whereas the anterior adductors appear to be separated by a very slight mesial carina which extends forward as the septum between the front of the diductor scars. The arborescent zone seems to give way to an irregular surface beneath the anterior adductors. Postlaterally the adductor scars are bounded by broad swells of the diductor floor, and immediately in back by forwardly diverging carinæ apparently originating at the base of the ventral "process". Of the last structure, little is shown in our material, but apparently it is present, well developed as an articulatory structure fitting between the prongs of the ventrally introduced dorsal process.

The hinge teeth are short, stubbed, but apparently not serving any articulatory function, since no corresponding sockets have been noted in the dorsal valve. These structures are shown by plate 2, fig. 6.

The interior of the dorsal valve is dominated not by musculature, but by the ruggedly developed cardinal process, its appurtenances and scoriaceous braceplates. The general features of this valve are shown by plate 6, figs. 9 and 10. There it will be seen that the cardinal process is very strong, composed of two essentially terete subparallel prongs which rise from the posterior callus, and overhang the hinge. They are buttressed behind by lamellar extensions against the posterior surface of the valve, thus creating a cavity between the prongs which is a little wider than the width of a single prong. This cavity was presumably occupied in part at least by a "process" extension from the ventral valve. Anteriorly the prongs of the process are supported by a thornlike carina or rounded septum which is subequal to the width of the interprong space at the place of origin and tapers to beyond the mid-point of the shell. Two additional pairs of brace carinæ radiate from the cardinal process; a short pair originates along side the median septum at the base of the prongs, and extends for about one-fourth the length of the septum, while a second pair originates at the side of each prong and divergently radiates toward the front, making, if projected, about a 20° angle with the median septum. Subparallel to the median septum, diverging slightly from it in front on either side for its anterior three-fourths are two very much roughened ridges which originate as low crests, rise gradually to stand relatively high near their mid-length and taper near the front, where they extend slightly beyond the median septum. These appear to be homeomorphs of the braceplates (Stützplatten) which probably served as muscle attachment sites and may also have had the same brace function as the homeomorphic structures in the Douvillinini, *i.e.* they kept the shells far enough apart to make life possible for the very much depressed animal. They have the appearance of being a scoriaceous callous deposit, of rather irregular surface and contour. Further comparison with the douvillinoid structure is hardly profitable. The crural plates are well developed as laterally diverging ridges on the posteriorly upbent wall of the shell. They probably rested against the ventral hinge teeth as a phase of the articulation.

Dimensions.—

	5426*	5451	5449	5426A*
Estimated hinge width	60 mm.	60 mm.	66 mm.	60 mm.
Median length shell	41 mm.	54 mm.	55 mm.	41 mm.
Length visceral disc	37 mm. est.	38 mm.	45 mm.	37 mm.
Width shell at lateral constriction	55 mm.	50 mm.	62 mm.	55 mm.
Median length ventral diductors		29 mm.	24 mm.	
Radial length ventral diductors		33 mm.	28 mm.	
Width ventral diductor scars		35 mm.	27 mm.	
Length ventral adductor scars		21 mm.	20 mm.	
Width ventral adductor scars		8 mm.	5 mm.	
Distance between hinge teeth		15± mm.	15 mm.	
Length dorsal median septum				22 mm.
Maximum width process				6 mm.
Between prongs of process				2.5 mm.
Between crural plates				12 mm.
Length pseudo-braceplates				16 mm.

Discussion.—The shells in this genus, although very large, are exceedingly thin; the primary costæ appear to be delicate radial corrugations of the shell, whereas the intermediate striæ are apparently formed by additional calcification. This character of the ornament may prove to be a generic feature. Hall and Clark, 1892 (p. 286), thought of *Stropheodonta* as without, or at most with obsolescent, cardinal teeth and dental plates. Certainly this Colombian species could hardly be so classified.

Plate 10, figs. 4 and 5, shows a ventral mold and cast which exhibit a more numerous type of surface radii. In this form there is less contrast in the strength of primary and secondary radii. It also shows more delicate differential corrugation than any other Colombian material. In this form also the hinge is slightly extended and there is a suggestion of a median fold on the

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* Holotype

ventral valve. It may, when better known, constitute a distinct variant of the main species.

Cymostrophia schucherti may be distinguished from the various stropheodonts in the Colombian or other South American deposits by the differentially corrugated and strongly concavo-convex shells; by the strong dorsal process and douvillinoid pseudobraceplates; by the nearly holocrenulated condition of the hinge which it probably shares only with *?Cymostrophia waringi*, below; and by the large flabellate ventral diductor scars which are incompletely delimited.

The closest resemblance (possibly homeomorphic) to the Colombian species seems to be the northern *Stropheodonta patersoni* Hall of authors in America and *Stropheodonta corrugatella* (Davidson) or *Stropheodonta stephani* (Barrande) in Europe. That a great many species as yet undescribed are still lurking under these names in literature seems very clear. *Stropheodonta reticulata* Stainbrook, 1938, is a species which has previously been concealed in this manner. Stainbrook's species appears to be assignable to *Cymostrophia*. *S. patersoni* Walcott, 1884, may be conspecific with Stainbrook's species, or, more likely, may be still another representative of the genus. At a distance it appears that *Stropheodonta corrugatella* Gosselet, Barrois, etc., 1920, of the Liévin Lower Devonian may be an early representative of the genus, which is probably specifically distinct. The relationship of *Stropheodonta inæquiradiata* Hall is discussed under *?Cymostrophia waringi*, below. But it should be noted here, that virtually all "boreal" species assigned to *S. patersoni* or *S. inæquiradiata*, and to a limited extent to *S. corrugatella*, have recorded representatives which show rather well developed intercostal reticulations, which our Colombian material does not show. The internal characteristics of the dorsal valve of the reticulated Colombian species, assigned below to a new genus *Dictyostrophia*, are very different from *Cymostrophia*. It seems not unlikely, however, that in many cases representatives of these two stocks have been lumped together under a common name.

Types.—Holotype: Pal. Res. Inst. No. 5426-5426A (outer and inner mold of dorsal valve); paratypes: Nos. 5427, 5428, 5449, 5450, 5451, 5451A, and 5466A.

?Cymostrophia waringi Caster, n. sp. Plate 2, figs. 13, 14; Plate 3, fig. 1

Shells large, concavo-convex, transversely scutelliform; hinge straight, apices somewhat produced in rounded auricular extensions, separated from the main body of the shell by lateral constrictions; periphery in front of the constrictions regularly rounded, and usually not centrally produced. On the anterior lateral and front margins the shells are slightly geniculated.

Contour of the shells regular. The exterior surface bears radial ornament comprised of alternating costellæ and fine striæ, which run very regularly from apex to margin, and show virtually no undulation or curvature. The radii arise as rounded ridges on the surface, and whether they are solid lines of accessory calcification, or miniature corrugations is not known. Their number is increased by intercalation. They very slowly increase in size toward the margin. The spaces between the principal costellæ are essentially flat, or only very slightly excavated, and are ornamented with very much finer micro-ornamentation. This consists of low-lying convex radii which usually number from 8 to 10 between the costellæ, and increase also by intercalation. These features are brought out by the illustrations. (*See* plate 3, fig. 1.) Crossing the finer striæ, but interrupted by the costellæ are exceedingly fine and closely spaced concentric striæ which are also elevated. This creates a very fine grid pattern over the better preserved interspaces of the shell. Apparently, however, not all regions of every shell had this fine reticulation, and some individuals show it not at all. The ventral palintrope is apsacline. Details of the hinge crenulation and shell interiors are not known.

Dimensions.—

	5448	5448B
Hinge width	64 mm.	60 mm.
Median length shell	42 mm.	40± mm.
Width shell at lateral constriction	50 mm.	56 mm.

Discussion.—Obviously, it is impossible to determine on the basis of the material at hand, the precise generic relationships of the present shells which seem clearly specifically distinct from the other Colombian stropheodonts. Almost exclusively on the basis of form they are tentatively assigned with some doubt to *Cymostrophia.* The internal features will be diagnostic. The surface ornament differs from the genotype and *C. schucherti,* above, in the absence of any sign of differential corrugation, and in having fewer striæ between costellæ. The shells differ from *Cymostrophia dickeyi* in being less transverse, more inflated, and more pronouncedly concavo-convex, and also in having no sign of corrugation. With *Dictyostrophia cooperi,* this species shares intercostal reticulation, but the contrast is much the same as between a fine muslin and a monks cloth, so much coarser is this feature in *Dictyostrophia,* which moreover has fasciculation of the radial elements, and subangular to angular crests to the fascicles in most cases. When the internal features of the present form are known it may prove to be more closely allied to *Dictyostrophia* than now appears.

On the surface of the holotype of this species is attached the external mold of what appears to be a new species of auloporid coral. The details of this cnidarian are too poorly preserved to make an analysis worthwhile at this time. It is an important bit of ecological data, however, since it is one of the only two cœlenterates known as yet from the Colombian deposit, the other being the calicinal imprint of a small tetracoral.

I have tended to view development of *Cymostrophia schucherti, ?C. waringi, C. dickeyi* and possibly *Dictyostrophia cooperi* in South America as a counterpart of the yet unsatisfactorily classified group in the Schoharie and Onondaga of North America which have ordinarily been assigned to *Stropheodonta patersoni, S. inæquiradiata* and variants, wherein occur most of the external variations recorded for the Colombian faunule. The curious douvillinoid internal features, especially of the dorsal valve, suggest isomorphism on a grand scale.

Types.—Holotype: Pal. Res. Inst. No. 5448; paratype: No. 5448B.

Cymostrophia dickeyi Caster, n. sp. Plate 3, fig. 20; Plate 4, figs. 3-8; Plate 8, fig. 15

Shell of medium to relatively large size, subplanoconvex or concavo-convex; only moderately inflated at most; usually both valves relatively flat; hinge line straight, greatest width of shell; slightly produced at extremities in rounded processes which are separated from the main body of the shell by lateral constrictions. Length usually about two-thirds the hinge width; anterior margin transversely rounded, and usually somewhat irregular. Anterior part of ventral valve slightly upbent, and dorsal valve correspondingly deformed, for the valves lie in close proximity throughout.

The surface is regularly striate. Relatively coarse cord-like costæ separated by 9 or 10 finer costellæ cover the entire surface in the stropheodont manner. The costæ are recessed in a furrow for their entire length, or until the extreme geniculation zone is reached. The intercostal zone is, on the other hand, convex upward. This gives the surface a curiously inverted aspect when compared with other stropheodonts in the fauna. The principal costæ originate as fine costellæ in the bottom of grooves on the apical portion of the shell. The interspaces, even on the early part of the shell, are finely costellate. New principal costæ originate in an intercalary manner out of furrows that develop in the midst of an intercostal space. The new costæ appear all at essentially the same stage of growth over the shell, and concomitantly with them new costellæ appear in an intercalary manner also, so that almost everywhere the number of intercostal costellæ is essentially the same. This regularity of surface sculpture is a very characteristic feature of this species. On the upbent portion of the shell, at least on the dorsal valve, the costæ rise out of the bounding grooves in which they lie elsewhere on the shell, and constitute the cordate crest of fascicular bundles of costellæ. In other words, the relative convexity of the costæ and costellæ is reversed on this zone. Here also the costellæ are irregular and wavering, which is in marked contrast to their regularity and straightness elsewhere. Over the entire surface fine varices of growth appear as delicate elevated striæ. They are so faint that they are invisible to the unaided eye and nowhere give a cancellate effect. The hinge margin of the dorsal valve, upper surface, is curiously concave, even at the beak, and the upper edge of the dorsal palintrope is elevated above the surface as a carina with rounded keel. What the nature of the palintrope surface may be is not known. Nature of the delthyrium is also not known.

The interior of the dorsal valve carries unusual features which seem to merit separate generic recognition for this fossil and congeners. These characteristics have been outlined under the foregoing generic analysis. The shell is exceedingly thin, and the surface ornamentation is seen from the internal mold to be truly corrugated, for the interior of the shell carries the negative form of even the finest surface radii nearly as distinctly as the external mold does the positive. The muscle markings are small, inconspicuous, and with poor delimitation. There is apparently no accessory calcification under the beak in the form of a muscle seat, for the surface radii are discernible over essentially the whole muscle area, but the postlateral region about the muscle scars is finely granulose.

The two prominent subparallel "braceplate" ridges extend forward from the bases of the pillars of the cardinal process. They are granulose on their crests and likewise the zone between them is granulose. This median zone is divided by a septum of less elevation than the "braceplates", but subequal to them in length. It is fused posteriorly to a slightly elevated callus which surrounds the bases of the pillars of the process and the termini of the parallel ridges. The central triad of ridges reaches about one-third of the distance toward the front margin. The cardinal process rises perpendicularly from the floor of the valve and posterior callus. It consists of two subparallel elongate pillars, triangular in cross section, and excavate posteriorly, which slightly overhang the hinge. The excavate terminus of each pillar is slightly crenulated. The space between the pillars is about one and a half times as wide as a single pillar. The adductor muscle scars are very faintly elevated from the floor of the valve. They are well defined on their postlateral margins by widely divergent ridges which extend outward from the bases of the cardinal process to the anterolateral corners of the scars. They are elsewhere *sans* limitation. The postlateral margins of the scars are slightly excavate. The front margin of the scars is not well defined, but in some shells has a truncated appearance and in most grades into the granulated pallial zone. The inner edge of the adductor scars is distinct as far as the junction with the cardinal callus, and is essentially a straight line. The surface of the scars is radially ridged. Sectors which are nearly as large as the scars themselves separate the outer muscle scars from the parallel carinæ. These sectors are striate and granulose after the same manner as the scars and may also have been the scene of muscle attachment. In back of the adductor scars, and slightly less divergent than they, two well developed subangular crural ridges appear to originate at the hinge and continue forward to the anterior side of the postlateral reëntrant in the adductor margin, where the ridge appears to fuse with the carina at the margin of the scars. The shallow posterior depression between the bounding carina and the crural ridges may represent a socket zone. Hinge crenulation occurs only on the central third of the hinge. The crenulations are weak and closely spaced under the beak, and disappear by gradual diminution laterally. The palintrope does not rise internally above the floor of the valve, and the crenulation sockets are inset below the general valve level. Externally the palintrope has been forced upward on the posterior margin as a vertical ridge. There is, therefore, no inner palintrope surface, and no posterior cavity. The dorsal valve was strictly opercular.

Dimensions.—The following measurements were taken from two external dorsal molds and one internal dorsal mold. All are incomplete, and the dimensions are approximations.

	5444	5437-5438
Width hinge	60 mm.	50 mm.
Length of shell	35 mm.	32 mm.
Visceral length	30 mm.	
Length median septum		13 mm.
Length parallel carinæ		12 mm.
Radial length adductors		6 mm.
Maximum distance across muscles		10 mm.
Width cardinal process		1.75 mm.
Total length hinge crenulations		17 mm.
Crural angle		120°
Cardinal boundary angle		125°
Angle inner adductor boundaries		65°
Angle pseudo-braceplates		12°

Discussion.—This species differs from *?C. waringi* in being much more leptostrophid in its shell relations and in having a much weaker cardinal process, an imperfectly crenulated hinge, and obsolescent differential corrugation. The strongly developed dorsal adductor scars are also very characteristic in this species, whereas they are not clearly defined in previous species, above. The surface markings in the present species are highly characteristic. In the delimitation of the costellæ by adjacent furrows we may have an example of arrested development, for in *Cymostrophia schucherti* it was pointed out that the principal costellæ *originate* in the midst of furrows, but soon all signs of the initial groove are lost. Some individuals in *C. dickeyi* show a tendency for the costellæ to form crests of subangular corrugations of the shell in much the same manner as seen in *Dictyostrophia.* It would appear in the few cases observed in *C. dickeyi* that the phenomenon might be attributed to lateral compression during fossilization rather than initial corrugation. In no cases have any concentric varices been noted in typical examples of this species. In 5438A, a dorsal mold, the usual frail trident is shown and also slight differential corrugations. The obviously incomplete and exceedingly weak hinge crenulation also points to the possibility of arrested development, as does likewise the delicacy of the cardinal process. The affinities with "boreal" forms here again probably lie in the *Stropheodonta patersoni*—*S. inæquiradiata* complex. With the "boreal" douvillinoid *Stropheodonta inæquiradiata* (Conrad) as interpreted by Hall, 1867 (*e.g.*, p. 106, pl. 18, figs. 2a-2k), there is considerable similarity in the structures of the dorsal valves. This last "boreal" species is assigned as genotype of a new genus in the forthcoming study of the Stropheodontidæ mentioned above. The details of the braceplates, musculature, ornament, and size preclude the possibility of the Colombian species being assigned to this genus. Homeomorphy is the probable explanation of the resemblance.

Types.—Holotype: Pal. Res. Inst. No. 5437-5438, internal and external dorsal molds of one shell; paratypes: No. 5444, an external dorsal mold; 5438A, an external and internal dorsal mold; also 5446, not illustrated.

Genus **Dictyostrophia** Caster, n. gen.

Genotype.—*Dictyostrophia cooperi* Caster, n. sp. Colombian Devonian.

The generic analysis is given above.

Dictyostrophia cooperi Caster, n. sp. Plate 2, figs. 7-12; Plate 4, fig. 9; Plate 6, figs. 1-6

Shells concavo-convex, transverse; hinge width greater than maximum length of shell; hinge termini auriculate, and rounded; anterior third of dorsal valve pronouncedly geniculate; the peripheral upbending continuing to near the hinge extension on both sides where a very sharp demarcation occurs in the form of a lateral constriction of the shells. The "visceral disc" is apparently somewhat more depressed at its front margin than elsewhere on the shell.

Surface of the dorsal and ventral valves prominently and angularly plicated posteriorly, and possibly on the venter throughout (5455). Each angular corrugation is surmounted by a cordate costa. The angularity of the corrugations gives way on the earliest part of the shell to mere rounded fascicles; when about half grown the angular corrugations become most prominent, and in the ephebic condition the addition of many intercalary costæ, each at the apex of a smaller angular corrugation, makes the plication less apparent. On the apical portion of the shell there is a curious reversal of corrugation: the principal costæ, which number between 16 and 18, appear first as very faint ridges in apical incised striæ or grooves between which there are convexities covered with very fine radial costellæ. About 5 mm. in front of the apex the faint ridges rise out of their grooves. Each ridge is for a short distance bounded on either side by a shallow continuation of the groove as delimiting furrows. The ridges soon attain such elevation that the bounding furrows are mere shallow concavities at the base of each costa, on the angular slope which descends to the middle of each intercostal zone. The intercostal zones are angularly excavated except at the places where costæ originate. The entire intercostal surface is crossed by fine costellæ. The grooves from which the principal costellæ emerge continue to the terminus of the beak, and likewise the very fine intercostal striæ, some of which reach the size of secondary costæ at later stages of shell growth. It appears, therefore, that a large part of the radial ornamentation of the later shell is represented in miniature on the earliest preserved portion of the shell. So far as can be deduced from the material at hand, the only radial elements to appear in later growth stages are intercostal striæ. These are not numerous. Progressive strengthening of the already present structures appears to have been the rule. The strengthening proceeded differentially, however. The striæ lying in essentially the middle of the intercostal spaces each time received the strengthening and this rather abruptly, essentially synchronously in all interspaces, and at periodic stages of shell growth, rather than constantly and variably. The effect is that of periodic intercalation. Apparently until the stage of growth was attained when a costella was to be enlarged into a costa, it maintained a rather constant size after the first few millimeters of growth. After enlargement began it continued gradually to increase in size. Costellæ were much more rapidly advanced into costæ from the zone of geniculation outward than on the area of the "visceral disc". On the geniculated region of the shell so many of the costellæ have been enlarged into small costæ that the angularity of the paucicostate juvenile zone gives way to a low-angled multifasciculate condition, where only a few costellæ exist between costæ of various sizes. On the extreme front margin of adult shells there is a uniformly multicostate ornamentation (of variably sized costæ, however), without corrugations or fascicles. The costellæ are not so straight as the costæ. They usually show a uniform irregularly wavering tendency.

Over the whole post-embryonic shell there are found strongly ridged varices which are most prominently developed in the spaces between costæ, but are represented on the costæ themselves as slightly elevated knobs and bosses of regular spacing. In the interspaces the varices are subequal to the costellæ and of about equal spacing, although somewhat more irregular. The intersections of the varices and costellæ are faintly nodose. The whole dictyate effect is rather similar to a loosely woven textile, such as cheese cloth. The prominence of the reticulation appears to vary slightly with individuals, and may be greater on the ventral valve than on the dorsal.

The nature of the palintrope, dentition and crenulation of the hinge are not known. The dorsal interior shows certain highly interesting characteristics. The whole interior of the shell is coarsely corrugated or radially striated, the depressions being along the raised lines of the surface. The whole surface is finely pustulose or granular, and very strongly so in the posterior part of the shell. There is an internal callus "diaphragm" at the line of upbending of the shell. This callus mass is thickest and of greatest length near the central part of the shell. In back of the diaphragmal callus the shell is concentrically excavated and strongly ridged. Subumbonally the muscle scars are embedded in a broad callus, the sloping sides of which are coarsely and abundantly pustulose.

The actual places of dorsal muscle attachment occupy a very small area in the postcentral part of the shell. The adductor scars are correspondingly small, elongate, ellipsoidal areas which are separated by a median carina. The scars are well delimited postlaterally by callous ridges which diverge from the base of the cardinal process. The scars are most elevated above the floor of the valve toward the front, where they are delimited by a precipitous slope. A reëntrant mesial zone between the anterior extension of the muscle seats is deeply excavated and mesially divided by a septum which appears to be the discontinuous extension of the median septum. The anterior septum extends to the beginning of the diaphragmal callosity. The sides of the excavated zone are slightly elevated above the general slope of the muscle callus. The zone occupies an ellipsodial area which ends with the anterior median septum at the diaphragmal callosity. This excavation may represent the attachment seat of the anterior adductors. The posterior pair was presumably attached along the median septum. The cardinal process appears to be pedunculate and to rise directly from the floor of the valve. The prongs of the process are laterally divergent. Crural characters are not preserved on the material.

Dimensions.—The following measurements were taken from the holotype, an internal and external mold of a nearly perfectly preserved ventral valve (5449A and 5445).

Width hinge	70 mm.
Length of shell	36 mm.
Hinge extension beyond visceral disc	17 mm.
Median length visceral disc	29 mm.
Width muscle scars	13 mm.
Radial length adductor scar	8 mm.
Length posterior median septum	7 mm.
Total length median septum	14 mm.
Width cardinal process	12 mm.
Width between sockets	12 mm.
Width anterior median depression	5 mm.

Discussion.—Without going into the generic features of this interesting reticulated species in any detail, it must be noted that certain gaps in our knowledge, most notable of which is lack of information on the hinge crenulations, sockets and process, make absolute assignment hazardous. The general contour of the shell, obvious concavo-convexity and unequal striæ bespeak northern forms usually assigned to *Strophеodonta concava* Hall (*e.g.*, Hall and Clarke, 1892, pl. 14, fig. 19), especially as developed in the North American Onondagan and Hamilton. Some of the structural features of this species have already been discussed in preceding pages. In the "boreal" species the very similar, albeit smaller, diaphragmal callosity is present; also narrow, ellipsoidal posterior adductor scars, and recessed anterior adductor scars, both separated by a median septum. Similarly in *S. concava* the process is broadly bi-pronged and the dental sockets relatively close together at the base of the process. The visceral disc portion of the shell of *S. concava* is coarsely ridged as in the Colombian species. Externally the profiles of *S. concava* (*e.g.*, Hall's 1867 illustration, pl. 14, fig. 2a) and *Dictyostrophia cooperi* are almost identical. Significant in the comparison are the alate hinge extensions. The surface markings especially point to the relationship between the two species, for both show similar surface corrugations, but the "boreal" form, although having closely crowded concentric striæ, does not ordinarily have a reticulated appearance. This last feature seems to be a Colombian specialization within the group, or a quite independent development in a stock which more or less paralleled the *S. concava* developments in other respects. It is not unlikely, however, that this line has a North American expression in such small forms as the one listed by Hall, 1867 (pl. 12, fig. 11), as *Stropheodonta patersoni?* from the Lower and lower Middle Devonian of New York State. The specimen illustrated in this connection does not have the well-wrinkled aspect of typical *S. patersoni,* and probably represents a distinct specific development. The surface costæ are angularly elevated as in the Colombian species, and the entire surface is finely cancellate after the general manner of our specimens. Walcott, 1884 (p. 120, pl. 2, fig. 11a), described and illustrated a reticulated specimen from the Lower Devonian of Combs Peak, Nevada, assigned to *Stropheodonta inæquiradiata* Hall of the New York Helderberg strata. Walcott's specimen has surface reticulations which are very reminiscent of the Colombian material, but are inadequately described for detailed comparison. The types of Walcott's material are not especially helpful, but certainly a distinct species was involved. It is an interesting occurrence parallel to that of the eastern American Helderbergian, where forms assigned to *S. inæquiradiata* and *S. patersoni* apparently intergrade. The Colombian fauna seems to echo this same association. Before closer comparisons can be made, a restudy of the North American Lower Devonian stropheodont fauna is essential.

Types.—Holotype: Pal. Res. Inst. No. 5445 and 5449A, internal and external molds of one individual; paratypes: No. 5455, a partial external mold of a ventral valve; 5445A.

THE TRUE STROPHEODONTIDS

The crenulate-hinged brachiopods having the general characteristics of *Stropheodonta demissa* (Conrad) are an entity apart from the rest of stropheodontids. The group appears to embrace structural lines that exceed the bounds of a single genus. It may develop that this aggregate will constitute the Stropheodontini in full, when a thorough revisory study is carried out. The genus *Stropheodonta,* as used below, in the strict meaning of the genotype, will apparently not cover the entire group of species now described or describable from the Lower into the Upper Devonian, and at one time or another for the most part referred to the genotype. Whatever may be the outcome of the true stropheodontids, only the genus in the strictest sense has any immediate bearing.

Genus **STROPHEODONTA** Hall, 1852, *s.s.*

Genotype.—*Strophomena demissa* Conrad. Middle Devonian.

The genus *Stropheodonta* in the restricted sense of this paper is typified by the genotype *Strophomena demissa* Conrad. It represents an end development apparently out of an as yet undetermined brachyprionid stock. (*See* discussion of *Mclearnia,* above.)

Stropheodonta, s.s., is in the adult stage characterized by a holocrenulate hinge. It seems likely that all species of true *Stropheodonta,* like the genotype, possess no foramina in the palintropes and usually no evidence of even deltidial plates. The genotype and its relatives have always an exceptionally high dorsal palintrope. The ventral muscle scars spread flabellately without carinate delimitation. The dental lamellæ are weak or obsolescent. The ventral bifid process is well developed and fits between the divergent prongs of the dorsal cardinal process which rest in cavities or even pits under the ventral beak. A posterior median septum or carina separates the elongate diductor muscles of the ventral valve. The process of the dorsal valve is sessile, the prongs rising from the subumbonal callus as parallel pillars which are posteriorly directed. The adductor scars are reniform and imperfectly delimited by callus deposits. A median septum extends forward from the posterior callus to about the middle of the shell. The crural plates are obsolescent and apparently were never functional in maturity in *Stropheodonta, s.s.* The adolescent and ephebic portions of the genotype externally bear subequal alternating radii which arise principally by bifurcation, but occasionally by intercalation. Costellæ are apparently not present in the group. The alternating radii are made up of mature and newly formed ones rather than consistently fine and coarse radii. In the genotype and related species the earlier part of the shell may be angularly corrugated or coarsely costate. Warthin and Cooper, 1938, have shown that the strata bearing *Stropheodonta demissa, s.s.,* do not occur west of New York State, and Cooper, 1938 (personal communication), has reported it quite unlikely that any of the specimens in the many reports of this species elsewhere are truly conspecific with *Stropheodonta demissa.* The use of the species name in the past has been virtually generic, and it is highly improbable that reports of the species in more distant places can be otherwise interpreted. *Stropheodonta, s.s.,* appears to be found only in the Middle and lower Upper Devonian, the world over. The first definitely known representatives in South America occur in the Colombian fauna.

Stropheodonta kozlowskii Caster, n. sp. Plate 3, figs. 3-15; Plate 5, figs. 14-19

This is a small to medium sized, symmetrical, concavo-convex brachiopod with a straight hinge line, produced extremities, and slightly greater width than length. The ventral valve is mesially most gibbous along an anteriorly expanding zone which has the aspect of an undefined fold (in some individuals very clearly defined, however) of which there is a counterpart in the dorsal valve in the form of an undefined sinus or mesial depression. The outline of the shells is essentially shield-shape; the periphery is slightly constricted just in front of the auriculate hinge extensions and thence is regularly curved toward the front. The front margin is subcircular, and only slightly produced mesially at the shallow sinus and fold. The greatest height of the ventral valve opercular in function; the beak is very low, and rises only slightly occurs at about the mid-point of the shell. The dorsal valve is above the hinge line as the only convexity of the shell. Over much of the surface the dorsal valve is essentially flat, but bears a shallow mesial sinus-like depression without conspicuous delimitations. At the front margin the shell is slightly up-flexed, thus indicating the recessed nature of the valve. The characteristics of the hinge margin are not known; likewise the internal features.

The surface markings constitute the chief character for recognition of this species in the Colombian fauna. These consist of many elevated, rounded or subangular radii arranged in fascicles, each with a common origin out of a series of original radii on the beak which merge into a single mesial swell at the extreme posterior part of the beak. The radii increase in threes, by trifidy; the mesial part of each radius is much larger than the newly arisen lateral branches which split off on either side at the same time.

At first the newly arisen branches are finer than the parent radius, but within a distance of about one-third the total length of the adult shell the lateral branches attain the same size as the parent, whereupon they give rise each to a pair of new lateral radii, but the "parent" radius in each case appears never to branch more than once. The rate of subdivision of the radii was much more rapid on the earliest part of the shell, and appears to have decreased as the individual matured, thus on most shells it appears that there are 15 principal radii all originating in equal development on the beak, yet in some specimens it can be seen that these are really two fascicles of seven each with a radius of equal strength in the middle. The radii appear to be of an alternating type only in those zones of growth where new ones have recently branched off. Definitely none of the shells has shown an intercalary origin of the radii; the barest approach to this comes where a varix appears to interrupt the juncture of the tiny nascent radii and the parent radius, but in all cases the paired nascent radii converge noticeably and for some distance lie on the slope of the parent radius. Having given rise to two lateral radii, the mesial or parental radii become the most elevated crests of fascicles in the ventral valve. In the dorsal valve this condition is not so prominent, and in fact, may well be reversed. Certainly the mesial swell of the ventral valve and mesial depression of the dorsal precisely conform to this scheme. In the dorsal valve there is a tendency for the primary or parental radii to give rise to essentially full-fledged lateral ones of essentially the same strength as the mesial one. This gives a curious tritonlike aspect to the ornamentation on the more mature parts of the shell. Branching on all radii appears to have occurred at essentially the same moment at regular intervals in the growth of the shell. The interspaces between radii are consistently narrower than the radii, usually being about half as wide, and are ordinarily essentially flat-floored. Concentric varices occur with no regularity on the surface. These are most prominent on the dorsal valve in our material. Concentric ornamental lines of great fineness are present over most of the shell surface, but can be seen with a lens best on the postlateral areas. They have most consistent development on the flanks of the elevated radii. The surface never has a cancellate aspect.

Dimensions.—

	5429*	5430	5431
Width hinge	26 mm.	26 mm.	28 mm.
Length of shell	18 mm.	26 mm.	28 mm.
Anterior width fold or sinus	10 mm.	9 mm.	8 mm.

Discussion.—In the absence of internal features and palintrope structures, it is admittedly impossible definitely to assign this interesting species to genus, but the preponderance of characters seems to lie with the true stropheodonts. Of these, the "boreal" genotype, *Stropheodonta demissa* (Conrad) bears the closest resemblance, so far as I can ascertain. Especially reminiscent are some of the Schoharie and Onondaga forms illustrated by Hall, 1867, in the first satisfactory diagnosis of the genotype. It is interesting, however, that none of Hall's material showed the cancellate surface and subtuberculated striæ which Conrad, 1842, described for the species. The Colombian material is compared with the species as recognized by Hall, 1867, rather than with Conrad's original material, which may possibly not be conspecific. In size and contour, *S. kozłowskii* and the early Devonian representatives of *S. demissa* (Hall, 1867, pl. 11, figs. 14-16) are very similar, but in surface markings the Colombian species appears to be unique in the trifid nature of the costæ and regularity of pattern. Hall's *S. demissa* is especially characterized externally by posteriorly prominent radii, originating as nine or ten on the beak and increasing very rapidly by both bifurcation and intercalation toward the front where the surface is covered with very fine subequal radii. In some variants the radii remain essentially coarse throughout and in strength compare with the Colombian material. But in general, compared with "boreal" *S. demissa*, even the fine striæ of the Colombian species would appear coarse. No specimens of *S. demissa,* to my knowledge, show trifid radial increase. Until better material from Colombia is obtainable, which may indicate other relationships, *S. kozłowskii* is considered as lying close to the genotype line of the stropheodonts, but showing highly individualistic features.

Apparently no "austral" material has been described which closely resembles *S. kozłowskii* in detail. It is likely that the con-

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* Dorsal valve of 5430.

geners will turn up in material generally listed or illustrated under *"Orthotetes"*, *"Schuchertella"* or even *"Orthis"*, for in general contour the species is very similar to many forms so identified in Brazil, Bolivia and South Africa, (*e.g.* Knod, 1908, pl. 27, fig. 7).

Strophomena hœferi Katzer, 1903, the types of which have been examined in the New York State Museum (8422/1), is presumably a *Stropheodonta, s.s.,* as Clarke, 1913 (p. 291), suggested. The lectotype has a few lines in the external mold of the palintrope which strongly suggest a crenulated hinge. The ventral valve only is known of Katzer's species, and the contour is similar to *Stropheodonta demissa* (Conrad). The surface, however, as impressed on the lectotype, is of a strongly alternating sort, and certainly cannot be closely compared with *S. demissa, s. s.* The musculature of the ventral interior is also quite different from *Stropheodonta, s. s.* Instead of being flabellate and divergent as in *Stropheodonta, s. s.,* the muscle area is a depressed, narrow, elongate, lenticular zone which reaches far beyond the middle of the valve, and bears mesially a low septum. This individuality, not found in any of the stropheodonts known to me, probably will eventually lead to a separate generic designation for Katzer's species.

The surface radii of *S. kozłowskii* are of much the same appearance as of *Schellwienella agassizi* and *S. sulivani.* It was with the former species that I first identified the material, but closer scrutiny showed a reversal (*i.e.* normal state) of convexity and the existence of an obscure sinus and fold in the present species. It showed as well a very different origin of the radial ornament. This species and *Schellwienella agassizi* have sufficient external similarity to suggest parallel development, and in the absence of *S. agassizi* and presence of the usually associated *S. sulivani,* it seems not unlikely that *Stropheodonta kozłowskii* may well have held in Colombia the ecologic niche usually occupied in the "austral" Devonian by Hartt's species. Further exploitation of the Colombian deposit will undoubtedly clarify this point. Hartt's, 1874, description indicated that several of his fragmental paratypes of *Streptorhynchus agassizi* had extended hinge margins, although Clarke, 1913, in reillustrating the species showed no specimens with this outline. Close scrutiny of Hartt's material may yield this present form among the paratypes. The trifid increase of radial ornament and small size of the species serve adequately to distinguish *S. kozłowskii* from any of the other stropheodonts described in this report.

Types.—Holotype: Pal. Res. Inst. No. 5406A; paratypes: Nos. 5429-5431, 5431A-E.

?Stropheodonta, sp. Plate 10, figs. 7, 8

A single specimen of an internal dorsal mold of a stropheodont shell is at hand which exhibits features not observed in other Colombian material, and so far as known, not hitherto recorded in "austral" faunas. The illustrations bring out the very prominent median boss of the shell which occupies the position of an anterior median septum, but may involve a depression of the shell itself, rather than being a mere secondary deposit. The frail sessile cardinal process is shown by the plasticine cast, and likewise the recessed and small muscle scars. The shell may represent a deformed, or even pathologic specimen belonging, possibly, to one of our species described above, but the closely packed radial ornament is not known for any of the already described forms.

Illustrated specimen.—Pal. Res. Inst. No. 5448A.

Tribe *Douvillinini* Caster, new

The true douvillinids are unknown from the Southern Hemisphere, and there is little point in discussing them in any detail at this time. Studies now under way indicate that the genus *Douvillina, s. s.,* as determined by the genotype, *Douvillina dutertrei* (Murchison) from the middle Frasnian of Europe, is not known in North America, although it now appears that the principal development of the tribe occurred on that continent. It furthermore appears that several distinct lines of douvillinid evolution are represented in North America, and await generic designation. Several of these are indicated in the preceding list; others are now in manuscript. The genus *Douvillina, s. s.,* apparently represents a highly specialized end-product rather than the prototypic line. Material from Moscow (Erian, Middle

Devonian) referred by Hall to *Stropheodonta inæquistriata* (Conrad), in Volume 4 of the Paleontology of New York, shows some of the specialized traits of true *Douvillina,* but the mass of subsequent material assigned to the Conrad species from the Hamilton and Tully is quite different in character. Principally, they fail to show anterior closure of the median dorsal pit which Oehlert's genus apparently requires.

Beginning in the Onondagan (possibly in the Oriskanian) small stropheodontids appear in which occur prominent dental plates bearing anterior elongations to border the diductor scars. The junction of the true dental plates and the prolongations (possibly paradental plates) is considerably elevated to form a *median apex* to each "dental plate". These apices are often incurved toward the middle of the valve and sometimes almost touch the apices of a secondary pair of lamellæ which form along the contact of the diductor and adductor scars, and have a midway elevation very similar to that occurring in the dental plates and their extensions. The secondary plates between the two sets of muscle scars are here termed the *muscular diaphragms.* Their apices curve outward, *i. e.* laterally, toward the apices of the dental lamellæ, and may in some cases join them at their apices to form calcareous rings. On the median line there is also a bladelike median septum which separated the adductor muscles. In derivative and gerontic forms the muscular diaphragms tend to disappear, or become concealed with secondary calcification which mantles them and the median septum as well. This forms an elevated mesial callus ridge probably for adductor attachment. The derived condition seems to be of generic worth. Derivative forms of this ilk first appear in the Tully limestone (uppermost Erian or basal Senecan), where they have usually been assigned to *Stropheodonta inæquistriata* (Conrad).

The dorsal valves show equally striking features, the development of which correlates very satisfactorily with those of the ventral valve. The evolution of the so-called braceplates or Stützplatten in the dorsal valve seems to be one of the principal criteria for generic differentiation in the tribe. These plates originate in the middle zone at the base of the cardinal process and on either side of the elongate but low median septum or platform which also abuts the cardinal process. From the very beginning the plates are differentiable into a posterior and an anterior half. The posterior portion consistently lies lower, and may in some cases be represented only by a slight roughening of the muscle scars adjacent to the median septum. The anterior halves, on the other hand, are ordinarily built up by granular callus material, and rise very abruptly with a posteriorly concave slope from the hinder halves. The anterior portions of the plates rise highest near their contact with the back portions, and slope off gradually toward the front of the shell. Their upper surfaces are usually roughened slightly, or even grooved in the earlier species. In the dorsal valve, as in the ventral, there is a tendency for the highest elevations on the plates to bend toward each other over the median septum, to which they sometimes fuse, but over which they more often become contiguous, sometimes to form a ring, but more frequently to form a posteriorly tapering calcareous half cone which lies on the septum toward the rear. The extensions of the anterior plates usually curve toward the center, but may diverge greatly. In *Douvillina, s. s.*, the plates apparently are joined anteriorly by an arcuate callus deposit which thus makes a subcircular pit between them. This is a highly specialized growth. In most of the earlier species the median dorsal septum reaches forward as far as or beyond the plates, but in later forms the septum stops near the origin of the anterior plates. In a few species a secondary anterior septum appears between the forward prongs, and in *Douvillina, s. s.*, this forward septum is fused to the arcuate callus and extends to near the front margin of the shell.

Contrary to the views expressed by Spriesterbach, 1925, this study of the douvillinid braceplates has lead me to view them with Hall and Clarke, 1892, as scenes of muscle attachment. The hinder half of each plate is the place of attachment of the posterior diductors, and the much elevated portion the place of attachment of the anterior diductors. That they may also have served some such brace function as Schmidt, 1912, and Spriesterbach, 1925, postulated, is not improbable. The condition of the braceplates seems to be a major generic feature. Ephebic shells, and not gerontic, however, must be examined in order to make use of almost any of these internal douvillinoid structures, for in the old age condition, much absorption and secondary callus deposition occurs throughout the tribe. Resupination is also apparently of generic value in this group. One complication in the study of these shells is the great similarity of the contour and surface details of quite distinct lines of development. Exceedingly critical study of the so-called species groups is essential to a clarification of the problem. External homeomorphy, or an extreme case of external conservatism seems to be the rule in the tribe.

This running survey indicates the essential generic criteria which seem to be of greatest value in studying and reassigning the douvillinids. It also indicates the nature of the structures in this group which have been mentioned in discussing the homeomorphic development of douvillinoid structures among some of the stropheodontids above.

Tribe *Leptostrophiini* Caster, new

The tribe as here recognized is essentially equivalent to the genus *Leptostrophia* of authors. That the genus was a very plastic one, subject to a great number of variations, has been recognized from its inception. Williams and Breger, 1916 (p. 26), Clarke, 1913 (p. 286), and others, have shown some of the innovations that occurred in the genus, and intimated a little of the part homeomorphy may have played in the derivation of similarly appearing lines of descent. Many of these structural differences appear to be of generic or subgeneric value, and certainly have great stratigraphic value as well. The classification here outlined will be dealt with more fully in an extended work now in progress on the crenulate-hinged Strophomenacea. Only the most striking and important generic lines in the Leptostrophiini are here mentioned.

The tribe Leptostrophiini is characterized by the well known set of traits by which the original division *Leptostrophia, s. l.*, was noted as a group distinct from the typical stropheodontids. Of these, the plano-convex shell is the most striking feature, but the presence of a strong, sessile cardinal process attached to a trifid posterior callus, enormous flabellate ventral diductors, and especially of ventral subumbonal process pits, and fascicular diductor muscles with secondary leaflike septa "muscle diaphragms" between them, all bespeak this as a line apart from the common company of stropheodonts.

A Key to the Divisions and Principal Genera of the Leptostrophiini

A. Surface ornament of the alternating type; consisting of principal costellæ which wax and wane to create a subspinose appearance in some cases. (The *Nervosa* condition.)
  B. Shells planate, or subplanate; no fold or sinus; shells thin; external ornamentation easily discernable on the interior.
    C. Shells of moderate size with distinctly nervose external ornament, and no marked tendency for different ornamentation pattern on the two valves .... *Nervostrophia* Caster, new.
    CC. Shells of huge size, very flat; nervose condition obscure; dorsal and ventral valve with slightly different ornament .... "*Leptostrophia junia*" group.
  BB. Shells concavo-convex, but otherwise with the characteristics of the Leptostrophiini; fold and sinus broadly developed; shells thick and lamellate .... *Sulcatostrophia* Caster, new.
AA. Surface ornament consisting of costellæ of essentially the same size, and never conspicuously of an alternating type.
    D. Shells very large, plano-convex; pedicle groove well developed in ventral valve, spondyloid; prongs of cardinal process biramous or bifoliate; process cavity in ventral valve obscure........ .... *Leptostrophia* Hall and Clarke, *s. s.*
    DD. Size usually medium to small for the group; pedicle groove usually absent; if present, very small and not spondyloid; cardinal process usually simple; well developed process cavities in the ventral valve.
      E. Shells markedly corrugated, either regularly or differentially; ventral process usually obscure; ventral muscles usually relatively narrow; cardinal process attached to a broad triangular platform resembling inner palintrope wall; external dorsal palintrope linear .... *Rhytistrophia* Caster, new.
      EE. Shells either not corrugated, or if so, obscurely, and without the characters listed in E, above.
        F. Hinge at least partially crenulated.. primitive Leptostrophids and *Protoleptostrophia* Caster, new.
        FF. Hinge edentulous, or with only a few nodes near the extremity which are apparently not comparable with crenulations...................................... *Australostrophia* Caster, new.

PRIMITIVE LEPTOSTROPHIDS

This is not the occasion to enter into a discussion of the ancestry of the leptostrophids; it does appear, however, that they are first clearly differentiable in the late Silurian. Certainly they were well along in the Manlius (uppermost Silurian, American column) and offer no especial difficulties in identification. The Silurian forms appear to have true dental teeth (nodes) and dental buttresses, which were poorly developed and are as a consequence only indifferently known in the Helderbergian and true Devonian forms. (*See Protoleptostrophia,* below.) The group was presumably derived independently of the other Stropheodontids from the brachyprionids, and has apparently therefore only a broad early relationship with the Stropheodontini. The hinge of the Leptostrophiini has in no case been found to be fully denticulate to the degree attained in the true stropheodonts. *Leptostrophia planulata* (Hall), *s. l.,* from the Manlius and Helderbergian, and *Stropheodonta bipartita* Hall from the Manlius apparently lie near the ancestral stock of the leptostrophid line, and will, when better known, probably be recognized as the nucleus of a protean genus, more primitive even than *Protoleptostrophia,* below.

THE PERPLANA GROUP

Genus **PROTOLEPTOSTROPHIA** Caster, n. gen.

The group of species, both described and in manuscript, which center around *Leptostrophia perplana* (Conrad) and *Leptostrophia blainvillii* (Billings) constitute a very highly characteristic branch of the Leptostrophiini, and one which is easily detected either by external or internal structures. The shells of most species in this group are only subplano-subconvex, and in many cases are sub-biplanate. In other instances, however, the dorsal valve is slightly concave. The surface of both valves is typically ornamented with closely crowded rounded costellæ of subequal width and height which are usually from two to three times as wide as the intervening concavely subangular spaces. The radii increase both by bifurcation and intercalation in the genotype, but in some species seem to increase entirely by intercalation. The radii are slightly irregular above, with a tendency in the genotype to become obscurely nodose, but in certain Middle Devonian forms become prominently nodose, or even spinose. (This has possibly attained the prominence of a generic character in the Middle Devonian.) Concentric varices are exceedingly fine, and cover the radii and interspaces. Lamellose growth lines are also irregularly developed, and obscure concentric corrugations are a common inheritance of the group, which probably may appear at any time. They are, however, never so strikingly developed as in the *L. beckii* group (*Rhytistrophia*). Some shells show very prominent punctæ in the interspaces between radii.

Internally the ventral valves of the genotype show low, callus-like nodes under and abutting the hingeplate on either side of the delthyrial zone. These have the position and apparent function of dental braces or obsolescent lamellæ. The dental nodes do not attain the commissure plane, and can have had no articulatory function. Moreover, they are not visible in many specimens, but material from the Gaspé sandstone in the U. S. National Museum referred to the genotype shows them very distinctly. Centrad of the inferred true dental nodes lie elongate, subangular ridges which bound the large flabellate diductor scars. Preparations in the U. S. National Museum by Beecher of related species in the Hamilton (*perplana* complex) show that these ridges are made up of globules, and even hollow spheres of calcareous callus material. They are not dental plates, since they lie inside the dental nodes, and overlap them for a short distance. They seem rather to be *paradental* plates or their homologues, already discussed under the Douvillinini. In virtually all other groups of the Leptostrophiini the dental nodes are not present, and were it not for this contrary information, the paradental plates might justifiably be construed as modified dental plates. The delthyrium is narrowly triangular, and open only at the hinge on either side of the terminus of the median septum which abuts the deltidium for its full height. The median septum is divisible into a subumbonal portion which is elongate, lozenge shape, and an anterior portion which may be tenuously connected with or quite disjunct from the posterior portion. The anterior septum is blade-like, tapering off to extreme delicacy at each end. It separates the adductor muscle scars and in some cases extends forward also to separate the anterior portion of the diductor scars. The posterior septum is really made up of the fusion of and callus filling between the anteriorly and downwardly (*i. e. down* from the posterior callus and inner palintrope wall toward the floor of the valve) divergent prongs of the ventral process and two posteriorly and upwardly divergent lamellæ which bound the pedicle pit anteriorly. This is inferred from other, less specialized stropheodonts in which these prongs apparently posteriorly bounded the lozenge-shaped pit in which the pedicle muscles were principally attached. These component parts are often much concealed by secondary calcification so that the posterior septal region is merely an elevated platform resembling a spearhead at the terminus of the bladelike true median septum. The posterior septum sometimes bears an obscure median dimple which is all that remains of the so-called pedicle pit. In other genera, these posterior parts create a structure around the base of the pedicle which might be compared (analogously) with either a syrinx or pseudospondylium. Postlaterad of the prongs of the ventral process and subumbonally placed are elongate, ovate pits for the reception of the cardinal process. For these the name *process pits* is suggested. In the present group the pits often reach to the palintrope wall or may be excavated into it. Shells have been seen in which the cardinal process had worn holes through the ventral palintrope on either side of the delthyrial zone. The diductor muscles were apparently split into bundles, and low radial bladelike septa separated these bundles on the scar. The diductors may reach nearly to the front margin of the shell, and are without definite anterior limitations. The adductor muscles are usually obscurely attached to a relatively large lenticular area on either side of the median septum. They extend from the posterior septum for usually about two-thirds the median length of the diductors. The interiors of both valves are coarsely pustulose.

In the dorsal valve the cardinal process is seen to be composed of sessile prongs which rise from the posterior callus and overhang the hinge. Each prong is tear-shaped in cross section, the narrow part directed toward the hinge. No evidence of hinge sockets is known in the group. Extending forward from the rear platform is a tapering median septum which is usually rather short. The posterior platform is continued around the ovate adductor scars as a broad callus into which they are posteriorly recessed. The posterior diductors were attached on either side of the median septum, in elongate areas, sometimes slightly depressed. The anterior diductors were attached mesially in an ovate zone at the end of the cardinal septum, but their seat of attachment is usually most obscure and is detected only in extreme gerontism. The posterior callus is very coarsely pustulose. The hinge is nearly completely crenulated in the genotype, but less so in several allied species.

The *Leptostrophia perplana* (Conrad) complex, including virtually all of the species placed under synonymy by Hall, 1867, and Williams and Breger, 1916, as well as many yet undescribed, will constitute the bulk of the present group of leptostrophids. At least two additional genera are apparently yet to be described in the group from the North American fauna. The group is probably represented in the Bolivian Devonian, and will undoubtedly turn up in the Colombian fauna when it has been more thoroughly collected. The genus *Protoleptostrophia, s. s.* is apparently limited to the Oriskanian, but may extend in each direction for a short space of time. The *perplana* complex is particularly well developed in the Middle Devonian and probably does not extend into the Upper Devonian, or at most, not beyond the true Chemung.

THE NERVOSE LEPTOSTROPHIDS

The nervose leptostrophids are a very distinct Middle and Upper Devonian (American column) development. They may be derived from the early *perplana* stock as Hall, Hall and Clarke, Williams and Breger, and others have inferred by their reference of virtually all subplanate leptostrophids to "*Stropheodonta perplana*". The nervose forms share a characteristic alternating type of surface ornament in which the main radii wax and wane in their course from beak to periphery, giving a very irregular and even elongate-nodose radial effect. Between these incomplete main costellæ are several much finer radii which are relatively regular in strength, but usually are wavering in direction for their entire length. The number of fine radii between the principal costellæ varies considerably, but seems to be always greater than that of costellæ. This is a very different type of surface detail from that seen in the *perplana* group, with which they do share very similar shape and convexity of the valves.

Internally the nervose forms ordinarily have the ventral process very strongly developed, so that it often gives the effect of a small secondary set of lamellæ comparable to the paradental ones which are also very well developed. The paradental plates often fail to reach the palintrope wall by a considerable distance. The hinge is incompletely crenulated in all of the known representatives of this group. In the dorsal valve the characters are rather similar to those in *Protoleptostrophia.*

Genus **NERVOSTROPHIA** Caster, n. gen.

This genus, based on *Stropheodonta nervosa,* Hall, is characterized by exceedingly thin shells which are subplanate, the ventral one usually being only very slightly more convex than the dorsal one, which in some cases is correspondingly very slightly concave. The surface ornament in the genotype usually gives a first impression of hirsuteness, for the principal costellæ are conspicuously discontinuous, and irregular in height where developed. The ornament is really comprised of delicate radial corrugations of the shell which usually are reflected in reverse on the interior. New radii originate by intercalation. Between the principal radii are usually from four to six very fine undulatory radii which also originate by intercalation, but are essentially continuous. The hinge is crenulated for about two-thirds of the width, the crenulations usually diverging from the median line toward the front of the shell. The delthyrium is closed by a convex deltidium which may be secondarily opened at the commissure plane for the reception of the cardinal process. Internally the ventral valve usually shows prominent paradental lamellæ which ordinarily fail to reach the palintrope wall. The ventral process is strongly developed, but the anterior boundary of the pedicle pit is usually obscure, but may be well developed as a specific feature. The median septum varies considerably in degree of development. The ventral muscle scars are usually not well defined. They are flabellate areas, which in certain Upper Devonian species of large size, are well differentiated by lateral bordures of callous material. The adductors were attached in the Upper Devonian shells to elongate median subparallel plates or platforms which are separated either by a median septum, or by a sharply angular median fossa, which sometimes has a relict septum in the bottom. In the genotype the adductor scars are ordinarily not well shown.

In the dorsal valve there are no striking differences from *Protoleptostrophia* which might be termed of generic value.

The Senecan epoch and Chemung age of the Chautauquan were the heydays of *Nervostrophia* in North America, although the stock is well represented in the Erian also. Certain shells from the Bolivian Devonian suggest its presence in the "austral" realm but it is unknown as yet in Colombia.

Leptostrophia junia (Hall) of the Erian is a specialized congener of *Nervostrophia* which attained truly gigantic size for so thin-shell and planate a brachiopod. In this form the nervose characteristic is not so striking, although readily detectable. There is a tendency for the intermediate radii to disappear on the ventral valve in *L. junia* while they become coarser on the dorsal valve, and form with relatively regular primary costellæ a very striking and characteristic surface detail. Fine concentric varices are also occasionally present, and may cause the radii to appear slightly lamellate. This feature is also seen in certain species of *Sulcatostrophia,* below. Internally *L. junia* also shows in exaggerated manner most of the features which characterize *Nervostrophia.* Especially striking is the nodose ventral process which recalls the strong process development in otherwise not very similar *L. esplanata* (Sowerby) of the lower Coblenzian, (which is presumably a true *Leptostrophia,* or assignable to a closely related subgenus). The hinge of *L. junia* is only about half crenulated; the palintrope nearly linear. It seems at this stage of investigation that *L. junia* represents a distinct generic offshoot of the Erian *Nervostrophia* line.

THE SULCATE NERVOSAE

While it is not improbable that the development of a shallow fold and sinus may have happened in several distinct lines of the leptostrophids, the group here under discussion seems quite definitely to be derivative from the nervose line. The principal distinctions are a strongly arcuate or ventricose shell of heavy composition, with a lamellose exterior in adulthood, and the presence of a broad fold and sinus. Internally the normal leptostrophid features, while present, are blanketed by much secondary calcification, at least in the genotype.

Genus **SULCATOSTROPHIA** Caster, n. gen.

The genotype *Leptostrophia camerata* Fenton and Fenton, 1924, from the Hackberry stage of the Upper Devonian is a highly specialized shell of diminuitive size for the leptostrophids. *Leptostrophia calvini* (Miller) [= *L. quadrata* (Calvin)] from the Independence shale is also assignable to this genus (or an antecedent subgenus) and appears to be the ancester of the genotype.* The allied form, *Leptostrophia rockfordensis* Fenton and Fenton, also from the Hackberry, is somewhat larger, but also well illustrates the characteristics of the new genus. The ventral valve of the genotype is strongly ventricose, or inflated. In some cases it is anteriorly geniculate. The hinge in the genotype is shorter than the greatest width of the shell which comes at about the anterior half or two-thirds. Mesially the ventral valve bears a shallow sinus which in the genotype often becomes very pronounced. The dorsal valve is strongly concave. This is of course unusual for the Leptostrophiini. In fact, this character excludes the shells from the leptostrophids as originally defined. The dorsal valve fits very closely upon the inner surface of the ventral valve, and bears a median fold which is the counterpart of the ventral sinus. The surface of the shells clearly bespeaks

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* I am indebted to Mr. Merrill A. Stainbrook of Texas Technological College, for his generosity expressed in a letter of October 24, 1938, in reply to one of my own outlining my proposals concerning *Sulcatostrophia*. Quotation from his letter follows: "Since it will be a year at least before I shall have anything ready on the Independence fauna it seems best for you to go ahead with your genus since it would be more appropriate to include it in your classification. I gladly relinquish what rights, if any, I have in the genus to you."

affinity with the nervose leptostrophids. There is, however, a difference of ornament on the two valves, which in some cases is extremely striking. The nervose characteristics come out well on the ventral valve where the principal radii are much elevated, and wax and wane very noticeably. The finer radii are undulatory in their course. Very often though, the intermediate radii are obscure in the ventral valve, or may be differentially developed on a single valve. In the dorsal valve the radii are very regular and of the alternating type. Although the shells of *L. camerata* are of marked difference in size, contour and relationship, the ornament, very curiously, recalls that of *Leptostrophia junia* of the Hamilton. The shell substance is very thick, and toward the front becomes characteristically foliate or lamellose. Often the dorsal valve is abbreviated anteriorly so that the interior of the ventral valve shows externally from the dorsal side. The interiors of both valves receive a great deal of secondary calcification, but this is probably an ecologic feature, since it occurs in many Hackberry shells. The dorsal valve usually bears a strong peripheral callus. The internal features are reminiscent of the condition already described for *Nervostrophia,* but tend to show also the effects of excess calcification.

The *Sulcatostrophia* development seems to be restricted to the calcareous shale facies of the Upper Devonian in the interior of the North American continent, but apparently embraces more specific diversification than the already described species would indicate. The stock is not known to me elsewhere. There are, however, other sulcate leptostrophids, such as curious linguate forms which occur in the Eifel (*Calceola* beds) of Germany. They probably represent a distinct genus. This is true also of the indistinctly sulcate *Leptostrophia assella* gens of Europe. The Chemung group of New York contains inflated leptostrophids, as yet undescribed, which recall *Sulcatostrophia* in the condition of the valves. They retain however the thin shells and characteristic ornament of the true *nervosa* group and bear no sign of median sulcation. The Chemung forms show internal features that mark them as probably meriting subgeneric assignment.

EDENTULOUS LEPTOSTROPHIDS

Genus **AUSTRALOSTROPHIA** Caster, n. gen.

Clarke, 1913 (p. 286), described an abundant leptostrophid fauna from the Amazonas Devonian of Brazil under the name *Leptostrophia?? mesembria.* This species superficially resembles *L. tardifi,* as Clarke pointed out, but amazingly enough does not possess hinge crenulations in adulthood, although it may show signs of them in early ontogenetic stages. The Brazilian development is certainly of generic importance, as Clarke himself intimated by his generic interrogation. For the genus the name *Australostrophia* is proposed, with Clarke's species as the genotype. Clarke has shown the presence of tiny chonetid-like nodes near the extremities of the hinge line in the shell, which may be looked upon as one of the generic features. His original diagnosis is so complete that there is no point in abstracting his discussion here. The Colombian fauna shows, however, that his conclusion that all "austral" leptostrophids were of the *Australostrophia* type is, in the light of discoveries in northern South America, not satisfactory to-day.

A few observations on the paratypes of Clarke's, 1913, Brazilian Devonian material of *Australostrophia mesembria* in the New York State Museum follow:

Clarke's figures show the outlines accurately and his fig. 40 shows surface detail rather well, although it exaggerates unnecessarily the nodes on the varices, which are very prominent, but not nearly so abundant as his figures would lead one to suppose. Figure 40 also shows the varices disproportionately wide. The ornament is, however, very highly characteristic and quite unlike any "boreal" leptostrophid known to me. The hinge is, as Clarke insists, wholly without crenulations.

Clarke's figures 39 and 40 represent very well the ventral interior of this genus. Characteristic of the genotype is the prominent pair of hinge teeth, 2.5 mm. long, which diverge at approximately 90°. The large flabellate muscle scars are delimited by low ridges which extend from the hinge teeth, but are less elevated above the floor of the valve than the teeth. The anterior border of the muscles is usually not so distinct as Clarke's illustrations would indicate. A strong median septum separates the diductor scars. In a nearly perfect internal mold (paratype) having the general proportions of Clarke's figure 41, the septum is 13 mm. long, and extends posteriorly to the apex of the delthyrial zone, where it appears to split slightly. The septum is triangular in cross section and sharp above.

In the dorsal interior, as Clarke showed on his plate 22 (figs. 33-36), the structures are much reduced. There is a frail, sessile cardinal process which probably performed little if any articulatory function, since it is barely elevated above the hinge. The crural plates are short, low and diverge at about the same angle as the ventral hinge teeth. They are separated from the hinge by relatively deep dental sockets. The adductor muscles are shown on some of the paratypes in the New York State Museum to have been attached to small flabellate depressed zones about 3 mm. in length. These are located on either side of a postmedian low smooth platform which extends anteriorly in a trifid manner. The posterior undivided part of the platform is about 2 mm. in length and the extensions of about the same length. Each prong, middle and two lateral, is split anteriorly or at least medially excavated. This creates a very curious structure which may have served as attachment place of the adductors and also perhaps as incipient braceplates which were possibly homeomorphs of the Stützplatten of the Douvillinini. Clarke's figure 35 suggests faintly the two lateral branches of this median structure. The lateral prongs of the median process are usually slightly more elevated above the interior of the valve than the posterior portion, and may stand out, as in Clarke's figure 35, as dissociated knobs which are medially excavate.

Discussion of "austral" leptostrophids.—As indicated above, the differences between the Amazonian fossils described by Clarke as *Leptostrophia?? mesembria* and any Colombian-Venezuelan materials as yet known are of generic importance. Chief external difference lies in the absence of corrugations and presence of nodose striæ and concentric varices in Clarke's material. Clarke, 1913

(p. 289), reviewed the other "austral" species having the aspect of *Leptostrophia,* and concluded that crenulate hinges were up to that time unknown in South America. This is a view which in the light of Weisbord's, 1926, discoveries in Venezuela and the present abundant development of the group in Colombia, will no longer hold. It may develop, however, as Clarke supposed, that many of the specimens assigned to *Leptostrophia, Stropheodonta,* and *Strophomena* will turn out to be representatives of the retrograde and edentulous stropheodont stock, here assigned to *Australostrophia.* Others are certainly true stropheodontids and are discussed under that heading in this paper. *Stropheodonta argentina* Thomas, 1905, may be a *Leptæna* as Clarke, 1913, indicated, but I see no reason to urge that it necessarily *per se* requires Silurian age determination for the Argentine deposits. This view is fortified by the presence of a leptænid in the present Devonian fauna. Apparently the corrugated Leptostrophias (*Rhytistrophia*) of the northern Andes are an unique occurrence for South America. They are, moreover, apparently unknown elsewhere in the whole "austral" realm.

Orthis concinna Morris and Sharpe, 1846, from the Falkland Islands has the aspect of a holocrenulate *Leptostrophia,* as Clarke, 1913 (p. 285), wrote, and as Reed, 1903 (p. 169), agreed, the while astutely pointing out its close affinities with the "boreal" *Leptostrophia perplana* gens. Morris and Sharpe's material seems to belong in the *Protoleptostrophia* grouping, and likewise much of Reed's Bokkeveld material. Clarke, 1900 (p. 87), also identified this gens (*L. perplana*) from the Amazonas Devonian of Maecurú and Cuaru and did not specifically rescind the identification in his, 1913 (p. 289), pronouncement, cited above. Corrugations of the *Rhytistrophia* type are to be expected in the "austral" representatives of *Protoleptostrophia,* in keeping with boreal developments, but appear as yet not to have been recorded. I do not share Clarke's views on the close relationship between *L. concinna* (Morris and Sharpe) and *L. magnifica-L. tardifi* of the north.

The forms which Clarke considers Morris and Sharpe's species from the Devonian of San Juan, Argentina, in which the crenulations are restricted to the umbonal zone in maturity, are probably not congeneric. They seem to belong rather with the New Zealand form described by Allan, 1935 (p. 12), from the Reefton beds as *L. reeftonensis.* These are to my mind more likely brachyprionids than leptostrophids. The subumbonal, or at least much restricted, denticles as well as the shallow sinus and fold belong rather with a *Brachyprion* of a *Douvillina* relative than with *Leptostrophia.* Corrugations such as those on *L. reeftonensis* are not present on shells from the Falklands or Argentina, to my knowledge. I see no striking points of similarity between the New Zealand material and *L. magnifica* and congeners, which Allan stressed. I have, however, seen none of the Reefton material at first hand.

THE CORRUGATED LEPTOSTROPHIDS

Leptostrophid shells of leptænoid aspect are a characteristic part of North American Oriskanian and Onondagan faunas. They extend downward into the Helderbergian (home of the genotype), but are apparently not known in Erian or later faunas. The stock is derived from the *perplana* group, which also shows in a sporadic and incomplete degree this tendency toward corrugation of the shells. It is even possible that Conrad's original specimen of *Strophomena perplana* from the Onondagan, which he described as having obscure corrugations, was an immature individual of the form later described by Hall as *Stropheodonta beckii,* but in the absence of the types, it seems wisest to follow Hall's lead in the recognition of *L. beckii* as a distinct species, inasmuch as his material came from the Helderbergian, with which the Onondagan has few, if any, species in common.

Genus **RHYTISTROPHIA** Caster, n. gen.

Genotype.—*Stropheodonta beckii* Hall. Helderbergian.

The new genus *Rhytistrophia* is here proposed for the Devonian (Helderbergian to Erian) leptostrophids having regularly and prominently corrugated shells in the manner of *Stropheodonta beckii* Hall, the genotype (Helderbergian). It is not unlikely that the genus may descend into the Manlius and may range upward into the lower Hamilton faunas of some areas. The surface details of this genus are very similar to the more conservative member of the *perplana* group, above; *i.e.* they have regular rounded costellæ which are closely crowded and much wider than the interspaces. The radii are slightly irregular, or even obscurely nodose. Concentric varices are present, but usually not prominent. Strong lamellæ of growth are also occasionally present. The corrugations of the shell usually extend from hinge margin on one side to the other, but may be discontinuous. They are usually symmetrical folds.

Material in the U. S. National Museum from the Linden formation (Helderbergian) at Perryville, Tennessee, of an undescribed species closely allied to the genotype, shows the internal features of the genus very well. The hinge is incompletely crenulated, and in the Helderbergian forms, the crenulations usually reach less than half the width. The ventral interior shows the presence of the ventral process, but in the genotype only obscurely. In the undescribed species the whole posterior area is amalgamated into an elongate lozenge-shape platform. The paradental plates are well developed and nearly attain the palintrope. The angle of the plates is apparently of specific value. In the dorsal valve the cardinal process shows each prong to be bipartite, after the manner of true *Leptostrophia.* This characteristic is only faintly shown in the Colombian material. (*See* pl. 5, fig. 12.) The cardinal process is attached to an elongate triangular callus that extends along the palintrope for about the same distance as the hinge crenulations. The prongs of the process are usually triangular in cross section, and behind them is a callus which closes the notothyrium. The dorsal median septum is short, broad and attached to the posterior platform. The adductor muscles are bounded by roughtened callus ridges. The exposed dorsal palintrope is essentially linear.

Additional structural features of the genus are brought out under the description of the Venezuelan-Colombian species and Colombian variant, below.

Rhytistrophia caribbeana, var. **colombia** Caster, n. var. Plate 5, figs. 5-13; Plate 6, fig. 14; Plate 8, figs. 5-12; Plate 11, fig. 9

One of the most abundant brachiopods in the Colombian Devonian fauna is a typically corrugated stropheodont of general leptostrophid characteristics which seems assignable to the same species as the fragmental shell described by Weisbord, 1926, as *Leptostrophia caribbeana* from the Devonian of Venezuela. An abundance of material showing both external and internal characteristics makes it now possible to give a more thorough analysis of this interesting fossil, and offers the basis for designating the Colombian shells a distinct variety of Weisbord's species.

Shell large, thin, and prominently corrugated; semielliptical, semicircular or even on rare occasions subquadrate in outline. Hinge straight, sometimes slightly produced, usually is greatest width of shell; hinge commissure denticulate for entire width. Shells are ordinarily biconvex, or planoconvex. The ventral valve is, however, never ventricose or inflated, and the dorsal valve shows no evidence of ever being concave, unless to a very slight degree peripherally, although usually somewhat flatter than the ventral valve. Narrow, but definitely not linear, interareas are in both valves; that of the ventral being apsacline and somewhat higher than that of the dorsal, which is anacline. Delthyrium broadly triangular and apparently closed by a flattened plate.

Surface covered with regular threadlike elevated striæ separated from each other by rounded furrows of about equal width. The striæ are consistently wavy or undulatory, and show slight irregularities in thickness. They increase by intercalation rather than by bifurcation and each stria is posteriorly, near the source of origin, much more wavy than in its peripheral development. Concentric varices are very obscure over the main body of the shell, but may be detected on the postlateral zones. Even here they play no conspicuous part in the surface ornamentation. Entire surface rugose due to leptænoid concentric corrugations of some irregularity. There are usually from 10 to 14 prominent corrugations in an adult shell, but in some cases there are fewer. The radii tend to be best developed in the zones between corrugation crests. Corrugations increase in prominence anteriorly.

The internal features of the ventral valve, as judged from several internal molds, are dominated by large flabelliform and recessed diductor scars which are delimited postlaterally by pustulose calli, the portions of which adjacent to the muscle scars are elevated as strong ridges. These ridges are apparently formed as callosities in adult shells about the extensions of the dental plates. Posteriorly the plates are extended onto the inner palintrope surface. The diductor scars extend anteriorly for more than half the length of the shell, and sometimes for as much as two-thirds the length; the front margin of each scar is lobate, but the number of lobes varies. The scars are without sharp anterior limits. Each diductor scar is radially striate throughout and anteriorly ridged; sometimes in gerontic individuals there are three or four prominent carinæ or *muscle diaphragms,* separating the anterior lobes of each muscle seat. Posteriorly the diductor recess is continued onto the palintrope as rather sharply defined somewhat circular depressions underneath the fragile deltidium. These subdeltidial pits were probably recipients of the prongs of the cardinal process. Mesially the flabelliform diductors are separated by a well elevated septum and toward the rear by an elongate, fusiform expansion of the adductor scars. The adductor scars are elevated on a slight callosity above the plane of the diductors, in adult shells, and are faintly defined, especially laterally, in immature shells. In adult shells the diductor scars are postlaterally bordered by forwardly diverging extensions of the dental ridges which end in front at or near the place of greatest width of the scars. The dental ridges converge behind and continue on the inner palintrope surface (deltidial surface) where in some specimens they apparently meet on the commissure plane. In either case, they stand up from the hinge plane as articulatory knobs which fit into sockets of the dorsal valve on either side of the cardinal process. These are probably the homologues of a ventral "process" described by Hall, 1867 (p. 78), for *Stropheodonta demissa,* genotype of *Stropheodonta.* All ventral valves at hand show these internal dental buttresses. The posteriorly bordering carinæ may converge toward the rear at the palintrope angle and therefore be accessory structures, possibly the scene of attachment of the posterior adductors and of separate origin from the true dental plates. Specimen 5149 (pl. 11, fig. 9) indicates this possibility on the internal mold. In no case is a conspicuous pedicle pit formed by the dental plates. The adductor scars are divided by a central deep narrow slash which extends to the front margin of the adductor zone. On either side of the slash are posteriorly diverging ridges which meet at its end to form the median septum between the diductor scars. The septum has its greatest elevation near the middle of the shell in gerontic forms and becomes evanescent before the front margin of the diductor zone is attained. In ephebic individuals the median septum is a structure of the posterior third of the shell. In some individuals the adductor zone occupies most of the posterior, or umbonal recess. The postlateral portions of the shell interior are thickened by callosities and bear many coarse granulations which decrease in size anteriorly. The shell corrugations show clearly on the interior, and likewise the surface radii, especially in the peripheral zone. Ventral valves are, however, much thicker than the dorsal ones and therefore the surface structures tend to show through less distinctly. Several shells bear prominent discontinuous radial grooves or scratch-like markings on the interior which are most deeply incised on the parts which correspond to the crests of the surface corrugations. The palintrope is thickest toward the axis and the hinge crenulations which extend across the entire commissure surface are best developed in this zone where they are longitudinal ridges. Toward the apices of the hinge the denticles become mere pointed elevations. Each crenulation is extended on the palintrope exterior as an elevated carina, only slightly less prominent than the commissure denticulations, thus giving the cardinal area, of the ventral valve at least, a vertically striated exterior.

The dorsal interior shows equally characteristic markings, the most prominent of which are the adductor muscle seats and strong bipartite cardinal process. The muscle scars are narrower than in the ventral valve, and more pronouncedly delimited postlaterally by pustulose callosities which extend from the base of the cardinal process anterolaterally for about three-fifths the length of the shell in this direction. The contact of the adductor seat and the callosities is essentially vertical and shows a difference of elevation usually exceeding a millimeter. The callosities begin to disappear toward the front of the shell near the anterolateral terminus of the muscle seats, and the postlaterally do not attain the hinge zone. The general plane of the adductor scars rises above the floor of the valve toward the front. The posterior adductors are about twice as large as the anterior ones and lie as elongate, outwardly encircling arcs which are covered with faint arborescent markings. The zone adjacent to the anterior adductors is elevated in an elongate swell. Toward the rear the posterior adductor seats are circularly bordered by the meeting of the explanate bases of the anteromesially converging process extensions and the bases of the delimiting callosities. The anterior adductor scars lie along side the prominent mesial ridge formed by the union of the convergent process extensions. They too are crescentic in outline and extend forward as attenuated lines on either side of the mesial carina a little beyond the posterior adductor scars. They are also covered with arborescent longitudinal grooves and ridges. The boundary between the two pairs of adductor scars is relatively sharp, the anterior ones being on a slightly lower plane (*i.e.* more recessed) than the posterior ones. The cardinal process consists of two strong and only slightly diverging pillars which rise nearly vertically from the posterior subumbonal callosity and are recurved behind so that the two termini overhang the palintrope and extend a slight distance into the umbonal cavity of the ventral valve, where they may rest against the posterior wall. The pillars of the process are braced as long as they are in the dorsal valve by narrow posterior buttresses between them and the inner surface of the palintrope, apparently forming inner thickenings along the notothyrial area. Basally the two prongs of the process are separated by an excavated area of about the same width as each pillar. Low, broadly rounded, descending extensions from the base of each pillar converge a short distance in front of the process to form a low, rounded mesial ridge which separates the adductor scars. At about the same radial distance forward as the vertical bounding ridges extend, the central ridge is bulbously expanded in the center of each anterior adductor arc, and abruptly narrowed toward the front where it continues as a sessile acicular extension several millimeters beyond the muscle zone to the edge of the pustulose pallial region.

No true teeth have been observed in the ventral valve. The median stropheodontid ventral "process" is well developed. The two small knobs rest in shallow sockets *between* the two prongs of the cardinal process, rather than on either side, for the knobs are so close together, and so often fused into a miniature process-like overhang in the ventral valve, that they must needs articulate between the widely spaced pillars of the process. There are, however, postlateral depressions at the base of each process pillar which certainly have the aspect of sockets, though no counterpart structures have been seen in the ventral valves.

The posterior three-fifths of the shell is internally pustulose and essentially without evidence of surface corrugations, presumably due to a mantle of secondary calcification in the pallial region. The peripheral zone of the shell shows internally the prominent surface corrugations and also the surface radii very clearly, which is in contrast to the ephebic condition of the ventral valve. The hinge surface rises but slightly above the inner surface of the valve, although the palintrope is externally about 3 mm. high at the beak. The umbonal cavity is filled by pallial deposition in the adult stage. The denticular fossettes are the negatives of the denticles in the ventral valve. Dorsal palintrope are without vertical striæ in all specimens observed.

As shown on plate 8, fig. 7, the corrugations of the shell in this species begin at an early ontogenetic stage. Wherever observed, the nascent corrugations are less regular than they are in their later state. Plate 8, figs. 8-11, shows the early stages of the massive median septum and posteriorly conjoined strong crural plates, which in the ephebic stage are largely obscured by a great amount of secondary callus material. At this early stage also, the hinge extremities seem nearly always to be rounded. The hinge crenulations are much coarser and fewer in number, although extending the full hinge length, than in adulthood. While it is presumable that these small shells represent a juvenal stage, they may in truth be a distinct species or variant. The very strength of the crural process in shells so small strongly suggests maturity. The absence of shells of intermediate size also fortifies this surmise. For the nonce, however, I consider them all as one species.

Dimensions.—The following dimensions in millimeters are taken from internal and external molds.

	5417	5418*	5419	5420*	5421†	5436
Length shell	21	32	29	26	25	35
Width shell	39	44	25	36	46	40
Umbonal height shell	1.5		2.5			2
Length median septum	10		15		14	8
Width muscle area	13		20		10	18
Length adductor scars	6		5.5			6
Width adductor scars	4.5		3			4.5
Width cardinal process					4.5	
Height cardinal process					2	
Diameter visceral zone					16	
No. strong corrugations of the shell	10	13+	6+	14	7-8	15

Discussion.—Internal characters in these shells seem to be of greatest generic value. Of these, the accessory carinæ or ridges which delimit the ventral adductor muscles posteriorly are important. These may have been occupied by the posterior set of adductor muscles. Also important are the strongly developed mesial "ventral process" plates of which the "accessory" ridges probably are the extensions. The apparently degenerate condition of the teeth, prominent development of the dental plates and crowding of the "accessory" plates on the internal palintrope wall to form a set of parallel, or upwardly converging "teeth" which overhang the hinge like a miniature, mesially split, ventral process, is rather unusual. The presence of lateral pit-areas on either side of the process in the dorsal valve, which are apparently not occupied by teeth from the ventral valve, and of a dorsal subumbonal pit into which the median "ventral process" fits is also characteristic. The "boreal" expression of the *L. beckii* gens does not seem to possess these characteristics. The "austral" representatives do not have a tiny, subumbonal pedicle pit which is one of the indicial characters of the genotype. In the Colombian material the dental extensions do not converge so obtusely as to appear like a transverse bar connecting the bases of the lamellæ as they do in *L. beckii.* The elongate lozenge-shape area formed by the intersection of the opposedly divergent "accessory" carinæ and low ?dental ridges which unite to form

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* External mold.

† Dorsal valve.

the mesial ridge may be the homologue of the pedicle pit in the "boreal" forms. The posterior buttresses of the cardinal process between the pillars and dorsal palintrope wall also appear to be unique features of the South American material. Clarke's species *Leptostrophia?? mesembria* (genotype of *Australostrophia*) has a somewhat similar cardinal buttress and dorsal musculature, but is edentulous and without the corrugations of the present form.

The Colombian representatives of *R. caribbeana* (Weisbord) appear to have fewer, more widely spaced prominent corrugations than topotypic material. The Venezuelan type is a fragment, however, of uncertain orientation and shows only external features. This specimen has about 16 prominent ridges whereas our material usually has about 12 to 14. His specimen indicates a more circular outline than any of our specimens show; a more nearly equal length and width. Weisbord reports that the striæ of the Venezuelan specimen increase by bifurcation, but the Colombian material shows definite intercalation instead. This may have been inaccurate observation, for many of the earlier described species having intercalation of new striæ were reported to increase by bifurcation. Examination of Weisbord's type substantiates this surmise.

The differences existant between the Colombian-Venezuelan material and the "boreal" *Rhytistrophia beckii* have already been brought out in the discussion. That the two groups are of common descent seems rather clear. The closest resemblance seems to occur between our shells and Helderbergian forms in the Appalachian province. *R. beckii,* var. *tennesseensis* (Dunbar) 1920 (p. 129,), from the Birdsong shale of Tennessee has a much larger, more circular shell than the South American fossils. It has moreover many more undulations on the surface and these are far more irregular and discontinuous than on any of the "austral" material.

Types.—Holotype: Pal. Res. Inst. No. 5421, an internal mold of the dorsal valve, but of equal importance for generic characters are the paraytpes 5417, 5419, and 5436, which are ventral inner molds. Additional paratypes: Nos. 5417A, 5418, 5420, 5421A-C.

TRUE LEPTOSTROPHIDS

The genus *Leptostrophia, s.s.,* must be taken as the basis of comparison for the tribe Leptostrophiini, and therefore establishes what is meant by "true leptostrophids." It is perhaps unfortunate that so striking and obviously phylogerontic a species as *Leptostrophia magnifica* should have been selected (Schuchert, 1897) as the genotype of the Hall and Clarke genus, for by so doing, the more protean forms, such as the protoleptostrophids, are atypical. It seems to me that *Leptostrophia, s.s.,* as determined by the genotype and congeners in the Oriskanian and homotaxial equivalents elsewhere is a byproduct rather than a phylogenetic stage in the history of the later species.

Genus **LEPTOSTROPHIA** Hall and Clarke, *s.s.*

As determined by the genotype, *Strophomena magnifica* Hall, from the Oriskanian, *Leptostrophia* is seen to be a very specialized and stratigraphically restricted group of shells, most of which are of gigantic size. The collections in the New York State Museum, U. S. National Museum, and University of Cincinnati Museum are the source of material here presented on the genotype of *Leptostrophia.*

The shells are large, and plano-convex, but in some cases the dorsal valve may be slightly concave. The shell material is relatively thin for the size of the shell. The surface is ornamented with closely spaced rounded radii which increase principally by implantation. There are ordinarily present also relatively prominent concentric varices which are strongly developed in the interspaces between radii, but usually are not visible on the crests of the radii themselves. This interrupted reticulation is not visible on all shells, and may prove to be a specific feature, especially of the genotype in the Oriskanian. The palintropes are very well developed in both valves, and are vertically cordate, the cords being the edges of plates whose ends on the commissure plane form the hinge crenulations in the ventral valve, and pillars between sockets in the dorsal valve. The palintrope wall is relatively thick.

Internally the ventral valve exhibits some of the most striking generic features. The delthyrium gives the impression of being agape, but it is apparently always closed by a deltidium which is extremely concave, and over the external surface of which the pedicle possibly functioned as in a trough. The concave deltidium extends internally for some little distance in front of the palintrope, and by the deposition of secondary lime beneath, creates the impression of a sort of "pseudospondylium" in the ventral valve. This grooved delthyrial filling is mesially ridged as though it were composed by the lateral outgrowth of paradeltidial material rather than by the formation of a single plate. It is also marked with concentric varices. The pedicle groove-plate apparently covers the ventral process. This presumably partially contributes to the lime filling beneath the plate which creates the pseudospondyloid appearance. The hinge is usually crenulated for nearly its full width. Although the cardinal process is a ponderous structure in the dorsal valve, the secondary calcification in the subumbonal portion of the shell fills the process cavities which are so well developed in the protoleptostrophids. The articulation of the two valves is very slight, as the almost universal dissociation of the fossil valves would indicate. There are neither hinge teeth nor dorsal sockets, although there are carinæ which may correspond to socket ridges in the dorsal valve. The diductor muscles are enormous, flabellate, and may reach to near the front margin of the shell. The muscles were apparently separated into strands, for the scars have well developed radial septa ("muscle diaphragms") subequal to their length. The scars are bounded laterally by callus ridges, which occasionally rise quite high above the surrounding callus deposit. These structures are apparently paradental ridges as in the other leptostrophids. The front margin of the muscles is without definite delimitation. The adductor muscles were attached to elongate lenticular zones on either side of the median septum. In some cases the anterior adductors are slightly more elevated than the posterior. The median septum is usually present, but seldom well developed. It extends from near the front margin of the pedicle groove to near the front edge of the diductors.

The dorsal interior is similarly highly specialized. The process is a ponderous device which rises as subparallel columns from the posterior callus. The prongs are elongate trigonal in cross section and apparently grooved above. They barely overhang the hinge. On either side of each prong of the process is a subsidiary ridge which in some cases is very prominent. These give the process a curious tetrapartite appearance in gerontic forms. The subsidiary plates are probably specialized, albeit nonfunctional, socket plates. The notothyrium is closed by a subangular convex callus, or chilidium, which appears to fit, at least at the apex, into the concave deltidium. The chilidial callus extends within the shell as a short acute growth between the prongs of the process in some shells. The posterior callus is subtriangular. Buttresses reach from the front of the process to encircle the adductor scars postlaterally. The adductor scars are elongate-ovate depressions which diverge only very slightly. Between them lie, on either side of the median septum (a variable structure), the posterior diductor scars which are relatively enormous, elongate roughened zones which in some shells are almost twice the length of the adductors, and may nearly attain the front margin of the shell. In the genotype there are additional anterior adductors in the form of irregular roughened mounds just in front of the adductor scars, and not reaching so far forward as the posterior scars. This condition is variable in allied species. The median septum in the genotype is very well developed as a blade-like carina separating the middle portion of the posterior diductors, but not attaining the posterior platform. In allied forms, the median septum is strictly leptostrophiid as in most of the tribe where it originates at the posterior platform, and extends as a blunt and stubbed spine about as far forward as the adductor scars. Most adult shells of the genotype show a well developed peripheral callus on the inside of the dorsal valve. This is in some cases a very striking ridge.

There are apparently several species lurking under the name of the genotype in eastern American deposits of Oriskanian age. *Leptostrophia magniventra* (Hall) is a ventricose relative of the genotype which shares most of the essential generic characters. *Leptostrophia explanata* (Sowerby) of the lower Emsien apparently occupies the same environmental niche, but is a separate generic strain, albeit not distantly removed from *Leptostrophia,* *s. s.* No South American representatives of this genus in the strict sense are known as yet. Certain fragments in the Colombian faunule offer a basis for expecting its eventual discovery there. This group will be taken up in more detail in a subsequent paper.

Subfamily **STROPHONELLINÆ** Caster, new

The subfamily *Strophonellinæ* has been proposed, above, for most of those *Stropheodontidæ* which are resupinate in their shell orientation. The following genera and species-groups are clearly recognizable:

Amphistrophia Hall and Clarke, 1892, *s. s. Strophomena striata* Hall, genotype. Niagaran.

?Pholidostrophia Hall and Clarke, 1892.* *Stropheodonta nacrea* Hall, genotype. Devonian.

Strophonelloides Caster, new. *Stropheodonta reversa* Hall, genotype. Upper Devonian.

Chemungia Caster, new. *Stropheodonta cœlata* Hall, genotype. Chemung, Upper Devonian.

Strophonella Hall, 1879, *s. s. Stropheodonta? semifasciata* Hall, genotype. Upper Silurian.

Principal Species-Groups in Strophonella, s.s.

A. American and European differentially corrugated forms, *e.g. S. jamesoni* Reed. Silurian.
B. Regularly corrugated strophonellids, *e.g. S. leavenworthana* (Hall), Helderbergian.
C. American and European forms of the *S. williamsi* Kindle and Breger type. Silurian.
D. Group having the surface ornament of *S. continens* Clarke, gens. Principally Oriskanian.
E. Group having subangular and fascicular plicæ, *e.g. S. ampla* (Hall). Helderbergian-Ulsterian.

It now seems very probable that at least three tribes are represented in this list of genera. The pholidostrophids, if they are genetically related at all to the strophonellids with which they are customarily considered, certainly constitute a separate line of evolution from the other generic stocks, and would merit at least tribal distinction. *Pholidostrophia* is not resupinate, and shows other non-Strophonellid characteristics. My present inclination, subject to further evidence before crystalizing, however, is that the genus *Pholidostrophia* as now used really embraces several generic groups, and should be given *subfamily* ranking on a par with the Stropheodontinæ and Strophonellinæ. Aside from men-

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* Not resupinate.

tion in the key below, the pholidostrophids will not be discussed at this time. The amphistrophids are apparently a tribal group, possibly including several undescribed genera, which occur principally in the Silurian. They seem to be quite apart from, albeit possibly ancestral to, the main line of strophonellid development. The third and largest group would center around the genus *Strophonella* and would include as a nucleus the last eight items on the foregoing list. Possibly the two holocrenulate genera would also constitute a tribe. Definite proposals in line with these intimations must await opportunity to study more fully American and especially European collections. A structural key to the genera and groups recognized at this time follows:

Key to the Principal Genera and Species-Groups of the Strophonellinæ

A. Shells nacreous, without radial ornament; not resupinate.................... *Pholidostrophia* Hall and Clarke.

AA. Shells not nacreous; with radial ornament; resupinate.

- B. Hinges only partially crenulated.
  - C. Hinge crenulations restricted to a small triangular plate adjacent to the partially open delthyrium; ventral adductor muscle scars elongate ovate, and ordinarily not completely encircled by paradental plates. Shells of relatively small size .... *Amphistrophia* Hall and Clarke (incl. *Strophoprion* Twenhofel).
  - CC. Hinge crenulations occur on elongate plates which usually reach for nearly half the width of the hinge or even a little further; delthyrium closed, or secondarily opened; ventral muscles flabellate, and completely encircled by the paradental plates and callus ridges. Shells usually of large size.
    - D. Surface of shell relatively regular; radii fine and of the alternating type, in usual proportion of 3 or 4 to 1; hinge less than half crenulated................................ *Strophonella* Hall, *s.s.*
    - DD. Surface of shell variable, may be regular; radial ornament variable; hinge half or more than half crenulated, but not holocrenulate.
      - E. Alternating type of radii; surface differentially corrugated in a "seersucker" manner................ Group of *S. jamesoni* Reed.
      - EE. Regular, non-alternating type of surface radii (or at least usually of this type); surface regularly, concentrically corrugated in a leptænoid manner ...... Group of *S. leavenworthana* (Hall)
      - EEE. Surface not corrugated either differentially or concentrically to any appreciable degree.

F. Surface ornament comprised of very widespaced principal costellæ between which occur large numbers of fine costellæ. No regular concentric varices........................ Group of *S. williamsi* Kindle and Breger.

FF. Surface ornament fasciculate, or subfasciculate, not conspicuously of the alternating type. Concentric varices may be well developed.

G. Surface ornament subfasciculate; concentric varices present and in closely spaced series. Shells of moderate size, not pronouncedly transverse in most cases........................ ....Group of *S. continens* Clarke.

GG. Surface ornament strikingly fasiciculate, or schuchertelloid; shells tending to huge size, and transverseness ....Group of *S. ampla* (*Hall*).

BB. Hinge holocrenulate or nearly so.

H. Shell substance thick, ponderous, lamellose, only faintly sulcate; radii fasciculate; shells of moderate size............................... *Strophonelloides* Caster, new.

HH. Shell substance normal, not thick, lamellose or ponderous; shells strongly sulcate; radii simple, regular and equally spaced; size large........................ *Chemungia* Caster, new.

Genus **AMPHISTROPHIA** Hall and Clarke, 1892, *s.s.* (including **STROPHOPRION** Twenhofel, 1914).

The characteristics of this genus, determined by typical examples of the genotype *Strophomena striata* Hall, from the Niagaran in the U. S. National Museum, New York State Museum, and the University of Cincinnati Museum, are very different from those of many of the later species usually assigned to this genus. The shells of all the species I have examined which seem definitely assignable to this genus, *s.s.*, are small to medium size. They are moderately resupinate, but may be pronouncedly so, being in some related species even strikingly geniculate. The surface radii are very fine and alternately costellate, with several different types of detail included under the genotype. The hinge is only very slightly crenulated on triangular plates on either side of the delthyrial area. The crenulation plates can be seen very distinctly to overlie the palintrope wall, and are separated from it by a stria or groove. This plate rises above the hinge in all observed specimens. The delthyrium is primitively open, or only partially closed at the apex by an outwardly convex callus. The interior of the ventral valve is without cardinal teeth, unless it should develop that the crenulation plates are themselves the homologues of such structures. There extend from near the inner palintrope wall for the full length of the diductor muscles outer bounding carinæ of callus origin. These are apparently paradental plates such as occur in the Stropheodontinæ. In the genotype the diductor muscles are not delimited in front, but in closely related species they may have a very faint anterior ridge setting them off. The ventral process is obscure in the genotype, but a very delicate spearhead terminus to the well developed median septum probably represents the homologue of this structure in the stropheodonts. The median septum while simple in *S. striata,* forks anteriorly in related species (possibly a generic character). The dorsal valve bears a weak cardinal process, and a faint posterior muscle platform.

The genus *Amphistrophia* has ovate, not flabellate, ventral muscle scars. They are not delimited by plates or callus. The hinge in this genus, as well as *Strophonella,* is incompletely crenulated, as is brought out below, but in *Amphistrophia* the crenulations are limited to a very few on a triangular plate on either side of the delthyrium, whereas in *Strophonella* they extend for a greater distance along the hinge, on a more evanescent plate.

The genus *Strophoprion* Twenhofel, 1914, is apparently almost precisely a synonym of Hall's and Clarke's *Amphistrophia,* as Holtedahl, 1916, and McLearn, 1924, have pointed out. The genus was seemingly introduced without examination of the genotype of *Amphistrophia* and with the picture in mind of many of the later forms usually assigned, apparently quite erroneously, to that genus. *Amphistrophia* was proposed by Hall and Clarke, 1892 (p. 292): "Should it be considered useful to recognize the incipient and progressive features of the species *S. striata* and probably *S. patenta* toward a full manifestation of generic characters, and distinguish them from *Strophonella* in its more mature condition of development, the term *Amphistrophia* may prove expressive of their apparent double relationships as shown in the young and mature shells." The type species was further described by them as "a reversed *Brachyprion,* bearing precisely the same relation to *Strophonella* in its fuller development as that group does to *Stropheodonta.*" Twenhofel's brief analysis of his genus is almost precisely that of Hall and Clarke for *Amphistrophia.* Furthermore, Twenhofel's genotype, *Strophomena geniculatum* Shaler is very closely allied, in my estimation after examining specimens in the U. S. National Museum from the Anticosti fauna, to *Strophomena striata* Hall, genotype of *Amphistrophia.* It is highly questionable if there are any supplementary features in Shaler's species on which a separate genus might be construed. Actually, of course, the genus *Strophoprion* is also at least philosophically a synonymn for *Strophonella, s.s.,* since here again is found a partially crenulated hinge, rather than a holocrenulate one such as Twenhofel postulated. I am not in accord with Holtedahl's opinion, 1916 (p. 64), that the absence of an anterior bounding ridge in front of the ventral diductor muscles is of no generic importance, for it seems to be of as much importance in the Strophonellids as in the Stropheodontids, where several genera seem justified chiefly on this criterion. Apparently the closing of the anterior diductor scars in the Amphistrophids came principally in the latest Silurian in North America. Currently however, no additional generic groups are being proposed in the Amphistrophids although several seem undoubtedly to be present, both in North America and Europe.

Genus **PHOLIDOSTROPHIA** Hall and Clarke, 1892

The genus *Pholidostrophia,* based on *Stropheodonta nacrea* Hall, as mentioned above, presumably is a very distinct development of the crenulated Strophomenacea and quite possibly deserves a separate family or subfamily ranking. That several generic lines are represented in these curious shells seems patent after only a cursory examination of the group. The current use of the generic name is far too broad, it seems, and even the specimens assigned to the genotype possibly embrace more than one genus, not to mention several species.

Genus **STROPHONELLA** Hall, 1879, *s.s.*

The genus *Strophonella* Hall, as determined by the Upper Silurian genotype, *Stropheodonta? semifasciata* Hall, is of quite different aspect from that commonly presented by species assigned to it. This brief discussion of the genus is based on genotypic material from the Silurian, principally Waldron, in the collections of the U. S. National Museum, New York State Museum, and University of Cincinnati Museum. It is found that the shells truly assignable to the genus are for the most part of large adult size, imperfect crenulation (usually not more than half of the hinge length) and with alternating costellæ (genotype). In fact, complete crenulation of the hinge presumably did not occur in the strophonellids to any marked degree until Upper Devonian times. (*See Chemungia* and *Strophonelloides,* below.) The ventral interior of the genotype shows very large, flabellate, albeit posteriorly pedunculate, diductor scars which are bordered their entire margin by callus ridges. These are presumably in part at least paradental. The median septum is present, but not ordinarily prominent. The adductor muscles occupy a large lenticular medial zone and are defined quite distinctly. The hinge crenulations number 25 or 30 or even more, and are attached to a plate superposed on the palintrope surface, apparently much as in *Amphistrophia,* but it does not so conspicuously overhang the hinge. The delthyrium is closed by a convex plate or callus, and no hinge teeth are known. A median ventral process is present and also a pedicle pit between the anteriorly fused prongs of the process. In the dorsal valve the musculature is usually obscure, and restricted subumbonally to a small zone. The process is sessile, and made up of two posteriorly directed tear-shaped (cross section) columns which very slightly overhang the hinge. Their upper surfaces are roughened. No definite cavity for their reception in the ventral valve has been observed. The interiors of both valves in the genotype have regular radial lines of pustules; there usually being two such radii between the primary corrugations of the shell.

There are several lines of development within the genus *Stro-*

phonella, as the preceding list would indicate. These lines will probably be found to merit subgeneric if not generic rank when the study now under way is completed. Only briefest mention of some of the structural features involved can be made at this time and place. It now appears that nearly all the lines are anticipated by occasional variants within the Silurian genotype. When these variations subsequently crystalized into consistency they apparently merit generic recognition. Brief discussion of some of these groups follows.

A.—In the Clinton and Niagara strata of North America and the middle Llandovery of Scotland, and probably elsewhere, are strophonellids of the type of *S. jamesoni* Reed (Llandoverian) which show differential corrugations of the shell in conjunction with alternate type of costellation (microplication) which recalls the Devonian development in the Stropheodontinæ, herein generically differentiated as *Cymostrophia.* The Llandoverian species shows striking convergent corrugations of the shell adjacent to the hinge, and differential corrugation linked with varices over the remainder of the shell. Foerste, 1917 (pl. 9, fig. 4) has illustrated, without naming, a similar although specifically distinct development from the Cedarville dolomite of Ohio. The Oldham limestone of Brassfield, Kentucky, has also yielded similarly corrugated strophonellids, not yet specifically described. The hinge crenulations in these forms are apparently very few, as might be expected in antecedent byproducts of strophonellid development.

B.—The *Strophonella leavenworthana* (Hall) development in the Helderbergian is possibly derived from the Silurian differentially corrugated forms, but more likely is a separate direct development out of the *Strophonella* stock. Here several species are apparently included in the widely distributed forms assigned to the Hall species, and in all likelihood, a line as distinctive as the *Rhytistrophia* one in the Stropheodontinæ is here involved. The corrugations are in the leptænoid manner, and very often the shells attain a striking resemblance to the pronouncedly geniculate form of *Leptæna.* This type of Strophonellid is common in the St. Alban beds of Gaspé Peninsula.

C.—What value is to be attached to the specialized condition found in *Strophonella williamsi* Kindle and Breger, 1904, from the Niagaran, is questionable. Here we find an extraordinarily wide spacing of the principal costellæ with a great number of fine ones between. There is also a very striking bulbous ventricosity of the dorsal valve in most instances, coupled with internal differences from *Strophonella, s.s.* It now appears that *Amphistrophia podolica* Kozłowski, 1929, from the Polish Silurian is a European equivalent of the American development. Apparently the maximum development of this line occurs in the West Point Silurian on the Gaspé Coast (near Port Daniel), several fine specimens of which have been seen in the U. S. National Museum.

D.—The development of *Strophonella continens* Clarke and varieties and congeners of specific value in the Oriskanian, is another noticeably distinctive line. Here, as Clarke has so well shown, is still found the incomplete hinge crenulation. This was the principal basis for Clarke's assignment of the species and allies to the genus *Amphistrophia.* Also present in *S. continens* are well developed plates on which crenulations occur overhanging the hinge on either side of the delthyrium. Here again the species recalls *Amphistrophia.* Crenulations occur, however, in addition for a considerable distance out from these plates toward the hinge termini. Concentric ornament is well developed in this group, as Clarke's figures bring out. A Colombian representative is discussed below.

E.—Apparently closely allied in some respects to the *S. continens* line is a large number of species centering around *S. ampla* (Hall), found from the Oriskanian into the Onondagan, characterized by a fasciculation of the radii, which are not of the alternating type found in *S. continens.* Corrugations of the shell may occur in the *S. ampla* group along the principal costellæ, as they do in the preceding one. *S. punctulifera* (Conrad) apparently belongs here, where it may possible represent a subordinate line of specialization. The largest known strophonellids, occurring in the mid-western Onondagan (and Hamilton?), belong to this group.

That there are European representatives of most of these lines is well shown by almost any collection of Silurian and Devonian fossils from abroad, and abundantly so by the works of Davidson and Barrande.

Genus **STROPHONELLOIDES** Caster, n. gen.

This genus, based on *Stropheodonta reversa* Hall of the Hackberry (Upper Devonian), is the first of two holocrenulate genera of strophonellids and these alone, so far as known, are the only ones so characterized. The genotype of *Strophonelloides* shows clearly the effect of a lime-charged environment, much as does the genotype of *Sulcatostrophia*, also from the Hackberry. Quite aside from these monstrous features of excess calcification, the genotype shows holocrenulation, lamellate and very heavy shell structure, fascicular and non-alternating radii, a prominent internal *ventral* peripheral callus which bears mesially at the front a deep groove for receiving an anterior dorsal septum of callus material. The ventral interior shows well developed median teeth which slightly overhang the hinge behind to interlock between the prongs of the cardinal process. These are accessary structures not observed elsewhere in the crenulate-hinged brachiopods. The ventral process equivalent is also well developed as the posterior v-shape boundary of the pedicle pit. Short hinge plates are present beneath the deltidium, and on either side of the accessory "process" and seem to be the equivalents of the amphistrophid crenulated plates, although here they are *sans* crenulations. The hinge is, however, crenulated from the boundary of the delthyrial zone to the extremities or nearly so in all shells of the genotype and related species and variants. The dorsal valve shows a prominent sessile cardinal process with a pair of pits between the prongs for the reception of the accessory "process" in the ventral valve. The anterior median septum is much elevated on a callus platform toward the center of the shell. This is in some cases nearly spinous in its great elevation. *Strophonella hybrida* (Hall and Whitfield) and var. *ponderosa* Fenton and Fenton, are Hackberry representatives of the genus.

Genus **CHEMUNGIA** Caster, n. gen.

The Chemung (Upper Devonian) shells described by Hall as *Stropheodonta cœlata* are closely allied to *Strophonelloides,* above*.

The new generic name *Chemungia* is proposed for *S. cælata* Hall, genotype, in order to call attention to real differences which may prove to be, however, of subgeneric value. *Chemungia* is ordinarily in adulthood a much larger brachiopod, with a prominent fold and sinus usually well developed. Fold and sinus are obscurely present on most *Strophonelloides* also. The surface ornamentation of *Chemungia* is much more regular, being made up of evenly spaced, elevated costellæ, which show no tendency toward fasciculation. The shell is one of moderate thickness and never lamellate. The hinge is holocrenulate, or very nearly so.

The ventral interior, while resembling that of *Strophonelloides,* fails to show on the commissure plane the plates which I have compared with crenulation plates, above. The accessory "process" is present, however, and very strongly developed in some individuals. The sockets for the reception of this "process" between the prongs of the cardinal process are well developed in the dorsal valve. Ventral process-pits are also present in this genus. In the dorsal valve, the prongs of the cardinal process are very often crowded by the ventral "accessory process" to a transverse orientation, so that they appear as rather widely separated socket plates rather than as a bipronged process of the usual ilk.

Genus **STROPHONELLA** Hall, 1879

Genotype.—*Stropheodonta? semifasciata* Hall, 1867. Middle and Upper Silurian.

Strophonella meridionalis Caster, n. sp. Plate 4, fig. 10; Plate 8, figs. 16, 17

The shell is very large, transversely semicircular in outline; length two-thirds width of hinge; hinge essentially straight and slightly produced at the angles, which are rounded; anterior mes-

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* Before final evaluation of the systematic import of the characteristics separating *Chemungia* and *Strophonelloides* can be made, the problem of the value in taxonomic work of relatively stable, although clearly environmentally-induced characters must be taken up. The present genera have a common heritage, and owe their structural differences, in a very large degree, to quite dissimilar facieological settings. The differences which each consistently maintains, are, however, certainly of generic ranking, and to me seem worthy of recognition in the manner here proposed.

ial commissure broadly and shallowly deflected by a low anteriorly expanding fold or swell. The shell is resupinate; posterior umbonal region convex, middle half concentrically concave and peripheral third pronouncedly downturned. Palintrope mesially slightly elevated, essentially orthocline in life position, thus creating a very sharp posterior angle. Beak extends about 2 mm. further to rear than the general hinge line.

The external surface of the palintrope is finely vertically striated and the hinge margin appears to be denticulate in the vicinity of the beak. Delthyrium closed by a flat or only slightly arched plate. The surface ornamentation consists of regular and prominent elevated and subangular costellæ which are of more or less nodose or subserrate and of subequal strength. The radii increase by intercalation and tend to become somewhat more closely spaced on the lateral posterior regions than elsewhere. The interspaces between radii are arcuately excavate and usually are from two to three times as wide as the bordering radii. There appear to be about 14 primary ribs on the earliest striate part of the shell. These seem to bifurcate soon after the point of initiation, but all other ribs are definitely intercalary. There is no evidence of a secondary system of radii on the specimens at hand, although there is good evidence of a very fine set of concentric striæ which show best with a hand lens in the excavate zones between radii. They seem to be best developed on the outer half of the shell. On the downflexed peripheral zone an intercalary series of costæ originate, essentially all at the same growth stage, and thus for a short distance gives the impression of an alternating series of coarse and not quite so coarse costellæ. In the lateral regions this condition continues to the commissure.

Dimensions.—Hinge width about 60 mm.; mesial length about 40 mm.; posterior median height of palintrope about 3 mm. The radii are a little less than 1 mm. apart on the median part of the shell, there being about 12 fully developed costellæ in 10 mm. at a point about 15 mm. in front of the beak. There are about 13-14 costellæ at the same radial distance from the beak on the postlateral slope.

Discussion.—It is clearly impossible to identify most of the stropheodontids generically on external characters alone. While it is not unlikely that this generic group has been recorded previously under another name from the South American Devonian, seemingly this is not so. Certainly none of the forms listed as *Stropheodonta* has the aspects of this fossil, and none of the *Strophomena* listed in the early reports is congeneric. Most similar shells are apparently the "*Amphistrophia*" *continens* group which Clarke, 1908 (pp. 195-197, pl. 40) described from the Grande Grève limestone of the Gaspé. Of the three varieties described by Clarke, the present material recalls most closely "*A.*" *continens*, var. *senilis,* especially in strophomenoid contour, prominent resupination, broad mesial fold, and in the radial regularity of the subangular costellæ. The Gaspésian representatives have much more angular riblets, and slightly more prominent concentric varices, best shown in the radial intercostal spaces. In *Strophonella ampla* from the New York Onondaga and Schoharie formations (*e.g.* Hall and Clarke, 1892, pl. 12, figs. 13-15), the serrate or irregular crest of each riblet of *S. meridionalis* has a rough counterpart. In both the New York and Gaspé material the ribs are sharper than in our material. See also discussion of *Strophonella floweri,* new, below.

Types.—Holotype: Pal. Res. Inst. No. 5411; paratypes: 5411A and 5411B.

Strophonella floweri Caster n. sp. Plate 2, figs. 2, 3; Plate 10, figs. 9-11

Internal molds of both valves of a small strophonellid have been found in the Colombian deposit. The general dimensions and contour are shown by the illustrations. As brought out by the photographs on plate 2, where the surface features appear to be impressed on the internal mold, the surface is seen to bear about 30 subangular radial plicæ which increase principally by intercalation, but also by bifurcation. The radii are obsolescent on the extremities, and most strongly formed mesially. The broad interspaces between radii bear well developed varices of growth which become slightly fasciculate on the extremities of both valves.

The internal features of the dorsal valve are obscure, but in the ventral valve a strong carina encircles the large and subcircular muscle zone, which appears not to be anteriorly bilobed as one would expect. Short dental lamellæ are also present, and the suggestion of a short frail ventral "process" leaves its apical imprint.

Discussion.—This species differs from the preceding principally in size. The radii here are angular and less regular. They tend to be obsolescent on the extremities. This bears to the preceding species almost identically the same relationship as Clarke's Gaspésian species *Strophonella continens* does to his *Strophonella continens,* var. *senilis,* (*e.g.* Clark, 1908, pl. 40, figs. 5, 7 and figs. 13, 16). Some specimens identified as *Strophonella punctulifera* (Conrad) from the Gaspé section of Canada in the New York State Museum collection recall slightly this small Colombian species. (*See* also Clarke, 1908, pl. 37, fig. 10.) More strikingly do specimens from the St. Alban beds now in the U. S. National Museum, (56700) referred by Clarke (*idem,* p. 11, pl. 37, fig. 10) to this species, recall the Colombian species. That we are here dealing with the same stock there seems little doubt, and that there is very close specific resemblances even a casual examination of the plates mentioned will bring out. No hinge crenulations have been observed in the Colombian species, despite the presence of nearly complete hinge imprints on specimens of *Strophonella floweri,* but here again the resemblance is with Clarke's material which also has a very frail hinge plate and obscure crenulations.

Types.—Holotype: Pal. Res. Inst. No. 5486; paratype: Nos. 5482, 5487.

Family **ORTHOTETIDÆ** Waagen, 1884, emend.

The subfamily Orthotetinæ of Waagen seems to merit full family ranking in the superfamily Strophomenacea.

"Austral" Devonian orthotetids appear to have been for the most part assigned to two species-groups. One group, perhaps the more abundant, has usually gone under the name of *Streptorhynchus agassizi* Hartt, 1879, and the other group, of perhaps phylogerontic shells, usually has been named or compared with

Orthis sulivani Morris and Sharpe, 1846. It is questionable if these groups comprise genetic lines. Only shells which would be assignable to the first group appear to be represented in the Colombian fauna at hand. Both "austral" groups appear, upon a study of the material in the New York State Museum, to have short dental plates, (or paradental* plates) and a low median ventral septum. These are the crucial features of *Schellwienella.*

Genus **Schellwienella** Thomas, 1910

Genotype.—*Spirifera crenistria* Phillips, 1836. Lower Carboniferous.

The salient features by which this genus is being recognized in the Colombian material, and for the first time, as far as I am aware, in the austral province, are: the usual orthotetoid contour, involving a reversed convexity of the valves and general shield-shape of the shells, plus the presence of short, but definitely existant divergent dental (or paradental) plates, and the absence of a true ventral septum. The last feature may be subject to modification if the elevated adductor platform, mesially located, is interpreted as a septum. These features, especially the short dental lamellæ, seem satisfactorily to separate this characteristic Silurian and Devonian genus from *Schuchertella* to which of late most "austral" species in the Orthotetidæ have been assigned. Dunbar and Condra, 1932, (p. 66), have discussed the characteristics of the subfamily (family) in detail, and their work, rather than the reactionary consolidation of Licharew, 1930, has largely guided me in my conclusions.

Some "Austral" Representatives of *Schellwienella*

The Colombian deposits bear an abundance of orthotetoid

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* After careful examination of the schellwienellids in the New York State Museum and the U. S. National Museum, I am not convinced of the presence of *true dental* plates in the group, *i.e.* outgrowths of lamellar buttresses from the hinge teeth. Rather it seems that the so-called dental plates in the group are of secondary, or relatively late ontogenetic origin, and are upgrowths from the floor of the valve in the form of callus ridges somewhat resembling the paradental plates in the crenulate-hinged *Strophomenacea.* The teeth in the schellwienellids I have seen appear to be unsupported by true dental lamellæ, as they are in the schuchertellids. The presence of paradental plates seems to be a generic feature, but whether it bespeaks the genus *Schellwienella, s.s.,* will bear further investigation. In this paper, where speaking of dental plates in this group, these accessory plates, resembling dental plates, are meant, and the identification of the genus *Schellwienella* is subject to revision when and if it is demonstrated that the genotype line possesses true dental plates.

fragments seemingly quite clearly assignable to *Schellwienella,* as the illustrations will bring out. Moreover, so far as can be determined, virtually all the orthotetoid species or specimens described from South America and South Africa appear to be similarly assignable, if the illustrations are to be relied on. Most of them show short dental plates, even when their presence is denied in the text. This is significant, of course, only in papers published since Thomas's genus was outlined in 1910. Much work must yet be done with the group in the Southern Hemisphere before entirely satisfactory specific assignments are possible. Intergradation here runs rampant, as elsewhere in this group, and the value of relatively great variation can be judged only after detailed statistical checks.

Schellwienella sulivani group.—The larger multiradiate shells in each faunule have hitherto been compared with or assigned to *Orthis* (or *Schuchertella*) *sulivani* Morris and Sharpe of the Falkland Islands. This is not the place to review this custom, in as much as none of the Colombian fauna seems to warrant such comparison or assignment. The characters of the Falkland species have been well shown by Clarke, 1913 (pl. 23, figs. 16-20). To my mind they have very little in common with the shells assigned to this species by Clarke from Brazil (*idem,* pl. 23, figs. 21-23). It seems possible on the basis of a casual comparison of the internal features that the Falkland shells are even generically distinct from the Brazilian. In the Falkland shells the ventral muscles occupy huge (two-thirds the length of the shell on occasion) confluent flabellate scars which are separated by a low median septum. The hinge area is ponderously thickened in most forms, and the dental plates are extraordinarily rugged. In the dorsal valve of the Falkland specimens the most striking features occur. The muscle scars are outlined in the ephebic stage by extensions from the bases of the crural socket plates, and a sessile, bipartite cardinal process with excavate prongs is found. (*See* Clarke, *idem,* pl. 23, figs. 17, 18). A dorsal median septum is also present. Clarke's Brazilian species *Schuchertella sancticrucis* appears to lie nearer to the true Falkland stock than the forms which he assigned to the Falkland species. It would be especially difficult, for example, to reconcile the internal mold of a dorsal valve from Ponta Grossa shown by Clarke (pl. 23, fig. 16) to the Falkland species. The narrow lenticular muscle scar, with the strong median septum, narrow cardinal zone and absence of a process certainly do not in the least resemble the Falkland species, and may well be a distinct species of orthotetid. Brazilian material in the New York State Museum collection which was assigned by Clarke to the Falkland species does not show the presence of the strong cardinal process or excavate hinge-crural plate of the Falkland specimens, and has a dorsal cardinal structure similar to *S. agassizi*. If this condition prevails in more extensive collections, it may well develop that the other large Brazilian orthotetids specimens are only external homeomorphs of the Falkland species. The specimen from West Falkland illustrated by Clarke (pl. 23, fig. 20) could easily belong to quite another genus. It might be compared quite convincingly, for example, with *"Rhipidomella" musculosa* of the North American Oriskanian series.

Schellwienella agassizi group.—The smaller orthotetid shells, having fewer radii, weaker articulatory apparatus, characteristic musculature, and other distinctive internal features, have usually been identified as or compared with *Streptorhynchus* (or *Schuchertella*)*agassizi* Hartt. The structural features of this species, *sensu stricto,* have also been shown by Clarke, 1913 (pl. 23, figs. 3-13). I have had the opportunity to study some of Clarke's material in the New York State Museum and can therefore offer a few notes on the Brazilian shells.

From Clarke's figures (omitting his figure 9 which is apparently not conspecific, and questionably congeneric with the rest of his figures) and the material in the New York State Museum, it appears that *Streptorhynchus agassizi* Hartt, *s.s.,* is a rather typical *Schellwienella.* Clarke has shown the typical ventral median septum, and suggested the ventral dental plates which are from 3.5 to 5 mm. long in the New York State Museum material from Ponta Grossa, Paraná. So strongly are these plates developed that in most shells which have been flattened down, the plates have broken through the exterior, or have been impressed, or forced through the opposite valve. This is a very characteristic condition in the Brazilian material. Neither Clarke nor Hartt mention this prevalent condition which makes the generic character patent even on the external molds. There does not seem to be any sign of attachment during immaturity, and no sign of consistent distortion. The dental plates extend to the inner palintrope wall directly on either side of the delthyrial area. They have the appearance of splitting toward the posterior, due to the origin of the arched deltidial plate deep within the shell (as much as 2.5 mm. from the outer palintrope surface) as a thin plate between the dental plates, and fused to them at the point of origin. In some shells the deltidial plate is nearly completely fused internally with the dental plates, and thus creates the impression of the plates meeting posteriorly, or continuing posteriorly as an uninterrupted arcuate and elevated ridge. The median ventral septum is low, but always quite distinct. The diductor and adductor scars have been well shown by Clarke. Curious tiny depressions lying postmesially from the adductors are striking features of most shells. In the dorsal valve the crural plates extend posteriorly to meet as an arched plate with a median corrugation, which is concave externally, and stands out as an internal subacute ridge. Laterally the crural plates are extended, and slightly recurved to surround (or form) dental sockets, but in some of the shells in the New York State Museum has the extreme condition shown by Clarke's figure 12 on plate 23 been observed. Usually the crura extend laterally with only a very slight backward tendency. They are generally much larger than Clarke's figure would suggest. There is no sign of a cardinal process, other than this medially grooved "spoon" which rises above the hinge and overhangs it posteriorly. This median "process' had apparently little articulatory function. In the dorsal valve only the slightest median septum is suggested.

The surface features of the shells of this species are also apparently of value in identifying it, although in this group I would consider internal features of possibly greater specific value than external. The following description of the surface is largely abstracted from Hartt's original description which is very well prepared:

Small to moderate size; transverse shell in which length is to width as 2 to 3, 3 to 4, or 3 to 5; biconvex, convexo-planate, or convexo-concave; greatest width a little behind middle; cardinal extremities usually rounded, but may be slightly mucronate; dorsal beak usually depressed and broadened. In the ventral valve the beak is usually bent to one side very slightly, and the palintrope is asymmetrical; surface of ventral valve arches up quite strongly near periphery; dental plates only on hinge area, not extending forward. The dorsal valve is more symmetrical than the ventral. According to Hartt, in this valve there is a shallow mesial sinus or mesial flattening; valve most convex posterior to middle; cardinal extremities flattened. The surface is covered with fine rounded, thread-like or sharp raised lines which increase by intercalation, and probably in some cases by bifurcation. The interspaces are slightly broader than the lines. One set of radii originates on the beak and increases in size anteriorly; intercalating lines generally begin to come in posterior to the middle and thence to the front and sides; new ones are continually being added until at the margin there is about double the number on the beaks, for there is in general but one intercalating line for every interspace commencing at the beak. Concentric lines are inconspicuous or extremely faintly developed. The surface is never cancellate. Adult specimens measure from 21 mm. to 29 mm. in length and 32 mm. to 40 mm. in width, respectively. The smaller figures are more normal.

It now appears that the following shells belong at least to the same genetic stock as *Schellwienella agassizi* (Hartt):

1856. *Strophomena baini* Sharpe. Sharpe, D., Trans. Geol. Soc., ser. 2, vol. 7, p. 208, pl. 26, fig. 13 (? fig. 17).

1874. *Streptorhynchus Agassizii* Hartt. Hartt, C. F., in Rathbun, R. Buffalo Soc. Nat. Sci., Bull., vol. 2, p. 248, pl. 9, figs. 3, 4, 10, 16, 17, 23, 25, 26, 28-30.

1892. *Orthothetes*, sp. α Ulrich. Ulrich, A., Beitr. zur Geol. und Palæo. von Süd Amerika, pt. 1 p,. 76, pl. 4, fig. 30. Stuttgart.

1903. *Orthothetes Sulivani* (Morris and Sharpe). Reed, F. R. C. (*pars*), Ann. S. African Mus., vol. 4, pt. 3, p. 170 (*non* pl. 20, fig. 8), *fide* F. R. C. R., 1925.

1905. *?Orthothetes*, sp. *?* Thomas. Thomas, I., Beitschr, d. Deutsch. Geol. Gesell., 1905, p. 260, pl. 14, fig. 41.

1908. *Orthothetes chemungensis* (Conrad). Knod, R. (*pars*), Neues

Jahrb. Mineral. Beil. Bd. 25, p. 541, pl. 26, figs. 13-14a; pl. 27, fig. 5 (*non* fig. 7).

1913. *Schuchertella Agassizi* (Hartt). Clarke, J. M., Mon. Serv. Geol. e Mineral. do Brasil, vol. 1, p. 276, pl. 23, figs. 5-13.

1923. *Schuchertella Agassizi* (Hartt). Kozlowski, R., Ann. de Pal., 1923, p. 85, pl. 9, fig. 30.

1925. *Schuchertella Baini* (Sharpe). Reed, F. R. C., Ann. S. African Mus., vol. 22, pt. 1, p. 42.

1934. *?Schuchertella Agassizi* (Hartt). Mendez-Alzola, R., Bol. del. Inst. de Geol. y Perfor. del Uruguay, No. 21, p. 31.

Excepting the new species to be described below, I tend to look upon this list as essentially the synonoymy of one species, for which the name *Schellwienella baini* (Sharpe) (*Strophomena baini* Sharpe, 1856) would have priority, if unfortunately we really did not know so very little about Sharpe's species. Our South African colleagues would do science a great boon if they would redescribe material which they feel typically represents Sharpe's species. On the other hand, Hartt's (*Streptoryhnchus agassizi* Hartt, 1874) analysis leaves little to be desired, and in the interest of justice as well as sentiment I would prefer to continue the usage of the name *S. agassizi* for the species, even though priority is established for the bare name *S. baini.* In discussing *S. baini* as conspecific with *S. agassizi* I have in mind the lectotype of Sharpe's species (11325 British Museum Nat. Hist.) which he illustrated, albeit poorly, as his figure 13. Reed, 1925 (p. 42), has pointed out that the two original specimens illustrated by Sharpe may not be conspecific. Clarke, 1913 (p. 281), in discussing the relationship after having studied the types, presumably gave undue weight to the specimen illustrated as fig. 17, which may very well be conspecific with *S. sulivani.* Reed, 1903, was the first to make this same composite comparison, but after examining the types carefully revised his opinion (1925).

In the Colombian faunule an additional form is plentifully represented which seems to belong to this species-group, but certainly bears specifically distinct features.

Schellwienella goldringæ Caster, n. sp. Plate 7, figs. 1-3; Plate 8, figs. 1-2

Shells of medium size, convexo-planate or convexo-concave, slightly wider than long, transversely scutelliform; hinge line straight; usually slightly produced, but in some shells terminations circularly truncate; sides of shell usually subparallel and normal to hinge line but may be slightly arcuate; anterior margin regularly rounded; dorsal valve with a low median sinus and ventral valve with an obsolescent fold.

Surface of both valves regularly radially costate. The costæ are elevated, essentially parallel-sided ridges rising abruptly from excavate inner spaces of about twice the width of each costa. The crest of each costa is regularly rounded in most cases. The radii originate principally by implantation, but occasionally appear to arise by lateral splitting from main ribs. In adult shells the total number of peripheral radii is usually 98 or 100, and has not been observed to exceed this number, but could easily do so without materially altering the general appearance of the shells. The interspaces between radii are covered with very fine concentric varices which are not visable on the elevated radii.

The interior of an adult dorsal valve is prominently radially costate around a peripheral zone about 3-4 mm. wide. The remainder of the dorsal interior is indistinctly costate, and gives the appearance of having a secondary callus coating on the older parts of the shell. The dorsal palintrope is somewhat narrower than the ventral one, but is not linear. Its external surface appears to be finely striate horizontally, and the internal surface is essentially smooth. In mature shells the cardinal process overhangs the median zone of the hinge and may secondarily obliterate the delthyrial structures. The cardinal process consists of a broad, shovel-like flange which reaches posteriorly beyond the hinge in a broad, beakward curve and apparently articulated with the ventral valve to form a strong hinge structure. The process is slightly bilobed at the apex where a very strong median septal buttress terminates. On either side of the septum the process is excavate; laterally the process is fused to strong crural plates which are curved outward to encircle large pits for the reception of the ventral hinge teeth. The median septum is keeled above, and subtriangular in cross section. It reaches anteriorly slightly beyond the flabellate adductor impressions. The muscle impressions of the dorsal valve are principally adductor scars which together constitute a subcircular zone in front of the crura The muscle scars are radially ridged as the figures bring out, and are slightly bounded postlaterally by extensions from the crural plates. Anteriorly the muscle seats are somewhat elevated above the floor of the valve by callus material. The attachment seats of the diductors are obscure.

In the ventral valve the peripheral costation reaches further in toward the middle of the shell, and there is always less evidence of secondary callus deposition. The dorsal palintrope is elevated mesially. The notothyrium is usually closed by a convex deltidium which is excavate toward the hinge for the entrance of the dorsal cardinal process. Strong, but stubbed, cardinal teeth are sessile on the inner wall of the palintrope, and are anteriorly supported by divergent buttresses or plates which arise from the floor of the valve and may extend forward as much as 4 mm. Between the dental plates and extending forward for a proportionately much greater distance than in the dorsal valve, the muscle scars spread fanlike, with uncertain delimitations, but may extend beyond the middle of the shell. Mesially the diductor scars are separated by a narrow, elevated platform whereon the adductors were attached in elongate shallow pits on either side of a low median septum which extends forward beyond the adductor platform for a very short distance.

Dimensions.—

	5463*	25466	5465	5467
Hinge width	32 mm.	30 mm.	35 mm.	35 mm.
Length of shell	25 mm.	22 mm.	31 mm.	30 mm.

Discussion.—It will be readily seen how strikingly this species differs from the Brazilian species *Schellwienella agassizi* (Hartt) if Clarke's, 1913, figures and text are consulted with the additional notes previously given in the present paper. The strong dorsal median septum, and strongly defined dorsal musculature are quite new features. They recall Clarke's figure 16, plate 23, of a Brazilian shell which he thought of as *Schellwienella sulivani*, but which I have shown really cannot have been very closely related to the Falkland Island species. The radii are essentially the same in the Colombian species as in typical *Schellwienella agassizi*, but the ventral dental plates are apparently weaker in the Colombian material, for they have not been observed breaking through the shell as they consistently do in Brazil. Adult

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* Holotype.

ventral internal molds are not known from Colombia as yet. The reader is referred to the supposedly immature shells of this species described below, wherein ventral structures are known. There seems to be no need of further comparison of this species with *Schellwienella sulivani.*

The "boreal" relatives of the present species may lie in the stock usually referred to *Schuchertella woolworthana* of the North American Helderbergian faunas. This stock apparently carries some species at least which bear short dental plates and are therefore eligible for *Schellwienella;* for example, see: *"Schuchertella" woolworthana,* var. *gaspensis* Clarke, 1908, or *"Orthothetes "woolworthana"* from the New Scotland limestone in New York State, as illustrated in Pal. N. Y., 1892 (vol. 8, pt. pl. 9, fig. 29) (type: N. Y. State Mus. 7938/1) which also has definite dental (or paradental) plates.

Types.—Holotype: Pal. Res. Inst. No. 5463; paratypes: 5464-5467, 5467A.

Schellwienella goldringæ, var. juvens Caster, n. var. Plate 8, figs. 3, 4, 18; Plate 9, figs. 12-24

Several small internal and external molds of shells in the Colombian deposits show very clearly the generic features of the genus *Schellwienella,* and while they may represent a diminuitive species, on the basis of characteristics brought out below, it seems wisest for the present to look upon them as immature specimens of the species described above. By referring to the illustrations, it will be seen that the shells are all of a rather uniform small size (no intermediate forms between the present tiny shells and the full-sized *Schellwienella goldringæ* are known). The surface radii increase by implantation. Usually five ribs appear on the earliest portion of the beak. Their characteristics are shown by the figures. Internally the ventral valve shows prominent dental plates in every case. The adductor muscle scars are extremely characteristic. They are small; situated on lenticular elevated platforms under the beak, and are separated by a median septum. The diductors are without anterior delimitation in these shells, and appear to have been attached directly upon a striated zone on the inner surface of the shell. In many cases there is no evidence of the diductor muscles. Until this variant is known from additional material, there seems little point in attempting detailed comparisons.

Types.—Holotype: Pal. Res. Inst. No. 5465A; paratypes: Nos. 5465C, 5420C, 5467B.

Family **PRODUCTIDÆ** Gray, 1840

Subfamily **PRODUCTELLINÆ** Schuchert and LeVene, 1929

Genus **Productella** Hall, 1867

Genolectotype.—(Hall and Clarke, 1892) *Productus subaculeatus* Murchison, 1840. Devonian.

Whether the European species will stand as the genotype or not, will apparently have to be settled by an opinion of the Commission on the International Rules of Zoölogical Nomenclature. This appears to be necessary for two reasons: first, Murchison's species was apparently a *species inquirendæ* to Hall at the time the genus was proposed, 1867, which might tend to invalidate the species as a genotype (Rules: Article 30, Section, II, beta); second, in view of the fact that Hall, 1867, did not designate Murchison's species definitely as genotype, the erroneous identification clause (Opinion 65) does not apply, and in view of the fact that certain definite American specimens (*see* Schuchert and LeVene, 1929, p. 100) influenced Hall's decision, the recommendation of Opinion 65 that the full details be submitted to the Commission for ruling certainly applies. From a standpoint of a better comprehension of the species it would be more satisfactory if *Productella spinulicosta* Hall, 1867, were designated genolectotype anew. It was to this species of Hall that Kindle, 1900, (p. 629), assigned Hall's forms originally identified as Murchison's species, and used to illustrate typical representatives of his new genus *Productella*. There is also a serious question if Hall's listing of Murchison's species as the earliest one in a stratigraphically arranged list (1867, p. 177) and description first (1867a p. 154) in a similarly arranged report should be construed (Hall and Clarke, 1892, p. 328; Schuchert and LeVene, 1929, p. 100) as designation of genotype. It seems highly improbable that Hall originally so construed his action.

One specimen of *Productella* (in the commonly accepted sense of that genus) has been found in the Colombian Devonian collection. This and Hartt's, 1878, *Productella mæcuruensis* are the only records of the subfamily of which I am aware in the "austral" province.

Productella cf. **spinulicosta** Hall Plate 7, figs. 19, 20

Productella spinulicosta Hall. Nat. Hist. N. Y., Pal., vol. 4, 1867, p. 160, pl. 23, figs. 6-8; 25-34.

The only evidence of the species at hand consists of the slightly deformed inner mold of a single ventral valve showing no features not brought out by the illustrations. While there is little doubt that this will, upon further opportunity for study, prove specifically distinct, present materials are inadequate for specific analysis. Especially is the Colombian form reminiscent of "boreal" ones of this species (and relatives) in the Onondagan (Ulsterian) of America. From the inner mold it appears that more than 60 spine bases are present in the ventral valve, which would be one slight difference from typical examples of the comparable species in the north, which has about 50-60 spines. Hall's Onondagan and Hamilton species *Productella navicella* to which Hartt, 1878, compared his Brazilian species is much more abundantly spinulose and is also sub-lamellate with strongly developed varices.

Specimen.—Illustrated material: Pal. Res. Inst. No. 5459.

Family **CHONETIDÆ** Hall and Clarke, 1892

Genus **Eodevonaria** Breger, 1906

Genolectotype.—(Schuchert and LeVene, 1929) *Chonetes arcuatus* Hall, 1857. Lower Devonian.

This genus of Lower and early Middle Devonian brachiopods is differentiated from *Chonetes,* to which many of its species were originally assigned, chiefly on the basis of a crenulated hinge in both valves, which apparently articulate in very much the same manner as in the stropheodontids. *Chonetes* appears often to have a series of low mounds along the hinge of internal molds, but these are formed by fillings of the bases of hollow spines, and appear to be quite distinct structures. Nearly all of the species of *Eodevonaria* are comparatively large chonetids, with relatively gibbous ventral valves and concave brachial valves. The surface is ordinarily finely striated, and bears a variable number of spines along the posterior angle of each valve. The internal features are essentially as in *Chonetes.* Four forms of *Eodevonaria* are differentiable in the Colombian material at hand.

Eodevonaria imperialis Caster, n. sp. Plate 7, figs. 11-14, 17, 18; Plate 9, fig. 3

Shells of medium to large size, concavo-convex; ventral valve strongly ventricose; dorsal valve essentially opercular; hinge line straight; slightly produced at the extremities; lateral angles subrectangular; sides concave posteriorly, regularly rounded toward the front; anterior margin rounded; shell shield-shape. Hinge width is slightly greater than the mesial length of the shells. Some shells are slightly more transverse.

The ventral valve is so gibbous postcentrally as to appear mesially bulbous. The maximum inflation is behind the middle. The beak is strongly incurved behind the hinge line. Lateral umbonal slopes are precipitous, and meet planate posterior lateral auricles almost at a right angle. The anterior slope is only slightly less steep, and continues to the commissure. The auricles are slightly convex, and a trifle wrinkled where they extend beyond the general rounded outline of the main body of the shell. Mesially the ventral valve bears a shallow sinus which widens and becomes evanescent near the front. The palintrope appears to be strongly anacline, and broadly triangular. The delthyrial zone is broadly triangular also.

The dorsal valve is slightly concave, and is not known inversely to approach remotely the swollen convexity of the ventral valve. The postlateral extensions are subplanate here as in the opposing shell. The central region is subcircularly depressed. The peripheral zone in some shells in front of the ears is subplanate in an anteriorly expanding arc, while in others the concavity carries to the periphery, or may be even slightly accentuated there. Mesially the dorsal valve bears a low fold which broadens and disappears anteriorly. The dorsal palintrope is essentially linear. Nature of external spines not known in either valve.

The surface of both valves is regularly radially costellate with rounded radii of about once and a half the width of arcuately excavate interspaces. In adult shells there are about 120 radii at the periphery. New radii appear quite suddenly in an intercalary manner, in all cases observed, but may occasionally arise by equal or subequal bifurcation it is presumed, though certainly implantation is by all odds the commonest mode of radial increase. The interspaces between costellæ appear from the external molds and squeezes to be finely pustulose externally, though there is some uncertainty here. No evidence of concentric varices is at hand, although they are to be expected occasionally, especially on the auriculate portions.

The internal features of the ventral valve are extremely well shown on the holotype, from which the following diagnosis is taken: interior of shell dominated by a postcentral subhemispherical area comprising the major part of the shell. This zone is laterally differentiated from the auricular portions by extensions of the dental lamellæ which are very prominent postlaterally and while differentiating the bulbous portion for its entire periphery, are inconspicuously developed toward the front. The floor of this zone is radially ridged with callus material, but not strongly so, and is clearly the attachment place of very large diductor muscles which adhered over nearly the entire inflated zone. They are separated along the median line by an angular septum which increases in width on the incurved portion of the beak, and disappears toward the front about halfway to the anterior margin. Just beneath the strongest development of the dental lamellæ and on the posteriorly facing portion of the beak are two strongly divergent, flabellate zones which are nearly devoid of radial callus ridges and stand at slight relief above the common muscle attachment zone. These may be differentiated into a narrow zone adjacent to the ridges and a somewhat larger flabellate zone laterad of these. What these flabellate areas may represent is not certain, in view of the evidence for much more extensive attachment of the giant diductors. Some writers on related forms have referred to them as barren areas, while Hall and Clarke, 1892 (*e.g.* pl. 16 fig. 35), thought of them as possibly being respectively anterior and posterior diductor scars. On either side of the median septum and extending forward for about half its length are narrow, posteriorly tapering, anteriorly slightly expanding adductor scars which are elevated likewise very slightly above the diductor scars. The complete central adductor area is an inconspicuous elongate ovate zone split mesially by the septum. The median septum merges with a subapical callus zone which apparently filled the incurved tip of the beak. The hinge teeth are not elevated above the inner palintrope wall, and are at best only strengthenings of the delthyrial zone. They seem obviously to serve no articulatory function. The entire length of the inner surface of the palintrope is crenulated, as shown by plate 7, fig. 14. The crenulations occur about 1 mm. *below* the commissure plane and extend from near the lateral apices (where the crenulations are evanescent) on a mesially expanding, arcuate zone of the inner palintrope until they reach the dental lamellæ on the edge of the delthyrial zone. The crenulations are long, slightly outwardly divergent, subequal and rounded ridges with concave interspaces. They disappear along a very distinct line marking the edge of a slightly concave zone about 1 mm. wide, which extends the full width of the palintrope. The line apparently represents the actual contact surface between the two valves when they are partially agape.

The hinge zone of the dorsal valve is internally similarly crenulated, but the denticles are shorter, stand out in sharper relief from the inner palintrope surface, and are not separated from the commissure plane by a noncrenulated zone. The crenulated palintrope structure in this and the other Colombian species of *Eodevonaria* was quite certainly an articulatory device.

The interior of the dorsal valve is conspicuously costellate over most of the surface. Here, in contrast to the regularity of the exterior, the ribs are somewhat irregular, due presumably to a secondary callus mantle and uniform pustulosity of the interior. Musculature is usually obscure. A pair of long flabellate zones extend divergently from under the beak for about one-fourth the length of the shell. They are smooth and defined only by a very slight recession in the shell. These are reasonably well shown by plate 7, fig. 17. Mesially there is developed a prominent septum in the midst of the inner concave surface of the external fold. This reaches about one-third of the distance to the front and stands out in sharp relief from the floor of the valve. It is rounded above and increases in strength slightly toward the rear. The nature of the cardinal process, if developed, is unknown.

Dimensions.—The dimensions of the holotype, which is an unusually complete ventral inner mold appear to be average for the species, a great many fragments of which are at hand. Hinge width 21 mm.; median length 19 mm.; depth of ventral valve 10 mm.; width of inflated zone 15 mm.; length of this zone approximately the same.

Discussion.—*Eodevonaria imperialis* belongs to the *Eodevonaria arcuata* (Hall) species-group and must be first compared with that species, especially as developed in the Onondagan strata of the northern part of the Appalachian Province in North America. In the Colombian material the shells are much more inflated, less transverse and slightly more coarsely radiate than *E. arcuata* (Hall) (*e.g.* 1867, p. 119, pl. 20, figs. 7, a-f). Hall's early material also apparently does not show the barren band on the inner palintrope surface adjacent to the commissure plane, although the illustrations of the genotype in Hall and Clarke, 1892 (pl. 16, fig. 35), suggest the possibility of fewer crenulations adjacent to the hinge. The "boreal" forms show less well evidence of a very broad muscle attachment in the inflated zone, and usually have a more ovate region of central adductor attachment. Only the American Onondagan forms are very closely similar to the present species. Of these perhaps most similar are Onondagan representatives illustrated by Kindle from Indiana, 1901 (p. 601, pl. 4, figs. 6, 6a). Forms illustrated from Little Moccasin Gap, Va., by Kindle, 1912 (p. 73, pl. 3, figs. 9, 10), show quite similar inflation and large central muscle scars. Clarke's, 1909 (p. 144, pl. 34, figs. 21-31), assignment of Oriskanian forms to *Eodevonaria arcuata* is certainly too conservative as he himself realized. At least one, and possibly several related species, seems to be present in Clarke's material. The present Colombian species and its variety *parva,* described below, recall this doreal species-group in the Oriskanian. In this connection, the shells from the Moose River sandstone of Maine assigned by Williams and Breger, 1916 (p. 53, pl. 3, figs. 6-11), without query to *E. arcuata* are especially pertinent. It seems likely that in Maine also several species were given the mantle designation of *E. arcuata.*

South American comparisons, none very close, with the exception of the Venezuelan, will be brought out under the following specific discussions, and the note on "austral" chonetids, below.

In Weisbord's, 1926, Venezuelan Devonian fauna, chonetids are similarly an important element. Examination of his types shows very clearly that the material which he described as *Chonetes venezuelensis* and *Chonetes subhemispherica* belongs to the genus *Eodevonaria.* His *Chonetes subhemispherica,* especially as typified by the lectotype (specimen in Pal. Res. Inst. collection which he illustrated on plate 3, fig. 4) shows some contour similarity to *Eodevonaria imperialis,* but is less ventricose, and has a remarkably coarsely punctose shell. The exterior has a coarsely pitted appearance, and the interior is coarsely pustulose. This may, of course, be a facies distinction, but apparently is of specific value. Weisbord's specimen illustrated on his plate 3, fig. 8, as *Chonetes venezuelensis?* is apparently not conspecific with the lectotype of that species, and has no counterpart in Colombia. His specimen illustrated on plate 3, fig. 6, is very similar to *Eodevonaria reedi* of this paper, but is really not well enough known to warrant too close comparison. The specimen shown on his plate 3, fig. 9, is very similar to the *parva* variety of *Eodevonaria imperialis* described below. This specimen does not appear to be conspecific with Weisbord's *Chonetes venezuelensis, s. s.*

Eodevonaria imperialis is an abundant species in the Colombian Devonian.

Types.—Holotype: Pal. Res. Inst. No. 5435; paratypes: Nos. 5433-5434, external and internal molds of one dorsal valve; Nos. 5433A-F.

Eodevonaria imperialis, var. **parva** Caster, n. var. Plate 7, figs. 9, 10, 15, 16; Plate 9, figs. 4-7

Shells of small to medium size; ventral valve moderately convex; dorsal valve only slightly concave; hinge line straight, very slightly produced at extremities; sides of shell nearly normal to hinge line; margin regularly rounded in front; length and width subequal.

The surface of both valves is costellate (plicate). The radii are very regular, straight, slightly wider than the arcuately excavated spaces separating them, and subangular above. They increase wholly by intercalation as far as known, and usually number about 80 on the margin.

The interior of the ventral valve is as prominently costellate as the surface, but the proportions are precisely opposite, of course. A subcircular zone is nearly completely delimited by recession below the general level of the valve in the posterior middle half of the shell. This is bordered by ridges extending from the position of obsolescent hinge teeth and fail by only a few millimeters to completely enclose an umbonal depression which recalls on a lesser scale the bulbosity of the species described above. The radial corrugations extend over this area as well as the remainder of the shell. The postlateral flank of the depression is occupied by a bipartite flabellar zone at a somewhat higher elevation, much like that in *E. imperialis, s. s.* A median septum reaches forward for about one-third the length of the shell. Crenulations, essentially vertical to the hinge line, extend the length of the inner wall of the palintrope, and may attain the commissure line. They appear to be located on a narrow ridge slightly above the general level of the palintrope wall.

The interior of the dorsal valve is similarly radiately marked. It bears crenulations for the full length of the hinge. These are recessed in a narrow groove just below the commissure plane. There appears to be a posteriorly directed frail, bipartite cardinal process in one specimen. On either side of the process, adjoining the delthyrial zone, appear to be divergent dental pits which are bounded inwardly by callus ridges. In front of the base of the process is a lozenge-shape depression principally occupied by a similarly shaped terminus of a well developed median septum which extends for about one-third the length of the shell, and is bounded on either side by a narrow furrow. The postlateral borders of the mesial pit seem to be occupied by muscle scars, the details of which are uncertain. These characters are brought out by the figures on plates 7 and 9.

Dimensions.—Several fragments are at hand, the dimensions of the most perfect of which are as follows: hinge width, 13 mm.; mesial length, 12.5 mm.; height of ventral valve, 2.5 mm. Illustrations on plate 7 are essentially natural size.

Discussion.—As intimated in the discussion of the species, *s.s.*, this form may represent either a young form or an arrested variant. From the abundance of material showing very consistently the features outlined, and in the absence of intermediate forms of larger size and inflation, it has seemed wise to mark out the variation by a varietal name. Pointing toward the possibility of this form being an ontogenetic stage of *E. imperalis, s.s.* is the striking similarity between the variant and the Oriskanian forms assigned by Clarke, 1909 (*see* above), and Williams and Breger, 1916 (*idem*), to *Eodevonaria arcuata*. This reminiscence in the Colombian fauna by the species and variant is an almost perfect rehearsal of the phylogenetic features shown by the various undescribed Oriskanian species which these authors have illustrated, and the genotype, in the strict sense, from the Onondagan. A comparison of the dorsal valves of the species, *s.s.*, and the present form, brings out the differences, however, that suggest specific distinctness. The matter can be settled only with larger collections.

Eodevonaria imperalis, var. *parva* is about as common as the species, *s.s.*, in the Colombian Devonian.

Types.—Holotype: Pal. Res. Inst. No. 5432; paratypes: Nos. 5420B, 5420D, 5434B.

Eodevonaria imperialis, var. **transversa** Caster, n. var. Plate 7, figs. 5, 6; Plate 11, figs. 18-20

Several specimens from the Floresta Devonian are at hand which are much more transverse than the average forms described as *Eodevonaria imperalis, s.s.*, and for which at least a varietal name seems appropriate. The adult characteristics, shown on plate 11, figs. 18-20, are such that two species may be involved. Specimen 5434A (pl. 11, fig. 18), which is designated the holotype of the varietal form, shares with the species, *s.s.*, the bulbous mesial swelling of the umbonal region, but has lateral extensions along the hinge and more numerous hinge crenulations. The musculature and septal structure of the varietal holotype are very similar to the species, *s.s.* The specimen illustrated on plate 11, figs. 19 and 20, on the other hand, is without the bulbous mesial expansion of the restricted species, and has a much more prominent and larger muscle zone than does either the restricted species or specimen 5434A. Without more material it is impossible to judge the meaning of the variations. The young condition is illustrated on plate 7, figs. 5 and 6. I have no proof at present that the small individuals may not be the immature of the species, *s.s.*, but the form is more transverse than in the adults of the strict species. The comparisons of the varietal forms discussed here are essentially those of the species, *s.s.*, for the variation observed here are no greater than those of *Eodevonaria arcuata* in "boreal" faunas.

This seems quite certainly to be the chonetid fossil illustrated by Weisbord, 1926 (pl. 3, fig. 10), as his species *Chonetes subhemispherica?* from Venezuela. That Weisbord's transverse form, showing the internal dorsal features so very well, is not conspecific with his species in the strict sense (determined by selection of the specimen which he illustrated on plate 3, fig. 9, as lectotype) seems very clear upon study of his types. *Eodevonaria imperialis,* var. *transversa* may prove not to be closely related to *Eodevonaria imperalis, s.s.*, when more material is available for comparisons, but apparently will include the "variant" of the Venezuelan species.

Types.—Holotype: Pal. Res. Inst. No. 5434A; paratypes: Nos. 5404, 5422B.

Eodevonaria reedi Caster, n. sp. Plate 7, fig. 4; Plate 9, figs. 1, 2

Shells transverse, of small to medium size; concavo-convex, neither valve strongly arched; hinge line straight, and representing maximum width of shell; width in some cases may be twice length, usually as 15 is to 8, or 9; extremities not especially produced, may be even slightly rounded, thus making the greatest width a little in front of the hinge; sides of shell rounded, and meet hinge usually at less than a right angle; front margin broadly but regularly arcuate.

The ventral valve is only moderately expanded, but the dorsal valve is very nearly correspondingly concave, so that the body capacity of the shell must not have been great. Neither fold nor sinus is well developed on either valve. The surface of both valves is regularly and finely costellate. The costellæ are about half the width of the interspaces, subangular to rounded above.

They increase principally by bifurcation, but also by implantation. The rounded interspaces show fine concentric growth varices, especially on the postlateral zones.

The interior of both valves is regularly costellate in a manner just opposite to the exterior. No clearly differentiated zones of musculature have been differentiated from the interiors at hand, but poorly defined zones on the postlateral slopes of the ventral inner umbo seem to be muscle scars. Median septa are present in each valve, and they seem to be subequal in length. The hinge zone is crenulated in the manner illustrated by Clarke, 1908 (pl. 45, fig. 10), for *Eodevonaria hudsonicus* Clarke and his metatype *gaspensis.* This coarse type of hinge crenulation is in contrast to any other type found in the Colombian deposits, and has not been hitherto recorded from the Southern Hemisphere, although the extreme features of several South American forms bespeak relationship to this species, as brought out below.

Dimensions.—Typical adult examples measure as follow: hinge width, 18 mm., 12 mm.; mesial length, 10.5 mm., 8 mm.; respectively. The usual height of a ventral valve above the commissure plane does not exceed 2-3 mm.

Discussion.—This form appears to belong to the *Eodevonaria hudsonicus* group of Clarke, 1900 (p. 49, pl. 7, figs. 1-6), and 1908 (p. 238, pl. 45, figs. 6-15), but shows certain advanced characters. The stock does not appear to be well developed in the "boreal" Onondagan. It now seems very likely that this species has been several times reported from South America, but has been ordinarily assigned to *Chonetes falklandicus,* which seemingly does not have a crenulated hinge. This character is easily overlooked when dealing with fragmental shells such as most South American material of the past has been. In general contour and surface ornament, *Eodevonaria reedi,* as well as many forms assigned to *Chonetes falklandicus,* recalls *Chonetes omalliana* de Koninck. Especially reminiscent are some of the Gedinnien forms in the Ardenne attributed to this species by Asselberghs, 1930 (pl. 3, figs. 8-11). This discussion will be continued under the general review of "austral" chonetids, below.

This is a relatively common form in the Colombian Devonian.

Types.—Holotype: Pal. Res. Inst. No. 5404A; paratypes: Nos. 5403, 5404B.

Genus **CHONETES** Fischer de Waldheim, 1830-1837

Genolectotype.—*Chonetes*, sp. Fischer (= *Chonetes variolatus* d'Orbigny, 1842, *fide* De Koninck, 1847) according to Schuchert and LeVene, 1929. Carboniferous.

At least two small species of brachiopods presumably attributable to this genus in the strict sense have been found in the Colombian Devonian strata. Neither form occurs in sufficient abundance or adequate state of preservation in our collection to warrant more than broad comparisons with already described forms.

?Chonetes cf. **stübeli** Ulrich Plate 8, figs. 20-22

Chonetes stübeli Ulrich, Beitr. zur. Geol. u. Pal. von Südamerika, Hft. I, 1892, p. 80, pl. 5, figs. 3, 4.

External and internal molds of several small chonetids occur in our collections which have a close similarity to Ulrich's *Chonetes stübeli* of the Bolivian Devonian. The Colombian material, although fragmental, shows the bases of a pair of spines near the extremities of the hinge on either side of the beak, and a smooth hinge line. This would seemingly warrant the generic assignment. The surface of the tiny shells is corrugated coarsely in much the same manner as the Bolivian material. From 15 to 18 coarse radii are present on each valve. Very fine concentric varices are also apparently present. This feature was not recorded on the shells from Bolivia, but is probably present there. One ventral valve (5443A) shows the imprint of a median septum. The closest "boreal" relative of the present form, and also apparently Ulrich's Bolivian material, seems to be some of the shells described by Clarke, 1908, from the Grande Grève limestone of the Gaspé as *Chonetes billingsi.* Apparently Ulrich was quite justified in comparing his material with the American *Chonetes mucronatus,* for until Clarke's species was described this would have seemed to be the most similar "boreal" form. I do not find that Ulrich compared his species with the quite dissimilar *Chonetes coronatus* (Conrad) and *Chonetes comstocki* Hartt as Clarke, 1913 (p. 300), reported. Clarke (*idem,* p. 299) pointed out, as Ulrich before him, that this species is very similar to North American early Devonian forms. Weisbord's *Chonetes zuliensis,* 1926, is a somewhat larger, coarsely plicated shell, possibly belonging in the same line, but apparently specifically distinct. It appears now that Clarke may have been too all-inclusive in designating so many quite dissimilar forms of shell in the Gaspé to his *Chonetes billingsi.* In making comparisons, the forms with nodose costæ which Clarke illustrated from the Gaspé have not been considered. This species, known in such fragmental state in Colombia, will probably be referable to a new chonetid genus now in process of description by Cooper* from the Michigan Devonian. The apparent fold in the specimen illustrated, which gives the fragment a tropidoleptid appearance, is a crushed zone and therefore quite misleading. Another closely related form, possibly conspecific with the present one, is discussed below.

Studied material.—Pal Res. Inst. Nos. 5443A, 5483, 5483A.

?Chonetes aff. **billingsi** Clarke, gens. Plate 7, figs. 7, 8

Chonetes billingsi Clarke, N. Y. State Mus., Mem. 9, Pt. 1, 1908, p. 209, 238, pl. 41, figs. 18-29, *pars.*

A few small globose impressions of chonetids with numerous rounded radii separated by excavate interspaces of about twice the width of the adjoining radii have been found in the Colombian collection. None of these is, however, adequately represented to make detailed comparisons possible. The closest resemblance which has been noted, is with the Gaspé forms included by Clarke, 1908, in his original analysis of *Chonetes billingsi.* The globose forms, such as Clarke illustrates by his fig. 24, seem to be very similar. The form may eventually prove to belong with the ones attributed to *Chonetes stübeli* Ulrich, above, if renewed study proves the wisdom of including in the *Chonetes billingsi* gens all of the forms which Clarke shows, some of which are certainly closely allied to *Chonetes stübeli* Ulrich of Bolivia.

Illustrated specimen.—Pal. Res. Inst. No. 5460B.

A Comparison of "Austral" Chonetids

Species of the Chonetidæ are relatively numerous in the various faunal analyses of "austral" Devonian deposits. The purpose of the following review is to bring out in the absence of essential comparative materials, what seems to be the relationship of the Colombian forms to the broader "austral" picture of the group.

Ulrich, 1892, described three chonetids from the Bolivian De-

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* Personal communication, 1938.

vonian: *C. arcei, C. rücki,* and *C. stübeli,* of which certainly *C. arcei* is an *Eodevonaria,* since in addition to quite unmistakable chonetid features, it has a crenulated hinge. Breger, 1906, in his original paper on the genus pointed out this fact. It was the crenulated hinge presumably which lead Knod (p. 581), to list the form as a *Stropheodonta,* wherein Clarke, 1913, gave tacit assent, for reasons not explained. Reed, 1925, followed the lead of Knod and Clarke in similarly identifying one of the Bokkeveld fossils, which appears to be still another species of *Eodevonaria.* It now appears from a distance that Ulrich was correct in his diagnosis for his time; that Breger was similarly correct, and likewise Thomas, 1905, in considering Ulrich's species a *Chonetes* when drawing comparisons for the Argentine strata. In this last connection, however, it now seems as it did to Clarke, that Thomas's Argentine form assigned to Ulrich's species is definitely distinct. It is proposed at this time that henceforth the Argentine species illustrated by Thomas, 1905 (p. 258, pl. 13, figs. 26a-c), be known as *Eodevonaria thomasi.* It was this form which Clarke, 1913, overlooking Breger's previous (1906) pronouncement on *Eodevonaria arcei* (Ulrich), nominated as first representative of the genus in South America. Ulrich's species is more transverse, has fewer striæ, larger ventral muscle area which is definitely bilobate, and less convexity to the ventral valve than *Eodevonaria thomasi,* new, of the Argentine. The Argentine form approaches the Colombian species *Eodevonaria imperialis* in the convexity of the ventral valve, but is without the bulbous swelling of the species in the strict sense, or the incipient swelling of the *parva* variety. The Colombian material has coarser costellæ which show much less tendency to bifurcate than either the Bolivian or Argentinian species. In all of these respects the Colombian form is more like the "boreal" forms of the Onondagan than any other of its known congeners in the Southern Hemisphere. In passing, it seems likely that the Bokkeveld fossil having the affinities of *Eodevonaria arcuata* Hall, (Reed ,1925, pl. 4, fig. 13), is really a distinct species very closely related to *Eodevonaria imperialis,* new.

Chonetes rücki Ulrich and *Chonetes stübeli* Ulrich are smaller shells, only the last of which is tentatively identified in the Colombian deposits. Both of Ulrich's species appear to be bona fide forms of *Chonetes.* Their relationships have been discussed more fully by Clarke, 1913.

Knod, 1908, in studying the Bolivian Devonian, identified the last two species of Ulrich, mentioned above, and also *Chonetes falklandicus* Morris and Sharpe, which is discussed below. *Strophedonta katzeri* Knod (p. 538, pl. 27, figs. 1-3a) bears the same relationship to *Stropheodonta,* apparently, as far as his description and figures will instruct us, as *Chonetes arcei,* which he also assigned to *Stropheodonta.* The pustulose exterior, and exceedingly granulose interior of *Stropheodonta katzeri* as well as the general contour and outline of the shell, the median septa, indefinite musculature and frail cardinal process all strongly bespeak the Chonetidæ. The crenulate hinge (not illustrated, but implied by Knod) smacks strongly of *Eodevonaria* to which I am prone to assign Knod's species. Clarke, 1913 (p. 290), thought of this as a true stropheodont related to the Oriskanian *Stropheodonta magniventer* Hall. That opinion I cannot share. However, if I am correct, *Eodevonaria katzeri* is much the largest species of the genus, of which I am aware. It differs principally from both *Eodevonaria arcei* and *Eodevonaria imperialis* in its adult giantism. Incidentally, Knod's *Stropheodonta perplana* (Conrad) (*idem,* p. 540, pl. 27, fig. 4) is a Chonetid and certainly not a stropheodontid and has all the internal dorsal earmarks of *Eodevonaria.* It may very well belong to his species *E. katzeri.* Clarke, 1913 (p. 289), doubted Knod's specific identification, but ventured no other opinions. Incidentally, Reed, 1925 (pl. 4, fig. 10), apparently also has compared a chonetid from the Bokkeveld to Knod's *Stropheodonta katzeri.*

In the Argentine Devonian (and Silurian? in some cases) *Eodevonaria arcei* (Ulrich) may be present, and *Eodevonaria thomasi,* new, is certainly represented. The other reported chonetids are all of the small, true *Chonetes* aspect, and not of immediate interest in Colombian comparisons. This will include the forms identified by Thomas, 1905, as *Chonetes coronata* Conrad, in the specific identification of which I share Clarke's, 1913 (p. 300), scepticism. It is more likely one of the small Bolivian or Brazilian species of *Chonetes* or close congener. To this last group would also go Kayser's, 1897, small *Chonetes fuertensis*, from Argentina, which Clarke, 1913 (p. 300), considered as Silurian (an age determination which is open to considerable difference of opinion, incidentally).

That Morris' and Sharpe's *Chonetes falklandicus*, 1846, is of widespread distribution in "austral" Devonian faunas can not be doubted. But certainly the identifications of this species have been in many cases of unwarranted breadth and inclusiveness. Reed, 1925 (p. 42), has attempted to purify these assignments by close comparisons with the apparent intentions of Morris and Sharpe, and has thereby tended as I do, to question several of Clarke's figures, 1913 (pl. 24, figs. 1-7, 9-11, 13, 15-21, 23-25), and possibly Kozłowski's, 1923 (pl. 12, fig. 5). When species of small Chonetids are being split as finely as almost all of the authors on "austral" Devonian have tended to do, it seems hazardous indeed to include under one heading what even in "boreal" faunas would pass for possibly four or five separate species. Clarke's figure 1, for example, might easily belong to *Eodevonaria reedi* of this paper, whereas his figure 18 would easily pass for a young *Eodevonaria imperialis.* It was this last form, incidentally, which Reed, 1925, compared with *Eodevonaria arcuata* (Hall) in pointing out the probable relations of certain Bokkeveld fossils. In molds and casts it is exceedingly easy to overlook crenulated hinges, especially if dealing with supposed representatives of a non-crenulate group. Clarke's figure 25, while showing a median ridge which is a recapitulatory feature of the protegulum of many chonetids (*e.g.* Clarke, 1909, pl 45), recalls Williams's, 1916, *Chonetes striatissimus* or even Clarke's, 1909 (pl. 45), *Eodevonaria antiops* (Billings).

Chonetes scottsbergi Clarke, 1913, from the Falklands, belongs to the smaller chonetid group, having its affinities with *Chonetes coronata* and relatives, and is unknown from Colombia. *Chonetes hallei* Clarke, also from the Falklands, with which Reed, 1925, compares certain Bokkeveld shells, may well be an *Eodevonaria* rather than a *Chonetes.* Clarke interpreted certain indistinct hinge "prickles" as impressions of hollow spines. It strikes me that this form should be closely compared with *Eodevonaria katzeri* (Knod).

The only form in the Brazilian Devonian described by Rathbun, 1874, and Hartt, 1878, which seems likely to be an *Eodevonaria* is *Chonetes onettianus* Rathbun, the similarity of which to *Eodevonaria hudsonicus* (Clarke), Clarke, 1913, pointed out. The hinge is not known to be crenulated in Rathbun's species, however. *Chonetes comstocki* Hartt and *Chonetes herbertsmithi* Hartt, as well as *Chonetes frutasi* Rathbun and *Chonetes cuaræensis* Rathbun, are small *Chonetes, s.s.,* no relatives of which are known from Colombia, and the bearing of which to other small "austral" and "boreal" forms need not here concern us.

Eodevonaria reedi, new, of this report differs from *Chonetes falklandensis, s.s.,* in the possession of hinge crenulations, apparently absent in the Falkland species, *sensu stricto* at least, and differs from most of the transverse forms assigned to that species in that the radii of the Colombian species principally increase by bifurcation. The Colombian species may prove to be very similar to Rathbun's *Chonetes onettianus* if that form proves to be an *Eodevonaria,* for both seem to belong to the *Eodevonaria hudsonicus* species-group.

The three new species of *Chonetes* described by Weisbord, 1926, from the Venezuelan Devonian are really not adequately known or sufficiently preserved to make comparisons very meaningful. It is likely, however, that his *Chonetes subhemispherica* (*idem,* p. 15, pl. 3, fig. 9) on the basis of probably globose contour of the ventral valve and relatively coarse radial ornament, may be allied to *Eodevonaria imperialis* of this report. His comparisons were principally with *Eodevonaria arcuata* of North America. While Weisbord was apparently quite correct in his generic assignment of this Venezuelan species to *Eodevonaria,* in the absence of essential generic features in the material which he had for examination, contour alone was the criterion used. That the Venezuelan and Colombian species are distinct is suggested, in addition to the evidence of general contour factors, by the presence on the surface of the Venezuelan material of a medial thickened riblet which has not been observed in the Colombian material. It seems very unlikely that Weisbord's figure 10, plate 3, assigned with question to his *Chonetes subhemispherica,* can possibly be conspecific with his figure 9. His specimen illustrated as figure 9, I feel should be designated the lectotype of the species and the proposal is here so made. Figure 10 is far too transverse, and has all the signs of being a highly distinctive new species. Certainly, if it proves (as Weisbord suggested it might) to be the dorsal valve of his *Chonetes subhemispherica,* then his species has little or no bearing on the Colombian species *Eodevonaria imperialis,* which exhibits none of the pecularities of this dorsal valve which Weisbord illustrates. It seems likely, moreover, that Weisbord's *Chonetes venezuelensis* may embrace several species, some of which, as he suggested (*idem,* p. 15) may belong to *Eodevonaria.* The first illustrated specimen (his fig. 3, plate 3) may well be designated the lectotype of the species, and therefore apparently insure a highly distinctive form for the name. The species as thus determined has as yet no known congener in the Colombian deposits, unless the specimens illustrated as *Strophonella floweri,* new, on plate 2, figs. 2 and 3; plate 10, figs. 9-11, should prove to be so related. His figure 4, plate 3, may well be the internal ventral mold of his species *Chonetes subhemispherica,* judging from the similarity to the ventral internal molds of *Eodevonaria imperialis* of Colombia. His figure 5, on the same plate, assigned to *Chonetes venezuelensis,* appears to have the general outline and ornamentation of *Eodevonaria reedi* of this paper, and figure 8, questionably assigned to *Chonetes venezuelensis* by Weisbord, may well belong to still another line. His figures 6 and 7 appear to be probably conspecific with the form here designated as lectotype of his species.

Genus **CHONOSTROPHIA** Hall and Clarke, 1892

Genotype.—*Chonetes reversa* Whitfield, 1882. Devonian.

Chonostrophia knodi Caster, n. sp. Plate 9, figs. 8-11

?*Strophomena* γ Ulrich. Ulrich, Beitr. zur. Geol. u. Pal. von Südamerika, Hft. 1, 1892, p. 70, pl. 4, fig. 25.

?*Stropheodonta perplana* (Conrad), Knod, R., Neues Jahrb. für Mineralogie etc., Beil.-Bd. 25, 1908, p. 540, pl. 27, fig. 4.

The illustrations on plate 9 convey all that is known of this rare chonetid in the Colombian Devonian. The fragment before me consists of an incomplete dorsal mold on which peripherally some of the surface markings are imprinted. This shell is very slightly concave, but appears to have been somewhat deformed from an original condition of low convexity, or at most from a planate state. The hinge is straight, and seems to show the position of several external spines on either side of the beak as faintly nodose swellings on the mold. No hinge crenulations of any type are observed. The scutellate form is conveyed by the illustrations. The surface is radially very finely costellate, there probably being several hundred very fine radii at the margin of the shell. As far as the imperfect specimen will lead me to judge, the radii increase both by intercalation and bifurcation. On the inner mold the peripheral radii leave an impression, whereas the older part of the shell seems to have been covered internally by a secondary mantle deposit. The inner mold shows the presence of a prominent median septum, which is fused posteriorly to a tiny subumbonal platform from which a frail bipartite cardinal process apparently extends backwards for a short distance over the hinge line. Radiating from essentially the junction of the septum and posterior platform are prominent crural plates which diverge anteriorly at about 110°. Behind these and adjacent to the palintrope are dental sockets fronted by elevated ridges. The illustration is natural size.

Discussion.—It is impossible on the basis of the material at hand to determine the precise generic standing of this form. Certainly from the tripartite structure in the inner dorsal mold (crural plates plus median septum) the chonetid character is pretty clear. While the delicate radial ornamentation suggests very strongly, as also does the planate condition of the shell, the genus *Chonostrophia* (a resupinate or planate chonetid), the determination is at best mildly hazardous. The Colombian species definitely recalls specimens of *Chonostrophia complanata* (Hall), 1859, or *Chonostrophia dawsoni* (Billings), as recorded by Clarke, 1908, (pp. 210, 241, pl. 46), from the Grande Grève limestone. Hall's original material from the Oriskany sandstone, and the species as recorded by Clarke, 1900, from the Becraft Mountain

Oriskanian are ordinarily much larger forms with apparently somewhat coarser radii. Smaller individuals from these faunas, however, in the New York State Museum collections, recall the fragment from Colombia. The similarity between the Gaspé forms and the Colombian may be an entirely superficial resemblance.

In the South American Devonian, two forms have been illustrated from the Bolivian Devonian strata which are in likelihood representatives of the present species, or at least closely allied forms. *Strophomena γ* Ulrich, 1892, has the same size and proportions as the present Colombian species, and as far as I can glean from the rather noncommittal analysis may well be the present species. It shows the same type of fine ornament, suggestion of planate or slightly resupinate form, relatively strong crural plates and sockets, but no suggestion in Ulrich's illustration of a median septum, which may well have been covered with surface material. Clarke, 1913 (p. 83), pointed out that the *Stropheodonta perplana* (Conrad) of Knod, 1908, was certainly not Conrad's species. It has more the semblance of a planate chonetid than a stropheodont. As far as known, the hinge of Knod's specimen was not crenulate, and certainly the strong median septum, divergent crural plates and relatively prominent sockets all better describe *Chonetes* (or *Chonostrophia*) than *Stropheodonta perplana* (Conrad). Knod's illustration apparently conveys an erroneous concept of concavity to the dorsal valve illustrated, for it is described as subplanate. The fine radii which are impressed upon the inner mold of Knod's specimen recall the present Colombian species rather than *Stropheodonta*. It may have been this form that Kayser, 1897, had before him when he reported *Chonostrophia,* sp. from the Argentine Devonian.

Type.—Holotype: Pal. Res. Inst. No. 5420A.

Order **TELOTREMATA** Beecher

Superfamily **ATRYPACEA** Schuchert and LeVene

Family **ATRYPIDÆ** Gill, 1871

Subfamily **ATRYPINÆ** Waagen, 1883

Genus **ATRYPA** Dalman, 1828

Genotype.—*Anomia reticularis* Linnæus, 1767.

Several specimens of *Atrypa* are in the Devonian collection from Colombia. This is the second time (Weisbord, 1926, the first) that the genus has been reported from the "austral" Devonian, to my knowledge. Somewhat better material in the Colombian collection than was available to Weisbord from Venezuela shows sufficient structural features to warrant assigning a new specific name to this Andean form, with which Weisbord's specimens are apparently conspecific.

Atrypa harrisi Caster, n. sp. Plate 7, figs. 22, 23, 24; Plate 10, fig. 19; Plate 11, figs. 4, 5

Atrypa cf. reticularis (Linné). Weisbord, Bull. Amer. Pal., vol. 11, No. 46, 1926, p. 17, pl. 4, figs. 2, 3.

Shells large, ovate or transverse, moderately inflated; greatest width of shell about one-third the length in front of the hinge; posterior somewhat produced; hinge considerably shorter than maximum width; posterior extremities regularly rounded; fold and sinus obscure. Surface ornamentation, shown by the figures on plates 7 and 10, consists of rounded radii which increase principally by implantation, but occasionally by splitting. The radii are definitely terraced where crossed by the relatively regular varices of growth. By the development of a slightly anteriorly expanding frill at each varix the effect created for each radius is that of a pile of elongate, slightly inflated pipes inserted one within the other.

The posterior ventral exterior (plate 11, figs. 4, 5) is incurved laterally and ornamented with elevated carinæ which parallel the hinge. These appear to originate as postlateral peripheral varices which continue in accentuated degree behind the posterior angle where the radii are not present. Whether these strong lines on the posteriorly incurved portion of the shell continue onto the palintrope surface has not been determined, but the presumption is that they do not. The characteristics of the dorsal valve are not known.

The interior of the ventral valve is dominated by a deeply recessed rostral cavity which was occupied by the muscles. The details of the interior of the specimens are essentially the same as those assigned to the genotype in the North American Devonian. (*See, e.g.* Hall and Clarke, 1892, pl. 55, fig. 9.) The relative breadth of the muscle recess is somewhat greater in the Colombian specimens than in average "boreal" forms. Likewise, in the Colombian specimens the vascular sinuses are somewhat less arborescent and the hinge teeth somewhat more powerful, and also more strongly posteriorly recurved. The illustrations are natural size.

Discussion.—The basis for assigning the Colombian material to a distinct species rather than to the ubiquitous "*Atrypa reticularis*" lies in the fact that up to the present the species has been so broadly identified both biologically and stratigraphically that it is by itself essentially generic. Until the time when a world-wide study of the type undertaken in the United States, for example, by Fenton and Fenton and more recently by Stainbrook, 1938, for certain Devonian forms, and by Grabau, 1933, for the Chinese Devonian *Atrypa,* is completed, it is much more helpful to designate highly characteristic forms by new specific names. This procedure gives us "handles" for future wide comparisons. Paleontology is little advance by reactionarily assigning such forms, without description or even examination, to "*Atrypa reticularis*". While no *Atrypa* of precisely the stamp of the Colombian form is known in "boreal" faunas, the closest resemblance, aside from Weisbord's Venezuelan fragments of uncertain structure, lies in the Onondagan. For example, Kindle, 1901 (p. 598, pl. 6, fig. 10), illustrated an Onondagan form much recalling the ornamentation of the Colombian species, likewise the forms occurring in the Camden chert (*e.g.* Dunbar, 1919). Certain explanate forms from the Onondagan are reminiscent of the Andean material. Those, for instance, discussed by Hall, 1867 (pl. 51), under *Atrypa reticularis,* and especially the forms assigned to this species which Hall, 1867 (p. 316, pl. 52, figs. 7-10), compared with Sowerby's *Atrypa desquamata* of Europe and Asia are significant in the connection. Grabau, 1933, (p. 174, pl. 26, *e.g.* figs. 2, 5), illustrated a variant of Sowerby's species *Alltrypa desquamata,* (var. *magna* Grabau) which in size and external features seems to show genetic bearing to the Colombian species, and it is to this division of "*Atrypa re-*

ticularis", best developed in the lower Middle Devonian, that it seems that the Colombian form belongs.

Types.—Holotype: Pal. Res. Inst. Nos. 5399, 5401B, ventral internal mold and partial (posterior) ventral external mold of one individual; paratypes: Nos. 5400, 5402.

Atrypa harrisi, var. **nasuta** Caster, n. var. Plate 11, figs. 1-3

An external and internal ventral mold of an atrypoid shell is at hand which has features sufficiently distinct from the species described above to warrant varietal, if not at this time specific (or even possibly generic) distinction. The illustrations bring out the salient features of the material at hand. Noteworthy is the posteriorly attenuate condition of the shell, and anterior expansion, the maximum width being at about the anterior third. The radii are subangular, and show less evidence of lamellation than the species, *s.s.*. Relatively fine varices are present on the sides of the shell, but show little tendency to become foliate. The internal ventral mold, although poorly preserved, shows only a very shallow and comparatively small rostral cavity, which bears mesially a platform (the reverse of the usual atrypoid condition) to which the adductors were attached. This platform is bifid posteriorly. The surface radii are impressed on the internal mold in reversed and subdued relief.

Discussion.—So very different are the internal features of this shell from those of specimen 5402 (plate 7, fig. 24) which is intermediate in size between the present variety and the holotype of the species, *s.s*, that it seems highly unlikely that the present form could be an ontogenetic stage of the larger individuals. At this time it is futile to attempt wide comparisons of this shell, which is so inadequately known, for obviously its significance in the Colombian fauna is not clear.

Type.—Holotype: Pal. Res. Inst. Nos. 5401-5401A, external and internal molds of a ventral shell.

Family **COELOSPIRIDÆ** Hall and Clarke, 1895

Genus **Vitulina** Hall, 1860

Genotype.—*Vitulina pustulosa* Hall. Middle Devonian.

Vitulina, sp. Plate 7, figs. 30, 31; Plate 13, fig. 23

One small *Vitulina* shell fragment is at hand which is highly interesting, but not specifically identifiable. The features as known are shown by the illustrations. Of undoubted diagnostic importance is the pauciplicate surface of this much flattened dorsal valve which is very finely and irregularly pustulose and lamellate. The pustules are not oriented in any special manner on the lamellæ, nor are they in radial series, thus differing from any of the other delicately spinose spiriferoids found thus far in the Colombian fauna. The gross appearance and surface detail recall very much the forms assigned by Kozłowski, 1923 (pl. 9, figs. 26 and 27), to *Vitulina pustulosa* Hall. Neither the Colombian nor the Bolivian material is adequate for precise identification, but it does appear that they will prove to be congeneric, if not conspecific, when better material is known. It would not be amazing if some of the supposedly immature shells of *Spirifer kayserianus* Clarke, 1913 (*e.g.* pl. 19, fig. 1), should prove to be of the same line. If the ornamentation of these shells is regular, as it is in adulthood, then this comparison is unjustified, although the gross structure is very similar. I do not feel that the form from the Argentine attributed to *Vitulina pustulosa* Hall by Thomas, 1905 (pl. 14, fig. 43), is really that species, and would hesitate to compare the Colombian form with that from the Argentine. The same statement applies to the fossils similarly named by Knod, 1908 (pl. 17, fig. 15), from Bolivia, although it would not be surprising if his *Spirifer planoconvexus* were a *Vitulina.* This Colombian fossil may also very well be the form referred to *Vitulina pustulosa* Hall by Rathbun, 1874 (*cf.* his plate 9), from Brazil. Clarke, 1913 (p. 238), calls attention to the similarity between some of Rathbun's original material and Knod's, 1908 (p. 550, pl. 27, figs. 9-10), *Spirifer planoconvexus,* as well as *Spirifer plicatus* (Weller) and *Spirifer disparilis* Hall.

Illustrated specimen.—Pal. Res. Inst. No. 5460.

Genus **ANOPLOTHECA** Sandberger, 1855

Genotype.—*Productus lamellosus* Sandberger, 1850. Devonian.

Anoplotheca (?) silvetii (Ulrich) Plate 7, figs. 25, 26

Cf. Centronella silvetti Ulrich. Beitr. zur Geol. u. Pal. von Südamerika, Hft. I, 1892, p. 51, pl. 4, figs. 15a-d.

An external ventral mold of a tiny shell resembling in external sculpture the form described by Ulrich as *Centronella silvetti* has been found in the Colombian collection. The characteristics are shown very well on plate 7. It is supposed that the dorsal valve is planate in accordance with Ulrich's form which the ventral valve so much resembles. What the generic affinities of this form may really be must await the discovery of material from which internal anatomy may be studied. Clarke, 1913 (p. 217), suggested that this form is quite probably a terebratuloid, but may possibly belong to an "austral" genus as yet undefined. That it is not a *Centronella* is very likely. Its aspect is more like that of the genus *Anoplotheca* than any other genus with which I am familiar. The relatively broad median riblet of the exterior seems the best of all features available on the present material to separate this tiny shell from *Leptocœlia flabellites,* to which it was first attributed. It is also somewhat more narrow than typical *Leptocœlia flabellites.*

Illustrated material.— Pal. Res. Inst. No. 5460C.

Superfamily **SPIRIFERACEA** Waagen
Family **SPIRIFERIDÆ** King, 1846
Subfamily ? **RETICULARIINÆ** Waagen, 1883

A brief word on the broader relationships of the Colombian reticulariid to be described below may well be in order at this point. As George, 1932, has pointed out, the *uncispinei* and *duplispinei* types of reticulariids show more signs of homeomorphic parallelism than actual genetic affinity. It looks very much as though the genera possessing the "double-barreled" and ramose type of surface spines should be looked upon as constituting a subfamily group apart from the simply spinose, true reticulariids to which the present subfamily name would apply. For the genera *Phricodothyris* George, 1932, *Elytha* Fredericks, 1918, as outlined below, and certain, if not all, forms assignable to *Squamularia* Gemmalaro, 1899, (especially reminiscent are the American Carboniferous forms assigned to this genus by Dunbar and Condra, 1932, which have septate spines) the subfamily name *PHRICODOTHYRIINAE* would be extremely convenient, and is hereby suggested.

Subfamily **PHRICODOTHYRIINÆ** Caster, new subfam.

Genus **Elytha** Fredericks, 1918

Genotype.—*Delthyris fimbriatus* Conrad, 1842. Middle Devonian.

The generic features of *Elytha,* which has been considered (*e.g.* Schuchert and LeVene, 1929) a synonymyn of *Reticularia* McCoy, 1844, can be clarified somewhat in the light of George's, 1932, seemingly final establishment of the genolectotype of *Reticularia* as *Terebratula imbricata* Sowerby (Davidson, 1852), rather than the inadequately known *Reticularia reticulata* McCoy, 1844, of which the holotype is lost, or the genolectotype *Anomites lineatus* Martin, 1796 (Waagen, 1883). George, 1932, proposed the new genus *Phricodothyris* (genotype, *P. lucerna* George) for the *Anomites lineatus* Martin stock to which it appears quite certain that the Devonian genus *Elytha* Fredericks is ancestrally related. The principal distinction between the Devonian and the Carboniferous genera seems to be differences in complexity of the surface spines. In species later assigned to *Phricodothyris,* Young, 1880, (in Davidson, p. 275) described and George, 1932 (p. 528), illustrated the "double-barreled", septate spines bearing lateral double hooklets which are slightly inclined to the axis of the main spine. This has all the appearance of a phylogerontic condition (*See* Beecher, 1898, or Fenton, 1931). *Delthyris fimbriatus* Conrad, as described by Hall and Clarke, 1892 (p. 20), on the other hand, bears septate spines which are laterally nodose, or sharply spinulose, but, as far as known, shows no evidence of the double hooklets of *Phricodothyris.* This would correspond very well to a phylephebic condition of spinosity. It is interesting to note in this connection that the American forms assigned to *Squamularia? perplexa* (McChesney) by Dunbar and Condra, 1932 (p. 313 and fig. 22, p. 314), show sharp annular bands around the surface spines which in cross section vividly recall the structures interpreted by Hall and Clarke as lateral acute spinules on *Delthyris fimbriatus.* Whether this observation has any genetic significance will necessitate further investigation. The internal features of *Elytha* differ from *Phricodothyris* principally by the presence in the former of a very definite ventral median septum of the intermediate type in addition to well developed dental lamellæ. *Phricodothyris* (and also *Squamularia*) apparently lack a median septum whereas *Reticularia* possesses one. George has pointed out the variable nature of the dental plates in his genus. *Elytha* also is somewhat more prominently plicated than the usual forms assigned to *Phricodothyris*. It is highly probable, however, that some workers, discounting surficial features and time relations, will consider *Phricodothyris* as a synonymn of *Elytha*.

Elytha colombiana Caster, n. sp. Plate 13, figs. 1-8

Shells medium to large size, reticularioid; pauciplicate, noncorrugated fold and sinus; hinge line less than greatest width of shell, which occurs some little distance in front of the hinge; shell extremities broadly rounded, explanate; cardinal area high, posterior margin of shell regularly curved to palintrope surface without an angle; ventral beak very slightly incurved; dorsal beak essentially straight; delthyrial zone large, triangular and apparently perforated toward the ventral apex; both valves broadly plicated with about 6 plus 1 folds on each side of the middle; surface prominently lamellose and fimbriated. Each spine base is divided by a median septum, thus creating a double-barreled effect. The base of each spine is externally grooved at the position of the internal septum, but is cylindrical where it rises above the surface of the shell. The terete portion of each spine tapers toward the front, and in some cases appears to have overhung the lamella on which it arises. The pustules are definitely aligned, but at no place form continuous radii. There are about 30-32 pustules on the front margin of the median fold, which is about the equivalent to 2 pustules per millimeter on this region. Over some parts of the shell they are slightly more distantly spaced.

The internal ventral mold shows the presence of a well developed median septum and strong dental lamellæ which extend forward for nearly one-third the length of the shell. The dental lamellæ delimit a rostral cavity for the attachment of muscles, as shown by fig. 4, plate 13. In immature individuals the rostral cavity is not so prominent, but the dental lamellæ and median septum are still very prominent. In many specimens the stronger surface details, including the pustules, leave their reversed imprint on the mold.

The interior of the dorsal valve does not show evidence of a median septum in any of the material, although there is suggested a very slight median elevation in some forms, which separates the somewhat depressed elongate muscle scars on the postumbonal region. Rather weak crural plates leave the palintrope wall at a low angle, and shallow sockets apparently lie between them and the palintrope surface. The nature of the process is not shown by our material. The dimensions are shown by the illustrations.

Discussion.—Elytha colombiana is extremely closely allied to the genotype in North America, and may prove to be merely a varietal expression of that form. The chief differences, as can be seen by consulting Hall, 1867 (pl. 33), are a lower umbonal region, more obscure plicæ, and somewhat narrower ventral rostral cavity in the Colombian forms than in the average Oriskanian, Onondagan, or Hamilton forms commonly assigned to Conrad's species. To my mind, the greatest similarity exists between the North American types of *Elytha* (almost universally referred to *E. fimbriata*) occurring in the Onondaga limestone, rather than to those in the Oriskany and Schoharie below, or in the Hamilton above. The earlier forms as shown by Hall, 1867 (*e.g.* pl. 33, figs. 1-4), or later by Clarke, 1908 (pl. 32, figs. 10-13), from the Glenerie chert (Oriskanian) have more prominent plicæ, for the most part, and less elevated ventral cardinal areas. In the Hamiltonian forms the plicæ are very nearly absent in most cases, and the cardinal area considerably elevated, whereas in the Onondagan, an intermediate type of ornament and stage of cardinal elevation seems usually to occur.

Weisbord's *Spirifer meridioamericanus* from Venezuela, 1926, is also an *Elytha,* as a study of his types in the Paleontological Research Institution brings out. The specimen which he figures on plate 4, fig. 5, shows very well the "double-barreled" impressions of surface spines. The material fails completely to bring out the australospiriferoid surface ornamentation of the sort outlined in the original description. The principal difference between the

Venezuelan and Colombian material lies in the presence in the former of fine concentric varices in addition to the somewhat stronger lamellæ bearing the pustules. Weisbord's figures do not bring out this character. In the Venezuelan species the pustules are larger and more distantly spaced than in any of the Colombian specimens of *Elytha.*

Elytha colombiana is one of the commoner fossils in the Floresta faunule.

Types.—Holotype: Pal. Res. Inst. Nos. 5439-5439A, an external and internal mold of a ventral valve; paratypes: Nos. 5441, an immature ventral internal mold, 5440, 5440A, external molds, 5442, an immature internal dorsal mold, 5443, a fragment of external ventral mold showing surface details very distinctly.

?Subfamily **SPIRIFERINÆ** Schuchert, 1913

In the Colombian faunule both the mesially plicate and mesially glabrous groups of spiriferoids (Schuchert and LeVene, 1929, pp. 20, 21) are represented, but whether these features have any genetic significance such as would warrant tribal designation is highly problematical right now.

With the delimitation (1928, International Zoöl. Comm. Opinion 100, *e.g.* in Schenk and McMaster, 1935), by genotype recognition, of the genus *Spirifer* to forms having the stamp of the Carboniferous *Anomites striatus* Martin, 1809, most Devonian spiriferoids must be otherwise designated. Furthermore, their remoteness from the genotypic species is so great in most cases, that to recognize the several generic groups already proposed as subordinate to *Spirifer, s.s.,* is quite misleading. The reader is referred to the clarifying attempt at synthesis in the Spiriferidæ undertaken by Paeckelmann, 1931.

From the Colombian Devonian faunule, one species having a plicate fold and sinus and uncispinous fimbriate surface of the "*Spirifer divaricatus*" type is described below. Such forms are clearly assignable to a new genus, as yet undescribed. Three species with nonplicated fold and sinus are assigned respectively to the genera *Acrospirifer* Helmbrecht and Wedekind, 1923, *Brachyspirifer* Wedekind, 1926, and *Paraspirifer* Wedekind, 1926, while a fourth species, identified as "*Spirifer*" cf. *antarc-*

ticus Morris and Sharpe, appears to show homeomorphic relationship to *Acrospirifer,* but is too poorly represented in our collections to warrant establishing on it the seemingly necessary generic receptacle. A generic name *Australospirifer* is herein proposed for the austral stock typified by *Spirifer kayserianus* Clarke. *S. antarcticus* is assigned to it. The differences between these several lines of spiriferoid development are so clearcut that it is as difficult to reconcile them to one subfamily as to reconcile the phricodothyrids and reticulariids to the Reticulariinæ. This is hardly the place, however, to undertake the herculean task before paleontologists of unravelling the tangled strands of genesis in the spiriferoids.

The "*Spirifer divaricatus*" Group

For the relatively small and rather unique group of species in the early Middle Devonian (Onondagan chiefly extending into the Hamilton, especially of North America) which centers around "*Spirifer divaricatus*" Hall, a new generic or subgeneric name is in order. It is understood (personal communication, 1938) that Dr. G. A. Cooper has such a genus in process of description. The structural features of the "*Spirifer divaricatus*" species group include: multiplicate shells on which the plicæ are usually multibifurcate; plicæ covering both fold and sinus. The plicæ may be rounded, but are usually subangular, and the original plica in each case tends to stand slightly higher than any divisions arising from it, thus suggesting the beginning of a fasciculate condition. The surface is covered everywhere by fine, concentric lamellæ and occasionally carries prominent varices. Both bear numerous simple elongate pustules usually arranged in radial series and occasionally protruding in front of the concentric lines to form very short blunt spines. The effect of the concentric imbricating striæ crossing the subangular plicæ is a well developed zigzag pattern. Internally the ventral valve shows strong dental lamellæ, and no median septum, while the dorsal valve has strong crural plates which hang unsupported from the palintrope, but are fused laterally to relatively strong socket plates. A weak median septum is present in the posterior fourth of the shell and appears to arise from a hinge platform formed by the fusion of the crural plates behind. *Spirifer multicostatus* Castlenau, 1843, may be congenetic, and even conspecific, and therefore has priority over Hall's species, but at the present there seems little likelihood of establishing definitely the nature of Castlenau's original.

The *"Spirifer divaricatus"* group, as here used, corresponds to the "(f) *Divaricatus*" type of the *Aperturati* in Hall and Clarke, 1893 (p. 38). This was separated in their table from the "(b) *Striatus*" type: "1. *Texanus*" line (now known essentially *in toto* as *Neospirifer* Fredericks, 1918). They had previously (p. 27) indicated that the *Divaricatus* group is unusual in the Devonian and is anticipatory (albeit probably homeomorphy) in its pronounced dichotomization and fasciculation of the Carboniferous *Spirifer cameratus* group. Dunbar and Condra, 1932 (p. 327), say that *Neospirifer* apparently differs from the true *Spirifer* (*Spirifer striatus*) stock in having the plicæ fasciculate. They also feel that this type of plication is exclusively an Upper Carboniferous development, although recognizing various sorts of simple nonfasciculate bifurcation in earlier faunas, especially Mississippian. The condition in the *"Spirifer divaricatus"* group, which is beyond any doubt fasciculate, may be homeomorphic. But in view of the quite similar internal structure, including a dorsal median septum there is still a chance that they may be related. The dorsal median septum has been observed in several Onondagan and Hamiltonian forms of the typical species, although it has been consistently omitted in specific discussions. An undescribed species of this group from Kentucky, illustrated by Nettelroth, 1889 (p. 12, fig. 10), as *Spirifer divaricatus* appears to have a similar septum. It was this form which Williams and Breger, 1916 (p. 86), considered as very nearly identical with *Spirifer daleidensis* Steininger, 1853. I do not share the Williams and Breger opinion, although concurring to the extent of considering both Nettelroth's and Steininger's forms congeneric. Similarly, the dorsal median septum is seldom mentioned in the *Neospirifer* group, although apparently usually present. Hall and Clarke, 1893 (pl. 32, fig. 13), show this structure in a form which they identify as *Spirifer cameratus,* and which appears to be a *Neospirifer.*

The present species group differs principally in degree from *Neospirifer,* which appears to be its nearest relative or homeomorph. The fasciculation of plicæ extends further in the Carboniferous form, and the microstructures of the shells differ somewhat. In the *divaricatus* group the surface exhibits a simple fimbriate condition, with discrete pustules regularly distributed over the surface, usually in radial alignment, and raised above the lamellæ. In *Neospirifer* the surface ornament is described as "very fine radial liræ which are crossed by equally fine concentric lines, giving a finely grilled appearance to the surface that can be seen only when the shells are well preserved." This is a type of structure which it seems could have been easily derived from the condition in this group, especially from the Colombian species. The species described below is the first record of the *"Spirifer divaricatus"* stock in South America or to my best knowledge in "austral" regions.

"Spirifer" kingi Caster, n. sp. Plate 8, fig. 19; Plate 10, fig. 14; Plate 12, figs. 1-4

Shells of medium to large size, moderately inflated; fold and sinus prominent, and relatively broad anteriorly; entire shell radially plicated with moderately coarse bifurcating corrugations; hinge line greatest width of shell, extremities subacute or slightly rounded.

The shell plications are subangular on both lateral and mesial regions; in each case the original plicæ, of which there are apparently about seven on a side, and one each on the fold and sinus, originate on the beak and remain most prominent throughout the growth of the shell. The lateral branches remain auxiliary to the main plica, thus creating a fascicular condition. No more than four bifurcations to one fascicle have been observed, but none of the Colombian specimens retains the peripheral zone of the adult shell. The mesial fold is delimited by a somewhat deeper furrow on either side, and is plicated principally by divisions of lateral plicæ on the early part of the beak. The interspaces between corrugations are subangular. Plicæ become evanescent on the postlateral area. Superimposed on the primary corrugation is a striking zigzag surface pattern comprised of conspicuous concentric lamellæ which form subangular posteriorly directed chevrons on the plicæ and reverse chevrons in the interspaces. In some shells an occasional lamella is more prominently developed than the rest, thus giving a subrugose appearance to the shell. The surface slope of each lamella is toward the rear, with an abrupt declivity in front. The anterior two-thirds of each lamella bears a regularly spaced series of elevated pustules arranged throughout the shell in a radial manner. Each pustule is slightly produced beyond the edge of the corresponding lamella to form an anterior spinose edge to each varix, thus giving to some specimens a delicately hirsute appearance. The pustules are apparently simple, and if hollow, certainly show no evidence of a median septum. There are about ten pustules on a side of each primary plica near the front of the shell.

The characteristics of the ventral valve are not known. The dorsal valve bears internally on the posterior third of the median fold a well defined septum which separates the inconspicuous narrow muscle zone, also located essentially on the fold. Posteriorly the median septum merges with a low arrowshape platform which gradually rises to join a "hinge plate" formed by the median coalescence of extensions of the crura. The crural plates stand out in bold relief from the inner palintrope wall and over-hang the visceral cavity. They appear to be attached postmedially toward the commissure plane to rather rugged socket plates, thus with the socket plates forming a curious "isoclinally" folded zone on either side of the beak. There seems to be a low bosslike cardinal process which rises from the "hinge plate" but does not over-hang the hinge.

The dimensions of typical material are given by the plate figures.

Discussion.—The comparisons for this unique South American form are wholly with the *"Spirifer divaricatus"* stock in northern faunas. From the typical Onondagan and Hamiltonian forms of the stock the Colombian species differs in having slightly fewer plicæ on the periphery of the shell. This implies slower rate of bifurcation, and a more marked tendency for the primary plica in each case to rise higher than the derivitives, thus creating more pronounced fasciculation, and recalling more vividly the neo-spiriferoid condition of the Carboniferous. The median dorsal septum is also somewhat more prominent in the Colombian form than in the North American representatives. The zigzag varices are usually sharper and more closely crowded on the "boreal" species than on Colombian. Most important is the difference in pustules. In Colombia they are conspicuous on the surface as rounded elevations tapering off posteriorly for about two-thirds the width of the relatively wide varices. In the North the pustules are smaller, not ordinarily obvious on the surface of the lamellæ except at the very front margins, and regularly extend as sharp little spines from the edges of the lamellæ so inconspicuous as hardly to warrant saying they are radially arranged. It seems likely that specific differences in this group must be drawn principally on the details of surface ornament, for the internal features and general surface contour of the group, wherever known thus far, appear to be very conservative. The only spiriferoid shell of which I am aware in South America having any suggestion of a plicated fold and sinus is *Spirifer hartti* Rathbun, 1878. That species was described as having a trilobed sinus and fold and about seven flat radii on each side of the fold and sinus. It is not unusual to find forms of this species group showing a tendency to suppress the bifurcation of the radii. The primary plica in the sinus, plus lateral bounding plicæ, if the latter should bifurcate only once, would easily create a "trilobed" median zone. Unfortunately naught is known of the surface ornament of Rathbun's species, and the comparison is pure conjecture.

Types.—Holotype: Pal. Res. Inst. Nos. 5397-5397A, external and internal molds of a dorsal valve; paratypes: Nos. 5397B, 5397C.

Genus **ACROSPIRIFER** Helmbrecht and Wedekind, 1923

Genolectotype.—(Allan, 1935, p. 17) *Spirifer primævus* Steininger, 1853. Lower Devonian.

Acrospirifer was proposed for early Devonian spiriferoids of the stamp of *Spirifer primævus* Steininger, one of the genosyntypes, which Allan, 1935, selected as genolectotype. While I am not prepared to judge the somewhat broader application which Allan recommended, by which his gens of *Spirifer hercyniæ* Giebel (including Scupin's, 1900, supposed genetic line *Spirifer hystericus-subhystericus-primævus-hercyniæ-paradoxus*) was referred to *Acrospirifer, in toto,* if the line is truly phylogenetic, Allan seems quite justified. This genus will include the North American *Spirifer raricostus* group (comprising among others *S. cyclopterus, S. murchisoni* and *S. gaspensis*). *Acrospirifer,* at least as developed in North America, and of which alone I feel more nearly competent to speak, is characterized by wholly fimbriated shells (*Fimbriata uncispinei* of Hall and Clarke, 1893). These are pauciplicate with a uniplicate anterior commissure, and relatively few lateral plicæ. In Northern forms there are usually five or six plicæ on a side, but there may be four, and some shells show evidence of seven or eight. In the ventral valve there are short dental plates and a median septum which in some cases is short and feeble, but may, as in *S. raricostus, s.s.,* be very well developed. There is also a median septum in the dorsal valve.

It appears, from a literature study only, that Grabau's, 1931, *Eospiriferina* is a synonymn of *Acrospirifer.* (It is perhaps of interest that before I had made the acquaintance of either *Acrospirifer* or *Eospiriferina* in literature, I coined the latter name in manuscript for the *Spirifer raricostus-Spirifer murchisoni* group.) All of the features of Grabau's genotype, *Eospiriferina lachrymosa* Grabau, 1931 (p. 494), which might be construed as generic, fit *Acrospirifer* very satisfactorily. This includes small size; few plicæ which are wider than high; smooth fold and sinus; hinge line shorter than greatest width; angles rounded; 4 plus 2 plicæ on a side; interspaces rounded and somewhat narrower than plicæ; two strong dental plates lying outside the bounding plicæ; faint median depression in the ventral inner mold suggesting an incipient septal ridge; entire surface marked by short sharp pustules of teardrop form with thickened end in front; these sometimes appearing arranged in lines, but also occasionally quite irregular. A few concentric lamellæ present.

Grabau said that the surface pustules "may be compared to some extent" with those in *Spirifer fimbriatus* (from all details shown, this must be a very generalized comparison) and recall better some of the North American *Spiriferina.* This seems to be an adequate diagnosis of the genus *Acrospirifer.*

Should future study bring out that Allan's surmise, 1935 (p, 17), is true that *Antispirifer* Williams and Breger, 1916, is merely a pathologic variant, then the question of priority of this name over *Acrospirifer* would arise. Certainly the genotype (*Antispirifer harraldi* Williams and Breger) has the stamp of the *Spirifer raricostus* group aside from its plano- or concavo-convex arrangement of the valves.

It is far from proven that the Paleozoic brachiopods usually referred to the genus *Spiriferina* (which has a Mesozoic genotype) are very closely allied structurally to that temporally remote form. The present genus, however, is certainly nearly as remote from *Spirifer, s.s.,* in both time and structure, and presumably could be assigned with as much justice to a new family as to either the Spiriferidæ or Spiriferinidæ.

The Colombian species described below seems to fulfill very well all of the requirements of either the genus *Acrospirifer* or *Eospiriferina,* and is apparently closely allied to this metropolitan early Devonian assemblage. It is truly amazing, however, that none of the superficially similar forms hitherto described from South America and South Africa can be satisfactorily assigned to the same generic group. In this stock, as apparently in all spiriferoids, surficial structure is of great genetic significance. Clarke has reported, 1913 (p. 252), that all the Brazilian spiriferoids (by implication most if not all of those in the South American Devonian, up to his time) belong to the *radiati* division of the *Spirifers.* Furthermore, Clarke, 1913 (pp. 260, 263-264), implied, when confronted with the complexity of comparisons between the South American forms and the North American, and unable to reconcile differences of surface structure in the two groups (discussed more fully below), that homeomorphy on a grand scale must have been operative. How far this applies to the New Zealand forms described by Allan, 1935, cannot be determined in the absence of the information on surface details. The Colombian faunule is strictly "boreal" in surface ornament and the generic relations seem certain. The South African and South American "austral" forms may well be assigned to distinct, albeit homeomorphic, genera.

Acrospirifer olssoni Caster, n. sp. Plate 7, figs. 28, 29; Plate 9, fig. 24; Plate 10, figs. 15, 18; Plate 11, figs. 10-12, Plate 12, figs. 10-13

Shells small, transverse; pauciplicate; moderately inflated ventral valve, and less convex dorsal one; hinge line greatest width of shell, slightly produced, acuminate; shell moderately constricted immediately in front of hinge in some specimens; in others apices regularly rounded; cardinal area relatively high; ventral beak slightly incurved; five or six regularly rounded plicæ on each side of median fold and sinus, which are without plications. Median sinus and fold delimited by plicæ and grooves respectively, which are somewhat more prominent than similar structures elsewhere on the shell. The plicæ are slightly wider than the interspaces in most cases, but may be much wider. Ordinarily the interspaces are as regularly rounded as the plicæ, but occasionally are subangular. The entire surface is covered with relatively prominent sublamellate varices which bear a regular simple series of elongate pustules everywhere on the surface. The pustules are arranged in radial alignment, but are entirely discontinuous, and show no signs of fusing into radii, or of originating as scattered pustules. Near the periphery of the shell the median fold bears over 100 pustules on one lamella, and the plicæ are similarly pustulose, there being about 20-25 pustules in 1 millimeter over the entire surface. Toward the postlateral apices the growth lines become rather strongly lamellate, or even subrugose. The plicæ are well shown on the inner molds, but on an average one or two fewer plicæ are present there than on the exterior. On the inner mold, also, the plicæ appear to be much more angular than on the external mold or actual surface of the shell. In some shells the concentric lines can barely be detected on the interior of the shell, but in no case has any sign of the simple pustules been seen there.

In the interior of the dorsal valve there is a well developed postmedian septum which extends for about one-third the length of the shell. The septum is attached to a rostral callus onto which it continues to the apex of the notothyrial zone which is relatively large and arcuately triangular. On either side of the septum postcentrally are elongate oval muscle scars which are recessed. The process appears to be broad, flattened, and slightly recurved. The crural plates originate on either side of the notothyrial zone, extend to the floor of the valve and protrude forward as slight knobs on the commissure plane. The area immediately adjacent to the crura is laterally filled with secondary calcification, thus forming a small "hinge plate" in which are found relatively deep, tearshaped sockets, but no structures which might be called socket plates.

The interior of the ventral valve shows a very prominent rostral cavity which is partially filled posteriorly by callus strengthening and thickening material. A short incipient septum divides the posterior part of the rostral cavity and the muscle scars located on its floor. The median part of the rostral cavity bears the diductor scars which are slightly arborescent. Laterally the cavity is bordered by extensions from rugged dental lamellæ which support strong, but radially small, hinge teeth. The apex of the delthyrial zone shows signs of being perforated. These features are shown by the illustrations.

Dimensions.—

	5409-5410	5397E	5447	5465B
Width hinge	24 mm.	19 mm.	24 mm.	9 mm.
Median width shell	12.5 mm.	10 mm.	17 mm.	6 mm.
Lateral plicæ	6 plus 1	5 plus 1	5 plus 1	3 plus 1

Discussion.—This species belongs very definitely in the *raricostus* branch of the spiriferoids, and therefore in the genus *Acrospirifer.* Its structural affinities are with the *Spirifer murchisoni-Spirifer gaspensis* stock of North America and structural equivalents in Europe. Although the general proportions recall strongly several southern species, such as certain forms referred to *Spirifer kayserianus* Clarke (*e.g.* Clarke, 1913, pl. 19, figs. 1, 3, 12) the details of surface ornament apparently preclude generic affinity. The alternative view is more likely: that in all probability several southern faunas, particularly those of Brazil, contain just such an admixture of homeomorphs as the Colombian fauna, and that in several instances the species as defined thus far are really polyphyletic. It would not be surprising if the cited figures on Clarke's plates refer to an undescribed species closely related to the present one. The specimens which Clarke illustrated differ from the Colombian forms by having much coarser and differently shaped punctæ, fewer plicæ and more planate dorsal shells. In no case do the Colombian specimens show any signs of ontogenetic shift in micro-ornament pattern such as Clarke records for the group here named *Australospirifer* (*Spirifer kayserianus* Clarke, genotype).

Weisbord's *Spirifer venezuelensis,* 1926, is definitely an *Acrospirifer* as an examination of his types brings out. The specimen which he illustrates on plate 4, fig. 6, is taken as the lectotype of his species. It shows a very prominent median sinus with extremely strong bordering plicæ. There are five or six plicæ on each side, and the surface is quite unmistakably of the *Acrospirifer* type. In the Venezuelan material, however, the plicæ are narrower, and higher than in Colombia, and the surface pustules are situated on much stronger and more closely spaced concentric lamellæ, which tend to become strongly chevroned on the plicæ in a manner recalling the surface ornament of *"Spirifer divaricatus"* . I have no doubt that the Colombian and Venezuelan species are closely related but they show easily detected differences.

The North American stock of *Spirifer murchisoni* apparently does not ordinarily have as prominent a median ventral septum, although one is certainly present in some cases recorded by Clarke from the Grande Grève (*e.g.* 1908, pl. 32, fig. 7). The ornament of *Acrospirifer olssoni* recalls very much that shown by Clarke, 1909 (pls. 30, 34), for *Spirifer aristookensis* although they differ in contour and general proportions. It recalls even more vividly *Spirifer cyclopterus* from the Gaspé region. The closest relative seems to be *Spirifer murchisoni* Castlenau especially as that form is developed in the Grande Grève limestone of Quebec. From this it appears to differ principally in having on the average one or two fewer plicæ on a side and those broader and more regularly rounded; also in having a somewhat more prominent median dorsal septum, and more recessed dorsal muscle scars. These are, of course, really insignificant differences, but appear to be adequate for distinguishing the widely separated forms.

Types.—Holotype: Pal. Res. Inst. Nos. 5409-5410, an external and internal mold of the dorsal valve; paratypes: Nos. 5447, a ventral internal mold, 5465B, an immature internal ventral mold, and 5397D, an internal dorsal mold.

Genus **AUSTRALOSPIRIFER** Caster, n. gen.

Genotype.—*Spirifer kayserianus* Clarke, 1913. Devonian. Brazil.

This typically South American genus is characterized by the curious combination of fimbriate, radiate and lamellose or concentric surface surcharge over a variably plicated shell ranging from pauciplicate to multiplicate in some species. The internal features are rather constant, showing a ventral median septum which in some species appears to be evanescent, and a dorsal median septum which also seems to be very faintly developed in some forms. Occasionally both are well developed, but either may be the stronger. The dental lamellæ are usually present as rugged plates, but may be elongate and septumlike. In virtually all forms the earliest part of the shell shows fimbriate structure which by alignment soon becomes radiate. The whole is usually also rather prominently concentrically marked, and especially is this type of ornament well developed in the newer parts of the shell. Clarke, 1913, and Kayser, 1897, have discussed the ornament in specimens assigned to *Spirifer antarcticus* Morris and Sharpe. Clarke, 1913 (p. 260), described this type of superficial ornament as follows in his description of the specimens which he referred to *Spirifer antarcticus* Morris and Sharpe with which he was comparing *Spirifer orbignyi* Morris and Sharpe:

> . . . the radially lineate surface is accompanied by slightly elevated lamellæ on which are well developed spinules in continuity with the radial lines. This is not a new observation, but is a confirmation of the structure made out by Kayser for the shells of like character. . . . Large shells usually fail to retain this character and external casts show only the marks of concentric lamellæ. It seems clear, however, that this fimbriate feature is to be accredited as a normal character of *S. antarcticus* and the combination of radii, spinules and lamellæ which we have shown to be present in several of the austral Spirifers is so highly distinctive that it is not known to me to occur in boreal species. . . . . All these facts indicate a common initial stock for the austral Spirifers

> which is unlike in sculpture any boreal stock, and the resultant mature or specific expressions seem to be the outcome of intensive and retrograde development under conditions of geographic isolation. (p. 264)

Clarke was obviously much impressed with the uniqueness of this group of "austral" spiriferoids, to which he assigned all his Brazilian material, and to which he implied that most previously described South American forms belonged. He was at a loss to make "boreal" comparisons, for the condition seemed to him not duplicated elsewhere. While admitting the unusual features of this development, I am neither impressed with the all-embrasive ubiquitousness of the group in "austral" faunas, nor of its utter dissociation from northern assemblages. Certainly in Colombia, as shown in this paper, many of the standard northern types of spiriferoids are present, and it is likely that this admixture of the elements from the antipodes is not wholly unique in this new faunule. Certainly many of the spiriferoids described from Brazil by Hartt and Rathbun, 1874, show none of the *Australospirifer* features, and even some of the specimens illustrated by Clarke are highly questionable.

Of the better known spiriferoids from South America, the following species seems to belong to *Australospirifer*: *Spirifer antarcticus* Morris and Sharpe, 1846; *idem,* Kayser, 1897; *idem,* Clarke, 1913 (*pars*); *Spirifer hawkinsi* Morris and Sharpe, 1846; *idem,* Clarke, 1913; *Spirifer kayserianus* Clarke, 1913 (*pars*); *Spirifer iheringi* Kayser; *idem,* Clarke, 1913; *?Spirifer parana* Clarke, 1913; *?Spirifer contrarius* Clarke, 1913; *?Spirifer laurosodreanus* Kayser, 1897; *?Spirifer chuquisaca* Ulrich, 1892, etc. All of these forms apparently show the structural features of the genus, although varying considerably in outline, number and type of plicæ, and degree of septation. *Spirifer antarcticus* Morris and Sharpe, 1846, has been an enigma ever since it was described, but if we may rely on the clarification which Clarke, 1913, gave the species as represented in the Falklands, it certainly has the surface details of the present genus, but has only the very faintest median dorsal septum (if any) and a relatively distinct ventral median septum. The form of the shells as reported by Clarke is exceedingly variable, and may be too inclusive. *Spirifer hawkinsi* and *Spirifer orbignyi* Morris and Sharpe are of the same general stamp and both possess a median dorsal septum as was originally shown (although the orientation of the valves was reversed in the plate analysis), and may possess a ventral one also. In *Spirifer kayserianus* Clarke the dorsal septum is very prominent, and the ventral one obscure. It is in this species that the ornamentation which I think of as crucial to the present genus is best developed (or at least most fully discussed). In *Spirifer iheringi* Kayser, especially as illustrated and discussed by Clarke, 1913, the radial ornament is very completely developed as it appears also to be in *Spirifer antarcticus, s.s.* In *S. iheringi* the median dorsal and ventral septa are best developed. *Spirifer parana, S. contrarius* and *S. lauro-sodreanus,* on internal features and the absence of contrary information on the exterior, appear to belong in the present genus. The *Spirifer buarqueanus* Hartt (in Rathbun) complex, as interpreted by Derby (in Clarke, 1913, p. 241), may also belong in this genus. Clarke's *Spirifer katzeri,* however, as well as Hartt's *Spirifer pedroanus* and the large specimen referred to *S. buarqueanus* by Katzer seem better referable to *Brachyspirifer* than to the present genus. Clarke presented no convincing evidence that they share the curious surface details of *Australospirifer.*

The surface texture of the present genus seems to be very much akin to the condition found in some of the forms which Hall and Clarke, 1893, assigned to the *Osteolati.* Clarke, 1913, referred all of his Brazilian spiriferoids to the *Radiati* on the basis of fine radial ornament, but they could in no sense be considered multiplicate (one diagnostic feature) although they are multiradiate. Furthermore, the presence of fine radii derived from elongate pustules of the fimbriate type recalls rather closely the condition in *S. marcyi* Hall. (*See* Williams, 1913, p. 54.) It is curious too, that Clarke, while pointing out that in some of the "austral" species the pustules or tiny spines are located on radii for part of the surface (precisely the description given by Hall and Clarke for their *Osteolati*), should still have pronounced them *Radiati.* The enormous delthyrial zone which Morris and Sharpe first described and illustrated in their *S. antarcticus* seems to carry through the entire group, and certainly fits the *Osteolati* picture very well. The intimation of a rudimentary syringeal plate in *Spirifer hawkinsi,* in Morris' and Sharpe's original analysis and Clarke's reanalysis, as well as a suggestion of this development in several of the "pre-syringothyrid" southern species (or variants), recalls *Spirifer marcyi* in the North which is a division of the *Osteolati.* From the boreal "pre-syringothyrids" (*see* Williams, 1913) *Australospirifer* differs principally in the recapitulatory aspect of the surface ornament, and in the presence of unusually strong concentric features in some representatives.

It looks now as though this "austral" Onondagan (or earlier) development may very well be the ancestral stock out of which the very typical "boreal" Middle Devonian *Osteolati* might have been derived. It still appears as though these primitive *Osteolati* developed a series of homeomorphs of the *Fimbriata unispinei* pauciplicates with which, in Colombia at any rate, they intermingled, and of course may possibly have interbred. *Australospirifer* may possibly be the ancestral stock of *Spinocyrtia.*

Two forms have been found in the Colombian fauna which seem quite definitely assignable to *Australospirifer.* Neither, unfortunately, is adequately known to make specific comparisons very reliable.

Australospirifer cf. **antarcticus,** var. 1. Plate 12, figs. 7, 8; Plate 13, figs. 21, 22

?Spirifer antarcticus Morris and Sharpe, Geol. Soc. London, Proc., vol. 2, 1846, p. 276, plate 11, figs. 2a, 2b.

Spirifer antarcticus Morris and Sharpe. Clarke, Mon. Serv. Geol. y Mineral. do Brasil, 1913, p. 258, pl. 18 (*pars*).

Several fragments of spiriferoid shell are at hand from the Colombian faunule which show many of the features usually assigned to *Spirifer antarcticus,* although hardly conforming to that species in the strict sense of the original designation or illustration. I have in mind such shells as Clarke, 1913 (plate 18, fig. 3), illustrated from Jaguariahyva as this species, the specific identification of which I feel may well be an open question. The lamellæ, even on these small shells, are exceedingly strongly developed. There are usually eight or nine subangular plicæ on each side, which are separated by contrastingly regularly concave interspaces.

There is no evidence of pustules on the early part of the shells, but then none is extremely well preserved. Over most of the shell the continuous fine lineations are well preserved, and in some instances can even be seen on the inner molds. The internal mold shows the presence of a pair of septumlike dental lamellæ which extend anteriorly for nearly one-third the length of the valve. They embrace not more than one plica on either side of the median sinus. A well marked median septum is also present in the ventral valve. The characters of the dorsal valve are not known. It seems futile to attempt further comparisons on such scant information, but the surface details coupled with the internal structure certainly point to shells hitherto referred to the Morris and Sharpe species, but which in all likelihood will warrant a separate name when better known.

Illustrated specimens.—Pal. Res. Inst. Nos. 5408, 5408A-C.

?Australospirifer cf. **antarcticus**, var. 2. Plate 7, fig. 27; Plate 13, figs. 19, 20.

Cf. Spirifer antarcticus Morris and Sharpe. Clarke, Mon. Serv. Geol. y Mineral. do Brasil, 1913, pl. 18 (*pars*).

Several fragmental specimens are at hand which have the contour, general plical arrangement, and internal ventral details of Falkland Island forms attributed to *Spirifer antarcticus* by Clarke, 1913. Without judging the accuracy of Clarke's portrayal of the species, present comparisons are made with such forms as those which he diagnosed as the Morris and Sharpe species on his plate 18, figs. 15, 16. In the Colombian shells certainly, differences are adequate to warrant specific separation when better preserved material is at hand. This variety is distinguished by slightly produced hinge, moderate inflation, very high and exceedingly thickened area, large delthyrial zone, prominent and regularly rounded ventral sinus of which the bounding plicæ are much the strongest on the shell. On either side of the sinus there are 10 plus 2 plicæ, which is a somewhat larger number than average for this species as portrayed by Clarke. Each plica is subangular on the sides, but rounded above; the interspaces are regularly concave, and slightly wider than the plicæ. Crossing the plicæ are lamellose varices which are especially prominent toward the front of the shells. None of the shells is well enough preserved for finer surface markings to show, although suggestions of radial striæ can be detected. The internal mold of the ventral valve shows a deep rostral cavity which is separated by a median septum. The hinge teeth are short and rugged, and their supports are continued as encircling bands nearly around the perimeter of the rostral cavity. The suggestion of a delthyrial plate (syringothyroid syringeal plate) shows on the inner mold, and recalls the impression recorded for *Spirifer hawkinsi* Morris and Sharpe, and many illustrations of *Spirifer antarcticus*. As in the preceding, it seems likely that the present form may well be quite distinct from the species, *s.s.*, but the material will not warrant the description of a new species. Some of the specimens attributed to *Spirifer pedroanus* Hartt by Rathbun, 1874, may fall here, but the comparisons are fraught with risk in view of the probability that most of the types of the Hartt species are Brachyspirifers.

Illustrated specimens.—Pal. Res. Inst. Nos. 5471B, 5407D, 5407G, all internal and external ventral molds in a poor state of preservation.

Genus **BRACHYSPIRIFER** Wedekind, 1926

Genotype.—*Spirifer carinatus.* Middle Devonian.

Brachyspirifer palmeræ Caster, n. sp. Plate 10, figs. 12, 13; Plate 12, figs. 5, 6

Shells of medium size, transverse; hinge line greatest width of shell; extremities acute; outline of shell essentially transversely triangular; sides from hinge extremities to median zone essentially a straight line; sinus produced anteriorly to a slight degree; valves moderately inflated; cardinal area moderately high; fold and sinus nonplicated, and very prominent; each side bears 17 or 18 plications which rise as rounded ridges above the common surface, and are separated by narrow subangular interspaces about one-half as wide as the plicæ. The interspaces adjacent to the fold and the plicæ adjacent to the sinus are somewhat more prominent than these features elsewhere on the shell, and thus very effectively delimit the mesial regions. The entire surface is covered with sublamellate varices which tend to become pronouncedly lamellate on the extremities. They stand out best in the interspaces between plicæ, but can be traced over the ribs as well. None of the specimens at hand shows any signs of surface punctæ, pustules or lineations in addition to the varices.

The dorsal internal mold shows very characteristic musculature: from a slight rostral filling or callus in the apex a well developed median septum extends anteriorly for about one-fourth the length of the shell and acts as a wall between two elongate oval, rather deeply recessed, muscle cavities which also extend for about one-fourth the length of the shell. These are very striking spiriferoid features. The crural plates leave the palintrope at a very low angle, and are not especially prominent. The internal features of the ventral valve are not known. The dimensions are brought out by the illustrations.

Discussion.—In the South American Devonian the closest form-ally of the present genus appears to be the Brazilian *Spirifer pedroanus* Hartt (in Rathbun), 1874, (=*Spirifer katzeri* Clarke, 1913, *fide* Derby in Clarke, 1913, p. 242) which has the same general outline and contour, but apparently fewer ribs (10-16) on a side, more angular median sinus and fold, and apparently much less conspicuous median dorsal septum and recessed dorsal muscle seats. The comparison can be made, of course, only on the proviso that Clarke was mistaken in assuming a radiate or pustulose surface for his species. He certainly did not succeed in showing such a structural surface in his magnified surface detail (*idem,* pl. 21, fig. 4), and mentions nothing in the text about the surface specifically, for he was merely proposing a new name for a mistaken identification of Katzer. Elsewhere in the report of course, Clarke pointed out that to his knowledge all of the Brazilian spirifers possessed the surface details here assigned to the new genus *Australospirifer.* Neither the account of *Spirifer pedroanus* in Rathbun, 1874, nor any subsequent specific detail would indicate that the Brazilian form, any more than *Brachyspirifer palmeræ,* shares the fimbriate-pustulose-striate-lamellate surficial features of the great group of southern spirifers. It is my impression that the present Colombian species and Hartt's Brazilian form are congeneric.

The Venezuelan specimens assigned by Weisbord, 1926 (pl. 5, fig. 8), to Hartt's species similarly do not show the "austral" type of spiriferoid surface, nor does Weisbord's *Spirifer audaculus,* var. *zulianus.*

In the northern faunas the closest relative or parallel appears to be the *Spirifer audaculus* (*S. medialis*)-*Spirifer macronotus* line of the Hamilton. It is here that we especially find the same general outline and contour duplicated many times, and the same sharply chiselled plicæ and lamellæ of growth without fimbriæ or pustules. It is here also, especially in the *Spirifer macronotus* line (*e.g.* Hall, 1867, pl. 38A, fig. 20), that we find very similar dorsal musculature and septation developed. The South American expression appears to be prenuncial of this stock in the North American Middle Devonian, and shows in subdued form the traits to be elaborated in the group later on. Size and gibbosity, increase in height of cardinal area, etc. are phases emphasized in the Hamilton faunas. It is very likely that Kozłowski's, 1923 (pl. 9, figs. 31, a, b), Bolivian form referred to *Spirifer,* aff. *audaculus* belongs to the same prenuncial stock as the Colombian form, but appears to show specific differences, among which the very apparent flattening and broadening of the plicæ, inflation of both valves, development of rounded extremities and inspicuous dorsal musculature are important. The Bolivian form would suggest more the true *S. audaculus* stock in these respects than would the Colombian material. Weisbord's, 1926, *Spirifer audaculus,* var. *zulianus* has received much the same comparisons as the present species, and may in truth be very closely allied. The Venezuelan form, however, appears to possess a much higher palintrope (*e.g.* Weisbord, pl. 5, figs. 1, 2), than the Colombian form, with apparently many more plicæ on a side (Weisbord reports 20 to 30) and no evidence of concentric varices or lamellæ, although Weisbord suggests their presence. His types show them very faintly. The interior of the dorsal valve (Weisbord's plate 5, fig. 8) shows much the same type of recessed muscle scars reported for *Brachyspirifer palmeræ,* although he does not show a median septum in his illustrations. It is important thus to establish quite certainly the presence of this highly typical Middle Devonian spiriferoid of the North in association with early Middle Devonian fossils. The suggestion of direction of migration seems inescapable.

If one were to judge by the Hartt, 1878 (p. 25), record only and overlook Clarke's, 1913, opinion on the surface details of all Brazilian spiriferoids, it seems very probable that Hartt's *Spirifer duodenarius* (?) Hall is closely allied with if not the same as *Brachyspirifer palmeræ*.

Types.—Holotype: Pal. Res. Inst. No. 5407, external and internal dorsal molds of an individual; paratypes: 5407A, an external ventral mold; 5407B, 5407C, 5407E, 5407F, partial external dorsal and ventral molds which show surface details very clearly.

Genus **PARASPIRIFER** Wedekind, 1926

Genotype.—*Spirifer cultrijugatus*. Middle Devonian.

Paraspirifer, sp. Plate 12, fig. 9

One gigantic internal ventral mold, which is unfortunately imperfect and poorly preserved, has the general aspects of the interior of *Spirifer acuminata* and congeners in the Onondagan and Coblenzian. The internal mold bears no record of surface plicæ or more delicate structures, and unfortunately is damaged at the crucial postumbonal region. For the nonce, its meaning and relationships are problematical, but it seems worth recording since I am unaware of similar forms in southern faunas. *Spirifer iheringi* Clarke approaches this form in size, but seems always to show evidence of surface plicæ, and certainly has a much less profound median sinus in the ventral valve. *S. iheringi* appears to have a proportionately smaller muscular zone, and much less rugged dental plates and hinge teeth.

Illustrated specimen.—Pal. Res. Inst. No. 5416.

Genus **SPINOCYRTIA** Fredericks, 1916

Genotype.—*Delthyris granulosa* Conrad, 1839. Middle Devonian.

One imperfect internal ventral mold from the Colombian fauna is identical with the spiriferoid described in Rathbun, 1874, as

Spirifer valenteana Hartt, (*cf.* Rathbun, pl. 8, fig. 11). This specimen, as also the original Rathbun one from Brazil, shows very distinctly the broad posterior rostral cavity of the *Spirifer granulosus-Spirifer marcyi* line. The dental plates are exceedingly strong and extend anteriorly from the inner palintrope as subparallel walls. Between them, and attached to the apical portion of the deltidial zone is the imprint of a syringeal plate, which also characterizes this branch of the *Osteolati* of Hall and Clarke, 1893. It appears that Rathbun's material from Brazil, and also the present Colombian discovery, are assignable to Fredericks's genus *Spinocyrtia* on the basis of internal comparisons with the genotype, even though the surficial features of both the Brazilian and Colombian materials are unknown, and for Fredericks at least, these are the diagnostic criteria.

?Spinocyrtia cf. valenteana (Hartt) Plate 13, fig. 27

Cf. Spirifer valenteana Hartt, in Rathbun, Buffalo Soc. Nat. Sci., Bull. vol. 2, 1874, p. 241, pl. 8, fig. 11.

Hartt's analysis in Rathbun's paper agrees with our material in nearly every respect, but this may well be due to the incomplete information on the materials from both Brazil and Colombia. Hartt's description (in Rathbun), 1874, follows:

> Test above medium size, ventricose, thick, trilobed in outline and slightly transverse, with the greatest width along the hinge line. Ventral valve very convex, most elevated between the beak and middle. Cardinal angles depressed, with the cardinal margins concave. Beak probably large and curving over a rather constricted area. The margin of the valve is distinctly trilobed, caused by the extension forward of the broad mesial sinus beyond the general margin of the valve; leaving the cardinal extremity on one side at nearly a right angle, it curves regularly inward for more than one-half the whole length of the valve and one-fifth the width, when it gradually bends outward, forming a shallow reëntrant curve before reaching the forward projection of the sinus, around which it extends in an elliptical curve. The distance across, from the center of one reëntrant curve to the other, is about twice the length of the prolongation of the sinus beyond the general margin of the valve. Mesial sinus very broad and shallow, regularly rounded in the bottom, and with its margins undefined; width of sinus nearly one-half the width of the valve, the whole anterior lobe of the valve being occupied by it; in the case it is nearly as broad near the beak as at the front. The surface of the valve curves regularly and quite strongly from the beak to the front margin; from each side it curves rapidly upward for about one-fourth the width, and then descends gradually to form the sinus, which is very slightly and regularly concave. The dental plates, as indicated by the moulds, were very high and thick behind, thinning out gradually as they advance. They are widely separated, the distance between them being nearly one-third the width

of the valve, and they extend forward, parallel with each other, for two-thirds the length of the valve. Between the dental plates in the mould are indistinct impressions of muscular markings, consisting of an ovate, slightly depressed space, rounded behind, where it is immediately enclosed by the dental plates, and gradually narrowing to a point anteriorly, not extending as far forward as the dental plates. This impression seems, however, too limited to include all the muscular markings of the ventral valve.

The illustration on plate 13, fig. 27, will indicate how far I am justified in applying Hartt's analysis to the Colombian specimen.

Illustrated specimen.—Pal Res. Inst. No. 5443B.

Superfamily **ROSTROSPIRACEA** Schuchert and LeVene
Family **MERISTELLIDAE** Hall and Clarke, 1892
Subfamily **MERISTELLINAE** Waagen, 1883
Genus **MERISTELLA** Hall, 1860

Genolectotype.—(Hall and Clarke, 1892) *Merista lævis* (Hall) (*Atrypa lævis* Vanuxem, 1842). Middle Devonian.

This is one of the rarer genera of brachiopods in the Devonian faunas of the southern continents, and is also rare in the Colombian fauna where it is represented by a large and striking species.

Meristella wheeleri Caster, n. sp. Plate 12, figs. 14, 15

Shell large, length and breadth subequal; maximum width at about middle of shell; ventral valve with a profound, broad and subangular sinus which is produced anteriorly and upwardly in a linguate manner. The surface of the shell is smooth, without even recognizable growth lines, but a varix or two is present near the front and many rather prominent ones are present on the lateral portions of the shell, where also faint radii and a suggestion of punctæ can be distinguished. Beak slightly incurved, probably perforated; area constricted and terebratuloid.

Interior of ventral valve is dominated by a large rostral cavity and recessed muscle seat. The cavity and muscle scars are bordered by very strong, dental ridges which posteriorly buttress large and powerful cardinal teeth. The muscle platform is radially striated and also bears concentric ridges. The surface of the interior, outside the postmedian zone, is indistinctly ridged and dimpled with vascular markings. These features are brought out by the illustrations. Dorsal features not known.

Dimensions.—

	5461	5462
Hinge width	15 mm.	18 mm.
Maximum width shell	33 mm.	40 mm.
Median length shell	32 mm.	34 mm.
Length to maximum width shell	17 mm.	25 mm.
Length rostral cavity and muscle seat	18 mm.	22 mm.
Width rostral cavity and muscle seat	11 mm.	12.5 mm.

All of these measurements are based on internal molds of ventral valves.

Discussion.—The generic assignment of this species is based wholly upon the features of the internal mold of the ventral valve, but these so closely conform to the general scheme of *Meristella* that there can be little doubt of the identification. In specific details this Colombian form differs so markedly in every respect from all other forms hitherto described or illustrated from the southern Devonian that close comparisons are really impossible. This is very nearly as true when northern faunas are considered. Ulrich, 1892, described a presumably genuine *Meristella* from the Bolivian Devonian as *Meristella riskowskyi* which compares rather well with the average North American forms attributed to *Meristella nasuta* Hall. Ulrich made his comparisons with that species while also mentioning the somewhat less similar *Meristella hoskinsi* Hall of the American Hamilton. The shell of the present species differs from Ulrich's in being larger, much more transverse and less globose. Especially striking in the Colombian species externally is the profound ventral sinus and corresponding dorsal fold. The internal features of Ulrich's shells are not known. It is doubtful if the form listed by Thomas, 1905, from the Argentine Devonian as *Meristella,* sp.? Kayser is really referable to this genus. Certainly it has no obvious affinity to the present form. Clarke, 1913 (p. 346), also questioned the Kayser-Thomas generic determination. The Brazilian form of *Meristella* first recorded as *Amphigenia* by Derby, but later described by Clarke (and Derby?) 1913 (p. 264), as *Meristella septata* is far larger than the present species, much more planate, and distinctly subcircular in outline. It is also without fold or sinus. The musculature, while that of *Meristella,* does not specifically recall the present form.

In the North American Devonian faunas there are several species with which broad comparisons are justified, though in no case is there evidence of especially close relationship. *Meristella princeps* Hall, (*e.g.* from the Coeymans) is nearly as large and does have a relatively deep sinus and corresponding fold. It is, however, not so transverse, the sinus is by no means so conspicuous, and the musculature is less recessed and more restricted in area. *Meristella lata* Hall of the Oriskany (and Grande Grève) is comparable in size, but is without more than a suggestion of median fold and sinus. *Meristella nasuta* Hall has variants in the Schoharie and Onondaga (*e.g.* Hall, 1867, pl. 48, fig. 5, 6) which compare with *Meristella wheeleri* in size, but are again without striking fold and sinus. The muscular differences are obvious if the illustrations are compared. It is likely that some of the variants within the species-group described from the Grande Grève limestone of the Gaspé Peninsula, as *Meristella champlaini* Clarke, 1908 (*e.g.* pl. 30), may approach the Colombian form in size and general aspect. If any northern forms were to be chosen as essential equivalents, this last one would be my selection.

Types.—Holotype: Pal. Res. Inst. No. 5461-5461A, internal and external ventral molds of one shell; paratype: No. 5462.

Genus **PENTAGONIA** Cozzens, 1846

Genotype.—*Atrypa unisulcata* Conrad, 1841 (=*Pentagonia peersi* Cozzens, 1846). Onondagan.

The genus *Pentagonia* shows characteristic meristelloid internal features with slight modification of the hinge plate. The external features are very strikingly characteristic: they include a pentagonal or hexagonal outline, and a very broad, somewhat flattened ventral sinus which is subangularly delimited from the lateral portions. In the dorsal valve there is a prominent median sulcus which usually bears a mesial groove, or subsidiary sinus. On each side of the central duplicate fold is typically a single prominent subangular corrugation near the posterior margin. In the Hamilton forms the lateral sulcus tends to be duplicate. The surface is prominently marked by concentric striæ.

Pentagonia gemmisulcata Caster, n. sp. Plate 10, figs. 16, 17

The external dorsal mold of a single specimen of *Pentagonia* has been found in the Colombian material. From this fragmental evidence, however, specific differences from the North American genotype and allies are clearly distinguishable.

The size of the shell is large; outline pentagonal. The valve bears mesially a very prominent duplicate sulcus, the groove between the two portions being very deep, but rounded in the bottom. The sulcar region stands up in sharp relief from the common contour of the valve. Postlaterally on each side is a single rounded, but subangular, corrugation which parallels the hinge margin. The zone between the lateral plicæ and the sulcus is broadly convex, suggesting an incipient corrugation in that area, and giving the shell a gibbous appearance. The surface is marked with regular elevated varices, which tend to become fasciculate or lamellate toward the front, on the flanks of the sulcus and in the intervening zone between the sulcus and the lateral folds. The shell is meristelloid in external texture. Illustrations are natural size.

Discussion.—There is nothing resembling this shell known from the South American fauna, or for that matter, as far as I am aware, from the entire "austral" province. Structural similarities are very close, however, between *Pentagonia gemmisulcata* and the North American genotype. The resemblance is less striking between the Colombian species and the duplicate forms ordinarily found in the Hamilton of the North. In none of the "boreal" material which I have been able to study in Albany or Washington, has the median sinus in the dorsal fold been nearly as deeply developed as in the Colombian specimens. The rule in the north seems to be for an almost universal disappearance of the median sinus on the fold toward the front of the shell. The lateral folds seem to be consistently less prominent and much shorter. They usually also fail to attain the margin of the valve. The resemblance seems to be closest to the Onondagan representatives of the genus in the North.

Type.—Holotype: Pal. Res. Inst. No. 5410A.

Superfamily **TEREBRATULACEA** Waagen, 1883
Family **MEGANTERIDAE** Waagen, 1882
Genus **MEGANTERIS** Suess, 1855

Genotype.—*Terebratula archiaci* de Verneuil, 1850 (*non Megalanteris suessi* Drevermann, 1902).* Devonian.

The characteristics of this genus have been discussed at some length by Hall and Clarke, 1892, and the known structures of the present species seem to fulfill every requirement for its inclusion in the genus *Meganteris* as currently employed.

Meganteris australis Caster, n. sp. Plate 9, figs. 25, 26; Plate 13, figs. 9-15

Shells large, moderately biconvex; outline elongate ovate, or even transversely ovate; greatest width usually about one-third the length in front of the hinge line; ventral valve somewhat more convex than dorsal, but not inflated or especially gibbous; beak slightly incurved; apparently bearing a tiny pedicle opening at apex; cardinal area terebratuloid; commissure essentially a plane, definitely so in front; anterior peripheral zone of both valves apparently consistently somewhat flattened. Surface of both valves is megascopically smooth, but microscopically very finely and evenly punctose, the punctæ being irregularly concentrically arranged and rather evenly spaced. On the outer half or third of the adult shell there are ordinarily present two or three very prominent equispaced sublamellose varices that have the appearance of being periods of growth cessation. They create a steplike anterior surface to the shell. The edges of the lamellæ sometimes bear very distinct radial lines which are also present in series on the margin of both shells in adult specimens.

The interior of the ventral valve shows in reverse the imprint of the strong anterior varices, and bears an anteriorly expanding subumbonal cavity for muscular attachment. The cavity is faintly delimited by dental lamellæ which become evanescent near the middle of the shell. The teeth are strong, triangular and overhang the hinge to fit in opposite sockets. These features, as

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* Allan, 1935, selected Drevermann's species as genolectotype. Opinion 65 of the International Rules of Zoölogical Nomenclature, also mentioned by Allan, 1935 (p. 23), stands in the way of this selection. To establish the Eifelian species, which Suess misidentified, as genolectotype, thereby fulfilling Suess's intentions, would apparently require action by the International Commission.

portrayed on the inner mold, are shown on plate 13, fig. 11.

The interior of the dorsal valve shows similarly the reverse imprint of the varices, but is dominated by the rugged process and affiliated callus. The process stands up in bold relief from the apical zone of the shell which it completely obscures internally. It apparently rises from a callus platform, from which anteriorly protrude, a few millimeters from the floor of the valve, two subparallel conical plates. The calc ribbon or loop that may have been present is not preserved in any of the material. The process is cleft behind and terminally. Each apophysis is slightly produced to over-hang the hinge. The terminus of each is faintly scored as if interlocking with some structural element in the ventral umbonal cavity. The musculature of the ventral and dorsal valves is shown by the illustrations.

Dimensions.—

	5424	5425	5422	5423	5422A
Hinge width	18 mm.	20 mm.	20 mm.	est. 24 mm.	7 mm.
Median length shell	38 mm.	36 mm.	35 mm.	25 mm.	13 mm.
Maximum width shell	32 mm.	31 mm.	40 mm.	35 mm.	14 mm.

Discussion.—To my mind there can be no question of the generic affinity of this Colombian species. The specific resemblances lie principally with the "boreal" forms from the Oriskanian, usually attributed to *Meganteris ovalis* (Hall). To this same species-group *Meganteris suessi* (Drevermann) (*e.g. Meganteris archiaci* (deVerneuil) of the Eifelian in Hall and Clarke, 1892, p. 281) apparently belongs; possibly also *Meganteris thunei* Clarke, 1908, and in all likelihood *Meganteris neozelanica* Allan, 1935, from the Reefton Devonian of New Zealand, which recalls strongly Clarke's *Meganteris diobolaris. Meganteris ovalis* (Hall), 1859, is a much smaller form, and bears radial ornament in the true *Rensselæria* tradition, albeit obscurely. The forms of this species illustrated by Hall and Clarke, 1892, may not be entirely conspecific, but the illustrated forms in this work, (figs. 19, 20, 21), recall very closely the posteriorly grooved and apically bifid ponderous cardinal process of *Meganteris australis,* although present on a smaller shell. Many of the smooth shells of *Meganteris thunei* Clarke, 1908, from the Grande Grève limestone of Gaspé, recall in outline, size and contour, the Colombian form, but appear consistently to have a much frailer cardinal process and hinge plate (*e.g.* Clarke, 1908, pl. 27). The immature specimens attributed to this species from the Colombian deposit recall in outline and contour certain forms from the Oriskanian described by Clarke, 1909, as *Meganteris diobolaris* which is a smaller and more rotund form, with smaller cardinalia. The New Zealand species, which is the only other representative of the genus known thus far from the so-called "austral" faunas, appears to be as highly variable in contour and outline as the present species. It seems, however, to be consistently smaller, and in general, more ovate than the Colombian specimens. The dorsal muscle zone appears to be proportionately narrower, and the process of dissimilar shape. That they belong to one rather closely allied stock, seemingly of world-wide distribution in late Lower or early Middle Devonian time, appears very clear. It is possible that some of the many *Rensselæria* reported from South Africa and South America may prove upon better acquaintance to be *Meganteris.* Most show prominent plications, however, and seem therefore to be at least specifically distinct from this nearly glabrous form.

Types.—Holotype: Pal. Res. Inst. Nos. 5425, 5422, internal and external molds of a dorsal valve; paratypes: Nos. 5424, an internal ventral mold, 5423, an external dorsal mold, and 5422A, external mold of an immature shell, orientation not known.

Incertæ sedis

?Camarotœchia, sp. Plate 7, fig. 21

A single fragment of an angularly plicated shell may be referable to *Camarotœchia* or a somewhat similarly plicated genus, but in the absence of any intimation of internal structures, or really critical external ones, further identification is at this time impossible. As far as the fragment at hand will indicate, the shell is probably new to the South American Devonian, but might prove to be congeneric with certain forms usually referred to *Leptocœlia flabellites* in "austral" faunas.

Illustrated specimen.—Pal. Res. Inst. No. 5427A.

?Cryptonella, sp. Plate 13, figs. 24, 25

One tiny external dorsal impression of a terebratuloid shell is at hand, which is too poorly preserved to warrant a guess at its identity. The known features are shown by the illustrations, which are natural size.

Illustrated specimen.—Pal. Res. Inst. No. 5463A.

?Derbyina, sp. Plate 11, figs. 15-17

One small shell in the collection shows on the internal ventral mold the strong dental plates of *Derbyina*. The shell is subangularly corrugated in the rhynchonelloid manner and is also marked by irregular growth lines. The corrugations show a tendency to become slightly inflated between the varices, thus creating a curious nodose appearance which, as far as I am aware, is unique in the South American Devonian.

The specimen has been compared with *Derbyina jamesiana* (Hartt) in the New York State Museum collection as identified by J. M. Clarke from the Devonian of Rio Maecurú, Brazil, which would appear to be the most closely resembling form as yet described. The Colombian shell is much narrower, with a more trigonal outline. The Brazilian form does not have nodose plicæ.

Illustrated specimen.—Pal. Res. Inst. No. 5485.

APPENDIX

The fauna of the Colombian Devonian which has come to light thus far is, as we have seen, quite amazingly rich in brachiopods of unusual stamp, but decidedly depauperate in most of the types of remains one ordinarily associates with the South American Devonian strata. Thus we see but the most meager fragments of Mollusca. Only one unidentifiable tiny gastropod was found after the most careful search. Half a dozen pectenoid shells and one small *Cypricardinia* complete the molluscan picture. There are no signs of either the conulariids or the cephalopods. The molluscan scraps thus far retrieved are illustrated on the plates and briefly discussed below.

Bryozoans are rare items in South American Devonian faunas, but are exceedingly abundant and varied in the Colombian deposits as they are in the Venezuelan. Here only two fragments are shown, and these quite uncritically, for it is hoped that this unusual phase of the fauna may be separately presented. The aspect of the Bryozoa is even more strikingly reminiscent of the early Onondagan faunas of the North, however, and will probably be of great value in establishing the relative age of the northern Andean Devonian.

Ostracods are also very abundant in much of the material, but their poor state of preservation has discouraged me from undertaking their study. Better material will certainly make a very interesting study. Crinoid columnals are common in the material at hand, although no terminal portions have been found. From the varied shapes of the columnals it seems safe to predict a numerous fauna when thorough collecting at Floresta is possible. The calicinal imprint of a single tiny tetracoral has been found in our material. This seems probably to be *Cyathophyllum bolivianum* Kozłowski so far as the poorly preserved fragment would warrant identification. The facies does not appear to have been one especially conducive to coralline growth, however, and no duplication of the fauna found in the rather pure limestone conditions which prevailed during part of the Devonian in Venezuela is anticipated.

Trilobite fragments are more abundant than any of the other lesser items in the fauna, but even here the material is extremely fragmental and the preservation is none too good. As far as can be judged from the collections, no new forms are involved. This is unusual in view of the large variety of new brachiopods.

PELECYPODA

Cypricardinia cf. subindenta Weisbord Plate 11, figs. 6-8; Plate 14, figs. 19-21

Cf. Cypricardinia subindenta Weisbord, Bull. Amer. Pal., vol. 11, No. 46, 1926, p. 26, pl. 6, fig. 6.

Several small fragments of pelecypod shell impressions have been found which suggest very much the form described by Weisbord, 1926, as *Cypricardinia subindenta* of the Venezuelan Devonian. The Colombian material shows the delicate chevron like markings of Conrad's *Cypricardinia indenta* which Weisbord could not detect on the Venezuelan form, although surmised might be present on better preserved material. As can be seen from the present figures, the material will hardly warrant detailed description or wide comparisons. It does apear, however, that this pelecypod is in all likelihood a relative of the North American Middle Devonian species.

Illustrated material.—Pal. Res. Inst. Nos. 5479, 5479A.

?Aviculopecten, sp. A Plate 12, fig. 16; Plate 13, figs. 17, 18

Several small fragments of a rather large monomyarian shell having the surface ornamentation of the aviculopectenoids is at hand. In view of the fact that none shows the hinge zone or musculature, generic placement seems hazardous. The surface sculpture of the commonest form is well shown by the illustrations. This type of shell is not known to me previously from the South American Devonian, but is nearly duplicated many times by northern species. The most striking features of the surface ornament are rounded, nodose, alternating radii which arise by implantation and are crossed by varices which are elevated in the interspaces but incised on the radii, thus creating the nodose expression on the latter.

Studied specimens.—Pal. Res. Inst. Nos. 5414A, 5414.

?Aviculopecten, sp. B Plate 13, fig. 16

Another pectenoid shell, apparently of somewhat larger size, and of quite different sculptural pattern is also known from fragments in the Colombian deposit. Unfortunately, the shell is too poorly preserved to warrant description. It is characterized by rather irregularly spaced radii of variable size, some of which are rounded, but others are definitely angular or subangular. The varices of growth are less prominent than on the form mentioned above, and it is not impossible that when better known it will prove to be the same as or closely allied to Weisbord's *Aviculopecten yeakeli* (1926, pl. 6, fig. 3), from Venezuela, which is also quite imperfectly known, but does appear to have subangular radii, at least on the internal mold.

Studied specimens.—Pal. Res. Inst. Nos. 5412, 5413, 5415.

?Pterinea, n. sp. Plate 11, figs. 13, 14

One tiny pterineoid shell is known from an imperfect external mold. While the surface pattern suggests the fossil attributed to *?Aviculopecten,* sp. A, above, the large extensiform wing on this left valve suggests rather *Pterinea,* or some closely allied genus. The known features are sufficiently well shown by the illustrations to make further analysis unnecessary. The shell is undoubtedly immature, and until better known, does not offer the necessary diagnostic features for specific description.

Illustrated specimen.—Pal. Res. Inst. No. 5412A.

GASTROPODA

Sp. illustrated Pl. 13, fig. 26

In the entire collection from Colombia only one tiny crushed fragment of a gastropod shell has been recovered. What its relationships may be I have not been able to determine, but illustrate it as a rarity in the faunule which promises to be of considerable interest in new collections from Colombia.

Illustrated specimen.—Pal. Res. Inst. No. 5484.

BRYOZOA

As already indicated the Colombian faunule is exceedingly rich in bryozoans, especially the fenestelloids, many of which are apparently new to science. Fortunately many of the zoaria are preserved sufficiently well in the residual clay to make specific description possible in some cases. In view of the advisibility of having these interesting remains studied by a specialist* in the group, only two fragments of the commonest types are shown in this paper as a gesture toward a better appreciation of the nature of the fauna. The specimen illustrated on plate 14, fig. 22 (5480A) is possibly the form described by Weisbord, 1926, as *Fenestella venezuelensis.* Certainly close counterparts of all of Weisbord's forms and many more are present in Colombia. Plate 14, fig. 24 (5480B) of this paper shows another type of fenestelloid which is exceedingly common. The conical fillings of this

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* This study is being undertaken by Dr. A. H. McNair, 1938.

type of zoarium are very abundant in the collection. Figure 23, plate 14, (5481) is probably the external mold of a zoarium which is rather unusual. It was molds of this sort that Kozłowski, 1923 (p. 101, pl. 4, figs. 19, 20, 20A), described as "Corps problematique" from the Bolivian Devonian. They are abundant in our collection, and may prove to be well enough preserved in some cases to make more complete description possible.

ANTHOZOA

The calicinal imprint of a single tiny tetracoral, about 3 mm. in diameter, occurs in the Colombian collection. It is too poorly preserved to warrant even tentative identification (unless it be *Cyathophyllum bolivianum* Kozłowski) but is of considerable ecological importance. The external mold of a single auloporid was found attached to a stropheodontid shell, and has been mentioned above.

OSTRACODA

Many of the clay blocks from Floresta show impressions of great numbers of Ostracoda. They have seemed, however, too poorly preserved to warrant description at this time, especially in view of the probability of securing much larger and more valuable collections in the future if the material is gathered with an eye to the rarer fauna. It might be mentioned that the few forms identified in our collection recalled rather strongly the ostracod fauna of the Camden chert of Tennessee, now in process of description of Dr. R. S. Bassler, (personal communication, July 1938).

TRILOBITA

When better material of the Colombian Devonian sediments is discovered, it will undoubtedly be very rich in trilobite material that will merit detailed study. The collection has yielded a great number of external and internal impressions of tests of all sizes, but for the most part in exasperatingly poor state of preservation. There are apparently four different generic groups represented in our fragments, and these are illustrated on plate 14. The fauna appears to be closely allied in its trilobite content with that which Kozłowski, 1923, described from Bolivia.

Phacops cf. **salteri** Kozlowski Plate 14, figs 1, 2, 7-16

Cf. Phacops salteri Kozlowski (new name), Ann. de pal., Tome 12, 1923, p. 54, pl. 6, figs. 1-6. (Synonymy here given.)

Relatively commonplace in the Floresta faunule are fragments of phacopid trilobites having the general aspect of *Phacops salteri* Kozłowski of the Bolivian Devonian. A representative suite of the fragments is illustrated on plate 14. The material retrieved thus far in Colombia will not warrant detailed comparisons or augmentation of Kozłowski's thorough analysis of the Bolivian fossils. The specimens illustrated by figures 14 and 15 may belong to quite another type of trilobite.

Illustrated specimens.—Pal. Res. Inst. Nos. 5405, 5452, 5456, 5458, 5458A, 5458B, 5476, 5478.

?Dalmanites cf. **patacamayaënsis** Kozlowski Plate 14, figs. 3-6

Cf. Dalmanites patacamayaensis Kozlowski, Ann. de Pal. Tome 12, 1923, p. 36, pl. 2, fig. 2.

Several pygidial casts and molds in the Floresta fauna recall *Dalmanites patacamayaënsis* Kozłowski from Bolivia, but in the absence of more data, even the generic identification is hazardous. The Colombian pygidia, while superficially resembling the Patacamaya trilobite, are externally papillose and bear a row of median bosses on the axis which the Bolivian species apparently does not possess. This feature is well shown by the internal view shown on plate 14, figures 3 and 4. It has been suggested that the speciemn illustrated in plate 14, fig. 5, recalls the proetid genus *Dechenella* more than *Dalmanites.*

Illustrated specimens.—Pal. Res. Inst. Nos. 5457, 5477, 5477A.

?Cyphaspis, sp. Plate 14, fig. 17

A single imperfect cranidium bears a superficial resemblance to the genus *Cyphaspis,* and whets the curiosity to see more and better preserved material from the Colombian faunule.

Illustrated specimen.—Pal. Res. Inst. No. 5480.

?Homalonotus, sp. Plate 14, fig. 18

A single relatively broad, imperfect pygidium may belong to an homalonotid trilobite, but only new material can establish the nature of the intriguing fragment.

Illustrated specimen.—Pal. Res. Inst. No. 5465A.

NOTES ON TWO NEW PAPERS DESCRIBING DEVONIAN FAUNAS OF THE SOUTHERN HEMISPHERE

While this paper was in press two recent monographs dealing with Devonian faunas of the Southern Hemisphere have come to my attention. The first, by Mendez-Alzola, 1938, (June) reached me in December, 1938. This report covers in a rather detailed manner the Devonian faunas of Uruguay previously reported on by Alzola, 1934. None of the Uruguayan species appears to have an especially close relationship to the Colombian assemblage. Dr. Alzola appears to have very fine supplimentary data on the well-known "austral" faunas of Argentina, the Falkland Islands, the Paraná area of Brazil and Bolivia. As might be suspected, the affinities are closest to faunas described from the immediately adjacent areas. The ubiquitous *"Schuchertella agassizi"* (Hartt), *Chonetes falklandicus* Morris and Sharpe, *"Leptocœlia flabellites"* (Conrad), *"Spirifer iheringi"* Kayser, etc., in the Brachiopoda, and a variety of pelecypods, some of which are new, but most of which are identified as Clarke's or Reed's "austral" species, illustrate the "orthodoxy" of the Uruguayan fauna. The trilobites apparently show certain specific and varietal dissimilarities from the well-known southern species, but augment the "austral" flavor of the assemblage. The Uruguayan fauna may be looked upon as typically southern, and without any conspicuous northern contamination. The Alzola report enlarges our picture of the typical South American Devonian fauna and extends the distribution of the fauna considerably.

In the current (December, 1938) number of the Quarterly Journal of the Geological Society of London, Dr. Jack Shirley publishes a paper on the Lower Devonian fauna of the Baton River beds of New Zealand. This paper adds considerably to our knowledge of the interesting New Zealand Devonian first gained through Allan's valuable paper on the Reefton fauna in 1935. The Baton River fauna has been described almost exclusively in terms of European (and subordinately North American) Lower Devonian species. This brings out very strikingly the "boreal" or cosmopolitan aspect of the fauna. The Baton River material, as illustrated, is even more deformed and fragmental than the South American material in this paper, and is apparently only very sparcely known. Without in any way disparaging the excellent work of Dr. Shirley, it does appear that the assignments are to be taken as only generically definitive in several instances. Apparently facies differences at least in part are responsible for the non-appearance of most of Allan's species. I noted in a rather hasty reading of the paper only two species reported in common. Several of the cosmopolitan species(genera) described and illustrated are beyond doubt generically allied to fossils described from Colombia in the present paper.

Shirley's *Stropheodonta stephani* (Barrande) is indubitably closely allied to Barrande's species, and is therefore certainly assignable to the new genus *Cymostrophia* of which Barrande's species is the genotype. As brought out in the foregoing text, this genus is very well represented in the Colombian fauna. His *Leptostrophia explanata* (Sowerby) will bear comparison with *Rhytistrophia caribbeana* (Weisbord) from the Cachira series of Venezuela and the variety *colombia* from the Colombian Floresta series. The New Zealand specimens are concentrically deformed, but do not show the regular corrugations of the genotype, *Stropheodonta beckii* Hall, or Colombian-Venezuelan specimens, but may prove to be allied to this stock. There are other comparisons to be made, but this will illustrate the bearing of the Baton River fauna on that of this paper.

As indicated above, the Baton River fauna has greater similarity to European-Asiatic and North American faunas than to most hitherto described faunas of South America. I would not now wish to stress any very close relationship between New Zealand and South America in the Devonian, but in tracing the the distribution of the cosmopolitan "boreal" faunas too little consideration has been given to the work of Hartt and Rathbun, 1875, 1878, on the Pará Devonian of Brazil and especially to the Cachira fauna of Weisbord, 1926, in Venezuela. The Colombian fauna of the present paper gives further data on these northern South American faunas, and likewise has important bearing on world distribution of the "boreal" faunas. Evidence is at hand, therefore, to show quite certainly that Venezuela and Colombia were boreal outposts in early Devonian times. This necessarily introduces the question of how completely the "austral" province was isolated at this time. All who have studied southern Devonian faunas concur in the opinion that there must have been an isolated center of evolution for the fauna. This was presumably South Atlantic in general location. It seems probable that this province was isolated in some manner to the north, east, south and west, except for relatively narrow places of contact. It now appears that one of the principal regions of contact with "boreal" faunas was through what is now the Andean area of South America. Clarke, Knod, and to a less degree Kozłowski, concurred on the isolation of South American faunas. Kozłowski's Bolivan faunas carried intimations of intermingling, and the present paper on Colombia illustrates an advanced stage of the admixture further north. I dare say that there was much the same isolation between "austral" and "boreal" faunas in Devonian times as we see today on the West Coast of South America where the tropical fauna of the Panamic province meets the "austral" cold water fauna of the Humbolt Current. If the paleogeographers of the future, using present criteria, were to examine the fossil evidence now in process of formation on the continental shelf of the East Coast of the United States they would probably require at least a long barrier peninsula if not an "isthmian link" running off to the northeast in the vicinity of Cape Hatteras, where the New England and Gulf Stream faunas meet so abruptly. Additional study brings out, however, considerable intermingling of certain elements of both faunas. This sort of condition seems better to fit the faunal relations of the Devonian of South America, now that intermingling is quite well established.

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EXPLANATION OF PLATES

Photographs made by the author with the aid of Mr. Stewart Jones, student of Geology at the University of Cincinnati.
(Plates furnished ready for insertion by the University of Cincinnati Museum through the Faber Fund for Paleontology)

PLATE I (VII)

All specimens illustrated on this and the succeeding plates are from the Devonian strata of Floresta, Department of Boyaca, northeastern Colombia, South America.

14. **Cymostrophia schucherti** Caster, n. sp. 48
    Dorsal external mold. See also plate 6, figs. 7-10. Holotype. Pal. Res. Inst. No. 5426; × 1

15. **Cymostrophia schucherti** Caster, n. sp. 48
    Enlargement of the surface of the holotype specimen (fig. 14). Pal. Res. Inst. No. 5426; ×3

16. **Cymostrophia schucherti** Caster, n. sp. 48
    Enlargement of the surface of a dorsal external mold on which concentric varices are unusually well developed. Paratype. Pal. Res. Inst. No. 5427; × 3

17. **Cymostrophia schucherti** Caster, n. sp. 48
    Enlargement of the well corrugated surface, likened to the fabric seersucker. For additional illustrations of this species see also plate 2, figs. 1, 4-6; pl. 3, fig. 2; pl. 6, figs. 7-10, 15, and pl. 10, figs. 4-6. Paratype. Pal. Res. Inst. No. 5428; × 3

EXPLANATION OF PLATE 1 (7)

Figure Page

1. **Pholidops florestæ** Caster, n. sp. 16
   Internal mold. Paratype. Pal. Res. Inst. No. 5454A; × 1

2. **Pholidops florestæ** Caster, n. sp. 16
   Enlargement of internal mold figured above. Paratype. Pal. Res. Inst. No. 5454A; × 3

3. **Pholidops florestæ** Caster, n. sp. 16
   Internal mold showing musculature. Holotype. Pal. Res. Inst. No. 5454; × 3

4. **Leptæna boyaca** Caster, n. sp. 19
   Ventral internal mold, somewhat compressed laterally. Paratype. Pal. Res. Inst. No. 5468; × 1

5. **Leptæna boyaca** Caster, n. sp. 19
   Ventral internal mold of an undeformed specimen, showing the strongly delimited diductor scars and papillose interior of the shell. Paratype. Pal. Res. Inst. No. 5469; × 1

6. **Leptæna boyaca** Caster, n. sp. 19
   Side view of same specimen seen in fig. 5, showing impression of the diaphragmal ridge and the degree of shell geniculation. Paratype. Pal. Res. Inst. No. 5469; × 1

7. **Leptæna boyaca** Caster, n. sp. 19
   Dorsal internal mold showing the imprint of the strongly elevated subumbonal platform and muscle seats. See also plate 10, fig. 1. Holotype. Pal. Res. Inst. No. 5470; × 1

8. **Leptæna boyaca** Caster, n. sp. 19
   Ventral external mold showing usual auricular tendency of the hinge extremities and wavering irregularity of the radial ornament on the geniculated surface. Paratype. Pal. Res. Inst. No. 5471; × 1

9. **Leptæna boyaca** Caster, n. sp. 19
   Dorsal external mold. Paratype. Pal. Res. Inst. No. 5472; × 1

10. **Leptæna boyaca** Caster, n. sp. 19
    Enlargement of specimen shown in fig. 9, bringing out surface details. Paratype. Pal. Res. Inst. No. 5472; × 2.5

11. **Leptæna boyaca** Caster, n. sp. 19
    Dorsal external mold of immature individual showing early establishment of the peltate outline. Paratype. Pal. Res. Inst. No. 5474; × 1

12. **Leptæna boyaca** Caster, n. sp. 19
    Enlargement of specimen in fig. 11, to show details of the narrow interspaces and wide costæ at this stage which is in contrast to adult ornament as shown in figure 10. Paratype. Pal. Res. Inst. No. 5474; × 1.75

13. **Leptæna boyaca** Caster, n. sp. 19
    Umbonal portion of a dorsal external mold showing the transition of ornament from immature to adult condition. For additional illustrations of this species see plate 10, figs. 1-3. Paratype. Pal. Res. Inst. No. 5475; × 1

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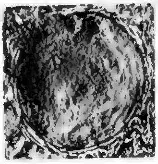
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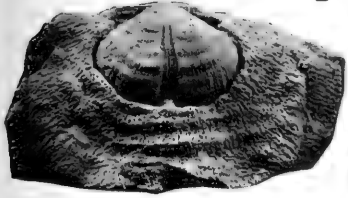
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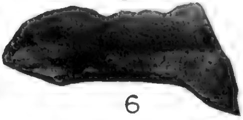
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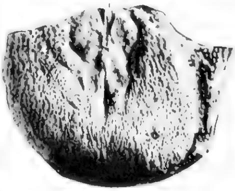
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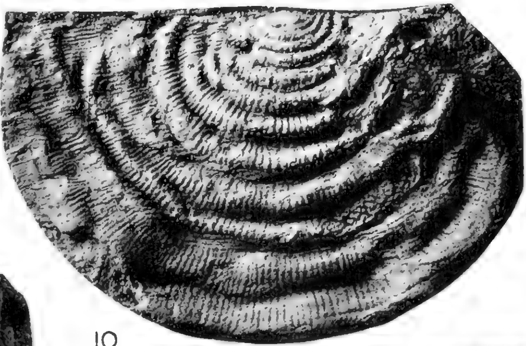
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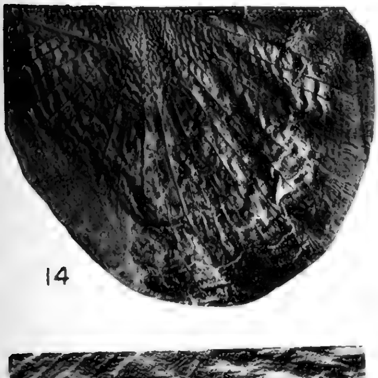
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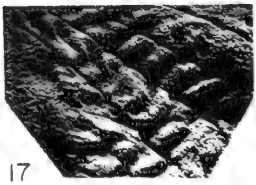
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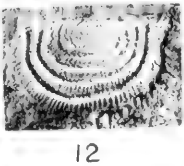
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PLATE II (VIII)

13. **?Cymostrophia waringi** Caster, n. sp. 54
Enlargement of a portion of the ventral external mold of the holotype. See also pl. 3, fig. 1. Pal. Res. Inst. No. 5448; × 2.5

14. **?Cymostrophia waringi** Caster, n. sp. 54
Still greater enlargement of the surface of the holotype, showing very fine reticulation. Pal. Res. Inst. No. 5448; × 3

EXPLANATION OF PLATE 2 (8)

Figure		Page
1.	**Cymostrophia schucherti** Caster, n. sp. …… Ventral external mold of umbonal area showing curious asymmetrical tendency sometimes occurring in this species. See also plate 3, fig. 2, for enlargement of this specimen. Paratype. Pal. Res. Inst. No. 5466A; × 1	48
2, 3.	**Strophonella floweri** Caster, n. sp. …… See also plate 10, figs. 9-11. Holotype. Pal. Res. Inst. No. 5486; × 1	109
4.	**Cymostrophia schucherti** Caster, n. sp. …… Ventral internal mold which has been slightly compressed laterally. Paratype. Pal. Res. Inst. No. 5449; × 1	48
5.	**Cymostrophia schucherti** Caster, n. sp. …… Fragment of the external mold of specimen 5449 (fig. 4). See also plate 6, fig. 15, showing concentric varices. Paratype. Pal. Res. Inst. No. 5450; × 1	48
6.	**Cymostrophia schucherti** Caster, n. sp. …… Ventral internal mold showing very well the characteristics of the musculature. The differential rippling of the surface has left its imprint on the anterior part of the mold. For additional illustrations of this species see pl. 1, figs. 14-17; pl. 3, fig. 2; pl. 6, figs. 7-10, 15; pl. 10, figs. 4-6. Paratype. Pal. Res. Inst. No. 5451; × 1	48
7.	**Dictyostrophia cooperi** Caster, n. sp. …… Dorsal external mold of the holotype. See also pl. 4, fig. 9 and pl. 6, fig. 1. Pal. Res. Inst. No. 5449A; × 1	60
8.	**Dictyostrophia cooperi** Caster, n. sp. …… Enlargement of the umbonal features of the external mold of the holotype, showing the absence of concentric varices, alternation of radii and slight convexity of the mid-zone of the radii between the principal radii. Holotype. Pal. Res. Inst. No. 5449A; × 1.5	60
9.	**Dictyostrophia cooperi** Caster, n. sp. …… Still greater enlargement of the umbonal portion of the external mold of the holotype to show character of the radii. Holotype. Pal. Res. Inst. No. 5449A; × 3	60
10.	**Dictyostrophia cooperi** Caster, n. sp. …… Enlargement similar to fig. 9, above, of the anterior portion (geniculated zone) of the external mold of the holotype, showing the reticulation occurring there. Holotype. Pal. Res. Inst. No. 5449A; × 3.	60
11.	**Dictyostrophia cooperi** Caster, n. sp. …… Portion of the ventral external mold of an individual that may have suffered slight lateral compression, although to no great extent. See also pl. 6, figs. 5, 6. Paratype. Pal. Res. Inst. No. 5455; × 1	60
12.	**Dictyostrophia cooperi** Caster, n. sp. …… Enlargement of the specimen seen in fig. 11, to show reticular detail. For additional illustrations of this species see pl. 4, fig. 9; pl. 6, figs. 1-6. Paratype. Pal. Res. Inst. No. 5455; × 3	60

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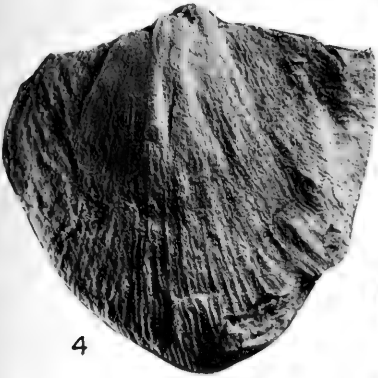

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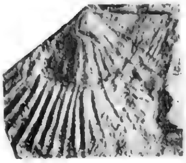

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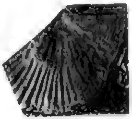

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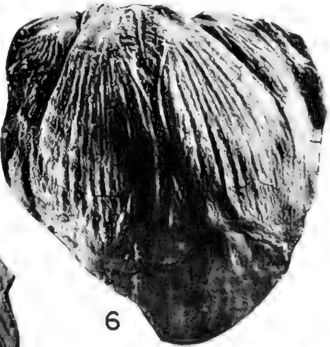

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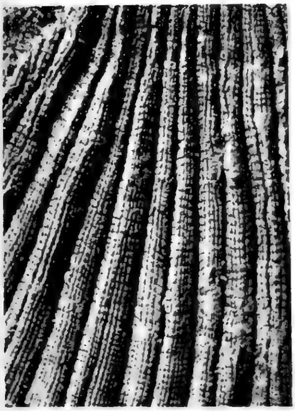

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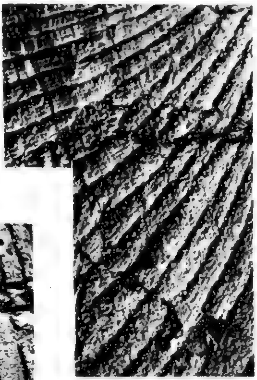

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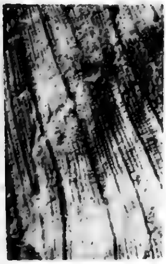

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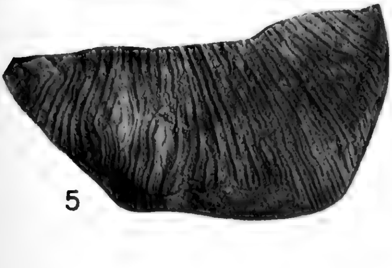

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PLATE III (IX)

14, 15. **Stropheodonta kozlowskii** Caster, n. sp. 66
Plasticine cast and original dorsal internal mold showing unusually well the internal features of the genus and species. Holotype. Pal. Res. Inst. No. 5406A; × 1

16-18. **Megastrophia pygmæa** Caster, n. sp. 45
Plasticine casts of the ventral interior of the holotype specimen. Figs. 17, 18 are two views of the same cast showing the secondarily opened delthyrium, median deltidial buttress, and incomplete hinge crenulation, as well as details of the musculature. See also pl. 5, figs. 1, 4; pl. 6, figs. 11-13; pl. 8, figs. 13, 14. Holotype. Pal. Res. Inst. No. 5398. Fig. 16, × 1. Figs. 17, 18, × 3

19. **Megastrophia hopkinsi** Caster, n. sp. 42
Plasticine cast of the ventral interior of the holotype, showing the details of the musculature and known features of the hinge. See also pl. 4, figs. 1, 2. Pal. Res. Inst. No. 5406; × 1

20. **Cymostrophia dickeyi** Caster, n. sp. 56
Plasticine cast of the dorsal interior of the holotype, showing the characteristic generic features. See also pl. 4, figs. 3-5. Holotype. Pal. Res. Inst. No. 5437; × 1

21. Possibly Bryozoan 179
External mold of structure of unknown relationship. Pal. Res. Inst. No. 5480.

EXPLANATION OF PLATE 3 (9)

Figure Page

1. **?Cymostrophia waringi** Caster, n. sp. 54
Plasticine cast of the ventral external mold showing the great contrast in strength of radii, the inconspicuous concentric varices, and regular surface. Attached to the shell is a new form of auloporoid coral. See also pl. 2, figs. 13, 14. Holotype. Pal. Res. Inst. No. 5448; × 1

2. **Cymostrophia schucherti** Caster, n. sp. 48
Enlargement of paratype also shown on pl. 2, fig. 1. Pal. Res. Inst. No. 5466A; × 3

3. **Stropheodonta kozlowskii** Caster, n. sp. 66
Plasticine cast of the ventral external mold of an immature individual, showing especially the acuminate beak at this stage. Paratype. Pal. Res. Inst. No. 5431C; × 1

4. **Stropheodonta kozlowskii** Caster, n. sp. 66
Original specimen from which squeeze shown in fig. 3 was taken. Paratype. Pal. Res. Inst. No. 5431C; × 1

5. **Stropheodonta kozlowskii** Caster, n. sp. 66
External ventral mold of a nearly mature individual. also plasticine cast, fig. 6, below, and figs. 10, 11, (5431B) internal mold of same individual. Paratype. Pal. Res. Inst. No. 5431A; × 1

6. **Stropheodonta kozlowskii** Caster, n. sp. 66
Plasticine cast of specimen in fig. 5, showing the auriculate hinge extension with faint development of alternating striæ, absent elsewhere on the shell, and low median fold which is highly characteristic. Paratype. Pal. Res. Inst. No. 5431A; × 1

7. **Stropheodonta kozlowskii** Caster, n. sp. 66
Enlargement of a plasticine cast of the dorsal external mold, showing the trifid splitting of the radii. See also pl. 5, figs. 14, 15. Paratype. Pal. Res. Inst. No. 5429; × 3

8, 9. **Stropheodonta kozlowskii** Caster, n. sp. 66
Original and plasticine cast of a dorsal external mold showing the slight concavity of the valve, the auricular hinge extension, and slightly wider than normal spacing of the radii. paratype. Pal. Res. Inst. No. 5431D; × 1

10, 11. **Stropheodonta kozlowskii** Caster, n. sp. 66
Original and plasticine cast of an internal ventral mold which shows the typical stropheodont musculature and hinge crenulation. See external mold and cast of this individual, figs. 5, 6, above (5431A). Paratype. Pal. Res. Inst. No. 5431B; × 1

12. **Stropheodonta kozlowskii** Caster, n. sp. 66
Plasticine cast of a ventral external mold, showing unusually well the ventral fold and outward curvature of the radii. See also pl. 5, figs. 18, 19. Paratype. Pal. Res. Inst. No. 5431; × 1

13. **Stropheodonta kozlowskii** Caster, n. sp. 66
Plasticine cast of a ventral external mold. See also pl. 5, figs. 16, 17. Paratype. Pal. Res. Inst. No. 5430; × 1

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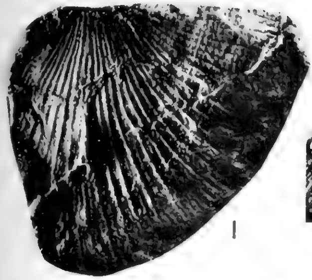
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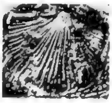
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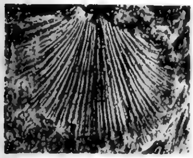
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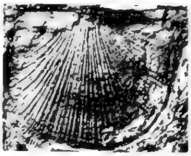
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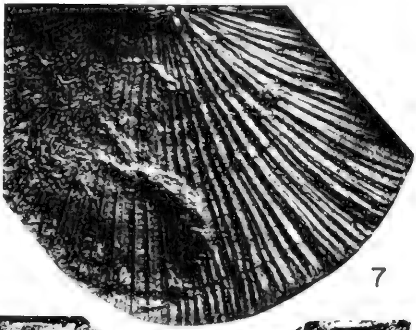
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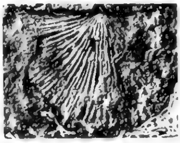
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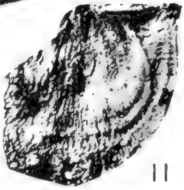
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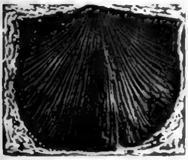
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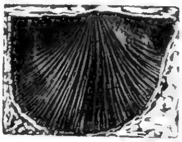
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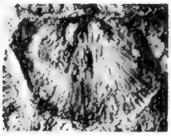
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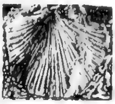
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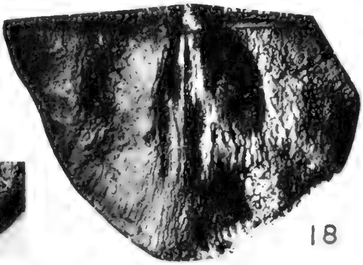
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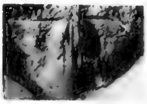
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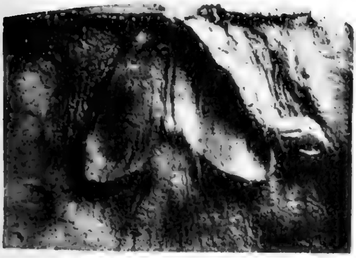
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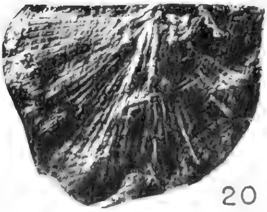
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PLATE IV (X)

EXPLANATION OF PLATE 4 (10)

Figure Page

1. **Megastrophia hopkinsi** Caster, n. sp. 42
Ventral internal mold of largest shell in the Colombian collection. Shows well the subplanate surface which is occupied by the muscle scars, and the produced zone in the middle part of the anterior region. This circular, globose variety is about as common as the scutelliform type shown as fig. 2 on this plate. This specimen is apparently slightly depressed. Paratype. Pal. Res. Inst. No. 5453; × 1

2. **Megastrophia hopkinsi** Caster, n. sp. 42
Ventral internal mold of largest shell in the Colombian collection. Shows well the subplanate surface, which is occupied Res. Inst. No. 5406; × 1

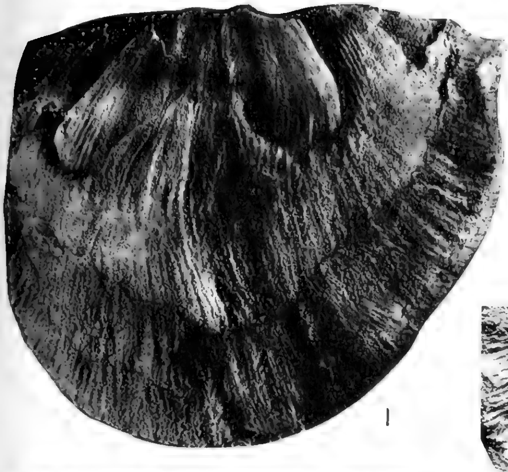
3-5. **Cymostrophia dickeyi** Caster, n. sp. 56
Dorsal internal mold showing the imprints of the brace plates, i.e. "Stutzplatten", median septum, and weak cardinal process. Fig. 4 is an enlargement of the holotype specimen with reversed lighting; fig. 5 is a further enlargement to show ornamental detail. For additional illustration of this specimen see pl. 3, fig. 20. Holotype. Pal. Res. Inst. No. 5437. Fig. 3, × 1; fig. 4, × 2

6, 7. **Cymostrophia dickeyi** Caster, n. sp. 56
External mold of a concave dorsal valve which shows the ornamentation very clearly. See also pl. 8, fig. 15 for plasticine cast. Paratype. Pal. Res. Inst. No. 5444. Fig. 6, × 1; fig. 7, × 2

8. **Cymostrophia dickeyi** Caster, n. sp. 56
External mold of a dorsal valve, which has been very slightly deformed. Holotype. Pal. Res. Inst. No. 5438; × 1

9. **Dictyostrophia cooperi** Caster, n. sp. 60
Dorsal internal mold. See also pl. 6, fig. 1 for plasticine cast, and pl. 2, fig. 7, for external mold. Holotype. Pal. Res. Inst. No. 5445; × 1

10. **Strophonella meridionalis** Caster, n. sp. 107
External ventral mold showing the broad median fold, pronounced resupination and widely spaced radii. See also pl. 8, figs. 16, 17. Holotype. Pal. Res. Inst. No. 5411; × 1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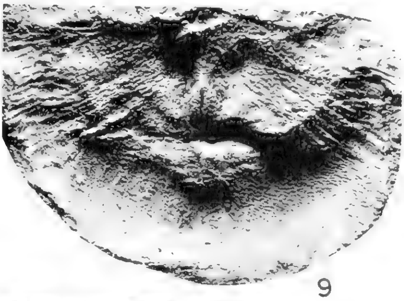
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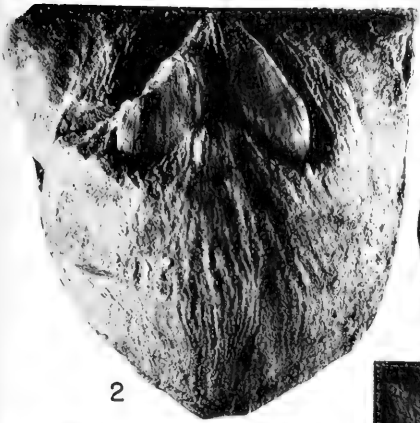
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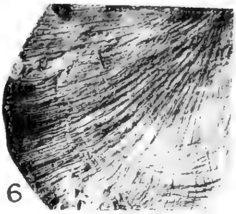
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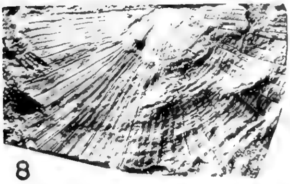
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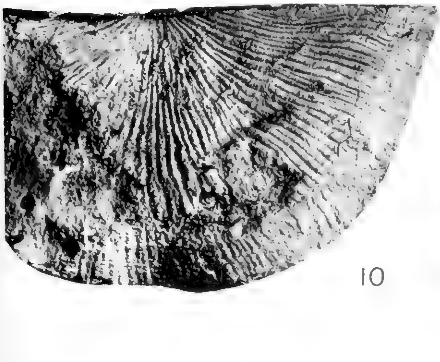
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PLATE V (XI)

EXPLANATION OF PLATE 5 (11)

Figure Page

1, 2. **Megastrophia pygmæa** Caster, n. sp. 45
External ventral mold. See also pl. 3, figs. 16-18; pl. 6, figs. 11-13; pl. 8, figs. 13-14. Holotype. Pal. Res. Inst. No. 5398A. Fig. 1, × 2.5; fig. 2, × 1

3, 4. **Megastrophia pygmæa** Caster, n. sp. 45
Internal ventral mold. See also pl. 3, figs. 16-18. Holotype. Pal. Res. Inst. No. 5398. Fig. 3, × 1; fig. 4, × 3

5, 6. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. 87
Internal ventral mold. See also pl. 8, fig. 5. Paratype. Pal. Res. Inst. No. 5417. Fig. 5, × 1; fig. 6, × 3

7, 8. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. 87
External ventral mold. See also pl. 6, fig. 14. Paratype. Pal. Res. Inst. No. 5418. Fig. 7, × 1; fig. 8, enlarged to show structural detail

9. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. 87
Internal ventral mold showing hinge crenulations and musculature. See also pl. 8, fig. 11 for plasticine cast. Paratype. Pal. Res. Inst. No. 5419; × 1

10. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. 87
External ventral mold showing outline, relative flatness of the valves, and sculptural details. The umbone has been eaten away, presumably by a burrowing sponge. Paratype. Pal. Res. Inst. No. 5420; × 1

11, 12. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. 87
Internal dorsal mold and plasticine cast showing the essential features of the genus and species. Holotype. Pal. Res. Inst. No. 5421; × 1

13. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. 87
Internal ventral mold showing slight secondary deformation. For additional illustrations of this species see pl. 6, fig. 14; pl. 8, figs. 5-12; pl. 11, fig. 9. Paratype. Pal. Res. Inst. No. 5436; × 1

14, 15. **Stropheodonta kozlowskii** Caster, n. sp. 66
External dorsal mold showing the relative flatness of the dorsal valve. See also pl. 3, fig. 7. Paratype. Pal. Res. Inst. No. 5429. Fig. 14, × 1

16, 17. **Stropheodonta kozlowskii** Caster, n. sp. 66
External ventral mold. Illumination reversed, showing contour and outline. See also pl. 3, fig. 13, for plasticine cast. Paratype. Pal. Res. Inst. No. 5430. Fig. 16, × 1

18, 19. **Stropheodonta kozlowskii** Caster, n. sp. 66
External ventral mold. Lighting reversed. See also pl. 3, fig. 12, for plasticine cast. Paratype. Pal. Res. Inst. No. 5431. Fig. 18, × 1


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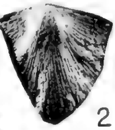
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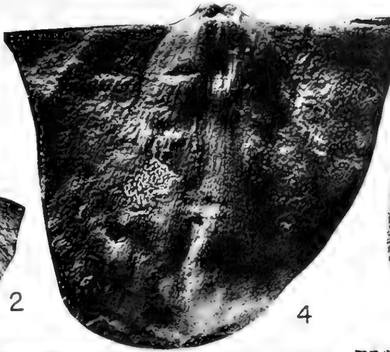
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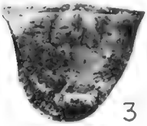
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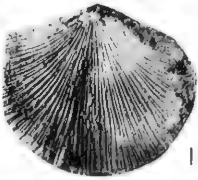
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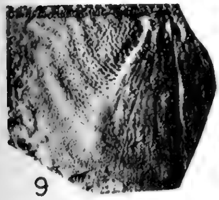
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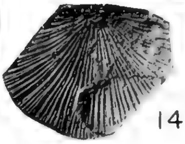
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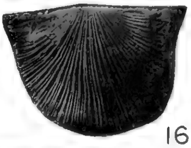
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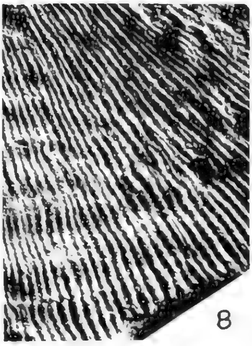
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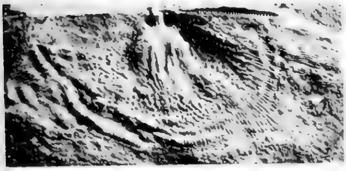
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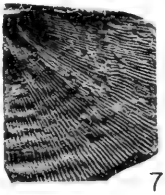
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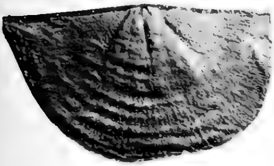
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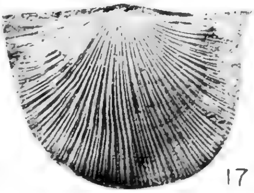
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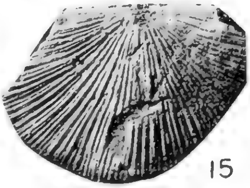
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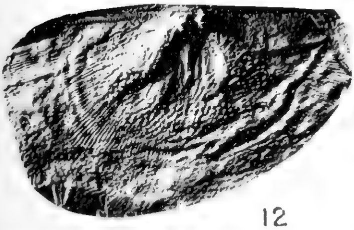
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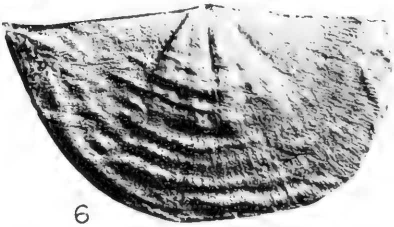
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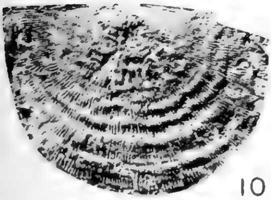
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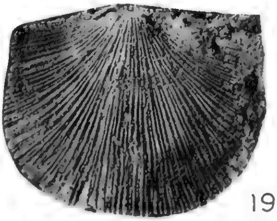
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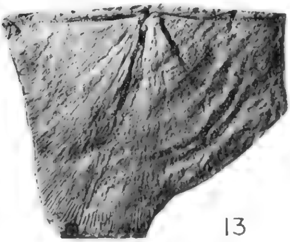
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PLATE VI (XII)

EXPLANATION OF PLATE 6 (12)

Figure — Page

1. **Dictyostrophia cooperi** Caster, n. sp. 60
Plasticine cast of the interior of a dorsal valve showing the generic features. See also pl. 2, fig. 7; pl. 4, fig. 9. Holotype. Pal. Res. Inst. No. 5445; × 1

2-4. **Dictyostrophia cooperi** Caster, n. sp. 60
Molds and casts of the ventral exterior of an immature specimen. Fig. 2, an external ventral mold, × 1; fig. 3, an enlargement of a portion of fig. 2, × 3; fig. 4, enlargement of plasticine cast, × 3. Paratype. Pal. Res. Inst. No. 5445A

5, 6. **Dictyostrophia cooperi** Caster, n. sp. 60
Plasticine cast of the specimen illustrated on pl. 2, figs. 11, 12, showing detail of surface ornament. Paratype. Pal. Res. Inst. No. 5455. Fig. 5, × 4; fig. 6, × 1

7, 8. **Cymostrophia schucherti** Caster, n. sp. 48
Plasticine cast of the exterior of the dorsal valve. See also pl. 1, figs. 14, 15. Holotype. Pal. Res. Inst. No. 5426. Fig. 7, × 1; fig. 8, × 3

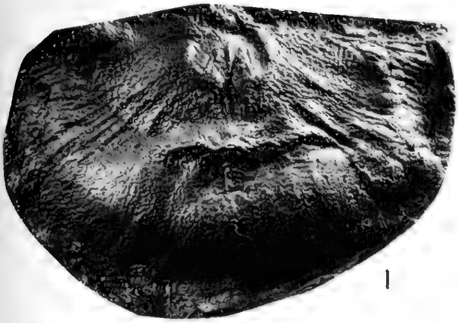
9, 10. **Cymostrophia schucherti** Caster, n. sp. 48
Plasticine cast and internal dorsal mold showing the salient features of the holotype. See also pl. 1, figs. 14, 15. Pal. Res. Inst. No. 5426A; × 1

11. **Megastrophia pygmæa** Caster, n. sp. 45
Ventral internal mold of a ventricose individual. See also pl. 5, figs. 3-4. Note musculature. Paratype. Pal. Res. Inst. No. 5398C; × 1

12, 13. **Megastrophia pygmæa** Caster, n. sp. 45
External ventral mold and plasticine cast showing typical surface ornament. For additional illustrations of this species see pl. 3, figs. 16-18; pl. 5, figs. 1-4; pl. 8, figs. 13-14. Paratype. Pal. Res. Inst. No. 5398B; × 1

14. **Rhytistrophia caribbeana,** var. **colombia** Caster, n. var. 87
Plasticine external ventral cast of specimen figured on pl. 5, figs. 7, 8. Paratype. Pal. Res. Inst. No. 5418; × 1

15. **Cymostrophia schucherti** Caster, n. sp. 48
Enlargement of the surface features on the external ventral mold, illustrated on pl. 2, fig. 5. For additional illustrations of this species see pl. 1, figs. 14-17; pl. 2, figs. 1, 4-6; pl. 3, fig. 2; pl. 10, figs. 4-6. Paratype. Pal. Res. Inst. No. 5450; × 3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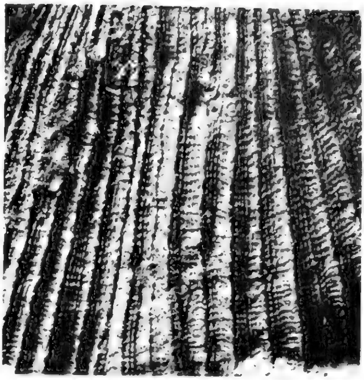
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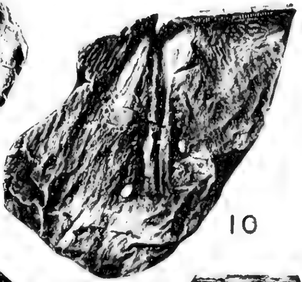
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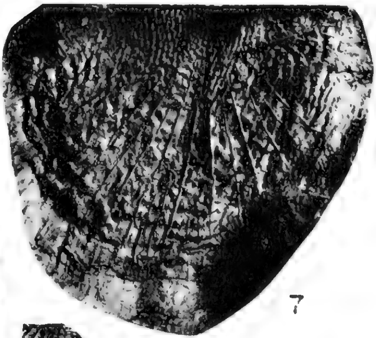
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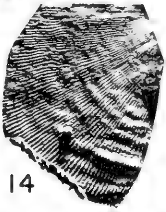
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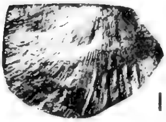
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PLATE VII (XIII)

23. **Atrypa harrisi** Caster, n. sp. 140
External ventral mold showing surface details. See pl. 10, fig. 19, for plasticine cast of this mold. See also pl. 11, figs. 4, 5. Paratype. Pal. Res. Inst. No. 5400; × 1

24. **Atrypa harrisi** Caster, n. sp. 140
Internal ventral mold of an immature individual. Paratype. Pal. Res. Inst. No. 5402; × 1

25, 26. **Anoplotheca** cf. **silvetii** (Ulrich) 143
External ventral mold and plasticine cast showing known features of this unique specimen in the Colombian collection. Pal. Res. Inst. No. 5460C. Fig. 25, × 1; fig. 26, × 3

27. **?Australospirifer** cf. **antarcticus** var. 2 163
External ventral mold (reversed illumination). For additional illustrations of this species see pl. 13, figs. 19, 20. Pal. Res. Inst. No. 5407G; × 1

28, 29. **Acrospirifer olssoni** Caster, n. sp. 156
Internal ventral mold showing median septum. For additional illustrations of this species see pl. 9, fig. 24; pl. 10, figs. 15, 18; pl. 11, figs. 10-12; pl. 12, figs. 10-13. Paratype. Pal. Res. Inst. No. 5447. Fig. 28, × 1; fig. 29, × 2

30, 31. **Vitulina**, sp. 142
External molds of a unique pustulose shell of unknown relationships. See also pl. 13, fig. 23. Pal. Res. Inst. No. 5460. Fig. 30, × 1; fig. 31, × 3

EXPLANATION OF PLATE 7 (13)

Figure		Page
1.	**Schellwienella goldringæ** Caster, n. sp. Internal dorsal mold, showing the short dental plates, low median septum, and flabellate muscle scars. See also pl. 8, fig. 2. Holotype. Pal. Res. Inst. No. 5463; × 1	116
2.	**Schellwienella goldringæ** Caster, n. sp. Fragmental external ventral mold. Paratype. Pal. Res. Inst. No. 5466; × 1	116
3.	**Schellwienella goldringæ** Caster, n. sp. External ventral mold. See pl. 8, fig. 1, for plasticine cast. Paratype. Pal. Res. Inst. No. 5467; × 1	116
4.	**Eodevonaria reedi** Caster, n. sp. External dorsal mold. For additional illustration of this species see pl. 9, figs. 1-2. Paratype. Pal. Res. Inst. No. 5403; × 1	129
5, 6.	**Eodevonaria imperialis,** var. **transversa** Caster, n. var. External dorsal molds showing the character of the surface ornament. See also pl. 11, figs. 18-20. Paratype. Pal. Res. Inst. No. 5404. Fig. 5, × 1; fig. 6, × 2	128
7, 8.	**Chonetes** aff. **billingsi** Clarke, gens. Fragmental external ventral mold and plasticine cast. Pal. Res. Inst. No. 5460B. Fig. 7, × 1; fig. 8, × 3	132
9, 10.	**Eodevonaria imperialis**, var. **parva** Caster, n. var. Plasticine cast of a dorsal internal mold showing the median septum, strong hinge crenulations, and weak cardinal plates. Paratype. Pal. Res. Inst. No. 5434B. Fig. 9, × 1; fig. 10, × 2	126
11, 12.	**Eodevonaria imperialis** Caster, n. sp. Exterlan dorsal mold showing the postlateral fasciculation of the varices, slight median fold, and peripheral flange. Paratype. Pal. Res. Inst. No. 5434. Fig. 11, × 1; fig. 12, × 3	122
13, 14.	**Eodevonaria imperialis** Caster, n. sp. Two views of the holotype internal ventral mold showing the characteristic hinge denticles, median septum, and extreme medial ventricosity. Pal. Res. Inst. No. 5435; × 1	122
15, 16.	**Eodevonaria imperialis**, var. **parva** Caster, n. var. Internal ventral mold of the holotype. For additional illustrations of this species see pl. 9, figs. 4-7. Pal. Res. Inst. No. 5432. Fig. 15, × 1; fig. 16, × 2	126
17, 18.	**Eodevonaria imperialis** Caster, n. sp. Internal dorsal mold, showing the median septum, and large, flabellate muscle impressions. For additional illustration of this species see pl. 9, fig. 3. Paratype. Pal. Res. Inst. No. 5433. Fig. 17, × 1; fig. 18, × 1.5	122
19, 20.	**Productella** cf. **spinulicosta** Hall Internal ventral mold with some of the surface features superimposed. Only specimen found in the collection. Pal. Res. Inst. No. 5459. Fig. 19, × 1; fig. 20, × 3	121
21.	**?Camarotœchia** sp. Pal. Res. Inst. No. 5427A; × 1	175
22.	**Atrypa harrisi** Caster, n. sp. Internal ventral mold of the holotype. Pal. Res. Inst. No. 5399; × 1	140

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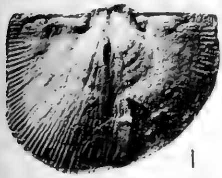
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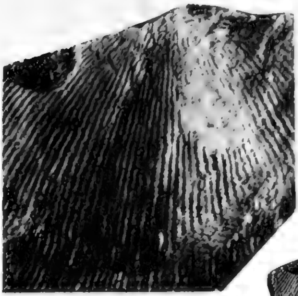
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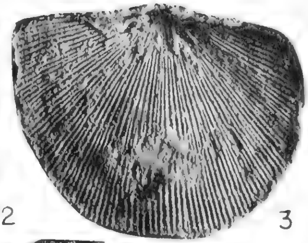
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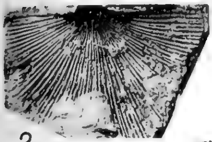
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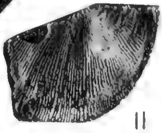
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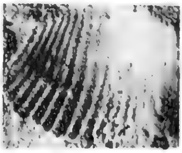
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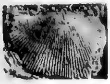
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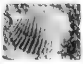
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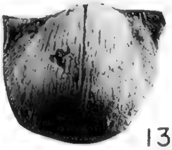
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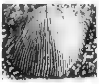
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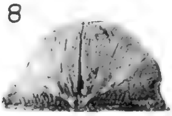
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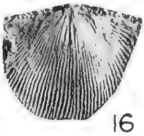
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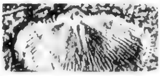
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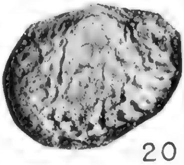
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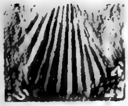
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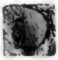
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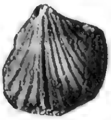
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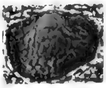
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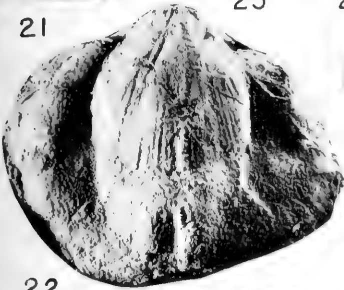
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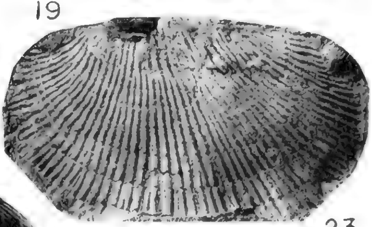
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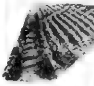
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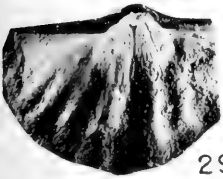
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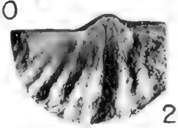
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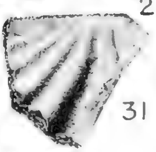
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PLATE VIII (XIV)

16, 17. **Strophonella meridionalis** Caster, n. sp. 107
External dorsal mold of a paratype and an enlargement to show surface detail. See also pl. 4, fig. 10. Pal. Res. Inst. No. 5411A. Fig. 16, × 1; fig. 17, × 4

18. **Schellwienella goldringæ**, var. **juvens** Caster, n. var. 119
See figs. 3, 4 this plate

19. **"Spirifer" kingi** Caster, n. sp. 151
Enlargement of the specimen illustrated on pl. 12, fig. 1, showing the chevroned pattern of the pustules and the splitting plicæ . See also pl. 10, fig. 14; pl. 12, figs. 1-4. Holotype. Pal. Res. Inst. No. 5397; × 3

20. **Chonetes** cf. **stübeli** Ulrich 131
Fragment of an external ventral mold showing the features illustrated by Ulrich from Bolivia. Pal. Res. Inst. No. 5483A; × 3

21, 22. **Chonetes** cf. **stübeli** Ulrich 131
External ventral mold of this highly characteristic shell. Pal. Res. Inst. No. 5483. Fig. 21, × 1; fig. 22, × 2.5

EXPLANATION OF PLATE 8 (14)

Figure — Page

1. **Schellwienella goldringæ** Caster, n. sp. — 116
Plasticine cast of the external mold illustrated on pl. 7, fig. 3. Paratype. Pal. Res. Inst. No. 5467; × 1

2. **Schellwienella goldringæ** Caster, n. sp. — 116
Plasticine cast of the internal mold illustrated on pl. 7, fig. 1. Holotype. Pal. Res. Inst. No. 5463; × 1

3, 4. **Schellwienella goldringæ**, var. **juvens** Caster, n. sp. — 119
Internal ventral mold. See also pl. 9, figs. 12-24. Holotype. Pal. Res. Inst. No. 5465A; × 1

5, 6. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. — 87
Plasticine cast of the internal ventral mold shown on pl. 5, figs. 5, 6. Figure 5 shows the strong lateral dental plates and the median septum. Fig. 6 is a hinge view to show the strong ventral "process" and its relation to the septum and the dental plates. Paratype. Pal. Res. Inst. No. 5417; × 1

7. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. — 87
External ventral mold of an immature individual showing the nature of the early corrugations and radii. Paratype. Pal. Res. Inst. No. 5421B; × 1

8, 9. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. — 87
Internal dorsal mold and plasticine cast of an immature shell which shows very well the early establishment of the strong trifid support and rugged cardinal process. Paratype. Pal. Res. Inst. No. 5421A; × 1

10, 11. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. — 87
Internal dorsal mold and plasticine cast of an immature shell showing slight variations in proportions from those seen on a specimen of the same stage in figures 8 and 9, above. Note particularly the difference in the size of the hinge crenulations and the variation in their abundance. Paratype. Pal. Res. Inst. No. 5421C; × 1

12. **Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. — 87
Plasticine cast of the ventral internal mold illustrated on pl. 5, fig. 9, showing the recessed diductor scars, elevated adductor scars and the nature of the rugged septum. For additional illustrations of this species see pl. 5, figs. 5-13; pl. 6, fig. 14; pl. 11, fig. 9. Paratype. Pal. Res. Inst. No. 5419; × 1

13, 14. **Megastrophia pygmæa** Caster, n. sp. — 45
Plasticine cast of the external ventral mold seen on pl. 5, figs. 1, 2, showing the details of the surface ornament, and the peripheral irregularity of the shell. Holotype. Pal. Res. Inst. No. 5398A. Fig. 13, × 1; fig. 14, × 3

15. **Cymostrophia dickeyi** Caster, n. sp. — 56
Plasticine cast of the external dorsal mold shown on pl. 4, figs. 6, 7. Note particularly the regularity of intercalation of the elevated radii, the concentric depressed varices, and marginal concavity of this paratype. See also pl. 3, fig. 20; pl. 4, figs. 3-8. Pal. Res. Inst. No. 5444; × 1

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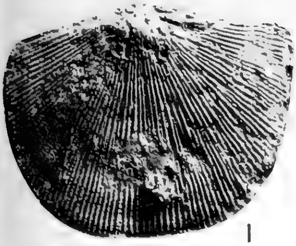
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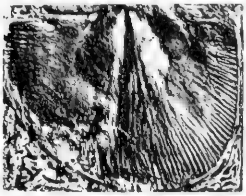
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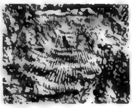
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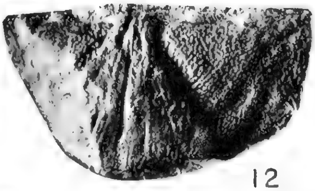
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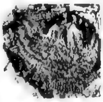
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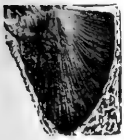
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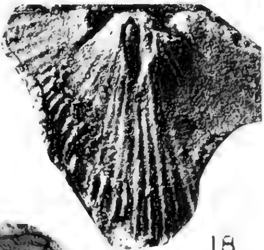
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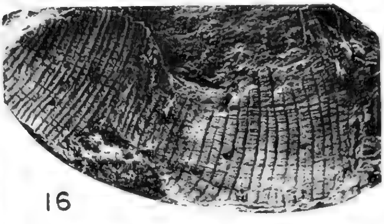
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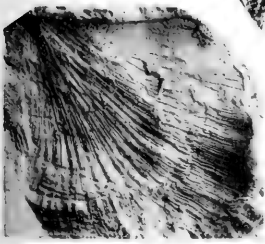
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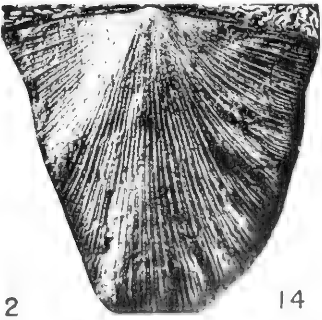
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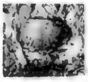
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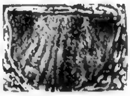
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PLATE IX (XV)

25, 26. **Meganteris australis** Caster, n. sp. 173
An external mold (25) and plasticine cast (26) of a dorsal (?) valve of an immature individual presumably assignable to the new species. For additional illustrations of this species see pl. 13, figs. 9-15. Paratype. Pal. Res. Inst. No. 5422A; × 1

EXPLANATION OF PLATE 9 (15)

Figure — Page

1, 2. **Eodevonaria reedi** Caster, n. sp. 129
Dorsal external mold (fig. 2) and enlarged plasticine cast to show surface details. For additional illustration of this species see pl. 7, fig. 4. Holotype. Pal. Res. Inst. No. 5404A. Fig. 2, × 1; fig. 1, × 4.5

3. **Eodevonaria imperialis** Caster, n. sp. 122
Enlargement of an external ventral plasticine cast of an immature individual, showing the nature of the surface radii. For additional illustrations of this species see pl. 7, figs. 11-14, 17, 18. Paratype. Pal. Res. Inst. No. 5433E; × 4

4-7. **Eodevonaria imperialis,** var. **parva** Caster, n. var. 126
Internal dorsal mold and plasticine cast showing characteristic internal structures. For additional illustrations of this species see pl. 7, figs. 9, 10, 15, 16. Paratype. Pal. Res. Inst. No. 5420B. Figs. 4, 6, × 1; figs. 5,7, × 3

8-11. **Chonostrophia knodi** Caster, n. sp. 137
Internal dorsal mold and plasticine cast showing the internal structural features and also the characteristic fine striation of the surface. Holotype. Pal. Res. Inst. No. 5420A. Figs. 8, 10, × 1; figs. 9, 11, × 3.5

12-15. **Schellwienella goldringæ,** var. **juvens** Caster, n. var. 119
Internal ventral mold (12, 13) and plasticine cast of the mold (14,15) showing the strong dental plates, much elevated median muscle platform, and early corrugation of the shell. Paratype. Pal. Res. Inst. No. 5465C. Figs. 12, 14, × 1; figs. 13, 15, × 3

16-19. **Schellwienella goldringæ,** var. **juvens** Caster, n. var. 119
External ventral mold (16, 17) and plasticine cast of the mold (18, 19) showing details of early ornamentation. On this shell 20 radii seem to appear simultaneously from an essentially glabrous protegulum. These show an early tendency to develop nodes on their crests for the first few millimeters of their length, but this trait disappears with maturity, when the radii become the crests of angular corrugations with subangular interspaces. Paratype. Pal. Res. Inst. No. 5420C. Figs. 16, 18, × 1; figs. 17, 19, × 3

20-23. **Schellwienella goldringæ,** var. **juvens** Caster, n. var. 119
External ventral mold (20, 21) and plasticine cast of the mold (22, 23) showing the details of the surface ornament at an early stage. On this shell 5 costellæ originate simultaneous on the smooth protegular apex. These are a median and two lateral radii. Soon intercalary radii appear to form what seems to be the initial ten early radii. Paratype. Pal. Res. Inst. No. 5467B. Figs. 20, 22, × 1; figs. 21, 23, × 3

24. **Schellwienella goldringæ,** var. **juvens** Caster, n. var. and **Acrospirifer olssoni** Caster, n. sp. 119, 156
See also pl. 8, figs. 3, 4, 18. Holotype and paratype respectively. Pal. Res. Inst. Nos. 5465A, 5465B; × 3

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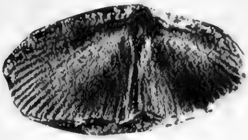
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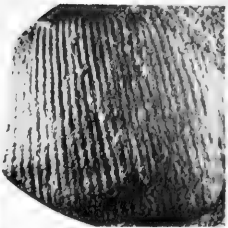
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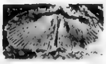
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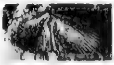
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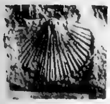
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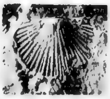
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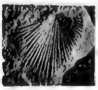
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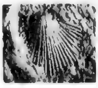
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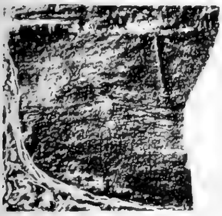
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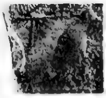
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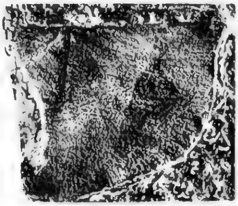
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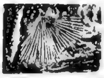
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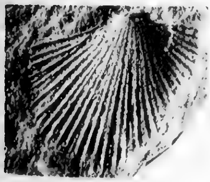
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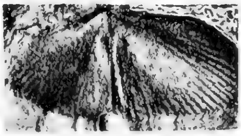
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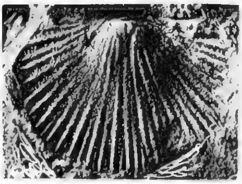
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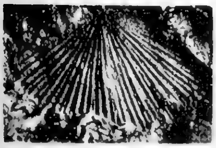
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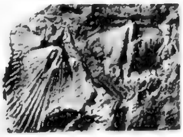
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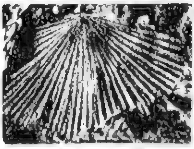
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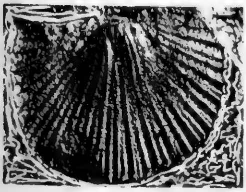
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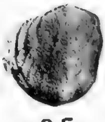
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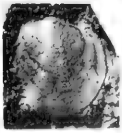
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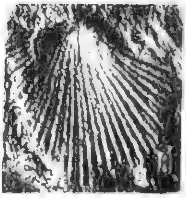
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PLATE X (XVI)

14. **"Spirifer" kingi** Caster, n. sp. 151
An external ventral mold of an immature individual showing the **divaricatus** type of plicæ and surface pattern of lamellæ and pustules. For additional illustrations of this species see pl. 8, fig. 19; pl. 12, figs. 1-4. Paratype. Pal. Res. Inst. No. 5397C; × 1

15. **Acrospirifer olssoni** Caster, n. sp. 156
An internal ventral mold of a young individual, showing the reduced number of plicæ at an early stage, but relatively strong development of the rostral cavity. Paratype. Pal. Res. Inst. No. 5465B; × 3

16, 17. **Pentagonia gemmisulcata** Caster, n. sp. 172
External dorsal mold and plasticine cast. Shows very well the median sinus on the dorsal fold, and the markedly pauciplicate condition of the shell. Holotype. Pal. Res. Inst. No. 5410A; × 1

18. **Acrospirifer olssoni** Caster, n. sp. 156
Plasticine cast of dorsal exterior, showing the pustulose surface, characteristic rounded plicæ and narrower interspaces. See also pl. 12, figs. 10-13; pl. 7, figs. 28, 29; pl. 9, fig. 24; pl. 11, figs. 10-12. Holotype. Pal. Res. Inst. No. 5410; × 1

19. **Atrypa harrisi** Caster, n. sp. 140
Plasticine cast of the external mold shown on pl. 7, fig. 23. Paratype. Pal. Res. Inst. No. 5400; × 1

EXPLANATION OF PLATE 10 (16)

Figure		Page
1.	**Leptæna boyaca** Caster, n. sp. Plasticine internal dorsal cast of the mold illustrated on pl. 1, fig. 1, showing the elevated muscle platforms of characteristic stamp, the strong median septum and pustulose interior. Holotype. Pal. Res. Inst. No. 5470; × 1.5	19
2, 3.	**Leptæna boyaca** Caster, n. sp. Plasticine cast and natural internal dorsal mold showing the strong rafinesquinoid crura and the features shown in fig. 1. This is an abnormally transverse individual, and somewhat larger than the average. Paratype. Pal. Res. Inst. No. 5471A; × 1	19
4, 5.	**Cymostrophia schucherti** Caster, n. sp. External ventral plasticine cast and natural mold of an individual which shows unusually regular differential corrugations, and a suggestion of a slightly produced hinge extremity. For additional illustrations of this species see pl. 1, figs. 14-17; pl. 2, figs. 1, 4-6; pl. 3, fig. 2; pl. 6, figs. 7-10, 15. Paratype. Pal. Res. Inst. No. 5451A; × 1	48
6.	**Cymostrophia schucherti** Caster, n. sp. External ventral mold of a fragment of shell which brings out the usual form of the "seersucker"-like surface corrugations, the broad hinge extension, and lateral constriction. The outline shown here is apparently not deformed. See also pl. 1, fig. 17. Paratype. Pal. Res. Inst. No. 5428; × 1	48
7, 8.	**?Stropheodonta,** sp. An imperfectly preserved internal dorsal mold and plasticine cast upon which some of the surface features have been impressed. Note the frail bilobed process, the recessed and tiny muscle scars, and the prominent median corrugation, callus or septum. The surface details do not correspond with those of any described forms in the Colombian faunule any better than do these unique internal features. Pal. Res. Inst. No. 5448A; × 1	70
9, 10.	**Strophonella floweri** Caster, n. sp. External dorsal mold and plasticine cast of this small form. Note especially the undulatory nature of the plicæ, their bifurcation, and the shield-shape outline of the shell. Paratype. Pal. Res. Inst. No. 5482; × 1	109
11.	**Strophonella floweri** Caster, n. sp. Plasticine internal ventral cast of the holotype showing the large muscle cup, the coarse plicæ, and the rugose concentration of varices on the postlateral areas. See also pl. 2, figs. 2, 3. Pal. Res. Inst. No. 5487; × 1	109
12, 13.	**?Brachyspirifer palmeræ** Caster, n. sp. Portion of an external dorsal mold which shows very well the nature of the plicæ and surface lamellæ. For additional illustrations of this species see pl. 12, figs. 5, 6. Paratype. Pal. Res. Inst. No. 5407A. Fig. 12, × 1; fig. 13, × 2.5	164

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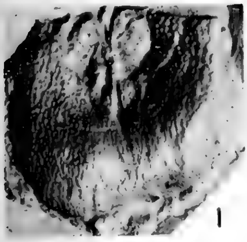
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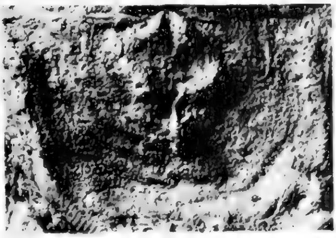
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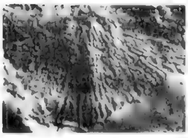
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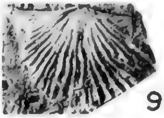
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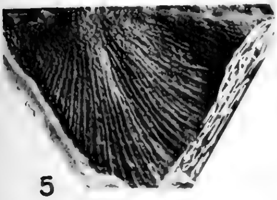
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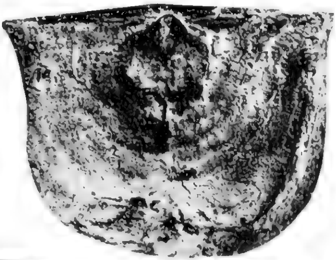
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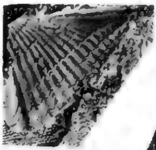
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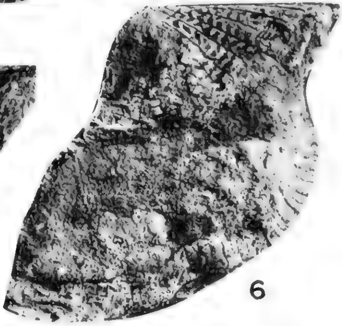
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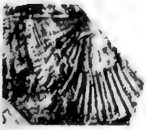
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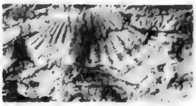
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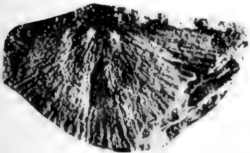
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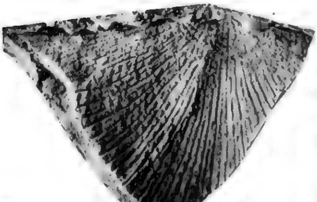
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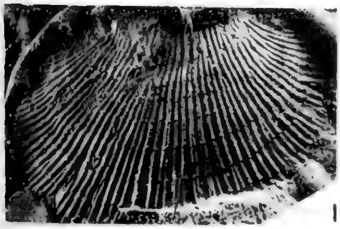
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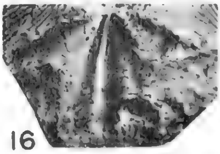
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PLATE XI (XVII)

surface markings, and the pustulose internal mantle deposit. For additional illustrations of this species see pl. 7, figs. 5, 6. Paratype. Pal. Res. Inst. No. 5422B; × 1

EXPLANATION OF PLATE 11 (17)

Figure		Page
1-3.	**Atrypa harrisi**, var. **nasuta** Caster, n. var. Fig. 1, a plasticine cast of external mold; fig. 2, internal dorsal mold; fig. 3, shows the posteriorly attenuate condition and the very characteristic surface ornament. Holotype. Pal. Res. Inst. Nos. 5401, 5401A, respectively; × 1	142
4, 5.	**Atrypa harrisi** Caster, n. sp. External plasticine cast and external mold of the hinge zone of a ventral valve, showing the prominence of the concentric ornament on this region, and relatively well defined cardinal area. For additional illustrations of this species see pl. 7, figs. 22-24; pl. 10, fig. 19. Holotype. Pal. Res. Inst. No. 5401B; × 1	140
6-8.	**Cypricardinia** cf. **subindenta** Weisbord External plasticine cast, external mold and enlargement showing one of the two fragments of this species known from the Colombian faunule. For additional illustrations of this species see pl. 14, figs. 19-21. Pal. Res. Inst. No. 5479A. Figs. 6, 7, × 1; fig. 8, × 2.5	177
9.	**Rhytistrophia caribbeana**, var. **colombia** Caster, n. var. Immature individual showing the early stage at which the shell corrugations appear in this form. For additional illustrations of this species see pl. 5, figs. 5-13, pl. 6, fig. 14; pl. 8, figs. 5-12. Paratype. Pal. Res. Inst. No. 5417A; × 1	87
10-12.	**Acrospirifer olssoni** Caster, n. sp. Plasticine internal dorsal cast, natural internal dorsal mold, and enlargement of the cast. Showing the strong crural plates, socket plates, median septum and recessed muscle seats. For additional illustrations of this species see pl. 7, figs. 28, 29; pl. 9, fig. 24; pl. 10, figs. 15, 18; pl. 12, figs. 10-13. Paratype. Pal. Res. Inst. No. 5397D. Figs. 10, 11, × 1; fig. 12, × 2.5	156
13, 14.	**?Pterinea**, sp. External mold of a left valve of a pelecypod whose affinities are uncertain. Probably a new species. Pal. Res. Inst. No. 5412A. Fig. 13, × 2.5; fig. 14, × 1	179
15-17.	**?Derbyina**, sp. Internal ventral mold of a unique shell of uncertain relationship. Pal. Res. Inst. No. 5485. Figs. 15, 16, × 1; fig. 17, × 3	176
18.	**Eodevonaria imperialis**, var. **transversa** Caster, n. var. Internal mold of a ventral valve, showing the mesial inflation, lateral extension of the shell, the median septum and nature of the hinge denticulation. Holotype. Pal. Res. Inst. No. 5434A; × 1	128
19, 20.	**Eodevonaria imperialis**, var. **transversa** Caster, n. var. Internal dorsal mold and plasticine cast showing the large flabellate muscle scars, the prominent median septum, striking concavity of the valve, some of the superimposed	128


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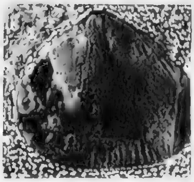
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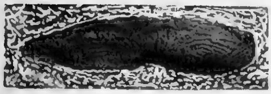
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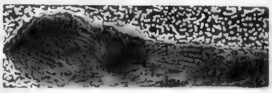
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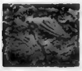
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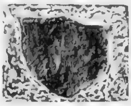
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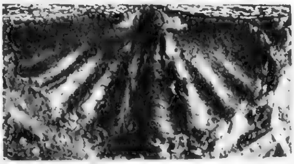
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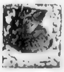
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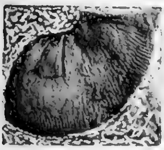
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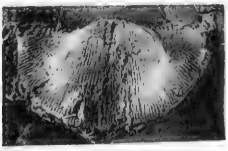
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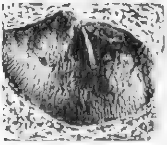
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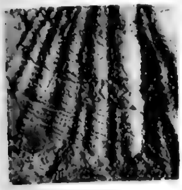
PLATE XII (XVIII)

EXPLANATION OF PLATE 12 (18)

Figure		Page
1, 2.	**"Spirifer" kingi** Caster, n. sp. External dorsal mold showing the divaricating plicæ and details of the pustulose surface. See also pl. 8, fig. 19. Holotype. Pal. Res. Inst. No. 5397. Fig. 1, × 1; fig. 2, × 4	151
3, 4.	**"Spirifer" kingi** Caster, n. sp. Internal dorsal mold showing the impression of the median septum, the strong crural bases, and bifurcating plicæ. For additional illustrations of this species see pl. 8, fig. 19; pl. 10, fig. 14. Holotype. Pal. Res. Inst. No. 5397A. Fig. 3, × 1; fig. 4, × 3	151
5, 6.	**?Brachyspirifer palmeræ** Caster, n. sp. External dorsal mold of the holotype showing the smooth surface and characteristic plication of the **audaculus** group. For additional illustrations of this species see pl. 10, figs. 12-13. Pal. Res. Inst. No. 5407. Fig. 5, × 1; fig. 6, × 2	164
7, 8.	**Australospirifer** cf. **antarcticus**, var. 1 An immature individual which fulfills the specifications of the Falkland species, or variants of that form, which have been hitherto included in the species, **s.s.** Internal ventral mold. For additional illustrations of this species see pl. 13, figs. 21, 22. Pal. Res. Inst. No. 5408. Fig. 7, × 1; fig. 8, × 3	162
9.	**?Paraspirifer**, sp. Gigantic internal ventral mold of a spiriferoid which recalls the northern Paraspirifers very much. Sole representative known from the faunule. May belong, on better acquaintance, to the **Australospirifer iheringi** stock. Pal. Res. Inst. No. 5416; × 1	167
10-13.	**Acrospirifer olssoni** Caster, n. sp. Internal dorsal mold and external dorsal mold of the holotype. Showing the median dorsal septum, the rugged crural plates, and the nature of the simple surface pustules. For additional illustrations of this species see pl. 7, figs. 28, 29; pl. 9, fig. 24; pl. 10, figs. 15, 18; pl. 11, figs. 10-12. Holotype. Pal. Res. Inst. Nos. 5409 and 5410, respectively. Fig. 10, × 1; fig. 11, × 1.5; fig. 12, × 1; fig. 13, × 3	156
14-15.	**Meristella wheeleri** Caster, n. sp. Internal and external ventral molds of the holotype showing the characteristic features of the rostral chamber, and deep, subangular, median sinus. Pal. Res. Inst. Nos. 5461, 5461A, respectively; × 1	169
16.	**?Aviculopecten**, sp. A Enlargement of the external mold of a pectenoid shell of undetermined affinities. See also pl. 13, figs. 17, 18. Pal. Res. Inst. No. 5414A; × 2.5	178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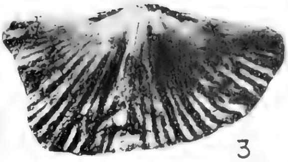
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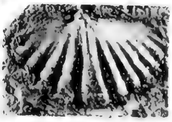
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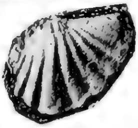
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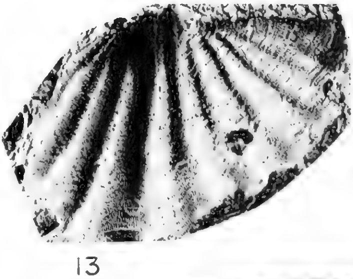
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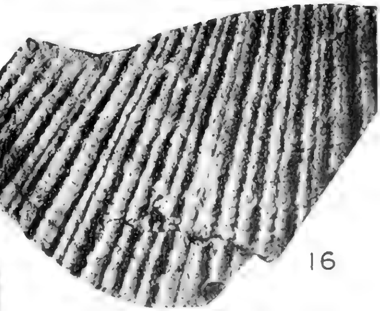
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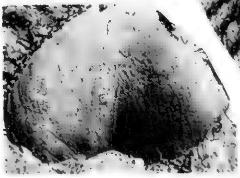

PLATE XIII (XIX)

16. **?Aviculopecten,** sp. B 178
Portion of an external mold of a broad-ribbed pectenoid shell which is too imperfectly known to identify. Apparently an undescribed species. Pal. Res. Inst. No. 5412; × 1

17, 18. **?Aviculopecten,** sp. A 178
Views of another pectenoid shell showing specific differences from the form illustrated above. Fig. 17 is an external mold, and fig. 18, a plasticine cast of the same. See also pl. 12, fig. 16. Pal. Res. Inst. No. 5414A; × 1

19. **?Australospirifer** cf. **antarcticus,** var. 2 163
A plasticine cast of the exterior of a fragment showing some features in common with the ubiquitous "austral" species, but too poorly preserved to warrant precise identification. Surface appears to be without pustules or radii. Pal. Res. Inst. No. 5471B; × 1

20. **?Australospirifer** cf. **antarcticus,** var. 2 163
Internal ventral mold of a form which may belong to the **antarcticus** gens, but is too poorly preserved to make final determination possible. For additional illustration of this species see pl. 7, fig. 27. Pal. Res. Inst. No. 5407D; × 1

21, 22. **Australospirifer** cf. **antarcticus,** var. 1 162
Showing a fragmental external dorsal mold of a form which appears to belong to the **antarcticus** gens, but will probably prove to be specifically distinct when better known. For additional illustrations of this species see pl. 12, figs. 7, 8. Pal. Res. Inst. No. 5408A. Fig. 21, × 1; fig. 22, × 3

23. **Vitulina,** sp. 142
Plasticine cast of the exterior of a dorsal valve of a tiny irregularly pustulose shell of undetermined specific affinities. See also pl. 7, figs. 30, 21. Pal. Res. Inst. No. 5460; × 3

24, 25. **?Cryptonella,** sp. 176
Dorsal external impression and plasticine cast of the single specimen known from Colombia. Fig. 24 is the external mold. Pal. Res. Inst. No. 5463A; × 1

26. Fragment of an external mold of a gastropod of undetermined relationships 179
Pal. Res. Inst. No. 5484; × 1

27. **?Spinocyrtia** cf. **valenteana** (Hartt in Rathbun) 168
Internal ventral mold showing the characteristic features of the Brazilian species which appears to be related to the **granulosus** stock of the North. Pal. Res. Inst. No. 5443B; × 1

EXPLANATION OF PLATE 13 (19)

Figure		Page
1, 2.	**Elytha colombiana** Caster, n. sp. An external ventral mold which shows very well the lamellate surface and "double-barreled" spine bases. See also fig. 4, below. Holotype. Pal. Res. Inst. No. 5439. Fig. 1, × 1; fig. 2, × 2.5	146
3.	**Elytha colombiana** Caster, n. sp. Portion of an external dorsal mold which shows rather well the variation in width of the shell and the strength of the concentric lamellæ. Paratype. Pal. Res. Inst. No. 5440; × 1	146
4.	**Elytha colombiana** Caster, n. sp. Internal ventral mold of the holotype. See figs. 1 and 2, above. Pal. Res. Inst. No. 5439A; × 1	146
5, 6.	**Elytha colombiana** Caster, n. sp. Internal ventral mold of an immature individual. Note the impression of the external spines on the internal mold. Paratype. Pal. Res. Inst. No. 5441. Fig. 5, × 1; fig. 6, × 2.5	146
7.	**Elytha colombiana** Caster, n. sp. Internal dorsal mold of an immature individual. Paratype. Pal. Res. Inst. No. 5442; × 1	146
8.	**Elytha colombiana** Caster, n. sp. Fragment of an external ventral mold, showing the median depression at the base of each spine which corresponds on the exterior to the position of the internal median diaphragm. Paratype. Pal. Res. Inst. No. 5443; × 1	146
9.	**Meganteris australis** Caster, n. sp. External dorsal mold showing the prominent lamellæ, and the faint radii toward the front of each lamella. See interior of same individual, fig. 12, below. Holotype. Pal. Res. Inst. No. 5422; × 1	173
10.	**Meganteris australis** Caster, n. sp. External ventral (?) mold of an immature individual. Note faintness of the radii on the varices. Paratype. Pal. Res. Inst. No. 5423; × 1	173
11.	**Meganteris australis** Caster, n. sp. Internal ventral mold of an individual of about the same size as the holotype. Note short but strong hinge teeth, well developed lamellæ, and obscure muscle scars. Paratype. Pal. Res. Inst. No. 5424; × 1	173
12-14.	**Meganteris australis** Caster, n. sp. Internal dorsal mold of the holotype. Note impression of bipartite cardinal process, rugged crura, and recessed muscle seats. Fig. 13 shows impression of the cardinal area, and fig. 14 is a plasticine cast of the same. See also fig. 9, above, for external characteristics. Holotype. Pal. Res. Inst. No. 5425; × 1	173
15.	**Meganteris australis** Caster, n. sp. Plasticine cast of a small portion of the external mold of the holotype. Shows the regular fine punctæ which are highly characteristic of the genus and species. For additional illustrations of this species see pl. 9, figs. 25, 26. Pal. Res. Inst. No. 5422; × 5	173

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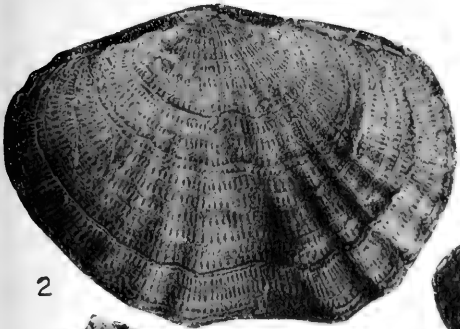
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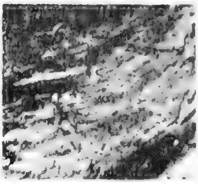
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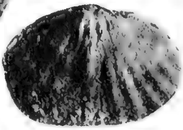
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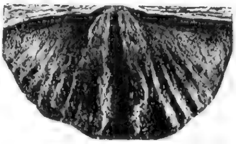
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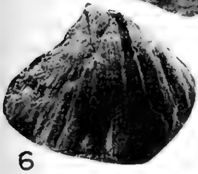
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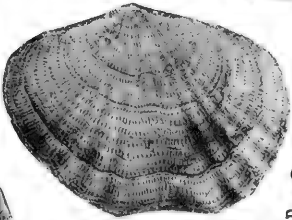
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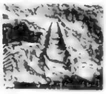
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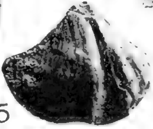
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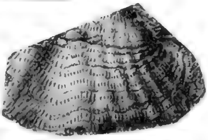
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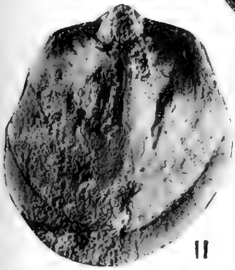
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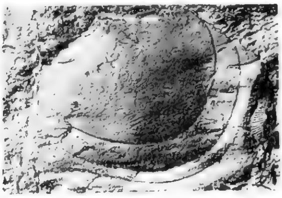
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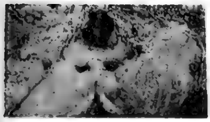
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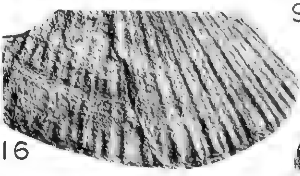
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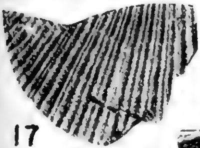
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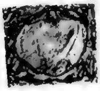
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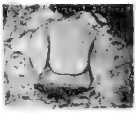
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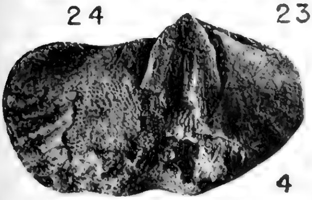
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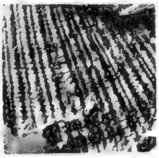
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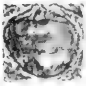
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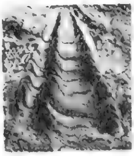
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PLATE XIV (XX)

fig. 21, which resemble very closely the surface of Conrad's **Cypricardinia indenta** of the North. For additional illustrations of this species see pl. 11, figs. 6-8. Pal. Res. Inst. No. 5479. Figs. 19, 20, × 1; fig. 21, × 2.5

22. **?Fenestella cf. venezuelensis** Weisbord 179
A portion of the mold of a zoarium. This is one of the commonest fossils in the Colombian faunule. Pal. Res. Inst. No. 5480A; × 1

23. **"Incertæ sedis"** 180
External mold of an organism of unknown relationship. Probably bryozoan. Compare with similar structure illustrated and discussed by Kozlowski, 1923. Pal. Res. Inst. No. 5481; × 1

24. **Fenestella,** sp. 179
The base of a zoarium, probably the same species as fig. 22, above. Pal. Res. Inst. No. 5480B; × 1

EXPLANATION OF PLATE 14 (20)

Figure Page

1, 2. **Phacops cf. salteri** Kozlowski 181
Fragment of an external mold showing the highly characteristic glabellar swelling and papillose surface of the species. Pal. Res. Inst. No. 5452. Fig. 1, × 3; fig. 2, × 1

3-6. **?Dalmanites cf. patacamayaënsis** Kozlowski 181
External and internal molds of the pygidium of a trilobite which recalls the Bolivian form described by Kozlowski. The median spines may prove to be a specific character, however. Figs. 3, and 4, an external mold; fig. 5, an internal mold showing the marginal flange very well. Pal. Res. Inst. Nos. 5477A and 5477, respectively. Fig. 3, × 3; fig. 4, × 1; fig. 5, × 1

7. **Phacops cf. salteri** Kozlowski 181
Fragment of an external dorsal mold of part of the thorax and pygidium. The circular hole is a cavity left by the weathering of a crinoid stem. Pal. Res. Inst. No. 5405; × 1

8. **Phacops cf. salteri** Kozlowski 181
Internal dorsal mold of a portion of the thorax. Pal. Res. Inst. No. 5458; × 1

9, 10. **Phacops cf. salteri** Kozlowski 181
Portion of an external mold and plasticine cast of the cephalon of an average sized adult. Pal. Res. Inst. No. 5458A; × 1

11, 12. **Phacops cf. salteri** Kozlowski 181
External cephalic mold of a young individual. Pal. Res. Inst. No. 5458B. Fifi. 11, × 1; fig. 12, × 3

13. **Phacops cf. salteri** Kozlowski 181
Plasticine cast of the head mold illustrated as figs. 11 and 12; × 3

14, 15. **?Phacops cf. salteri** Kozlowski 181
An internal cephalic mold presumably belonging to this species, but showing exceptionally widely spaced eyelobes. Pal. Res. Inst. No. 5456. Fig. 14, × 1; fig. 15, × 3

16. **Phacops cf. salteri** Kozlowski 181
Internal mold of a portion of the mentum of this trilobite. Pal. Res. Inst. No. 5478; × 1

17. **?Cyphaspis,** sp. 181
A portion of the cranidium of an unknown trilobite which shows some resemblance to the form illustrated by Kozlowski, 1923, pl. 4, fig. 11, from the Bolivian Devonian. Pal. Res. Inst. No. 5480; × 1

18. **?Homalonotus,** sp. 181
Internal mold of the pygidium of an unknown trilobite. Pal. Res. Inst. No. 5456A; × 1

19-21. **Cypricardinia cf. subindenta** Weisbord 177
External mold and squeezes of a fragment of shell presumably closely related to Weisbord's Venezuelan species. Note the chevron markings on the enlargement of the squeeze,

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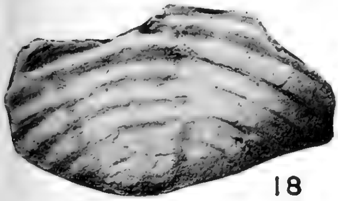
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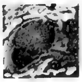
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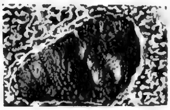
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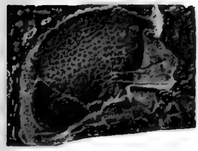
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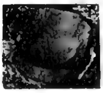
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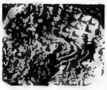
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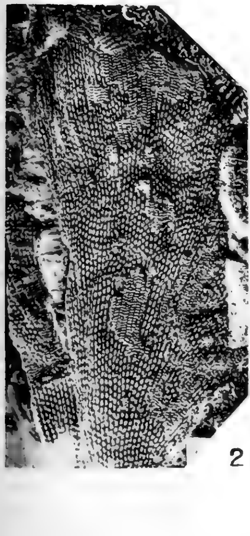
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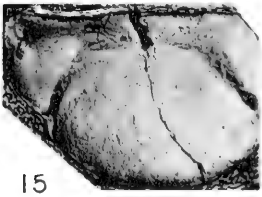
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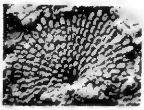
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Notes on Cypraea Heilprini Dall and Cypraea Chilona Dall with New Species from the Pliocene of Costa Rica

By William Marcus Ingram

April 15, 1939

Paleontological Research Institution
Ithaca, New York
U. S. A.

NOTES ON CYPRAEA HEILPRINI DALL AND CYPRAEA CHILONA DALL WITH NEW SPECIES FROM THE PLIOCENE OF COSTA RICA*

By
William Marcus Ingram
Cornell University

NOTES ON CYPRAEA HEILPRINI DALL AND CYPRAEA CHILONA DALL

During a recent study of fossil *Cypræidæ* in the United States National Museum the writer had opportunity to examine type material of *Cypræa heilprini* Dall and *Cypræa chilona* Dall. A comparison of the former species with the illustration accompanying Dall's original description showed that the figure of the ventral view was idealized, and does not represent the true character of the ventral surface of the shell. Illustrations of the holotype specimen of *C. heilprini* Dall are included here to aid one in identifying this species when a comparison with the holotype is impossible. (Figs. 1, 2.) Dall's original description of *heilprini* is also included here with the writer's comments about the figure of the ventral view.

Cypræa heilprini Dall Plate 1, figs. 1, 2

Cypræa heilprini Dall, 1890, Trans. Wagner Free Inst. Sci., vol. 3, p. 166, pl. 11, figs. 2, 2a.

This species is best described by comparison with *C. pinguis*. It differs from the latter in being more cylindrical; in its somewhat straighter and proportionally narrower aperture, which is also less curved at the posterior commissure; in being less elevated in proportion to its length and having the posterior slope of its dome less abrupt; in being more attenuated laterally at either end, and in the greater production of the extreme ends of the base; lastly, it appears to average smaller than *pinguis*, and none of the specimens indicate any such *Aricia*-like basal

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* Greatful acknowledgment is extended to Dr. Paul Bartsch, Dr. Harald Rehder, and Mr. F. S. MacNeil of the United States National Museum for courtesies offered the writer. Appreciation for advice rendered is due Dr. C. W. Merriam of the Department of Paleontology of Cornell University. The photographs were obtained through the courtesy of the United States National Museum. The writer wishes to thank Professor G. D. Harris and Dr. K. V. W. Palmer of the Paleontological Research Institution, Ithaca, New York.

callus as *pinguis* assumes in its fullest stage of development. The specimens show nothing of the spire; the teeth are strong but small, and not extended (even faintly) across the basal callus; there are twenty-two on the right lip and about eighteen on the left, which latter are less prominent. The largest specimen measures 26.5 mm. long, 17.0 mm. wide and 15.0 mm. high. The smallest was only 21.5 mm. long, but of about the same proportions.—(Dall, 1890).

Dall's illustration of the ventral view of *heilprini* gives the impression that the specimen is broader in proportion to its length than it really is. His figure shows no tooth bordering the columella incisure anteriorly; in reality there is a prominent tooth anterior to the incisure, and the incisure is deeper than his figure portrays. The photograph of the ventral view shows that the anterior canal lips are produced ventrally, the columellar lip being especially pointed. The original figure does not indicate this condition of the anterior canal lips, and shows the columellar lip to be blunt.

Holotype.—Numbered 114103 in the United States National Museum, Washington, D. C.

Type locality.—Ten Mile Creek, one mile west of Bailey's Ferry, on the Chipola River, Calhoun County, Florida. Lower Miocene.

Cypræa chilona Dall Plate 1, figs. 3, 4

Cypræa chilona Dall, 1900, Trans. Wagner Free Inst. Sci., vol. III, p. 1195, pl. 39, figs. 1, 3.

Shell rotund, heavy, anterior canal very slightly produced; base angled at outer margins on both columellar and outer lip sides; anterior canal straight, about 4 mm. broad at point of maximum width; posterior canal curved, about 5 mm. broad at point of maximum width; the strange curvature of the aperture at the center is possibly due to a malformation of the shell in this region; anteriorly the aperture is straight, posteriorly it is curved to the left; the aperture is about 6 mm. broad at the point of maximum width; teeth heavy, rounded, indefinite toward the posterior end of the base; incisures between the teeth broad; no shell color is preserved. This description is based upon the lectotype. Length 42.25 mm.; width 37 mm.

Dall (1900) described the species *Cypræa chilona* from an illustration. In order to facilitate further identification of this species the writer has included here a brief description based on the lectotype. Figures of the lectotype designated by the writer (figs. 3, 4) are also included. The lectotype in the United States National Museum is without doubt the specimen in dorsal view figured by Dall for specific distinction. A syntype figured by Dall in ventral view is numbered 164928 in the above museum.

Lectotype.—Numbered 498388 in the United States National Museum, Washington, D. C.

Type locality.—Chipola Beds, Alum Bluff, Florida. Lower Miocene.

NEW CYPRAEA FROM COSTA RICA

The *Cypræa* reported here are from the Pliocene of Costa Rica. They were collected by Dr. W. P. Woodring in 1917 from a railroad cut two and one-half miles outside of the town of Limon, Costa Rica. They are now housed in the United States National Museum, locality No. 8461.

Cypræa bartschi, n. sp. Plate 1, figs. 5, 6, 7

Shell ovate-subdepressed; from point of greatest width, 17 mm., shell narrows to 5 mm. anteriorly, and to 6 mm. posteriorly; canals produced; dorsal convexity slopes gradually toward anterior canal, and abruptly toward posterior canal, forming nearly a right angle; spire obscured; rounded depression in shell just to left of spire; lateral extremities marked by a raised line formed by the angled shell base; base convex; posterior canal noticeably curved to the left, anterior canal slightly curved to the left; aperture narrower posteriorly than anteriorly; teeth strong; columellar teeth extend but slightly on columella into aperture; columellar teeth arranged in a fairly straight line along base, and extend from 2 to 3 mm. over base; 4 posterior columellar teeth extend further on base than the rest, 3 of them extending over the columellar side of the posterior canal; outer lip teeth are arranged about evenly in their extent over the base, central few being shorter than the rest; teeth rounded; interstices between teeth broad and concave; most anterior few of outer lip and columellar teeth extend over the anterior canal lips.

Dimensions.—Length 25.75 mm.; width 17.00 mm.; height 12.75 mm.

Cypræa bartschi is apparently related to the lower Miocene fossil, *Cypræa raymondrobertsi* Pilsbry (1921) of Santo Domingo. It differs from it in having the columellar lip of the posterior canal more produced; also the columellar teeth in *bartschi* extend as raised ridges over the columellar lip projection of the posterior canal. The anterior canal in *raymondrobertsi* is straight and in *bartschi* it is curved to the left. The teeth in the former species do not extend over the lips of the anterior canal as they do in the latter species. The anterior canal lips are straight in a dorso-ventral direction in Pilsbry's species while they are angled in *bartschi*. The aperture is narrower, and the base is more angled in *bartschi*.

This species is named for Dr. Paul Bartsch, Curator of Mollusca and Cenozoic Invertebrates, of the United States National Museum.

Holotype.—Housed in the United States National Museum, Washington, D. C.

Type locality.—Morin Hill, railroad cut 2½ miles outside of the town of Limon, Costa Rica. Pliocene.

Cypræa cinerea, var. **morinis**, n. var. Pl. 1, figs. 8, 9

Shell cylindrically-oblong; canals surrounded dorsally by an impression; posterior and anterior canals but slightly produced; spire obscured, depressed; base convex; teeth finer on columellar side of aperture than on outer lip side; columellar teeth longer than outer lip teeth; aperture narrow, curved toward the left posteriorly, nearly straight anteriorly; aperture about twice as broad anteriorly as posteriorly.

The enamel is preserved. The shell color is a uniform dirty-brown dorsally, fading to a greyish-white on the shell base. Some of the interstices between the columellar teeth are colored brown.

This variety differs from *Cypræa cinerea* Gmelin in possessing an elongate shell, resembling that of *Cypræa isabella* Linnæus. The columellar and outer lip teeth are finer. Although the shell color was described above this may not be the original coloration, for it is not unlikely that some color distortion has taken place. However, the color of the interstices between the columellar teeth seems to have been well preserved.

Dimensions.—Length 28 mm.; breadth 16 mm.; height 13.50 mm.

Holotype.—Housed in the United States National Museum, Washington, D. C.

Type locality.—Morin Hill, railroad cut 2½ miles outside of the town of Limon, Costa Rica; locality No. 8461. Pliocene.

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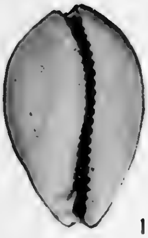
EXPLANATION OF PLATE 1 (21)

Figure		Page
1, 2.	**Cypræa heilprini** Dall Lower Miocene, Florida; holotype, No. 114103 in U. S. N. M.; about natural size.	3
3, 4.	**Cypræa chilona** Dall Lower Miocene, Florida; lectotype, No. 498388 in U. S. N. M.; about natural size.	4
5-7.	**Cypræa bartschi,** n. sp. Pliocene, Costa Rica; holotype. Housed in U. S. N. M.; about natural size.	5
8, 9.	**Cypræa cinera,** var. **morinis**, n. var. Pliocene, Costa Rica; holotype. Housed in U. S. N. M.; about natural size.	6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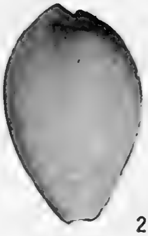
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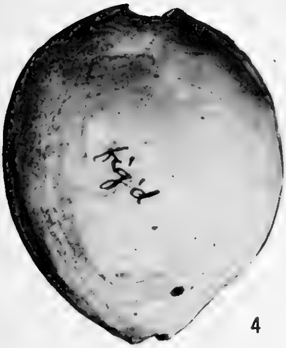
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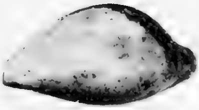
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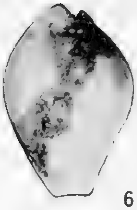
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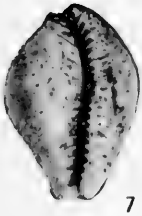
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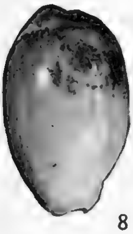
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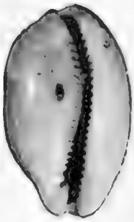
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BULLETINS

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Volume 24

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Number 85

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New Fossil Cypraeidae from the Miocene of the Dominican Republic and Panama, with a Survey of the Miocene Species of the Dominican Republic

By William Marcus Ingram

April 15, 1939

Paleontological Research Institution

Ithaca, New York

U. S. A.

NEW FOSSIL CYPRAEIDAE FROM THE MIOCENE OF THE DOMINICAN REPUBLIC AND PANAMA, WITH A SURVEY OF THE MIOCENE SPECIES OF THE DOMINICAN REPUBLIC

By

William Marcus Ingram
Cornell University

The family *Cypræidæ* is well represented in numbers of fossil species occuring in Santo Domingo. The following species have been reported from the Miocene: *Cypræa campbelliana* Pilsbry, *Cypræa cinerea* Gmelin, *Cypræa dominicensis* Gabb, *Cypræa henekeni* Sowerby, *Cypræa isabella* Linnæus, *Cypræa raymonrobertsi* Pilsbry, *Cypræa spurca* Linnaeus, *Cypræa spurcoides* Gabb, *Cypræa noueli* Maury, and *Nuclearia gabbiana* (Guppy). This paper adds one new species and one new variety of *Cypræidæ* to the Miocene fauna of Santo Domingo, and one new species to the Miocene fauna of Panama.

Grateful acknowledgment is due Dr. Paul Bartsch, Dr. Harald Rehder, and Mr. F. S. Mac Neil of the United States National Museum for allowing the writer to examine these species that are housed in the National Museum and are described here.

DESCRIPTION OF SPECIES

Cypræa gurabonis, n. sp. Pl. 1, figs. 6, 7

Shell light, ovate; dorsal surface rounded; anterior and posterior canal extremities slightly produced; outer lip portion of anterior canal extremity slightly longer than columellar lip portion; outer lip portion of posterior canal extremity produced about twice that of columellar lip portion; lateral shell margins rounded gradually into the base; outer lip angled, leaving a ridge on outer lip lateral surface; aperture filled with matrix so that the teeth are not visible; both anterior and posterior canals curve toward the left of the shell; anterior portion of shell slopes gradually to anterior production of canal; posterior portion of shell slopes abruptly to production of posterior canal. Color wanting.

Named for Gurabo formation.

This species in the general bulbous character of the dorsal surface of the shell superficially resembles this character in *Cypræa semen* Cooke, from the lower Miocene of Anguilla. This bulbous character is not well shown in the figures included here. The species is quite distinct from others reported from Santo Domingo.

Dimensions.—Length 17 mm.; width 11 mm.; height 9.25 mm.

Holotype.—Numbered 483461 in the United States National Museum, Washington, D. C.

Type locality.—United States National Museum station 8737, District of Monte Cristi, Gurabo River about 5 miles above Gurabo Adentro at base of coral limestone and above conglomerate. Gurabo formation, middle Miocene.

Cypræa merriami, n. sp. Plate 1, figs. 10, 11

Shell heavy with a high dorsum; anterior and posterior canals produced, deeply notched; posterior canal notch 9 mm., anterior canal notch about 6 mm.; anterior canal covered by a shelf about 5 mm. broad on the dorsal surface; anterior canal bounded laterally by flanges which are quite prominent; spire obscured, with a depression to the right; base but slightly convex on columellar side, convexity exists in center, the base becoming flattened anteriorly and posteriorly; outer lip side of base slightly convex throughout its length; teeth especially prominent on outer lip; these teeth broad, rounded, interstices between them rounded; anterior 7 columellar teeth prominent, other columellar teeth very indistinct; interstices between columellar teeth broad; columellar teeth extend but slightly on columella; teeth on both sides confined to lips surrounding aperture.

Named for Dr. C. W. Merriam of the Department of Paleontology of Cornell University.

This is the largest species of fossil cowry recorded from Panama, and exceeds in size and general shell bulk the large *Cypræa willcoxi* Dall from Florida. The shell is extremely heavy, and bulky, and superficially resembles the general outline of a living *Cypræa arabica* Linnæus.

Dimensions.—Length 74.90 mm.; width 50 mm.; height 40 mm.

Holotype.—Housed in the United States National Museum, Washington, D. C.

Type locality.—North shore of Nancy's Cay, Panama. Miocene?

Cypræa henekeni var. **potreronis**, n. var. Pl. 1, figs. 8, 9

Shell obovate; two nodules on dorsal surface with a deep pit between them, nearest to the nodule on the left of the shell; posterior shell portion extremely thick, heavy; anterior canal much produced, narrow, flanged; flanges depressed in center, leaving a prominent raised ridge around their margins; posterior canal bounded dorsally by shell extensions which are heavy and extend about 6 mm. out from canal; teeth confined to extreme ventral margins of aperture; teeth on columella side of aperture narrower than those on outer lip side; incisures between columellar teeth broader than those of outer lip teeth; anterior part of aperture broad, and fairly straight; posterior part of aperture curved to the left; shell color brown on both dorsal and ventral surfaces; teeth and columella both colored brown.

Named for Potrero, Santo Domingo.

This variety differs from the species in possessing a deep pit between the nodules on the dorsal surface. The posterior canal notch is deeply cut, and the anterior canal is extremely narrow. The shell flanges around the anterior canal are much broader than in the species, *henekeni*, and these are bounded by a raised ridge that is prominent. The posterior bulk of the shell is heavier, the bulk being slightly produced in this region. The combination of these characters will readily separate this variety from the species, *C. henekeni* Sowerby.

Dimensions.—Length 61 mm.; breadth 48 mm.; height 31.25 mm.

Holotype.—Housed in the United States National Museum, Washington, D. C.

Type locality.—Bluff on the right bank of Rio Amina at ford near Potrero, Provincia de Santiago, Santo Domingo. Gurabo formation, middle Miocene.

MIOCENE SPECIES OF THE DOMINICAN REPUBLIC

In reviewing the literature of the fossil *Cypræidæ* of the Americas and the West Indies during a recent study, I have found no one work that contains a complete summary of the fossil species found in the Miocene of the Dominican Republic.

In formulating a general bibliography of the fossil *Cypræidæ* of the Americas and the West Indies much time was consumed in tracing scattered literature pertinent to the subject; with this in mind original descriptions concerning Miocene species of Santo Domingo are included here.

By carefully checking the collections of the United States National Museum, Academy of Natural Sciences, Paleontological Research Institution, and the Paleontological collection of Cornell University several type specimens have been located. The numbers of certain of these are now cited for the first time, and should facilitate the location of such specimens for one desirous of examining them.

The writer wishes to thank Dr. C. W. Merriam for advice rendered. Acknowledgment is made to the following institutions and persons who have aided in this study: Dr. C. W. Merriam for examination of specimens in the Paleontology collection of Cornell University; Dr. Paul Bartsch, Dr. Harald Rehder, and Mr. F. S. Mac Neil for examination of material in the United States National Museum; Professor G. D. Harris and Dr. K. V. W. Palmer for examination of material in the Paleontological Research Institution; and Dr. B. F. Howell for examination of material in the Academy of Natural Sciences.

SPECIES LISTED

Cypræa campbelliana Pilsbry

Cypræa campbelliana Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, pp. 365, 366, pl. 30, figs. 9, 10.

The shell is oblong-oval, but slightly produced at the ends, moderately calloused laterally, the callouses dappled with rather small dark spots; dorsal outline evenly arched, spire concealed. Outer lip having 24 teeth. Inner lip with 20 short teeth not running inwards as in *C. cinerea.* In the lower part of the columella an inner series of 5 short teeth may be seen.

Length 30.3, lateral diameter 18.7, dorso-ventral diameter 15 mm.

It is less convex than *C. cinerea,* the posterior slope of the dorsal outline less abrupt. Moreover, the markings of the lateral callouses seem to be of a different character. The teeth are far less numerous than in *C. dominicensis.*—(Pilsbry, 1921)

Holotype.—Numbered 3000 in the Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality.—Santo Domingo. Miocene.[1]

Cypræa cinerea Gmelin

Cypræa cinera Gmelin, 1791, Systema Naturæ, 13th ed., p. 3402.

Cypræa cinerea Gmelin, Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, p. 364.

Pilsbry (1921) reports one specimen from the Miocene of Santo Domingo.

The present day distributional range of this species is in the waters of the West Indies, Florida, and South and Central America.

Cypræa dominicensis Gabb

Cypræa dominicensis Gabb, 1873, Transactions of the American Philosophical Society, vol. 15, new series, p. 236.

Cypræa dominicensis Gabb, Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, p. 364.

Shell very similar to *C. lurida* in form, sides sub-parallel, anterior end tapering more than the posterior, base slightly flattened; inner lip flexous in advance; teeth small, very numerous and not extended over base.

This shell is closely allied to *C. lurida* and *C. pulchra,* but differs from both in that its teeth are small, regular, uniform, and end abruptly along a straight line. The last character at once separates it from the latter, while the size of the crenulations equally distinguish it from the former. The largest specimen is 1.5 inch long.—(Gabb, 1873)

The type has the form of *C. lurida,* being a little more produced at both ends. There are 36 teeth on the outer lip, 29 on the inner. Length 39.5, lateral diam. 23.2, dorso-ventral diam. 19 mm.—(Pilsbry, 1921)

Maury (1917) lists a *Cypræa dominicensis* ? Gabb, from Rio

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[1] Pilsbry, 1921, ''With two or three exceptions, none of the labels bore any identification of locality or horizon further than 'Santo Domingo'.''

Gurabo at Los Quemados, Santo Domingo. Middle Miocene.

A comparison of the holotype of this species to that of *C. campbellina* Pilsbry included here show the general shell shape of the two species to be similar. However, differences in the canals, apertures and teeth readily separate the two.

Holotype.—Numbered 3003 in the Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality.—Santo Domingo. Miocene.[2]

Cypræa henekeni Sowerby Plate 1 fig. 3

Cypræa henikeri Sowerby, 1850, Quarterly Journal of the Geological Society of London, vol. 6, p. 45, pl. 9, fig. 3.

Cypræa henekeni Sowerby, Gabb, 1873, Transactions of the American Philosophical Society, vol. 15, p. 235

Cypræa henekeni Sowerby, Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, p. 365.

Cypræa henekeni Sowerby, Maury, 1917, Bulletins of American Paleontology, vol. 5, No. 29, p. 114, pl. 19, fig. 4.

Testa obovata, ventricosa, inflata, lævis, dorso postice irregulariter tuberculifero, lateribus, paræcipue sinistro, obsolete granosis; extreminatibus, posticâ brevissimâ, anticâ, subproducta, aperturâ angustâ, marginibus dentatis, dentibus paucis, magnis, rotundatis, canali brevissimo, reflexo.

This species bears a general resemblance to *Cypræa Mus* and several others, which occasionally have irregular tubercles on the posterior part of the back; it may however be easily distinguished from all such by the dentition of both edges of the aperture, the teeth in this species, though not numerous, being large and prominent.—(Sowerby, 1850).

Pilsbry (1921) states in comparing *C. henekeni* to *C. mus*, "This species resembles the recent *C. mus*, and has parallel variations, both having smooth and bicornute or bituberculate forms. In *C. henekeni* the tuberculate form predominates, and the tubercles are larger, being thus more specialized than the modern race of the same stock."

There seems to be confusion in the literature concerning the proper spelling of the specific name of this species. Sowerby (1850) in the original description spelled the specific name *henikeri*. Sowerby in applying this name misinterpreted the collectors' names as J. S. Heniker instead of J. S. Heneken. Subsequent writers have corrected Sowerby's misinterpretation of the above name.

Holotype.—?

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[2] See footnote No. 1.

Type locality.—Santo Domingo. Miocene.

Maury (1917) lists this species from Cercado de Mao, Rio Gurabo, and Rio Cana at Caimito. Middle Miocene.

Cypræa isabella Linnæus

Cypræa isabella Linnæus, 1758, Systema Naturæ, 10th ed., p. 722.
Cypræa patrespatriæ Maury, 1917, Bulletins of American Paleontology, vol. 5, No. 29, pt. 1, p. 116, pl. 19, fig. 10.
Cypræa isabella patrespatriæ Maury, Woodring, 1928, Carnegie Institution of Washington, Publication No. 385, p. 317, pl. 21, fig. 9.
Cypræa isabella Linnæus, Gabb, 1873, Transactions of the American Philosophical Society, vol. 15, new series.

Cypræa isabella Linnæus has been reported from the Miocene of Santo Domingo by Pilsbry (1921), Gabb (1873), and Maury (1917). The latter's locality for this species is Cercado de Mao, Bluff 1 Gurabo formation, middle Miocene, Dominican Republic.

In reducing *Cypræa patrespatriæ* Maury to synonymy with *Cypræa isabella* Linnæus Pilsbry (1921) states: "Two specimens, which present no characters differing from the recent shells. The larger one closely resembles a recent *C. isabella mexicana* Stearns which we compared."

The living representative of *C. isabella* Linnæus in North America is *Cypræa isabella mexicana* Stearns (1893) from the Gulf of California. The holotype of this species is numbered 46581 in the United States National Museum from Tres Maries, Gulf of California. Additional localities based on material in the above museum are: Cape St. Lucas, Lower California, and Clarion Island, West Coast of Mexico.

In the living state *Cypræa isabella* Linnæus has a wide Pacific distribution, being found abundantly in the Fiji Islands, Tuamotu Islands, Hawaiian Islands, Samoan Islands, etc. Its distribution has been recorded by Ingram (1937a), (1937b), (1938), (1939) from the following Islands of the Pacific; Hawaiian Islands, Palmyra, Washington, Fanning, and Christmas Islands, Guam Island in the Mariana Islands, and from American Samoa.

Cypræa noueli Maury Plate 1, fig. 5

Cypræa noueli Maury, 1917, Bulletins of American Paleontology, vol. 5, No. 29, pt. 1, pp. 114, 115, pl. 19, fig. 5.

Shell large, exceedingly globose, showing the apex of the spire, aperture somewhat curved; inner lip with about 16 rather weak teeth, the strongest anterior; outer lip with about 20 teeth, also strongest anteriorly and fading out posteriorly; upper margin of outer lip projecting; surface of shell entirely smooth, with traces on the back of a color pattern of white spots of varying size on a dark ground. Length of shell 60, width 44, thickness 39 mm.—(Maury, 1917)

The closest relative of this species is *Cypræa henekeni* Sowerby. It is readily separated from *henekeni,* however, by the bulbous character of the shell and the absence of the two tubercles on the dorsal surface.

Holotype.—Numbered 36984 in the Invertebrate Paleontology collection of Cornell University, Ithaca, New York.

Type locality.—Expedition locality No. 16, Bluff 1, Cercado de Mao, Santo Domingo, middle Miocene.

Cypræa raymondrobertsi Pilsbry

Cypræa raymondrobertsi Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, p. 365, pl. 30, figs. 1, 2. 3.

The shell is subovate in basal outline, solid, with the sides heavily calloused, laterally angular, the callus rising high, especially on the left side, and covering the spire, which is marked by a shallow irregular pit. Ends but little produced. The outer lip has 19 strong teeth, narrower than their intervals. Inner lip with 17 teeth. The base is rather strongly convex.

Length 27, lateral diameter 19.2, dorso-ventral diameter 14.9 mm.

Somewhat like *C. arabicula* Lam. by its angular sides, the aperture as in *C. albuginosa* Mawe.—(Pilsbry 1921)

A similar form called by Pilsbry (1921) *Cypræa raymondrobertsi bowdenensis* occurs in the middle Miocene of Bowden, Jamaica.

It seems to the writer that this species is closer to *C. spurca* L. than to the above species mentioned by Pilsbry.

Holotype.—Numbered 3995 in the Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality.—Santo Domingo. Miocene.[3]

Cypræa spurca Linnæus Plate 1, fig. 2

Cypræa spurca Linnæus, 1758, Systema Naturae, ed. 10, p. 724.

Cypræa spurca Linnæus, Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, p. 365.

Cypræa spurca Linnæus, Gabb, 1873, Proceedings of the American Philosophical Society, vol. 15, new series, p. 235.

Cypræa spurca Linnæus, Maury, 1917, Bulletins of American Paleontology, vol. 5, No. 29, pt. 1, p. 115, pl. 19, fig. 6.

Maury (1917) reports a definite locality for this species, having taken it in the fossil state from Bluff 1, Cercado de Mao; Zone

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[3] See footnote 1.

1, Rio Cano at Caimito, Santo Domingo, middle Miocene. Maury (1921) states that this species is rare.

In the living state this species has a varied distributional range. It has been reported from the North African Coast, South and Central America, Florida, and the West Indies. It is most abundant at the present time in the West Indies.

Cypræa spurcoides Gabb Plate 1, fig. 4

Cypræa spurcoides Gabb, 1873, Transactions of the American Philosophical Society, vol. 15, new series, p. 235.
Cypræa spurcoides Gabb, Maury, 1917, Bulletins of American Paleontology, vol. 5,No. 29, pt. 1, p. 115, pl. 19, figs. 7, 8, 9.
Cypræa spurcoides Gabb, Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, p. 365, pl. 30, figs. 4, 5.

Shell similar in form to *C. spurca,* but somewhat broader and more narrowed in advance. Callus broad, convex below and slightly expanded laterally, not crenulated above as *C. spurca.* Crenulations of both lips well defined, more numerous on the inner than on the outer lip. Color pattern mottled irregularly.

In color and size, this is not unlike *C. bicallosa,* but it differs from it in form and in the absence of the two callosities. It wants entirely the marginal pittings of *C. spurca,* which it approaches nearest in form.—(Gabb, 1873).

Pilsbry (1921) states, "Gabb has compared it with *C. spurca,* but of recent species it seems to us closest to large examples of *C. annulus* in shape."

Holotype.—Numbered 2999 in the Academy of Natural Sciences, Philadelphia, Pennsylvania.

Type locality.—Santo Domingo. Miocene. Maury's (1917) locality, Bluff 1, Cercado de Mao; Zone D, Rio Gurabo at Los Quemados, would indicate a middle Miocene occurence.

Nuclearia gabbiana (Guppy) Plate 1, fig. 1

Cypræa gabbiana Guppy, 1876, Quarterly Journal of the Geologlcal Society of London, vol. 32, pp. 528-529, pl. 19, fig. 10.
Pustularia nucleus (Linnæus), Gabb, 1873, Transactions of the American Philosophical Society, vol. 15, p. 236 (not *C. nucleus* Linn.)
Pustularia gabbiana (Guppy), Pilsbry, 1921, Proceedings of the Academy of Natural Sciences, vol. 73, p. 366.
Cypræa gabbiana Guppy, Maury, 1917, Bulletins of American Paleontology, vol. 5, No. 29, pt. 1, pl. 19, fig. 12.

Oval-elongate, rostrated at both ends, superiorly covered with large shining tubercles which are almost circular upon the back, but become elongate and have a tendency to run into ribs near the thickened regularly grooved lip, whose dentations are continuous with the ribs on the outside. A dorsal groove separates the back into two nearly equal halves.

The tubercles are larger than those of *C. nucleus.*

> The cowry for which I propose the above name has hitherto been considered by me to be *C. pustulata,* and has been identified by Gabb as *C. nucleus.* I think it may be regarded as intermediate between those two species and it presents, I think, some characters which, combined with its distance in time and space from its nearest congeners, may warrant a provisional specific name.—(Guppy, 1876)

Pilsbry (1921) presents conclusive evidence to show that this species is distinct from *Cypræa nucleus* Linnæus, "While this species has a general resemblance to *P. nucleus* L., it differs by the following characters: the raised transverse lines which net the tubercles together are more numerous and conspicuous; the tubercles along the lateral margins are larger; the transverse ridges of the base alternate in size, but the smaller ones terminate at the margin of the aperture in teeth equal to those terminating the larger ridges; the teeth of the columellar side do not extend entirely within the aperture, but end on a sort of projecting ledge, inward from which a latticed-granulose sculpture is seen. Finally, the aperture curves more to the left at the upper end. Length 15.4 to 20.2 mm."

Holotype.—?

Type locality.—Haiti. Miocene. Maury (1917) reports this species from Zone D, Rio Gurabo at Los Quemados, middle Miocene.

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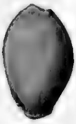

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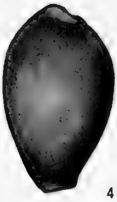

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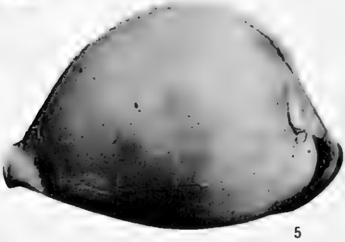

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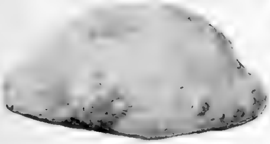

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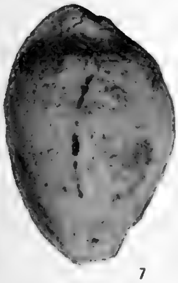

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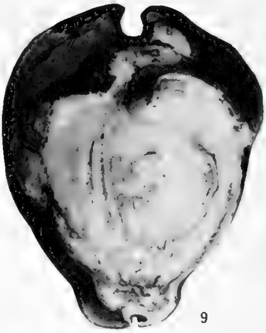

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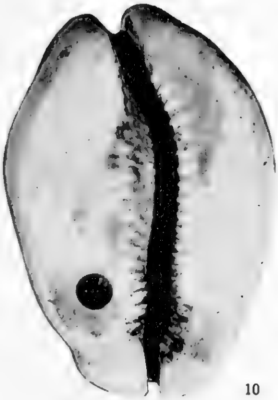

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Reprint of Conrad's Jackson Eocene Fossils as Described and Illustarted in the Philadelphia Academy of Natural Sciences, Proceedings for 1855, pp. 257-63 and Wailes' Report on the Agriculture and Geology of Mississippi, 1854, pls. XIV-XVII.

(*Note*: *The editors have endeavored to follow the original copy of these articles irrespective of gross orthographic and typographic errors.*)

July 15, 1939

Paleontological Research Institution
Ithaca, New York
U. S. A.

[Proc. Phila. Acad. Nat. Sci., 1855, p. 257]

Observations on the Eocene deposit of Jackson, Mississippi, with descriptions of thirty-four new species of shells and corals.

By T. A. Conrad.

The following table will show the order of succession of the Eocene groups; but is not pretended to be more than an exposition of my limited knowledge of them, though they are doubtless presented in the true order of superposition. Further research may develope intercalated groups. Number 6, is probably synchronous with the Orbitulite limestone of St. Stephens, Alabama, as its two most prominent fossils are very abundant in this stratum at Vicksburg. Number 5, is the lowest bed exposed in the bank of the Mississippi river, at Vicksburg. Col. Wailes found a large **Ostrea** on the top of the Jackson group, which is probably the shell referred to in No. 5. It would be convenient to designate these subdivisions thus:- Claiborne group; Jackson group; Vicksburg group; St. Stephens group;

GROUPS OF CHARACTERISTIC FOSSILS

8.	Crassatella Mississippiensis, Arca Mississippiensis, Meretrix sobrina, M. imitabilis. Turbinella Wilsoni.	Newer Eocene, Vicksburg.
7.	Corbula alta, Natica.	
6.	Pecten Poulsoni, Orbitulites Mantelli.	
5.	Ostrea Georgiana?	
4.	Umbrella planulata, Cardium Nicolleti, Conus tortilis, Cypraea fenestralis, Galeodia Petersoni, Rostellaria extenta, &c.	Older Eocene, Jackson.
3.	Crassatella alta, Pectunculus stamineus, Meretrix aequorea, Gratelupia Hydii, Leda coelata. Crepidula lirata &c.	Older Eocene, Claiborne.
2.	Ostrea sellæformis.	
1.	Cardita densata. Cyclas—	

Alabama river.

Nos. 1 to 3 will represent the Claiborne group; 4, Jackson group; 6, St. Stephens group; 7 and 8, the Vicksburg group.

When a group of corresponding fossils is to be found elsewhere, its relative position can be stated by referring to the typical subdivision which contains many identical species.

Since my discovery of the Eocene formation of Claiborne, Alabama, in 1832, by means of fossil shells collected by Judge Tait, numerous localities have been found in the southern States, and characteristic fossils have also been obtained by Maj. Emory, in Western Texas, and even in California, by Mr. Blake. Localities widely separated contain some species in common, but I did not anticipate that groups would vary to the extent they do in the three localities of Claiborne, Alabama, Jackson and Vicksburg, Mississippi. Col. B. L. C. Wailes, of Mississippi, has lately discovered a new group of Eocene fossils at Jackson, in which none of the Vicksburg species occur; and of forty species, five only are identical with Claiborne fossils. One of the Jackson shells, **Cardium Nicolletti,** Conrad, was first discovered in the bank of Red river, Washita; and, therefore, this latter locality will probably prove to belong to the same division of the Eocene as that of Jackson. The Mississippi deposit described by Col. Wailes, is a group of shells chiefly, of more than ordinary beauty and preservation, imbedded in sand of a gray color, consisting of fine angular grains of quartz and minute fragments of shells. One of the species, **Cypraea fenestralis,** is closely ....

[Proc. Phila. Acad. Nat. Sci., 1855, p. 258]

[illegible] related to **C. elegans,** of Deshayes; two remarkable species which have no analogue or kindred shell in the later Tertiary formations. The state of preservation and the forms of these fossils are closely analogous to those of the Paris basin; and I find no recent nor any Miocene species among them. I believe the group to be newer than the Claiborne deposit, and clearly older than that of Vicksburg.

I think it will be found that No. 6, of the above table, represents that extensive limestone, which, in Alabama, contains the Basilosaurus remains; the **Laganum Rogersi,** Morton, near Claiborne, and near Brandon, Mississippi, where it has been discovered by Col. Wailes, occupying a higher position than the Jackson group. The limestone of Jacksonboro', Georgia, described by Lyell, is probably referrible to the same division, and contains the **Laganum Rogersi, (Scutella Jonesi,** Forbes).

The following species of organic remains were collected by Col. B. L. C. Wailes, and are figured in his work on the Geology of Mississippi. Those illustrations are referred to in the descriptions.

CORBULA.

1. **C. densata,** Geol. Miss., Pl. xiv., fig. 9.—Triangular, subequilateral, very thick in substance; surface undulated and having angular concentric striae; umbonal slope submarginal and acutely carinated, posterior extremely angular.

Related to **C. nasuta,** Con. but proportionally shorter, thicker, with a more rounded base, &c. The description applies to the larger valve as I have not seen the opposite one.

2. **C. bicarinata,** Pl. xiv, fig. 3.—Elevated, triangular, slightly oblique, thick in substance, profoundly ventricose, with robust reflected concentric lines; umbo profoundly prominent and the beak incurved; posterior slope biangulated; space between the angles flattened, direct.

Resembles **C. oniscus,** Con., but is thicker, more elevated, not rostrated, and its slight obliquity is the reverse of that in the former species. I have not seen the smaller valve.

LEDA. Schum.

L. multilineata, Pl. xiv., fig. 4.—Ovato-elliptical, inequilateral ventricose, with fine sharp concentric lines, which are somewhat undulated; anterior side rostrated, with closely-arranged, radiating, minute, tuberculated striae; posterior side with unequal fine radiating lines, a few of which are very distinct; a few raditaing lines are continued near the base over the middle of the valves.

Allied to **N. cœlata,** Con., but very distinct.

NAVICULA, Blainville.

N. aspera, Pl. xiv, fig. 5.—Trapezoidal, disc contracted behind the middle, cancellated; concentric lines distant, imbricated; radiating lines largest towards the umbonal slope, subspinous; umbonal slope acutely angulated; posterior slope excavated; series of cardinal teeth uninterrupted; inner margins crenulated.

CARDIUM, Lin.

C. (Protocardia) Nicolletti, Pl. xiv., fig. 6.—Proc. Ac. Nat. Sci., 1841, p. 33. This shell agrees, except in size, with the specimen originally described from the Washita, and doubtless the beds of that locality will prove to be of synchroncus origin with those of Jackson. A species of Cardium very nearly allied to this, I formerly believed to be the same; but it accompanies a different group, and presents variations entitling it to be a specific distinction.

It is from Pamunkey river, Virg.

Compared with **C. Nicolletti;** umbo less inflated, posterior margin oblique, shell proportionally longer, and the radiating lines 22; in the other 25. The posterior cardinal tooth larger &c. It may be named **C. lene.**

[Proc. Phila. Acad. Nat. Sci., 1855, p. 259]

CRASSATELLA, Lam.

C. flexura, Pl. xiv., fig. 7.—Trapezoidal, inequilateral; ventricose medially; slightly contracted anteriorly, and more so posteriorly; umbonal slope angulated and prominent; whole surface with concentric prominent lines, some of which bifurcate anteriorly; inner margin crenulated.

Approaches **C. protexta,** Con., but has the striæ over the whole disk, the cardinal teeth more compressed; inner margin with larger crenulations, &c.

GLOSSUS.

G. filosus, Pl. xiv., fig. 8.—Orbicular, ventricose, with radiating lines, unequal, medially flattened, and towards the ends angulated; concentric lines microscopic, series of cardinal teeth uninterrupted, generally large and prominent.

Allied to **G. stamineus,** Con., but very distinct.

OSTREA, Lin.

O. trigonalis, Pl. xiv., fig. 10.—Triangular, flat, surface irregular, with some indistinct radiating lines; muscular impression obliquely suboval, situated nearer the summit than the base; margin somewhat ascending, submargin carinated.

A single imperfect upper valve is all that I have seen of this shell, but it is widely different from any other Eocene species known to me.

PECTEN, Lin.

P. nuperus, Pl. xiv., fig. 11.—Suborbicular, ventricose, with about twenty-three angular prominent ribs, crossed by fine, closely-arranged wrinkled lines; ears finely striated obliquely.

A single valve with the ears broken is all of this species in the collection.

UMBRELLA.

U. planulata, Pl. xiv., fig. 1.—Suboval, flattened, surface undulated, rising a little towards the apex, which is prominent and acute, and situated much nearer to one side and nearer to one end; lines of growth conspicuous; inner side with a very large suboval cicatrix, with radiating interrupted lines.

This fine species is the only one yet known in North America. Two specimens occur, one of which is marked with some hair-like brown radiating lines, both internally and externally.

CAPULUS, Mont.

C. Americanus, Pl. xv., fig. 1.—Obliquely ovate, longitudinally contracted on one side; lines of growth profound; summit very oblique; apex profoundly prominent, acute, curving towards the base and projecting far beyond the basal margin; aperture obtusely oval or suborbicular.

TROCHITA, Schum.

T. alta. Pl. xv., fig. 3.—Conic, elevated, with three or four transverse undulations; radii prominent, rounded, very irregular, interrupted, somewhat tuberculated; vertex central, spiral, somewhat prominent.

CLAVELLA, Swains. CLAVILITHES, Swains.

1. **C. humerosa.** Pl. xv., fig. 2.—Fusiform, volutions eight?, rounded; body whorl and penultimate entire, the others with broad rounded ribs; whorls carinated below the suture and with revolving lines, most prominent towards the apex; body whorl and penultimate, channeled above and contracted near the summit; body whorl angulated inferiorly; beak long and straight.

2. **C. varicosa.** Pl. xvi., fig. 7.—Fusiform, spire and beak elongated; whorls nine, with distant, rounded, thick ribs and with revolving acute lines, which are obsolete or less prominent on the ventricose portion of the body whorl; papillated apex formed of three volutions; columella nearly straight, and with microscopic longitudinal lines.

C. Mississippiensis. Pl. xvii., fig. 8 is probably the same species.

[Proc. Phila. Acad. Nat. Sci., 1855, p. 260]

MITRA, Humph. Lam.

Subgenus LAPPARIA, Conrad

Short-fusiform, spinose; apex papillary; beak very short, thick, twisted; plaits as in Mitra.

M. (Lapparia) **dumosa**, Pl. xv., fig. 4.—Short-fusiform, volutions seven, direct, obliquely flattened above, with a series of transversely compressed, distant spines on the two largest whorls; on the contiguous whorl they become nodules; two whorls below the apex papillary, smooth; the next two longitudinally ribbed, and the others longitudinally striated or with prominent lines of growth; whole surface with revolving wrinkled lines; plaits four; beak profoundly ridged.

CONUS, Lin.

C. tortilis, Pl. xv, fig. 5.—Ovato-turbinate; spire obtusely conical with the apex exserted, acute; whorls obliquely flattened, with revolving impressed lines and transverse wrinkles, carinated near the base, direct between the carina and suture; lines of growth on body whorl profoundly curved; base with a profound thick fold.

Differs from **C. saurodens**, Con., in having a more prominent and convex spire, in the large twisted callus at base, &c.

ROSTELLARIA, Lam.

1. **R. velata**, Con., Pl. xv., fig. 7. **R. Lamarckii**, Lea, Cont. fig. 164.
2. **R. staminea**, Pl. xvi, fig. 9.—Fusiform, spire elongated, subulate above; whorls fifteen; body whorl slightly concave with fine closely-arranged revolving lines and obsolete longitudinal undulations; three upper whorls with curved longitudinal acute ribs; the remainder covered with a polished calcareous deposit, and excavated at the suture; body whorl angular on a line with the upper margin of the aperture; labrum thin; beak slightly curved.

This species occurs at Claiborne in great abundance.

VOLUTALITHES, Swains.

1. **V. symmetrica**, Pl. xv., fig. 8.—Subfusiform; with longitudinal acute ribs terminating above in short spines on the body whorl; volutions excavated above, where they are striated but not ribbed, body whorl with raised alternated revolving distinct lines; above the angle they become almost microscopic; suture margined below by a series of small points, and somewhat carinated; plaits three, slender.

Allied to **V. Sayana**, Conrad.

NATICA, Lam.

N. permunda, Pl. xvi., fig. 2.—Suborbicular; body whorl somewhat excavated near the suture; spire very short; umbilicus very long, profound, with a central broad rounded ridge, and the lower margin subcarinated; columella subrectilinear.

APORRHAIS.

Subgenus PLATYOPTERA, Conrad.

Shell with a profoundly expanded labrum which is entire, or without a rostrum, and with the margin very thin and acute.

A. (P.) extenta. Pl. xvi., fig. 3.—Shell independent of labrum fusiform, with prominent revolving rounded lines and intermediate fine lines, from one to three, and longitudinal microscopic lines; volutions rounded, covered towards the apex with a polished calcareous deposit; labrum within with impressed radiating lines, becoming well marked furrows towards the base.

[Proc. Phila. Acad. Nat. Sci., 1855, p. 261]

MITRA.

Subgenus FUSIMITRA, Conrad.

Elongate-fusiform, smooth and polished with impressed revolving lines; aperture narrow; plaits two prominent, and two obsolete or much smaller than the others; beak elongated.

To this subgenus belongs **M. conquisita** Con. **M. Mississippiensis,** and Con. of the Vicksburg deposit.

M. (Fusimitra) Mellingtoni. Pl. xvi., fig. 5.—Profoundly elongated, fusiform; volutions ten, convex, six of which towards the apex have revolving impressed lines, with the interstices transversely striated; in the contiguous whorl they are distant and obsolete, except near the summit, where there are two distinct impressed lines; on the penultimate whorl one distinct impressed line, and the summit of the body whorl obtusely carinated; spire longer than the aperture, which is narrow; plaits four, the two superior ones very prominent, robust.

Allied to **M. conquisita,** but much larger, proportionally longer, and with the striae less deeply impressed. It may prove, however, to be the same when many specimens from the two localities can be compared. If it should be identical with the former it is the only specimen common to the Vicksburg and Jackson deposits out of the 40 species of the latter and 100 of the former deposit.

CARICELLA, Con.

1. **C. subangulata,** Pl. xv. fig. 8.—Turbinate; labrum expanded; shoulder subangulated; body whorl flattened above; spire short, conical, consisting of 4½ volutions, with microscopic revolving lines near the apex; columella with four remote plaits the two inferior ones most oblique.

2. **C. polita,** Pl. xvi, fig. 4.—Fusiform; smooth and polished, with revolving lines inferiorly, and on two volutions of the spire; the whorl above is papillary and smooth; columella with closely-arranged microscopic longitudinal lines; plaits four, slender, prominent, remote; beak slightly curved.

Allied to C.   but proportionally shorter and very distinct.

SCALARIA, Lam.

S. nassula, Con., Pl. xvi., fig. 6.—Foss. Shells of Tert. Form. This shell, though much larger than the Claiborne specimens, specifically agrees with them. Probably Lea's **S. planulata** is the same species.

ARCHITECTONICA, Bolton. SOLARIUM, Lam.

1. **A. acuta,** Pl. xvii, fig. 1.—Much depressed, very thin and acutely carinated on the margin; convex above, lower half of the whorls somewhat excavated; revolving striae linear, crenulated, with a minute intermediate crenulated line, and a still finer line or two in some of the interstices; base convex, flattened and somewhat excavated towards the periphery, revolving striae linear, alternated with a medial smaller line and two minute ones, nearly smooth, except four from the umbilical margin which rapidly increase in size towards the inner margin; The marginal line profoundly crenulated; a carinated beaded line on the middle of each whorl within the umbilicus, which is profoundly scalariform.

2. **A. bellastriata,** Pl. xvii, fig. 2.—Discoidal, with radiating impressed lines, which frequently bifurcate and are most profound at the suture; whorls of the spire carinated below near the suture; periphery acutely carinated, margined above by two approximately raised lines, and below by a prominent line which is slightly marked by a microscopic impressed line; base with three impressed lines, that nearest the umbilicus profound; radiating striae interrupted by the revolving lines; base convex towards the periphery and concave towards the umbilicus.

[Proc. Phila. Acad. Nat. Sci., 1855, p. 262]

GASTRIDIUM, Sow.

G. vetustum, Con., Pl. xvii, fig. 4.—Proc. Acad. Nat. Sc, vol. 6, p. 321.. The Jackson specimens of this species, being more perfect than those of Claiborne, Alabama, exhibit six or seven denticulations below the tooth on the labrum, which denticle is very short; the base of the shell is carinated, and an acute carinated line runs within the umbilicus near the outer margin.

CYPRAEA, Lin.

1. **C. pinguis**, Pl. xvii, fig. 3.—Obtusely ovate, rounded at base, but obliquely flattened towards the aperture which is very narrow and denticulato-striate on both sides; columella deeply indented near the base, and a dentate line on the margin; labrum excavated towards the base.

Allied to **C. sphaeroides**, Con., of Vicksburg, but much less ventricose and very distinct.

Subgenus CYPRAEDIA, Swains.

2. **C. fenestralis**, Pl. xvii., fig. 5.—Ovate, ventricose, decussated with acute, prominent, distant lines, the transverse ones alternated in size; interstices with microscopic lines parallel to the transverse ones; aperture narrow, much curved above; columella with four or five plaits.

This beautiful species is nearly allied to **C. elegans**, Desh., but is much broader, and has microscopic regular lines which are not mentioned in the description of the former, and it is probably destitute of them. The plaits on the columella of the Jackson shell are much larger than in its European relative. These two shells are so different from any in the more recent formations that they appear to be entitled to a generic distinction, and they are peculiar to the Eocene period.

PHORUS, Mont.

P. reclusus, Pl. xvii, fig. 6.—Trochiform; whorls seven, obliquely flattened on the sides; base flattened, slightly excavated near the periphery, striated; lines profoundly curved, wrinkled, acute, many of them minutely beaded; base partially covered with a polished calcareous deposit.

GALEODIA Link. CASSIDARIA, Lam.

G. Petersoni, Pl. xvii, fig. 9.—Obtusely ovate, spire short, scalariform; body whorl with three distant revolving lines much larger than the others, which are alternated, suture margined by a prominent acute line; inferiorly three revolving lines larger than the others; lower whorl of the spire carinated in the middle; longitudinal wrinkled lines very fine; labrum margin thickened, somewhat reflected; inner margin denticulato-striate, with a prominent tooth near the upper extremity; labrum reflected; columella striated, inferiorly tuberculato-striate.

Approaches **G. funiculosa (cassidaria)** Desh. but very distinct.

PAPILLINA, Con.

Pyriform; shoulder angular and spinous; beak long, with an obtuse fold on the columella; three volutions from the apex forming a papillated summit.

P. Mississippiensis, Pl. xvii., fig. 10.—Fusiform, with a series of distant, very prominent spines and longitudinal undulations; revolving lines prominent, alternated, wrinkled and undulated; three volutions from the apex entire, and forming the papillary top; fold on the columella obtuse; beak slightly tortuous.

In the geology of Mississippi where the shell is figured, I have incorrectly referred it to the genus **Clavelithes.** To this genus **Papillina** belongs the Eocene species, **Fusus papillatus** Con., of Claiborne. I have never met with a species of this genus in the Miocene or more recent formation. It is probably most nearly related to **Turbinella.**

[Proc. Phila. Acad. Nat. Sci., 1855, p. 263]

TURRITELLA, Lam.

T. alveata. Pl. xvii., fig. 7.—Elongated; whorls about nineteen; revolving lines prominent, about six in number alternated by a minute line; volutions excavated at base and minutely striated.

Allied to **T. obruta,** Con., (**T. lineata,** Lea) of Claiborne, but greatly more elongated.

Polyparia.

ENDOPACHYS, Lonsdale.

1. **E. expansum.**—Cuneiform, dilated, much compressed on the sides; middle ventricose with two prominent ribs; end margins straight, direct, obliquely truncated inwards inferiorly; medial ridge tapering gradually to the base, which is thickened in the middle; surface regularly and beautifully granulated.

Locality. Jackson, Miss. Claiborne, Alabama.

2. **E. triangulare.**—Triangular; sides a little undulated on the margin and tapering towards the middle of the base, which is thickened truncated and rounded, medial elevation very wide, rounded, with two prominent ribs; sides excavated and suddenly compressed near the margins, which are acute; granulations in form of radiating striae.

Locality. Occurs with the preceding.

The sides between the ribs and the depression are convex, and when perfect have probably a rib on the middle.

3. **E. alticostatum.**—Cuneiform, subtriangular; medial elevation tapering gradually to the base, which is thick and irregularly rounded; ribs two, profoundly elevated, compressed; lateral depressions profound, margins acute, oblique; surface densely and minutely granulated; base truncated or obtusely rounded.

Locality. Claiborne, Alabama.

FLABELLUM, Les.

F. Wailesii.—Triangular or cuneiform, concentrically somewhat undulated; periphery irregularly subcarinated, sides plano-convex, subcostate, with impressed radiating lines, many of them bifurcated; lamellae unequal, three smaller between each of the larger ones; sides with longitudinal tuberculated striae.

Locality. Jackson, Miss.

OSTEODES, Conrad.

Form of Turbinolia; transversely oval; lamellae numerous, anastomosing or branched; centre composed of small, angular cells; submargin with similar but smaller cells; cellular or bone-like structure characterizing the sides beneath the surface.

Very distinct from **Turbinolia** or **Turbinolopsis.** To this genus belong my **Turb. cyanthus,** from near City Point, Va., in the older Eocene; and **T. caulifera,** newer Eocene, Vicksburg.

O. irroratus.—Conical, sometimes elongated, recurved, transversely oval; sides with closely arranged, acute, prominent, densely granulated striae; lamellae numerous and finely granulated.

Locality. Occurs with the preceding.

TURBINOLIA.

T. lunulitiformis.—Obtusely conical, with acute, prominent, densely granulated ribs; lamellae numerous, unequal, finely granulated, three smaller between the larger ones; periphery profoundly indented by the prominence of the ribs.

Locality. Occurs with the preceding.

[Geol. Miss.: Wailes, p. 287]
Fossils of the Vicksburg Eocene Beds. Described by
T. A. CONRAD, Esq.
(See Journ. of Acad. Nat. Sciences of Philad., Vol. I. Pl. 11, 12, 13, 14, and Vol. II. p. 1.)

Acteon Andersoni.
Avicula argentea.
Amphidesma Mississippiensis.
Arca Miss.
Bulla crassiplica.
Buccinum Miss.
Bisoarca Miss.
——— lima.
——— protracta.
Catopygus ———?
Cypræa sphæroides.
——— lintea.
Chenopus liratus.
Cancellaria Miss.
——— funerata.
Cassidaria lintea.
Cassis cælatura.
——— Miss.
Caricella demisa.
Cardium Vicksburgensis.
——— eversum.
——— diversum.
Corbula engongata.
——— intastriata.
——— alta.
Crasatella Miss.
——— ———?
Cytherea Miss.
——— astartiformis.
——— imitabilis.
——— sobrina.
——— perbrevis.
——— semipunctata.
——— pyga.
——— lenis.
——— liciata.
——— eversa.
——— subimpressa.
Cerithium siliceum.
——— solitarium.
——— nassuta.
——— Clairbornensis.
Corbis staminea.
Chama Miss.
Clavelithes Vicks.
——— pachyleurus.
Cardita bilineata.
——— subquadrata.
——— subrotunda.
——— vigintinaria.
——— densata.
Catopygus Conradi.
Dentalium Miss.
Discoidea Haldermani.
Fulgoraria Miss.
Fulgar nodulatum.
Fissurella Miss.
Fusus Miss.
——— spinger.
——— Vicks.
Infundibulum trochiformis.
Loripes eburnea.
——— turgida.
Lucina perlevis.
Lima staminea.
Lithophaga Carolinaensis.
——— Claib.
Murex Miss.
Melongena crassicornuta.
Mitra conquesta.
——— Miss.
——— cellulifera.
——— staminea.
——— terebræformis.
——— Georgiana.
Mactra funerata.
——— Miss.
Modiola Miss.
Narica Miss.
Natica Miss.
——— Vicks.
Nucula Vicks.
——— serica.
——— improcera.
——— parilis.
——— Claib.
Nucleolites Mortoni.
——— Lyelli.
Oniscia harpula.
Ostrea Vicks.
——— Georgiana.
Plurotoma Miss.
——— porcellana.
——— servata.
——— congesta.
——— cristata.
——— tantula.
——— tenella.
——— cochlearis.
——— eboroides.
——— abundans.
——— rotædens.
——— decliva.
Phorus humilis.
Psammobia papyria.
——— Missi.
Plolas triquetra.
Panopæa oblongata.
Pecten elixatus.
Pectunculus Miss.
——— arctatus.
Pinna argentea.
Ringicula Miss.
Sagaretus Miss.
Solarium triliratum.
Scalaria trigintanaria.
Turritella Miss.
Terebra diversum.
——— tantula.
Turbinellus Wilsoni.
——— protracta.
Triton Miss.
——— subalveatum.
——— crassidens.
——— abbreviatus.
Tellina lintea.
——— pectorosa.
——— serica.
——— perovata.
——— Vicks.

[Geol. Miss.: Wailes, p. 288]

Since the publication of the preceding list of the Vicksburg fossils, it has been found that some of these fossils should be referred to different genera; priority of description rendering it proper, Mr. Conrad proposes to restore the original names. The following, therefore, must give way to the terms first applied by earlier naturalists.

Bisoarca	to	Navicula.
Chenopus	to	Aporrhais.
Cassidaria	to	Morio.
Citherea	to	Meretrix.
Corbis	to	Fimbria.
Fulgur	to	Busycon.
Infundibulum	to	Trochita.
Loripa	to	Diplidonta.
Melongena	to	Cassidula.
Nucula	to	Leda.
Pectimculus	to	Axinæa.
Sigaretus	to	Stomatia.
Solarium	to	Architectonica.
Terebra	to	Acus.

PLATE XIV.—SHELLS.

BIVALVES.

1 *a.* Umbrella planulata (*top*).
1 *b.* " " (*bottom*).
2. Astarte paralis.
3. Corbuld bicarinata.
4. Leda multilineata.
5. Navicula aspersa.
6. Cardium nicolleti.
7. Crassatella flexura.
8. Glossus fillosus.
9. Corbula densata.
10. Ostrea trigonalis.
11. Pecten nuperum.

(NOTE — Plates republished at nine-tenths original dimensions)

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BIVALVES

Plate XIV

JACKSON TERTIARY SHELLS

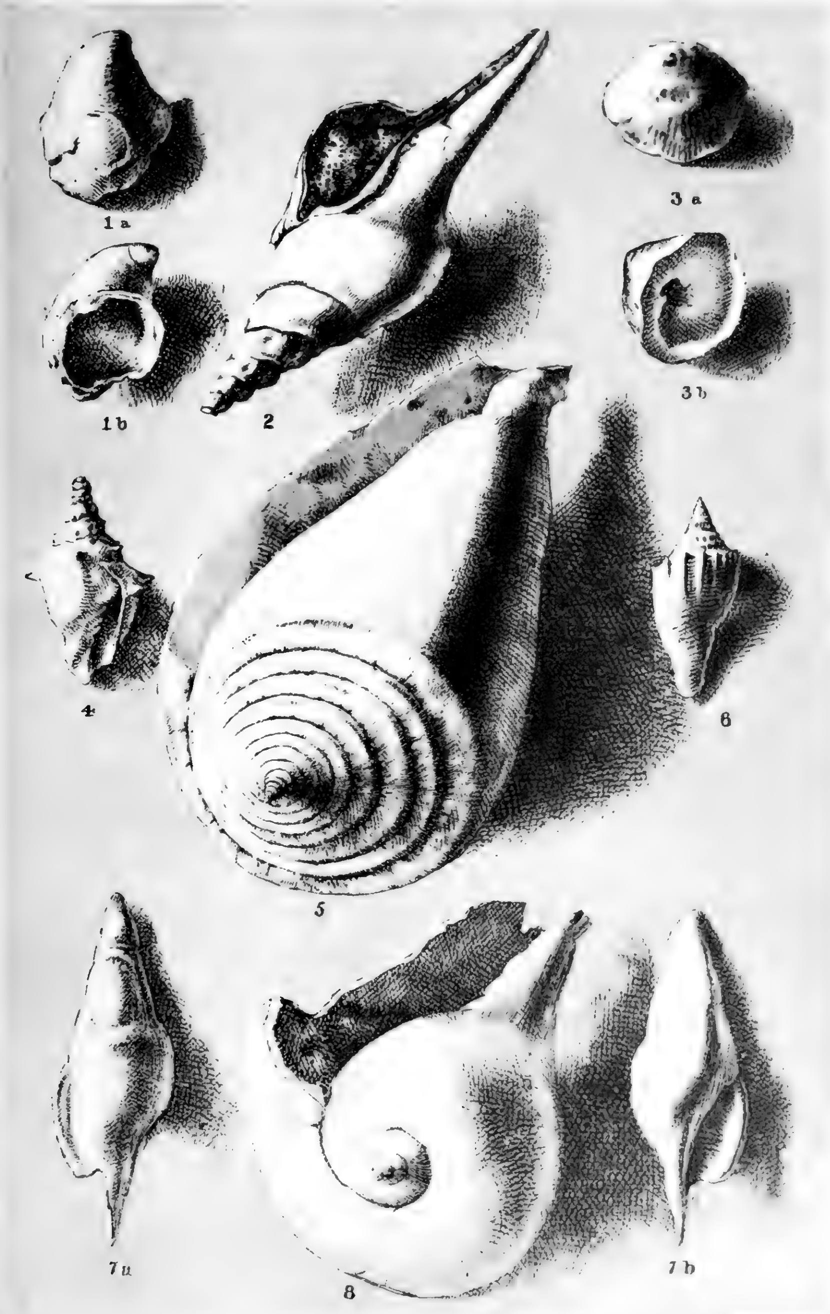
[Geol. Miss.: Wailes]

PLATE XV.—SHELLS.

UNIVALVES.

1. Capulus Americanus.
2. Clavelithes humerosus.
3. Trochita alta.
4. Mitra dumosa.
5. Conus tortilus.
6. Volutalithes symmetrica.
7. *a. b.* Rostellaria vellata.
8. Caricella subangulata.

Page 289 **UNIVALVES** Plate XV



Lith by L.N. Rosenthal Phil

JACKSON TERTIARY SHELLS

PLATE XVI [XVII]—SHELLS.

UNIVALVES.

1. Architectonica acuta.
2. Architectonica bellastriata.
3. *a. b.* Cypræa pinguis.
4. Gastridium vetustum.
5. Cypræa fenestratis.
6. *a. b.* Phorus reclusus.
7. Turritella alveata.
8. Clavelithes Mississippiensis.
9. Morio Petersoni. (Galeodia, of *Link.*)
10. Strepsidura dumosa.

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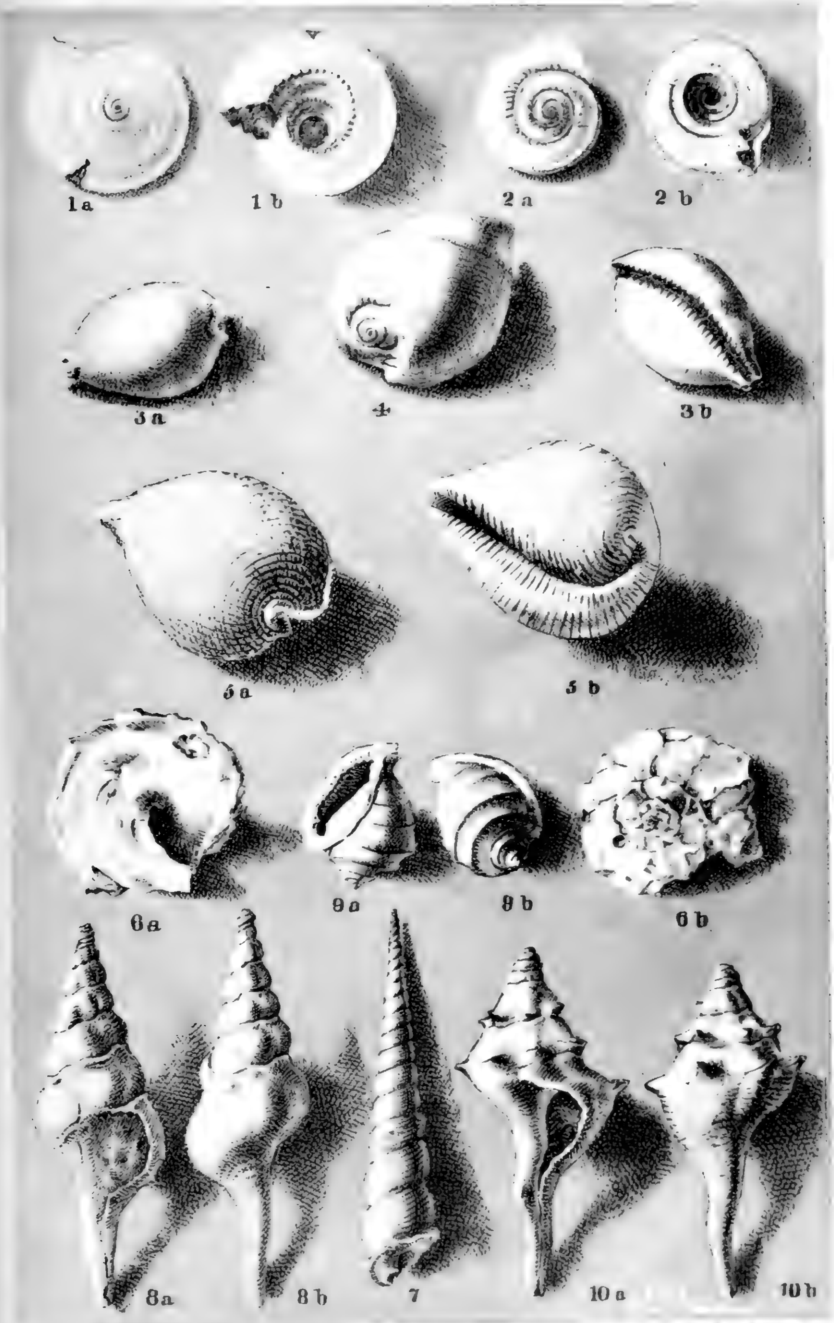
UNIVALVES

Plate XVII



Cromolith by L. N. Rosenthal Phil

JACKSON TERTIARY SHELLS

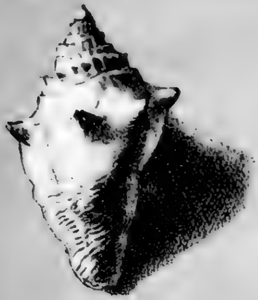
[Geol. Miss.: Wailes]

PLATE XVII [XVI]—SHELLS.

UNIVALVES.

1. Volutalithes dumosa.
2. Natica permunda.
3. Rostellaria extenta.
4. Caricella polita.
5. Mitra Millingtoni.
6. Scalaria nassuta.
7. Clavelithes varicosa.
8. Teredo Mississippiensis.
9. Rostellaria (*young*).

Pag 289 **UNIVALVES** Plate XVI



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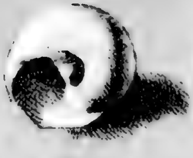

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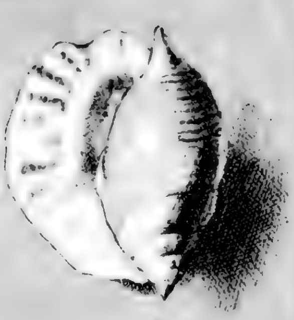

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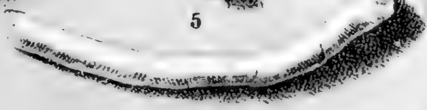

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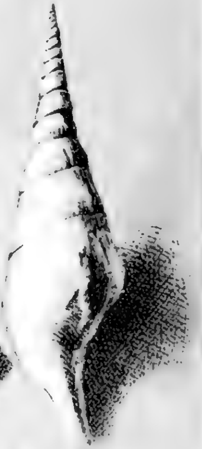

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Chromo Lith by L. N. Rosenthal Phil.

JACKSON TERTIARY SHELLS

[Geol. Miss.: Wailes, p. 289]

Fossil Testacea of the Tertiary Green-sand Marl-bed of Jackson, Miss.
Determined and named by T. A. CONRAD, Esq.

BIVALVES.

Astarte. *Lamark.*
Astarte parilis. *Con.*

Cardita. *Brug.*
Cardita planicosta. *Lam.*
Cardita tetrica. *Con.*

Cardium. *Lin.*
Cardium Nicolleti. *Con.*

Corbula. *Brug.*
Corbula densata. *Con.*
Corbula bicarinata. *Con.*

Crassatella. *Lam.*
Crassatella flexura. *Con.*

Glossus. *Poli.*
Glossus filosus. *Con.*

Leda. *Schum.*
Leda multilineata. *Con.*

Meretrix. *Lam.*
Meretrix profunda. *Con.*

Navicula. *Blain.*
Navicula aspersa. *Con.*

Ostrea. *Lin.*
Ostrea trigonalis. *Con.*

Pecten. *Lin.*
Pecten nuperum. *Con.*

MULTIVALVE.

Teredo. *Lin.*
Teredo Mississippiensis. *Con.*

UNIVALVES.

Architectonica. *Bolton.*
Architectonica bellastriata. *Con.*
Architectonica acuta. *Con.*

Capulus. *Mont.*
Capulus Americanus. *Con.*

Cypræa. *Lin.*
Cypræa fenestratis. *Con.*
Cypræa penguis. *Con.*

Conus. *Lin.*
Conus tortilus. *Con.*

Caricella. *Con.*
Caricella polita. *Con.*
Caricella subangulata. *Con.*

Clavalithes. *Swain.*
Clavelithes humerosus. *Con.*
Clavelithes varicosus. *Con.*
Clavelithes Mississippiensis. *Con.*

Gastridium. *Sow.*
Gastridium vetustum. *Con.*

Natica. *Adan.*
Natica permunda. *Con.*

Mitra. *Hump.*
Mitra Millingtoni. *Con.*
Mitra dumosa. *Con.*

Morio.
Morio Petersoni. *Con.*

Phorus. *Mont.*
Phorus reclusus. *Con.*

Rostellaria. *Lam.*
Rostellaria vellata. *Con.*
Rostellaria extenta. *Con.*

Scalaria. *Lam.*
Scalaria nassuta. *Con.*

Strepsidura. *Swain.*
Strepsidura dumosa. *Con.*

Trochita. *Schum.*
Trochita alta. *Con.*

Umbrella. *Lam.*
Umbrella planulata. *Con.*

Volutalithes. *Swain.*
Volutalithes dumosa. *Con.*
Volutalithes symmetrica. *Con.*

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U. S. A.

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A Group of Pennsylvanian Crinoids from the Vicinity of Bartlesville, Oklahoma

By

HARRELL L. STRIMPLE

July 28, 1939

PALEONTOLOGICAL RESEARCH INSTITUTION
Ithaca, New York
U. S. A.

A GROUP OF PENNSYLVANIAN CRINOIDS FROM THE VICINITY OF BARTLESVILLE, OKLAHOMA

By

HARRELL L. STRIMPLE

Considerable careful comparison and study together with consistent collecting will be necessary before the full scope and various manifestations of Pennsylvanian crinoids will be known. A few are presented herein as follows:—

Of the Flexibilia—

Amphicrinus oklahomaënsis, n. sp., is apparently the first complete specimen of this genus to be figured from North America. A distinct form from Wayside, Kansas is described as *Amphicrinus poundi,* n. sp. With *Cibolocrinus robustus,* n. sp., we have our first definite knowledge of the flexible arms of this and allied genera.

Of the Inadunata—

Delocrinus nodosarius, n. sp., is a robust representative of this genus having strong nodes developed, *Delocrinus tumidus,* n. sp., a small representative having tumid plates and depressions at the upper apex of BB and the lower apex of RR, as well as a vertical facet below the ligamental furrow. *Moundocrinus osagensis,* n. g., n. sp., represents a new form with prominently protruded posterior side and articular facets no wider than normal thickness of RR. *Pentadelocrinus typus,* n. g., n. sp., is a new form similar to *Delocrinus* save in the possession of a pentagonal stem and a different type anal X. *Graphiocrinus stantonensis,* n. sp., is distinct mainly in the full bowl-shape. *Euerisocrinus waysidensis,* n. g., n. sp., is a form with an anal plate within the cup yet very close to *Erisocrinus typus*. *Ethelocrinus convexus,* n. sp., is quite distinct from all other known species in the possession of IBB visible from side view, having a shallow convex base. *Hydreionocrinus deweyensis,* n. sp., is distinct in being the only known species having a cup similar to the genotype, *H. woodianus*. *Decadocrinus regularis,* n. sp., is a small, distinct, little known form in the locale under consideration. *Melbacrinus americanus,* n. g., n. sp., is a distinct small turbinate cup form with anal arrangement as in *Hydriocrinus* but differing mainly in the branching of the arms and possession of a round stem. *Agassizocrinus mcguirei,* n. sp., is a distinct species based on the IBB cone, being the second species observed above the Morrow subseries. *Lecythiocrinus ollicuæformis* and *Lecythiocrinus adamsi* are included merely to figure the well nigh perfect calices found in this locale and give a more comprehensive view of these unusual forms. *Lecythiocrinus urnæformis,* n. sp., is a distinct new form.

It is with considerable pleasure that I acknowledge the excellent collecting and assistance of my wife, Mrs. Melba Strimple. Dr. R. S. Bassler of the U. S. National Museum, and Dr. Edwin Kirk of the U. S. Geological Survey have been kind enough to favor me with much technical information and advice.

All specimens figured herein were collected by Mrs. Melba Strimple, or the author, save that described as *Amphicrinus poundi,* n. sp., which was collected by our friends and occasional fellow collectors, Mr. and Mrs. R. I. Pound of Bartlesville, Oklahoma.

Family **ICHTHYOCRINIDÆ** Angelin
(Emend. Wachsmuth and Springer)

Genus **AMPHICRINUS** Springer

Amphicrinus oklahomaënsis, n. sp. Plate 1, figs. 1, 2

Calyx shallow expanding rapidly, some 60 mm. from axial canal to tips of arms. Proximal columnals in place but usual structure is apparent with BB and part of RR in columnar scar, post. B extending out of basal circlet, RR large heptagonal save those two which are posterior being hexagonal. IBr^1 large, hexagonal or pentagonal, wider than high. IBr^2 hexagonal or pentagonal, axillary, wider than RR. IIBr^1 hexagonal or heptagonal, slightly wider than high. IIBr^2 hexagonal or pentagonal. IIBr^3 pentagonal to heptagonal, axillary. IIIBr are hexagonal to quadrangular branching on fifth or sixth plate, following inner ray comprised of some 12 plates tapering to tip with no further branching, outer ray branching again on $IVBr^6$ or $IVBr^5$, inner ray following tapering to tip, outer ray branching again on fifth or sixth brachial following, further branching unobserved. It is to be noted that the outer rays expand strongly toward ends. iBr^1 hexagonal, that of the anterior slightly larger than the others, all followed by a double row of plates, some thirteen to the interradii save the anterior which has nineteen observed. $iIIBr^1$ normally pentagonal followed by axillary plate and then a double row of small irregular plates, some seven in all. Anal X pentagonal, axillary, not quite as large as normal iBr^1 following supplementary plates two, hexagonal, followed by two single plates the first pentagonal, the second hexagonal and supporting obliquely to the left a small pentagonal plate, solidly above a large hexagonal plate, five plates of similar structure and placement are observed above. Plates smooth, rather thin and undecorated. Proximal columnals very thin.

This species is easily distinguished from *A. scoticus* Springer in that it has a double row of anal plates whereas *A. scoticus* has a single row. Of *A. carbonarius* Springer we have only the arms of the poorly preserved holotype and those cups referred to the species by Laudon (1937). The arms of the holotype taper evenly to the tips whereas in the form at hand there is a noticable swelling distally. Of the cups figured by Laudon, anal X is followed by two single plates the third being axillary, whereas in the form at hand the anal X is axillary with the following plates following a distinctly different pattern.

Occurrence and horizon.—Stanton limestone member, Ochelata group, Pennsylvanian. The mound just west of the city limits of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Amphicrinus poundi, n. sp. Plate 2, figs. 18, 19

Cup low rapidly expanding, 5 mm. high by 10.4 mm. wide at IBr^1. Columnar depression is occupied by the diminutive IBB and rather large BB, with the BB developed as a rim externally so that the RR never enter the basal circlet. The sutures of IBB are rather indistinct but apparently five tiny pentagonal plates are present. BB five large pentagonal plates extending very slightly out of basal depression save for post. B which is elongated and truncated for the reception of anal X. RR five large heptagonal plates save for those two posterior which are hexagonal. IBr^1 quadrangular wider than high. iBr^1 hexagonal, rather large, followed by double row of very small plates. Anal X axillary, rather elongated, heptagonal being comparable in size to iBr^1, followed by two very small plates.

This species differs from *A. scoticus* and those forms referred to *A. carbonarius* by Laudon in that the anal X of *A. poundi* is axillary. In *A. oklahomaënsis* the anal X is axillary but is pentagonal and smaller than iBr^1, wherein *A. poundi* is elongated heptagonal. Also in the present species the RR do not enter the basal depression.

We are indebted to Mr. and Mrs. R. I. Pound of Bartlesville, Oklahoma for the figured specimen of this species which takes their name.

Occurrence and horizon.—Stanton limestone member, Missouri series, Pennsylvanian, near Wayside, Kansas.

Type.—Springer Collection of the U. S. National Museum.

Order **FLEXIBILIA** Zittel

Suborder **SAGENOCRINOIDEA** Wachsmuth and Springer

Family **LECANOCRINIDÆ** Springer

Genus **CIBOLOCRINUS** Weller, (Emend. Moore and Plummer)

The genus was established to include Permian forms from Texas with 3 IBB and one anal plate within the cup, with *Cibolocrinus typus* Weller as the genotype. Moore and Plummer (1938) restricted the genus to those forms having low cup-shaped calices with the IBB not visible from side view, the RR having narrow articular facets that are not appreciably wider than the normal thickness of the RR, and with the stem impression round and slightly depressed. The range of the genus was taken into the Morrow subseries of the Pennsylvanian. From the Ochelata group (upper middle Pennsylvanian) now comes a species herein described as *Cibolocrinus robustus,* n. sp.

Cibolocrinus robustus, n. sp. Plate 1, figs. 3, 4

Cup loosely bowl-shaped; base somewhat flattened, diam. of holotype 18 mm.; height 9 mm.; plates very gently bulbous, tendency for posterior side to protrude. IBB disk has a diameter of some 7 mm. of which the sharply depressed round stem impression occupies some 5.5 mm., same being 1 mm. deep. IBB 3, unequal elements, pentagonal, smallest r. post. in position. BB 5 equal hexagonal elements save that of the posterior which is broadly truncated for the reception of anal X, lower margins curved under slightly to form portion of basal area, length and width about equal. RR 5 equal pentagonal elements, those of the posterior losing a portion of their width to the anal X, about twice as wide as high, articular facets developed inward very slightly but decidedly so, at the interradial sutures the laterally developed muscle scars attain their maximum width making a shallow basin with the confluent scars of adjoining plates, to the fore is a rather strong cross ridge adjoined by sharp ligamental furrow. The cross ridge does not quite reach the interradial sutures leaving a small but sharp notch. Anal X rather large, heptagonal in outline, resting broadly on post. B, lower half within cup, upper half curving slightly inward and has a tendency to become very thin.

Of the arms only a portion is known. IBr^1 low covering entire width of RR, lower edges fitting snugly into interradial notches. IBr^2 low, axillary. Three secundibrachs observed with no further branching.

Surface of entire specimen covered by close spaced small to minute sharp granules.

Stem known only from a few thin, smashed proximal columnals. Stem impression in cup is not crenulated.

Tegmen unknown.

The species is quite distinct from other known forms.

Three good specimens have been observed, two with portions of the arms attached.

Occurrence and horizon.—Shales associated with the Stanton limestone member, Ochelata group, Pennsylvanian, at the mound just west of the city limits of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Order **INADUNATA** Wachsmuth and Springer
Suborder **FISTULATA** Wachsmuth and Springer
Family **POTERIOCRINITIDÆ** Bassler
Genus **DELOCRINUS** Miller and Gurley

This genus is well known and understood so that further discussion is not attempted. Two new species are described herein one as *Delocrinus nodosarius,* n. sp., the other as *Delocrinus tumidus,* n. sp.

Delocrinus nodosarius, n. sp. Plate 1, figs. 13, 14, 17

Calyx saucer-shaped, deeply invaginated base, measuring 21 mm. diam. by 9 mm. high; IBB 5, equal pentagonal elements limited to basal depression; BB 5, entering strongly into basal cavity, regular hexagonal elements save for post. B which is truncated for reception of anal X; RR 5, regular pentagonal elements, facets developed inward as horizontal shelves, shallow ligamental groove to the fore backed by strong crenulated cross ridge, shallow muscle scars developed laterally; anal X hexagonal slightly higher than wide, half in half out of cup, upper portion curved strongly inward, articular facet possessing shallow rounded groove encircled by sharp ridge; IBr^1 axillary, small spine developed at apex but not affecting balance of plate to any great extent. All observed plates covered by thin, small, sharp and closely spaced protuberances with occasional large nodes appearing particularly in distal portions of cup.

Tegmen unknown.

Relationship.—The species is very close to *D. hemisphericus* from which it differs in having strongly nodular surface and different type of spine development of the IBr^1.

Occurrence and horizon.—Figured specimens from those shales associated with the Stanton limestone member, Ochelata group, Pennsylvanian, the mound just west of the city limits of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Delocrinus tumidus, n. sp. Plate 2, figs. 1-8

Calyx saucer-shaped with invaginated base, measuring from 7 mm. to 11 mm. diameter by 3 mm. to 4 mm. height in observed specimens; IBB 5, pentagonal regular elements limited to funnel-shaped basal concavity; BB 5, hexagonal regular elements save for post. B which is truncated for the reception of anal X, tumid plates; RR 5, equal pentagonal elements, very tumid in distal portion where more or less vertical facets are developed, articular facets developed strongly inward as horizonal shelves, ligamental furrows backed by sharp cross ridge, shallow muscle scars developed laterally; anal X hexagonal, slightly longer than wide, normally half in half out of cup, followed by single azygous plate, articular facet with shallow rounded depression encircled by sharp ridge; IBr[1] axillary, height and width about equal, being strongly tumid to slight projections as spines in region just below apex. Plates of cup devoid of ornamentation, sutures slightly depressed, small area about lower apex of RR and upper apex of BB sharply depressed.

Growth stages.—Immature calices do not differ greatly from those more fully developed save in the greater tumidity of BB and RR.

Relationship.—This species is no doubt closely related to *D. hemisphericus* from which it is distinguishable in the smaller, shallower cup, particularly in the tumidity of the RR and BB with the sharply depressed areas at the upper apex of BB and lower apex of RR, and the vertical facets just below ligamental furrows of RR.

Occurrence and horizon.—Figured specimens from the Stanton limestone member, Ochelata group, Pennsylvanian, the mound just west of the city limits of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Genus **MOUNDOCRINUS**, n. g.

Genotype.—*Moundocrinus osagensis*, n. sp.

The unusual protrusion of posterior side, large nonaxillary anal X, articular facets no wider than the normal thickness of the RR, more or less flattened base, five IBB, BB, and RR, and round stem distinguishes this form from any known genus.

Certain manifestations of *Cibolocrinus* are similar but in that genus there are only three IBB, and the columnar scar is slightly but sharply depressed, usually comparatively large. The form at hand has a small columnar scar with the sides sloping inward and is sharply crenulated which is more in keeping with the Inadunata than the Flexibilia.

Among the Inadunata *Euerisocrinus* is quite similar in some respects, but is close to *Erisocrinus,* having wide horizontal articular facets and lacking the protrusion of the posterior side found in the form at hand. It is doubtful that they are even remotely related.

Occurrence and horizon.—Pennsylvanian of North America.

Moundocrinus osagensis, n. sp. Plate 1, figs. 5, 6, 10

Calyx irregular outline, anterior side curving evenly upward but posterior side sloping upward at a forty-five degree angle, diam. 21.5 mm., height 9.0 mm., basal area flattened. IBB disk measures 8.0 mm. across, of which the round columnar scar occupies 3.5 mm., depression sloping gently inward and is pierced by minute round axial canal, the circumference being sharply crenulated. IBB 5, small equal pentagonal elements; BB 5, large equal hexagonal elements, save that of the posterior which is truncated for the reception of the anal X, lower extremities curved under to form part of basal area; RR 5, large equal pentagonal elements and since the posterior side is protruded those of the posterior do not lose any of their width to the large anal X, articular facets no wider than the normal thickness of the plates, outwardly a strong ligamental furrow adjoined by sharp cross ridge, muscle area slopes inward evenly divided by a narrow groove, that area adjoining the cross ridge is backed by small leaf-shaped, low protuberances which join at the groove and in turn possess shallow muscle depressions, the main muscle area is backed at the inward and lateral extremities by a low ridge, the notch developed at the outer extremity of the interradial suture expands inward to form shallow confluent depressions; anal X large hexagonal, resting broadly on post. B, extending only slightly above upper extremity of RR.

Plates of cup smooth, only slight depression of sutures, rather thick plates.

Arms and tegmen unknown. Stem unknown save for columnar scar which is small, round and crenulated.

Occurrence and horizon.—Stanton limestone member, Ochelata group, Pennsylvanian, the mound just west of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. Museum.

Genus **PENTADELOCRINUS**, n. g.

Genotype.—*Pentadelocrinus typus*, n. sp.

The form here under consideration is comparable to *Delocrinus* in having a funnel-shaped basal concavity, wide articular facets, a single anal plate within the calyx, and the same general appearance, differing mainly in having a pentagonal stem and the anal X being axillary and similar to those found in *Cibolocrinus* and associated genera. *Parasaplocrinus* Moore and Plummer is quite close but has only 3 IBB and a round stem. There is a strong possibility that the present form will eventually find its way to the Lecanocrinidæ but for the present is assigned to the Inadunata.

Occurrence and horizon.—Pennsylvanian of North America.

Pentadelocrinus typus, n. sp. Plate 1, figs. 7, 8, 9

Cup low saucer-shaped, measuring 20 mm. diam. by 6.5 mm. high, strongly invaginated base. IBB 5, small equal pentagonal elements entirely within basal cavity. BB 5, large equal hexagonal elements save that the posterior which is truncated for the reception of anal X, proximal portion curved under to participate in basal concavity. BB 5, large equal pentagonal elements, those two of the posterior losing some of their width to the rather large anal X, almost twice as wide as high, left lateral side of r. post. R 0.5 mm. longer than normal, right lateral side of l. post. R 0.5 mm. shorter than normal. Articular facets developed strongly inward as horizontal shelves, slanting slightly inward, sharp ligamental furrow, larger than usual, to the fore adjoined by cross ridge, inner edge strongly notched by ambulacral furrow ending just back of the cross ridge with a minute circular opening, muscle scars very shallow, developing broadly laterally until stopped by a low ridge just short of interradial sutures, which are in turn depressed and widen slightly inward. Anal X rather large, heptagonal, lower extremity 4.0 mm. wide; 6.5 mm. greatest width; 6.1 high; right lateral side measuring 4.2 mm. left lateral side 3.1 mm.; right upper edge 3.6 mm.; left upper edge 2.2 mm. These measurements are given to show the unusual shape and ensuing effect on adjoining plates. Upper facets are developed inward and are strongly crenulated to the fore. Several plates which have fallen into the cup cavity indicate through measurements and comparison, that they are azygous. These plates are low and broad, strongly rounded, and inwardly notched by ambulacral-like grooves, as is also the upper facets of anal X.

Stem unknown save for columnar scar, same being strongly pentagonal and pierced by minute round axial canal.

Arm and tegmen unknown.

Occurrence and horizon.—Stanton limestone member, Ochelata group, Pennsylvanian, from road cut 3 miles due west of Ramona, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Genus **GRAPHIOCRINUS** de Koninck

Graphiocrinus stantonensis, n. sp. Plate 2, figs. 11, 12

Cup full, bowl-shaped, basal area mildly convex, diam. 9 mm. by 4 mm. high. IBB disk occupied in the main by sharply depressed columnar scar, which is round heavily crenulated and pierced by minute axial canal, IBB 5 small pentagonal elements. BB 5 rather large hexagonal plates, post. B differing in being truncated for reception of anal X. RR 5 pentagonal elements. Anal X hexagonal, protruding well out of cup, followed by single unobserved azygous plate. Articular facets of RR developed inward as horizontal shelves, strong ligamental furrow to the fore backed by cross ridge, pronounced ambulacral groove, shallow muscle scars developed laterally and divided by shallow, small perpendicular groove.

A specimen with the IBr^1 attached has been observed but is not figured herein because it is not well enough preserved. IBr^1 axillary, slightly elongated, mildly constricted laterally in median portion, quite similar to that found in *G. carbonarius.*

Plates of cup very mildly tumid, fine granular appearance in some instances; balance of arms, tegmen and stem unknown.

Relationship.—The only stratigraphically associated species known is *G. carbonarius* (Meek and Worthen) which is quite distinct in having the anal X axillary, IBB restricted to depressed area, and strong protuberances at the interradial sutures of the articular facets. The plates of the cup are also more tumid in *G. carbonarius.*

Occurrence and horizon.—Stanton limestone member, Missouri series, Pennsylvanian, near Wayside, Kansas.

Type.—Springer Collection of the U. S. National Museum.

Genus **EUERISOCRINUS**, n. g.

Genotype.—*Euerisocrinus waysidensis*, n. sp.

This form is close to *Erisocrinus* specifically *E. typus* differing only in the possession of a single anal plate within the cup. Unfortunately only a single complete cup has been observed to date, however, portions of cups and fragments bear out the conclusion that this form is distinct. The specimen at hand does not have the anal X resting on the post. B, but same has migrated a short distance distally, however, the genus is intended to include those forms having the anal X well established within the cup and the cup being high, slow steady expansion, a flattened base, and round stem.

Occurrence and horizon.—Pennsylvanian of North America.

Euerisocrinus waysidensis, n. sp. Plate 2, figs. 14-16

Cup high, slow expanding, height 6 mm., diam. 8 mm., flattened base, IBB not visible from side view. IBB small pentagonal plates occupying a sharp depression in the center of the flattened basal area, BB 5 large hexagonal plates, lower extremities curved under to participate in flattened base. RR 5 pentagonal plates save those two of the posterior which are hexagonal by virtue of closing behind the anal X, articular facets developed inward as horizontal shelves, notched to the fore by ligamental groove which is adjoined by sharp cross ridge, muscle scars developed laterally, ambulacral groove prominent. Anal X pentagonal, rather large, resting well within the cup with distal portion only protruding.

Relationship.—This form is close to, and no doubt the predecessor of, *E. typus* from which it differs only in having a single anal plate well within the cup and possibly being a little higher than the normal representative of that species.

Occurrence and horizon.—Stanton limestone member, Missouri series, Pennsylvanian, near Wayside, Kansas.

Type.—Springer Collection of the U. S. National Museum.

Genus **ETHELOCRINUS** Kirk

Ethelocrinus convexus, n. sp. Plate 1, figs. 11, 12, 15, 16

Cup broad, bowl-shaped, IBB disk shallow, convex, saucer-shaped, visible from side view, young figured specimen 12 mm.

wide by 9.2 high, mature specimen approximately 29 mm. wide by 12 mm. high. Median portion of IBB disk is slightly depressed and occupied by the proximal columnal which is smaller in diameter. IBB 5 large pentagonal elements. BB 5 large hexagonal elements, gently tumid, that of the posterior being truncated for the reception of anal X and together with the r. post. R carries the radianal. RR 5 regular pentagonal elements, slightly tumid, that of the r. post. encroached on by the radianal, articular facets developed inward as horizontal shelves, very pronounced ligamental furrow to the fore adjoined by sharp cross ridge, shallow muscle scars developed laterally. Anal X elongated, heptagonal, approximately one-fourth extending out of cup and followed by two unobserved azygous plates, measuring in smaller specimen 4 mm. high by 1.5 mm. wide, large specimen 9.6 mm. high by 6 mm. wide. Radianal placed obliquely resting on post. B and supported by r. post. B, quadrangular loaf-shaped. No ornamentation, plates thick.

Of the arms our knowledge is limited to IBr^2 of the l. post. and r. ant., 10 cuneiform arms indicated. IBr^1 axillary, height and width about equal, mildly constricted laterally in median portion.

Of the stem we have only the proximal columnal, same being round, small, heavily crenulated, and pierced by minute round axial canal.

Tegmen unknown.

Relationship.—This species is close to *E. plattsburgensis* Strimple which species however, has a concave basal area.

Occurrence and horizon.—Stanton limestone member, Ochelata group, Pennsylvanian, the mound just west of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Genus **HYDREIONOCRINUS** de Koninck
(Emend. Moore and Plummer)

Whereas *Hydreionocrinus* and allied genera are quite prolific in these formations, considerable more research will be necessary for their proper handling. Moore and Plummer (1938) restricted *Hydreionocrinus* to those forms having the IBB visible from side view with the notation that no forms from North America con-formed in that respect, taking into consideration also the arm structure. Although the arms are unknown there is at hand a cup with the IBB visible from the side, same being presented herein as *Hydreionocrinus deweyensis,* n. sp.

Hydreionocrinus deweyensis, n. sp. Plate 2, figs. 13, 17

Cup low, widely expanded, with the IBB visible from side view, measuring 9.5 mm. diam. by 3.9 mm. high. IBB 5 small pentagonal elements, distal portions curved under to form flattened area occupied by small columnar scar, same area being round, heavily crenulated, and pierced by minute round axial canal. BB 5 rather large hexagonal plates save for the post. B which is truncated for the reception of anal X and together with r. post. B assists in the support of the radianal. RR 5 equal pentagonal elements, slightly wider than high, those adjoining the anal series losing some of of their width, facets developed inward as horizontal shelves, notched to the fore by a short ligamental furrow which is adjoined by sharp cross ridge, shallow muscle scars developed laterally and ambulacral groove pronounced. Anal series composed of three plates within the cup, anal X hexagonal, slightly elongated, resting solidly on post. B, distal portion extending out of cup, radianal rather large, slightly elongated, pentagonal, placed obliquely on post. B, supported by r. post. B, assisting in the support of anal X, and supporting the small right tube plate, which is missing.

Arms, tegmen and stem unknown.

Cup covered by irregular, wide spaced, minute spinelike nodes, entire surface rough.

Relationship.—The only known form comparable with this species is the genotype, *H. woodianus* de Koninck from the Scottish Carboniferous, which although larger has the same general appearing calyx.

Occurrence and horizon.—Dewey limestone, Pennsylvanian, Dewey Portland Cement Quarry, Dewey, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Genus **DECADOCRINUS** Wachsmuth and Springer

Of this genus a single representative has been observed in the specimens at hand, same proving distinct and is described herein as *Decadocrinus regularis,* n. sp.

Decadocrinus regularis, n. sp. Plate 2, figs. 20, 21

A small species, cup evenly expanded, very small basal area rather flattened, diam. of cup 4.3 mm., height 2 mm. IBB 5 small pentagonal plates. BB 5 large hexagonal elements save that of the posterior which is truncated for the reception of anal X and together with r. post. B supports the radianal, lower extremities slightly entering basal area. RR five, not so large as BB, pentagonal equal elements save where encroached on by anal series, facets developed inward as shelves but unobserved beyond the ligamental furrow. Anal series of three plates, anal X hexagonal, resting solidly on post. B, small, extending slightly out of cup, radianal elongo-pentagonal, resting obliquely on post. B, lower extremity supported by r. post. B, carrying above the small hexagonal right tube plate.

Arms ten to the IIBr^4, cuneiform, branching on IBr^1. IBr^1 elongated, median portion slightly constricted laterally. Brachials following slightly elongated, strongly rounded, median portions mildly constricted. Left and right anterior IBr^1, shorter than other three.

Stem unknown save for the columnar scar which is small, round, crenulated and pierced by minute round axial canal.

Tegmen unknown.

No ornamentation observed. Sutures of the cup very slightly depressed.

Relationship.—This species is readily distinguished from other known species of the genus and is considerably higher stratigraphically. It is comparable in size to those known.

Occurrence and horizon.—Stanton limestone formation, Ochelata group, Pennsylvanian, the mound just west of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Genus **MELBACRINUS**, n. g.

Genotype.—*Melbacrinus americanus*, n. sp.

There has appeared a very distinct form with a turbinate shaped cup and the anal series of three plates not extending above the upper extremity of the RR. *Hydriocrinus* Trautschold is immediately thought of but in that genus the stem is pentagonal and the branching of the arms different. It is with pleasure that I dedicate this genus to my wife, Mrs. Melba Strimple.

Occurrence and horizon.—Pennsylvanian of North America.

Melbacrinus americanus, n. sp. Plate 3, figs. 1-4

Cup high, turbinate-shaped, largest observed specimen approx. 5 mm. high by 4.5 mm. wide. Columnar scar round, circumference deeply crenulated, and pierced by minute round axial canal. IBB 5 pentagonal elements rising sharply above columnar area, higher than wide. BB 5 equal hexagonal elements save that of the posterior which supports the anal X above and the radianal to the right along with the post. B. RR 5 equal pentagonal elements, slightly wider than high . Radianal pentagonal, resting to the right on r. post. B to the left on post. B, assisting to the right in the support of r. post. R supporting above the right tube plate, and assisting to the left in support of anal X; anal X pentagonal; right tube plate quadrangular. The anal series do not appreciably extend above the upper margin of RR; anal X and rt forming a horizontal line.

The articular facets of RR are not appreciably produced inward, shallow muscle scars developed laterally, ligamental notch to the fore very pronounced. The upper facets of the anal X and rt plate are similarly developed.

Of the arms we know the following: In the immature specimen the r. post. and l. post. IBr^1 are axillary, very elongate and narrow, l. post. IBr^1 is 4.4 mm. in length, r. post. IBr^1 3.5 mm. Ant. IBr^1 is elongated, 3.6 mm. in length, and followed by a single series of brachials. L. ant. IBr^1 and r. ant. IBr^1 are not axillary, measuring 1.7 mm. and 1.8 mm. respectively, the IBr^2 following being axillary and measure 2.1 mm. and 1.9 mm. in length respectively. A light raised ray extends the length of the brachials and is retained in the single IBr^1 preserved with the more mature specimen, same being l. post.

Relationship.—The closest known form is *Hydriocrinus pusillus* Trautschold which, however, has a pentagonal stem and the arms branch on the primibrachs of all rays.

Occurrence and horizon.—Stanton limestone member, Ochelata group, Pennsylvanian, the mound just west of the city limits of Bartlesville, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Genus AGASSIZOCRINUS Owen and Shumard

Whereas the practice of using fragmentary remains is to be discouraged, a distinct fused IBB cone of this genus is considered worthy of specific segregation. *Agassizocrinus mcguirei*, n. sp., is proposed, named for the so ardent collector, Mr. Paul McGuire of Fairfax, Oklahoma, who called attention to the location where this form occurs.

Agassizocrinus mcguirei, n. sp. Plate 2, figs. 9, 10

Fused narrow IBB cone measuring 8 mm. diam. by 8.2 mm. high, no evidence of sutures or stem attachment, expanding very slowly until approximating upper extremity where there is a sudden flare. This is quite different from any other known species. The only other known Pennsylvanian representative above the Morrow subseries is *A. tarri* Strimple, in which the cone expands evenly.

Occurrence and horizon.—A friable limestone associated with the Nellie Bly formation, just north of the city limits of Ramona, Oklahoma.

Type.—Springer Collection of the U. S. National Museum.

Family **CYATHOCRINIDÆ** Roemer

(Emend. Wachsmuth and Springer)

Genus **LECYTHIOCRINUS** White

As there are at hand well nigh perfect specimens of the only two previously known species *L. ollicuæformis* White and *L. adamsi* Worthen, same are figured herein to give a more adequate perspective of these unusual forms. From the Stanton limestone near Wayside, Kansas we have a new form, described herein as *Lecythiocrinus urnæformis*, n. sp.

Lecythiocrinus ollicuæformis White Plate 3, figs. 5-7

Lecythiocrinus ollicuæformis White, 1880, Proc. U. S. Nat. Mus., vol. II, p. 257; White, 1880, Geol. Survey of the Territories, p. 124, pl. 35, figs. 2a, b.

Lecythiocrinus ollicuæformis Wachsmuth and Springer, 1886, Rev. Paleo.; Part III, Acad. Nat. Sci. Phila., Proc., vol. 38, p. 152.

The species is now well established and known but the holotype was poorly preserved. Information derived from the well preserved specimens herein figured is thought interesting.

White noted only three IBB but anticipated five. There are usually three, occasionally five IBB in observed specimens. The peculiar rather large interradial aperture occuring entirely within the cup was no doubt obliterated in the holotype. Whether the small tubes observed emerging from the aperture perform some function of the animal or are foreign is necessarily a matter of conjecture. If the aperture was an anal opening, as seems quite probable, such as found in *Edapocrinus rugosus* Wright for example, one would expect either a smaller opening, covering plates, or a leathery peristome. There is no evidence of covering plates. With a leathery covering one would expect some attempt to place the anus at some distance from the calyx, which function could be performed by the tubes. Similar tubes hav been observed in *L. adamsi.*

Occurrence and horizon.—Holotype— Upper Coal Measure strata, "30 miles W. of Humbolt, Kansas." The type specimen is in the U. S. National Museum.

Figured specimen.—Dewey limestone, Pennsylvanian, Dewey Portland Cement Quarry, Dewey, Oklahoma. Specimen in the Springer Collection of the U. S. National Museum.

Lecythiocrinus adamsi Worthen Pl. 3, figs. 8-10

Lecythiocrinus Adamsi Worthen 1882, Ill. State Mus. Nat. Hist., Bull. I, p. 37; 1883, Geol. Rep. Ill., vol. VII, p. 317, pl. 30, fig. 8.

Lecythiocrinus Adamsi Wachsmuth and Springer, 1886, Rev. Paleo.: Part III, Acad. Nat. Sci. Phila., Proc., vol. 38, p. 152.

The specimen on which this species was based merely indicated the interradial aperture shown herein. In other respects the species was well described and illustrated, however, 5 IBB are shown by Worthen, and only three have been noted in specimens at hand.

Occurrence and horizon.—Holotype—about the horizon of Coal No. 8 of the Lower Coal Measures, Sec. 13-11N-6E, Peoria County.

Figured specimen.—Dewey limestone, Pennsylvanian, Dewey Portland Cement Quarry, Dewey, Oklahoma. Specimen is in the Springer Collection of the U. S. National Museum.

Lecythiocrinus urnæformis, n. sp. Plate 3, figs. 11-13

Calyx high, urn-shaped, with full base and constricted distal portion, diam. at upper extremity 5.9 mm., greatest width 7.9 mm., height 8.9 mm. IBB 5 small pentagonal plates, gently convex basal disk, columnar scar small, round, with heavy crenulations and pierced by minute round axial canal. BB 5 large hexagonal plates. RR 5 comparatively small pentagonal plates, facets not filling distal face of RR and slightly protruded. Fully within the cup and interradial in position is a small oval-shaped opening. The basal is mildly protruded just below the opening, and on all other BB at similar location. There is no evidence of covering plates.

Relationship.—This species is very close to *L. ollicuæformis* differing only in having comparatively greater height and the quite distinct urn-shape.

Occurrence and horizon.—Stanton limestone member, Missouri series, Pennsylvanian, near Wayside, Kansas.

Type.—Springer Collection of the U. S. National Museum.

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EXPLANATION OF PLATE 1 (27)*

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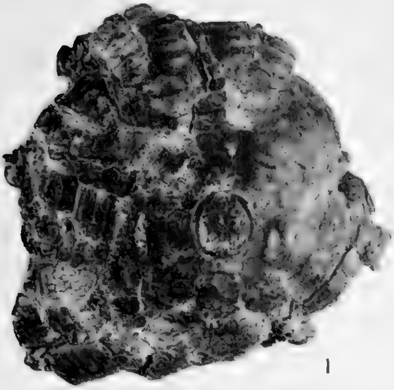
*(All Figures Natural Size)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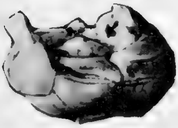
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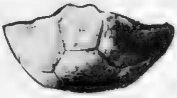
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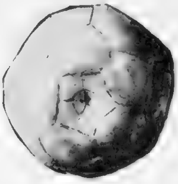
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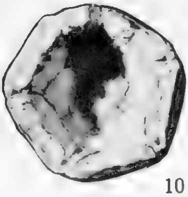
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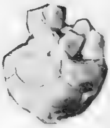
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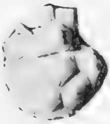
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EXPLANATION OF PLATE 2 (28)

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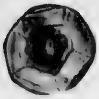
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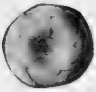
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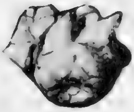
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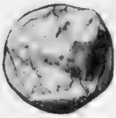
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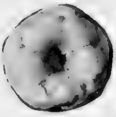
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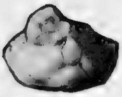
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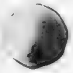
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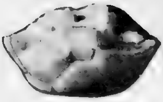
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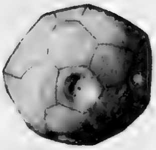
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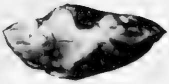
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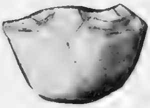
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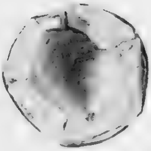
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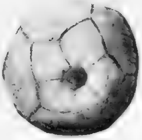
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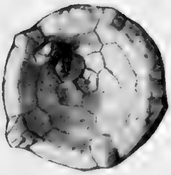
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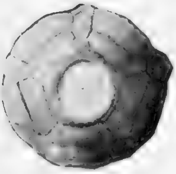
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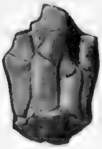
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EXPLANATION OF PLATE 3 (29)*

Figure Page

1-4. **Melbacrinus americanus,** n. g., n. sp. ---------- 17

Figs. 1 and 2, mature specimen; fig. 1, posterior view; fig. 2, anterior view; figs. 3 and 4, immature specimen; fig. 3, anterior view; fig. 4, posterior to the left. Stanton limestone, mound west of Bartlesville, Oklahoma.

5-7. **Lecythiocrinus ollicuæformis** White ---------- 18

Fig. 5, view showing interradial aperture; fig. 6, side view; fig. 7, view from below. Dewey limestone, Dewey, Oklahoma.

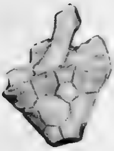
8-10. **Lecythiocrinus adamsi** Worthen ---------- 19

Fig. 8, view showing interradial aperture; fig. 9, side view; fig. 10, view from below. Dewey limestone, Dewey, Oklahoma.

11-13. **Lecythiocrinus urnæformis,** n. sp. ---------- 19

Fig. 11, view showing interradial aperture; fig. 12, view of anterior; fig. 13, view from below. Stanton limestone, Dewey, Oklahoma.

*(All Figures X 2)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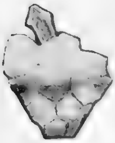
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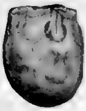
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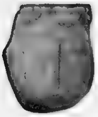
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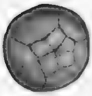
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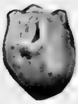
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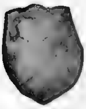
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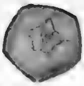
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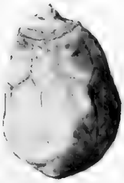
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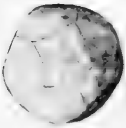
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